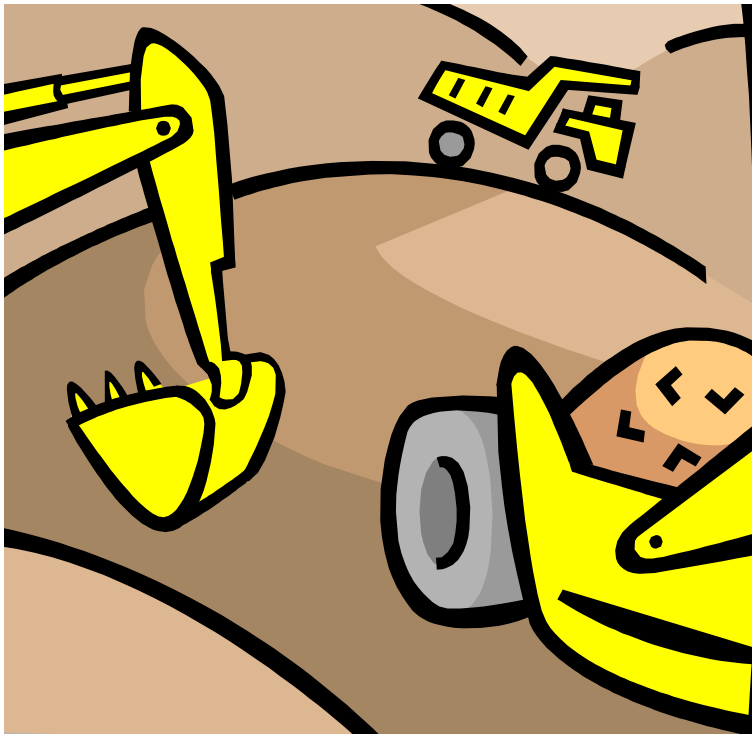


STUDY GUIDE
FOR
AGGREGATE CERTIFICATION

Revised: 05/02/2012

BASICS

OF

AGGREGATE CERTIFICATION

TABLE OF CONTENTS

SECTION I

INTRODUCTION

INTRODUCTION

This text is intended as a study guide for Quality Control/Quality Assurance of aggregates at the mining and processing facility. Webster defines quality control as "a system for ensuring maintenance of proper standards in manufactured goods by random inspection." For the purpose of the Georgia Producer Certification Program this is a good definition for Quality Assurance or "Certification Sampling." Quality control on the other hand is a much larger and more complex issue for which representative sampling, although absolutely essential, is only a part of the process. Excellence in quality control requires a team effort on behalf of everyone associated with the product from top management all the way through the mining, processing, handling, storage, and shipment of the aggregates.

This text is basic in nature and explains the purposes for sampling as they relate to production control versus sampling for certification of aggregates. It also provides general guidelines for determining when and where samples should be taken. It also includes a discussion of sampling devices, Standard Operating Procedure No. 1 (SOP 1), sampling procedures, specifications, test procedures, the Aggregate Rating System, policies regarding the reporting of certification test data and policies regarding the written exam.

SECTION II

COMMON SAMPLING DEVICES

SECTION II

Common Sampling Devices

Learning Objectives

In this section, the following learning objectives will be discussed:

- ✓ Identify the accepted devices for sampling aggregates
- ✓ Identify when to use each device

SQUARE POINTED SHOVEL

There hasn't been a device specifically designed to sample aggregates. However, a squared pointed shovel is the accepted standard for coarse aggregate. It should be used when taking samples to represent gradation. A round pointed shovel or a spade may be used to facilitate collecting a mass of material when representing the gradation isn't necessary. Although, all three of these devices distort gradation samples to the fine side, the square pointed shovel is the preferred tool for sampling products for gradation testing.

FINE AGGREGATE SAMPLING TUBE

A tube with an inside diameter of 2 inches (50 mm) to 3-1/2 inches (89 mm) and a minimum length of 30" (762 mm) should be used for sampling concrete sand.

COAL SCUTTLE BUCKET

A coal scuttle bucket or an approved alternate should be used to catch a cross sectional area of material being discharged from a conveyor belt. The narrow configuration of the opening of a coal bucket results in it being the most acceptable sampling device for this application that is readily available commercially.

SECTION III

SAMPLING FOR QUALITY CONTROL

SECTION III

Sampling for Quality Control

Learning Objectives

In this section, the following learning objectives will be discussed:

- ✓ Understand the two reasons for sampling
- ✓ Understand the three categories of locations where to sample
- ✓ Identify the different sampling locations
- ✓ Identify the proper method to sample Graded Aggregate Base
- ✓ Define Segregation, Contamination, and Degradation

WHY SAMPLE?

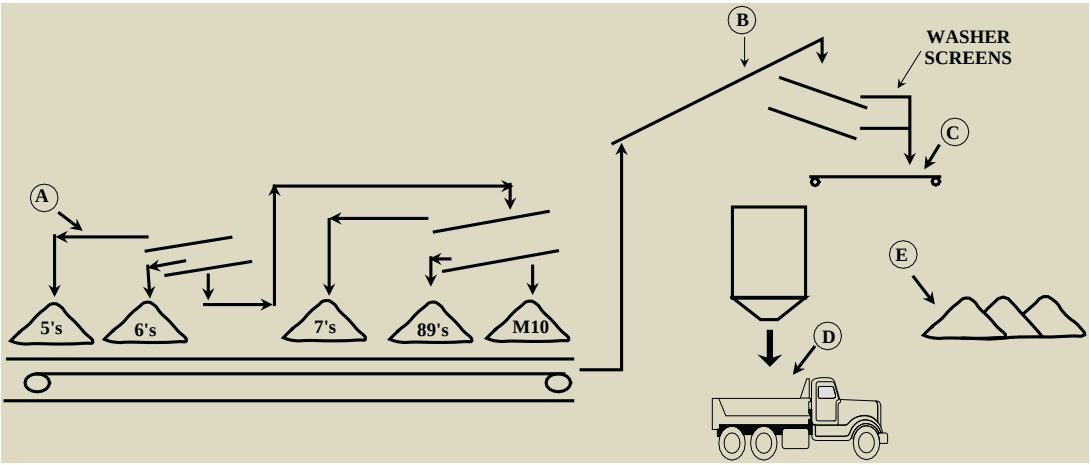
Samples are taken for two basic reasons.

One is to “control” product quality during the production and storage phase. Samples should be taken during production and the gradations adjusted and controlled based on the test results to allow for normal segregation and degradation that are expected to occur during further handling.

The second reason for sampling is to “verify” product quality during shipment. Provided the more complex issues of “control” have been properly addressed, the samples taken for verification of quality should be a simple matter of randomly taking representative samples during shipment and reporting the test results. These samples serve the purpose of quality assurance and for certification of product quality during shipment.

WHERE TO SAMPLE

There are three basic categories of locations where samples should be taken. Generally, samples should be taken at the point that is most representative of the product just after it is screened, just before it is stored and as it is shipped. Each has its purpose. Consider these examples:



Example No. 1

There is a gradation problem with No. 5 stone and screens have been changed to correct it. There are numerous points where the material could be sampled as indicated by the letters A, B, C, D, and E. For the purpose of evaluating the effect of the screen change samples should be taken from the conveyor belt at point A just after the material has been screened. Here the material can be sampled to precisely evaluate the effect of the screen change without degradation, contamination and segregation influencing test results and producing misleading data.

Example No. 2

Material is being shipped directly from the wash bin and certification samples need to be taken. Individual truck loads (point D) will vary due to normal segregation. The most representative sampling point to base any blend adjustment on and to represent the bulk of the delivered material would be from the belt at point C just after the material is washed and just before it enters the bin.

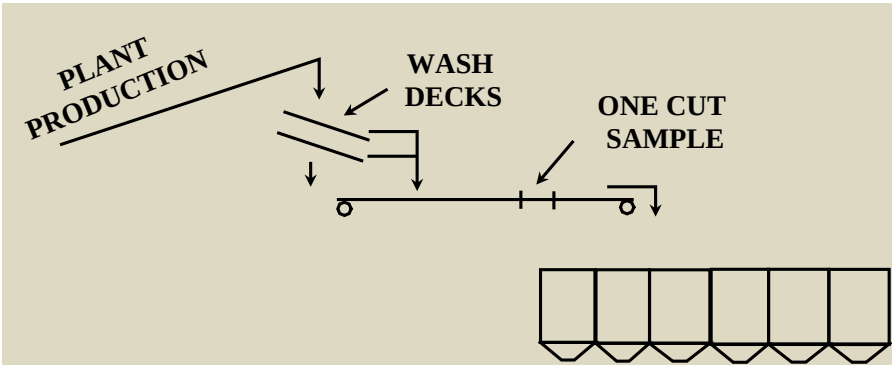
Example No. 3

Material is being stockpiled at point E for later shipment. For the same reasons indicated under Example No. 2, the belt samples at point C would be the best place to control the material that is going into the stockpile.

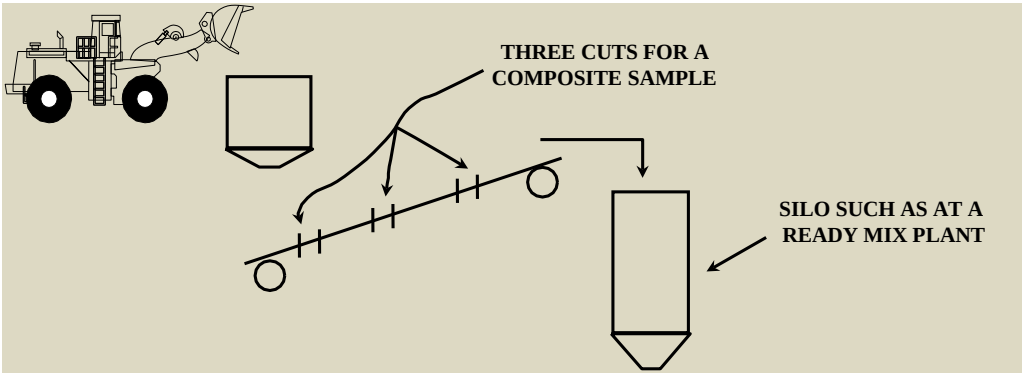
SAMPLING CONVEYOR BELTS

When sampling conveyors the following guidelines should be observed:

- For conveyors that are discharging current production, sampling a single cross section of it is considered acceptable.



- For conveyors discharging material from a loader or truck feed bin or hopper, segregation will influence results more so than the circumstances illustrated above. In this instance three cross sections of the conveyor should be sampled to produce a composite sample as shown below. Depending upon the length of the belt, the conveyor may have to be started and stopped three times in order to acquire a composite sample.



- All of the materials, including fines, should be removed from each of the cross sectional cuts.

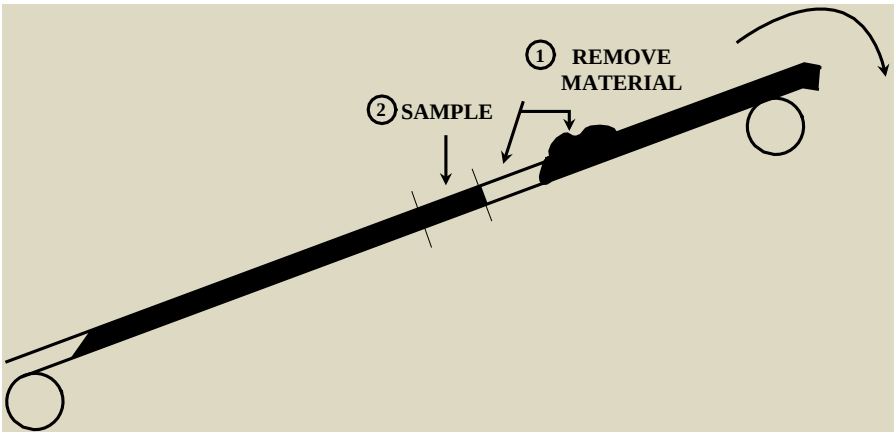
Now let's look at specifics for physically removing a sample from the belt.

STOPPED LEVEL BELTS

To sample a level stopped belt simply remove all of the material from a cross section.

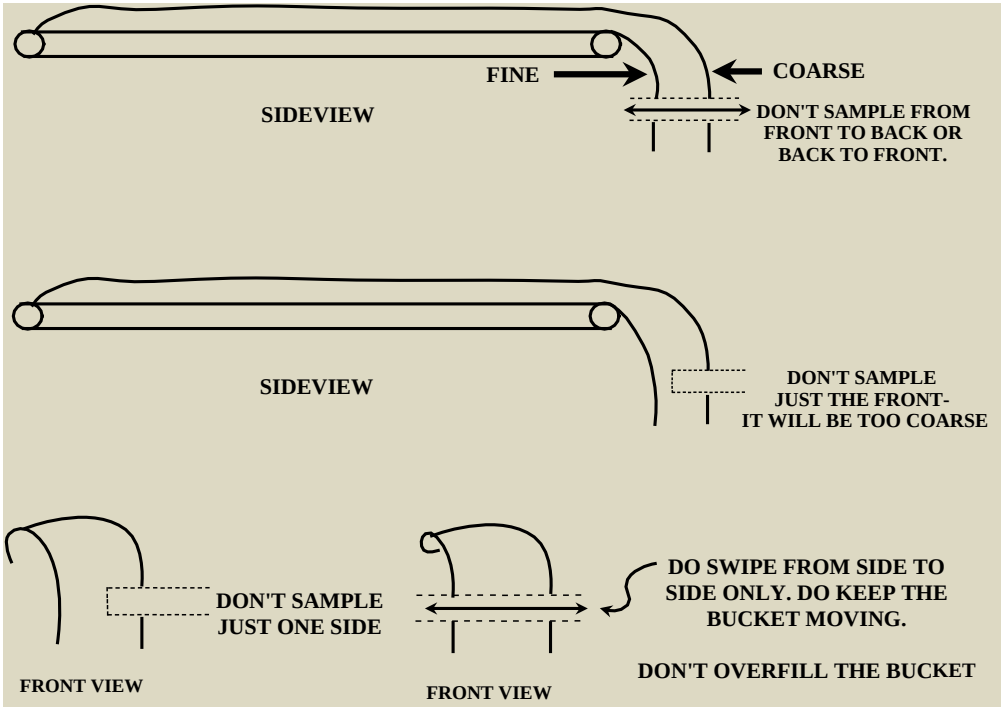
INCLINED STOPPED BELTS

To sample an inclined belt begin by moving material forward on the belt to create a sheer face for sampling at the downhill side of the cut. The sheer face at the downslope side of the cut can then be sampled with a minimum of segregated material rolling into the sample. Any particles that roll from the upper portion of the belt into the sampling area should be discarded.

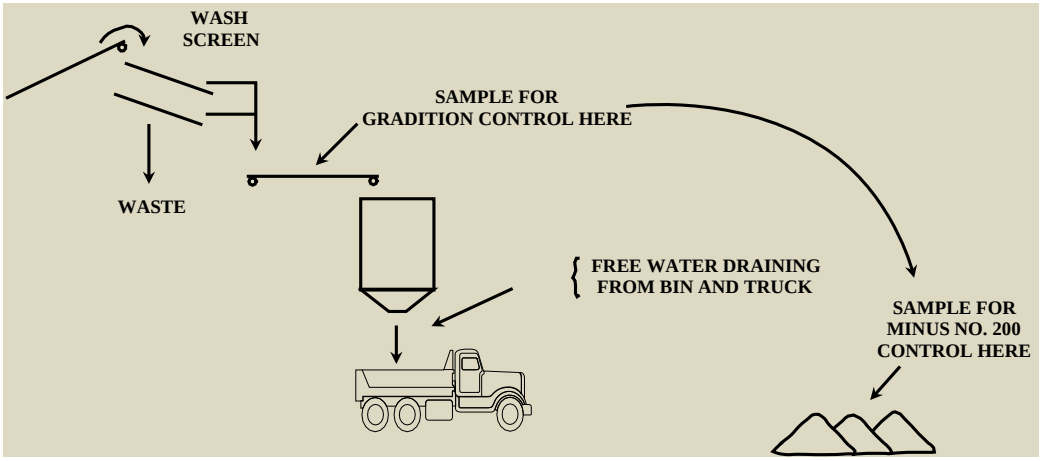


MOVING BELTS

Moving belts are sampled by moving a container through the flow of aggregate as it discharges from the belt. Materials on the belt are always segregated with the top portion typically being coarser than the bottom. Oftentimes, one side of the belt will also be coarser than the other due to the direction from which material was discharged onto the belt. Therefore, catching an entire cross section sample of the material being discharged from the belt is very important. It is also important that the sampling container be "swiped" all the way through the flow without stopping, slowing down or overfilling the container. Allowing any of these errors to occur will render the sample non-representative. The sketches shown below are intended to illustrate the Do's and Don'ts for sampling the discharge from a moving belt:



A WORD OF CAUTION ABOUT BELT SAMPLES: If free moisture is present, the sample should not be tested for minus No. 200 (75µm). This is because the fines are concentrated in the water and will drain off the shovel when the sample is taken. Samples for minus No. 200 (75µm) should be taken after free water has drained and the fines are more evenly distributed such as after the material has been stockpiled. A truck load of material discharged from a bin just after the material is washed is a good example of material that contains free water.



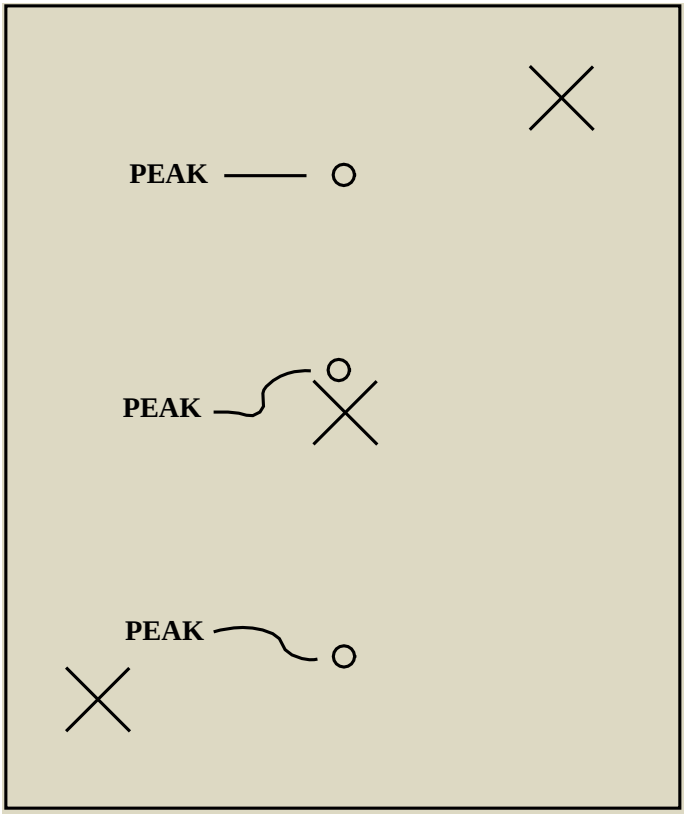
In this instance, a sample taken to represent minus No. 200 (75µm) would have to be taken after the material is stockpiled.

CAUTION: When materials containing free moisture are stockpiled the minus No. 200 (75 µm) material will drain inward with the water and concentrate within the load while the outside may appear to be clean. In this case it is important to establish a loading face wherein a mix of the material can be sampled after it has drained. The best control for minus No. 200 (75 µm) content in washed stone is a VISUAL inspection of the water and the material. The water supply should be clear and the stone should appear clean. Otherwise there is a production or handling problem that should be corrected.

SAMPLING TRUCKS OR RAILCARS

The same procedure is used to sample both trucks and rail cars. In many instances during load out from a bin a truck will begin loading at the front of the truck bed and pull up two more times before being completely loaded. This results in three conical shaped peaks. Depending upon the length of the truck and the bin configuration or the size of the loader being used to load the truck there may be only one peak. It really doesn't matter, the same principal that is applied to sampling three peaks can be applied to sampling just one peak.

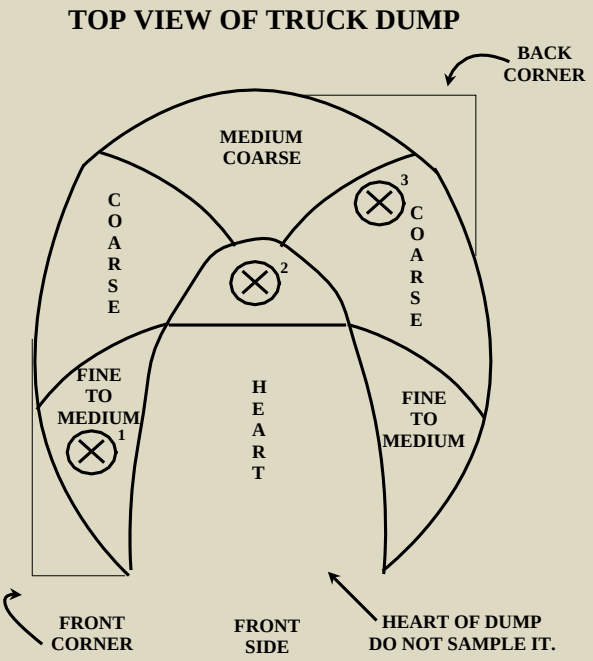
The X's indicate the points that should be sampled in a direction from one corner straight across to the opposite corner. Point 1 is situated about 1/3 the way between the front corner and the first peak in the load. Point 2 is at the top of one of the peaks just away from the extremely fine material that may be directly in the center of the peak. The third point is about 1/3 the distance from the back corner of the load to the peak. It is important that these three points be represented to produce a single composite sample.



TOP VIEW

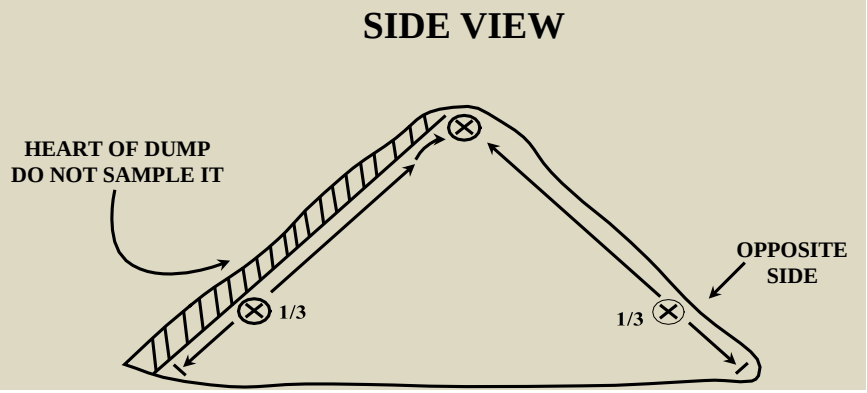
SAMPLING A SINGLE TRUCK DUMP

If sampling a single truck dump, use essentially the same pattern as for sampling a truck before it is dumped.



The X's indicate the points that should be sampled in a direction from a front corner straight across to the opposite back corner. The first point is of an intermediate gradation and situated about 1/3 the way between the front corner and the peak of the pile. The middle point is at the peak of the pile just behind and out of extremely fine material that is in the heart section. The last point is about 1/3 the distance from the back corner to the peak of the pile and is of a coarse gradation. It is important that these three points be represented to produce a single composite sample. Further illustration is shown in the side view on the next page.

Now let's look at a side view of the same dump. These are the same points shown in the top view and is intended to better illustrate where the shovel should be inserted. The 1/3 points that are shown on the sketch are referring to the distance from the bottom corner of the pile to the peak of the pile. This is not etched in stone. The idea is to get a shovel full that looks typical of the specific section being sampled.



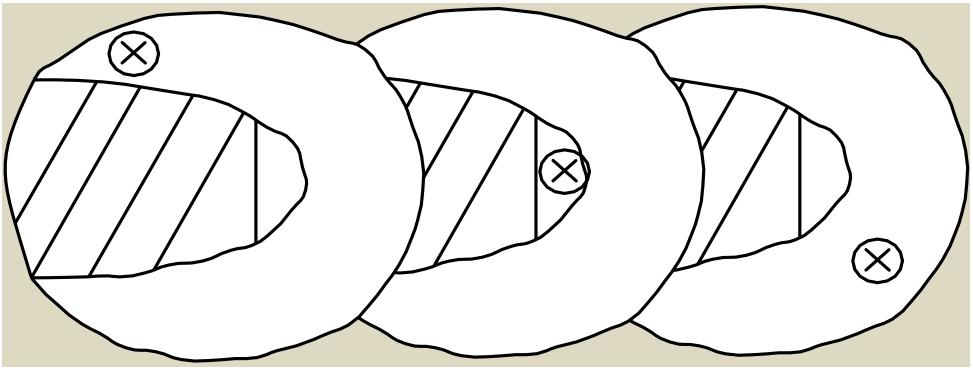
There are three things to remember about the actual shoveling of a sample from a stockpile:

1. Do not rake back or disturb the material before sampling. Sample it just like it is.
2. Push the shovel straight in at about 90° and as far as it will go.
3. Remove the shovel carefully to minimize spilling material off of the shovel blade. Material spilled off the shovel is coarser than that which is left on the shovel and distorts test results.

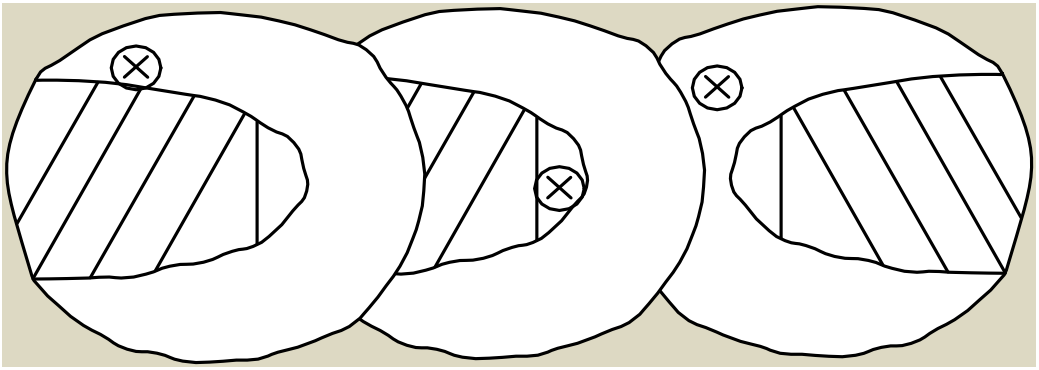
SAMPLING A STOCKPILE OF SINGLE LIFT TRUCK DUMPS

Now that sampling a single load has been discussed, let's look at how to apply this same pattern but use three loads instead of one to produce a composite sample.

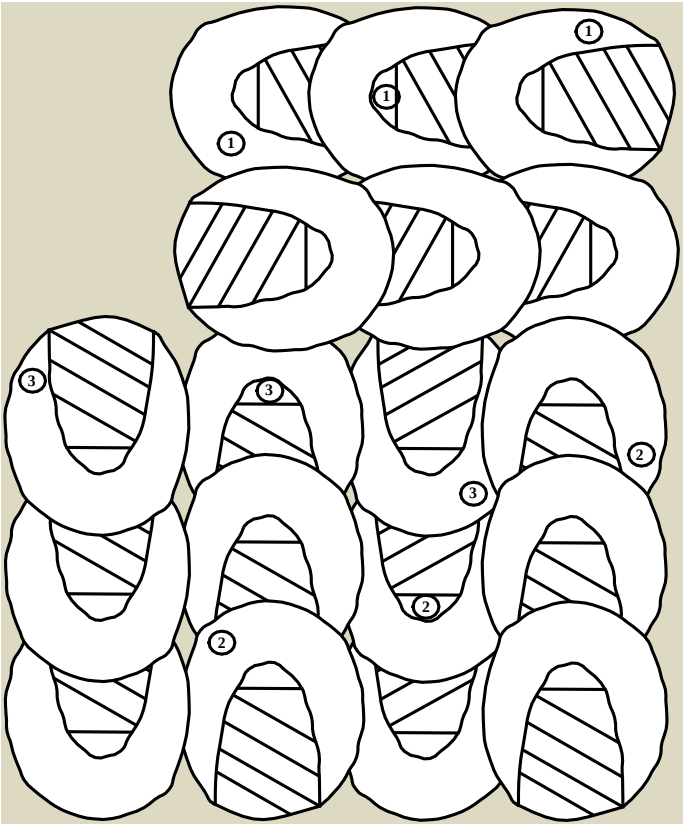
Looking at this sketch it is easy to see how this should be accomplished.



In the next sketch, one of the loads have been dumped from a different direction and it is a little more confusing to stick to the pattern.



Now it is a lot more difficult.



As shown in these illustrations the individual truck loads may vary in the direction from which they were dumped. It is very important to determine the direction so that you can follow the three point pattern to produce a representative composite sample. Depending upon how tightly the loads are dumped it may be impossible to determine the direction from which some loads were dumped. Unless there is a reason to single out a load, such as obvious contamination or the wrong size, sample only those piles where you can determine the direction of dumping. The circled numbers in the illustration are examples of points that would be used for composite samples. The same numbers would be combined for a sample and so on.

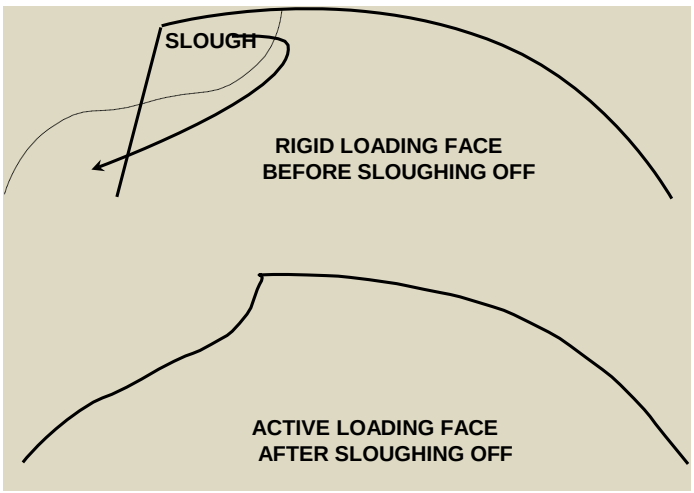
SAMPLING STOCKPILE LOADING FACES

GRADED AGGREGATE BASE

Graded aggregate should be sampled by the loader backdrag sampling procedure as shown below:

AREA TO BE SAMPLED

A typical active loading face should be sampled. If there isn't a loading face, remove enough material from the stockpile so that the entire face will slough downward to create a loading face.

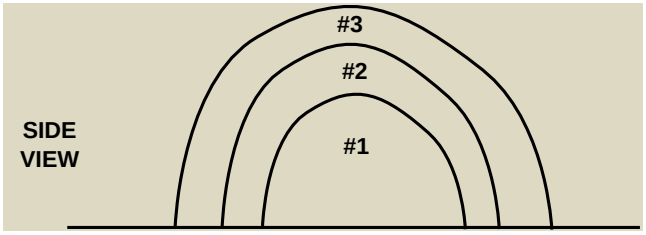


Sample Size

Typically, three loader buckets should be used.

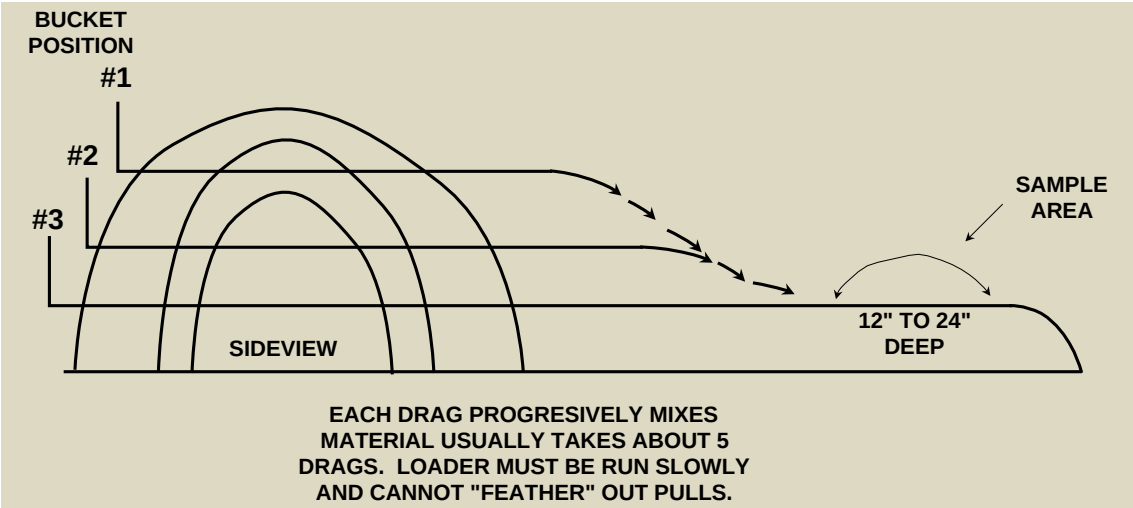
SAMPLE EXCAVATION

The loader that is used should not have teeth on the bucket. Each bucket load should be removed from the loading face in the same manner that represents loading a truck. The width of the area being sampled should be limited to no more than the width of two loader buckets and each of the three buckets should be poured one on top of the other as indicated in the sketch below.



Sample Preparation

The loader operator should reach across the sample, position the bucket at approximately 90° to the material, move the bucket downward to approximately 1/3 to ½ the height of the pile and drag through the material while backing up. The bucket should be maintained at a constant height during the back dragging process so that there will be a consistent depth of material upon completion of each drag. Care should be taken to not feather it out to a thin lift at the end of the drag.



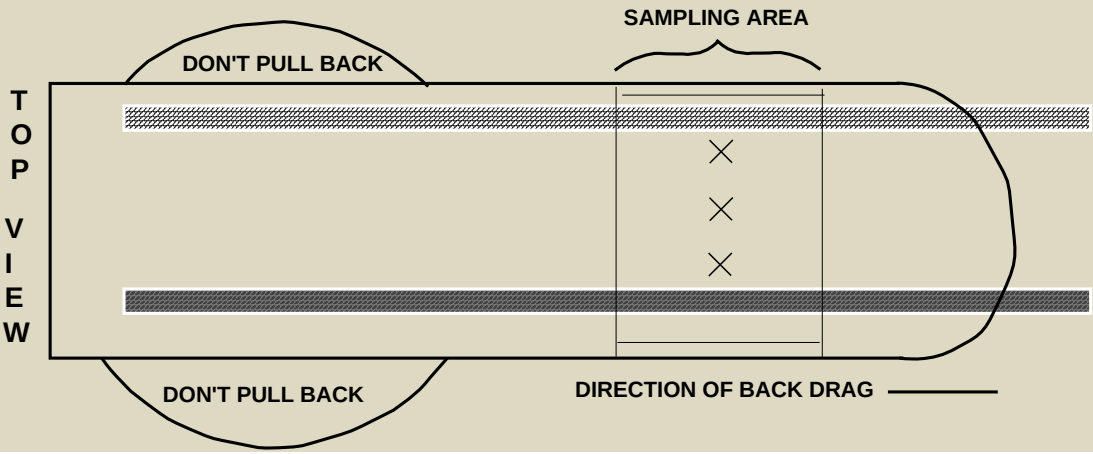
This process should continue, with minimum tracking onto the material until the pile has been flattened to a relatively uniform thickness of approximately 12” to 24”.

The loader should back drag through the center of the pile each pull. The bucket should also extend beyond the forward edge of the preceding pull each time.

Sampling

The sample should be taken from the back one-third of the back drag. This would be in the direction away from where the materials were originally dumped.

The sample shall be taken from three locations approximately equal distance from each other and the edges of the sampling area.



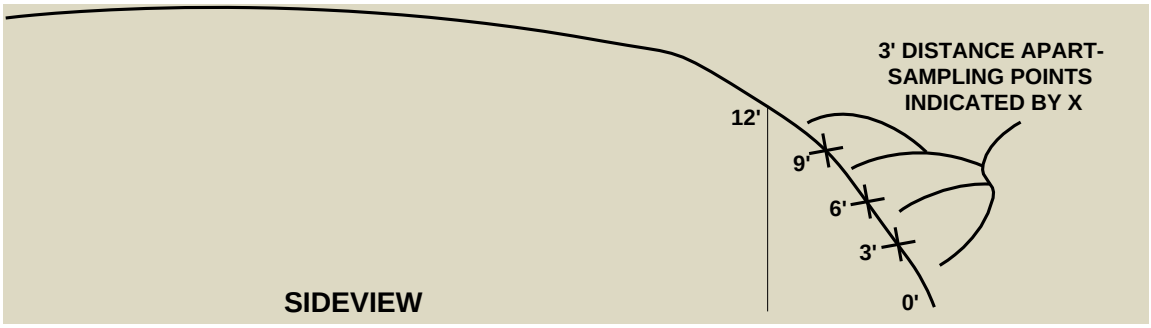
The shovel should be inserted at 90°, and pushed downward. The material should be extracted by pushing downward on the shovel blade before removing it from the back drag and emptying it into a container. Patting down helps to compact the material so that the larger particles don't roll off the shovel.

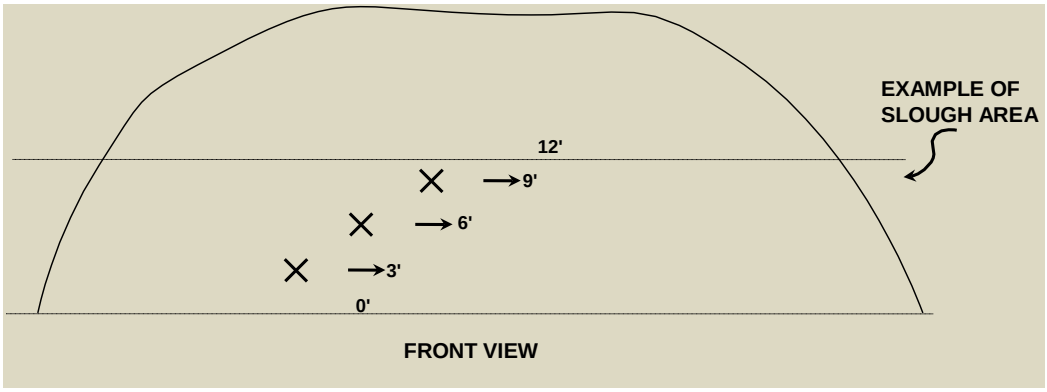
Care should be taken at each of the three sampling points to insure that the shovel is inserted to the same depth each time. Sampling in the loader tracks should be avoided because those areas will have become more densified than the other areas being sampled.

ALL OTHER AGGREGATES

All other aggregates should be sampled directly from the slough without the use of a loader. A standard square pointed shovel should be used to sample all materials except concrete sand. The shovel should be inserted at 90° and pushed in, then gently remove to minimize spillage of material. A sampling tube should be used for concrete sand.

The stockpile slough should be sampled at a minimum of three points that are approximately equal distances apart in a diagonal direction from the bottom to the top of the slough. The space between the bottom of the stockpile and the first sampling point and the space between the highest sampling point and the top of the slough should also be approximately the same distance as between the sampling points.





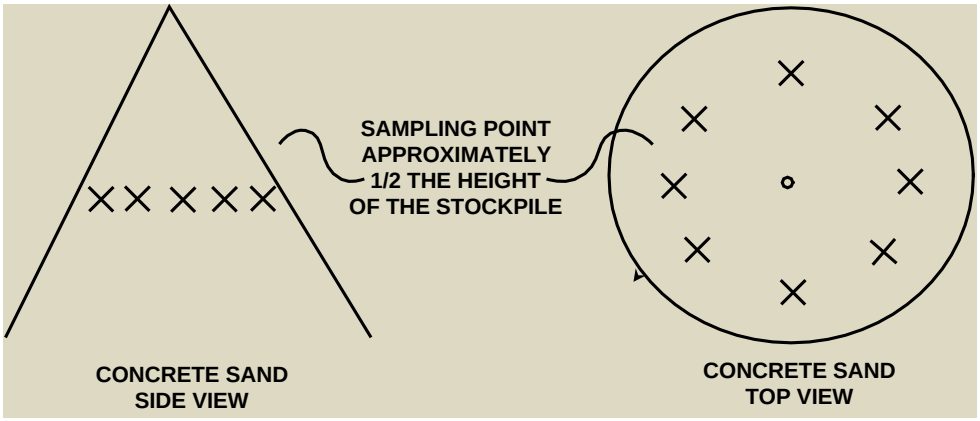
The width of the area sampled should be confined to no more than two times the width of the loader bucket that is being used for loading out materials.

SAMPLING CONICAL SHAPED STOCKPILES

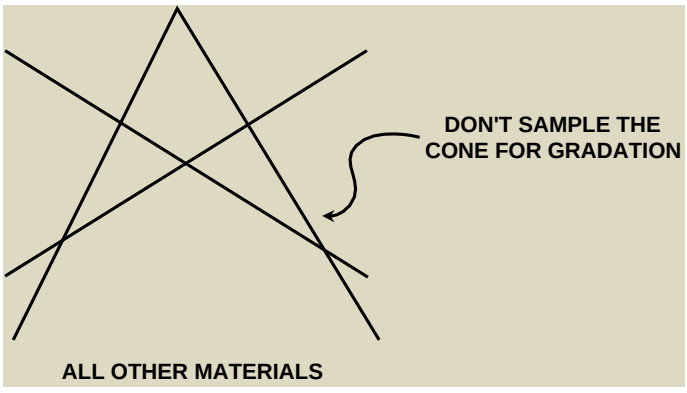
CONCRETE SAND

For production control purposes and for a standardized evaluation procedure, concrete sand may be sampled at equal points all the way around the cone at approximately ½ the height of the stockpile. These samples should always be compared to those that represent shipments. Typically shipping samples taken after the cone has been opened up or re-stocked will contain more fines than production samples. This is believed to be caused by free water migrating fines toward the heart of the cone during production. The difference between the two sampling locations should be noted and production adjusted accordingly.

ALL OTHER MATERIALS



The segregation pattern of all other materials in conical shaped stockpiles is so extreme and so variable that they shouldn't be sampled. The misleading data that is likely to be obtained from such samples has no value.



STOCKPILING CONSIDERATIONS

Aggregates that are used in construction should be stockpiled in a manner that will minimize segregation, contamination, and degradation. Thousands of dollars are lost each year through rejected materials, additional production and testing costs, replacement construction costs, delays to construction, lost man-hours and reduced life of the end product. Many of these problems can be minimized by the proper handling and stockpiling of aggregates.

Before any aggregates are stockpiled, a suitable location should be identified. A location should be identified that would minimize segregation, contamination and degradation. The mat should also be considered. The mat should be comprised of material that is the same or smaller size of the material being stockpiled. The mat should be placed on hard ground as opposed to soft soil to minimize the loss of aggregate that is mixed into the soil. Previously used sites where similar sized materials were stored make excellent stockpile sites because the mat has been stabilized and hardened. The loss of aggregate will be minimal and the potential for contamination with oversize is negligible.

The best way to build a stockpile is to use the Windrow Procedure. This consists of taking individual loads and stacking them side by side and then placing additional loads in between them. This results in a pyramid effect. Once the initial row is started, the base of the pile can be expanded in whatever direction space will permit. By placing loads in between other loads, the material is confined. The segregation cycle is interrupted and held to a minimum.

Segregation is the natural tendency for aggregate particles to separate from the mass. This can be minimized by proper restocking techniques. By keeping production cones under stationary conveyor belts to a manageable height, segregation is minimized. When these cones are left to build up, they become segregated to their fullest extent. When this material is restocked, that stockpile also becomes segregated. Restocking from production cones should be accomplished frequently by the loader entering the cone from a point of intermediate gradation. This is usually at a ninety-degree angle from the front of the production cone. In making the production cone, the coarsest material will be thrown to the front of the cone because it is the heaviest. The finer material will fall to the rear of the cone because it is the lightest. The point of intermediate gradation will be somewhere in between the two towards the side of the cone. For materials with cleanliness requirements, restocking should be only as high as the loader can reach without traveling over the material. Restocking material as high as the loader can reach may sound simple enough, but if not done properly severe segregation will occur.

Contamination is to pollute or make inferior by adding undesirable elements, to make dirty or to soil. Clean stone is usually regarded as material that has been washed in the manufacturing process. Examples of such are surface treatment stone and stone used in Portland cement concrete. These materials have a cleanliness specification. Again, the choice of stockpile locations may seem insignificant in regards to contamination, but there are several points that should be considered.

Trees pose a contamination problem. If materials stockpiled near trees are not used promptly, contamination from leaves, sticks, twigs, etc., can cause construction problems. If stockpiling space is limited and conditions require that materials be stored near trees, the trees should be removed.

Standing water should also be avoided. A considerable amount of effort and money goes into washing and processing clean stone. These stockpiles should be located away from low areas that may accumulate and hold water. Do not let it be rejected due to vehicles contaminating it with muddy water and yard fines splashing onto the stockpile.

Stockpiles should also be guarded against *different size materials*. Load out from overlapped stockpiles of different sizes can cause gradation failure, workability problems and construction failures. Stockpiles should be separated as best as possible.

Degradation is to reduce in rank, status or grade, to reduce in quality or intensity. In stockpiling aggregate material, degradation comes mainly from equipment traveling over the material. For this reason, clean stone products should not be traveled over, but stockpiled in a single lift as high as the loader can reach. Material for asphalt and graded aggregate base may be traveled over provided a ramp is made and used. The ramp should not be loaded out or shipped and should be limited to a specific area in the stockpile. In addition, dozers and tracked loaders should not be used on granite aggregates. The brittle nature of this aggregate type tends to lead to rapid degradation under tracked equipment. This can lead to mix design and asphalt performance problems. Tracked dozers and loaders are permitted on limestone aggregates but, rubber tired loaders are preferred. Limestone aggregates do not degrade as severely as granite aggregates. However, these materials do tend to polish and generate excessive minus 200 fines, so in this regard, a rubber-tired loader is the preferred piece of equipment. The primary difference in handling techniques is that equipment can be used on these stockpiles without adversely affecting the final product. These materials contain a variable range of particle sizes depending on the type of material specified. The important difference between these materials and those used for clean stone applications is they contain coarse and fine aggregate and include some dust of fracture or minus 200 material.

There is one aggregate product however, that equipment does not adversely affect. That is alluvial sand. This material is predominately-pure quartz with a marble like particle shape that can withstand the weight and the grinding effect of equipment without significant degradation. It is very important though, that the dozer or loader stay on a clean mat. Getting off the mat and getting mud and dirt in the cleats or tracks, or allowing trucks with muddy tires to back onto the mat may contaminate the material.

QUALITY CONTROL CONSIDERATIONS

Many aspects of quality control are not found in this study guide. That is because those things are meant to be learned through experience gained working in a lab under a trained quality control technician. Even so, there are a few things that are worth noting and will not be found anywhere else in this study guide.

- In our specifications, weathered rock is limited to two (2) percent. It is acceptable to blend this material with specification material as long as the result is within the two percent limit.

- Along with sampling for certification, the quality control technician performs other tests depending upon the characteristics of the rock being mined. These include testing for weathered rock, specific gravity, flat and elongated, shale and any other tests that are to be recorded on our general-purpose log.

- There are no gradation specifications for coarse and fine aggregate for asphaltic concrete. This is because the aggregate is only a part of the complete product. Asphalt specifications are set for the complete product and can be found in Section 828 of our specifications.

- In most cases, a sand equivalent or weathered rock problem can be identified by a change in the color of the aggregate products, especially graded aggregate base. Soil and/or stained and weathered rock will give the aggregate a tan, brown or reddish tint.

- Before testing a sample, the quality control technician should inspect all equipment daily, especially the Gilson screens for enlarged openings and loose, sagging wire cloth.

- Because the specifications are different for Group I and Group II aggregates, the quality control technician should know which group is being mined at the source where they intend to work.

SECTION IV

STANDARD OPERATING PROCEDURE NO. 1

(SOP 1)

SECTION IV

Standard Operating Procedure No. 1

(SOP 1)

Learning Objectives

In this section, the following learning objectives will be discussed

- ✓ Familiarization with the current Standard Operating Procedure for monitoring coarse and fine aggregate

Laboratory SOP-1
Revised March 7, 1995
Reissued December 6, 1996
Revised September 17, 1999
Revised October 15, 2003
Revised May 5, 2006
Revised May 7, 2007
Revised May 25, 2010
Revised April 16, 2012

Georgia Department of Transportation
Office of Materials and Research

Standard Operating Procedure (SOP) 1

Monitoring the Quality of Coarse and Fine Aggregates

I. General

The Pit and Quarry Control Branch of the Office of Materials and Research is charged with the responsibility of monitoring all coarse and fine aggregates used on Department of Transportation projects. In order to facilitate the accomplishment of this task, lists of fine and coarse aggregate sources are maintained and published in the form of Qualified Products Lists 1 and 2, Sections A, B, C, and D. In addition, those sources that are listed on Qualified Products List 2, Sections A, B and C will be subject to the conditions of the Aggregate Rating System. Those sources that are listed in Section A, B, and C of Qualified Products List 1 and 2 are also required to transfer aggregate certification data electronically. A Producer desiring placement or re-instatement to one of these lists must meet the requirements set forth in this Standard Operating Procedure.

II. Fine and Coarse Aggregate Source Lists

The following is a general description of the Qualified Products Lists.

A. Qualified Products List 1 - "Fine Aggregate Sources"

This is a list of sources that may supply fine aggregate for use in Departmental construction as stipulated within the following sections:

1. **Q.P.L. 1 - Section A - "Standard List"**

   This is a list of Fine Aggregate Sources that meet the quality requirements of Subsection 801.2.02 of the Specifications. All of these sources are approved to certify fine aggregates for use in Portland Cement Concrete and asphaltic concrete. Acceptable Quality Control Programs have been established for these sources. These source code numbers will end in an F, designating specification sand or a B designating a gradation deficiency that requires blending at the point of use to correct the grading deficiency.

2. **Q.P.L. 1 - Section B - "Temporary Sources"**

   This is a list of sources that are approved to certify fine aggregates only for those uses that are listed. Acceptable Quality Control Programs have been established. These source codes will end in a T, indicating the occasional use or temporary status of the source.

3. **Q.P.L. 1 - Section C - "Vendor Sources"**

   This is a list of sources that are approved to vend and certify fine aggregates originating from an approved source or stockpile. Acceptable Quality Control Programs have been established for handling and certification of the materials to be vended. These source codes will end in a V, designating them as Vendor Sources.

4. **Q.P.L. 1 - Section D - "Stockpile Basis Only Sources"**

This is a list of sources that do not meet the criteria for being placed under Sections A or B of Qualified Products List 1. However, these sources can supply fine aggregates for Departmental use as they are available. Shipments from these sources will require prior certification by a Departmental representative on a stockpile basis. These source codes will end in an S, designating Stockpile Basis. **The current Qualified Products List 1 may not list any stockpile-basis-only fine aggregate sources due to the rarity of this type of source.**

B. Qualified Products List 2 - "Coarse Aggregate Sources"

This is a list of sources that may supply coarse aggregate for Departmental use as stipulated under the following sections:

1. **Q.P.L. 2 - Section A - "Standard List"**

   This is a list of sources that meet the quality requirements of Subsection 800.2.01 of the Specifications. All of these sources are approved to certify aggregates for use in Portland Cement Concrete and/or asphaltic concrete. Depending upon plant design and deposit characteristics, these sources typically supply a full range of products. Acceptable Quality Control Programs have been established for routine control and documentation of all products potentially for DOT use. These source codes will end in a C, designating a coarse aggregate source.

2. **Q.P.L. 2 - Section B - "Temporary Sources"**

   This is a list of sources that due to plant or deposit characteristics, or, simply not having a need to meet the criteria for Section A, are approved to certify only a limited number of items. Only those products that are specifically listed may be certified by the Producer. Acceptable Quality Control Programs have been established for the specific items listed. These source codes will end in a T, indicating the occasional use or temporary status of the source.

3. **Q.P.L. 2 - Section C - "Vendor Sources"**

   This is a list of sources that are approved to vend and certify aggregates originating from an approved source or stockpile. Acceptable Quality Control Programs have been established for handling and certification of the various materials to be vended. These source codes will end in a V, designating them as Vendor Sources.

4. **Q.P.L. 2 - Section D - "Stockpile Basis Only Sources"**

   This is a list of sources that do not meet the criteria for being placed under Sections A or B of QPL 2. However, these sources can supply aggregates for Departmental use as they are available. Shipments from these sources will require prior certification by a Departmental representative on a stockpile basis. These source codes will end in an S, designating Stockpile Basis.

III. Source Evaluations

Initial inspection of aggregate sources is required in the following situations:

A. New Sources

This may be a totally new operation for which there is no previous listing or quality data, or an old operation that has not previously requested an evaluation.

B. Reopened Sources or Sources Requesting Reinstatement

Sources that have been removed from the Qualified Products List for whatever reason will require a reevaluation prior to approval. This action is necessary to evaluate any changes which may have occurred in the deposit, production processes and/or Quality Control Programs.

C. New Owner

Since different owners can achieve varying results with the same source and since new owners often change equipment and manufacturing processes, a change in ownership may necessitate that a new evaluation of the source be made.

D. Relocated Sources

If a sand pit or quarry is relocated or if mining operations are extended into a new area, even if such extension or relocation is in the same general area, a new inspection may be required.

E. Significant Change in Material

If a significant change in the character of the material occurs, a new study may be required. Early detection and investigation of a change often works to the Producer's advantage by allowing applicable changes in the design mixtures at an early date.

IV. Source Approval Procedures—Qualified Products Lists 1 and 2

A. Sections A (Standard), B (Temporary) and C (Vendors)

A Producer desiring consideration for placement on one of these lists should direct a request in writing to the State Materials and Research Engineer or visit the Office of Materials and Research website at http://tomcat2.dot.state.ga.us/PitQuarry/index.cfm to apply online.

After a formal request for source approval has been received, a thorough evaluation will be conducted. This will include an evaluation of the geology of the deposit as well as an evaluation of production facilities and finished products. Provided basic quality and production capabilities are determined acceptable for inclusion to Sections A or B of the Qualified Products Lists, an acceptable Quality Control Program must be established prior to source approval. Those sources that lack the capability to consistently produce specification aggregates through the plant operations will not be placed under Section A or B of the Qualified Products List.

Source approval will not be granted as long as test results indicate marginal material is being produced. Material is considered marginal if test results are consistently at or very near the specification limits. The significance of marginal material is dependent upon the material characteristic in question and will be considered on a case-by-case basis.

In the case of Section C - "Vendor Sources", evaluations will focus primarily on off-loading, stockpiling and shipping procedures as they relate to the character of material involved and intended uses. Once acceptable facilities and procedures have been determined, an acceptable Quality Control Program must be established prior to approval.

B. Section D (Stockpile Basis Only)

Sources that do not meet the criteria for being listed under Sections A or B of the Qualified Products Lists may be listed as a Stockpile Basis Only Source. This may be done provided the Producer has the potential to produce some specification aggregates through selective quarrying, selective stockpiling and/or mixing on the yard.

Approval to ship materials must be obtained from a Departmental representative on a stockpile basis at the source prior to shipping. Stockpile size will be restricted to 2500 tons. This will ensure that representative samples are obtained when sampled by standard sampling procedures. Shipping documentation for the specific product(s) must be supplied for Departmental construction.

Acceptance testing of materials delivered to the project or plant site shall be performed by Testing Management at the prescribed frequencies shown in the "Sampling, Testing, and Inspection Manual." In addition, acceptability must be confirmed prior to the materials being incorporated into the work. The exceptions would be base, stabilizer and backfill materials. These materials may be placed but not covered up or otherwise rendered inaccessible for removal prior to completion of tests.

V. Establishing and Maintaining an Acceptable Quality Control Program

After a source of fine or coarse aggregate has been thoroughly investigated and found to meet basic quality and uniformity requirements, an acceptable Quality Control Program is established by the Department with input from the producer prior to approval. Sources listed under Section A, B and C of the Qualified Products Lists will be allowed to certify their aggregates at the source, thereby eliminating the necessity of pretesting on the project, unless non-uniform or non-specification material is suspected. To qualify for an approved quality control program, the following control requirements must be met:

A. Quality System

1. General

   An acceptable Quality Control Program must be in effect based upon plant and deposit characteristics, type of materials to be certified, as well as any available history. The items listed in the following subsections reflect standard policies of the Department. These policies are not all inclusive. There may be other handling procedures that are either permissible or non-permissible but are not specifically addressed herein. The Department will initiate and implement additional policies as necessary to insure adequate quality control.

2. Production

   Production control will generally be at the producer's discretion. However, the Department may specify production control measures for specific problems that are detected or anticipated due to characteristics of the deposit, recycled raw material, and/or production processes. This may be required as a prerequisite to source approval, or as an amendment necessary to maintain status of a source already on the Qualified Products List.

   Special production requirements for recycled concrete base produced from unknown sources of concrete demolition waste.

   Environmental requirements are as follows:

   - The Producer must have a Georgia Solid Waste Handling Permit (or the equivalent State permit if the material is produced from an adjacent state), and a copy must be on file at the producer's facility.
   - All raw material must be screened and tested using Environmental Protection Agency test procedures for the presence of hazardous materials and asbestos, and final product(s) must be certified as non-hazardous prior to shipment.

   Recommended production procedures are as follows:

   - Ensure that the stockpile of raw material being processed is of sufficient size to allow spreading of material from a single source over a large area thereby avoiding pockets of similar material. Stockpiles of raw material should not be less than 25 feet in height.
   - Ensure that stockpiles of raw material are not constructed by dumping incoming material directly over the side, ends or loading face; by pushing incoming material directly over the side or ends prior to placing a quantity sufficient to represent the total product; or by pushing over the loading face where material is actively being reclaimed for processing.
   - Ensure that production controls are in place to remove steel reinforcement, wood, clay balls, soils, epoxy expansion material and non-construction material and to ensure that brick, asphalt and weathered rock do not exceed specification limits.
   - The use of a telescoping radial stacker is required to ensure that the finished product is stockpiled in such a way to evenly distribute or dilute any contaminants or variations in material.

3. Certified Aggregate

   a. Certification of aggregate by testing

      Aggregate products will be considered certified when test results are within specification limits and the producer is in compliance with Departmental policies related to certified personnel and laboratory facilities. (See Section V.B "Approved Laboratory", V.C "Certified Personnel, and V.D "Producer Testing").

   b. Certification of aggregate as it relates to product handling and shipping

      In order to ensure aggregate products of consistent quality, proper handling and shipping procedures must be followed. **Certified personnel must be present and actively performing quality control duties when aggregate is being shipped to Departmental projects or approved concrete or asphalt plants.**

      1) Shipment from bins

Production and load out must be accomplished in such a manner that consistency in quality and specification compliance can be expected. Bins shall be maintained at least ¼ full during active load out. Bins shall be inspected daily for contamination. Contaminated materials are not to be shipped.

2) Shipment from stockpiles
   a) Stockpiles under stationary conveyors

      Coarse aggregate for asphaltic concrete may be supplied directly from a stockpile under a conveyor provided:

      i. The height of the stockpile is controlled to minimize segregation.
      ii. The producer informs the customer and the customer agrees to and accomplishes proper restocking prior to use.
      iii. Gradation control problems are not experienced at the asphalt plant.

      Problems experienced with any of the above listed items will result in discontinued use of this practice by the producer. No other aggregate products are to be supplied from stockpiles situated underneath a conveyor belt.

   b) Stockpiles that were placed by Non-Telescoping Radial Stackers and have not been restocked

      Graded aggregate base shall not be loaded out from these type stockpiles. It will generally be acceptable to load out other aggregate products from these type stockpiles provided:

      i. The height of the stockpile is adequately controlled to minimize segregation.
      ii. Load out is accomplished from the ends only and not from front to back or back to front and not from current production.
      iii. Gradation control problems are not experienced.

      Problems experienced with any of the above listed items will result in discontinued use of this practice.

   c) Stockpiles that were placed by telescoping radial stackers and have not been restocked

      All materials may be loaded out from the ends of stockpiles that have been placed in multiple arcs and lifts. The height of such stockpiles may be restricted for aggregate with specific gradations and cleanliness requirements to control segregation.

   d) Stockpiles of aggregate with specific cleanliness and gradation Specifications

      These materials shall not be loaded out from stockpiles that have sporadic pockets, lenses or strata of non-specification materials, such as occurs from contamination and degradation that results from ramping onto crushed stone products.

   e) Stockpiles of graded aggregate base and fine aggregate for asphaltic concrete

      Load out shall <u>not</u> be from stockpiles that are being or were constructed by:

      i. Dumping production directly over the side, ends or loading face.
      ii. Pushing production over the sides or ends prior to placing a quantity sufficient to represent the total product.
      iii. Pushing over a loading face during active load out.

iv. Using materials that do not meet Specifications during the production process.
v. Placing in a single lift only or in heights of less than 12 feet (applicable only to graded aggregate base)
vi. Are being added to when the existing inventory is less than 2000 tons (0.9 Mg).
vii. Consists of less than 2000 tons (0.9 Mg) prior to commencing shipment.

Correct handling and load out of materials, including cleanliness of haul units and accurate identification of product, are recognized as the Producer's responsibility, and are considered an integral part of the Quality Control Program. **Refer to the Appendix, "Correct Stockpiling and Material Handling Procedures."**

Marginal quality materials are not to be certified. (See Section IV.A for a definition of marginal material.)

B. Approved Laboratory

Laboratory equipment and facilities must be certified to meet the minimum requirements as set forth by the Department of Transportation. A certification document must be posted in the laboratory, and recertification must be made on a yearly basis or as indicated by need. Minimum laboratory requirements are listed below. Those requirements that pertain only to coarse versus fine aggregate sources are so indicated. All other requirements pertain to both.

- Capability to maintain a minimum temperature of 70ºF (21ºC).
- Scales having a maximum capacity of not less than 50 lbs. graduated to 0.1 lb. or less and calibrated to an accuracy of ±0.1 lb. (Coarse aggregate sources)
- Scales having a maximum capacity of not less than 2,500 grams, graduated to 0.1 gram or less and calibrated to an accuracy of ±0.5 grams.
- Coarse Aggregate splitter. (Coarse aggregate sources)
- Fine Aggregate splitter.
- Adequate drying device.
- Sink and running water.
- Sand Equivalent kit.
- Gilson-type, coarse aggregate, sieving device in good working condition. (Coarse aggregate sources)
- Coarse aggregate sieves in good condition (no enlarged openings or loose mesh). Sizes: 1½", 1", ¾", ½", ⅜", No. 4, No. 8, and No. 10. (Coarse aggregate sources)
- Fine aggregate sieves in good condition (no enlarged openings, holes or sagging mesh). Sizes: ⅜", No. 4, No. 8, No. 10, No. 16, No. 30, No. 50, No. 60, No. 100, No. 200, pan, and a 12" No. 200 sieve for washing material.
- Electronic or hand dial calipers. (Coarse aggregate sources)
- Fine aggregate shaker or approved alternate.
- An orderly filing system.
- An area free from vibrations for Sand Equivalent testing.
- Sand Equivalent solution jug placed 36" – 46" above working surface where graduated cylinders are placed.
- Lab certificate
- A computer with the Field Data Collection System software and an internet service provider (ISP) connection. The minimum/preferred computer requirements are listed below.
    - Computer: IBM PC or compatible
    - Software: Windows 98 – Preferred: Windows 2000 or Windows XP
    - Processor: Intel Pentium III or better (above 500 Hz) – Preferred: 2.5 GHz.
    - RAM: 256 MB – Preferred: 512 MB or better

- Hard Drive: 10 GB or better with 500 MB of free space.
- Pointing Device: Mouse or other Windows-compatible pointing device.
- Floppy Disk Drive: 3.5-inch 1.44 MB Floppy disk drive.
- Multimedia: CD-ROM drive.
- Display: Super VGA (1024 X 768 pixels.
- Printer: Windows-compatible laser or ink jet printer.
- Internet: Dial up okay for uploads, but slow for download installation – Preferred: DSL or Cable.

- Additional lab equipment may be required based on testing need. This may include but is not limited to: L.A. Abrasion Machine, Specific Gravity Tank (Coarse aggregate sources) and Color Testing Equipment (Fine aggregate sources).

In addition, the building itself shall have a minimum of 240 square feet of floor space. This area is to be separated into two parts, one for testing and the other for clerical and office type activities. The testing area shall have adequate table or counter space for preparing samples, as well as adequate cabinet space for equipment storage. The other area shall be environmentally acceptable for clerical and office type work. It shall contain a desk and adequate filing space.

Note: Any modifications to the above must be approved by Area Aggregate Engineer.

C. Certified Personnel

The producer's sampling and testing personnel must be certified to sample aggregate and to perform the various tests required by the Office of Materials and Research. The individuals certified will be issued a certification which will be subject for review and revocation for cause.

1. **Certification of Quality Control Technicians**

   The certification of quality control technicians will be administered by the Pit and Quarry Branch. The certification process will consist of a written examination (depending upon type of aggregate source) given at the Office of Materials and Research in Forest Park, Georgia and a laboratory examination (or "hands on" examination) conducted by Pit and Quarry personnel in the laboratory of the aggregate source where the technician is employed.

   After passage of the written (if required) and laboratory examinations, a quality control technician will be assigned a technician number and issued a certification card. The certification card will list the tests the technician is certified to perform. The technician's certification will be valid for three years.

   a. **Written Examination**

      Because of the various types of aggregate sources on Qualified Products Lists 1 and 2, the type of written examination will depend on the aggregate source where the technician is employed. Examinations will be tailored specifically for technicians working at the following types of aggregate sources.

      - Standard coarse aggregate sources and coarse aggregate vending yards
      - Temporary, coarse and fine, crushed stone sources
      - Natural sand sources (standard and temporary)

      Written examinations will be given on the first Thursday of each month, unless the date falls on a State holiday. The examination will be open book, and a score of 80 or above will be required to pass. In the event that a person does not pass the examination, it may be taken again after a minimum period of 30 days. If the technician does not pass the examination on the second attempt, it may be retaken after a minimum period of 90 days. If the technician does not pass the examination on the third attempt, it may be taken annually thereafter at intervals of not less than one year between examinations.

Technicians conducting testing at temporary sources of recycled or excavated project material and at fine aggregate vending yards will be required to take the laboratory examination only.

b. **Laboratory Examination**

For the laboratory examination, the technician will perform the tests that he/she will be required to perform to certify their aggregate. The types of tests performed may vary, depending upon the type of aggregate source or its geologic characteristics.

2. **Recertification of Quality Control Technicians**

A technician's certification will expire three years from the date of issuance of the certification card. Technicians may renew their certification by retaking and passing the written and laboratory examinations prior to expiration of their certification. It will be the technician's responsibility to track his/her training and credit hours. Training may be substituted for retaking the written examination. A minimum of 18 credit hours of training is required (Table 1). Any combination of the following training may be counted toward the 18 hour total. Specific training will be required for recertification only where indicated. Any of the listed training may be repeated annually. **Credit for training other than that listed below will be considered on a case-by-case basis. Technicians may view their certification information at the DOT website at:**
http://tomcat2.dot.state.ga.us/otc/public_html/external/otc_report_criteria.jsp

- Attendance of industry conferences, meetings, and symposia (such as those sponsored by the Georgia Construction Aggregate Association, the Portland Cement Association, the American Concrete Pavement Association, the Georgia Highway Contractors Association, or the Georgia Partnership for Transportation Quality, etc.). (4 hours)
- Attendance of the GDOT class, Quality Control/Principles of Aggregate Certification, which is offered three times annually. (6 hours)
- Attendance of the GDOT class, Field Data Collection System. (4 hours). This class will be required for newly certified technicians, but thereafter will be optional.
- Attainment of a regional or national certification, such as the American Concrete Institute certification. (6 hours)
- Attendance of industry-sponsored training given by outside consultants or internal training personnel (6 hours if comparable to the GDOT training class). The training must be approved by the State Materials and Research Engineer. The producer must inform the GDOT as to the date and location of the training at least one week prior to the training, and the GDOT reserves the right to attend the training.
- Attainment of another State's certification. (2 to 4 hours, depending on requirements).
- Attendance of quality control/sampling training ("winter training") conducted by the Pit and Quarry Branch for Testing Management Branch personnel. (1 to 4 hours, depending upon content). This training is usually conducted at a local quarry.

Training may not be substituted for the laboratory examination.

The requirement for recertification of technicians at natural sand sources (producers of products 10NS and 20NS), at temporary sources of recycled or excavated project material, at Type 2 temporary sources, and at fine aggregate vending yards will consist of the laboratory examination only. See Table 1.

Table 1
CERTIFICATION AND RECERTIFICATION
REQUIREMENTS BY SOURCE TYPE*

SOURCE TYPE	INITIAL CERTIFICATION	RECERTIFICATION
Standard "C" Sources	Standard Examination Laboratory Examination	Standard Examination OR 18 hours training PLUS Laboratory Examination
Vendor Sources (Coarse aggregate products)	Standard Examination Laboratory Examination	Standard Examination OR 18 hours training PLUS Laboratory Examination
Vendor Sources (Fine aggregate products)	Laboratory Examination	Laboratory Examination
Temporary Sources – Type 1 (Crushed stone sources not able to certify sized stone for concrete or asphalt, but do certify all other products)	Standard Examination Laboratory Examination	Standard Examination OR 18 hours training PLUS Laboratory Examination
Temporary Sources – Type 2 (Mainly out-of-state, fine and coarse, crushed stone sources supplying precast or prestressed concrete plants)	Temporary Source Examination Laboratory Examination	Laboratory Examination
Natural Sand Sources (Standard, Blend, and Temporary)	Natural Sand Examination Laboratory Examination	Laboratory Examination
Temporary Sources of Material Excavated or Produced (Recycled) on a Project	Laboratory Examination	Laboratory Examination

***Certification and recertification requirements for personnel employed by private testing laboratories will be considered on a case-by-case basis.**

3. **Revocation and Reinstatement of Certification**

   An individual's certification may be revoked for misconduct in regard to quality control activities. Indisputable, willful falsification of test results will be grounds for permanent revocation of certification. Suspension of certification for all other misconduct will be for at least 60 days. After 60 days, certification may be reinstated after written appeal to the State Materials and Research Engineer.

D. Producer Testing

The Producer will sample and test at a specified frequency for each type of material being certified. Producer certification will be in the format of DOT forms 640 and 641. Test data will be reviewed during regular inspections by Pit & Quarry Control personnel. The certification data will be electronically transferred to the Office of Materials and Research at a frequency of not less than once per two weeks.

E. Frequency of Producer Tests

The Minimum Testing Frequencies established for each type material in accordance with Item "D" will remain in effect until evidence of unacceptable material or proof of uniformly acceptable material warrants an increase or decrease, respectively, in the testing frequency.

F. Comparison Tests

To insure uniformity of testing between the Department and the Producer, comparison tests will be run at least annually by the Producer and the Department.

G. Product Certification Restrictions

Sources listed on Qualified Products List 2 - Section A, B or C, may be restricted from certifying a certain product or products. This may be due to deposit characteristics, production capabilities, inadequate Quality Control, lack of testing capability for a specific material or substandard product ratings. In these instances, use of such products may be allowed under stockpile basis or other stipulations as deemed necessary by the Department for adequate control. In the case of substandard product ratings, specific guidelines are outlined in the aggregate rating procedure for resuming certification of the product.

H. Separation of Sizes and/or Type Materials

Since different materials require different combinations for production of asphaltic concrete, Portland cement concrete, graded aggregate and other mixtures, material of different sizes and/or types must be kept separated and properly identified.

VI. Policy for Departmental Testing, Acceptance, and Use of Certified Aggregates

A. Use of Certified Aggregate

The eligibility of a source to certify material is defined under each section of the Qualified Products Lists. Aggregate delivered from a source with an approved quality control program will be certified by the Producer to comply with the Specifications. Use of materials delivered from these sources will not be delayed pending completion of agency testing unless non-uniform or non-specification material is suspected.

B. Agency Testing and Inspections

To verify the quality of materials actually incorporated into the work and to evaluate the Quality Control Program, certain materials evaluation procedures will be followed. These are listed below:

1. Periodic Inspection by Geologists

   Thorough inspections will be made periodically by a geologist of the Pit and Quarry Control Branch. Generally, this will occur annually. The primary purpose of these inspections is to:

a. Evaluate the condition of existing aggregate inventories which may be shipped for departmental use.

b. Determine changes in material character and production processes which have occurred since the last inspection.

c. To forecast problems so that control provisions can be established at an early date.

2. Independent Verification Testing

   Personnel from the Pit and Quarry Control Branch will sample and test at an unspecified frequency at the source and as needed on the project. These tests will be used to assist in verification of compliance to Specifications and Quality Control Programs.

3. Acceptance Sampling and Testing

   Project control or acceptance samples will be routinely taken by Testing Management personnel on the project or at the plant. Specific lots or shipments will not be tested for acceptance except as provided for in the "Sampling, Testing, and Inspection Manual."

4. Independent Assurance Program

   Independent Assurance (IA) provides an independent verification of the reliability of the acceptance (or verification) data obtained by the agency and the data obtained by the contractor. The results of IA testing are not to be used as a basis of acceptance. IA provides information for quality system management.

C. Review of Test Results

The Pit & Quarry Control Branch of the Office of Materials and Research will review and evaluate all test reports from all parties to assess the effectiveness of the Quality Control Program. It will be the responsibility of the Pit & Quarry Control Branch to determine the need for further evaluation or changes in the Quality Control Programs and/or the approved status of sources. In addition, the Quarry Certification Samples will be used to compute "ratings" for those sources listed on QPL 2, Section A, B and C.

VII. Removal and Reinstatement to Qualified Products List, Sections A, B, and C

A. Removal

1. Inadequate Quality Control

   Producers having inadequate Quality Control will be removed from Sections A, B or C of the Qualified Products List, whichever is applicable. In this instance, provided the Producer desires to supply materials for Departmental use, the source may be placed under Section D - "Stockpile Basis Only" of the Qualified Products List.

2. Change in Deposit or Specification

   Whenever a source is removed from Section A of the Qualified Products List due to reasons beyond the Producer's control rather than failure of the Quality Control Program, the Producer, at his request, will be considered for placement under Section B - "Temporary Sources." This would be in lieu of placement on the "Stockpile Basis Only" list and would allow for producer certification of specific items that meet applicable Specifications.

3. Non Use

   It is the policy of the Department to remove sources from the Qualified Products List when materials are not received for a Departmental project for a period of twelve (12) months.

B. Reinstatement

After being removed from Section A, B or C of the Qualified Products List, a source may be reinstated after meeting applicable requirements as outlined under Section IV and reestablishing an acceptable Quality Control Program as outlined under Section V of this Standard Operating Procedure.

VIII. Assistance to Producers

In an effort to stimulate and promote the aggregate industry and to foster a competitive atmosphere in the production of high quality materials, a number of services are extended to producers. The services available are as follows:

A. Unofficial Samples and Evaluation of Results

A limited number of unofficial or preliminary samples of aggregate or cores supplied by owners of prospective sites or from pits or quarries currently being mined, will be subjected to quality tests in the Laboratory. The number of tests provided will only be those which can be accommodated by the personnel and facilities available after the normal workload is accomplished.

The Department will offer an informal interpretation of test results as to how the data may relate to specification aggregate production. These evaluations are advisory only and are not binding on any future action by the Department of Transportation. The Department also does not accept responsibility for the accuracy of any information provided.

B. Producer Quality Problems

The Pit and Quarry Control Branch will offer limited assistance in determining effective methods of controlling gradation or other quality problems that arise due to the production process, handling procedures or deposit characteristics. Early cooperation between the Producer and the Department can serve to prevent shortages of specification materials and construction delays at a later date.

IX. Samples for Complete Analysis

Samples for complete analysis will be secured from each source by Pit and Quarry Control personnel on a regular basis. This data will be used to monitor compliance with the quality requirements of the Specifications. It will also be used to provide test data for annual publication of the Qualified Products Lists as well as to monitor consistency of characteristics that affect designs, batching and other construction applications.

A. Source of Samples

Samples will generally be taken from current production at the source. With consideration to economics, samples from out of state or other long distance sources may sometimes be taken from a project or plant site rather than at the source of origin.

B. Frequency of Complete Analysis Testing

In order to maximize efficient use of manpower, samples submitted for complete analysis will not be subjected to the full range of specification tests unless specifically requested. Specific Gravity tests will be performed on all samples for complete analysis. The frequency of other tests such as abrasion and soundness will be monthly, quarterly, biannually or annually based on the history and consistency of the deposit.

C. Sample Size

Samples submitted shall be representative of the quality of the material being sampled. Coarse aggregate samples should have a minimum weight of 75 pounds (35 kg). Fine aggregate samples should have a minimum weight of 15 pounds (10 kg). However, with consideration to handling and lifting safety, no single bag or container should weigh in excess of 40 pounds (20 kg).

X. Department Of Transportation Materials Producer Files

A file on each Aggregate Producer will be maintained at the Office of Materials and Research. These files contain source evaluations, geological reports and test results. Files will also include copies of Department of Transportation correspondence concerning the source. The Pit and Quarry Control Branch may also keep additional files as necessary to fulfill the responsibilities of the Branch.

A. Producer Review of Files

Producers may consult files for their respective source(s) upon notification to the Pit and Quarry Control Branch Chief. Appropriate personnel will be made available to assist in locating desired information and producing any copies needed.

B. Confidentiality of Producer Files

Data published on the Qualified Products List will be made available to the public in general. Any other information in the Producers' files will not be released to Non-Departmental or Non-Company employed personnel without written consent of an appropriate company representative.

_____
Georgene M. Geary, P.E.
State Materials and Research Engineer

_____
Thomas B. Howell, P.E.
Director of Construction

STANDARD OPERATING PROCEDURE 1

APPENDIX

CORRECT STOCKPILING AND MATERIAL HANDLING PROCEDURES

These procedures were developed in cooperation with the Georgia crushed stone industry, February 2000.

STOCKPILING TECHNIQUES FOR CLEAN STONE

DON'T CONE UP

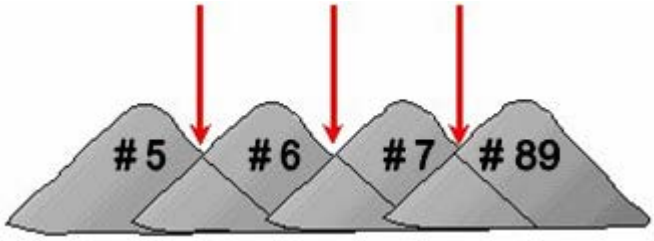
DO DUMP TIGHTLY IN SINGLE PILES

DON'T DUMP OVER THE END

DO STACK AS HIGH AS LOADER WILL REACH

DON'T OVERLAP SIZES

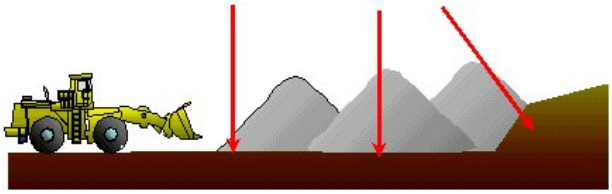
CONTAMINATION



DO SEPARATE DIFFERENT SIZES

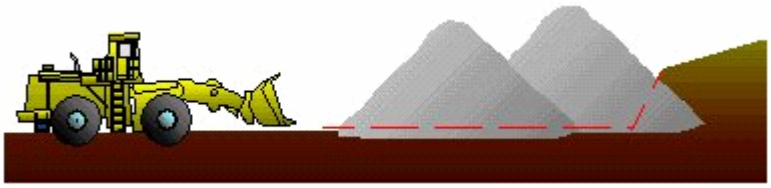
STOCKPILING TECHNIQUES FOR CLEAN STONE

DON'T DIG UP THE MAT



CONTAMINATION

DO KEEP THE BUCKET UP

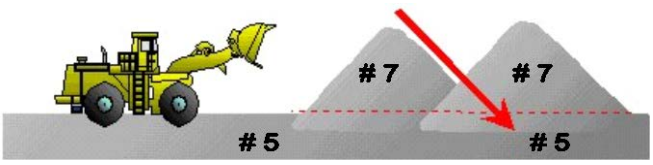


DON'T STOCKPILE
NEAR CONTAMINANTS

DO REMOVE CONTAMINANTS

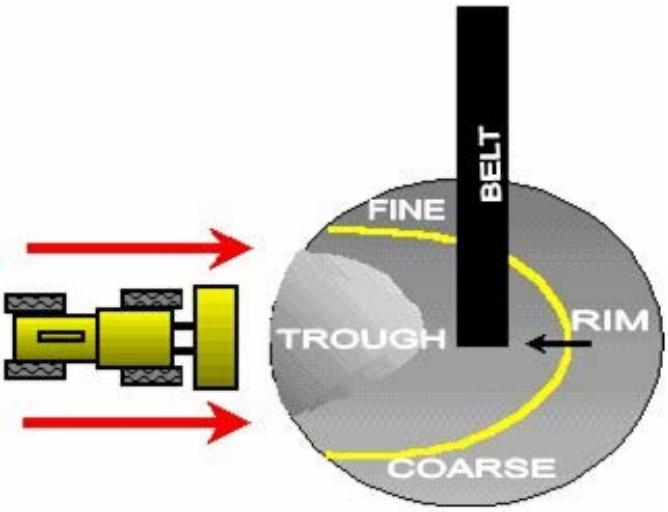
DON'T STOCKPILE OVER
LARGER SIZES

OVERSIZE



DO STOCKPILE OVER
SAME SIZE OR SMALLER

TO SHIP FROM PRODUCTION CONE

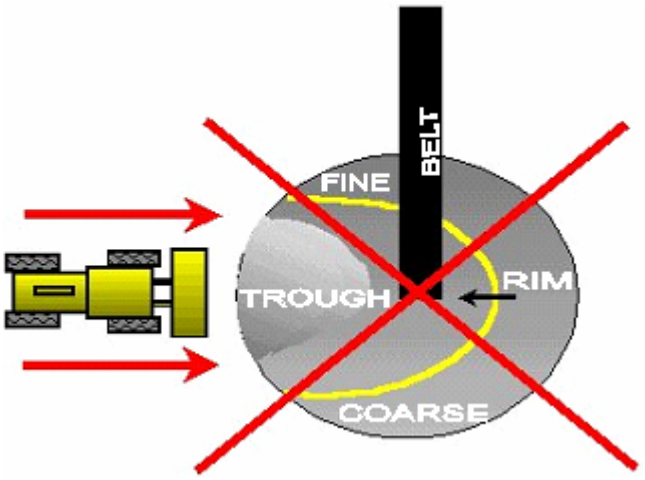


TO SHIP FROM THE PRODUCTION CONE THE LOADOUT MUST BE EQUAL TO PRODUCTION

REALISTICALLY THIS DOESN'T HAPPEN

THEREFORE

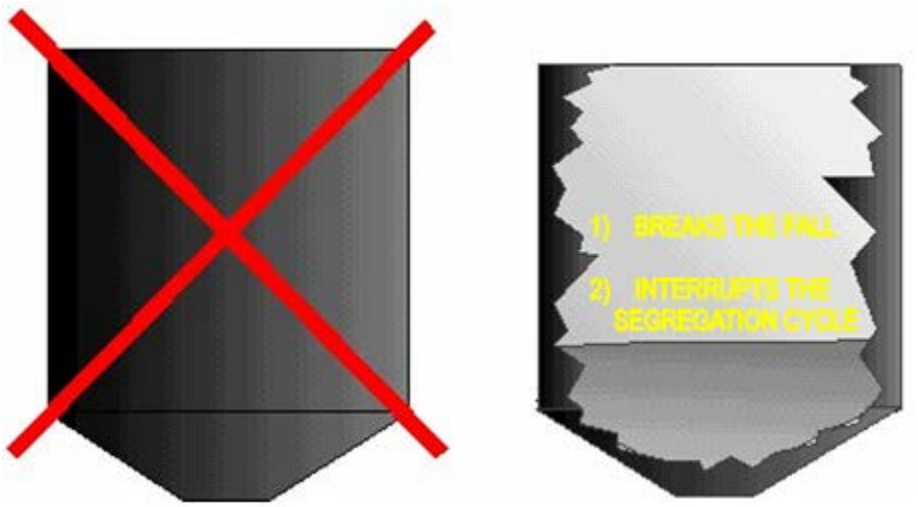
NO SHIPPING FROM UNDER CONVEYORS



THIS INCLUDES NOT SHIPPING FOR PRIVATE JOBS IF SOME MATERIAL IS BEING RESTOCKED FOR D.O.T. USE.

BIN SEGREGATION AND DEGRADATION SOLUTION

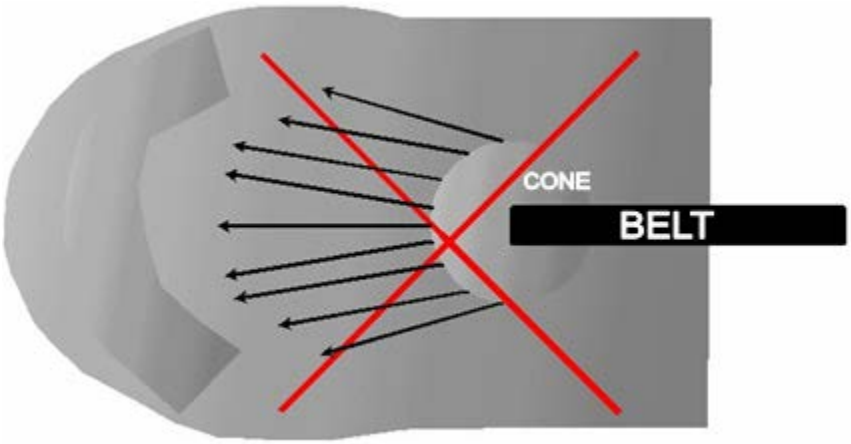
DON'T EMPTY THE BIN WHILE IN THE PROCESS OF SHIPPING. LEAVING MATERIAL IN THE BIN BREAKS THE FALL. ROCK ON ROCK DOESN'T BREAK AS BAD AS ROCK ON METAL. IT ALSO INTERRUPTS AND DISTORTS THE SEGREGATION CYCLE.



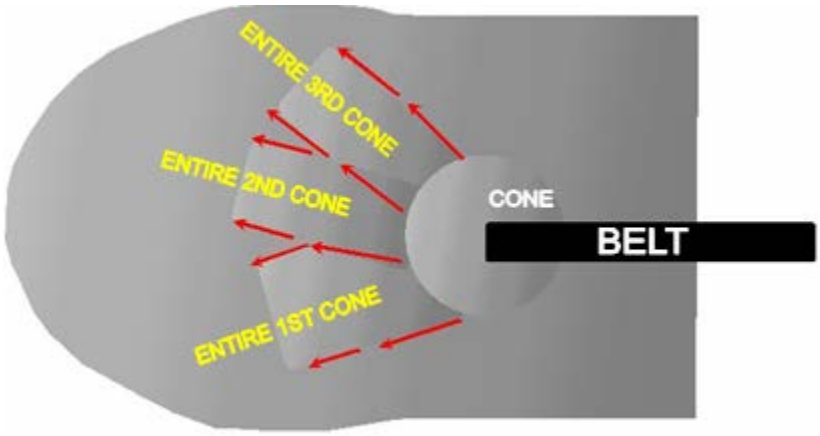
DO LEAVE THE BIN 1 / 4 OR MORE FULL, PREFERABLY 1 / 3

DON'T EMPTY IT!

G.A.B. STOCKPILE PUSHING METHODS



DON'T FAN OUT WHILE PUSHING A G.A.B. CONE

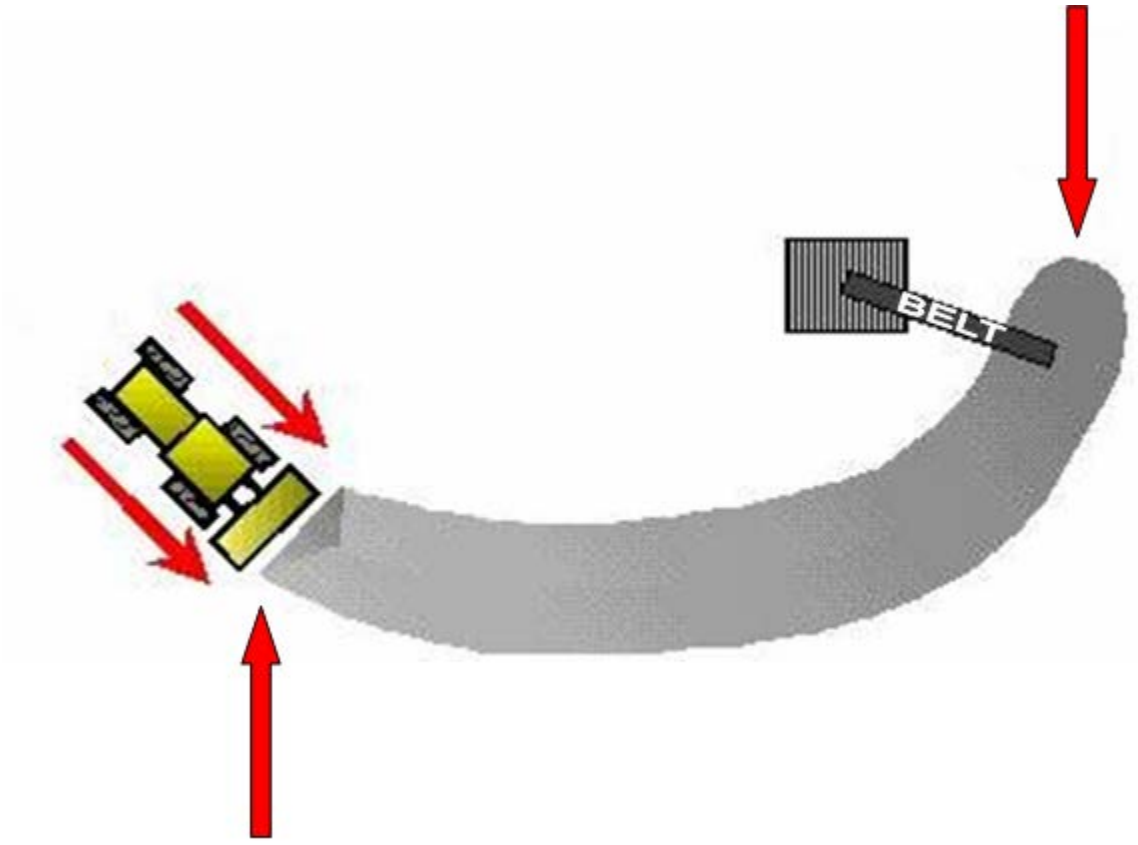


DO PUSH THE ENTIRE G.A.B. CONE IN ONE DIRECTION ONLY

RADIAL STACKER LOADOUT AND RESTOCKING

IT IS GENERALLY ACCEPTABLE TO LOAD OUT MATERIALS (OTHER THAN G.A.B.) FROM THE ENDS OF RADIAL STACKER STOCKPILES. THIS IS PROVIDED THE HEIGHT OF THE STOCKPILE IS CONTROLLED. A MAXIMUM HEIGHT OF 15 FEET IS USUALLY ACCEPTABLE.

DON'T LOAD OUT OR RESTOCK FROM HERE.
NEVER LOAD FROM CURRENT PRODUCTION.

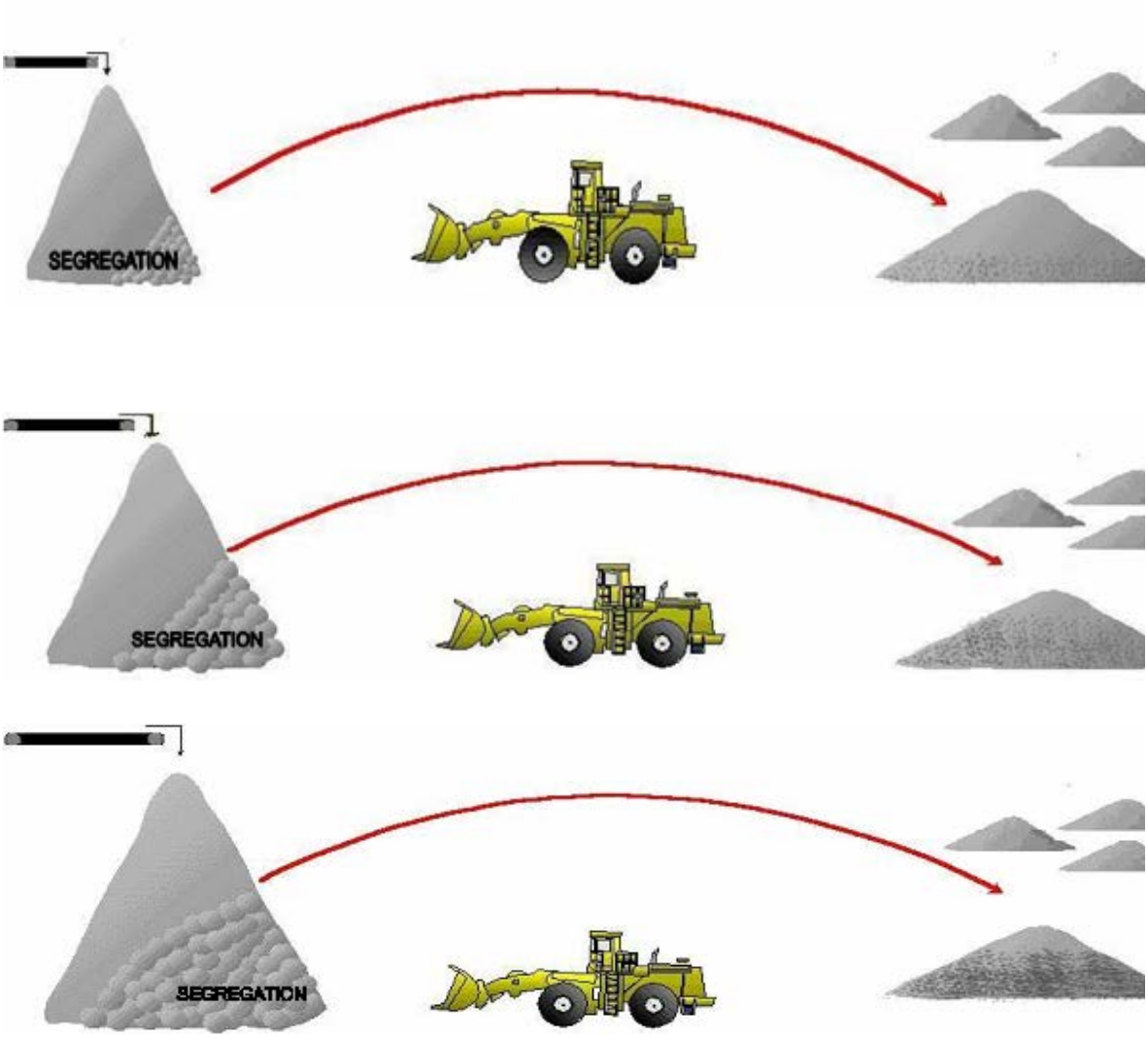


DO LOAD OUT OR RESTOCK FROM HERE, THE INACTIVE END

RESTOCKING TIP

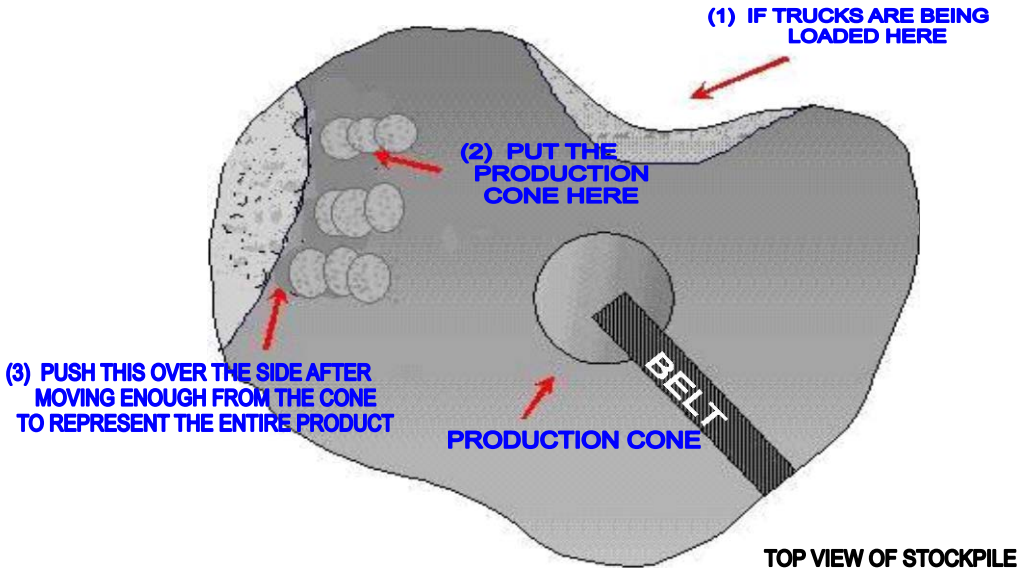
MOVE THE CONE FREQUENTLY AND CONTINUOUSLY

THE SMALLER THIS IS **THE BETTER THIS IS**

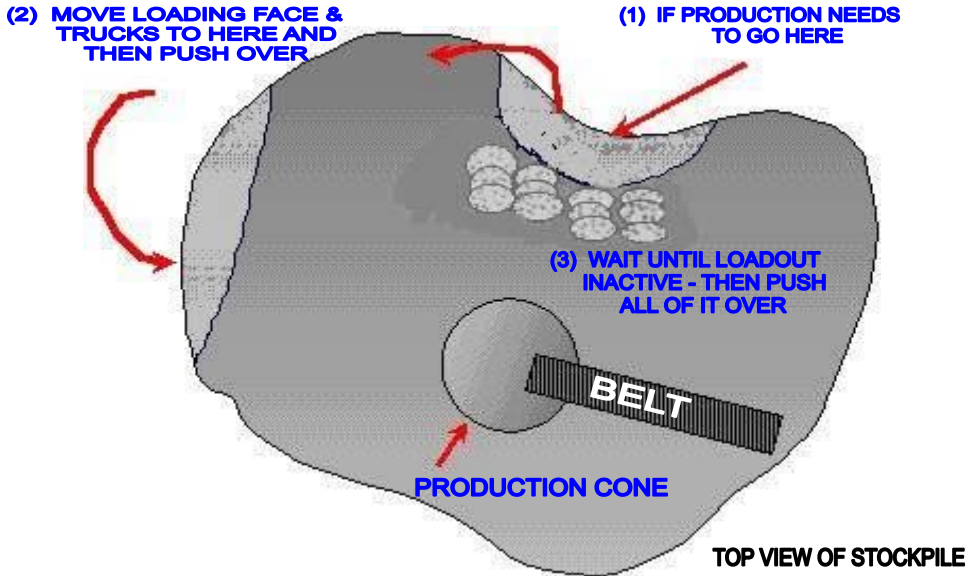


THE CONE CAN BECOME SO SEGREGATED THAT IT SIMPLY CANNOT BE RECLAIMED WITHIN SPECIFICATIONS. THIS IS PARTICULARLY TRUE WITH CLEAN STONE BECAUSE YOU CAN'T RAMP ON THE MATERIAL TO MIX LAYERS. IF YOU STOCKPILE FIVE LOADS THAT FAIL (TOO COARSE), YOU WILL SHIP FIVE LOADS THAT FAIL (TOO COARSE).

SIMULTANEOUS CONSTRUCTION AND LOADOUT OF STOCKPILES



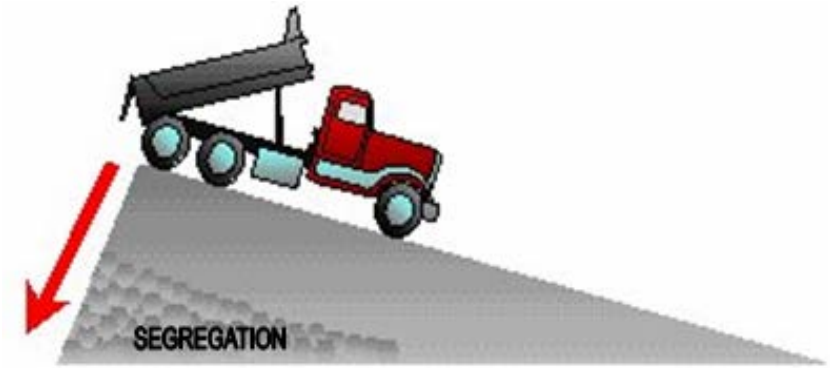
OR



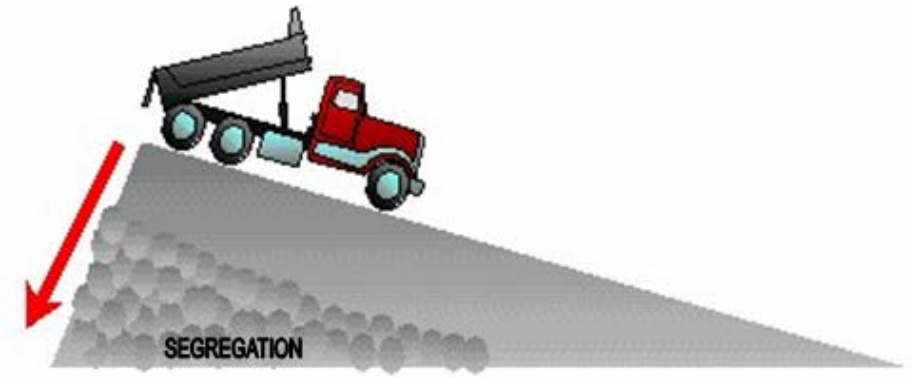
IMPROPER STOCKPILE CONSTRUCTION

IF AN ENTIRE STOCKPILE IS ALLOWED TO BE BUILT BY RAMPING ONTO IT AND DUMPING EACH LOAD OVER THE END…

IT WILL SEGREGATE TO ITS FULLEST EXTENT…

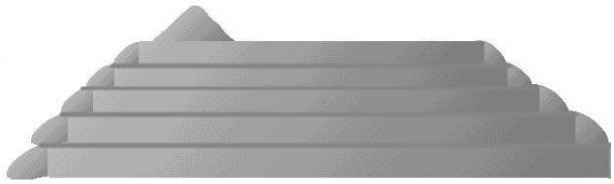


THE LARGER THE STOCKPILE BECOMES, THE WORSE THE PROBLEM IS.

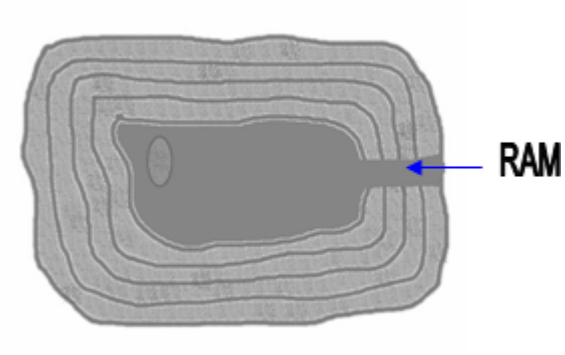


G.A.B. AND ASPHALTIC MATERIALS

AFTER PLACING EACH LIFT, FLATTEN THE TOP SO THAT THE NEXT LIFT CAN BE CARRIED ONTO THE STOCKPILE. THE RAMP SHOULD BE NO LONGER THAN NECESSARY TO GET ONTO THE STOCKPILE. DURING THE PLACEMENT OF EACH LIFT, CARE SHOULD BE TAKEN NOT TO DUMP OR PUSH MATERIAL OVER THE EDGE OF THE UNDERLYING LIFT. ALWAYS STOP JUST SHORT OF THE EDGE.



SIDE VIEW OF STOCKPILE



TOP VIEW OF STOCKPILE

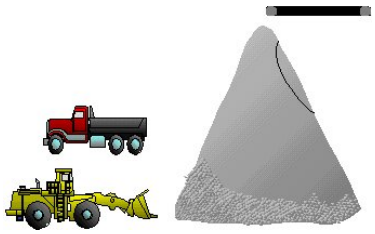
DO LEAVE TERRACES; DON'T LET ROCK ROLL OVER EDGES OF UNDERLYING LAYERS.

EACH LAYER SHOULD BE THE SAME THICKNESS ALL ACROSS THE STOCKPILE. THE COMPLETED STOCKPILE SHOULD BE RELATIVELY FLAT, NOT WEDGE-SHAPED IN APPEARANCE.

IMPROPER LOADOUT METHODS

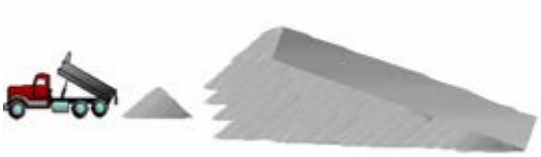
DON'T PULL THE BIN EMPTY

DON'T LOAD FROM UNDER THE BELT



DON'T DUMP OVER THE SIDE OR THE END OF A STOCKPILE

DON'T DUMP PRODUCTION IN FRONT OF THE LOADING FACE

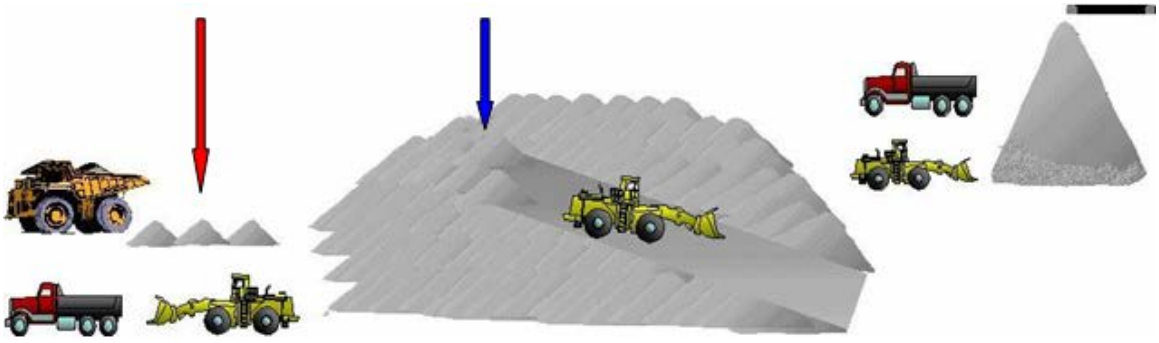


DON'T PUSH OVER THE LOADING FACE DURING ACTIVE USE

WHERE TO PUT PRODUCTION

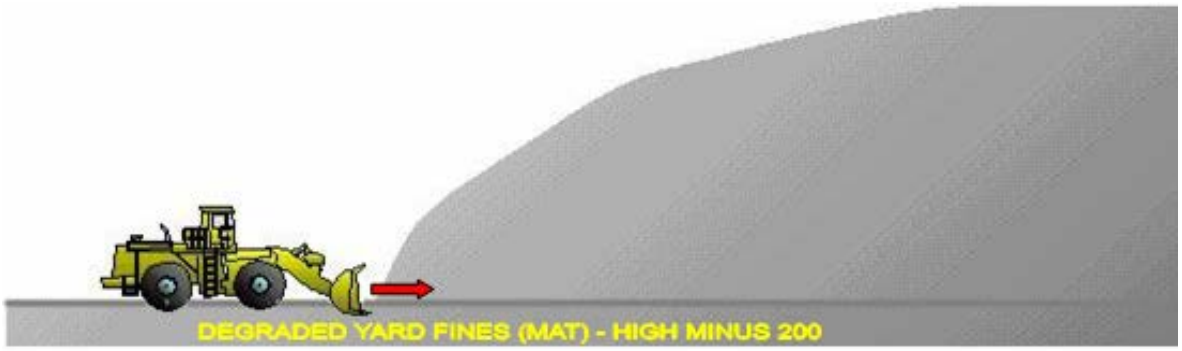
DUMPING PRODUCTION IN FRONT OF THE LOADING FACE IS NO DIFFERENT THAN LOADING FROM UNDER THE BELT.

NOT HERE **HERE**

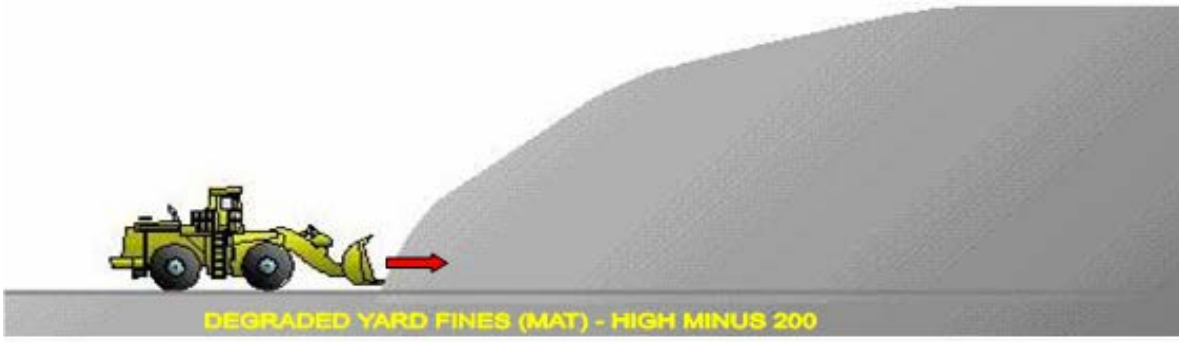


LOAD OUT FROM STOCKPILES

DON'T CONTAMINATE YOUR MATERIAL
BY DIGGING INTO THE MAT WHILE LOADING.



DO KEEP THE BUCKET UP AND MAKE SURE
THE BUCKET IS CLEANED OUT WHEN SWAPPING
FROM ONE SIZE TO ANOTHER.

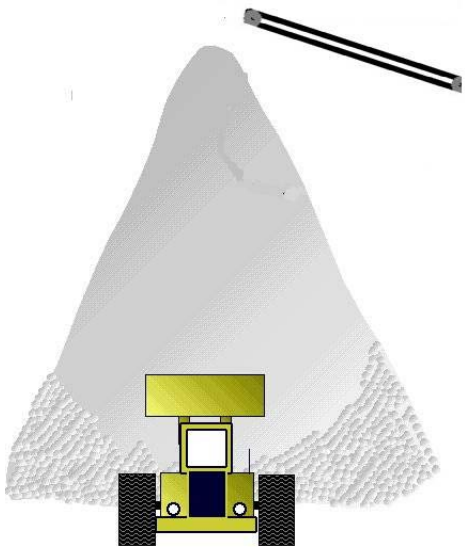


DO CHECK THE TRUCK BEDS -
IT ISN'T YOUR FAULT IF THE BED IS HALF FULL OF DIRT,
BUT WHO WILL SUFFER THE CONSEQUENCES AFTER IT
IS DELIVERED? IS YOUR CUSTOMER GOING TO PAY FOR IT?
IS THE TRUCK DRIVER?

RADIAL STACKER STOCKPILE LOADOUT TIPS

DON'T LOAD FROM CURRENT PRODUCTION

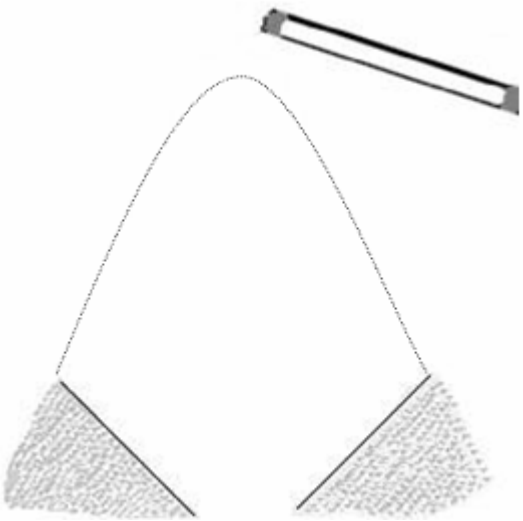
DO LOAD FROM THE INACTIVE END ONLY



DON'T LOAD FROM A STOCKPILE THAT IS TOO HIGH—MAXIMUM HEIGHT = 15 FEET

DO KEEP THE STOCKPILE SMALL ENOUGH THAT A REPRESENTATIVE PORTION OF ALL OF IT CAN BE PUT ON EACH LOAD

DON'T LEAVE THE TOES TO BE LOADED OUT BY THEMSELVES



DO KEEP THEM CLEANED UP AS YOU GO

STOCKPILING CLEAN STONE WITH A LOADER

DON'T STOCKPILE ON A MAT OF LARGER SIZE STONE OR DIRTY MATERIAL
DO STOCKPILE ON A CLEAN MAT, PREFERABLY OF THE SAME SIZE MATERIAL

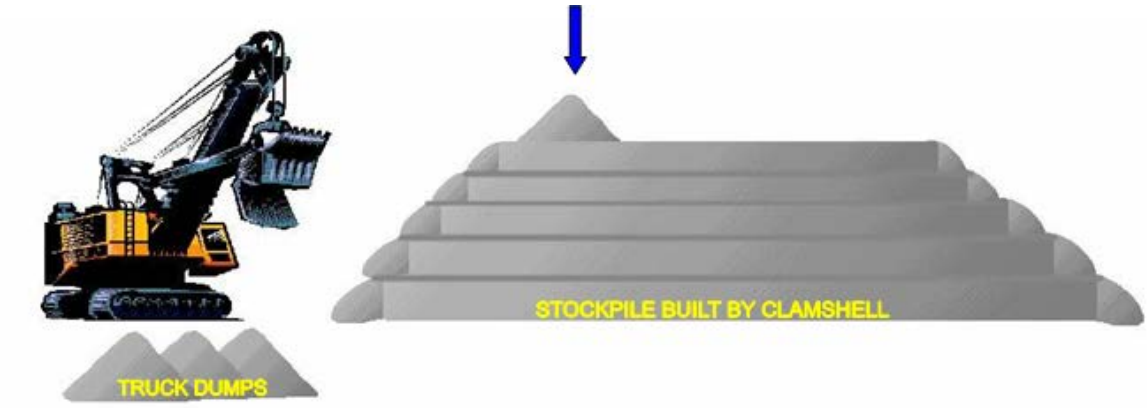
DON'T LET MATERIAL ROLL FROM THE TOP TO THE BOTTOM OF THE STOCKPILE
DO LEAVE A SLIGHT TERRACE AT THE END TO STOP MATERIAL FROM ROLLING
DO PLACE FIRST PILE ON BOTTOM AND SECOND ON TOP, AND STACK AS HIGH AS THE LOADER CAN REACH WITHOUT TRAVELING OVER THE STOCKPILE

DON'T CONE THE STOCKPILE UP

CONSTRUCTING LARGE STOCKPILES OF CLEAN AGGREGATES

DO CONSTRUCT THE STOCKPILE USING MULTIPLE LIFTS OF RELATIVELY UNIFORM THICKNESS, STOPPING JUST SHORT OF THE EDGE OF THE PREVIOUS LIFT.

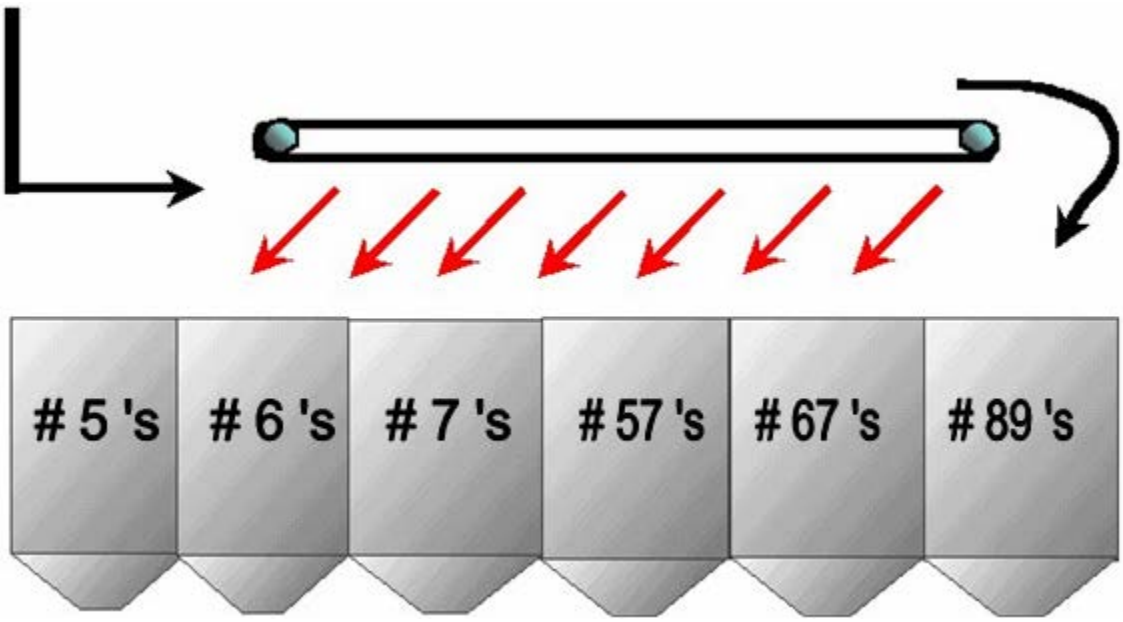
DO THIS



BIN CONTAMINATION

THE MOST COMMON CONTAMINATIONS THAT OCCUR IN BINS ARE:

A) OVERSIZE THAT HANGS IN THE BINS
B) OVERSIZE THAT HANGS IN THE CHUTES
C) OVERSIZE THAT BOUNCES FROM SCREENS OR CONVEYORS
D) FINES AND DIRTY WATER THAT STICK TO CONVEYORS AND DRIBBLES OFF ONTO OTHER AGGREGATES



- **CONTAMINATION FROM FINES IS TYPICALLY INSIGNIFICANT WHEN MATERIALS ARE STEADILY BEING LOADED OUT.**

- **CONTAMINATION BECOMES A PROBLEM WHEN A PARTICULAR BIN IS SUBJECTED TO IT FOR TOO LONG – INSPECT DAILY FOR FINES AND OVERSIZE.**

- **BE SURE TO INFORM THE SUPERVISOR OF WHAT YOU ARE OBSERVING – THERE MAY BE SOMETHING HE/SHE CAN DO TO MINIMIZE THIS TYPE OF CONTAMINATION.**

- **THERE IS NOTHING UNIQUE ABOUT THIS; IT HAPPENS ALL THE TIME. THE MAIN POINT HERE IS TO LOOK AT IT.**

- **BIN OPERATORS SHOULD ALSO CHECK TRUCK BEDS FOR CONTAMINATION PRIOR TO LOADING.**

SECTION V

Georgia Standard Specifications

Learning Objectives

In this section, the following learning objectives will be discussed:

- ✓ Familiarization with the current Georgia Standard specifications pertaining to aggregates

Section 800—Coarse Aggregate

800.1 General Description

This section includes requirements for coarse aggregate. All aggregate shall be the specified type, class, and grade, and shall meet the requirements for the intended use.

800.1.01 Related References

A. Standard Specifications

Section 424—Bituminous Surface Treatment

B. Referenced Documents

AASHTO	ASTM	
T 11	C 277	C 295
T 27	C 289	C 586
T 96	C 294	E 30
T 104		G 23

GDT 104

GDT 129

GDT 133

QPL 2

800.2 Materials

800.2.01 Coarse Aggregate

A. Requirements

The Contractor shall use the type, group, class, and grade of coarse aggregate specified. For coarse aggregate sources, see QPL 2.

1. Coarse Aggregate Types

Type	Characteristics
Crushed stone	Sound, durable rock particles.
Gravel	Sound, durable rock without damaging coatings.
Air-cooled blast furnace slag	Sound, durable particles with uniform density and quality, or other slags that have a good service record. Dry slag shall weigh at least 70 lb/ft³ (1120 kg/m³) compacted and shall contain less than 30% glassy particles by weight. Do not use slag as aggregate for Portland cement concrete.
Synthetic aggregate	Sound, durable, expanded clay, shale, or other manufactured product.

2. Coarse Aggregate Groups
   a. Group I: Limestone, dolomite, marble, or any combination thereof. Ensure Group I aggregates meet the abrasion requirement for Class A stone when used in Portland cement concrete of any type or class.
   a. Group II: Slag, gravel, granitic and gneissic rocks, quartzite, synthetic aggregate, or any combination thereof.

3. Classes

Aggregates are classified by physical properties that determine how they are used.

a. Do not blend aggregates that meet abrasion requirements with aggregates that do not meet requirements.

b. "Class A" and "Class B" aggregate used in Portland cement concrete, asphaltic concrete, and bituminous surface treatment shall meet these limits:

c.

Percent Wear AASHTO T 96 ("B" Grading)		
	Class A	**Class B**
Group I Aggregates	0-40	41-55
Group II Aggregates	0-50	51-60

d. "Class B" aggregates used in all applications other than Portland cement concrete, asphaltic concrete, or bituminous surface treatment shall meet these limits:

Percent Wear AASHTO T 96 ("B" Grading)	
	Class B
Group I Aggregates	41-55
Group II Aggregates	51-65

4. Soundness

Test coarse aggregate used in Portland cement concrete, bituminous surfaces, bituminous bases, aggregate bases, or surface treatment with five alternations of the magnesium sulfate soundness test.

a. Use aggregate with a weight loss of less than 15 percent.

b. The 15 percent soundness loss for a Class "CS" concrete is waived if it has a 5-year service record.

c. If the material meets all the requirements except for the 15 percent soundness requirement, the material may be used in Zones 3 and 4 (see Subsection 424.3.05, "Construction Requirements") under the following conditions:

1) The aggregate in bituminous courses and in all types and classes of Portland cement concrete construction, except as stated in Group I, has a satisfactory five-year service record under similar service and exposure.

2) The Engineer's investigation shows that it equals or exceeds the quality of approved aggregate (in cases where the material's uniformity changes at the source, or does not have a five-year service record).

5. Grades

Use coarse aggregate that is well graded within the limits and sizes specified in Table 800.1.

6. Detrimental Substances

a. Detrimental substances include shale, weathered or decomposed rock, friable particles, or any substance that may be detrimental for the use intended..

b. Do not use any aggregate that can cause a deleterious reaction.

c. Do not use aggregates that contain Chrysotile (defined as fibrous serpentinite) as a temporary or permanent unbound surfacing for roads, nor as stabilizer for soil used as subgrade, base, or surface course.

d. Detrimental substances shall not exceed the following limits:

1) For Portland Cement Concrete:

Substance	Max % Allowed
Mica schist—Materials defined in ASTM C 294 as phyllite or schist. Use GDT 104 to analyze these materials.	5
Materials that pass the No. 200 (75 µm) sieve.	1.5
Flat and elongated pieces (with lengths more than five times the average thickness).	10
Sulphur content computed as sulfide sulphur (for bridge-type structures)—If the sulphur content exceeds 0.01%, do not use the aggregate unless it passes a petrographic analysis and a weathering test equivalent to 6 months or more of exposure.	0.01
Other local detrimental substances. (Any Combination)	2.0
NOTE: Do not use aggregate in Portland Cement concrete that is capable of producing a deleterious reaction when combined with Portland Cement.	

2) For Asphaltic Concrete:

Substance	Max. % Allowed
Mica schist—Materials defined in ASTM C 294 as phyllite or schist. Use GDT 104 to analyze these materials. (Use this requirement for Interstate Construction only.)	10
Flat or elongated particles (with lengths more than five times the average thickness).	10
Glassy particles (slag).	30
Other local detrimental substances. (Any combination)	2.0

3) For Bituminous Surface Treatment:

Substance	Max. % Allowed
Mica schist—Materials defined in ASTM C 294 as phyllite or schist. Use GDT 104 to analyze these materials.	10
Material finer than No. 200 (75 µm) sieve. #5 Stone #6 Stone #7 Stone #89 Stone	 0.5 0.7 0.7 1.0
Flat and elongated particles (with lengths more than five times the average thickness).	10
Glassy particles (slag).	30
Other local detrimental substances. (Any combination)	2

e. Ensure that gravel used in asphaltic concrete and bituminous surface treatment meets the following additional requirements:

- Consists of siliceous particles.
- A minimum of 85%, by count, of the material retained on the No. 4 (4.75 mm) sieve has one or more fractured faces.
- The fracture is for the approximate average diameter or thickness of the particle.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Material that passes the No. 200 (75 µm) sieve	AASHTO T 11
Sulphur content	ASTM E 30, Leco method
Weathering	ASTM G 23
Petrographic analysis	ASTM C 295
Soundness (magnesium sulfate)	AASHTO T 104
Percent wear	AASHTO T 96
Aggregate gradation	AASHTO T 27
Reactivity	ASTM C 227, C 289, and C 586
Schist or phyllite	GDT 104
Flat and elongated particles	GDT 129
Friable Particles	GDT 133

D. Materials Warranty

General Provisions 101 through 150.

TABLE 800.1 - SIZES OF COARSE AGGREGATES

SIZE NO	NOMINAL SIZE SQUARE OPENINGS		AMOUNTS FINER THAN EACH LABORATORY SIEVE (SQUARE OPENINGS). %, BY WEIGHT										
	(1)	mm	2 ½"	2"	1 ½"	1"	¾"	½"	3/8"	No. 4	No. 8	No- 16	No. 50
			63 mm	50 mm	37.5mm	25 mm	19 mm	12.5 mm	9.5 mm	4.75 mm	2.36mm	1.18 mm	300 µm
3	2-1	50 - 25	100	90-100	35-70	00-15	-----	00-5	----	-----	-----	-----	-----
357	2-No. 4	50 - 4.75	100	95-100	-----	35-70	-----	10-30	----	00-5	-----	-----	-----
4	1 ½ -3/4	37.5 - 19	-----	100	90-100	20-55	00-15	-----	00-5	-----	-----	-----	-----
467	1 ½- No. 4	37.5 - 4.75	-----	100	95-100	-----	35-70	-----	10-30	00-5	-----	-----	-----
5	1-1/2	25 – 12.5	-----	-----	100	90-100	20-55	00-10	00-5	-----	-----	-----	-----
56	1-3/8	25 – 9.5	-----	-----	100	90-100	40-75	15-35	00-15	00-5	-----	-----	-----
57	1-No. 4	25 – 4.75	-----	-----	100	95-100	-----	25-60	-----	00-10	00-5	-----	-----
6	¾-3/8	19 – 9.5	-----	-----	-----	100	90-100	20-55	00-15	00-5	-----	-----	-----
67	¾-No. 4	19 – 4.75	-----	-----	-----	100	90-100	-----	20-55	00-10	00-5	-----	-----
68	¾-No. 8	19 –2.36	-----	-----	-----	100	90-100	-----	30-65	05-25	00-10	0-5	-----
7	½-No. 4	12.5 – 4.75	-----	-----	-----	-----	100	90-100	40-70	00-15	00-5	-----	-----
78	½-No. 8	12.5 – 2.36	-----	-----	-----	-----	100	90-100	40-75	05-25	00-10	0-5	-----
8	3/8-No. 8	9.5 – 2.36	-----	-----	-----	-----	-----	100	85-100	10-40	0-10	0-5	-----
89	3/8-No. 16	9.5 – 1.18	-----	-----	-----	-----	-----	100	90-100	20-55	0-15	0-10	0-5
9	No. 4-No. 16	4.75 – 1.18	-----	-----	-----	-----	-----	-----	100	85-100	10-40	0-10	0-5

(1) In inches, except where otherwise indicated. Numbered sieves are those of the United States Standard Sieve Series.

Section 801—Fine Aggregate

801.1 General Description

This section includes the requirements for fine aggregate. All aggregate shall be the specified type, class, and grade.

801.1.01 Related References

A. Standard Specifications

Section 800—Coarse Aggregate
Section 441—Miscellaneous Concrete

B. Referenced Documents

AASHTO	ASTM
T 11 T 21 T 27 T 112 T 303	C 295

GDT 4

GDT 5

GDT 63

GDT 75

GDT 132

801.2 Materials

801.2.01 Fine Aggregate for Cushion

A. Requirements

Use the type, class, and grade of fine aggregate specified.

1. Types

   Use fine aggregate for cushion under granite curb or brick that is natural or manufactured sand with hard, strong, durable particles. Make manufactured sand from crushed gravel or stone meeting the requirements of Section 800. For a list of fine aggregate sources, see QPL 1.

2. Grades

   Use fine aggregate for cushion with less than 10 percent total silt and clay. Grade as follows:

Size	Percent by Weight
Passing No. 4 (4.75 mm) sieve	100
Passing No. 16 (1.18 mm) sieve	25-75
Passing No. 100 (150 µm) sieve	0-25

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

- Sieve analysis—AASHTO T 27

D. Materials Warranty

General Provisions 101 through 150.

801.2.02 Fine Aggregate for Portland Cement Concrete of All Types and for Mortar

A. Requirements

1. Concrete and Mortar

Use fine aggregate for concrete and mortar that consists of natural sand, manufactured sand, or blends of natural and manufactured sands, having hard, clean, strong, durable, uncoated particles, meeting the requirements of the Specifications.

2. Manufactured Sand

Use manufactured sand made exclusively from crushed stone or gravel that meets Section 800 requirements.

Manufactured sand used in concrete for construction of Portland cement concrete pavement, approach slabs, and bridge decks, shall be made from Group II aggregates as specified in Subsection 800.2.01.A.2.

3. Miscellaneous Concrete

Sand manufactured from synthetic aggregate meeting the requirements of Section 800 may be blended with natural sands or manufactured sands made from crushed stone or gravel for use in miscellaneous concrete as described in Section 441.

Blend at least 50 percent natural sand or manufactured sand made from crushed stone or gravel.

4. Concrete Sand

Concrete sand that passes the No. 10 (2 mm) sieve shall have these characteristics:

Characteristic	Requirement
Durability index	70 or greater
Sand equivalent	70 or greater

5. Detrimental Substances

Keep detrimental substances within these limits:

Substance	Maximum Percent by Weight
Clay lumps	0.5 maximum in total sample
Coal and lignite	0.5 maximum in total sample
All detrimental substances (any combination)	2.0 maximum in total sample
NOTE: Do not use fine aggregate in Portland cement concrete that is capable of producing a deleterious reaction with Portland cement	

a. Provided the material passing the No. 16 (1.18 mm) sieve is petrographically determined to be essentially free of detrimental substances, test results for coal and lignite and other detrimental substances listed will be based upon a petrographic analysis of material retained on the No. 16 (1.18 mm) sieve.

b. Calculations will be based upon the weighted average for the total sample.

c. Other detrimental substances include constituents such as shale, weathered or decomposed rock, soft or friable particles, coated grains, or other substances that might be considered detrimental for the use intended.

6. Organic Impurities (natural sands only)

   Ensure all fine aggregate is free from detrimental amounts of organic impurities.

   Do not use materials that have colorimetric test (AASHTO T 21) results darker than the Reference Standard color plate.

7. Grades

   Grade fine aggregates for Portland cement concrete and mortar as follows:

Size No.	Description	Total Percent by Weight Passing Each Sieve					
		3/ 8 in (9.5 mm)	No. 4 (4.75 mm)	No. 16 (1.18 mm)	No. 50 (300 µm)	No. 100 (150 µm)	No. 200 (75 µm)
10 NS	Natural concrete sand	100	95-100	45-95	8-30	1-10	0-3
20 NS	Natural mortar sand	100	100	90-100	15-50	0-15	0-5
10 SM	Standard manufactured concrete sand	100	95-100	45-95	8-30	1-10	0-4
10 FM	Fine manufactured concrete sand	100	95-100	45-95	15-42	6-22	0-9

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Petrographic analysis	ASTM C 295
Material that passes a No. 200 (75 µm) sieve	AASHTO T 11
Organic impurities	AASHTO T 21
Sieve analysis	AASHTO T 27
Sand equivalent	GDT 63
Reactivity	AASHTO T 303
Durability index	GDT 75
Clay lumps	AASHTO T 112
Friable Particles	GDT 132
NOTE: The percent passing the No. 200 sieve (75 µm) for size 10FM will be based upon the total percent determined by AASHTO T-11 and AASHTO T-27. The percent passing the No. 200 sieve (75 µm) for sizes 10NS, 20NS and 10SM will be as determined by AASHTO T-11 only.	

D. Materials Warranty

General Provisions 101 through 150.

801.2.03 Fine Aggregate for Sand Cement Rip Rap

A. Requirements

1. Make fine aggregate for sand cement rip rap out of hard, durable particles without detrimental amounts of organic impurities.
2. Material that passes the No. 10 (2 mm) sieve shall contain less than 7 percent clay and have less than 20 percent that passes the No. 200 (75 µm) sieve.

3. The Engineer may allow up to 30 percent by weight of the material retained on the No. 4 (4.75 mm) sieve if:
    - The aggregate still meets the intended purpose.
    - All of the particles pass the 3 in (75 mm) sieve.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

The Department will conduct laboratory tests to determine whether or not the material reacts favorably with Portland cement. If it does not, the Department will reject it, even though it may meet the other requirements.

The Department will use the following tests:

Test	Method
Soil gradation	GDT 4
Portland cement reaction	GDT 5

D. Materials Warranty

General Provisions 101 through 150.

Section 802—Aggregates for Asphaltic Concrete

802.1 General Description

This section includes the requirements for fine and coarse aggregates used in asphaltic concrete.

802.1.01 Definitions

Fine Aggregate: All aggregate passing a No. 8 (2.36 mm) sieve

Coarse Aggregate: All aggregate retained on a No. 8 (2.36 mm) sieve

802.1.02 Related References

A. Standard Specifications

Section 800—Coarse Aggregate

Section 828—Hot Mix Asphaltic Concrete Mixtures

B. Referenced Documents

AASHTO T 27

AASHTO T 96

ASTM C 295

GDT 63

GDT 76

802.2 Materials

802.2.01 Fine Aggregate for Asphaltic Concrete

A. Requirements

Use the appropriate type, group, class, and grade of fine aggregate.

1. Types

   Use fine aggregate made of sharp, strong, angular material meeting the required performance characteristics when combined into a mixture.

   a. Ensure that the aggregate meets the following requirements:

   - Does not contain any deleterious substances.
   - Natural sand is free of organic matter, roots, or twigs.
   - Aggregate is manufactured from Class A or B crushed stone, gravel, slag, or synthetic aggregate that meets the requirements of Section 800.
   - A combination of natural and manufactured sands meets the requirements in Subsection 802.2.01.A.3 and Subsection 802.2.01.A.4 after being combined.

   b. Do not use crushed alluvial gravel as virgin aggregate in any mixture.

2. Groups

   Fine aggregate groups include:

   a. Group I—Limestone, dolomite, marble, or combination thereof

   b. Group II—Gravel, slag, granitic and gneissic rocks, quartzite, natural sand, or a combination thereof

3. Sand Equivalent

   Use these sand equivalent values:

Material	Sand Equivalent Value
Group I	At least 28
Group II	At least 40
Natural sand	At least 25
Blended sand*	Natural sand at least 20; combined blend at least 25
*Blended natural sands or natural sand blended with stone screenings that meet the Group I or Group II sand equivalent limits.	

4. Mica
   a. Use fine aggregate with no more than 35 percent free mica in asphaltic concrete surface mixes.
   b. When approved by the Engineer, use fine aggregate with more than 35 percent mica if blended with natural sand or sand manufactured from Group II aggregates. Ensure the blend has no more than 35 percent free mica and meets all other requirements of this Section, Section 800 and Section 828.
5. Aggregate for Stone Matrix Asphalt

   Manufactured screenings will be considered as fine aggregate and shall contain no more than 20 percent by weight coarser than a No. 4 (4.75 mm) sieve.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test the fine aggregate as follows:

Test	Method
Aggregate gradation	AASHTO T 27
Sand equivalent	GDT 63
Mica content	GDT 76 or ASTM C 295

D. Materials Warranty

General Provisions 101 through 150.

802.2.02 Coarse Aggregate for Asphaltic Concrete

A. Requirements

1. Types

Ensure coarse aggregate meets the following requirements:

- Class A or B crushed stone, gravel, slag, or synthetic aggregate as in Subsection 800.2.
- Have uniform quality throughout without any deleterious substances.
- Meet the required performance characteristics when combined into a mixture.

NOTE: Do not use alluvial gravel as virgin aggregate.

2. Groups

Coarse aggregate shall be one of either group below as specified in the composition Table in Subsection 828.2.A.2:

- Group I—Limestone, dolomite, marble, or combination thereof
- Group II—Gravel, slag, granite and gneissic rocks, quartzite, or combination thereof

3. Aggregate for Stone Matrix Asphalt

Use coarse aggregate that meets requirements of this Section and Section 800 except as follows:

- Use Class A aggregate only with percent wear of each individual size not to exceed 45 percent based on the B grading of AASHTO T 96
- Use aggregate which contains no more than 20 percent flat and elongated pieces (length greater than three times the average thickness) for that portion of the blend of all aggregate retained on the No. 4 (4.75 mm) sieve.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Coarse Aggregate	Subsection 800.2.01.C

D. Materials Warranty

General Provisions 101 through 150.

Section 803—Stabilizer Aggregate

803.1 General Description

This section includes the requirements for stabilizer aggregate, Types I through III, and Type IV stabilizer sand.

803.1.01 Related References

A. Standard Specifications

Section 800—Coarse Aggregate

B. Referenced Documents

AASHTO T 27

AASHTO T 96

GDT 63

803.2 Materials

803.2.01 Type I Stabilizer

A. Requirements

Use the appropriate type, class, and grade of stabilizer aggregate.

Use material of uniform quality that meets the requirements of Section 800, Class A or B aggregate. Crushed concrete may be used provided it meets the requirements of Section 800 that are applicable to Group 2 aggregates. Ensure the material meets the following gradation:

Sieve Size	% Passing by Weight
1-1/2 in (37.5 mm)	100
1 in (25 mm)	80-100
No. 8 (2.36 mm)	0-5

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Use the following test:

Test	Method
Sieve analysis	AASHTO T 27

D. Materials Warranty

General Provisions 101 through 150.

803.2.02 Type II Stabilizer Aggregate

A. Requirements

Use material that meets the requirements of Section 800, Class A or B aggregate. Crushed concrete may be used provided it meets the requirements of Section 800 that are applicable to Group 2 aggregates.

The aggregate shall:

- Not contain overburden soil or disintegrated rock
- Have a sand equivalent value of at least 20 for material passing the No. 10 (2 mm) sieve

- Meet these gradation requirements:

Sieve Size	% Passing by Weight
2 in (50 mm)	100
1-1/2 in (37.5 mm)	95-100
No. 10 (2 mm)	15-45
No. 200 (75 µm)	0-12

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test type II stabilizer as follows:

Test	Method
Sieve analysis	AASHTO T 27
Sand equivalent	GDT 63

D. Materials Warranty

General Provisions 101 through 150.

803.2.03 Type III Stabilizer Aggregate

A. Requirements

Use material that meets the requirements of Section 800, Class A or B aggregate. Crushed concrete may be used provided it meets the requirements of Section 800 that are applicable to Group 2 aggregates.

Ensure the stabilizer aggregate does not contain soil or decomposed rock and that the Sand Equivalent value of the material passing the No. 10 sieve is not less than 20.

The aggregate shall meet these gradation requirements:

Sieve Size	% Passing by Weight
6 in (150 mm)	100
2 in (50 mm)	25-75
No. 10 (2 mm)	15-35

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test Type III stabilizer as follows:

Test	Method
Sieve analysis	AASHTO T 27
Percent wear	AASHTO T 96

D. Materials Warranty

General Provisions 101 through 150.

803.2.04 Type IV Stabilizer Sand

A. Requirements

Make Type IV stabilizer sand from either natural sand, manufactured sand, or any combination of natural and manufactured sands.

1. If using manufactured sand, make the sand from Class A or B crushed stone, gravel, slag, or synthetic aggregate that meets Section 800 requirements.

2. Type IV stabilizer sand shall have a sand equivalent of at least 35 for material passing the No. 10 (2 mm) sieve and shall also meet these gradation requirements.

Sieve Size	% Passing by Weight
No. 10 (2 mm)	60-100
No. 60 (250 µm)	5-40
No. 200 (75 µm)	0-20

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test Type IV stabilizer as follows:

Test	Method
Sieve analysis	AASHTO T 27
Sand equivalent	GDT 63

D. Materials Warranty

General Provisions 101 through 150.

Section 804—Abrasives for Blast Cleaning

804.1 General Description

This section includes the requirements for abrasives used in blast cleaning.

804.1.01 Related References

A. Standard Specifications

General Provisions 101 through 150.

B. Referenced Documents

TCLP-EPA SWD 846-1311

AASHTO T 27 Aggregate Gradation

QPL 68

804.2 Materials

804.2.01 Abrasives

A. Requirements

1. Types
   - Make the abrasives of low dusting mineral with a minimum of 10 percent by weight G–80 steel grit added, and blended homogeneously throughout the abrasive.
   - Use a mineral abrasive listed on QPL 68.
   - If you propose to use an alternative abrasive mixture, submit it to the Office of Materials and Research for approval before use.
2. Detrimental Substances

   Use abrasives that contain less than 100 ppm of any corrosive compound such as sulfate, chloride, or any EPA characteristic compound such as lead, chromium, or arsenic that can be detected by the EPA Toxicity Characteristic Leaching Procedure (TCLP).
3. Grades

   Ensure that the mineral abrasive used to blend with steel grit meets the grade for the sizes in the following table (Size A fits coal and copper slag; Size B fits staurolite abrasive)

Fractional Percent by Weight Retained on Each Sieve, by Sieve Size								
Size	No . 16 (1.18 mm)	No. 20 (850 µm)	No. 30 (600 µm)	No . 40 (425 µm)	No. 50 (300 µm)	No. 60 (250 µm)	No. 100 (150 µm)	PAN
A	0-10	5-35	25-50	20-45	5-35	0-10		0-10
B	0-2	0-2	0-2	0-5	5-25	5-25	30-60	0-20

.

4. Packaging
   a. Furnish abrasives for blasting in moisture-proof and mildew-resistant bags.
   - Plainly show the size designation, requisition number, and purchase order number on the bags or on tags firmly affixed to each bag.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

The Department will take representative samples of the material sent to the Department, and test as follows:

Test	Method
Aggregate gradation	AASHTO T 27
Toxicity Characteristic Leaching Procedure (TCLP)	TCLP-EPA SWD 846-1311

D. Materials Warranty

General Provisions 101 through 150.

Section 805—Rip Rap and Curbing Stone

805.1 General Description

This section includes the requirements for rip rap and curbing stone. Construction and material will be covered under the Special Provisions.

805.1.01 Related References

A. Standard Specifications

General Provisions 101 through 150.

B. Referenced Documents

AASHTO T 96

AASHTO T 104

ASTM C 295

GDT 64

805.2 Materials

805.2.01 Rip Rap

A. Requirements

1. Aggregate Quality

All rip rap stone shall be made of sound, durable rock pieces that meet these requirements:

Aggregate Quality	Maximum Percent
Abrasion loss “B” grading	65
Soundness loss	15
Flat and slabby pieces (length five times more than the average thickness)	5
Weathered and/or decomposed pieces and shale	5

2. Gradation for Stone-Dumped rip rap Type 1 and Type 3:

Severe Drainage Conditions or Moderate Wave Action (Type 1)*		
Size By Volume	**Approx. Weight**	**Percent Smaller Than**
4.2 ft³ (0.12 m³)	700 lbs (320 kg)	100%
1.8 ft³ (0.05 m³)	300 lbs (135 kg)	50% - 90%
0.8 ft³ (0.02 m³)	125 lbs (55 kg)	20% - 65%
*Between 0% and 15% of the Type 1 rip rap shall pass a 4 in (100 mm) square opening sieve.		

General Use Normal Drainage Conditions (Type 3)*		
Size By Volume	**Approx. Weight**	**Percent Smaller Than**
1.0 ft³ (0.03 m³)	165 lbs (75 kg)	100%
0.1 ft³ (0.003 m³)	15 lbs (7 kg)	10% - 65%
*Between 0% and 15% of the Type 3 rip rap shall pass a 2 in (50 mm) square opening sieve.		

3. Stone for Plain Rip Rap

The stones shall be clean and free of rock dust and fines.

a. Process the stone so that the largest pieces have a volume of 2 ft³ (0.06 m³) or less.

b. Ten percent or less of the total rip rap weight can consist of spalls that pass a 5 in (125 mm) sieve.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Percent wear	AASHTO T 96
Petrographic analysis	ASTM C 295
Soundness (magnesium sulfate)	AASHTO T 104

D. Materials Warranty

General Provisions 101 through 150.

805.2.02 Curbing Stone

A. Requirements

1. Type 1:

   Provide Type 1 curb that meets these requirements:

   a. Curb thickness and height as shown on the Plans

   b. Cut in lengths of not less than 5 ft (1.5 m) nor more than 10 ft (3 m)

   c. Tops dressed to an even, smooth surface for the full length

   d. Have straight, even edges

   e. Top sloped ¼ in (6 mm) from back to front

   f. Have squared ends to permit joints to be constructed not more than ½ in (13 mm) wide for the full depth of the curb.

   g. Backface hand dressed at least 4 in (100 mm) below that part of the back that will be exposed

   h. Front face hand dressed to a depth of 1 in (25 mm) below the indicated elevation of the base course, pavement or gutter

   i. Have ends of circular curb sections cut along radial lines to permit joints to be constructed not more than ½ in (13 mm) wide

   j. Circular curb conforms accurately to the required radius

   k. Dressed surfaces do not contain projections or depressions more than 3/8 in (10 mm) from the plane surface of the curb

2. Type 2:

   Provide Type 2 curb that meets these requirements:

   a. Dimensions shall be 5 in (125 mm) thick, 17 in (425 mm) deep, and 5 ft (1.5 m) long, unless otherwise specified.

   b. Front face to have a top margin draught with a smooth face 10 in (250 mm) deep

   c. Have a smooth face (Note: A quarry face may be considered a smooth face if free from holes and all bumps exceeding allowed tolerances are pointed level

   d. Tops of curbs present even, smooth faces for the full length

   e. Have squared joints that when abutted with adjacent sections, present no crack or joint exceeding ½ in (13 mm) in width

f. Have ends of circular curb sections cut along radial lines to permit joints to be constructed not more than ½ in (13 mm) wide

g. Circular curb conforms accurately to the required radius

h. The allowable tolerances for Type 2 Curb dimensions are as follows:

Measurement Item	Dimension & Tolerance
Thickness	5 ¼ in (131 mm) +/- ¼ in (6mm)
Depth	17 in (425 mm) +/- 1 in (25 mm)
Top Surface	¼ in (6 mm) in 5 ft (1.5 m)
Side Surface	½ in (13 mm) in 5 ft (1.5 m)

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test for Percent Wear according to AASHTO T 96

D. Materials Warranty

General Provisions 101 through 150.

Section 806—Aggregate for Drainage

806.1 General Description

This section includes the requirements for aggregate used for drainage.

806.1.01 Related References

A. Standard Specifications

Section 800 – Coarse Aggregate

B. Referenced Documents

AASHTO T 11

AASHTO T 27

GDT 4

806.2 Materials

806.2.01 Coarse Aggregate for Underdrains

A. Requirements

Use Class A or B coarse aggregate graded for size No. 89 in Table 800.1

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test the aggregate as follows:

Test	Method
Sieve analysis	AASHTO T 27

D. Materials Warranty

General Provisions 101 through 150.

806.2.02 Crushed Stone Drainage Material

A. Requirements

Use Class A or B coarse aggregate that is graded as follows:

Sieve Size	Percent by Weight
Passing 2 in (50 mm)	100
Passing 1-1/2 in (37.5 mm)	95-100
Passing No. 10 (2 mm)	10-35
Passing No. 100 (150 µm)	0-10

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test the crushed stone as follows:

Test	Method
Sieve analysis	AASHTO T 27

D. Materials Warranty

General Provisions 101 through 150.

806.2.03 Drainage Blanket

A. Requirements

Use Class A or B coarse aggregate that is graded as follows:

Sieve Size	Percent by Weight
Passing No. 10 (2 mm)	75-100
Passing No. 40 (425 µm)	25-50
Passing No. 60 (250 µm)	0-25
Passing No. 200 (75 µm)	0-8
Percent clay	0-5

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test the aggregate as follows:

Test	Method
Sieve analysis	AASHTO T 11 and AASHTO T 27
Percent clay (8 minute elutriation test)	GDT 4

D. Material Warranty

General Provisions 101 through 150.

Section 809—Geogrid Materials

809.1 General Description

This Specification includes requirements for geogrid used in reinforced slopes and Mechanically Stabilized Embankment (MSE) Wall backfill.

809.1.01 Definitions

ASTM—American Society for Testing and Materials

GRI—Geosynthetic Research Institute

809.1.02 Related References

A. Standard Specifications

Section 106—Control of Materials

Section 626—Mechanically Stabilized Embankment Retaining Walls

Section 627—Mechanically Stabilized Embankment Retaining Wall—Contractor Design

B. Referenced Documents

AASHTO Task Force 27 Guidelines

U. S. Environmental Protection Agency, Method 9090—Chemical Compatibility

Association of Textile Chemists and Colorists, Method 30—Soil Burial

American Association of Textile Chemists and Colorists, Method 100—Preparation of Bacterial Broth

ASTM D 638

ASTM D 746

ASTM D 975

ASTM D 1238

ASTM D 1505

ASTM D 1525

ASTM D 2165

ASTM D 4335

ASTM D 4595

GRI—GG1

GRI—GG2-87

GRI—GG3a or GG3b

GRI—GG5

809.1.03 Submittals

Supply certification from the manufacturer showing the physical properties of the material used and conformance with the Specifications according to Subsection 106.05 of the Specifications.

Provide evidence from the manufacturer that the geogrid has been used successfully in installations with similar environmental and project conditions.

Obtain prior approval from the Office of Materials and Research for all materials before use on construction.

Submit product specifications and test results to the Engineer for review and approval at least 45 days prior to intended use.

Do not begin placement of geogrid until the test results have been reviewed and approved by the Engineer.

809.2 Materials

A. Requirements

Use geogrid that is free of defects, punctures or flaws.

1. Geogrid for Reinforced Slopes

Use geogrid materials for reinforced slope construction that consist of the following:

- Either a biaxial or uniaxial grid of polymer tensile elements manufactured into a regular network with apertures of sufficient size to allow for soil interlock.
- A commercially prepared material of high tenacity polyester, high density polyethylene (HDPE) or polypropylene that is formed by stretching, heat welding, chemical welding, knitting, weaving or combinations of these methods.

Adhere to the following additional requirements:

a. Long Term Design Strengths

1) Use geogrid that meets the minimum long-term design strengths (TLT) in the machine direction as indicated on the plans.

1) Provide to the Engineer, in writing, the ultimate tensile strength of the grid (TULT) to verify the calculation in obtaining the long-term design loads (TLT).

These strengths are required for the Project and are determined based on the AASHTO Task Force 27 guidelines, which incorporates reduction factors to the ultimate strength of the geogrid for creep, site damage and durability.

2) Calculate the long-term design strength using the following formula:

$$TLT = \frac{TULT \times CRC}{FC \times FD}$$

Where:
TLT = Long-term design load—lb/ft (kg/m)
TULT = Geogrid ultimate tensile strength—lb/ft (kg/m)
CRC = Creep reduction coefficient
FC = Factor of safety to account for construction damage
FD = Factor of safety to account for product durability

b. Determine TULT

Determine the TULT based on wide strip tensile testing as noted in Subsection 809.2.02.

c. Determine Reduction Factors

Determine the reduction factors by the methods described in paragraphs a - e as follows:

1) Creep

a) Provide evidence from the manufacturer that the geogrid has been tested in laboratory creep tests according to the following criteria:

- Conducted for a minimum duration of 10,000 hours
- Tests were made for a range of load levels, including loads that the geogrid will be subjected to on the Project.

b) Ensure these tests are conducted as specified in Subsection 809.2.02.

c) Extrapolate the results extrapolated to a minimum design life of 75 years.

d) Determine the tension level at which the total strain of the geogrid is not expected to exceed 10% within the design life of 75 years (designated Tw).

e) Calculate the creep reduction factor as follows:

$$CRC = \frac{Tw}{TULT}$$

In the absence of test data, use the following creep reduction factors for different polymers:

Polymer Type	Creep Reduction Coefficient
Polyester	0.40
Polypropylene	0.20
Polyamide	0.35
Polyethylene	0.20

2) Construction Damage

a) Provide evidence from the manufacturer that the geogrid has been subjected to full scale construction damage tests using fill materials and construction procedures which are representative of those on the Project.

b) Excavate and test the grid according to Subsection 809.2.02.

c) Calculate the construction damage factor of safety using the following formula:

$$FC = \frac{TULT}{TC}$$

Where: FC = The construction damage factor

TC = The ultimate strength of the excavated grid that has been subjected to construction damage tests.

TULT = Geogrid ultimate tensile strength—lb/ft (kg/m)

d) If construction damage tests have been made, but with fills or construction procedures other than those represented on the Project, use a minimum value of FC of 1.25. Use a lower value of FC only if substantiated with damage tests using fills and construction procedures specific to the Project.

e) In the absence of any construction damage tests, use a FC value of 3.0.

3) Product Durability

a) Provide evidence from the manufacturer that the geogrid has been subjected to a series of durability tests to examine the effects of chemical and biological exposure on the grid, as described in the AASHTO Task Force 27 report.

b) Include the following in the durability studies:

- Effect on short-term and long-term mechanical properties.
- Changes to the following:
    - Reinforcement microstructure
    - Dimensions
    - Mass
    - Oxidation
    - Environmental stress cracking
    - Hydrolysis
    - Temperature
    - Plasticization

- Surface micrology
- Variations in the infrared spectrum analysis.

- A full investigation into the synergetic effects of different environments, particularly temperature. Subject the reinforcement to a working stress during the environmental test.

c) Ensure that geogrid used in the Work has been subjected to the environmental conditioning as outlined by the following, as a minimum:

- U.S. Environmental Protection Agency, Method 9090 – Chemical Compatibility.
- Association of Textile Chemists and Colorists, Method 30 – Soil Burial.
- American Association of Textile Chemists and Colorists, Method 100 – Preparation of Bacterial Broth.

d) Investigate the full range of soil environments to which the reinforcements may be potentially exposed and shall include as a minimum:

- pH in the range of 2, 4, 8, 12 – ASTM-D-2165
- Diesel oil – ASTM-D-975
- Fungi and Bacteria
- UV exposure 500 hrs – ASTM-O-4335
- Solvents and agents that are site specific.

In the performance of this testing the conditioning temperature is laboratory standard plus 1.5 times laboratory standard for the pH environments.

When no conditioning time period is given, use 30 days. Extrapolate results from short-term tests to the required design life of 75 years.

After the geogrid is subjected to these conditions, test the geogrid according to Subsection 809.2.02, and calculate the durability factor of safety by the following formula:

$$FD = \frac{TULT}{TD}$$

Where: TD= The ultimate strength of the geogrid subjected to product durability tests.

The minimum allowable value of FD is 1.10. In the absence of any geogrid durability tests, use a Durability Factor (FD) of 2.0.

3) Pullout Resistance:

a) Provide evidence from the manufacturer that the geogrid has been subjected to full-scale pullout tests using backfill materials representative of those on the Project, as described in the AASHTO Task Force 27 report.

b) Base pullout resistance for design on a maximum of elongation of the embedded geogrid of ¾ in (19 mm) as measured at the leading edge of the compressive zone within the soil mass and not the ultimate pullout capacity.

c) Where insufficient data exists to evaluate the pullout resistance of geogrid as a function of soil type, conduct pullout tests on a project specific basis until the engineering behavior of the soil-reinforcement system is clearly defined.

d) Perform pullout using vertical stress variations (Sv) and reinforcement element configurations simulating actual project conditions.

e) Perform pullout tests according to Subsection 809.2.02 on samples with a minimum embedded length of 2 ft (600 mm). Perform the tests on samples with a minimum width of 1 foot (300 mm), or a width equal to a 4 longitudinal grid element, whichever is greater. Conduct the tests at 70 ^{o}F ±4 ^{o}F (21ºC ± 2 °C) at constant strain rates of 0.02 in (0.5mm) per minute.

Evaluate the pullout resistance by the following relation:

$$Tp = (2 \tan P) \times Sv \times Ls \times fd$$

Where:

Tp = Ultimate pullout capacity of tensile reinforcement—lb/ft (kg/m)

Sv = Vertical stress—lb/ ft^2 (kg/m^2)

Ls = Total length of geogrid beyond failure plane—ft (m)

P = Internal angle of friction of select backfill

fd = Equivalent coefficient of direct sliding derived from pullout tests

The equivalent coefficient of direct sliding, fd, may be related to the open area of the grid. In the absence of product specific data tested with site-specific granular backfill, estimate the from the following preliminary analysis:

% Open Area of Grid	Direct Sliding
80% more	0.5
51 to 79	0.7
50 or less	0.6

Ensure the pullout resistance, Tp, meets the following minimum strength requirement:

Tp = FPO **x** TLT with a displacement less than or equal to ¾ in (19 mm)

Where:

FPO = Factor of safety against pullout, equal to 1.5

TLT = Long-term design load—lb/ft (kg/m)

4) Junction Strength:

a) Ensure that the summation of the shear strength of the joints occurring in a 12 in (300 mm) length of the grid sample is greater than the ultimate tensile strength of the element to which they are attached.

b) If this condition is not met, reduce the allowable reinforcement tension, Tw, by the ratio of the shear strengths to the ultimate strength.

c) Determine the ultimate tensile strength according to Subsection 809.2.02 and translate it into an ultimate strength per element by dividing the number of elements per foot (meter) of width.

d) Measure the junction strength according to Subsection 809.2.02.

2. MSE Wall Backfill Stabilizing Geogrid (SR 3)

Use geogrid materials for MSE wall construction that meets the following requirements:

- Is a biaxial grid of polymer tensile elements manufactured into a regular network with apertures of sufficient size to allow for soil interlock.
- Is a commercially prepared material of copolymerized high density polyethylene (HDPE) that is formed by stretching, heat welding, chemical welding, or combinations of these methods.
- Has the following physical properties:

Physical Properties	
Property	**Requirement**
Melt Index	0.00176 - 0.00846 oz./10 min. (0.05 -0.24 grams/10 min.)
Density	59.0 – 59.6 pcf (0.945 - 0.955 grams/cc)
Tensile Strength	500 ksf (24 000 kPa) minimum
Ultimate Elongation	500% min.
Brittleness	-100 ^{o}F (-73 ^{o} C) maximum
Vicat Softening Point	260 ^{o}F (127 ^{o}C) minimum
Chemical Resistance	Resistant to all natural occurring alkaline and acidic soil conditions
Biological Resistance	Resistant to attack by bacteria and fungi

- Has the following structural and mechanical properties:

MSE Wall Geogrid—Structural and Mechanical Properties	
Property	**Requirement**
Roll Length	100 ft.(30 m)
Roll Width	3 ft. or 4.5 ft. (1 m or 1.4 m)
Roll Weight	82 lb—3 ft roll (37.2 kg—1 m roll); or 114 lb—4.5 ft roll (51.7 kg—1.4 m roll)
Grid Pitch	0.6 in. x 4 in. (15 x 100mm)
Color	Black
Ultimate Tensile Strength	7.47 kips/ft (109 kN/m)
Extension @ Ult. Tensile Strength	17.0% maximum
Extension @ Design Load (0.4 Ult.)	3.0% maximum

Modulus in Tension	9000 ksi (62 000 MPa)
Thermal Stability	Stable over a range of -60 ^{o}F to 174 ^{o}F (-51 ^{o}C to 79 ^{o}C)
Note: Tests are based on 10 single rib samples extended at a constant rate of 1 inch (25 mm)/min. at a temperature of 68 $\pm$ 4 ^{o}F (20 $\pm$ 2 ^{o}C.)	

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test geogrid according to the following:

Test Property	Test Method
Reinforced Slopes	
Tensile Strength—Wide Width	ASTM D 4595
Tensile Strength—Single Rib Strand	GRI – GG1
Junction Strength	GRI – GG2-87
Tensile Creep Testing	GRI – GG3a or GG3b
Geogrid Pullout	GRI –GG5
MSE Wall Backfill Stabilizing Geogrid (SR 3)	
Melt Index	ASTM D 1238
Density	ASTM D 1505
Tensile Strength	ASTM D 638
Ultimate Elongation	ASTM D 638
Vicat Softening Point	ASTM D 1525
Brittleness	ASTM D 746

D. Materials Warranty

General Provisions 101 through 150.

809.2.01 Delivery, Storage, and Handling

During shipment and storage, protect the grid from mud, dirt, dust, debris and exposure to ultraviolet light, including sunlight.

Section 810—Roadway Materials

810.1 General Description

This section includes the requirements for the materials used in roadway construction.

810.1.01 Related References

A. Standard Specifications

General Provisions 101 through 150.

B. Referenced Documents

GDT 4

GDT 6

GDT 7

GDT 67

810.2 Materials

810.2.01 Roadway Materials

A. Requirements

Do not use materials containing logs, stumps, sod, weeds, or other perishable matter.

1. Classes

   The materials are divided into six major classes. Classes I, II, and III are further subdivided and identified by description and physical property requirements specified in the table below and in Table 1. Classes IV, V, and VI are identified by descriptive requirements.

Class I	
IA1 and IA2	Medium- to well-graded sand or clayey sand.
IA3	Fine-grained, silty, or clayey sand; usually less dense than IA1 or IA2. These soils have an excellent bearing capacity.
Class II	
IIB1, IIB2, and IIB3	Medium- to well-graded sandy clays, sandy silts, and clays with some mica. These soils generally have low volume change properties and good densities that serve well as subgrade material.
IIB4	Similar to IIB1, IIB2, and IIB3, but generally contain more mica and are more sensitive to moisture. The bearing value of these soils is less predictable. The soils may or may not be satisfactory for subgrade material. Analyze file data or run laboratory and/or field tests for Class IIB4 when considering it for a subgrade material.
Class III	
IIIC1, IIIC2, IIIC3 and IIIC4	Medium- to fine-graded micaceous sandy silts, micaceous clayey silts, chert clays, and shaly clays. Undesirable characteristics are high volume change properties and/or low densities. The bearing values are unpredictable. The Department recommends testing these materials in a laboratory, where possible, before use. One exception is District 6, where chert clay soils are prevalent. Chert clay soils (IIIC4) with less than 55% passing the No. 10 (2 mm) sieve may be considered suitable for subgrade materials. These soils are found generally in the northwest corner of the state in Dade, Walker, Catoosa, Whitfield, Murray, Chattooga, Gordon, and Floyd counties.

Class IV	Highly organic soils or peat, muck, and other unsatisfactory soils generally found in marshy or swampy areas.
Class V	Shaly materials that are not only finely laminated but have detrimental weathering properties and tend to disintegrate.
Class VI	Rock or boulders that cannot be readily incorporated into the embankment by layer construction, and that contain insufficient material to fill the interstices when they are placed.

Table 1: Physical Properties (Material Passing No. 10 (2.00 mm) Sieve)

Sub-Class	No. 60 (250 µm) Sieve % Passing	No. 200 (75 µm) Sieve % Passing	Clay, %	Volume Change, %	Maximum Dry Density lbs/ft^3 (kg/m^3)
Class I					
A1	15-65	0-25	0-12	0-10	115+ (1840+)
A2	15-85	0-35	0-16	0-12	110+ (1760+)
A3	15-100	0-25	0-12	0-18	98+ (1570+)
Class II					
B1		0-30	0-20	0-10	120+ (1920+)
B2		0-45	0-30	0-15	110+ (1760+)
B3		0-60	0-50	0-20	105+ (1680+)
B4		0-75		0-25	90+ (1440+)
Class III					
C1		0-75		0-30	90+ (1440+)
C2				0-35	80+ (1280+)
C3				0-60	80+ (1280+)
C4*					80- (1280-)
*Chert clay soils in District 6 having less than 55% passing the No. 10 (2.00 mm) sieve may be considered suitable for subgrade material.					

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Soil gradation	GDT 4
Volume change	GDT 6
Maximum density	GDT 7 or GDT 67

D. Materials Warranty

General Provisions 101 through 150.

Section 811—Rock Embankment

811.1 General Description

This section includes the requirements for material used in rock embankment.

811.1.01 Related References

A. Standard Specifications

General Provisions 101 through 150.

B. Referenced Documents

AASHTO T 96

AASHTO T 104

ASTM C 295

811.2 Materials

811.2.01 Rock Embankment Material

A. Requirements

1. Use unweathered quarry-run stones, smaller than 4 ft (1.2 m), in any dimension as rock embankment material.
2. Include all other quarry stone sizes in the embankment. Limit rock fines to a maximum of 25 percent passing a 2 in (50 mm) sieve and 10 percent passing a No. 4 (4.75 mm) sieve.
3. Ensure that the material contains 5 percent or less shaly or flaky particles and meets abrasion requirements for a Class A or B coarse aggregate.
4. Ensure that the material has 15 percent or less loss in the magnesium sulfate soundness test.
5. Use the material only when approved by a petrographic rock analysis.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Abrasion	AASHTO T 96
Soundness (Magnesium Sulfate)	AASHTO T 104
Petrographic analysis	ASTM C 295

D. Materials Warranty

General Provisions 101 through 150.

Section 812—Backfill Materials

812.1 General Description

This section includes the requirements for four types of material used as backfill: foundation backfill, Types I and II, imperfect trench backfill, Type III, and mechanically stabilized wall backfill.

812.1.01 Related References

A. Standard Specifications

Section 810—Roadway Materials

B. Referenced Documents

AASHTO T 27

GDT 4

GDT 6

GDT 7

GDT 67

812.2 Materials

812.2.01 Foundation Backfill, Type I

A. Requirements

1. Use natural or artificial mixtures of materials consisting of hard, durable particles of sand or stone, mixed with silt, clay and/or humus material for Type I backfill.
2. Have the final blend of material meet the requirements of Class I or II soils in Subsection 810.2.01.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Soil gradation	GDT 4
Volume change	GDT 6
Maximum density	GDT 7 or GDT 67

D. Materials Warranty

General Provisions 101 through 150.

812.2.02 Foundation Backfill, Type II

A. Requirements

1. Type

Use material that meets the requirements of Section 800, Class A or B aggregate. Crushed concrete may be used provided it meets the requirements of Section 800 that are applicable to Group 2 Aggregates.

Do not use backfill aggregate containing soil or decomposed rock.

2. Gradation

Use material that meets the following gradation requirements:

Sieve Size	% Passing by Weight
1-1/2 in (37.5 mm)	100
1 in (25 mm)	80-100
No. 8 (2.36 mm)	0-5

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Sieve analysis	AASHTO T 27

D. Materials Warranty

General Provisions 101 through 150.

812.2.03 Imperfect Trench Backfill, Type III

A. Requirements

1. Type

Use material made from either of the following for Type III backfill:

- A natural soil with a density of less than 95 lb/ft³ (1520 kg/m³) when tested with GDT 7
- An artificial mixture of soil and organic material, such as hay, leaves, or straw

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

The laboratory will:

Test the soil density with GDT 7.

1. Review the mixture and the percentages of each material, and approve a mixture suitable for the Project.

D. Materials Warranty

General Provisions 101 through 150.

812.2.04 Mechanically Stabilized Embankment Backfill

A. Requirements

Use material comprised of crushed stone, natural sand, or a blend of crushed stone and natural sand free of soils, organic or any other deleterious substances that meet the following additional requirements:

1. Crushed Stone

   Use a material manufactured from Class A or B stone free of soil overburden and having a soundness loss of not more than 15 percent.

2. Natural Sand

   Use material that consists of strong, hard, durable particles, is non-plastic, and has a durability index of at least 70.

3. Gradation

Sieve Size	% Passing by Weight
4 in (100 mm)	100
2 in (50 mm)	80 -100
No. 10 (2 mm)	20 - 90*
No 200 (75 μm)	0 - 12
* Natural Sand may be 20 - 100	

4. Chemical

Ensure the material meets the following chemical requirements:

Test Method	Requirement
pH	6.0 – 9.5
Resistivity	>3000 ohms/cm
Chlorides	<100 ppm
Sulfates	<200 ppm
Note: These chemical requirements are not applicable to MSE walls stabilized with an approved extensible reinforcement.	

5. Maximum Dry Density

Use backfill material with a maximum dry density equal to or greater than the design unit weight shown on the plans. If no maximum dry density of the backfill material is shown, use a weight of 125 lb/ft^3 (2000 kg/m^3) .

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test the material as follows:

Test Method	Requirement
Percent Wear	AASHTO T96 (“A” Grading)
Sieve Analysis	AASHTO T 27
Material Passing No. 200 (75 μm) Sieve	AASHTO T 11
Durability Index	GDT 75
Maximum Dry Density	GDT 7 or GDT 24a, GDT 24b
Soundness (Magnesium Sulfate)	AASHTO T 104

D. Materials Warranty

General Provisions 101 through 150.

Section 813—Pond Sand

813.1 General Description

This section includes the requirements for pond sand.

813.1.01 Related References

A. Standard Specifications

General Provisions 101 through 150.

B. Referenced Documents

GDT 4

GDT 6

GDT 7

GDT 67

AASHTO T 11 and AASHTO T 27

813.2 Materials

813.2.01 Pond Sand

A. Requirements

Make pond sand exclusively of granular crushed stone fines, relatively free of silt balls, that meet these requirements:

Gradation	
Sieve Size	**Percent Passing by Weight**
4 in (100 mm)	100
1-1/2 in (37.5 mm)	90-100
No. 200 (75 µm)	0-35
Other Properties	
Maximum dry density	90 lb/ft³ (1440 kg/m³) (minimum)
Volume change	0-25%

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Gradation	AASHTO T 11 and AASHTO T 27
Maximum dry density	GDT 7 or GDT 67
Volume change	GDT 6

D. Materials Warranty

General Provisions 101 through 150.

Section 814—Soil Base Materials

814.1 General Description

This section includes the requirements for soil base materials, including topsoil or sand-clay, soil-cement, sand for bituminous stabilization, and chert.

814.1.01 Related References

A. Standard Specifications

Section 301– Soil-Cement Construction

Section 800–Coarse Aggregate

Section 810–Roadway Materials

Section 831–Admixtures

B. Referenced Documents

AASHTO T 89

AASHTO T 90

GDT 4

GDT 6

GDT 7

GDT 65

GDT 67

814.2 Materials

814.2.01 Topsoil or Sand-Clay

A. Requirements

1. Use topsoil or sand-clay that is a natural or artificial mixture of clay or soil binder with sand or other aggregate.
   - Do not use a mixture that contains substances detrimental to the material.
   - Obtain the materials from sources approved by the Engineer.
   - Ensure that the aggregate retained on No. 10 (2 mm) sieve (coarse aggregate) is of hard, durable particles.
2. Sand and Binder

   Use hard, sharp, durable, siliceous particles. Use binder made from quality clay.
3. Oversize

   Remove particles with diameters greater than 2 in (50 mm) before depositing the topsoil or sand-clay on the road.

   Remove particles with screens or grizzlies, or by hand if few oversized pieces exist. You may crush the oversized pieces and use them.
4. Topsoil

   Use a topsoil that is a natural, generally pebbly material occurring in shallow surface deposits on usually elevated areas.
5. Natural Sand-Clay

   Use a natural sand-clay that is a mixture of natural material, largely sand and clay in proper proportions, occurring in deposits of considerable depth.

6. Artificial Sand-Clay

   Use an artificial sand-clay that is largely a mixture of artificial sand and clay. You may make the mixture by combining clay or soil binder and sand or aggregate in the proper proportions.

7. Topsoil and Sand-Clay

   Use topsoil and sand- clay with the following properties:

Sieve Size	Amount
Passing 2 in (50 mm)	100% by weight
Passing 1-1/2 in (37.5 mm)	80-100% by weight
Passing No. 40 (425 µm)	Liquid Limit (LL) of 25 or less Plasticity Index (PI) of 9 or less

8. Ensure that material passing the No. 10 (2 mm) sieve meets the following requirements:

Sieve Size	Percent Passing by Weight
Passing No. 10 (2 mm) sieve	100
Passing No. 60 (250 µm) sieve	15-85
Passing No. 200 (75 µm) sieve	9-35
Clay	9-25
Volume change, max. percent	12
Maximum density, lb/ft³ (kg/m³)	110+ (1760+)

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

The Department or Producer will test as follows:

Test	Method
Soil gradation	GDT 4
Volume change	GDT 6
Maximum density	GDT 7 or GDT 67
Liquid Limit	AASHTO T 89
Plastic Limit and Plasticity Index	AASHTO T 90

D. Materials Warranty

General Provisions 101 through 150.

814.2.02 Soil-Cement Material

A. Requirements

1. Ensure that the material for soil-cement base will:

   Meet the requirements of Subsection 810.2.01 for Classes IA1, IA2, IA3, or IIB1 with the following modifications:

Clay content	4 to 25%
Volume change	18% maximum
Liquid Limit	25% maximum
Plasticity Index	10% maximum
Maximum dry density	95 lb/ft³ (1520 kg/m³) minimum

   Be friable and not contain large amounts of heavy or plastic clay lumps, organic material, roots, or other substances that would interfere with how the Portland cement sets, plant production, or the finished surface of the base and meet the requirements of Subsection 301.3.05.A.2, "Pulverization" or Subsection 301.3.05.B.1, "Soil".

   Produce a laboratory unconfined compressive strength of at least 450 psi (3.1 MPa). To make the sample, mix in a maximum of 8 percent Type I Portland cement, moist-cure for 7 days, and test with GDT 65.

2. Analyze the soil-cement design and create a Job Mix Formula for each Project where soil-cement base or subbase is specified. Have the Job Mix Formula approved by the Engineer before starting base or subbase construction.
3. You may use fly ash or slag that meets the requirements of Subsection 831.2.03 as admixtures for poorly reacting soils when the blend of soil and fly ash, or slag, meets the design requirements in this Subsection.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Soil-Cement Design	GDT 65

D. Materials Warranty

General Provisions 101 through 150.

814.2.03 Sand for Bituminous Stabilization

A. Requirements

1. Submit the bituminous stabilization sand materials to the laboratory in advance. If the laboratory approves the material, use it in constructing the sand- bituminous base course.
2. Use hard, durable particles without organic impurities such as roots or trash that may prevent the bituminous material from bonding with the individual particles.

3. Grade the material as follows:

Size	Percent Passing by Weight
Passing 1 in (25 mm) sieve	100
Passing No. 10 (2.00 mm) sieve	80-100
Passing No. 200 (75 µm) sieve	0-25
Clay	0-16

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Soil gradation	a. GDT 4

D. Materials Warranty

General Provisions 101 through 150.

814.2.04 Chert

A. Requirements

Use materials that are natural mixtures of binder and chert rock with the following characteristics:

- Ensure that the aggregate retained on the No. 10 (2 mm) sieve (coarse aggregate) is a hard, durable chert rock meeting requirements for Class A or B coarse aggregate (see Subsection 800.2.01).

  Use aggregate sizes in the final mix that can be properly placed, compacted, and finished.
- Ensure that the portion of material passing the No. 10 (2 mm) sieve is sand and clay or another satisfactory bonding material.

1. Gradation

Grade the material as follows:

Size	Percent by Weight
Passing 1-1/2 in (37.5 mm) sieve	80-100
Passing No. 10 (2 mm) sieve	30-60
Material Passing No. 10 (2 mm) Sieve	
Passing No. 10 (2 mm) sieve	100
Passing No. 60 (250 µm) sieve	20-85
Passing No. 200 (75 µm) sieve (silt less clay)	5-25
Clay	15-50

Ensure that the material passing the No. 40 (425 µm) sieve has a Liquid Limit (LL) of 35 or less and a Plasticity Index (PI) of 10 or less.

2. Stockpiles

In all cases, stockpile the end product so that the material will be blended before any of it is loaded and delivered to the job.

Make a stockpile big enough to uniformly blend the workable strata in the pit.

The Engineer will determine the minimum volume of the stockpile. The Engineer will also be the sole authority as to the quality and workability of the various strata occurring in the pit.

Maintain the minimum volume of the stockpile until the suitable material in the pit has all been stockpiled or until the material remaining in the stockpile is enough to complete the operation, as governed by haul limitations.

3. Equipment for Delivery

Use equipment that will mix the material again while the material is being loaded for delivery.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Soil gradation	GDT 4
Liquid Limit	AASHTO T 89
Plastic Limit and Plastic Index	AASHTO T 90

D. Materials Warranty

General Provisions 101 through 150.

Section 815—Graded Aggregate

815.1 General Description

This section includes the requirements for material to be used for base, subbase, or shoulder course material, and includes graded aggregate, unconsolidated limerock base, and crushed concrete base.

815.1.01 Related References

A. Standard Specifications

Section 800—Coarse Aggregate

B. Referenced Documents

AASHTO T 27

ASTM C 295

ASTM D 3042

FL DOT Method FM5-515

SOP–1

GDT 63

815.2 Materials

815.2.01 Graded Aggregate

A. Requirements

1. Type

   Use graded aggregate base, subbase, or shoulder course material of uniform quality.

   Obtain the graded aggregate from an approved source or deposit that will yield a satisfactory mixture meeting all requirements of this Specification.

   Use material that is crushed or processed as a part of the mining operations, or, mix two grades of material so that when combined in the central mix plant, the mixture meets the specifications.

2. Retained on the No. 10 (2 mm) sieve

   Ensure that the material retained on the No. 10 (2 mm) sieve is Class A or B aggregate that meets the requirements of Section 800.

3. Passing the No. 10 (2 mm) sieve

   Ensure that any material passing the No. 10 (2 mm) sieve is relatively free of detrimental substances, such as soil overburden, decomposed rock, and/or swelling silts.

4. Stabilized Mixtures

   Ensure that mixtures to be stabilized react satisfactorily when mixed with Portland cement. The Engineer will specify the percentage of Portland cement to use.

5. Gradation

   Grade the graded aggregate base, subbase, or shoulder material as follows:

Sieve Size	Percent Passing By Weight
Group I Aggregates	
2 in (50 mm)	100
1-1/2 in (37.5 mm)	97-100
3/4 in (19.0 mm)	60-95
No. 10 (2 mm)	25-50 (Note 1, 2 and 3)

Sieve Size	Percent Passing By Weight
No. 60 (250 µm)	10-35
No. 200 (75 µm)	7-15
Group II Aggregates	
2 in (50 mm)	100
1-1/2 in (37.5 mm)	97-100
3/4 in (19 mm)	60-90
No. 10 (2 mm)	25-45 (Note 2 and 4)
No. 60 (250 µm)	5-30
No. 200 (75 µm)	4-11
NOTE 1: Group I aggregates having less than 37% passing the No. 10 (2 mm) sieve, shall have at least 9 percent passing the No. 200 (75 µm) sieve.	
NOTE 2: For graded aggregate stabilized with Portland Cement, 30-50 percent by weight shall pass the No. 10 (2 mm) sieve. All other requirements remain the same.	
NOTE 3: Material passing the No. 10 (2 mm) sieve shall have a sand equivalent of at least 20 for Group I aggregates.	
NOTE 4: Material passing the No. 10 (2 mm) sieve shall have a sand equivalent of at least 28 for Group II aggregates. Sand Equivalent values as low as 20 will be acceptable provided they are attributed exclusively to rock flour and the percent passing the No. 10 (2 mm) sieve does not exceed 40.	

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Gradation	AASHTO T 27
Sand Equivalent	GDT 63

D. Materials Warranty

General Provisions 101 through 150.

815.2.02 Unconsolidated Limerock Base

A. Requirements

1. Type

Use limerock base, subbase, or shoulder course material of uniform quality.

a) To ensure uniform quality, the Department may restrict approved sources to specific mining areas, mining processes at a specific mining site, or both.

b) Use a limerock base that yields a mixture to meet these Specifications.

c) Use material that is crushed or processed as a part of the mining operations, or mix two grades of material so that when combined in the central mix plant the mixture meets the specifications.

d) Use limerock base, subbase, or shoulder material that has the following characteristics:

Limerock bearing ratio	At least 100.
Deleterious substances	Do not allow chert or other extremely hard pieces that will not pass the 2 in (50 mm) sieve. Do not allow clay, sand, organics, or other materials in quantities that may damage bonding, finishing, or strength. All material passing the No. 40 (425 μm) sieve shall be non-plastic.
Carbonate content (magnesium or calcium)	At least 90%.

2. Gradation

a) Grade the limerock base so at least 97 percent by weight passes the 3-1/2 in (90 mm) sieve.

b) Grade the material uniformly to dust. The fine portion passing the No. 10 (2 mm) sieve shall all be dust of fracture.

c) Crush or break the limerock base, if necessary to meet size requirements before placing the material on the road.

d) Ensure that materials having soundness losses of 20% or less, comply with the following gradation requirements:

Gradation Requirements

SIEVE SIZE	PERCENT PASSINGBY WEIGHT
2” (50 mm)	100
1-1/2” (37.5 mm)	97-100
3/4” (19 mm)	60-95
No. 10 (2.00 mm)	25-45
No. 60 (250 μm)	10-30
No. 200 (75 μm)	7-20

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Gradation	AASHTO T 27
Limerock bearing ratio	FL DOT Method FM5-515
Petrographic analysis	ASTM C 295
Total carbonates (insoluble residue)	ASTM D 3042

D. Materials Warranty

General Provisions 101 through 150.

815.2.03 Crushed Concrete Base

A. Requirements

1. Sources

   Obtain sources of crushed concrete materials approved by the Office of Materials and Research. The criteria for approval will be as outlined in Standard Operating Procedure No. 1, "Monitoring the Quality of Coarse and Fine Aggregates" except that the raw material will be recyclable concrete as specified herein rather than a geological deposit of aggregate.

2. Type

   Use crushed concrete derived exclusively from Portland cement concrete pavement or structural concrete as a base, subbase, or shoulder course.

   Ensure that the material does not contain delivery unit washout material.

3. Gradation

   Ensure that the finished product meets the quality and gradation requirements of Subsection 815.2.01 for Group II aggregates, except that the aggregate will be recycled concrete.

   Ensure that the finished product is free of foreign materials such as asphaltic concrete, steel reinforcement, clay balls, soils, epoxy expansion material, and miscellaneous paving materials.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Gradation	AASHTO T 27
Sand Equivalent	GDT 63

D. Materials Warranty

General Provisions 101 through 150.

815.2.04 Inorganic Mineral Ash

A. Requirements

Inorganic mineral ash base, subbase, or shoulder course material is restricted to use on local roads only and shall not be used on Interstates or State Highway System routes.

1. Sources

Obtain inorganic mineral ash from an approved source or deposit that will yield a satisfactory mixture meeting all requirements of this Specification after it has been processed or crushed as a part of the mining operations.

The inorganic mineral ash shall be of uniform quality throughout. To ensure uniformity in quality, approved sources may be restricted to specific mining areas and/or mining processes at a specific mining site.

2. Type

   Ensure inorganic mineral ash base, subbase, or shoulder course material conforms to the following types:

   Class C Fly Ash: Class C fly ash is the finely divided residue that results from the combustion of ground or powdered coal and is transported from the boiler by flue gases.

   Circulating Fluidized Bed Combustor Ash (CFBC Ash): CFBC ash is the residue that results from the combustion of petroleum coke with the injection of lime or crushed limestone directly into the boiler for sulfur removal and is transported from the boiler by flue gases.

   The CFBC ash shall have a minimum Available Lime Index of 5 percent.

3. Gradation

Use inorganic mineral ash that has at least 97 percent (by weight) of the material passing a 3 ½-inch (90 mm) sieve and is graded uniformly down to dust.

Perform all crushing or breaking up necessary to meet the size requirements before the material is placed on the road.

A grading range on material being shipped to Department Projects may be established as a guide to verify consistency of the product.

Do not use inorganic mineral ash that contains extremely hard pieces of material retained on the 2-inch (50 mm) sieve when they are considered deleterious to the clipping and finishing of the base material when placed on the roadway.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Sieve Analysis	AASHTO T 27
Class C Fly Ash	AASHTO M 295
Available Lime Index	ASTM C 25

D. Materials Warranty

General Provisions 101 through 150.

Section 816—Soil Aggregate Bases

816.1 General Description

This section includes the requirements for material to be used as soil aggregate base.

816.1.01 Related References

A. Standard Specifications

Section 815—Graded Aggregate

B. Referenced Documents

AASHTO T 89

AASHTO T 90

GDT 4

GDT 6

GDT 7

GDT 13

816.2 Materials

816.2.01 Soil Aggregate

A. Requirements

1. Type

   Use a soil aggregate base, subbase, or shoulder base course material that is of uniform quality.

2. Material Retained on No. 10 (2 mm) sieve

   Ensure the material retained on the No. 10 (2 mm) sieve meets the requirements of Subsection 815.2.01.A.

NOTE: You may substitute Group I graded aggregate base that meets the requirements of Subsection 815.2.01.A for soil aggregate base.

3. Gradation

   Ensure the soil aggregate base, subbase, or shoulder material meets the following gradation:

Size	Percent by Weight
Passing 2 in (50 mm) sieve	100
Passing 1-1/2 in (37.5 mm) sieve	95-100
Passing 3/4 in (19 mm) sieve	60-97
Passing No. 10 (2 mm) sieve	25-55
Material passing No. 10 (2 mm) sieve	
Passing No. 10 (2 mm) sieve	100
Passing No. 60 (250 µm) sieve	15-85
Passing No. 200 (75 µm) sieve (silt less clay)	3-25
Clay (8 minutes suspension on elutriation test)	10-25

   a. Ensure that the material passing the No. 10 (2 mm) sieve has a total volume change of 15 or less.

   b. Ensure that the material passing the No. 40 (425 µm) sieve has a Liquid Limit (LL) of 25 or less and a Plasticity Index (PI) of 9 or less.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Gradation	GDT 4 and GDT 13
Volume change	GDT 6
Liquid limit	AASHTO T 89
Plastic limit and plasticity index	AASHTO T 90

D. Materials Warranty

General Provisions 101 through 150.

816.2.02 Soil Mortar for Soil Aggregate Base

A. Requirements

Use a soil mortar for soil aggregate bases of friable materials meeting these requirements:

Percent passing No. 200 (75 µm) sieve	0-65
Volume change	0-15
Maximum dry density	95 lb/ft³+ (1520 kg/m³ +)

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Test as follows:

Test	Method
Gradation	GDT 4
Volume change	GDT 6
Maximum dry density	GDT 7

D. Materials Warranty

General Provisions 101 through 150.

SECTION VI

TEST PROCEDURES

**TO VIEW GDT TEST PROCEDURES,
PLEASE VISIT
"THE SOURCE"
ON THE OMR WEBSITE**

at

http://www.dot.ga.gov/doingbusiness/TheSource/Pages/sti.aspx

PLEASE NOTE:

Due to copyright laws, the AASHTO procedures are not on the Source and cannot be reproduced.

SECTION VI

Test Procedures

Learning Objectives

In this section, the following learning objectives will be discussed:

- ✓ Familiarization with the current AASHTO and Georgia test procedures pertaining to aggregates

GDT Table of Contents

Sand Equivalent of Soils and Fine Aggregate

GDT 63

A. Scope

For a complete list of GDTs, see the Table of Contents.

This method serves as a rapid field-correlation test. The purpose of this method is to indicate, under standard conditions, the relative proportions of clay-like or plastic fines and dust in granular soils and fine aggregates that pass the No. 10 (2.00) mm sieve. The term "sand equivalent" expresses the concept that most granular soils and fine aggregates are mixtures of desirable coarse particles, sand, and generally undesirable clay or plastic fines and dust.

B. Apparatus

1. Graduated Measuring Cylinder—Graduated measuring cylinder made of transparent acrylic plastic having an inside diameter of 1.2 in (30.75 mm), a height of 17.25 in (431.8 mm) with graduations up to 15 in (381 mm) by tenths of an inch (1mm) increments, beginning at the inside bottom, and a rubber stopper to fit in the mouth of the cylinder (WS-E-02).
2. Irrigator Tube—Irrigator tube made of 1/4 (6 mm) outside diameter stainless steel tubing with one end closed to form a wedge-shaped point. Drill a hole [drill size No. 60 (1.016 mm)] on each side of the wedge approximately 1/8 in (3 mm) from the tip. The angle of the holes should be between 30 and 50 degrees from the vertical (WS-E-07).
3. Siphon Assembly—A siphon assembly consisting of a 1 gal (3.785 liter) bottle (WS-E-06), a 1/4 (6 mm) diameter copper bent tube 16 in (406.4 mm) long, 48 in (1219.2 mm) of 3/16 in (4.76 mm) inside diameter rubber tubing (WS-E-09) (pure gum or equal) with pinch clamp, a blow tube, 2 in (50 mm) of 1/4 in (6 mm) diameter copper tube, (50 mm) of 3/16 (4.76 mm) inside diameter rubber tube and a No. 6 rubber 2-hole stopper. In lieu of the specified plastic bottle, you may use a glass or plastic vat having a larger capacity, provided you maintain the liquid level of the working solution between 3 ft (0.9144 m) and 3.8 ft (1.1684 m) above the work surface.
4. Weighted Foot Assembly—Weighted foot assembly consisting of a 1/4 (6 mm) diameter brass rod 17.5 in (445 mm) long, threaded on both ends, a brass foot 1.187 in (30.15 mm) hex by 0.54 in (13.72 mm), a weight approximately 2 in (50 mm) by 2.078 in (52.78 mm) of cold-rolled steel, a sand reading indicator 1.13 in (28.7 mm) in diameter by 0.59 in (14.99 mm) made of Nylon 101, Type 66 Annealed. The top edge of the sand reading indicator shall be exactly 10.1 in (256.54 mm) from the bottom of the brass foot. The total weight of the assembly shall be 2.2 lbs ± 0.01 lbs (1000g ± 5 g).

NOTE: The older model weighted foot assembly has a guide cap that fits over the upper end of the graduated cylinder and centers the rod in the cylinder. The foot of the assembly has a conical upper surface and three centering screws to center it loosely in the cylinder. The older model does not have the sand reading indicator affixed to the rod, but a slot in the centering screws of the weighted foot is used to indicate the sand reading. You may use this weighted foot assembly if the newer model is not available.

5. Measuring Can—Measuring can, 3 oz ± 0.18 oz (85 ml ± 5 ml) capacity (W-SE-05).
6. No. 10 (2.00 mm) Sieve—No. 10 (2.00 mm) sieve conforming to the requirements of AASHTO Designation M-92 (WS-08-#010).
7. Funnel—Funnel, wide mouth, for transferring soil into the cylinder (WS-E-04).
8. Bottle—1 gal (3.78) liter bottle to store the working solution (WS-E-06).
9. Plastic Bag—(WB0])
10. Timing Clock—Timing clock or watch (WS-15).
11. A Large Spoon—A large spoon with the sides bent in an approximate "V" shape, (WS-14).

- Materials
  1. Stock Solution (WS-E-03)—Make this solution by dissolving 1 lb (454 g) of calcium chloride in 1/2 gal (1.89 L) of distilled water. Cool and filter through ready-pleated rapid filtering filter paper. Add 4.5 lbs [(2050 grams (1640 ml)] of USP glycerin and 1.7 oz (47 grams (45 ml) of formaldehyde to the filtered solution, mix well and dilute to 1 gal (3.78 L).
  2. Working Solution—Dilute 1 measuring can full 3 oz (85 + 5 ml) of the stock solution to 1 gal (3.78 L) with distilled water. You may use demineralized or tap water of good quality, but compare results of the sand equivalent tests on identical samples using solutions made with the water in question and with the distilled water.

- Precautions
  1. Perform the test in a vibration-free location. Vibrations may cause the suspended material to settle at a faster rate, or may prevent settlement.
  2. Do not expose the plastic cylinders to direct sunlight any more than necessary.
  3. Occasionally you may need to remove a fungus growth from the working calcium chloride solution container and from the inside of the flexible tubing and irrigator tube. This fungus is easily detected as a slimy substance in the solution. To remove this growth, follow these steps:
     a. Prepare a cleaning solvent by diluting sodium hypochlorite (Clorox, or its equivalent, is satisfactory) with an equal quantity of water.
     b. Fill the solution container with the prepared solvent, allow about 1/4 gal (liter) of the solvent to flow through the siphon assembly and irrigator tube.
     c. Close the pinch clamp on the end of the tubing to hold the solvent in the tube.
     d. Refill the container and allow to stand overnight.
     e. After this soaking, remove the solvent through the siphon assembly and irrigator tube.
     f. Remove the siphon assembly from the solution container and rinse both with clear water. Rinse the irrigator tube and siphon assembly by connecting a hose between the tip of the irrigator tube and a water faucet and backwash fresh water through the tube.
  4. Occasionally the holes in the tip of the irrigator tube may become clogged by a particle of sand. If the obstruction cannot be freed by less destructive methods, use a pin or other sharp object to force it out using extreme care not to enlarge the size of the opening.

C. Sample Size and Preparation

1. Perform the sand equivalent test on soils or fine aggregate materials passing the No. 10 (2.00 mm) sieve. Perform the sieving on oven-dried material. Break down any lumps of finer material present in the original sample to pass the No.10 (2.00 mm) sieve by grinding with a rubber covered pestle or wooden mallet. Add the resulting fines to the sample.

NOTE: When running samples in the field for control purposes, you may run them damp, but they must not have free moisture present. Take extreme care to prevent the fines from being left stuck to the coarser particles when sieving over the No. 10 (2.00 mm) sieve. Results obtained with damp samples will almost always be lower, so if a sample fails when run damp, run it using oven-dried material.

2. The prepared sample shall be approximately 1.1 lbs (500 g). Put the material in a plastic bag (if available) and twist the end of the bag closed to trap air in the bag. Thoroughly mix the sample by holding the bag at both ends and vigorously shake it back and forth in an elliptical motion.

NOTE: If a plastic bag is not available, thoroughly mix the prepared sample in a flat bottom pan or bowl. Take care to prevent the sample from segregating or from losing fines.

3. Place the plastic bag on its side so you may scoop into the material with the large spoon that has been bent into an approximate "V" shape. Ensure that the sample for any one test is one measuring can full.
4. When filling the 3 oz (85 ml) cans, tap the bottom edge of the cans on the work table or other hard surface to consolidate the material and to allow more material to be placed in the cans. Fill the cans to the

brim or give a slightly rounded surface above the brim, but do not overflow. Use extreme care in this procedure to obtain a truly representative sample.

D. Procedures

1. Place the 1 gal (3.78 L) bottle of the siphon assembly 3 ft ± 1 in (914.4 mm ± 25.4 mm) above the working surface. Start the siphon by blowing into the top of the solution bottle through the short piece of tubing while the pinch clamp is open. The apparatus is now ready to use.
2. Siphon the working solution into the plastic cylinder to a depth of 4 in ± 1 in (1219.2 mm ± 25.4 mm).
3. Pour one measuring can full of the prepared sample into the plastic cylinder, using the funnel to avoid spillage. Tap the bottom of the cylinder firmly on the heel of the hand several times to dislodge any air bubbles and to aid in wetting the sample. Allow to stand for 10 minutes.
4. At the end of the 10 minute soaking period, stopper the cylinder then loosen the material from the bottom by tilting and simultaneously shaking the cylinder.
5. After loosening the material from the bottom of the cylinder, shake the cylinder and contents using the following method:
   a. Hold the cylinder in a horizontal position and shake it vigorously in a horizontal linear motion from end to end.
   b. Shake the cylinder 90 cycles in approximately 30 seconds, using a throw of 9 in ± 1 in (225 mm ± 25 mm). A cycle is a complete back and forth motion. To shake the cylinder properly at this speed, have the operator shake with forearms only, relaxing the body and shoulders.
6. Following the shaking operation, set the cylinder upright on the work table and remove the stopper.
7. Insert the irrigator tube in the cylinder and rinse material from the cylinder walls as the irrigator tube is lowered. Force the irrigator tube through the material to the bottom of the cylinder by applying a gentle stabbing and twisting action, while the working solution flows from the irrigator tip. This flushes the fine material into the suspension above the coarser sand particles. Continue to apply a stabbing and twisting action while flushing the fines upward until the cylinder is filled to the 15 in (381 mm) mark.
8. Raise the irrigator tube slowly without shutting off the flow so that the liquid level is maintained at approximately 15 in (381 mm) while the irrigator tube is being withdrawn. Regulate the flow just before the irrigator tube is entirely withdrawn and adjust the final level to 15 in (381 mm).
9. Allow the cylinder and contents to stand undisturbed for 20 minutes 15 seconds. Start timing immediately after withdrawal of the irrigator tube is complete.
10. At the end of the 20-minute sedimentation period, read and record the level of the top of the clay suspension on the graduated cylinder. This is the "clay reading. " If no clear line of demarcation has formed at the end of the specified 20-minute sedimentation period, allow the sample to stand undisturbed until a clay reading can be obtained. Then immediately read and record the level of the clay suspension and the total sedimentation time. If the total sedimentation time exceeds 30 minutes, rerun the test 2 times using 2 individual samples of the same material. Read and record the clay column height of that sample requiring the shortest sedimentation period only. If clay or sand readings fall between the 0.1 in (2.54 mm) graduation, record the level of the higher graduation as the reading. For example, a clay level at 7.95 in (201.93 mm) is recorded as 8.0 (202 mm). A sand level at 3.22 in (81.788 mm) is recorded at 3.3 in (81.8 mm).
11. When using the weighted foot assembly having the sand reading indicator on the rod of the assembly, place the assembly over the cylinder and gently lower the assembly toward the sand. Do not allow the indicator to hit the mouth of the cylinder as the assembly is being lowered. As the weighted foot comes to rest on the sand, tip the assembly toward the graduations on the cylinder until the indicator touches the inside of the cylinder. Subtract 10 in (254 mm) from the level indicated by the extreme top edge of the indicator and record this value as the "sand reading."
12. If using an older model weighted foot assembly having centering screws, keep one of the centering screws in contact with the cylinder wall near the graduation so you can see it at all times while the assembly is being lowered. When the weighted foot has come to rest on the sand, read the level of the centering screw and record this value as the "sand reading."

13. To empty the cylinder, insert the stopper and shake the cylinder up and down in an inverted position until the sand plug is disintegrated. Empty immediately and rinse twice with water.
14. Perform the sand equivalent test twice. If the results are within 4 points of each other, report the average. Variances of more than 4 points between results indicate too much error in operator procedure or sample selection. In such cases, run a third test and average the 2 closest results (within 4 points of each other) using the method shown in Calculations, 3 below. Report the results.

E. Calculations

1. Calculate the sand equivalent (SE) to the nearest 0.1 using the following formula:

$$SE = \frac{Sr}{Cr} \times 100$$

Sr = Sand reading

Cr = Clay reading

2. When the result of this calculation is not a whole number, the sand equivalent (SE) shall be the next higher whole number as in the example below.
3. To determine the sand equivalent (SE) for a material after performing the series of tests called for in Procedures, 14 above on the material, average the sand equivalents from the two tests selected. The sand equivalent value shall be that average raised to the next higher whole number when the result of this calculation is not a whole number as in the example below:

$$\text{If SE values} = 41 \text{ and } 42, \text{ average SE} = \frac{41+42}{2} = 41.5 = 42$$

F. Report

The average sand equivalent shall be reported as in the example below:

SE= 42

Rapid Determination of the Apparent Specific Gravity of Coarse Aggregate

GDT 74

A. Scope

For a complete list of GDTs, see the Table of Contents.

Use this test method to rapidly determine the apparent specific gravity of coarse aggregate to be used in asphaltic concrete.

Note: This method does not apply to all types of aggregate. Use this method only when you have a definite correlation in gravities between this method and the method described in AASHTO T 85-74.

B. Apparatus

The apparatus consists of the following:

1. Sieves—Use a No. 4 (4.75 mm) sieve, conforming to the requirements of the "Standard Specifications for Sieves for Testing Purposes," AASHTO M 92 (WS-08-#XXX).
2. Container—Use a pan or vessel big enough to contain the sample during washing and drying.
3. Balance—Use a balance or scale with at least a 11 lb (5 kg) capacity, sensitive to 0.002 lb (1.0 g) or less, and accurate within 0.1 percent of the test load at any point within the range used for this test.
4. Submerged Sample Container—Use a wire basket of No. 6 (3.35 mm) or finer mesh, and a bucket or vat large enough to contain enough water to suspend the basket.
5. Oven—Use a device capable of drying the material to a constant weight.

C. Sample Size and Preparation

1. Use a sample splitter or quartering device to select approximately 11 lb (5000 g) of the aggregate from the sample to be tested.
2. Discard all material passing the No. 4 (4.75 mm) sieve.

D. Procedures

1. Place the test sample in a container.
2. Wash the sample thoroughly to remove dust and other coatings from the surface of the particles.
3. Dry the sample to a constant weight.
4. Let the material cool to the surrounding air temperature.
5. Determine and record the dry weight in air for the washed sample.
6. Place the sample in the wire basket.
7. Immerse the basket in the vat filled with water.
8. Immediately determine and record the weight of the basket in the water.

E. Calculations

Calculate the apparent specific gravity as follows:

Approximate Apparent Specific Gravity $= Wd \div (Wd - Ww)$

where:

Wd = dry weight in air

Ww = weight in water

F. Report

Report the results of the test on Form 658.

Determining Production of Plastic Fines in Fine Aggregate

GDT 75

A. Scope

For a complete list of GDTs, see the Table of Contents.

Use this test method to determine the durability of aggregate. The durability index is a value indicating the relative resistance of an aggregate to produce detrimental clay-like fines when subjected to the prescribed mechanical methods of degradation.

B. Apparatus

The apparatus consists of the following:

1. Mechanical Washing Vessel ("Pot")—Use a flat bottom, straight-sided, cylindrical vessel. (A discarded air meter bucket with dimensions as shown in GDT 26 alternate is satisfactory. Mill the top and lip of the bucket to prevent leaks and to make the container adaptable to the shaker.)
2. Lid—Use an 8 in (200 mm) sieve pan with nesting skirt fitted with an "O" ring.
3. Agitator—Use a modified Tyler Portable sieve shaker set to operate at 285, ± 10 complete cycles per minute.
4. Graduated Cylinder—Use a 33.8 oz (1000 ml) graduated cylinder for measuring water (OC-16).
5. Measuring Can—Use a 3 oz (85, ± 5 ml) can.
6. Funnel—Use a wide mouth for transferring material into cylinder (W-SE-4).
7. Timing Clock or Watch (WS-15-2).
8. Sieves—Use sieves that conform to the requirements of AASHTO M 92 (WS-08-#XXX).
9. Balance or Scale—Use a balance or scale with a minimum capacity of 1.5 lb (700 g) and accurate to 0.0002 lb (0.1 g).
10. Mechanical Sand Equivalent Shaker—Use a mechanical shaker having a horizontal throw of 8 in, ± 0.04 in (200 mm, ± 1.02 mm) and operating at 175, ± 2 cycles per minute, modified with the addition of a 30 minute timer. The shaker should be securely fastened to a firm and level mount.
11. Plastic Bag (WB-01)
12. Spoon—Use a large spoon with the sides bent in an approximate "V" shape (WS-14).
13. Graduated Plastic Cylinder (W-SE-1, includes items 13 through 16; W-SE-2 is the measuring cylinder only)—Use a cylinder made of transparent acrylic plastic with an inside diameter of 1-1/4 in (32 mm) and a height of 17 in (432 mm). It must have gradations up to 15 in by 1/10 in (380 mm by 2.5 mm), starting at the inside bottom, and a rubber stopper to fit in the mouth of the cylinder.
14. Irrigator Tube—Use 1/4 in (6 mm) outside diameter, stainless-steel tubing. Close one end to form a wedge-shaped point. A hole (drill size No. 60 (250 µm)) is drilled on each side of the wedge, approximately 1/8 in (3 mm) from the tip. The angle of the holes should be between 30 and 50 degrees from vertical.
15. Siphon Assembly—Use a 1 gal (3.8 L) bottle; a 1/4 in (6 mm) diameter, 16 in (406 mm) long, bent copper tube; 48 in of 3/16 in (1.2 m of 5 mm) inside diameter rubber tubing (pure gum or equal) with pin clamp; a blow tube; 2 in of 1/4 in (50 mm of 6 mm) diameter copper tube; 2 in of 3/16 in (50 mm of 5 mm) inside diameter rubber tube; and a No. 6 (3.5 mm) rubber two-hole stopper.

    Fit the siphon assembly to a 1 gal (3.8 L) bottle of working calcium chloride solution. Place it on a shelf 36 in, ± 1 in (1 m, ± 25 mm) above the work surface. In place of the bottle, you may use a larger-capacity glass or plastic vat, provided you keep the liquid level of the working solution between 36 and 46 in (1 m and 1.17 m) above the work surface (WS-E-01).
16. Weighted Foot Assembly—Use a 1/4 in (6 mm) diameter brass rod 17-1/2 in (445 mm) long, threaded on both ends; a brass foot 1.187 in hex by 0.54 in (244 mm hex by 14 mm); a weight 2 in by 2.078 in (50.8 mm by 52.8 mm) of cold-rolled steel; a sand reading indicator 1.13 in (28.7 mm) diameter by 0.59 in (15

mm) made of Nylon 101, Type 66 Annealed. The top edge of the sand reading indicator shall be exactly 10.1 in (256.54 mm) from the bottom of the brass foot. The total weight of the assembly shall be 2.2 lbs ± 0.01 lb (1000g, ± 5 g).

17. Stock Calcium Chloride Solution (WS-E-03)—Make the stock solution by dissolving 1 lb (454 g) of calcium chloride in 1/2 gal (1.89 L) of distilled water. Cool and filter through ready-pleated, rapid filtering filter paper. Add 2050 g (1640 ml) of USP glycerin and 47 g (45 ml) of formaldehyde to the filtered solution. Mix well and dilute to 1 gal (3.8 L).
18. Working Calcium Chloride Solution—Dilute 3 oz (85, ± 5 ml) of the stock solution to 1 gal (3.8 L) with distilled water.
19. Water—Use demineralized or tap water of good quality but check it by comparing results of the Durability Index Tests on identical samples using water in question and distilled water.

C. Sample Size and Preparation

1. Precautions

Use the following precautions while performing the tests:

a. Perform the test in a location free of vibrations. Vibrations may cause the suspended material to settle at a faster rate or prevent settling.

b. Do not expose the plastic cylinders to direct sunlight any more than necessary.

c. You may occasionally need to remove a fungus growth (a slimy substance in the solution) from the working calcium chloride solution container and from the inside of the flexible tubing and irrigator tube.

   1) To remove the growth, prepare a cleaning solution by diluting sodium hypochlorite (like Clorox or its equivalent) with an equal quantity of water.
   2) Fill the solution container with the prepared solvent and allow about 1.2 qt (1 L) of the solvent to flow through the siphon assembly and irrigator tube.
   3) Close the pin clamp on the end of the tubing to hold the solvent in the tube.
   4) Refill the container and allow to stand overnight.
   5) After the soaking, remove the solvent through the siphon assembly and irrigator tube.
   6) Remove the siphon assembly from the solution container and rinse both with clear water. You may connect a hose between the tip of the irrigator tube and a water faucet and backwash fresh water through the tube and the siphon assembly.

d. Occasionally the holes in the tip of the irrigator tube may be clogged with a particle of sand. If you cannot remove the sand with water or another non-destructive method, use a pin or other sharp object to force it out.

Note: Use extreme care to not enlarge the opening.

e. Perform this test without strict temperature control. In the event of dispute, retest the material with the temperature of the water and working calcium chloride solution at 72 °, ± 5 °F (22 °, ± 3 °C).

f. Frequently check the play between the cam and eccentric on the modified Tyler portable shaker.

   1) Grasp one of the hanger rods and attempt to move the sieve base. If you notice any play, replace the cam and/or bearing.

g. Lubricate the sieve shaker at least every 3 months.

2. Sample Preparations

a. Dry the preliminary test sample to constant weight at 230 °, ± 9 °F (110 °, ± 5 °C).

b. Cool to room temperature.

c. Sift the sample over a No. 10 (2.00 mm) sieve.

d. Break up any lumps of clay or bonded fine material and remove the coatings of fines from the plus No. 10 (2.00 mm) material without appreciably reducing the natural individual particle sizes.

e. Discard the plus No. 10 (2.00 mm) material.
f. Split or quarter a representative portion from the material passing the No. 10 (2.00 mm) sieve so that it weighs 1.1 lbs ± 0.05 lbs (500, ± 25 g).
g. Place this preliminary test sample in the mechanical washing vessel.
h. Add 33.8 oz (1000 ml) of distilled or demineralized water and clamp the vessel lid in place.
i. Secure the vessel in the sieve shaker so you can begin agitation 10 minutes ± 30 seconds after you added wash water to the material.
j. Agitate the vessel for 2 minutes ± 5 seconds.
k. After the 2-minute agitation period, remove the vessel from the shaker.
l. Unclamp the lid and carefully pour 1/3 of the contents into a No. 200 (75 µm) sieve.
m. Wash the sample until the water passing the sieve is clear.
n. Repeat with the other 2/3 of the sample.
o. Rinse any remaining fines from the vessel onto the sieve.
p. Flush the material from the sieve to a drying pan and let the material settle.
q. Pour off the excess water, being careful not to lose any of the sample.
r. Dry the material to constant weight at 230 °, ± 9 °F (110 °, ± 5 °C) and allow to cool.
s. When cool, put the material in a plastic bag and twist the end of the bag closed so it traps air in the bag.
t. Thoroughly mix the sample by holding the bag at both ends and vigorously shaking it back and forth in a elliptical motion.
u. Lay the plastic bag on its side so you can scoop into the material with the large spoon that has been bent into a “V” shape.
v. Fill the 3 oz (85 ml) measuring can. While filling, tap the bottom edge of the cans on the work table or other hard surface to consolidate the material and to allow more material to be placed in the can.
w. Fill the can to the brim or to give a slightly rounded surface above the brim, but do not overflow. Use extreme care to obtain a truly representative sample.

D. Procedures

1. Siphon 4 in, ± 0.1 in (100 mm, ± 2.5 mm) of working calcium chloride solution into the plastic cylinder.
2. Pour the prepared test sample through the funnel into the plastic cylinder.
3. Tap the bottom of the cylinder sharply with the heel of your hand several times to release air bubbles and to thoroughly wet the sample.
4. Allow the sample to soak undisturbed for 10, ±1 minutes.
5. After soaking, stopper the cylinder.
6. Loosen the material from the bottom by partially inverting the cylinder and shaking it.
7. Place the stoppered cylinder in the mechanical sand equivalent shaker.
8. Let the machine continuously shake the cylinder and contents for 10 minutes ± 15 seconds.
9. After shaking, set the cylinder upright on the work table and remove the stopper.
10. Insert the irrigator tube into the cylinder and rinse the material from the cylinder walls as you lower the irrigator tube.
11. Force the irrigator tube through the material to the bottom of the cylinder. Gently stab and twist the material while the working solution flows from the irrigator tip. This flushes the fine material into suspension above the coarser sand particles.
12. Continue to stab and twist the material until the cylinder is filled to the 15 in (381 mm) mark.
13. Slowly raise the irrigator without shutting off the flow so that the liquid level is maintained at about 15 in (381mm) while withdrawing the irrigator.
14. Regulate the flow just before removing the irrigator and adjust the final level to 15 in (381 mm).

15. Allow the cylinder and contents to stand undisturbed for 20 minutes, ± 15 seconds for sedimentation. Start tracking time immediately after withdrawing the irrigator tube.
16. After the 20-minute sedimentation period, read and record the level of the top of the clay suspension. This is the "clay reading."
    a. If you cannot clearly see a line of demarcation at the end of the 20-minute period, let the sample stand undisturbed until you can obtain a clay reading. Continue to track the time.
    b. Immediately read and record the level of the top of the clay suspension and the total sedimentation time.
    c. If the total sedimentation time exceeds 30 minutes, rerun the test using three individual samples of the same material.
    d. Read and record only the clay column height of that sample requiring the shortest sedimentation period.
17. After taking the clay reading, place the weighted foot assembly over the cylinder with the guide in position on the mouth of the cylinder.
18. While lowering the weighted foot, keep one of the centering screws in contact with the cylinder wall near the gradations so you can see it at all times.
19. Gently lower the weighted foot until it rests on the sand.
20. Read and record the level of the centering screw. This reading is the "sand reading."
21. If either clay or sand reading falls between the 0.1in (2.5 mm) graduations, record the level of the higher graduation as the reading. For example, record a clay level at 7.95 as 8.0 in (201.93 as 202 mm) and a sand level at 3.22 in as 3.3 in (81.788 mm as 83.8 mm).
22. If the results of the two tests are within four points of each other, report the average.
    a. Variances of more than four points between results indicate too much error in operator procedure or sample selection. In such cases, run a third test and average the two closest results (within four points of each other) using the method shown in GDT 4.

E. Calculations

1. Calculate the durability index of the fine aggregate to the nearest 0.1 using the following formula:

$$D_f = \frac{\text{Sand Reading}}{\text{Clay Reading}}(100)$$

2. If the calculated durability index is not a whole number, report it as the next higher number. For example, if the durability index were calculated from the example in Procedures, step 21, the calculated durability index would be:

$$D_f = \frac{3.3}{8.0}(100) = 41.2$$

   Since this calculated durability index is not a whole number, report it as the next higher number, or "42".

3. If the average of the two tests is not a whole number, round it to the next higher number as in the example below:

$$\frac{41+42}{2} = 41.5 = 42$$

F. Report

Report the average durability index on the appropriate form, as in this example:

D_f – 42

Water Soluble Material in Granular Backfill

GDT 98

A. Scope

For a complete list of GDTs, see the Table of Contents.

Use these test methods to determine chemical properties of backfill material used in Reinforced or Retained Earth Walls.

B. Apparatus

The apparatus consists of the following:

1. Rust-Free Shovels
2. Plastic Bags or Buckets

NOTE: Using above sampling apparatus eliminates contaminated electrolytes.

3. De-ionized or Distilled Water
4. pH Meter
5. Buffer—Use a buffer for pH at 7.00, 4.00, and 9.00.
6. Glass Stirring Rods
7. Conductivity Bridge
8. Containers—Use 1 gal (3.785 L) plastic containers.
9. Chemical Reagents and Glassware—Use chemical reagents and glassware as required by Standard Methods of the Examination of Water and Wastewater and ASTM.
10. Sieves—Use a brass No. 10 (2 mm) sieve, 12 in (305 mm) diameter, and a brass 1-1/2 in (37.5mm) sieve, 12 in (305 mm) diameter.
11. Brass Pan—Use a 12 in (305 mm) diameter pan.

C. Sample Size and Preparation

1. Quarter two representative samples using one for the gradation analysis and one for the chemical analysis.
2. After determining the gradation results (GDT 4), use the remaining sample and the 12-in (305 mm) brass sieves to separate material for the chemical test.
3. Shake this sample to divide it into two sizes: the minus 1-1/2 in (37.5 mm) portion and plus No. 10 and minus No. 10 portions.
4. Using the method below, obtain approximately 4.4 lb (2000 g) of minus 1-1/2 in (37.5 mm) material.

The 4.4 lb (2000-g) sample is calculated from the results of the gradation analysis by using the percentage passing the No. 10 (2 mm) sieve.

	Sieve Size	Percent
Passing	4-in (101.6 mm)	100
Passing	2-in (50.8 mm)	87
Passing	1-1/2-in (37.5 mm)	79
Passing	No. 10 (2.00 mm)	30

0.30 x 2000 = 600 g of minus No. 10 (2 mm)

2000 - 600 = 1400 g of minus 1-1/2 in (37.5 mm) plus No. 10 (2 mm) material

Total = 2000 g sample for chemical analysis

5. Place the material in a 1 gal (3.785 L), wide-mouth plastic jug.
6. Add an equal weight of de-ionized or distilled water to the sample and let this mixture stand for approximately 30 minutes.
7. Place a lid on the container and vigorously shake the mixture for 3 minutes.
8. Repeat the agitation at the 2-hour and 4-hour test times.
9. Allow the sample to stand for approximately 20 hours after the 4-hour agitation so the solids settle out. At this time, remove a sufficient amount of the supernate by decanting and filtering, if necessary.

D. Procedures

Evaluate the supernate using the following procedures from the Standard Methods for The Examination of Water and Waste Water and ASTM (17th Edition).

Procedure	Section
Electrical Conductivity and Resistivity	ASTM D 1125
Acidity or Alkalinity (ppm)	ASTM D 1067 Test Method B
pH	ASTM D 1293
Sulfates as SO4 (ppm)	4500 SO-C, Standard Method
Chlorides as NaCl (ppm)	ASTM D 512 Test Method B Titration

E. Calculations

No calculations are necessary for this test.

F. Report

Report the results of the procedures on Form 168.

Determining Percent Schist, Phyllite or Shale by Weight of Coarse Aggregate

GDT 104

A. Scope

For a complete list of GDTs, see the Table of Contents.

Use this test method to determine the percentage, by weight, of phyllite, schist or shale particles in coarse aggregates.

In this test, you manually separate phyllite, schist or shale particles by petrographic analysis and determine the percent by weight of those particles.

B. Apparatus

The apparatus consists of the following:

1. Sample Splitter or Quartering Device (WQ-01).
2. Scales: Use gram scales with a minimum capacity of 5.5 lbs (2500 g) and accurate to ± 0.00022 lbs (±0.1 g).
3. Drying Device
4. Water Supply
5. Sieves: Use sieves that conform to the "Standard Specifications for Sieves for Testing Purposes," AASHTO M 92.
6. Shaker: Use a Gilson or other approved device for mechanically agitating the sieves to separate the coarse material into portions of specific sized particles.
7. Brass Rod: Use a 1/16 in (1.6 mm) diameter rod, with a rounded point, mounted in a hand held device. The brass rod should be of a hardness so when filed to a sharp point, it will scratch a U.S. copper penny but fail to scratch a U.S. nickel.

C. Sample Size and Preparation

1. Take a sample that is representative of the grading from the supply. Use coarse aggregate from material retained on the No. 4 (4.75 mm) sieve for the test.
   a. If you cannot gather a representative gradation sample, you may use a known representative gradation of material sampled for the calculations

Note: When the minus No. 4 (4.75 mm) and plus No. 8 (2.36 mm) portion exceeds 50% of the total plus No. 8 (2.36 mm) material, include the minus No. 4 (4.75 mm) and plus No. 8 (2.36 mm) portion in the test sample.

2. Test a sample size that will yield the amounts of the applicable sizes prescribed below.

Minimum Size of Sample to be Tested (Square Opening Sieves)	
Sieve Size	**Sample Mass (grams)**
No. 8 - No. 4 (2.36 mm - 4.75 mm)	50
No. 4 - 3/8” (4.75 mm - 9.5 mm)	100
3/8” - 1/2” (9.5 mm - 13 mm)	200
1/2” - 3/4” (13 mm - 19 mm)	600
3/4” - 1” (19 mm - 25 mm)	1500
1" - 1-1/2” (25 mm - 37.5 mm)	4500
1-1/2” - 2” (37.5 mm - 50 mm)	12000

3. If the sample contains less than 5 percent of any of the sizes prescribed, do not test that size.
4. To calculate the test results, consider the sample to have the same percent schist, phyllite or shale as the next larger or next smaller size, whichever is present.

D. Procedures

1. Obtain a representative portion (see Sample Size and Preparation, step 2) of each particle size that represents
   5 percent or more of the plus No. 4 (4.75 mm) portion.
2. Wash and dry the sample.
3. Depending on the sample’s grade (see the Note in Sample Size and Preparation), you may need to test the minus No. 4 (4.75 mm) and the plus No. 8 (2.36 mm) portion also.
4. Spread each aggregate portion on a large enough area or work table so you can carefully examine the individual particles.
   a. By visual inspection, separate and classify the schist, phyllite or shale separately from the remainder of the sample.
      1) Wet the material or use other suitable visual aids to help you separate the sample.
      2) In the case of questionable schist, phyllite or shale particles (No. 4 (4.75 mm) and larger) that are integrated with other minerals, you may use the scratch hardness tool to determine if the particles are to be classified as schist, phyllite or shale. Any visible brass left on 2/3 or more of an individual particle scratched perpendicular to the planar structures (i.e., foliation in phyllite/schist or bedding in shale) shall be considered acceptable.

E. Calculations

1. Determine the dry total weight of particles of each size for each sample tested.
2. Determine the dry total weight of particles of each size for each sample classified as schist, phyllite or shale.
3. Calculate the percentage of each particle size for each sample classified as schist, phyllite or shale.
4. Determine the weighted average of schist or phyllite particles calculated from step 3 and based on the grading determined in Sample Size and Preparation.
5. In these calculations, the weighted average will be based on either the plus No. 8 (2.36 mm) or the plus No. 4 (4.75 mm) gradation, whichever is applicable under Sample Size and Preparation, step 1.

6. The calculation will be:

$$A = B \div C$$

where:
A = percent schist, phyllite or shale
B = dry weight of schist, phyllite or shale
C = total dry weight of sample

F. Report

1. The report on Form 658 includes the following:
   a. Dry total weight of particles of each size for each sample tested
   b. Dry total weight of particles of each size for each sample classified as schist, phyllite or shale
   c. Percentage of each particle size for each sample classified as schist, phyllite or shale
   d. Weighted average of schist or phyllite particles from Procedures, step 3

Note: If the sample represents the appropriate portion's grade, split or quarter the sample down to one composite sample of at least the size shown in Table 104-1. This is in lieu of testing each size separately as described above.

2. Only personnel authorized to do so by the Office of Materials and Research perform acceptance testing.

Table 104-1: Minimum Size of Sample (grams) to be Tested (Square Opening Sieve)

	+ No. 8 (2.36 mm)	+ No. 4 (4.75 mm)	+ 3/8" (9.5 mm)	+ 1/2" (13 mm)	+ 3/4" (19 mm)	+ 1" (25 mm)	+ 1-1/2" (37.5 mm)
- No. 4 (4.75 mm)	50						
- 3/8" (9.5 mm)	150	100					
- 1/2" (13 mm)	350	300	200				
- 3/4" (19 mm)	950	900	800	600			
- 1" (25 mm)	2450	2400	2300	2100	1500		
- 1-1/2" (37.5 mm)	6950	6900	6800	6600	6000	4500	
- 2" (50 mm)	18950	18900	18800	18600	18000	16500	12000

Determining Flat and Elongated Particles in Coarse Aggregates

GDT 129

A. Scope

For a complete list of GDTs, see the Table of Contents.

Use this test method to determine the percentages of flat and elongated particles in coarse aggregate.

1. Referenced Documents

   AASHTO Standards

   T 2 Methods of Sampling Aggregates

   T 27 Method of Test for Sieve Analysis of Fine and Coarse Aggregates

   T 248 Method of Test for Reducing Field Samples of Aggregate to Testing Size

2. Definitions

   Flat and Elongated Particles in Coarse Aggregate – those particles of coarse aggregate having a ratio of length to average thickness greater than a specified value.

3. Summary Of Test Method

   Individual particles of aggregate are measured to determine the ratios of length to average thickness.

4. Significance And Use

   a. Flat or elongated particles of aggregates, for some construction uses, may interfere with consolidation and result in harsh, difficult to place material. These type particles tend to orient horizontally along the particles longest axis and contribute to rutting susceptibility, particularly in bituminous mixes.

   b. This test method provides a means to examine particles for compliance with specifications that limit flat and elongated pieces.

B. Apparatus

1. A vernier-type caliper accurate to 0.001 in (0.03 mm) and capable of measuring particles up to 2.5 in (63 mm) in size.
2. Balance – the balance or scales used shall be accurate to 0.5% of the mass of the sample.

C. Sample Size and Preparation

Sample the coarse aggregate in accordance with AASHTO T 2. Subject the sample to a sieve analysis in accordance with AASHTO T 27 and discard all the material that passes the No 4 (4.75 mm) sieve. Recombine and thoroughly mix the remainder of the sample.

D. Procedures

Based upon the gradation as determined by AASHTO T 27, look to the left side of the chart and select the smallest sieve size that more than 90% of the sample will pass through.

Next, look to the top of the chart and find the largest sieve size that less than 10% of the sample will pass through. The mass listed where the two sieve sizes intersect is the minimum mass of material to be tested.

In the event that more than 10% of the sample passes the No 4 (4.75 mm) sieve, use the mass listed where the appropriate sieve size listed to the left and the No. 4 (4.75 mm) sieve intersect.

Reduce the sample in accordance with the AASHTO T 248 to obtain a representative size of sample (in grams) in accordance with the table below.

Sieve Sizes	No 4 (4.75 mm)	3/8 in (9.5 mm)	1/2 in (12.5 mm)	3/4 in (19.0 mm)	1 in (25.0 mm)	1 1/2 in (37.5 mm)
3/8 in (9.5 mm)	100					
1/2 in (12.5 mm)	300	200				
3/4 in (19.0 mm)	900	800	600			
1 in (25.0 mm)	2400	2300	2100	1500		
1 1/2 (37.5 mm)	6900	6800	6600	6000	4500	
2 in (50 mm)	18 800	18 600	18 600	18 000	16 500	12 000

NOTE: As well as consisting of the minimum mass that is specified above, a sample shall not consist of less than 150 particles.

Measure each particle in the sample to determine its length and average thickness. The particle is flat and elongated if its length exceeds the specified ratio of length to average thickness.

After the particles have been classified into categories as flat and elongated or not flat and elongated, determine the mass of each category.

E. Calculations

Calculate the percentage flat and elongated particles by dividing the weight of the flat and elongated particles by the total sample weight and multiplying by 100.

F. Report

Report results to the nearest 0.1%.

Determining Friable Particles in Fine Aggregates

GDT 132

A. Scope

For a complete list of GDTs, see the Table of Contents.

Use this test method to determine the percentages of friable particles in fine aggregate by manipulating individual particles of aggregate between the fingers to determine the percentage of friable particles.

Friable particles in fine aggregates are those particles of fine aggregates that lack competency due to weathering, alteration, fracturing or inherent physical properties and, as a result, are easily broken into finer particles.

Friable aggregate particles are inherently weaker than the other particles and may have a detrimental effect on Portland cement concrete and bituminous mixes. This test method provides a rapid means to examine particles for compliance with specifications that limit friable particles.

Referenced documents for this test include:

AASHTO Standards:

M 92	Wire-cloth Sieves for Testing Purposes
M 231	Weighing Devices Used in the Testing of Materials
T 2	Methods of Sampling Aggregates
T 11	Amount of Material Finer Than No. 200 Sieve in Aggregate
T 27-88	Sieve Analysis of Fine and Coarse Aggregate
T 248-89	Reducing Field Samples of Aggregate to Testing Size

B. Apparatus

1. Balance – Ensure the balance has sufficient capacity, and be readable to at least 0.1 % of the sample mass, and conform to the requirements of AASHTO M 231.
2. Containers – Rust-resistant containers of a size and shape that will permit the spreading of the sample on the bottom in a thin layer.
3. Sieves – Sieves conforming to AASHTO M 92.

C. Sample Size and Preparation

Sample the aggregate in accordance with AASHTO T 2. Dry the sample and reduce it to 0.9 to 1.2 lbs (400 to 550 g) in accordance with AASHTO T 248. Weigh the reduced sample to the specified accuracy.

D. Procedure

1. Perform a sieve analysis on the sample in accordance with AASHTO T 27 and separately retain the materials retained on the No. 4 (4.75 mm), No. 8 (2.36 mm) and No. 16 (1.18 mm) sieves.
2. If any of these three sizes represent less than 5% of the total sample, do not test it. However, for calculation purposes assign it the same percent friable particles as the next smaller size that does represent 5% or more of the total sample.
3. Ensure that each sieve size represents at least150 particles. The small sample size can be obtained by pouring material retained on a sieve into a conical pile, flattening the pile and quartering it with a straightedge.
4. Using opposite quarters the process can be repeated as necessary. Assume that all material passing the No. 16 (1.18 mm) sieve to have 0% friable particles and calculated as such unless a qualified petrographer determines that the material smaller than the No. 16 (1.18 mm) sieve needs to be tested also.

5. Record the weight of the material retained on each of the sizes to be tested to the specified accuracy.
6. Place each sample into a clean container. Lay out three additional containers, one for friable material, one for non-friable material and one over which each particle is manipulated.
7. While holding individual particles from each sample over one container, manipulate them between the thumbs and forefingers in an effort to crumble them. Do not use the fingernails to break up particles or press the particles against the sides of the container or each other. If a particle does not crumble, the particle and any pieces that may have broken or become dislodged from it should be placed into the container designated for the non-friable particles.
8. Repeat this process for each particle, emptying the tested material into the friable or non-friable container after each particle is tested. Weigh the friable portion to the specified accuracy.

E. Calculations

Calculate the percent friable particles as a weighted average by the following method:

1. Using the original gradation from Section D.1, calculate the percent retained on the three sieves.
2. Calculate the percent friable particles for each sieve size by dividing the weight of the friable particles by the total weight of the sample for that sieve size and multiplying by 100.
3. Calculate the total percent friable particles by multiplying the percent friable particles by the percent retained on each sieve, adding these three products and dividing by 100.

$$\text{Total percent friable} = \frac{(S1 \times F1) + (S2 \times F2) + (S3 \times F3)}{100}$$

where:

S_1 = percent retained on first sieve

S_2 = percent retained on second sieve

S_3 = percent retained on third sieve

F_1 = percent friable from first sieve

F_2 = percent friable from second sieve

F_3 = percent friable from third sieve

F. Report

Report results to the nearest 0.1%.

Determining Friable and/or Weathered Particles in Coarse Aggregate

GDT 133

A. Scope

For a complete list of GDTs, see the Table of Contents.

Use this test method to determine the percentages of friable and/or weathered particles in coarse aggregate by manipulating individual particles of aggregate between the fingers to determine the percentage of friable and/or weathered particles.

Friable and/or weathered particles in coarse aggregates are those particles of coarse aggregates that lack competency due to weathering, alteration, fracturing or inherent physical properties and, as a result, are easily broken into finer particles.

Friable and/or weathered aggregate particles are inherently weaker than the other particles and may have a detrimental effect on Portland cement concrete and bituminous mixes. This test method provides a rapid means to examine particles for compliance with specifications that limit friable and/or weathered particles.

Referenced documents for this test include:

AASHTO Standards:

M 92	Wire-cloth Sieves for Testing Purposes
M 231	Weighing Devices Used in the Testing of Materials
T 2	Methods of Sampling Aggregates
T 11	Amount of Material Finer Than No. 200 Sieve in Aggregate
T 27-88	Sieve Analysis of Fine and Coarse Aggregate
T 248-89	Reducing Field Samples of Aggregate to Testing Size

B. Apparatus

1. Balance – Ensure the balance has sufficient capacity, and be readable to at least 0.1 % of the sample mass, and conform to the requirements of AASHTO M 231.
2. Containers – Rust-resistant containers of a size and shape that will permit the spreading of the sample on the bottom in a thin layer.
4. Sieves – Sieves conforming to AASHTO M 92.

C. Sample Size and Preparation

Sample the aggregate in accordance with AASHTO T 2.

D. Procedure

1. Perform a sieve analysis on the sample in accordance with AASHTO T 27 and discard all material that passes the No. 4 (4.75 mm) sieve.
2. Based on the gradation as determined by AASHTO T 27 and the table below, look to the left side of the table and select the nominal maximum sieve size (the smallest sieve size that more than 90% of the sample will pass through).
3. Next, look to the top row of the table and find the largest sieve size that less than 10% of the sample will pass through. The mass (in grams) listed where the two sieve sizes intersect is the minimum mass of material to be tested.
4. In the event that more than 10% of the sample passes the No. 4 sieve (4.75 mm), use the mass listed in the row where the nominal maximum sieve size in the left column and the No. 4 sieve column intersect.

5. Reduce the sample in accordance with AASHTO T 248 to obtain the representative sample size determined from the above procedure.

Nominal Maximum Sieve Size	No. 4	3/8”	1/2”	3/4”	1”	1-1/2”
3/8” (9.5 mm)	100					
1/2” (12.5 mm)	300	200				
3/4” (19 mm)	900	800	600			
1” (25 mm)	2400	2300	2100	1500		
1-1/2” (37.5 mm)	6900	6800	6600	6000	4500	
2” (50 mm)	18800	18600	18600	18000	16500	12000

NOTE: As well as consisting of the minimum mass that is specified above, ensure that a sample consists of at least 150 particles.

6. Wash the sample over a No. 4 (4.75 mm) sieve to remove fine material.
7. Dry the sample and allow to cool.
8. Weigh the sample to the accuracy specified in Section B.
9. Spread the sample out in a large pan or bowl. Three separate containers should be designated for friable and/or weathered particles, non-friable and/or unweathered particles, and particle inspection. While holding individual particles over the particle inspection container, manipulate each one between the thumb and forefinger in an attempt to break each particle into smaller pieces. Special attention should be paid to pieces that are stained or oxidized. Do not snap particles or use the fingernails to break up particles or press the particles against the sides of the container or each other.
10. If a third or more of the particle crumbles, all of the particle should be placed in the friable and/or weathered particles container. If none or less than one third of the particle crumbles then the remaining particle and all of the smaller pieces removed during manipulation should be placed in the non-friable and/or unweathered particles container.
11. After all particles are tested in this manner, weigh the material in the friable and/or weathered container to the accuracy specified in Section B.

E. Calculations

Calculate the percent friable and/or weathered particles by dividing the weight of the friable and/or weathered particles by the total weight of the sample and multiplying by 100.

F. Report

Report results to the nearest 0.1%.

SECTION VII

AGGREGATE RATING SYSTEM

SECTION VII

Aggregate Rating System

Learning Objectives

In this section, the following learning objectives will be discussed:

- ✓ Familiarization with the Department's aggregate rating system for coarse aggregate sources

GEORGIA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS AND RESEARCH
RATING SYSTEM FOR COARSE AGGREGATE SOURCES THAT CERTIFY AGGREGATES

(Revised July 1, 2005)

I. GENERAL

The Pit and Quarry Control Branch of the Office of Materials and Research is charged with the responsibility of monitoring all coarse and fine aggregates used on Department of Transportation projects. A major portion of this responsibility is devoted to ensuring that established standards for quality control are met or exceeded by the respective Aggregate Producers.

To facilitate accomplishment of this task, a rating system for Standard Coarse and Fine, Temporary and Vendor Sources has been developed. This system is designed to provide Industry and the Department with a management tool for measuring the success of the Producer Certification Program and to promote consistency of products.

II. DEFINITIONS

In order to produce the ratings, certain data must be calculated. The following definitions are applicable to producing data for the rating system:

A. Target Band

A gradation band for a product that when rated 70 or above, at the point of shipment, should allow for specification compliance at the point of use after normal degradation and stockpile variation has occurred.

Example:

Washed 0057 Concrete Stone
Passing 1/2"
(25-60) Spec
(32-48) Target Band

B. Range From Target Band (RFTB)

The range that either the upper or lower limit of the Target Band is exceeded by when the standard deviation is either added to or subtracted from the mean. When the upper limit is 100 and the mean plus the standard deviation exceeds 100, the RFTB factor will be zero. When the lower 1imit is zero and the mean minus the standard deviation is a negative number, the RFTB factor will be zero.

NOTE: The Mean, Standard Deviation and RFTB value are to rounded to the nearest tenth.

Example: Washed 0057 Concrete Stone
% Passing ½"
(25-60) Spec
(32-48) Target Band
37.4 Mean
5.0 Std. Deviation
37.4 (Mean) ± 5.0 (Std. Dev.) = 32.4 - 42.4 (Range)

(32-48) Target Band
Compared to
(32.4 - 42.4) Range
RFTB=0

Example: Washed 0057 Concrete Stone
% Passing ½"
(25-60) Spec
(32-48) Target Band
37.4 Mean
8.0 Std. Deviation
37.4 (Mean) ± 8.0 (Std.Dev.) = 29.4 - 45.4 (Range)

(32-48) Target Band
Compared to
(29.4 - 45.4) Range
RFTB=32 - 29.4 = 2.6

C. RFTB Factor

The factor (taken from tables) that the RFTB is multiplied by.

Example: Washed 0057 Concrete Stone
% Passing No. 8 Sieve
(0-5) Specifications
(0-1) Target Band
1.5 Mean
0.5 Std.Dev.

1.5 (Mean) ± 0.5 (Std. Dev.) = 1.0 - 2.0 (Range)

(0-1) Target Band
Compared to
(1.0 - 2.0) Range
RFTB = 1.0

RFTB Factor From Tables For Washed 0057's

RFTB	No. 8 Sieve Factor
0-1	0
1.1 - 1.5	5
>1.5	15

Factor for RFTB of 1.0 = 0

Example:

Washed 0057 Concrete Stone
% Passing No. 8 Sieve
(0-5) Specification
(0-1) Target Band
2.0 Mean
0.5 Std.Dev.

2.0 (mean) ± 0.5 (Std. Dev.) = 1.5 to 2.5 (Range)

(0-1) Target Band
Compared to
(1.5 - 2.5) Range
RFTB = 1.5

RFTB Factor From Tables For Washed 0057's

RFTB	No. 8 Sieve Factor
0-1	0
1.1 - 1.5	5
>1.5	15

Factor for RFTB of 1.5 = 5

D. Product Rating (For all products except for asphaltic concrete aggregates)

The sum of RFTB per sieve multiplied by the appropriate factor per sieve (from the tables) and subtracted from 100.

Example:

Washed 0057 Concrete Stone

	% Passing				
1 l/2	1	1/2	No. 4	No. 8	
100	95-100	25-60	0-10	0-5	Specification
100	97-100	32-48	0-5	0-1	Target Band
100	98	47	3	1.5	Mean
-	0.5	3.0	1.0	0.5	Std. Dev.
	0	2.0	0	1.0	RFTB
	x 0	x 5.0	x 0	x 0	Factor (From Tables)
	= 0	= 10	= 0	= 0	Deductions

Total Deductions = 10
Product Rating = 100 - 10 = 90 Very Good

E. Product Rating (for Fine Aggregate for Asphaltic Concrete)

The sum of the standard deviation for the 3/8, No. 4, No. 8, No. 16, No. 50, No. 100 and No. 200 sieves divided by 1.5 and subtracted from 100, when the minus No. 8 portion is computed as 100% minus No. 8. All products that are coded "used in B" will be rated.

Example:

% Passing								
Total Sample			Minus No. 8 Portion					
3/8	No.4	No.8	No.8	No.16	No.50	No.100	No.200	
100	98	82	100	85	49	27	13.7	Mean
0	1.6	4.1	0	1.5	1.8	1.4	2.3	Std. Dev.

0 + 1.6 + 4.1 + 0 + 1.5 + 1.8 + 1.4 + 2.3 = 12.7 (Total Std.Dev.)
Product Rating = 100 _ 12.7 (Total Std. Dev.) = 91.5
1.5 (Division Factor)

NOTE: A division factor of 1.5 is used to condense the Total Standard Deviation so that the Product Rating can be expressed in common terms of Excellent, Very Good, etc.

F. Product Rating for Coarse Aggregate for Asphaltic Concrete.

The sum of the standard deviation per screen size divided by 1.5 and subtracted from 100. All products that are coded "used in B" will be rated.

Example:

Unwashed 0057's for Asphalt Stone

% Passing

1 1/2	1	1/2	No.4	No.8	
100	98	46	6	2	Mean
-	.9	5.0	1.0	.5	Std. Dev

.9 + 5.0 + 1.0 + 0.5 = 7.4 (Total Std. Dev.)

Product Rating 100 - $\frac{7.4 \text{ (Total Std. Dev.)}}{1.5 \text{ (Division Factor)}} = 95.1$

NOTE: A factor of 1.5 is used to condense the Total Standard Deviation so that the Product Rating can be expressed in common terms of Excellent, Very Good, etc.

G. Category Rating

The categories that will be rated are as follows:

Concrete Aggregates
- Coarse
- Fine

Asphalt Aggregates
- Coarse
- Fine

Graded Aggregate

Surface Treatment Stone

The category rating is defined as "The arithmetic average of the ratings for products within a specific category," except as follows:

1. Concrete Aggregates Category

This rating will be computed based upon 80% of the coarse Aggregate Rating and 20% of the Fine Aggregate Rating.

Example:

Coarse Aggregate

Products	Product Ratings
Washed 0057's	93
Washed 0067's	85
	178 ÷ 2 = 89

Fine Aggregate

Product	Product Rating
10 SM	70
10 FM	90
	160 ÷ 2 = 80

		Rating		Value	=	Weighted Value
Coarse Aggregate	-	89	X	80%	=	71.2
Fine Aggregate	-	80	X	20%	=	16.0
						87.2 = Category Rating

2. Asphaltic Concrete Aggregate Category

This rating will be computed based upon 50% of the Coarse Aggregate Rating and 50% of the Fine Aggregate Rating.

Example:

Coarse Aggregate

Products	Product Rating
Unwashed 0005	75
Unwashed 0006	79
Unwashed 0067	88
Unwashed 0089	74
Unwashed 0057	92
Unwashed 0067	90
Unwashed 0078	84
Washed 0057	85
Washed 0007	94
	761 ÷ 9 = 84.6

Fine Aggregate

Products	Product Rating
No. M10's	79
No. 810's	85
W10's	90
	254 ÷ 3 = 84.7

		Rating		Value	=	Weighted Value	
Coarse Aggregate	-	84.6	X	50%	=	42.3	
Fine Aggregate	-	84.7	X	50%	=	42.4	
						84.7	= Category Rating

H. Source Rating

The average of the category ratings with all values treated equally except Surface Treatment Stone. Surface Treatment Stone will be assigned a value of 10%.

Example:

Category	Rating		Value	=	Weighted Value
Concrete Aggregates	86.3	X	.30	=	25.9
Asphalt Aggregates	80	X	.30	=	24.0
Graded Aggregate	90	X	.30	=	27.0
Surface Treatment	85	X	.10	=	8.5
					85.4

Source Rating = 85

In the event that a category is not rated, the categories that are rated will be given a proportionally higher value.

Example:

Category	(Rating)		Value	Redistributed Value	=	Weighted Value
Concrete Aggregates	(86.3)	X	.30	$\frac{.30}{.70}$ = (.43)	=	37.1
Asphalt Aggregates	(80)	X	.30	$\frac{.30}{.70}$ = (.43)	=	34.4
Grade Aggregate	not rated					
Surface Treatment	(85)	X	.10	$\frac{.10}{.70}$ = (.14)	=	11.9
		(total)	.70			83.4

Source Rating = 83.4

III. AUXILIARY PLANTS

Ratings for Auxiliary Plants will be produced per product only. The product ratings will then be given equal value and included in the arithmetic average for the category under the primary source number.

Example: Coarse Aggregate For Concrete

Source	Product	Product Rating
Primary	Washed 0057	95
Primary	Washed 0067	85
Auxiliary	Washed 0057	79
		259 ÷ 3 = 86.3

IV. USE OF TEST DATA FOR COMPUTATIONS

A. Sample location, (belt, stockpile, truck, railcar, other)

The test data for a given product will be computed separately per sample location. The "Product Rating" will be the arithmetic average of the averages per product per sample location. A weighted average based upon the number of samples per location or quantities represented will not be computed.

B. Number of Samples

Products with less than 10 samples tested per required screen per sample location during a quarter will not be rated for that quarter. The product will be rated year to date when there are 10 or more samples on record.

V. FREQUENCY OF RATING

Rating periods will begin January 1 and end December 31 each year. Ratings will be produced as follows:

A. Per Quarter Rating

This rating will be based upon the data for the designated quarter only.

B. Year to Date Rating

This rating will be produced for the 2nd, and 4th quarters and will be based upon cumulative data to date for the year.

In the event that a below 70 rating is involved during the fourth quarter, any imposed restriction will carry over into the new year until the problem is resolved. Once the problem has been resolved, the rating for the new year will begin again as of the formal date that the problem was resolved.

VI. PUBLICATION OF RATINGS

The "Source Ratings" and "Category Ratings" will be published and issued to all sources semi-annually as follows:

Source Rating	_____
Category Ratings	
Concrete Aggregates	
Coarse	_____
Fine	_____
Asphalt Aggregates	
Coarse	_____
Fine	_____
Graded Aggregate Base	_____
Surface Treatment Stone	_____

In the event that there is a product rating below 70, it will be identified as shown in the following example:

Source Rating	84
Concrete Aggregates	
Coarse	83

Note: The washed 0067's rated 65. The washed 0067's may be approved on a stockpile basis at the point of use only.

Fine	90
Asphalt Aggregates	
Coarse	85
Fine	75

Note: 0810's have a substandard consistency value.

Graded Aggregate Base	88
Surface Treatment Stone	80

VII. ADMINISTRATION OF RATING SYSTEM

A. "Product Ratings" (for all products except those for Asphaltic Concrete)

1. When the rating for a specific product falls below 70 for a given quarter or year to date, acceptance of Producer Certification for the product will be discontinued. There is an exception to this. If the year to date rating is below 70 but the current quarterly rating is 70 or above, the quarterly rating will take precedence.

2. In order for Producer Certification of the product to be resumed, the producer must:

   a) Take corrective action and notify the Department in writing as to the measures that have been taken.
   b) Request a re-evaluation and re-rating of the product. The request should specify a beginning date for the evaluation such that previously existing problems will not be reflected during the re-evaluation period. The request should also detail a plan for controlling the use of any existing inventories of the problem product.
   c) A quarterly product rating of 75 or greater must be achieved.

   During the interim the product may be accepted on a stockpile basis at the point of use only.

B. "Product Rating" (for Asphaltic Concrete Aggregate)

1. When the rating for a specific product falls below 70 for a given quarter or year to date, rating of the product will be discontinued. The published ratings for the product would then state, "This Product has a substandard consistency value." There is an exception to this. If the year to date rating is below 70 but the current quarterly rating is 70 or above, the quarterly rating will take precedence.

2. In order to resume participation in the rating system, the producer must:

   a) Take corrective action and notify the Department in writing as to the measures that have been taken.
   b) Request a re-evaluation and re-rating of the product. The request should specify a beginning date for the evaluation such that previously existing problems will not be reflected during the evaluation period. The request must also detail a plan for controlling the use of any existing inventories of the problem product.

TARGET BANDS AND RFTB FACTORS / AGGREGATE RATING SYSTEM

	Sieves		1 ½"	Lower Limit 1"	Upper Limit 1"	Lower Limit ¾"	Upper Limit ¾"	Lower Limit ½"	Upper Limit ½"	Lower Limit 3/8"	Upper Limit 3/8"
Washed 0005 Surface Treatment Stone	Specifications		100	90	100	20	55	0	10	0	5
	Target Band		100	93	100	23	45	0	5	0	1
	RFTB	Range	-	0-3	-	0-3	All	-	0-1	-	0-1
		Factor	-	5	-	5	5	-	5	-	0
	RFTB	Range	-	> 3	-	> 3	-	-	> 1	-	1.1-1.5
		Factor	-	10	-	10	-	-	10	-	5
	RFTB	Range	-	-	-	-	-	-		-	>1.5
		Factor	-	-	-	-	-	-	-	-	15

	Sieves		1"	Lower Limit ¾"	Upper Limit ¾"	Lower Limit ½"	Upper Limit ½"	Lower Limit 3/8"	Upper Limit 3/8"	Lower Limit No. 4	Upper Limit No. 4
Washed 0006 Surface Treatment Stone	Specifications		100	90	100	20	55	0	15	0	5
	Target Band		-	93	100	23	40	0	7	0	1
	RFTB	Range	-	0-3	-	0-3	All	-	0-3	-	0-1
		Factor	-	5	-	5	5	-	5	-	0
	RFTB	Range	-	> 3	-	> 3	-	-	> 3	-	1.1-1.5
		Factor	-	10	-	10	-	-	10	-	5
	RFTB	Range	-	-	-	-	-	-	-	-	> 1.5
		Factor	-	-	-	-	-	-	-	-	15

TARGET BANDS AND RFTB FACTORS / AGGREGATE RATING SYSTEM

	Sieves		¾ "	Lower Limit ½"	Upper Limit ½ "	Lower Limit 3/8"	Upper Limit 3/8"	Lower Limit No. 4	Upper Limit No. 4	Lower Limit No. 8	Upper Limit No. 8
Washed 0007	Specifications		100	90	100	40	70	0	15	0	5
Surface Treatment Stone	Target Band		-	93	100	45	60	0	9	0	1
	RFTB	Range	-	0-3	-	0-3	All	-	0-4	-	0-1
		Factor	-	5	-	5	5	-	5	-	0
	RFTB	Range	-	> 3	-	> 3	-	-	> 4	-	1.1-1.5
		Factor	-	10	-	10	-	-	8	-	5
	RFTB	Range	-	-	-	-	-	-	-	-	> 1.5
		Factor	-	-	-	-	-	-	-	-	15

	Sieves		½"	Lower Limit 3/8"	Upper Limit 3/8"	Lower Limit No. 4	Upper Limit No. 4	Lower Limit No. 8	Upper Limit No. 8	Lower Limit No. 16	Upper Limit No. 16	Lower Limit No. 50	Upper Limit No. 50
Washed 0089	Specifications		100	90	100	20	55	0	15	0	10	0	5
Surface Treatment Stone	Target Band		-	93	100	23	43	0	7	0	5	0	1
	RFTB	Range	-	0-3	-	0-3	0-4	-	0-4	-	0-3	-	0-1
		Factor	-	5	-	5	5	-	5	-	5	-	0
	RFTB	Range	-	> 3	-	> 3	> 4	-	> 4	-	> 3	-	1.1-1.5
		Factor	-	10	-	10	10	-	8	-	10	-	5
	RFTB	Range	-	-	-	-	-	-	-	-	-	-	> 1.5
		Factor	-	-	-	-	-	-	-	-	-	-	15

TARGET BANDS AND RFTB FACTORS / AGGREGATE RATING SYSTEM

	Sieves		1 ½"	Lower Limit 1"	Upper Limit 1"	Lower Limit ½ "	Upper Limit ½ "	Lower Limit No. 4	Upper Limit No. 4	Lower Limit No. 8	Upper Limit No. 8
Washed 0057	Specifications		100	95	100	25	60	0	10	0	5
Concrete Stone	Target Band		-	97	100	32	48	0	5	0	2
	RFTB	Range	-	0-2	-	All	All	-	0-2	-	0-1
		Factor	-	5	-	5	5	-	5	-	0
	RFTB	Range	-	> 2	-	-	-	-	> 2	-	1.1-1.5
		Factor	-	15	-	-	-	-	15	-	5
	RFTB	Range	-	-	-	-	-	-	-	-	> 1.5
		Factor	-	-	-	-	-	-	-	-	15

	Sieves		1"	Lower Limit ¾"	Upper Limit ¾"	Lower Limit 3/8"	Upper Limit 3/8"	Lower Limit No. 4	Upper Limit No. 4	Lower Limit No. 8	Upper Limit No. 8
Washed 0067	Specifications		100	90	100	20	55	0	10	0	5
Concrete Stone	Target Band		-	93	100	23	45	0	5	0	2
	RFTB	Range	-	0-3	-	0-3	All	-	0-2	-	0-1
		Factor	-	5	-	5	5	-	5	-	0
	RFTB	Range	-	> 3	-	> 3	-	-	> 2	-	1.1-1.5
		Factor	-	10	-	10	-	-	15	-	5
	RFTB	Range	-	-	-	-	-	-	-	-	> 1.5
		Factor	-	-	-	-	-	-	-	-	15

TARGET BANDS AND RFTB FACTORS / AGGREGATE RATING SYSTEM

No. 10SM Standard Manufactured Concrete Sand	Sieves		3/8”	Lower Limit No. 4	Upper Limit No. 4	Lower Limit No. 16	Upper Limit No. 16	Lower Limit No. 50	Upper Limit No. 50	Lower Limit No. 100	Upper Limit No. 100	Lower Limit No. 200	Upper Limit No. 200
	Specifications		100	95	100	45	95	8	30	1	10	0	4
	Target Band		--	97	100	51	90	12	24	2	9	0	3
	RFTB	Range	--	0-2	--	0-4	0-4	0-4	0-3	0-1	0-1	--	0-1
		Factor	--	5	--	5	5	5	5	10	0	--	0
	RFTB	Range	--	>2	--	>4	>4	>4	>3	>1	>1	--	>1
		Factor	--	15	--	7	8	6	10	15	30	--	30

10FM Fine Manufactured Concrete Sand	Sieves		3/8”	Lower Limit No. 4	Upper Limit No. 4	Lower Limit No. 16	Upper Limit No. 16	Lower Limit No. 50	Upper Limit No. 50	Lower Limit No. 100	Upper Limit No. 100	Lower Limit No. 200	Upper Limit No. 200
	Specifications		100	95	100	45	95	15	42	6	22	0	9
	Target Band		--	97	100	51	90	19	36	7	18	2	7
	RFTB	Range	--	0-2	--	0-4	0-4	0-4	All	0-1	0-4	0-1	0-2
		Factor	--	5	--	5	5	5	5	0	5	0	5
	RFTB	Range	--	>2	--	>4	>4	>4		>1	>4	>1	>2
		Factor	--	15	--	7	8	8		30	8	30	15

TARGET BANDS AND RFTB FACTORS / AGGREGATE RATING SYSTEM

Product 15CR Group II GAB for Stockpile, Truck, and other Samples Only	Sieves		2"	Lower Limit 1 ½"	Upper Limit 1 ½"	Lower Limit ¾"	Upper Limit ¾"	Lower Limit No. 10	Upper Limit No. 10	Lower Limit No. 60	Upper Limit No. 60	Lower Limit No. 200	Upper Limit No. 200
	Specifications		100	97	100	60	90	25	45	5	30	4	11
	Target Band		-	99	100	70	86	32	40	8	25	6	9
	RFTB	Range	-	0-2	-	All	0-3	0-5	0-3	0-2	0-5	0-1	0-1
		Factor	-	3	-	6	5	5	5	5	5	0	0
	RFTB	Range	-	> 2	-	-	> 3	> 5	> 3	> 2	> 5	1.1-1.5	1.1-1.5
		Factor	-	15	-	-	10	6	10	10	6	5	5
	RFTB	Range	-	-	-	-	-	-	-	-	-	>1.5	>1.5
		Factor	-	-	-	-	-	-	-	-	-	20	20

Product 15CR Group II GAB for Belt Samples Only	Sieves		2"	Lower Limit 1 ½ "	Upper Limit 1 ½"	Lower Limit ¾"	Upper Limit ¾"	Lower Limit No. 10	Upper Limit No. 10	Lower Limit No. 60	Upper Limit No. 60	Lower Limit No. 200	Upper Limit No. 200
	Specifications		100	97	100	60	90	25	45	5	30	4	11
	Target Band		-	99	100	70	86	30	38	8	25	6	9
	RFTB	Range	-	0-2	-	All	0-2	0-3	0-3	0-2	0-5	0-1	0-1
		Factor	-	3	-	6	5	5	5	5	5	0	0
	RFTB	Range	-	> 2	-	-	> 2	> 3	> 3	> 2	> 5	1.1-1.5	1.1-1.5
		Factor	-	15	-	-	10	8	10	10	6	5	5
	RFTB	Range	-	-	-	-	-	-	-	-	-	>1.5	>1.5
		Factor	-	-	-	-	-	-	-	-	-	20	20

TARGET BANDS AND RFTB FACTORS / AGGREGATE RATING SYSTEM

Product 15CR Group I GAB Sources that meet 9% minus No. 200	Sieves		2"	Lower Limit 1 ½"	Upper Limit 1 ½"	Lower Limit ¾"	Upper Limit ¾"	Lower Limit No. 4	Upper Limit No. 4	Lower Limit No. 10	Upper Limit No. 10	Lower Limit No. 60	Upper Limit No. 60	Lower Limit No. 200	Upper Limit No. 200
	Specifications		100	97	100	60	95	-	-	25	50	10	35	9	15
	Target Band		-	99	100	70	91	45	69	29	43	-	-	10	12
	RFTB	Range	-	0-2	-	All	0-3	All	All	0-3	0-2	-	-	0-1.0	0-1.0
		Factor	-	3	-	5	5	3	3	5	5	-	-	0	0
	RFTB	Range	-	> 2	-	-	> 3	-	-	> 3	> 2	-	-	> 1.0	> 1.0
		Factor	-	15	-	-	10	-	-	10	10	-	-	20	15

* For Group I Aggregate having less than 37% passing the No. 10 sieve, a minimum of 9 % passing the No. 200 sieve will be required.

TARGET BANDS AND RFTB FACTORS / AGGREGATE RATING SYSTEM

Product 15CR Group I GAB	Sieves		2"	Lower Limit 1 ½"	Upper Limit 1 ½"	Lower Limit ¾"	Upper Limit ¾"	Lower Limit No. 4	Upper Limit No. 4	Lower Limit No. 10	Upper Limit No. 10	Lower Limit No. 60	Upper Limit No. 60	Lower Limit No. 200	Upper Limit No. 200
Sources that are required to meet 37% passing the No. 10 Sieve	Specifications		100	97	100	60	95	-	-	37	50	10	35	7	15
	Target Band		-	99	100	70	91	45	69	38	43	-	-	8	12
	RFTB	Range	-	0-2	-	All	0-3	All	All	0-1.5	0-2	-	-	0-1	0-2
		Factor	-	3	-	5	5	3	3	5	5	-	-	0	0
	RFTB	Range	-	> 2	-	-	> 3	-	-	1.6-2.0	> 2	-	-	> 1	> 2
		Factor	-	15	-	-	10	-	-	10	10	-	-	20	15
	RFTB	Range	-	-	-	-	-	-	-	> 2.0	-	-	-	-	-
		Factor	-	-	-	-	-	-	-	15	-	-	-	-	-

* For Group I Aggregate having less than 37% passing the No. 10 sieve, a minimum of 9 % passing the No. 200 sieve will be required.

SECTION VIII

POLICIES REGARDING REPORTING OF DATA FOR CERTIFICATION

SECTION VIII

Policies Regarding Reporting of Data for Certification

Learning Objectives

In this section, the following learning objectives will be discussed

- ✓ Identify what samples should be submitted for certification
- ✓ Understand the reporting of the No. 200 sieve for certification
- ✓ Familiarization with the DOT640/641 forms
- ✓ Understand how to generate reports in the Field Data Collection System

GUIDELINES FOR SUBMITTING TEST DATA
FOR PRODUCER CERTIFICATION OF AGGREGATES

PRODUCTION SAMPLES

All producers should sample and test materials during the production process. However, production samples should not be submitted for producer certification.

BELT SAMPLES

Belt samples should not be submitted for producer certification unless they are representing materials being loaded out through the bins.

CERTIFICATION SAMPLES

Sampling frequencies are specified in units of time or tons. When a frequency per ton is specified it is in reference to tons per day. In either case, all samples that are tested to represent shipments during the specified unit of time or tons must be submitted for certification. When materials are not shipped during the specified unit of time, or tons, the samples tested during that time should not be submitted for certification.

Example of frequencies specified in units of time:

- The testing frequency for asphalt screenings is a minimum of two samples per week.
- During the week of 7/8/02 thru 7/12/02 a sample is tested every day but none of the screenings are shipped to an asphalt plant. In this event none of the samples would be submitted. If screenings had been shipped to an asphalt plant on one or more of those days, all five of the samples would have been submitted for the week.

Example of frequencies specified in units of tons per day:

- The testing frequency for graded aggregate base is one test per 1,500 tons, not less than one per day when shipping.
- During the week of 7/8/02 thru 7/12/02, three samples are tested each day, 900 tons are shipped to a State project on 7/8/02 and 200 tons are shipped to a State project on 7/11/02.
- All three samples tested on 7/8/02 and all three samples tested on 7/11/02 would be submitted for certification. None of the other samples would be submitted.

MINUS NO. 200 TESTING AND REPORTING PROBLEM STATEMENT

The most common discrepancy in the manner in which fine aggregate sieve analysis and minus No. 200 (75 μm) test results have been performed and reported is reporting the results of a sample that was dry sieved only. Dry sieved samples should only be reported through the No. 100 sieve. Report the No. 200 results only when a washed or total No. 200 test has been performed. The applicable procedures are AASHTO T11 and AASHTO T 27.

BRIEF SUMMARY OF TEST PROCEDURE

1. Acquire a representative sample of at least 15 lb. (6.81 kilograms)
2. Dry the entire sample.
3. Using a fine aggregate splitter (maximum opening of ½" or 12.5 mm) reduce the sample to approximately 300 to 500 grams in size. (No single sieve shall retain more than 194 grams.)
4. Record the dry weight.
5. Subject the sample to the washed minus No. 200 (75 μm) test.
6 Dry the sample and record its weight. Subtract this weight from the weight recorded under step No. 4 above. Divide the difference by the weight recorded under No. 4 above to calculate the percent washed Minus No. 200 (75μm).
7. Shake the sample in a nest of the required sieves for 10 minutes.
8. Calculate the gradation based upon the total sample weight recorded under No. 4 above and the accumulated weight retained per sieve including the No. 200 (75 μm) after shaking. The minus No. 200 (75μm) calculated in this manner is the Total Minus 200 (75 μm).

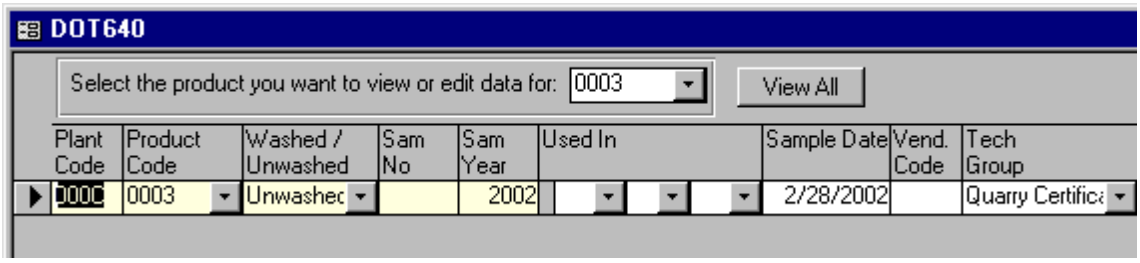
REPORTING MINUS NO. 200 (75 μm) TEST RESULTS

1. The washed minus No. 200 (75 μm) test should be reported for 10SM (Standard Manufactured) concrete sand and 10NS (Natural Sand).
2. The total minus No. 200 (75 μm) should be reported for all other fine aggregates including 10FM (Fine Manufactured Sand) and the minus No. 10 (2 mm) portion of GAB.
3. Do not report any other type of minus No. 200 (75 μm) test results.

REPORTING SIEVE ANALYSIS RESULTS

Do not report **ANY** No. 200 sieve analysis results except as obtained by the procedures outlined above.

THE DOT 640 AGGREGATE QUALITY DATA ENTRY FORM



The DOT 640 Form:
This form enables easy and accurate entry of DOT 640 Aggregate Quality data.
This form only allows viewing one product type at a time. This is because required sieve sizes are different for each product, and the data in the columns would become meaningless if all products were viewed at once.

The DOT 640 Aggregate Quality Producer information is the data obtained from a test **sample** of a specific **product** from an aggregate **source**.

A computerized database must have designated fields that in combination uniquely identify each record. The fields that identify an individual DOT 640 record are: **Source Plant Code, Product Code, Washed/Unwashed, Sample Number**, and the **Year** of the sample (because sample numbers repeat yearly). These fields are required and may not be left blank.

The fields in the DOT 640 are as follows:

Source Plant Code:
A Source Plant Code is the designation assigned by the DOT to producers that supply material to the DOT. The Source Plant Code entered must be the Code of the plant shipping the reported quantity of material.
The plant code is a 4-character field. The first 3 characters are a zero padded right-justified number and the last character is an upper case letter.

Correct: 032C, 141C
Incorrect: 32C, 141

Aggregate Product Code:
The Aggregate Product Code is a designation assigned by the DOT to various aggregate materials supplied to the DOT.
The Product Code field is a 4-character field that must contain a valid Product Code designation. To ensure the accuracy of this field, the designation is selected from a list.

Washed/Unwashed
Indicates that the product is (W)ashed or (U)nwashed.

Sample Number

This is the arbitrarily assigned number assigned to the sample by the testing technician. This is an integer numeric value. The same sample number may be used for different products.

Sample Year
Because the sample numbers restart at the beginning of each year, each sample number must also be accompanied by the year in which the sample was taken.

Used in codes 1-3
These fields specify up to three different ways in which the material will be used. These are each single character fields that may contain "A" through "Y". A list of DOT used in-codes are provided in a drop-down box. Values may be left blank if there are less than 3 uses.

Sample Date
This is the date on which the sample was tested. The Date field is a date time object that can contain any date between 1/1/100 and 12/31/9999. Under the Microsoft Windows operating system a date can be entered and displayed in a number of different ways depending on the country settings in the Windows control panel.

Vendor Code:
This is the DOT assigned Vendor designation of a company that is to resell the material. This value is only supplied if the material is being re-sold instead of being delivered to a project. This is a 4-character code from QPL2, and is NOT the site manager code. If there is no vendor then leave this field blank.

Technician Group
Specifies the group the technician taking this sample belongs to. These samples may be taken by either Quarry Certification (Technicians employed by the aggregate plant) or Independent assurance (technicians employed by the DOT).

DOT Technician Code
The code assigned by the DOT to designated people who are authorized to submit test reports to the DOT

Aggregate Group
Specifies if the material falls in to aggregate group 1 (limestone) or aggregate group 2 (granite)

Sampled From
A generalized location from which the sample was taken. This is either (S)tockpile, (B)elt, (R)oadway, rail (C)ar, (T)ruck, or (O)ther.

Percent Passing **1-10**
The percent of material passing each of the required sieves (ten max). The sieve sizes required for testing are pulled from a pre-programmed list and are displayed on the column heading on the entry form. Decimal values may be specified. Each percent passing value obtained from the test is required to be less than the previous value. A larger value would represent a physical impossibility.

Sand Equivalent
If applicable, the numeric results obtained from a GDT-63 sand equivalent test.

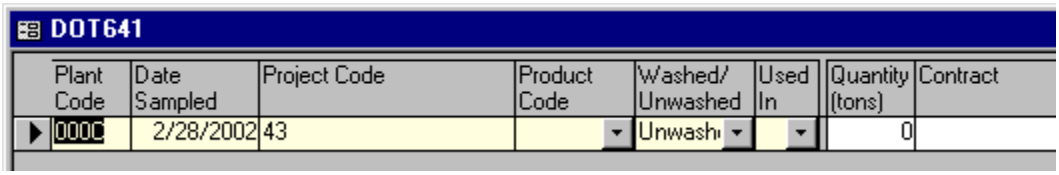
Meets Requirements
Indicates if the sample is passing or failing based on the results.

Remarks
The remark field is a memo field where users can enter any additional relevant data they want.

Send

Checking this box indicates that you have accurately and honestly entered your data and that it is ready to send to the GDOT. The label next to this box indicates if this record has been sent (Or more accurately, extracted for sending)

THE DOT 641 AGGREGATE QUANTITY FORM



The DOT 641 Form:
This form enables easy and accurate entry of DOT 641 Aggregate Quantity data.

The DOT 641 Aggregate Quantity Producer Report is a report of the quantity of material supplied by a **source plant** on a specific **day**, separately reporting the quantities of each **product** for each **use** for each **project.**

The fields that uniquely identify a DOT 641 report are the **Plant Code**, **Date Sampled**, **Project Code**, **Product Code, Washed/Unwashed** and **Used In**.

The fields in the DOT 640 are as follows:

Source Plant Code:
A Source Plant Code is the designation assigned by the DOT to producers that supply material to the DOT. The Source Plant Code entered must be the Code of the plant shipping the reported quantity of material.
This plant code is a 4-character field. The first 3 characters are a zero padded right-justified number and the last character is an upper case letter.

Correct: 032C, 141C
Incorrect: 32C, 141

Date Sampled
The date is the single date on which the quantity of material was supplied. The Date field is a date time object that can contain any date between 1/1/100 and 12/31/9999. Under the Microsoft Windows operating system a date can be displayed and entered in a number of different ways and depends on the country settings in the Windows control panel.

Project Code:
This is the project designation for the specific project being performed under the contract. You must type the project code in EXACTLY as it is issued; otherwise your data may not be filed properly.

Aggregate Product Code:
The Aggregate Product Code is a designation assigned by the DOT to various aggregate materials supplied to the DOT.
The Product Code field is a 4-character field that must contain a valid Product Code designation. To ensure the accuracy of this field, the designation is selected from a list.

Washed/Unwashed
Indicates that the product is (W)ashed or (U)nwashed.

Used In:
The Used In code specifies what the material is going to be used for. The code is from a list of DOT Used In codes. The Used In code field is a single upper case letter from A to Z. Each letter represents a different way in which the material can be used.

Quantity:
The Quantity is the amount, in **TONS** of the specified product that the Supplier has shipped on that day for a specific contract for a specific use.

Contract ID:
This is the ID of the contract under which this work is being preformed and paid under. The Contract ID's format is upper case, letter "O"s are not allowed, and dashes in the format: 000000-00-000-0.

County Number:
The DOT county designation code that the work for this contract is being preformed in.

Vendor code:
This is the DOT assigned Vendor designation of a company that is to resell the material. This value is only supplied if the material is being re-sold instead of being delivered to a project. This is a 4-character code from QPL2.

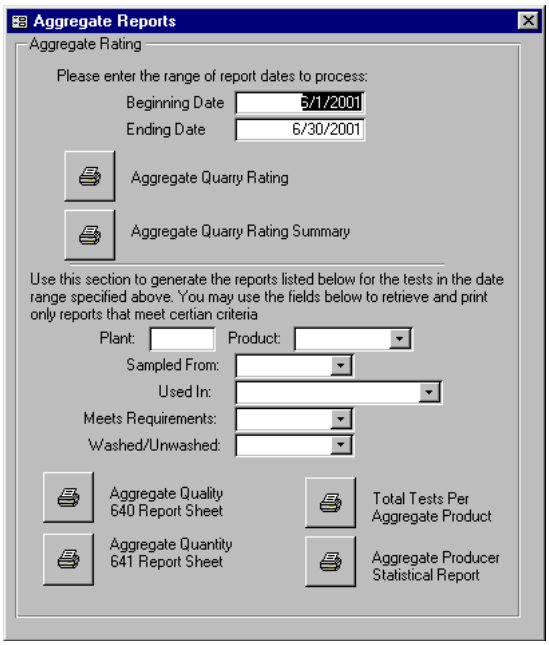
Beginning Sample No
Ending Sample No
The beginning and ending Sample Numbers are the sample numbers from the DOT 640 tests, which were run on the quantity of material being reported in this report. Because the sample numbers restart at the beginning of each year, the year of these samples MUST match the year on the report.

Results passed
This indicates if the test samples, specified above, were generally passing or failing from the DOT 640 tests run on the material.

Send
Checking this box indicates that you have accurately and honestly entered your data and that it is ready to send to the GDOT. The label next to this box indicates if this record has been sent (Or more accurately, extracted for sending)

PRINTING AGGREGATE DATA AND STATISTICAL REPORTS

When you click the “Aggregate reports" button from the main menu, you will see the following screen:



From here, you may generate the following reports:

Before running any of the reports listed here, you must enter a range of dates that you wish to work with.

Aggregate Quarry Rating: This is the same rating that the GDOT runs on your data in combination with all other received data. This, however, will enable you to get immediate results on your own local data that you have entered.

Aggregate Quarry Rating Summary: A summary of the above rating report.

For the remainder of these reports you may additionally select data for the plant, product, sampled from location, used in, meets requirement, and washed/unwashed values you specify. These are optional, however you must still specify a date range.

Aggregate Quality 640 Report Sheet – This will print a sheet of all entered data for the specified 640 forms.

Aggregate Quantity 641 Report Sheet – This will print a sheet of all entered data for the specified 641 forms.

Total Tests per Aggregate Product: Is a summary report that shows how many tests were performed per aggregate product.

Aggregate Producer Statistical Report: Generates averages and standard deviations of percent passing for all specified Samples for each product.

SECTION IX

NATURAL SAND

SECTION IX

Natural Sand

Learning Objectives

In this section, the following learning objectives will be discussed

- ✓ Define Natural Sand
- ✓ Understand how to sample Natural Sand
- ✓ Identify what test procedures are relevant for Natural Sand
- ✓ Understand Stockpiling of Natural Sand
- ✓ Familiarization with the Quality Assurance Program for a Natural Sand Source

NATURAL SAND

I. GENERAL

Natural sand is fine rock particles that have accumulated on the earth's surface by natural weathering and erosional processes. It is mined by dredging from a floodplain or river and sometimes dry mined from a pit or hill side. After mining, the material must be subjected to a washing and classifying process to meet GDOT specifications. The washing process largely removes clay and organic impurities. GDOT specifications require that 100 percent of the sand pass a ⅜ inch sieve. Any material retained on the ⅜ inch sieve is considered oversized material and is not allowed in GDOT concrete sand.

Natural Sand (product No. 10NS) is used primarily in Portland Cement Concrete, but may also be used in Asphaltic Concrete. Most natural sand sources also produce mortar sand (product No. 20NS), which is considerably finer than the sand used in Portland Cement Concrete.

Sand can also be produced from the mining of overburden. Although the material mined by this type of operation does not technically meet the geologic definition of natural sand, it is designated as such by the GDOT for the sake of expediency.

II. SAMPLING

Samples are taken and tested for two basic reasons.

1. **To control product quality during the production and stockpiling phase.** Samples must be taken frequently during production to ensure that the end product meets GDOT Specification requirements. Adjustments made to plant operations should be based on the test results and allowances made for normal segregation and degradation that are expected to occur during further handling.

2. **To verify product quality during shipment.** Provided the more complex issues of "control" have been properly addressed, the verification of quality is simply a matter of randomly taking representative samples during shipment and reporting the test results through the Field Data Collection System (FDCS). These samples serve the dual purpose of quality assurance and product certification during shipment.

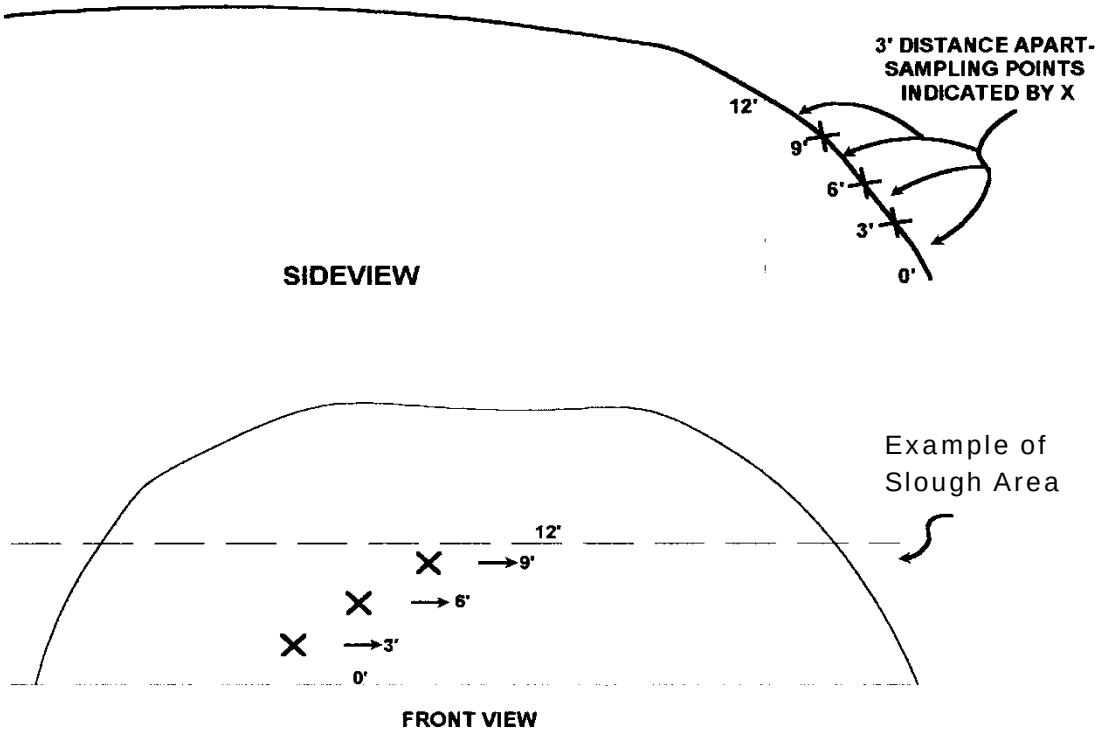
   Testing frequencies are established in the Quality Assurance Program (source specific), which is provided by the Office of Materials and Research. Adjustments to the minimum testing frequencies may be made if deemed necessary.

LOAD FACE SAMPLING PROCEDURE

A fine aggregate sampling tube is the preferred device for sampling natural sand. This tube should have an inside diameter of 2 inches (50mm) to 3 ½ inches (89mm) and a minimum length of 30 inches (762mm).

The stockpile slough should be sampled at a minimum of three points that are equal distances apart (approximately) in a diagonal direction from the bottom to the top of the slough. The space between the bottom of the stockpile and the first sampling point and the space between the highest sampling point and the top of the slough should also be the same distance as between the sampling points.

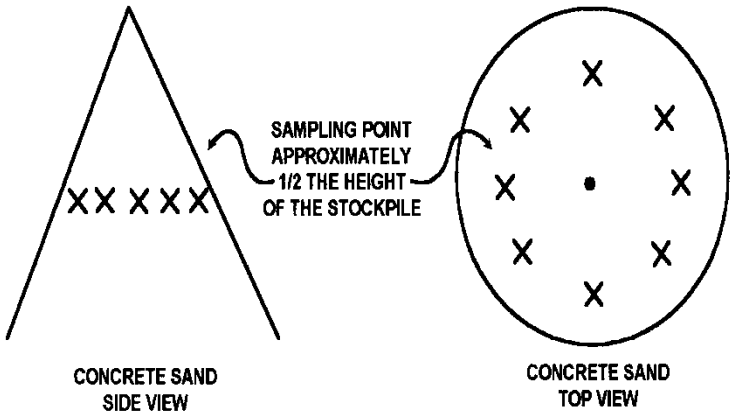
Note: The width of the area sampled should be confined to no more than two times the width of the loader bucket that is being used for loading out materials.



CONICAL STOCKPILE SAMPLING PROCEDURE

CONCRETE SAND

For production control and standardized evaluation procedures, concrete sand may be sampled at equal points around the cone at approximately 1/2 the height of the stockpile. These samples should always be compared to those that represent shipments. Typically, samples taken after the cone has been opened up or re-stocked will contain more fines than the production samples. This is believed to be caused by free water transporting fines toward the heart of the cone during



production. The difference between the two sampling locations should be noted and production adjusted accordingly.

III. TEST PROCEDURES

Natural Sand must be subjected to the following tests at the frequency prescribed in the Quality Control Program designated by the Office of Materials and Research.

- AASHTO T-11 – Material Finer than No. 200 Sieve
- AASHTO T-21 – Organic Impurities in Aggregates for Concrete
- AASHTO T-27 – Sieve Analysis of Fine and Coarse Aggregate
- AASHTO T-248 – Reducing Field Samples of Aggregate to Testing Size
- GDT-63 – Sand Equivalent of Fine Aggregates
- GDT-75 – Durability (Required at only a few sources)

Performing these tests assures that the material meets gradation and is free from any detrimental material such as clay balls, organic material, coal or lignite. ***The limits for detrimental materials can be found in Section 801 of the GDOT Standard Specifications and in Section V of this study guide.***

IV. STOCKPILING, HANDLING, AND SHIPPING PROCEDURES

Natural sand typically is stocked by a non-telescoping radial stacker. In this case, load out should be done perpendicular to the conveyor from the opposite end of the stockpile from where current production is being placed. If the sand is placed by a stationery conveyor into a single conical stockpile, it should be restocked into a single- or multiple-lift stockpile. Limited ramping onto the sand is allowed when restocking. Load out should be from a loading face on the restocked material. For this and all other stockpiling and handling procedures refer to Standard Operating Procedure 1 in Section IV of this study guide.

V. QUALITY CONTROL PROGRAM

Quality Control Programs are based on the geology of the deposit and contain the minimum testing frequencies for producer certification. GDOT will only accept certified material from sources that have been evaluated and approved by the Office of Materials and Research. Below is a generic example of a Quality Assurance Program that you might see at a typical natural sand source.

Date

QUALITY CONTROL PROCEDURES

NAME OF COMPANY
LOCATION
SOURCE NO

The following procedures are in accordance with SOP-1 as revised May 5, 2006, and are intended to allow producer certification of coarse aggregates.

1. Test all shipments as indicated in the attached Minimum Testing Frequencies Guide.

2. Maintain daily a record of project numbers, sizes, quantities and intended uses when shipping directly to Departmental projects, and record in the format of DOT Form 641.

3. Materials shipped for use in Portland cement concrete and Asphaltic concrete are generally stockpiled with the respective producer's current inventory and may not be used in Departmental construction. It is imperative that all such shipments be certified to meet ***Georgia DOT Specifications***. Since these shipments cannot be correlated to a specific project number, do not report the quantities in the format of DOT Form 641.

4. It is the responsibility of the Pit and Quarry Control Branch to notify testing personnel of Special Provisions modifying the Standard Specifications.

5. "*The Company*" will be responsible for the cleanliness of haul units and correct loading practices.

6. Any modification of standard testing procedures must have prior approval by the Office of Materials and Research.

7. Testing of production aggregate should be done by the producer to control quality during the manufacturing process. Do not report production samples to the DOT unless otherwise specified but maintain them in an orderly file at the source for future reference and as an aid in problem solving.

8. Take producer certification samples at the point and time of shipment.

9. Record all test run during the period of shipment in the format of DOT Form 640.

10. Maintain copies of all test data and DOT certifications in an orderly filing system at the source.

11. Complete and upload to the Field Data Collection System database producer certification reports at a minimum frequency of every two weeks.

Date

MINIMUM TESTING FREQUENCIES GUIDE

NAME OF COMPANY
LOCATION
SOURCE NO.

TESTS FOR CERTIFIED AGGREGATE SHIPMENTS

Test	Product	Frequency
	NO.10 CONCRETE SAND **NO.20 MORTAR SAND**	
1. AASHTO T27 Gradation		One test per 1,000 tons shipped. Not less than one test per week per size.
2. AASHTO T11 Washed Minus 200		One test per 4,000 tons shipped. Not less than one per month per size
3. GDT-63 Sand Equivalent		One test per week. Daily if results are below 80.
4. AASHTO T21 Organic impurities		One test per week as long as the colorimetric test results are 2 or less. Test daily when the results are 3.

TESTS FOR PRODUCTION CONTROL

Test: **GDT-132**
FRIABLE PARTICLES

1. Fine Aggregate (2% Maximum)	Not less than per when friable particles are present. All test results are to be listed on the attached log. The log will be submitted to the Forest Park Laboratory by the aggregate engineer on a monthly basis.

ACKNOWLEDGEMENT OF INTENT TO COMPLY

I have read the preceding pages of the Quality Assurance Program for the ***Name of Mine or Quarry (Source No.)***. I agree to comply with this Program, Standard Operating Procedure No. 1 dated May 5, 2006, and the Georgia DOT Specifications.

Print: _____

Signed: _____ _____ _____
President of Company Region or Division Date

Print: _____

Signed: _____ _____
Quality Control Manager Date