

DIVISION 5
SUBGRADE, BASES, AND
SHOULDERS

SECTION 500
FINE GRADING SUBGRADE, SHOULDERS AND DITCHES

500-1 DESCRIPTION

Perform the work covered by this section including but not limited to preparing, grading, shaping, and compacting either an unstabilized or stabilized roadbed to a condition suitable for placement of base course, pavement, and shoulders. Clean, shape, and maintain roadway ditches; strip existing vegetation; and place and compact in accordance with Sections 235 and 560 all materials resulting from the shaping operation. Stockpile surplus material for the construction of shoulders and dispose of any necessary surplus stockpile material as waste. Perform this work on all portions of the project which will be paved under the contract.

On those portions of the roadway where there is no pavement to be placed under the contract, perform the work covered by this section under the requirements of Section 225 or Section 230, depending upon the source of the material. The provisions of this section will not be applicable to such work.

500-2 CONSTRUCTION METHODS

(A) General

Shape the roadway to conform to the lines, grades, and typical sections shown on the plans. Strip all existing vegetation from the ground surface wherever shaping of the roadway is to be done. Utilize all suitable surplus material in the construction of the roadway or stockpile for use in shoulder construction. Dispose of surplus material in excess of that needed for roadway or shoulder construction as waste. Obtain additional material, if needed, from roadway excavation or borrow sources.

Remove all unsuitable material, boulders, and all vegetative matter and replace with suitable material. Obtain suitable material, when not available from the shaping or fine grading operation, from roadway excavation or borrow sources.

Clean, reshape, and maintain roadway ditches in a satisfactory condition until final acceptance of the project.

Conduct operations in such a manner as to avoid damage to any previously constructed structures and facilities.

(B) Preparation of Subgrade

Shape the subgrade to the lines, grades, and typical sections shown on the plans. Where the Engineer directs that areas of the subgrade are to be stabilized with aggregate, the subgrade surface in such areas may, subject to the approval of the Engineer, be left uniformly below grade to provide for the addition of the stabilizer material.

Store or stockpile material excavated in preparing the subgrade in such a manner as to not interfere with proper drainage or any subsequent operations of stabilization, placing base, or placing pavement.

(C) Compaction of Subgrade

Compact all material to a depth of 200 mm below the finished surface of the subgrade to a density equal to at least 100% of that obtained by compacting a sample of the material in accordance with AASHTO T99 as modified by the Department. Copies of these modified testing procedures are available upon request from the Materials and Tests Unit.

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Compact the subgrade at a moisture content which is approximately that required to produce the maximum density indicated by the above test method. Dry or add moisture to the subgrade when required to provide a uniformly compacted and acceptable subgrade.

Where the subgrade is to be stabilized with lime, aggregate, or cement, the above density requirements will not apply prior to the incorporation of the stabilizing material, however, perform compaction in accordance with the requirements of Article 501-10, 510-3, or 542-9, as appropriate.

500-3 TOLERANCES

A tolerance of plus or minus 13 mm from the established grade will be permitted after the subgrade has been graded to a uniform surface.

Perform the grading operation such that the maximum difference between the established grade and the graded subgrade within any 30.5 m section is 13 mm.

500-4 PROTECTION OF SUBGRADE

Provide and maintain ditches and drains as may be necessary to satisfactorily drain the subgrade. Where previously approved subgrade is damaged by natural causes, by hauling equipment, or by other traffic, restore the subgrade to the required lines, grades, and typical sections and to the required density at no additional cost to the Department.

500-5 MEASUREMENT AND PAYMENT

Fine Grading will be paid for at the contract lump sum price. Such lump sum price will be full payment for all material excavated to a depth of 0.1 m below the existing graded surface.

Any material which has been excavated from the subgrade at the depth greater than 0.1 m below the existing graded surface will be considered unclassified excavation and will be paid for as provided in Article 225-8.

As an exception to the above, on those areas in which the Contractor is responsible for constructing the embankment on which the subgrade is located, no payment will be made for that excavation that may be necessary to bring the grade to the established subgrade elevation and typical section. Incorporate such surplus material into the project at no additional cost to the Department.

When sufficient material is not available from the fine grading operation to complete the work of fine grading, additional material will be paid for as provided in Article 225-8 for Unclassified Excavation or in Article 230-6 for Borrow Excavation, depending on the source of material.

Surplus material stockpiled for shoulder construction and incorporated into the work will be paid for as provided in Article 560-5 for Shoulder Borrow. No payment will be made for the removal and disposal of any surplus material remaining in the stockpile after the shoulders have been completed.

Payment will be made under:

Pay Item	Pay Unit
Fine Grading	Lump Sum

**SECTION 501
LIME-TREATED SOIL**

501-1 DESCRIPTION

Perform the work covered by this section including but not limited to treating the subgrade, embankment, natural ground, or existing pavement structure by adding water and lime in the form specified herein, mixing, shaping, compacting, and finishing the mixture to the required density. Prepare the soil layer to be stabilized; haul, proportion, spread, and mix the materials within the depth range as shown on plans; manipulate, compact, and finish the lime treated soil; correct, repair, and maintain the lime treated

soil; and apply a sand seal in accordance with the requirements of Article 501-3. Construct the work in conformity with the typical sections, lines, and grades shown on the plan, and in accordance with these Specifications.

501-2 MATERIALS

Refer to Division 10

Item	Section
Lime	1052-3
Water	1024-4

Use soil material which consists of material upon which the pavement is to be placed, existing material upon which the embankment is to be placed, approved borrow material, or a combination of these materials proportioned as directed. Remove all vegetation, roots, or other objectionable matter from the soil, as well as all aggregate or stone larger than 50 mm for the full depth to be treated.

501-3 LIMITATIONS

Do not perform lime stabilization when the air temperature is below 7°C or in the period from November 1 to March 15 except by written permission. Do not mix the lime with frozen soils or when the soils contain frost. Apply lime to such areas as can be initially mixed and sealed during the day of application. Do not apply lime when wind conditions, are such that blowing lime becomes hazardous to traffic, workers, or adjacent property owners, or when excessive loss of lime may occur.

Do not construct lime-treated soil that will not be covered with a layer of pavement or base by December 1 of that same calendar year. The Engineer may suspend the lime stabilization operations in writing when he determines that the Contractor will not cover the completed stabilization by December 1 as specified above. Failure of the Contractor to cover the lime treated soil as required above will result in the Engineer notifying the Contractor in writing to cover the lime treated soil with a sand seal. Apply the sand seal in accordance with the requirements of Section 660 except that Articles 660-3, 660-11, and 660-12 will not apply. Perform this work at no cost to the Department. In the event the Contractor fails to apply the sand seal within 72 hours after receipt of such notice, the Engineer may proceed to have such work performed by other forces and equipment. The cost of such work performed by other forces will be deducted from monies due or to become due to the Contractor. The application of the sand seal by the Contractor or other forces will in no way relieve the Contractor of the responsibility to maintain or repair the damaged stabilization, no matter what the cause of damage, at no cost to the Department.

501-4 EQUIPMENT

(A) General

Use any combination of machines and equipment to produce the required results that meet the approval of the Engineer. Correct any leakage of fluids and/or materials promptly or the Engineer may order such equipment removed and replaced with satisfactory equipment. Comply with Article 107-22 with respect to operation of equipment and prevent damage to the base while applying water, curing seal and blotting sand.

(B) Lime Spreaders

Spread lime at the required rate by methods and equipment, which have been approved.

(C) Water Distribution Equipment

Add water to the soil with a pressure distributor or other suitable equipment capable of uniformly distributing the required amount.

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(D) Mixers

Perform mixing with a self-propelled rotary mixer, except that disc harrows, motor graders, and other equipment may be used only to supplement the mixing done by the rotary mixer.

Use mixing equipment capable of mixing to a compacted depth of at least 250 mm.

(E) Compaction Equipment

Use compaction equipment that is self-propelled. Perform finish rolling with a pneumatic tired roller, or as permitted, a smooth, steel-wheel roller, or a combination of both types.

(F) Scarifying Equipment

Use a grader-scarifier for the initial scarification of the soil. Use equipment capable of scarifying to the full depth of the stabilized treatment. When required, use a weeder, spiketooth harrow, or nail drag, followed by a broom drag to scarify during finishing operations.

501-5 PROTECTION AND SAFETY

Take necessary precautions to protect personnel from dust created by the lime application and mixing operation to include eye protection, dust masks and appropriate training.

501-6 PREPARATION OF ROADBED

Prior to the addition of any lime to the soil, grade and shape the area to be stabilized in close conformity to the typical sections, lines, and grades shown on the plans. Remove all materials such as roots, turf, and aggregate larger than 50 mm.

501-7 SCARIFYING

When required by the method of application, scarify the soil to the required depth and width and then partially pulverize by making one pass through the area with a pulverizing rotary mixer. Delete the pulverizing portion of the scarifying operation in areas where the soil types or conditions make pulverizing with a rotary mixer impractical.

501-8 APPLICATION OF LIME

(A) General

When the Contractor has brought the soil layer to the elevation required by the plans, the Engineer will sample the soil to be stabilized in order to determine the quantity of lime to be incorporated. Allow 24 calendar days for the Engineer to perform the required sampling, testing, and final design of the lime stabilization.

Spread lime or lime slurry only on an area of such size that all primary mixing operations can be completed in the same day during daylight hours except where the work is to be done at night as required by the contract.

Incorporate the lime or lime slurry into the soil mixture at the rates determined by the Engineer. Distribute the lime at the uniform rate and in such a manner as to reduce the scattering by the wind to a minimum. Mix the lime into the soil within 2 hours after application.

No equipment, except that used in spreading, slaking, and mixing, will be allowed to pass over the freshly spread lime until it is mixed with the soil.

(B) Slurry Method

Do not add lime slurry to the soil when the moisture content exceeds 2% above optimum moisture. Aerate soil having a moisture content higher than 2% above optimum or allow to dry naturally until it contains no more than this percentage of moisture. The optimum moisture will be determined by the Engineer.

Mix hydrated lime applied by this method with water in approved agitating equipment and apply to the soil to be treated as a thin water suspension or slurry. When quicklime is used to produce the slurry, use equipment specifically manufactured for the slaking of quicklime. Use distributing equipment that provides continuous agitation of the slurry from the slurry production site until the slurry is applied to the soil. Proportion the lime so that the "Dry Solids Content" is at least 30% by weight.

Split the lime application into approximately 2 equal applications with the first being partially mixed into the soil to a minimum depth of 76.2 mm prior to applying the second application.

(C) Quicklime

Do not add dry quicklime to the soil when the moisture content exceeds 4% above optimum moisture. Aerate soil having a moisture content higher than 4% above optimum or allow to dry naturally until it contains no more than this percentage of moisture. The optimum moisture will be determined by the Engineer.

Where the "Bottom-Dump" method of application is used, omit the preliminary scarification of the soil surface. Apply the quicklime by slowly driving the tanker truck over the coverage area with the bottom discharge valves open creating a windrow of quicklime.

Repeat the process until the tanker is empty in order to provide a minimum of 3, for 7.3 m roadway, reasonably uniform and equally spaced windrows over the area being stabilized. The number of windrows required will depend on the width of the section being stabilized and will be stipulated by the Engineer.

Carefully spread the windrows of quicklime with a motor grader into an equal depth layer over the entire area to be stabilized.

After the lime has been spread, follow with a sprinkling of water to slake the lime. After a complete slaking of the lime, thoroughly mix the lime with the soil. The Engineer may direct that the lime first be mixed into the soil followed by sprinkling and additional mixing to ensure complete slaking of the lime throughout the layer to be stabilized.

(D) Hydrated Lime

Use hydrated lime only with written permission and do not add to the soil when the moisture content exceeds 6% above optimum moisture.

501-9 MIXING

(A) Primary Mixing

Immediately after the lime has been spread (and slaked, if required), mix the lime into the soil for the full depth of treatment. Mix the lime into the soil to provide a minimum compacted depth of 200 mm. A minimum number of mixing passes will be required to ensure uniform incorporation of the lime. Add water as necessary and thoroughly mix with the soil lime mixture so that the mixture contains no less than optimum moisture. A tolerance of 3% above optimum will be allowed. Incorporate all of the lime thoroughly and uniformly into the soil layer to the full depth of treatment in such a manner that the result is a homogeneous, friable mixture of soil and lime, free of clods or lumps exceeding 50 mm in size.

After primary mixing operations and prior to curing, shape and lightly compact the lime-treated area to the approximate section to allow for proper drainage and to minimize evaporation loss.

(B) Preliminary Curing

Following primary mixing operations, cure the stabilized layer for 1 to 4 days. The actual duration of this curing period will be determined by the Engineer.

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During the curing period keep the surface of the material moist to prevent drying and cracking, and maintain in a properly sealed and crowned condition. Mix, compact, shape, and finish the stabilized layer no later than 4 days after primary mixing.

(C) Final Mixing and Pulverizing

Immediately after the completion of the preliminary curing period, Mix and pulverize completely the stabilized layer to the full depth of the stabilization. Continue the final mixing until all of the clods are broken down to pass a 13 mm sieve and at least 80% pass a 4.75 mm sieve, exclusive of rock. Add water as required during the final mixing to raise the moisture content prior to compaction.

501-10 COMPACTING, SHAPING, AND FINISHING

Begin compaction of the mixture immediately after completion of the final mixing operations. Aerate or moisten the mixture as necessary during compaction operations to maintain the moisture between optimum and optimum plus 2%. Compact the full depth of the mixture to a density equal to at least 97% of that obtained by compacting a sample of the soil lime mixture in accordance with AASHTO T99 as modified by the Department. Copies of these modified procedures are available upon request from Materials and Tests Unit. Accompany the compaction with sufficient blading to eliminate irregularities.

Perform the final rolling of the completed surface with a pneumatic- tired roller or if permitted a smooth, steel wheel roller.

Complete shaping, final mixing, compacting and finishing on the same day upon completion of the preliminary curing. This work is to be completed no later than 4 days after primary mixing and done during daylight hours, unless otherwise provided in the contract. If the above work is not completed as specified, rip up the entire section and add additional lime, as directed, at no additional cost to the Department.

501-11 THICKNESS

The compacted thickness of the completed treated soil layer will be determined by measurements made in test holes located at random intervals not to exceed 152 m. Do not deviate the measured thickness from that shown on the plans by more than plus 25.4 mm or minus 13 mm.

Where the lime-treated soil layer is deficient in thickness by more than 13 mm, remove and replace the area of deficient thickness with lime-treated soil having the required thickness at no cost to the Department.

As an exception to the above, if the deficiency is not considered sufficient to seriously impair the required strength of the lime-treated soil layer, the deficient area may, at the discretion of the Engineer, be left in place. However, only 50% payment will be made for the lime-treated soil and the theoretical amount of lime used.

501-12 FINAL CURING

After the lime-treated soil has been finished in accordance with Article 501-10, protect it against drying for a 7-day curing period in accordance with the requirements of Section 543.

501-13 TRAFFIC

Completed sections of the lime-treated soil may be opened when necessary to lightweight local traffic, provided it has hardened sufficiently to prevent marring or distorting of the surface, and provided the curing is not impaired. Do not use construction equipment on the lime-treated soil except as necessary to discharge material into the spreader during paving operations, or except as may be otherwise permitted for embankment construction.

501-14 MAINTENANCE

Maintain the lime-treated soil in an acceptable condition until final acceptance of the project. Include immediate repair of any defects or damage that may occur in maintenance operations. Perform this work at no cost to the Department and repeat as often as may be necessary to keep the lime-treated soil in an acceptable condition. Perform repairs to lime-treated soil by replacing the lime-treated soil for its full depth rather than by adding a thin layer of lime stabilized material to the existing layer. An alternate repair method may be used if approved in writing.

501-15 MEASUREMENT AND PAYMENT

Lime-treated soil will be measured and paid for as the number of square meters of each layer of lime-treated soil that has been completed and accepted. In determining this quantity, the width of the lime-treated soil will be measured across the top surface of the treated layer. The length will be the actual length constructed, measured along the centerline of the surface of the treated layer.

Lime for Lime-Treated Soil Where hydrated lime or quick lime is spread directly on the soil in solid form or when hydrated lime is used to produce a slurry, the quantity of lime to be paid for will be the number of metric tons of lime that has been incorporated into the soil at the required rates. No measurement will be made of any lime added or replaced for corrective measures during construction or for repairing damaged areas. Measurement is to be made in bulk in the truck on certified platform scales or other certified weighting devices.

Where quicklime is slaked on the project and applied in slurry form, measurement will be calculated as indicated below for each truckload using the certified lime purity for that load.

- A = Certified weight of quicklime delivered x % purity x 1.32
- B = Certified weight of quicklime delivered x % inert material
- A+B = Total hydrated lime produced (pay quantity)

Asphalt curing seal will be paid for as provided in Article 543-5.

Blotting sand will be paid for as provided in Article 818-5.

In the event that a layer of lime-treated soil is deficient in thickness but has been permitted to be left in place in accordance with Article 501-11, payment for that lime treated soil and lime will be made at 50 percent of the contract unit prices for Lime-Treated Soil and Lime for Lime-Treated Soil.

Payment will be made under:

Pay Item	Pay Unit
Lime-Treated Soil	Square Meter
Lime for Lime-Treated Soil	Metric Ton

**SECTION 510
AGGREGATE STABILIZATION**

510-1 DESCRIPTION

Perform the work covered by this section including but not limited to furnishing all aggregate and water; hauling, spreading, and mixing the required amount of aggregate with the subgrade materials; shaping and compacting the stabilized subgrade to the required grade and typical section; and maintaining the aggregate.

510-2 MATERIALS

Refer to Division 10.

Item	Section
Stabilizer aggregate	1008-1

Section 510

510-3 CONSTRUCTION METHODS

(A) Mixing

Remove sufficient subgrade material, if necessary, to compensate for the addition of the stabilizer aggregate. Spread the quantity of aggregate required by the contract uniformly over the subgrade by means of a mechanical spreader. Spread the aggregate on the subgrade in advance of the mixing operations only to the extent that processing can be completed within one week. Mix the aggregate with the top 75 mm of the subgrade soil. Continue mixing until the aggregate is uniformly mixed with the soil to the width and depth to be treated.

Have the aggregate sampled, tested, and approved prior to the placing layers of base material or pavement thereon.

(B) Shaping and Compaction

Shape the stabilized subgrade to the lines, grades, and typical sections shown on the plans.

Compact the entire depth and width of the stabilized subgrade to a density equal to at least 100% of that obtained by compacting a sample of the material in accordance with AASHTO T99 as modified by the Department. Copies of these modified testing procedures are available upon request from the Materials and Tests Unit. Compact the stabilized subgrade at a moisture content which is approximately that required to produce the maximum density indicated by the above test method. Dry or add moisture to the material as required to provide a uniformly compacted and acceptable subgrade.

510-4 TOLERANCE

A tolerance of plus or minus 13 mm from the established grade will be permitted after the stabilized subgrade has been graded to a uniform surface.

Perform grading of the subgrade such that the maximum differential between the established grade and the stabilized subgrade within any 30.5 m distance is 13 mm.

510-5 PROTECTION

The requirements of Article 500-4 will be applicable to the protection of the aggregate stabilized subgrade.

510-6 MEASUREMENT AND PAYMENT

Stabilizer Aggregate will be measured and paid as the actual number of metric tons of aggregate, exclusive of any corrective material, which has been mixed with the completed and accepted subgrade. This quantity will be measured as provided for in Article 520-11.

Payment will be made under:

Pay Item	Pay Unit
Stabilizer Aggregate	Metric Ton

**SECTION 520
AGGREGATE BASE COURSE**

520-1 DESCRIPTION

Perform the work covered by this section including but not limited to constructing a base composed of an approved aggregate material hauled to the road, placed on the road, mixed, compacted, and shaped to conform to the lines, grades, depths, and typical sections shown in the plans and applying a sand seal in accordance with the requirements of Article 520-5, and maintaining the base.

520-2 MATERIALS

Refer to Division 10.

Item	Section
Aggregate base course	1006 and 1010

520-3 METHODS OF PRODUCTION

Furnish aggregate upon which no restrictions are placed on the production or stockpiling except as provided in Sections 1005, 1006, and 1010. Place on the roadway aggregates which have been sampled, tested and approved in accordance with the requirements of Article 520-6.

520-4 SUBGRADE PREPARATION

Prepare the subgrade in accordance with Section 500 prior to placement of the base material.

520-5 HAULING AND PLACING AGGREGATE BASE MATERIAL

Place the aggregate material on the subgrade with a mechanical spreader capable of placing the material to a uniform loose depth and without segregation except that for areas inaccessible to a mechanical spreader, the aggregate material may be placed by other methods approved by the Engineer.

Where the Contractor elects to use more than one source of aggregate as described in Section 1005, place the various types of aggregate used in an approved manner which will permit the sampling and testing required by Section 1006 and 1010.

Where the required compacted thickness of base is 250 mm or less, the base material may be spread and compacted in one layer. Where the required compacted thickness is more than 250 mm spread the base material and compact in 2 or more approximately equal layers. Compact the base material to a minimum thickness of approximately 100 mm for any one layer.

Have each layer of material sampled, tested, compacted, and approved prior to placing succeeding layers of base material or pavement.

Do not place base material on frozen subgrade or base.

Cover, within 7 calendar days, base course placed between November 15 and March 15 inclusive with a subsequent layer of pavement structure or with a sand seal. Apply sand seal in accordance with the requirements of Section 660 except that Articles 660-3 and 660-11 will not apply.

Failure by the Contractor to cover the base course as required above will result in the Engineer notifying the Contractor in writing to cover the base course with a sand seal and to suspend the operations of placing aggregate base course until such cover has been placed. Perform this work at no cost to the Department. In the event that the Contractor fails to apply the sand seal within 72 hours after receipt of such notice, the Engineer may proceed to have such work performed with other forces and equipment. The cost of such work performed by the Department will be deducted from monies due or to become due the Contractor. The application of the sand seal by the Contractor or by others will in no way relieve the Contractor of the responsibility to maintain or repair the damaged base or subgrade, no matter what the cause of damage, at no cost to the Department.

Do not allow traffic on the completed base course other than necessary local traffic and that developing from the operation of essential construction equipment as may be authorized by the Engineer. Repair any defects that develop in the completed base or any damage caused by local or construction traffic acceptably at no cost to the Department. Hauling equipment may be operated with the approval of the Engineer, over a lower layer of base, however, acceptably repair any rutting, weaving, or soft areas that develop at no cost to the Department.

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Do not exceed 35 miles per hour with hauling equipment traveling over any part of the base.

Utilize methods of handling, hauling, and placing which will minimize segregation and contamination. If segregation occurs, the Engineer may require that changes be made in the Contractor's methods to minimize segregation, and may also require mixing on the road which may be necessary to correct any segregation. No additional compensation will be allowed for the work of road mixing as may be required under this provision. Remove and replace all aggregate which is contaminated with foreign materials to the extent that the base course will not adequately serve its intended use at no additional cost to the Department. The above requirements will be applicable regardless of the type of aggregate placed and regardless of prior acceptance.

520-6 SAMPLING, TESTING, AND ACCEPTANCE

Perform sampling for the determination of gradation, liquid limit, and plasticity index for the various types of aggregate, as defined in Articles 1010-1, and 1010-2.

Where visual observation indicates the need to do so, the Engineer may require the Contractor to road mix areas of nonuniform gradation at no additional cost to the Department. The Engineer reserves the right to take samples in addition to the lot acceptance samples from within the lot in areas exhibiting nonuniform gradation. When the test results from such an additional sample is outside the gradation limits given in Column C of Table 1010-1 and the nonuniformity cannot be corrected by road mixing, the aggregate base course represented by the sample will be rejected and replaced by the Contractor at no cost to the Department.

520-7 SHAPING AND COMPACTION

Machine and compact the layer of base within 48 hours after beginning the placing of a layer of the base. Maintain each layer to the required cross section during compaction and compact each layer to the required density prior to placing the next layer.

When electing to use conventional density test number 3 (ring test) to determine density, compact each layer of the base to a density equal to at least 100% of that obtained by compacting a sample of the material in accordance with AASHTO T180 as modified by the Department. Copies of these modified testing procedures are available upon request from the Materials and Tests Unit.

Follow the requirements as specified in Article 520-9 when electing to use nuclear methods to determine the density.

Compact the base material at a moisture content which is approximately that required to produce a maximum density indicated by the above test method. Dry or add moisture to the material when required to provide a uniformly compacted and acceptable base.

Shape the final layer of base material to conform to the lines, grades, and typical section as shown on the plans. Construct the base course so that it is smooth, hard, dense, unyielding, and well bonded upon completion. A broom drag may be used in connection with the final finishing and conditioning of the surface of the base course.

520-8 TOLERANCES

After final shaping and compacting of the base, the Engineer will check the surface of the base for conformance to the grade and typical section and determine the base thickness.

Construct the base so that the thickness of the base is within a tolerance of plus or minus 13 mm of the base thickness required by the plans.

Construct the base so that the maximum differential between the established grade and the base within any 30.5 m section is 13 mm.

520-9 DENSITY DETERMINATION BY NUCLEAR METHODS**(A) Application**

The Engineer may utilize nuclear means as described below to determine the density of selected base course materials required by Sections 520 and 540. The target density will be from the material's most recent AASHTO T180 test results, which may be obtained from the Materials and Tests Unit.

A new target density is to be obtained when there is a change in the source of material, when a significant change occurs in the composition of the materials from the same source, or when determined necessary.

Testing will be performed in the direct transmission mode on all aggregate base course. Additional information on testing is provided in the current *N.C.D.O.T. Nuclear Gauge Operator's Manual*, copies of which are available from the Materials and Tests Unit.

(B) Test Sections**(1) General**

Provide a test section which has a depth no greater than the layer depth shown in the plans or required by the Specifications, whichever is less. Determine the length of the section by the width as shown in the current *Nuclear Gauge Operator's Manual*.

In situations where the chemical composition of the material affects the gauge moisture readings, the Materials and Tests Unit will provide specific instructions.

(2) Equipment

Equipment used in the compaction of test sections shall be approved prior to use. Where uniform density is not being obtained throughout the depth of the layer of material being tested, change the type and/or weight of the compaction equipment as necessary to achieve uniform density even though such equipment has been previously approved.

When aggregate base course material is involved, use at least one steel wheel vibratory roller weighing not less than 5.4 metric tons.

(3) Compaction

After the material in a test section has been spread and shaped to the required width and depth, begin the compaction of the section. Carry out compaction in such a manner as to obtain uniform maximum density over the entire test section.

Immediately prior to compacting the aggregate base course material, make sure it has satisfactory moisture content. If it is necessary to add water after the material is placed, scarify the material, and add water uniformly throughout the full depth of the layer of the base course material.

(4) Testing Procedures

After the Contractor has completed compaction of the test section, the Engineer will conduct 5 density tests at random within 5 equal segments of the test section. Provide a smooth surface on the material being tested prior to any tests being performed. Density tests will not be made when the surface of an aggregate base course contains free moisture. The required density will be expressed as a percentage of the target density.

(5) Acceptance Requirements

Provide a density for aggregate base course of at least 98% of the nuclear target density. In addition, the nuclear density of any single test location shall be at least 95% of the nuclear target density.

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The required density will be determined by the average of 5 nuclear density tests made at random locations within 5 equal segments of the test sections.

520-10 MAINTENANCE

Where the base material is placed in a trench section, provide adequate drainage through the shoulders to protect the subgrade and base until such time as the shoulders are completed.

Maintain the surface of the base by watering, machining, rolling, or dragging when necessary to prevent damage to the base by weather or traffic.

Where the base or subgrade is damaged, repair the damaged area; reshape the base to required lines, grades, and typical sections; and recompact the base to the required density at no cost to the Department.

520-11 MEASUREMENT AND PAYMENT

Aggregate Base Course will be measured and paid for at the contract unit price per metric ton for will be the actual number of metric tons of aggregate which has been incorporated into the completed and accepted work.

When the Contractor has elected to leave a lot in place which exceeds the range of Column D of Table 1010-1, but which is otherwise in accordance with the requirements of Article 1010-2, the quantity of base course included in this lot will be paid for at a reduced unit price. The reduced unit price will be established in accordance with Article 1010-2. The aggregate will be measured by being weighed in trucks on certified platform scales or other certified weighing devices. If permitted by the contract, the weight of base course material shipped by barge may be determined from water displacement measurements.

No deductions will be made for any moisture contained in the aggregate at the time of weighing.

Payment will be made under:

Pay Item	Pay Unit
Aggregate Base Course	Metric Ton

**SECTION 530
SOIL TYPE BASE COURSE**

530-1 DESCRIPTION

Perform the work covered by this section including but not limited to furnishing the source of material; building, maintaining, and obliterating haul roads; clearing and grubbing the material source; removal and disposal of overburden; excavation; hauling; spreading materials; mixing; compacting; shaping to conform to the lines, grades, depth, and typical sections shown on the plans; reconditioning; maintaining the base; restoration of the source and haul roads to an acceptable condition; and seeding and mulching the source.

530-2 MATERIALS

Refer to Division 10.

Item	Section
Soil type base course	1010-3

530-3 PREPARATION OF SUBGRADE

Prepare the subgrade in accordance with the requirements of Section 500.

530-4 MATERIAL SOURCES

(A) General

Clear and grub the surface of the material sources and thoroughly clean it of all unsuitable material before beginning excavation. Dispose of material resulting

from clearing and grubbing in accordance with Article 200-5. Remove and dispose of overburden in accordance with Section 802.

Where payment is to be made by measuring the material in its original position, notify the Engineer sufficiently in advance of beginning excavation of this material in order that the area may be staked and cross sectioned by the Engineer. No payment will be allowed for any material excavated prior to cross sections being taken. Excavate the material to the lines and slopes as staked by the Engineer and perform the excavation in an orderly manner to facilitate measurement at any time.

Where payment is to be made by truck measurement, furnish trucks with bodies suitable for accurate measurement. Load trucks uniformly and in such a manner as to prevent spillage.

Where it is necessary to haul material over existing roads or streets, the requirements of Article 105-15 will apply. Use all necessary precautions to prevent damage to the existing structures or pavement. Conduct hauling operations in such a manner as to not interfere with the normal flow of traffic and keep the traffic lanes free from spillage at all times.

(B) Department Furnished Sources

Where the Department furnishes material sources, the location of such sources will be as designated on the plans.

The Department will furnish the necessary haul road right of way at locations designated by the Engineer. Build, maintain, and when directed, obliterate all haul roads required at no cost to the Department. Where the haul road is to be reclaimed for cultivation, plow or scarify the area to a minimum depth of 200 mm.

Remove overburden prior to the excavation of the base material when indicated by the plans.

Where it is necessary to drain the material source, perform this work in accordance with Section 240.

Leave the material source in a neat and presentable condition after use. Smooth, round, and construct all slopes not steeper than 2:1. Plow or scarify to a minimum depth of 200 mm, disc harrow, and construct terraces where the source is to be reclaimed for cultivation.

Seed and mulch the sources in accordance with Sections 1620, 1660, 1661, or 1663.

(C) Contractor Furnished Sources

Approval of material sources furnished by the Contractor is subject to the requirements of Subarticle 230-4(C).

(D) Substitute Sources

Follow the requirements of Subarticle 530-4(C) when electing to substitute material sources for those provided by the Department.

530-5 PLACING MATERIAL

Deposit the material on the subgrade in such a manner that when all layers are spread, mixed, and compacted, the required depth of base material will be obtained. Where more than one type of material is to be used, spread each uniformly over the subgrade prior to placing the next material.

530-6 MIXING AND COMPACTING

Immediately after placing and spreading the base material, begin mixing operations. Perform the mixing in a manner which will produce a thoroughly and uniformly mixed base course.

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Compact the base uniformly throughout the depth and width of the base. Where the base is thicker than 200 mm, spread the base and compact it in 2 layers approximately equal in thickness.

Compact the base to a density equal to at least 100% of that obtained by compacting a sample of the material in accordance with AASHTO T99 as modified by the Department. Copies of these modified testing procedures are available upon request from the Materials and Tests Unit.

Compact the base material at a moisture content which is approximately that required to produce the maximum density indicated by the above method. Dry or add moisture to the material when required to provide a uniformly compacted and acceptable base.

530-7 FINAL SHAPING

Shape the base to conform to the lines, grades, and typical sections shown on the plans. Take care to prevent the formation of slippage planes in the surface. Thoroughly dry, remix or remove and replace all soft or unstable areas.

530-8 SAMPLING, TESTING, AND ACCEPTANCE

Where the depth of the base is such that the placement of more than 1 layer is required for proper mixing and compacting, sample, test and have approved each layer of material prior to placing additional base material thereon.

Samples will be taken from the road immediately after the base material has been spread, mixed, and shaped to a true cross section. Sampling and testing for acceptance will be as hereinafter provided.

Use a sampling unit consisting of 152.4 m when the roadway base is placed in widths 8.2 m or less. Use a sampling unit consisting of 836 m² when the base is placed in widths over 8.2 m. As an exception to the above, when the base course is constructed utilizing materials in the existing subgrade the sampling units will be reduced to one half the size indicated above. Use a sampling unit consisting of 305 m when placing base on a shoulder or widening of 3.7 m or less.

One sample will be taken from a location selected by the Engineer in each unit. The sample will be taken by cutting 3 cores for the full depth of the base course, one on the center line and one approximately 0.9 m from each edge, and combining the material as one sample representing the material in that unit.

If the sample tested fails to meet specification requirements, obtain 2 check samples, one on each side of the original sample at 15.2 m spacing. The unit will be rejected unless both of these samples meet specification requirements.

Where a unit is rejected, no further samples will be taken from that unit until the material is either corrected by the addition and mixing of suitable material or the rejected material is removed and replaced.

Where the material source is furnished by the Contractor and the Engineer permits the Contractor to correct a rejected unit by the addition and mixing of corrective material, perform all work necessary due to the addition of the corrective material at no cost to the Department.

Where the material source is furnished by the Contractor and the rejected unit is in a final layer of base, furnish and incorporate any material added to correct gradation at no cost to the Department.

Resampling of a corrected or replaced unit will be performed in the same manner as original sampling.

530-9 TOLERANCES

After final shaping and compacting of the base, the Engineer will check the surface of the base for conformance with the grade and typical section and will determine the base thickness.

Construct the base with a thickness that is within a tolerance of plus or minus 13 mm of the base thickness required by the plans.

Construct the base such that the maximum differential between the established grade and the base within any 30.5 m section is 13 mm.

530-10 RECONDITIONING

Where sampling and testing indicate that additional material shall be added to the base to produce the required quality, add the required material, remix, recompact, and reshape the base to the required lines, grades, and typical sections.

Where the Contractor furnishes the material source, perform the work of reconditioning at no cost to the Department.

530-11 MAINTENANCE

Where the base material is placed in a trench section, provide adequate drainage through the shoulders to protect the subgrade and base until such time as shoulders are completed.

Maintain the surface of the base by machining, watering, and rolling or dragging when necessary to prevent damage to the base by weather or traffic.

Within 24 hours of completion of the base, prime the base slopes where required or, where prime is not required, place sufficient shoulder material against the edges of the completed base to protect the base.

Where the base or subgrade is damaged due to negligence on the part of the Contractor, repair the damaged area; reshape the base to the required lines, grades, and typical sections; and recompact the base to the required density at no cost to the Department.

530-12 MEASUREMENT AND PAYMENT

Soil Type Base Course, Type _____ will be measured and paid for at the contract unit price per cubic meter or ton for the actual number of cubic meters or metric tons of base course material that has been incorporated into the completed and accepted work. However, no measurement will be made of any additional material which the Engineer has permitted the Contractor to incorporate into a final base layer in the work of reconditioning where the Contractor has furnished the material source.

Measurement of the base course material will be made in accordance with one of the following methods:

- (A) When the material is to be measured in its original position, measurement will be made by cross sections and computations will be made by the average end area method. No measurement will be made of any material excavated prior to cross sections being taken.
- (B) When the material is to be measured in trucks, the level to which each truck is to be loaded will be measured by the Engineer and each truck shall be suitably marked to indicate the loaded level. Each truck shall bear a suitable mark or number for identification. Load each truck to at least its measured load level when it arrives at the point of delivery. The recorded quantity of material will be adjusted by making a 25 percent deduction to allow for shrinkage, and the adjusted quantity will be the quantity to be paid for.
- (C) Where the contract calls for the material to be paid for by the metric ton, the material will be measured by being weighed in trucks on certified platform scales or other certified weighing devices. No deduction will be made for any moisture contained in the material at the time of weighing.

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(D) Reconditioning Road

When material sources are furnished by the Department and the Engineer directs the incorporation of additional material into a rejected sampling unit, the work of reconditioning as provided in Article 530-10 will be measured as provided below.

When the Contractor furnishes material sources, no measurement of reconditioning will be made.

The quantity of reconditioning to be paid for at the contract unit price per 1,000 square meters for *Reconditioning, Soil Type Base Course* will be the actual number of units of 1,000 square meters of base course over which the work of reconditioning has been acceptably performed. The length will be the actual length measured along the centerline of the surface of the base. The width will be the width required by the plans or as directed by the Engineer measured across the top surface of the base.

Where the material source has been furnished by the Department, payment for clearing and grubbing the source will be made as provided in Article 200-7, payment for removal and disposal of overburden will be made as provided for unclassified excavation in Article 225-7, payment for draining the source will be made as provided in Article 240-4, and payment for seeding and mulching the source when required will be made as provided in Article 1660-8.

Where the material source has been furnished by the Contractor, no separate payment will be made for clearing or grubbing, removal and disposal of overburden, draining the source, or seeding the mulching as such work will be considered as incidental to the work covered by this section.

Payment will be made under:

Pay Item	Pay Unit
Soil Type Base Course, Type _____	Cubic Meter
Soil Type Base Course, Type _____	Metric Ton
Reconditioning, Soil Type Base Course	1,000 Square Meters

**SECTION 535
CONDITIONING EXISTING BASE**

535-1 DESCRIPTION

Perform the work covered by this section including but not limited to scarifying, shaping, furnishing water, compacting, and maintaining the base. Included in the work is:

- (A) Conditioning of an existing base to prepare it for the placement of a pavement directly upon the base. Included in the conditioning is scarifying, shaping, and compacting the base to conform to the required lines, grades, depths, and typical sections established by the plans.
- (B) Conditioning of an existing base in preparation for the placement of additional layers of base material. Included in the conditioning is scarifying, shaping, and compacting the base to conform to the approximate lines, grades, depths, and typical sections established by the plans.

535-2 CONSTRUCTION REQUIREMENTS

Compact the base to a degree satisfactory to the Engineer. Dry or add moisture to the material when required to provide a uniformly compacted and acceptable base.

Do not condition the existing base when it contains excess moisture or is frozen.

Maintain the base in accordance with the requirements of Article 520-10 or 530-11.

535-3 MEASUREMENT AND PAYMENT

Conditioning Existing Base will be measured and paid for at the contract unit price per 1,000 square meters for the actual number of units of 1,000 square meters of base over which the work of conditioning existing base has been acceptably performed. The length will be measured along the centerline of the surface of the base. The width will be the width required by the plans or established by the Engineer measured across the top surface of the base.

Payment will be made under:

Pay Item	Pay Unit
Conditioning Existing Base	1,000 Square Meters

**SECTION 540
CEMENT TREATED
BASE COURSE**

540-1 DESCRIPTION

Perform the work covered by this section including but not limited to construction and curing a cement treated base composed of aggregate, furnishing of water and aggregate; the mixing, proportioning, hauling, and spreading of the materials; furnishing Portland cement at the point where it is incorporated into the mix; manipulating, compacting, and finishing the base; maintaining the base; making repairs or corrections to the base; and applying sand seal in accordance with Article 540-3. Compact, shape, and cure the base to conform to the lines, grades, depths, and typical sections shown on the plans.

When Cement Treated Base Course is called for on the plans, the Contractor has the option of providing a Plant Mixed Cement Treated Base Course or a Road Mixed Cement Treated Base Course as specified below.

540-2 MATERIALS

Refer to Division 10.

Item	Section
Aggregate	1010-4
Portland Cement, Type I	1024-1
Water	1024-4

Use aggregate that meets the requirements of Article 1010-1 and Article 1010-2 or Article 1010-3, except for gradation which meets the requirements of Table 1010-4.

540-3 LIMITATIONS

Do not construct cement treated base from November 1 to March 15 inclusive. Do not construct base when the air temperature is less than 5°C in the shade nor when conditions indicate that the temperature may fall below 5°C within 24 hours. Do not incorporate frozen materials into the mixture nor place material on frozen subgrade. Protect the base from freezing for a period of 7 days after completion. Perform work during daylight hours unless otherwise provided by the requirements of the traffic control plans.

Do not place cement treated base that will not be covered with pavement by December 1st of the same year. Failure of the Contractor to cover the cement treated base as required above will result in the Engineer notifying the Contractor in writing to cover the cement treated base with a sand seal. Apply the sand seal in accordance with the requirements of Section 660 except that Articles 660-3 and 660-11 will not apply. Perform this work at no cost to the Department. In the event the Contractor fails to apply the sand seal within 72 hours after receipt of such notice, the Engineer may proceed to have the work performed with other forces and equipment. The cost of such work performed by other forces will be deducted from monies due or to become due the

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Contractor. The application of the sand seal by the Contractor or other forces will in no way relieve the Contractor of the responsibility to maintain or repair the damaged base, no matter what the cause of damage, at no cost to the Department.

540-4 PREPARATION OF SUBGRADE

Prepare the subgrade in accordance with Section 500. Prepare the subgrade so that it is firm and able to support without displacement the construction equipment and the compaction operations hereinafter specified. Soft or yielding subgrade will be corrected and made stable before construction proceeds. Moisten the subgrade as needed prior to spreading the base material.

540-5 CONSTRUCTION METHODS

(A) General

Composition of Mixture

When the Contractor proposes to use a source of aggregate that is not documented by a currently approved job mix formula, submit to the Department's Materials and Tests Unit, samples of all aggregates proposed for use at least 3 weeks prior to beginning production. Take the aggregate samples in the presence of the Engineer. Submit in writing the proposed gradation for the cement treated base material. The Department will then prepare a mix design based upon the samples submitted and the Contractor's stated proposed gradation.

A job mix formula will be established for the cement treated base material within the design limits indicated in Table 1010-4, Column B. Use the job mix formula unless modified in writing by the Engineer.

Prepare all cement-treated base material mixtures so that they conform to the job mix formula within the tolerance ranges specified in Table 540-1. In the event the Contractor is not able to maintain the production within the tolerance ranges specified in Table 540-1, production will cease until such time as a new mix design and job mix formula has been established and approved by the Engineer.

**TABLE 540-1
TOLERANCES FOR JOB MIX FORMULA
PORTLAND CEMENT-TREATED BASE**

Sieve Size	Tolerance for Percent Passing
37.5 mm	0
25.0 mm	± 5
12.5 mm	± 8
4.75 mm	± 7
2.0 mm	± 7
.425 mm	± 4
.075 mm	± 2
Material Passing No. 10 Sieve (Soil Mortar)	
.425 mm	± 8
.075 mm	± 5

(B) Plant Mixed Cement-Treated Base Course**(1) Mixing****(a) General**

Add to the aggregate the quantity of cement specified by the Engineer.

Thoroughly mix the cement, aggregates, and water in an approved central mixing plant. Use a batch or continuous-flow type stationary mixer and equip it with feeding and metering devices that will add aggregate, cement, and water into the mixer in the specified quantity. Use batch weights or rates of feed of cement that are within 0.3 percent of the quantity designated by the Engineer. Use batch weights or rates of flow of water that are within a range of optimum to optimum plus 1.5 percent moisture. Use batch weights or rates of feed of aggregate that are within 5 percent of the amounts designated by the Engineer.

Mix materials a minimum of 20 seconds to assure a proper blend of materials.

(b) Batch Type Plant

Equip the mixer with a sufficient number of paddles of a type and arrangement to produce a uniformly mixed batch.

Add water during the mixing operation as required to provide the quantity of moisture specified; however, do not add water to the mixture before the aggregate and cement have been mixed sufficiently to prevent the formation of cement balls.

Equip the mixer with a timing device which will indicate by a definite audible or visual signal the expiration of the mixing period.

(c) Continuous Flow Type Plant

Calibrate and mark cement storage silos so that the amount of cement in the silo can be readily determined at any time. Design feeders and/or meters for introducing the cement into the mixer such that the amount of cement can be accurately determined before it is introduced into the mixer. Use a variable speed motor on the cement feeder which is regulated by a control mechanism indicating the speed of the motor in r.p.m. or equivalent measure. Design the indicator so that it can be read in daylight from a point 1.2 m from the indicator. Equip the cement holding tank which is used in feeding cement with an air pressure gauge and air pressure regulating control such that air pressure can be regulated to a uniform flow.

Measure the water by a meter which determines flow in liters per minute and control it with 2 valves. Use a variable flow valve for controlling the rate of flow of the water only on one valve and use an on-off valve connected to the plant controls such that the water is turned on and/or off when the plant is started and stopped for the other valve.

After the material has been processed by the pug mill, store it in a holding bin with the minimum capacity of 2.7 metric tons before discharging into trucks. Hold the material in the holding bin for loading purposes only and do not store for loading subsequent trucks. Loading trucks directly from a belt or auger box will not be permitted.

Have available a satisfactory platform for obtaining samples from trucks. Make provisions for calibrating the plant daily and at other times as deemed necessary by the Engineer. On plants that are electronically controlled, manual calibration will be required to verify the electronic calibration and shall be performed at the beginning of a project. If the plant operation is interrupted by more than 4 calendar days during an active project, perform the manual calibration process again. Perform random manual calibrations at the direction of the Engineer.

(2) Hauling and Placing

Haul the mixed base material to the roadway in trucks with protective covers to avoid moisture loss. Do not exceed 1 hour between the loading of the haul trucks and the beginning of compaction.

Place stringlines for alignment control for placing a layer of base.

Place the base in a uniform layer on the moistened, prepared subgrade to produce the depth required by the plans. To insure homogenous distribution of the base material in each layer, place the material using approved spreaders. Perform the spreading operations in such a manner as to eliminate pockets of material of non-uniform gradation resulting from segregation in the hauling or discharging operations. Spread each layer so that compaction can be started without further shaping.

A single spreader may be used provided it is capable of placing a uniform, full-depth layer of material across the full width of the base in one pass. Otherwise, 2 or more spreaders will be required, and operate the spreaders so that the spreading progresses along the full width of the base in a uniform manner.

Base placed on areas inaccessible to mechanical spreading equipment may be spread in one layer by approved methods. After spreading, compact the material thoroughly to the required lines, grades, typical sections by means of pneumatic tampers, or with other compaction equipment which will constantly obtain the degree of compaction required.

(C) Road Mixed Cement-Treated Base Course

(1) Equipment

Use any combination of machines or equipment that will produce the required results meeting the approval of the Engineer. Use a cement spreader which has an adjustable rate of flow and the capability of spreading the required amount of cement in one pass. Mix cement, aggregate, and water with a self-propelled rotary mixer capable of mixing to a depth of 250 mm. Correct any leakage of fluids and/or materials promptly or the Engineer may order such equipment removed and replaced with satisfactory equipment. Use equipment and methods for applying cement, water, curing seal, and blotting sand that does not damage the base and meets the requirements of Article 107-22.

(2) Spreading and Mixing

Place the required quantity of aggregate on the prepared subgrade in a uniform layer. Spread aggregate on the subgrade in advance of the mixing operations only to the extent that processing can be completed within one week. Apply the required quantity of cement in a uniform spread on the aggregate in place and immediately blend the aggregate until the cement is uniformly distributed throughout the aggregate. Have the moisture content at or below the optimum moisture at the time of application of the cement. Do not apply cement on excessively windy days and apply only to such an

area that all operations shall be completed on the same day during daylight hours.

The Engineer will establish the actual cement content during construction.

Immediately after the aggregate and cement have been thoroughly blended, apply water as needed and incorporate into the mixture. Control the application of the water so that there is no excessive concentration on or near the surface of the mixture. After the necessary water has been applied, continue mixing until a thorough and uniform mixture is obtained.

Maintain the moisture content at the time of final mixing and during compaction within a range of optimum to optimum plus 1.5% as determined. Make sure that the moisture content in the mix does not exceed the quantity that will cause the base course to become unstable during compaction or finishing operations.

540-6 **COMPACTION**

Begin compaction immediately after the plant mixed base has been placed on the prepared subgrade or immediately after cement and water has been incorporated into the previously placed aggregate. Compact any one layer of base so that the thickness does not exceed 200 mm and is not be less than 100 mm.

After spreading, maintain the moisture content of the material within a range of optimum to optimum plus 1.5% moisture during compaction. Accomplish compaction by the use of approved self-propelled rollers except do not use a sheep-foot roller for more than 2 passes. Compact the base by the use of approved self-propelled rollers to a density equal to at least 97% of the maximum density obtained by compacting a sample of the material in accordance with AASHTO T180 as modified by the Department. Copies of these modified testing procedures are available upon request from the Materials and Tests Unit. The Engineer may, at his option, utilize nuclear methods as described in the current *Nuclear Gauge Operators Manual* to determine the density of the base in lieu of the methods required above. Copies of this manual are available upon request from the Materials and Tests Unit.

Complete final compaction, including that necessary due to correction of high or low areas, within 3 hours after water has been added to the mixture. Do not leave any cement-aggregate mixture undisturbed for more than 30 minutes if it has not been compacted and finished. When rain causes excessive moisture, reconstruct the entire section. When such reconstruction is necessary, perform the work of reconstruction and provide the cement required at no cost to the Department.

540-7 **CONSTRUCTION JOINTS**

At the end of each day's construction, form a straight transverse construction joint by cutting back into the completed work to form a vertical face. Build the base for large, wide areas in a series of parallel lines of convenient length and width meeting the approval of the Engineer. Form straight longitudinal joints at the edge of each day's construction by cutting back into the completed work to form a vertical face free of loose or shattered materials. Where traffic considerations require that a longitudinal joint be exposed for an excessive length of time, the Engineer may require that it be covered with a curing seal in accordance with Section 543.

540-8 **TOLERANCES**

After final shaping and compacting of the base, the Engineer will check the surface of the base for conformance to the grade and typical section and determine the base thickness.

Construct the thickness of the base so that it is within a tolerance of plus or minus 13 mm of the base thickness required by the plans.

Construct the base so that the maximum differential between the established grade and the base within any 30.5 m section is 13 mm.

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540-9 CURING

After the cement treated base has been finished as specified herein, cure it in accordance with Section 543.

540-10 AGGREGATE FOR CEMENT-TREATED BASE

Use aggregate for cement-treated base course from an approved source participating in the Department's Aggregate Quality Control/Quality Assurance Program (Aggregate QC/QA Program) which has been sampled, tested, and approved in accordance with the requirements of Article 1010-4.

540-11 TRAFFIC

Completed sections of the base may be opened when necessary to lightweight local traffic, provided the base has hardened sufficiently to prevent marring or distorting of the surface, and provided the curing is not impaired. Do not operate construction equipment on the base except as necessary to discharge into the spreader during paving operations.

540-12 MAINTENANCE

Maintain the base in an acceptable condition until final acceptance of the project. Include immediate repair of any defects or damage that may occur in any maintenance operation. Perform this maintenance at no cost to the Department and repeat as often as may be necessary to keep the base in an acceptable condition. Perform repairs to the base by replacing the base for its full depth rather than by adding a thin layer of cement-stabilized material to the existing layer of base.

540-13 MEASUREMENT AND PAYMENT

Aggregate for Cement Treated Base Course will be measured and paid for at the contract unit price per metric ton that has been incorporated into the completed and accepted work. The quantity will be measured by weighing in trucks on certified platform scales or other certified weighing devices. No deduction will be made for any moisture contained in the aggregate at the time of weighing. Measurement will not be made of any base mixture added or replaced for corrective measures during construction or for repairing damaged areas.

Portland Cement for Cement-Treated Base Course will be measured and paid for at the contract unit price per metric ton that has been incorporated into the mix. When bulk cement is used, the quantity will be measured by weighing in trucks on certified platform scales or other certified weighing devices. When cement-treated base is produced at a commercial source for more than one project, the Engineer may elect to measure the cement based upon the cement content shown in the approved job mix formula. Measurement will not be made of any cement added or replaced for corrective measures during construction or for repairing damaged areas.

Asphalt Curing Seal will be paid for as provided in Article 543-5.

Blotting Sand will be paid for as provided in Article 818-4.

The above prices and payments will be full compensation for all work covered by this section including but not limited to the furnishing of water and aggregate; the mixing, proportioning, hauling, and spreading of the materials; furnishing Portland cement at the point where it is incorporated into the mix; manipulating, compacting, and finishing the base; maintaining the base; making repairs or corrections to the base; and applying sand seal in accordance with Article 542-3.

Payment will be made under:

Pay Item	Pay Unit
Aggregate for Cement Treated Base Course	Metric Ton
Portland Cement for Cement-Treated Base Course	Metric Ton

SECTION 542 SOIL-CEMENT BASE

542-1 DESCRIPTION

Perform the work covered by this section including, but not limited to constructing and curing a soil cement base by treating the subgrade, existing subbase, existing base or any combination of these materials. Proportion, spread and mix the materials on the roadway; manipulate, compact and finish in accordance with these Specifications and in conformance to the lines, grades, depths and typical sections shown on the plans or established by the Engineer.

542-2 MATERIALS

Refer to Division 10.

Item	Section
Portland Cement, Type I	1024-1
Water	1024-4

Use soil material that consists of material existing in the area to be paved, approved borrow material, or a combination of these materials proportioned as directed by the Engineer that is free from vegetation, roots, or other objectionable matter; and does not contain aggregate or stone larger than 50 mm.

542-3 LIMITATIONS

Do not construct the soil-cement base from November 1 to March 15 or when the air temperature is below 5°C in the shade nor when conditions indicate that the temperature may fall below 5°C within 24 hours. Do not place or mix materials with frozen subgrade. Protect the base from freezing for a period of 7 days after completion. Perform the work only during daylight hours except as otherwise provided in the contract.

Do not construct soil-cement base that will not be covered with a layer of base or pavement by December 1st of the same year. Failure of the Contractor to cover the soil-cement base as required above will result in the Engineer notifying the Contractor in writing to cover the soil-cement base with a sand seal. Apply the sand seal in accordance with the requirements of Section 660 except that Articles 660-3 and 660-11 will not apply. Perform this work at no cost to the Department. In the event the Contractor fails to apply the sand seal within 72 hours after a receipt of such notice, the Engineer may proceed to have the work performed with other forces and equipment. The cost of such work performed by other forces will be deducted from monies due or to become due the Contractor. The application of the sand seal by the Contractor or other forces will in no way relieve the Contractor of the responsibility to maintain or repair the damaged base, no matter what the cause of damage, at no cost to the Department.

542-4 EQUIPMENT

(A) General

Use any combination of machines or equipment that will produce the required results meeting the approval of the Engineer. Correct any leakage of fluids and/or materials promptly or the Engineer may order such equipment removed and replaced with satisfactory equipment. Use equipment and methods for applying cement, water, curing seal and blotting sand that will not damage the base and meets the requirements of Article 107-22.

(B) Cement Spreaders

Use mechanical spreaders that have an adjustable rate of flow and the capability of spreading the required amount of cement in one pass.

(C) Water Distribution Equipment

Add water to the soil with a pressure distributor or other suitable equipment capable of uniformly distributing the required amount.

(D) Mixers

Perform all mixing with a self-propelled rotary mixer. Disc harrows, motor graders, and other equipment may be used only to supplement the mixing done by the rotary mixer.

Use mixing equipment that is capable of mixing to a compacted depth of at least 250 mm.

(E) Compaction Equipment

Use self-propelled compaction equipment. Accomplish finish rolling with a pneumatic-tire roller or if permitted by the Engineer, a smooth steel-wheel roller.

(F) Scarifying Equipment

Use a grader-scarifier for the initial scarification of the soil. Use equipment capable of scarifying the soil to the full depth of the stabilized treatment. When required by the Engineer, use a weeder, spiketooth harrow, or nail drag, followed by a broom drag when scarifying during finishing operations.

542-5 PREPARATION OF ROADBED

Prior to the addition of any cement to the soil, grade and shape the area to be stabilized in close conformity to the typical sections, lines, and grades shown on the plans. Perform drying or addition of moisture where necessary prior to the application of cement. Create the subgrade so that it is firm and able to support the construction equipment and the compaction operations specified. Correct and make stable soft or yielding subgrade before construction proceeds.

542-6 SCARIFYING

Scarify the soil in the area to be stabilized to the required depth and width prior to application of cement. Pulverizing with a rotary mixer will follow scarifying except that it may be deleted in areas where, if determined, the soil types or conditions make pulverizing with a rotary mixer impractical.

542-7 APPLICATION OF CEMENT

When the Contractor has brought the subgrade to the elevation required by the plans, the Engineer will sample the soil to be stabilized in order to determine the quantity of cement to be incorporated. Incorporate 24 calendar days into the schedule to allow the Engineer sufficient time to perform the required sampling, testing, and final design of the cement stabilization.

Incorporate cement into the mix at the rate directed by the Engineer. Uniformly spread the quantity of cement required for the full depth of treatment over the surface in one pass. Do not apply cement on excessively wet grade or on windy days.

Apply cement to the soil when the percentage of moisture in the soil material is the correct amount that assures a uniform mixture of soil material and cement during the mixing operation. Do not exceed the optimum moisture content established by the Engineer for the soil-cement mixture except by permission.

The optimum moisture content and density will be determined in the field by a moisture-density test on representative samples of soil-cement mixture; however, preliminary moisture-density values may be determined by laboratory tests using soils from the project. Moisture content will be determined by the Engineer in accordance with standard test procedures used by the Department.

Apply cement only to such an area that all operations shall be completed in the same day during daylight hours. Complete finishing the soil-cement mix within 4 hours of adding water to the soil-cement mixture. No equipment, except that used in spreading

and mixing, will be allowed to pass over the freshly spread cement until it is mixed with the soil. Replace all spread cement that has been displaced before mixing is started at no cost to the Department.

542-8 MIXING

Immediately after the cement has been spread, mix it with the loosened soil material for the full depth of the treatment until a homogenous and uniform mixture is produced. Mixing will be considered sufficient when 100% of the mixture passes a 12.5 mm sieve and a minimum of 80% passes a 4.75 mm sieve, exclusive of any aggregate.

Immediately after mixing the soil and cement, add any additional water that is necessary to bring the moisture content between optimum and optimum plus 2% as determined by the Engineer. If moisture content exceeds the specified range, the soil-cement mixture may, if approved by the Engineer, be manipulated by remixing or blading to reduce the moisture content to within the specified range. Avoid excessive concentrations of water as well as wet spots or streaks on or near the surface. After all mixing water has been applied, continue mixing until a uniform mixture is obtained at the required moisture content. Perform the operations of cement spreading, water application, and mixing so that they result in a uniform soil, cement, and water mixture for the full depth and width of the area being treated. Remix any soil and cement mixture that has not been compacted and finished within 30 minutes.

542-9 COMPACTION

Begin compaction of the mixture immediately after the mixing operation is completed. At the start of compaction, make sure that the percentage of moisture in the mixture is no more than 2 percentage points above or below the optimum moisture content, and is less than the quantity which will cause the soil-cement mixture to become unstable during compaction and finishing. Compact the mixture to at least 97% of that obtained by a moisture-density test using AASHTO T134 as modified by the Department. Copies of these modified testing procedures are available upon request from the Materials and Tests Unit.

Prior to compaction, prepare the mixture in a loose condition for its full depth. Compact the loose mixture uniformly to the specified density. During the compaction operations, initial shaping may be required to obtain uniform compaction and required grade and cross-section.

542-10 FINISHING

When initial compaction is nearing completion, shape the surface of the soil-cement to the required lines, grades, and cross-section. Maintain the moisture content of the surface material at not less than optimum during finishing operations.

If necessary, lightly scarify the surface to remove any tire imprints or smooth surfaces left by equipment. Continue compaction until a uniform and adequate density is obtained.

Perform the compaction and finishing in such a manner as to produce a dense surface free of compaction planes, cracks, ridges, or loose material.

When rain causes excessive moisture, reconstruct the entire section. Where such reconstruction is necessary, furnish all work and cement required at no cost to the Department.

542-11 THICKNESS

The compacted thickness of the completed soil-cement base will be determined by measurements made in test holes located at random intervals not to exceed 152.4 m. Construct the soil-cement base so that the measured thickness does not deviate from that shown on the plans by more than plus 25.4 mm or minus 13 mm.

Where the base is deficient in thickness by more than 13 mm, remove and replace the area of deficient base with base of the required thickness at no cost to the Department.

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As an exception to the above, if the deficiency is not considered sufficient to seriously impair the required strength of the soil-cement base, the deficient area may, at the discretion of the Engineer, be left in place. However, only 50% payment will be made for the base and the theoretical amount of cement used.

542-12 CURING

After the cement treated base has been finished as specified herein, cure it in accordance with Section 543.

542-13 CONSTRUCTION JOINTS

At the end of each day's construction, form a straight transverse construction joint by cutting back into the completed work to form a true vertical face.

Build soil-cement for large wide areas in a series of parallel lanes of convenient length and width meeting the approval of the Engineer. Form straight longitudinal joints at the edge of each day's construction by cutting back into completed work to form a true vertical face free of loose or shattered material.

Construct joints to provide a vertical joint having adequately mixed properly compacted material immediately adjacent to the joint. A longitudinal joint adjacent to partially hardened soil-cement built the preceding day may be formed by cutting back into the previously constructed area during mixing operations. Set guide stakes for cement spreading and mixing if deemed necessary.

542-14 TRAFFIC

Completed sections of the base may be opened when necessary to light-weight local traffic, provided the base has hardened sufficiently to prevent marring or distorting of the surface, and provided the curing is not impaired. Do not use construction equipment on the base for hauling except as necessary to discharge into the spreader during paving operations.

542-15 MAINTENANCE

Maintain the soil-cement base in an acceptable condition until final acceptance of the project. Include in maintenance operations immediate repair of any defects or damage that may occur. Perform this work at no cost to the Department and repeat as often as may be necessary to keep the base in an acceptable condition. Perform repairs to the base by replacing the base for its full depth rather than by adding a thin layer of soil-cement mixture to the existing layer of base.

542-16 MEASUREMENT AND PAYMENT

Soil-Cement Base will be measured and paid for at the contract unit price per square meter that has been completed and accepted. In measuring this quantity, the width of the base will be measured across the top surface of the base. The length will be the actual length constructed, measured along the centerline of the surface of the base.

Portland Cement for Soil-Cement Base will be paid for at the contract unit price per metric ton that has been incorporated into the mix. When bulk cement is used, the quantity will be measured by weighing in trucks on certified platform scales or other certified weighing devices. Measurement will not be made of any cement added or replaced for corrective measures during construction or for repairing damaged areas.

Asphalt Curing Seal will be paid for as provided in Article 543-5.

Blotting Sand will be paid for as provided in Article 818-4.

Payment will be made under:

Pay Item	Pay Unit
Soil-Cement Base	Square Meter
Portland Cement for Soil-Cement Base	Metric Ton

SECTION 543 ASPHALT CURING SEAL

543-1 DESCRIPTION

Perform the work covered by this section including but not limited to keeping the stabilized layer moist; furnishing and applying the asphalt curing seal; correcting, maintaining, and repairing the asphalt curing seal; and blotting sand where directed, to either a chemically stabilized soil layer or to a cement stabilized base course. Perform this work in conformity with the contract.

543-2 MATERIALS

Refer to Division 10.

Item	Section
Asphalt, Grade RS-1	1020-6
Asphalt, Grade RS-1H	1020-6
Asphalt, Grade CRS-1	1020-7
Asphalt, Grade CRS-1H	1020-7
Asphalt, Grade CRS-2	1020-7

543-3 EQUIPMENT

Use equipment to apply the asphalt material that meets the requirements of Article 600-5.

Use equipment to apply water, curing seal, and blotting sand that is of such type and weight that it will not damage the completed stabilized layer.

543-4 CONSTRUCTION REQUIREMENTS

Continuously moisten the finished stabilized layer or base course until the asphalt curing seal is placed. Place the curing seal as soon as possible, but no later than 24 hours after completing finishing operations except where delayed by wet weather. If wet weather delays application of the curing seal, apply the curing seal as soon as the surface becomes sufficiently dry.

At the time the asphalt curing seal is applied, prepare the surface of the stabilized layer or base so that it is free of all loose or extraneous material, and contains sufficient moisture to prevent excessive penetration of the asphalt material. If deemed necessary, sweep the base surface clean of loose material prior to applying the curing seal. Apply the curing seal in accordance with Section 600.

Apply the asphalt material to the surface of the completed stabilized layer or base at the rate of 0.45 to 0.90 liters per square meter with approved equipment. Apply the asphalt material at the exact rate and temperature of application as established by the Engineer.

Cure the asphalt material for a period of 7 days. Curing time will be counted in not less than 1/2 day units and only when the air temperature in the shade is at least 10°C. Complete the curing prior to placement of subsequent layers of pavement.

Maintain the curing material during the curing period so that all of the stabilized layer or base will be covered effectively during the period. Provide sufficient protection from freezing to the stabilized layer or base during the entire curing period and until it has hardened. Replace excessive loss of curing seal caused by heavy rains within 8 hours of placement at no cost to the Department.

Should the Engineer determine that it is necessary to allow local traffic to use parts of the stabilized layer or base before the asphalt material has cured sufficiently, protect those areas by applying blotting sand in accordance with Section 818.

Section 543

543-5 MEASUREMENT AND PAYMENT

Asphalt Curing Seal will be measured and paid for at the contract unit price per liter that has been placed on the stabilized layer or base. Seal material placed on the stabilized layer or base in excess of the authorized rate plus 0.09 liters per square meter will not be measured for payment. Measurement will not be made of any curing seal used to replace curing seal lost by heavy rains which occur after placing the curing seal.

Blotting sand will be paid for as provided for in Article 818-4.

Payment will be made under:

Pay Item	Pay Unit
Asphalt Curing Seal	Liter

**SECTION 545
INCIDENTAL STONE BASE**

545-1 DESCRIPTION

Perform the work covered by this section including but not limited to furnishing, hauling, placing and shaping a graded stone material for use in driveways, temporary maintenance of traffic, adjacent to mailboxes, beneath traffic island, median covers and at any other locations, other than use as a part of any base course on which pavement is to be placed; shaping; tamping when required; maintaining the base; and disposing of any surplus stockpiled material.

545-2 MATERIALS

Use stone or gravel for the graded stone material which is well graded from the 38 mm through the .075 mm sieve sizes that conforms to the requirements of Article 1006.

545-3 GRADATION SAMPLING, TESTING, AND ACCEPTANCE

Acceptance of the graded stone material will be made by visual inspection and approval by the Engineer as being satisfactory for the purpose intended prior to its use. No sampling or testing of the graded stone material will be performed.

545-4 PLACING AND SHAPING STONE

Spread the stone material uniformly over the area required and then shape and dress to the satisfaction of the Engineer.

Uniformly spread, grade to the required depth, and firmly tamp the stone material beneath traffic island and median covers. If the Contractor desires, the surface of the stone material may be covered with a sufficient amount of fine material to facilitate grading and shaping.

545-5 MAINTENANCE

Maintain the stone material until final acceptance of the project by reshaping and by the addition of incidental stone base material when directed by the Engineer.

Maintain all stone material beneath traffic islands and median covers in satisfactory condition until the covers are placed.

545-6 MEASUREMENT AND PAYMENT

Incidental Stone Base will be measured and paid for at the contract unit price per ton that has been stockpiled or incorporated into the completed and accepted work. This quantity will be measured as provided for in Article 520-11. Incidental stone base which has been stockpiled will not be measured more than one time.

Payment will be made under:

Pay Item	Pay Unit
Incidental Stone Base	Metric Ton

SECTION 560 SHOULDER CONSTRUCTION

560-1 DESCRIPTION

Perform the work covered by this section including but not limited to furnishing the source of the borrow; building; maintaining, and obliterating haul roads; clearing and grubbing the borrow source; removal, hauling, and disposition of overburden and other unsuitable material; excavation; hauling; formation of roadway shoulders include the reshaping and finishing of slopes adjacent to the shoulders and roadway ditches; restoration of the source and haul roads to an acceptable condition; disposal of surplus stockpiled material; and seeding and mulching.

560-2 MATERIALS

Use soil consisting of loose, friable, sandy material free of subsoil admixtures, refuse, stumps, rocks, roots, root mats, or other unsatisfactory material.

Use soil with a P.I. greater than 6 and less than 25 and with a pH ranging from 5.5 to 6.8. Remove stones and other foreign material 50 mm or larger in diameter. All soil is subject to testing and acceptance or rejection by the Engineer.

Use Engineer approved material in the construction of earth shoulders, which has been obtained from unclassified excavation, fine grading operations, or from borrow sources as provided in Section 230.

560-3 CONSTRUCTION METHODS

Construct the top 150 mm of shoulders with soils capable of supporting vegetation.

Construct the shoulders in proper sequence with the type of base and pavement being constructed. Perform the work in such a manner as to provide proper drainage at all times. Shape and roll the shoulder material during placement in such a manner as will provide for satisfactory bonding of layers and compacted to a degree satisfactory to the Engineer.

Prior to placing any earth material on existing graded shoulders, remove all existing vegetation and scarify the existing shoulders to ensure a proper bond.

Perform the final shaping of the shoulders, adjacent slopes, and ditches in accordance with the typical section shown on the plans.

Provide adequate equipment to perform the work. Exercise care not to damage base, surface, pavement, or drainage features during the construction of the shoulders. Should damage occur because of the Contractor's operations, repair the damaged portions or remove and replace them as directed at no cost to the Department.

560-4 MEASUREMENT AND PAYMENT

(A) General

Shoulder Borrow will be measured in its original position or in the haul truck, as directed by the Engineer.

No measurement will be made of material transported directly from unclassified excavation or fine grading and deposited directly in the place on the shoulder.

The quantity of shoulder borrow will be paid for at the contract unit price per cubic meter for "Shoulder Borrow", except as otherwise provided below.

(B) Measured in Original Position

The quantity of shoulder borrow to be paid for will be the actual number of cubic meters of approved material, measured in its original position in the borrow source or stockpile by cross sectioning and computed by the average end area method, which has been incorporated into the completed and accepted work. No measurement will be made of any overburden or unsuitable material removed from the borrow source, nor of any material excavated prior to cross sections being taken.

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(C) Truck Measurement

The quantity of shoulder borrow to be paid for will be the actual number of cubic meters of approved material, measured in trucks, which has been incorporated into the completed and accepted work. Each truck will be measured by the Engineer and shall bear a legible identification mark indicating its capacity. Load each truck to at least its measured capacity at the time it arrives at the point of delivery. The recorded capacity will be adjusted by making a 25 percent deduction to allow for shrinkage, and the adjusted capacity will be the quantity to be paid for.

When shoulder material is obtained as a result of fine grading operations, trenching out existing subgrade, and/or shaping slopes and ditches, no direct payment will be made for the work of shoulder construction as such work will be considered incidental to the work of constructing the base or pavement.

No payment will be made for the removal and disposal of any surplus material remaining in the stockpile after the shoulders have been completed.

Where the borrow source has been furnished by the Department, payment for clearing and grubbing the source will be made as provided in Article 200-7 and payment for draining the source will be made as provided in Article 240-4. Where the source has been furnished by the Contractor, no separate payment will be made for clearing and grubbing or draining the source as such work will be considered as incidental to the work covered by this section.

Payment for seeding and mulching all borrow sources will be made at the contract unit prices for the items established in the contract as payment for the work of seeding and mulching.

Payment will be made under:

Pay Item	Pay Unit
Shoulder Borrow	Cubic Meter