SECTION 02700
CEMENT-STABILIZED BASE COURSE

PART I: GENERAL

1.1 GENERAL REQUIREMENTS
- A. Foundation course of cement-stabilized crushed stone.
- B. Foundation course of cement-stabilized bank run gravel.

1.2 MEASUREMENT AND PAYMENT
- A. Unit Prices:
  1. Payment for cement-stabilized base course is on a square yard basis. Separate pay items are used for each different required thickness of base course.
  2. Payment for asphaltic seal cure is by the gallon.
  3. Refer to Section 01270 – Measurement and Payment for unit price procedures.
  4. Refer to Paragraph 3.9, Unit Price Adjustment.
- B. Stipulated Price (Lump Sum):
  1. If Contract is Stipulated Price Contract, payment for Work in this Section is included in Total Stipulated Price.

1.3 REFERENCES
- A. ASTM – American Society for Testing and Materials.
  1. ASTM C131 – Standard Test Method for Resistance to Degradation of Small-Size Course Aggregate by Abrasion and Impact in Los Angeles Machine.
  2. ASTM C150 – Standard Specification for Portland Cement.
  3. ASTM D698 – Standard Test Method for Laboratory Compaction Characteristics of Soils Using Standard Effort (12,400 ft-lbf/ft_3 (600kN kN-m/m_3).
  4. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
  5. ASTM D2922 – Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
  6. ASTM D4318 – Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- B. CFTS – City of Friendswood Technical Specifications.
- C. TxDOT – Texas Department of Transportation.
  1. TxDOT Tex-101-E – Preparing Soil and Flexible Base Materials for Testing.
  2. TxDOT Tex-110-E – Particle Size Analysis of Soils.
  3. TxDOT Tex-120-E – Soil-Cement Testing.

1.4 SUBMITTALS
- A. Conform to requirements of Section 01330 – Submittal Procedures.

B. Submit samples of crushed stone, gravel and soil binder for testing.
C. Submit manufacturer's description and characteristics for pug mill and associated equipment, spreading machine and compaction equipment for approval.

1.5 TESTS
A. Perform testing under provisions of Sections 01470 – Testing Laboratory Services and Section 01475 – Quality Control Testing Procedures.
B. Perform tests and analysis of aggregate and binder materials in accordance with ASTM D1557 and ASTM D4318.

1.6 DELIVERY, STORAGE AND HANDLING
A. Make stockpiles from layers of processed aggregate to eliminate segregation of materials. Load material by making successive vertical cuts through entire depth of stockpile.
B. Store cement in weatherproof enclosures. Protect from ground dampness.

1.7 QUALITY ASSURANCE
A. Provide manufacturer's affidavits that material was manufactured in compliance with standards and Technical Specifications referenced in this Section.

PART II: PRODUCTS

2.1 CEMENT
A. ASTM C150 Type I; bulk or sacked.

2.2 WATER
A. Clean, clear; and free from oil, acids, alkali or vegetable matter.

2.3 AGGREGATE
A. Crushed Stone: Material retained on No. 40 Sieve meeting following requirements:
1. Durable particles of crusher-run broken limestone, sandstone or granite obtained from approved source.
2. Los Angeles abrasion test percent of wear not to exceed forty (40) when tested in accordance with ASTM C131.
B. Gravel: Durable particles of bank run gravel or processed material.
C. Soil Binder: Material passing No. 40 Sieve meeting following requirements when tested in accordance with ASTM D4318:
1. Maximum Liquid limit: thirty-five (35).
2. Maximum Plasticity index: ten (10).
D. Mixed aggregate and soil binder shall meet the following requirements:
1. Grading in accordance with TxDOT Tex-101-E and Tex-110-E within the specified limits in TABLE 4.1 – SIEVE ANALYSIS.
2. Obtain prior permission from the Project Manager for use of

additives to meet above requirements.

2.4 ASPHALT SEAL CURE
- A. Cutback Asphalt: MC30 conforming to requirements of Section 02730 – Prime Coat.
- B. Emulsified Petroleum Resin: EPR-1 Prime conforming to requirements of Section 02730 – Prime Coat.

2.5 MATERIAL MIX
- A. Design mix for a minimum average compressive strength of two hundred pounds per square inch (200 psi) at forty-eight hours (48 Hrs) using TxDOT Tex-120-E unconfined compressive strength testing procedures. Provide a minimum cement content of one and one-half (1-1/2) sacks, weighing ninety-four pounds (94 Lbs) each, per ton of mix.
- B. Increase cement content when average compressive strength of tests on field samples fall below two hundred pounds per square inch (200 psi). Refer to Part III concerning field samples and tests.
- C. Mix in stationary pug mill equipped with feeding and metering devices for adding specified quantities of base material, cement and water into mixer. Dry mix base material and cement sufficiently to prevent cement balls from forming when water is added.
- D. Resulting mixture shall be homogeneous and uniform in appearance.

2.6 SOURCE QUALITY CONTROL
- A. Perform testing under provisions of Sections 01470 – Testing Laboratory Services and Section 01475 – Quality Control Testing Procedures.
- B. Perform testing for unconfined compressive strength by TxDOT Test Method Tex-120-E as follows:
  1. Mold a minimum of three (3) samples each day or three (3) for each three hundred tons (300 Tn) of production.
  2. Compressive strength shall be the average of the minimum of three (3) samples or of the three (3) tests for each production lot.

PART III: EXECUTION

3.1 EXAMINATION
- A. Verify compacted subgrade is ready to support imposed loads.
- B. Verify lines and grades are correct.

3.2 PREPARATION
- A. Complete backfill of new utilities below future grade.
- B. Prepare subgrade in accordance with requirements of Section 02115 – Embankment and Section 02135 – Excavation for Roadway.
- C. Correct subgrade deviations in excess of plus or minus one-quarter inch (±1/4 In) in cross section or in sixteen foot (16 Ft) length by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling.

D. Prepare sufficient subgrade in advance of base course for efficient operations.

3.3 PLACEMENT

A. Do not mix and place cement-stabilized base when the ambient temperature is below forty degrees Fahrenheit (40° F) and falling. Base may be placed when the ambient temperature taken in the shade and away from artificial heat is above thirty-five degrees Fahrenheit (35° F) and rising.

B. Place material on prepared subgrade in uniform layers to produce thickness indicated on the Drawings. Depth compacted of layers shall not exceed six inches (6 In).

C. Spread with approved spreading machine. Conduct spreading so as to eliminate planes of weakness or pockets of non-uniformly graded material resulting from hauling and dumping operations.

D. Provide construction joints between new material and stabilized base that has been in place four hours (4 Hrs) or longer. Joints shall be approximately vertical. Form joint with temporary header or make vertical cut of previous base immediately before placing subsequent base.

E. Use only one (1) longitudinal joint at center line under main lanes and shoulder unless shown otherwise on the Drawings. Do not use longitudinal joints under frontage roads and ramps unless indicated on the Drawings.

F. Place base so that projecting reinforcing steel from curbs remain at approximate center of base. Ensure proper firm bond between reinforcement and base.

3.4 COMPACTION

A. Start compaction as soon as possible but not more than sixty minutes (60 Mins) from start of moist mixing. Compact loose mixture with approved tamping rollers until entire depth is uniformly compacted. Do not allow stabilized base to mix with underlying material.

B. Correct irregularities or weak spots immediately by replacing material and recompacting.

C. Apply water to maintain moisture between optimum and two percent (2%) above optimum moisture as determined by ASTM D698. Mix in with spiked tooth harrow or equal. Reshape surface and lightly scarify to loosen imprints made by equipment.

D. Remove and reconstruct sections where average moisture content exceeds ranges specified at time of final compaction.

E. Finish by blading surface to final grade after compacting final course. Seal with approved pneumatic-tired rollers which are sufficiently light to prevent surface hair line cracking. Rework and recompact at areas where hair line cracking develops.

F. Compact to a minimum density of ninety-five percent (95%) of maximum dry density at moisture content of treated material between optimum and

two percent (2%) above optimum as determined by ASTM D1557, unless otherwise indicated on the Drawings.

G. Maintain surface to required lines and grades throughout operation.

3.5 CURING

A. Moist cure for a minimum of seven days (7 D) before adding pavement courses. Restrict traffic on base to local property access. Keep subgrade surface damp by sprinkling.

B. If indicated on the Drawings, cover base surface with curing membrane as soon as finishing operation is complete. Apply with approved self-propelled pressure distributor at following rates or as indicated on the Drawings:

1. MC30: One tenth gallon per square yard (0.1 Gal/Sy).
2. EPR-1 Prime: Fifteen hundredths gallon per square yard (0.15 Gal/Sy).

C. Do not use cutback asphalt during period of April 16th to September 15th.

3.6 TOLERANCES

A. Smooth and conform completed surface to typical section and established lines and grades.

B. Top surface of base course: Plus or minus one and one-quarter inches (±1-1/4 In) in cross section or in sixteen feet (16 Ft) of length.

3.7 FIELD QUALITY CONTROL

A. Perform testing under provisions of Sections 01470 – Testing Laboratory Services and Section 01475 – Quality Control Testing Procedures.

B. Take a minimum of one (1) core at random locations per one thousand linear feet (1000 Lf) per lane of roadway or one (1) per every five hundred square yards (500 Sy) of base to determine in-place depth.

C. Request additional cores in vicinity of cores indicating nonconforming in-place depths at no extra cost to the City. When average of tests fall below required depth, place additional material and compact at no additional cost to the City.

D. Perform compaction testing in accordance with ASTM D698 or ASTM D2922 and ASTM D3017 at randomly selected locations. Remove and replace areas that do not conform to compaction requirements at no additional cost to the City.

E. Fill cores and density test sections with new compacted cement-stabilized base.

3.8 NONCONFORMING BASE COURSE

A. Remove and replace areas of base course found deficient in thickness by more than ten percent (10%), or that fail compressive strength tests, with cement-stabilized base of thickness shown on the Drawings.

B. Replace nonconforming base course sections at no additional cost to the City.

3.9 UNIT PRICE ADJUSTMENT

A. Make the unit price adjustments for in-place depth determined by cores as follows:
   1. Adjusted unit price shall be ratio of average thickness as determined by cores to thickness bid upon, times the unit price.
   2. Apply adjustment to lower limit of ninety percent (90%) and upper limit of one hundred percent (100%) of the unit price.

3.10 PROTECTION

A. Maintain stabilized base in good condition until completion of Work. Repair defects immediately by replacing base to full depth.
B. Protect asphalt membrane, when used, from being picked up by traffic. Membrane may remain in place when proposed surface courses or other base courses are to be applied.

PART IV: TABLES

4.1 SIEVE ANALYSIS

Sieve	**Percent Retained**			
	Crushed Stone	Processed G. 1	Processed G. 2	Bank run Gravel
1 3/4 inch	0 to 10	0 to 5	-	0 to 5
1/2 inch	-	-	0	-
No. 4	45 to 75	30 to 75	15 to 35	30 to 75
No. 40	55 to 80	60 to 85	55 to 85	65 to 85

END OF SECTION

SECTION 02705
CRUSHED CONCRETE BASE COURSE

PART I: GENERAL

1.1 GENERAL REQUIREMENTS
- A. Crushed concrete base course.

1.2 MEASUREMENT AND PAYMENT
- A. Unit Prices:
  1. Payment for Crushed Concrete Base Course is on a per ton basis furnished and compacted in place.
  2. Refer to Section 01270 – Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum):
  1. If Contract is Stipulated Price Contract, payment for Work in this Section is included in Total Stipulated Price.

1.3 REFERENCES
- A. ASTM – American Society for Testing and Materials.
  1. ASTM C150 – Standard Specification for Portland Cement.
- B. CFTS – City of Friendswood Technical Specifications.
- C. TxDOT – Texas Department of Transportation.
  1. TxDOT Tex-101-E – Preparing Soil and Flexible Base Materials for Testing.
  2. TxDOT Tex-106-E – Calculating the Plasticity Index of Soils.
  3. TxDOT Tex-110-E – Determining Particle Size Analysis of Soils.
  4. TxDOT Tex-113-E – Laboratory Compaction Characteristics and Moisture-Density Relationship of Base Materials.
  5. TxDOT Tex-115-E – Field Method for Determining In-place Density of Soils and Base Materials.
  6. TxDOT Tex-120-E – Soil-Cement Testing.

1.4 SUBMITTALS
- A. Conform to requirements of Section 01330 – Submittal Procedures.
- B. Submit representative samples of crushed concrete for testing.
- C. Submit weight tickets, certified by supplier, for each delivery of recycled crushed concrete, gravel and soil binder.
- D. Submit manufacturer's description and characteristics for pug mill and associated equipment, mixer trucks, spreading and compaction equipment for approval.

1.5 TESTS
- A. Follow Sections 01470 – Testing Laboratory Services and 01475 – Quality Control Testing Procedures.
- B. Test and analyze aggregate and binder products per TxDOT Tex-110-E.

1.6 DELIVERY, STORAGE AND HANDLING
- A. Provide materials from stockpiles that are protected during storage from contaminates detrimental to concrete base.
- B. Load material from same area of stockpile to maintain uniformity of each successive delivery to the Project site.
- C. Store cement in weatherproof enclosures. Protect from ground dampness.

1.7 QUALITY ASSURANCE
- A. Provide manufacturer's affidavits that material was manufactured in compliance with standards and Technical Specifications referenced in this Section.

PART II: PRODUCTS

2.1 SYSTEM DESCRIPTION
- A. Provide Crushed Concrete Base Course with following performance:
  1. Minimum seven percent (7%) cement content.
  2. Minimum compressive strength: Six hundred fifty pounds per square inch (650 psi) at fourteen days (14 D) following TxDOT Tex-120-E.
  3. Prepare concrete product in on-site or off-site pug mill or in on-site or off-site portable concrete mixer.
- B. Preliminary Design: Prepare preliminary mix with minimum cement to crushed concrete ratios of five percent (5%) by dry mass of materials.
  1. Designate source of concrete for crushing. Follow Sections 01470 – Testing Laboratory Services and 01475 – Quality Control Testing Procedures for tests of concrete from source.
  2. Results of laboratory and compression tests shall be used by the Project Manager to select final mix design.

2.2 PORTLAND CEMENT
- A. ASTM C150 Type I, II or III; bulk or sacked.

2.3 WATER
- A. Potable.

2.4 AGGREGATE
- A. Recycled Crushed Concrete: Material retained on No. 40 Sieve and durable coarse particles of crusher-run reclaimed cured Portland cement concrete, obtained from approved source. Organic material of any kind is prohibited in crushed concrete. The crushed concrete shall be substantially free of foreign matter including, but not limited to, asphalt, base and dirt.
- B. Soil Binder (classified below): Meeting following requirements when tested following TxDOT Tex-106-E:
  1. Maximum liquid limit: thirty-five (35).
  2. Maximum plasticity index: ten (10).

C. Mixed Aggregate and Soil Binder: Grading following TxDOT Tex-101-E and Tex-110-E as specified in TABLE 4.1 – MIXED AGGREGATE AND SOIL BINDER in this Section.
   2. Bank sand may be added to mix at pug mill.

2.5 ASPHALTIC SEAL CURE
A. Acquire written approval from the Project Manager before curing and before proceeding with curing.
B. Use following as option to curing by sprinkling:
   1. Cut-back asphalt: MC30 following Section 02730 – Prime Coat.
   2. Emulsified petroleum resin: EPR-1 Prime following Section 02730 – Prime Coat.

2.6 MATERIAL MIX
A. Design mix for a minimum compressive strength of six hundred fifty pounds per square inch (650 psi) at fourteen days (14 D) following TxDOT Tex-120-E unconfined compressive strength.
B. Cement Ratio: Follow paragraph 2.1.A. Increase cement content in two percent (2%) steps up to nine percent (9%) maximum when compressive strength of design mix samples fail TxDOT Tex-120-E test.

2.7 MIXING EQUIPMENT
A. Mix following Paragraph 2.1.A, with metering devices adding specified quantities of crushed concrete, cement and water into mixer. Dry mix crushed concrete and cement prior to adding water. Produce homogeneous and uniformly mixed product.

2.8 SOURCE QUALITY CONTROL
A. Test following Sections 01470 -Testing Laboratory Services and 01475 – Quality Control Testing Procedures.
B. When directed by the Project Manager, test for unconfined compressive strength following Test Method TxDOT Tex-120-E as follows:
   1. Mold a minimum of three (3) samples each day or three (3) for each five hundred tons (500 Tn) of production or one (1) for each day.
   2. Compressive strength: shall be the average of the minimum three (3) samples or three (3) for each production lot.

PART III: EXECUTION

3.1 EXAMINATION
A. Follow Section 01455 – Inspection Services.
B. Verify buried utility work is complete.
C. Verify lime treatment of base is complete.
D. Verify subgrade is ready to support imposed loads.
E. Verify flatwork, foundations, projecting reinforcement and similar work interfacing with base is in place.

F. Verify lines and grades are correct.

3.2 PREPARATION

A. Complete backfill of new utilities below future grade.
B. Prepare subgrade in accordance with requirements of Section 02115 – Embankment and Section 02135 – Excavation for Roadway or Section 02720 – Lime-Stabilized Base Subgrade and Section 02725 – Portland Cement-Stabilized Base Subgrade.
C. Correct subgrade deviations in excess of plus or minus one-quarter inch (1/4 In) in cross section or in sixteen foot (16 Ft) length by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling.
D. Prepare sufficient subgrade in advance of base course for efficient operations.
E. Have sufficient products and equipment on hand to expeditiously apply base.

3.3 MIXING

A. Maintain moisture content of between optimum and five percent (5%) above optimum.

3.4 PLACEMENT

A. Place mixture with approved spreading equipment. Spread to eliminate planes of weakness or pockets of nonuniformly graded material resulting from hauling and dumping operations.
B. Provide approximately vertical construction joints between fresh base and base-in-place four hours (4 Hrs) or longer. Form joint with temporary header or make vertical cut of in-place base immediately before placing fresh base.
C. Make cold joints at center line of head-to-head parking stalls.
D. Place base so that projecting reinforcing steel from curbs remain at approximate center of base. Ensure proper bond between reinforcement and base.
E. Transverse and longitudinal joints shall be vertical.
F. Unless noted otherwise, place recycled crushed concrete base in courses not to exceed eight inches (8 In) in depth. All courses shall be placed on same working day unless approved by the Project Manager. Construction joints between new base and base previously placed shall be wetted and coated with dry cement prior to addition of new base.
G. Complete finishing operations within period of six hours (6 Hrs) after cement is added to base materials.

3.5 COMPACTION

A. Start compaction a maximum three hours (3 Hrs) after start of mixing. Compact loose mixture with approved tamping rollers until entire depth is uniformly compacted. Do not allow base to mix with underlying material.

1. Do not rework uncompacted material that has set up for more than thirty minutes (30 Min).
2. Complete placement and compaction work within six hours (6 Hrs) from start of moist mixing.

B. Correct irregularities or weak spots immediately by replacing material and recompacting.
C. Apply water to maintain moisture between optimum and five percent (5%) above optimum moisture.
D. Remove and reconstruct sections where average moisture content exceeds ranges specified at time of final compaction.
E. Finish by blading surface to final grade after compacting final course. Seal with approved pneumatic tired rollers or flat wheel rollers which are sufficiently light to prevent surface hair line cracking.
F. Compact to a minimum density of ninety-five percent (95%) of dry density, following TxDOT Tex -113-E, at moisture content of treated material between optimum and five percent (5%) above optimum.
G. Test roadway base course compaction in accordance with TxDOT Tex-115-E.
H. Maintain surface to required lines and grades throughout operation.

3.6 CURING

A. Moist cure for a minimum of seventy-two hours (72 Hrs) before adding pavement courses.
B. Use sprinkling or, at option, apply following curing membrane as soon as initial set begins, using approved light-weight self-propelled pressure distributor:
   1. MC30: One tenth gallon per square yard (0.1 Gal/Sy).
   2. EPR-1 Prime: Fifteen hundredths gallon of asphalt residual per square yard (0.15 Gal/Sy).
C. Do not use cut-back asphalt during period of April 16th through September 15th.

3.7 TOLERANCES

A. Completed Surface: Smooth and conform to typical section and established lines and grades.
B. Top Surface of Base Course: Plus or minus one-quarter inch (±1/4 In) in cross section or in sixteen feet (16 Ft) of length.

3.8 FIELD QUALITY CONTROL

A. Test following Sections 01470 – Testing Laboratory Services and 01475 – Quality Control Testing Procedures.
B. Perform compaction tests following TxDOT Tex-113-E at randomly selected locations. Remove and replace areas failing compaction requirements at no additional cost to the City.

3.9 PROTECTION

A. Maintain base in proper condition until surface is placed. Surface must

be placed within fourteen days (14 D) after final mixing and compaction unless otherwise approved by the Project Manager. Repair unacceptable base course immediately by replacing base to full depth.

B. Curing membrane may remain in place at areas where surface courses or other base courses are applied.

C. Prevent construction traffic on base for a minimum three days (3 D). Light vehicles, used to maintain proper cure, are permitted on base after initial set or as permitted by the Project Manager.

PART IV: TABLES

4.1 MIXED AGGREGATE AND SOIL BINDER

Sieve	**Percent Crushed Concrete Retained**
1 3/4 inch	0 to 10
No. 4	45 to 75
No. 40	55 to 85*
* Classified as Soil Binder	

END OF SECTION

SECTION 02710
FLEXIBLE BASE COURSE

PART I: GENERAL

1.1 GENERAL REQUIREMENTS
- A. Foundation course of crushed concrete or stone.

1.2 MEASUREMENT AND PAYMENT
- A. UNIT PRICES:
  1. Measurement for flexible base is on a square yard basis. Separate measurement shall be made for each different required thickness of base course.
  2. Refer to Section 01290 – Payment Procedures for unit price procedures.
- B. Stipulated Price (Lump Sum):
  1. If Contract is Stipulated Price Contract, payment for Work in this Section is included in Total Stipulated Price.

1.3 REFERENCES
- A. ASTM – American Society for Testing and Materials.
  1. ASTM D1556 – Density of Soil in Place by the Sand-Cone Method.
  2. ASTM D698 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12.44 ft-lbf/ft3).
  3. ASTM D2922 – Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
  4. ASTM D361 – Test Method for Water Content of Soils and Rock in Place by Nuclear Methods (shallow depth).
  5. ASTM D3017 – Test Method for Water Content of Soils and Rock in Place by Nuclear Methods.
  6. ASTM D4318 – Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- B. CFTS – City of Friendswood Technical Specifications.
- C. TxDOT – Texas Department of Transportation.
  1. TxDOT Tex-101-E – Preparation of Soil and Flexible Base Materials for Testing.
  2. TxDOT Tex-110-E – Determination of Particle Size Analysis of Soils.

1.4 SUBMITTALS
- A. Submittals shall conform to requirements of Section 01330 – Submittals Procedures.
- B. Submit samples of flexible base course and soil binder for testing.

1.5 TESTS

A. Tests and analysis of soil materials shall be performed in accordance with ASTM C131, ASTM D698, ASTM D4318, Tex-101-E and Tex-110-E under provisions of Sections 01470 – Testing Laboratory Services and 01475 Quality Control Testing Procedures.

1.6 DELIVERY, STORAGE and HANDLING

A. Provide materials from stockpiles that are protected during storage from contaminates that would be detrimental to the flexible base course.
B. Load materials from same area of stockpile to maintain uniformity of each successive delivery to the project site.

1.5 QUALITY ASSURANCE

A. Provide manufacturer's affidavits that material was manufactured in compliance with standards referenced in this Section.

PART II: PRODUCTS

2.1 MATERIALS

A. Crushed Stone or Concrete: Material retained on the No. 40 sieve meeting the following requirements:
   1. Durable particles of crusher-run broken limestone, crushed concrete, crushed sandstone or granite obtained from an approved source.
B. Soil Binder: Material passing the No. 40 sieve meeting the following requirements when tested in accordance with ASTM D4318:
   1. Maximum Liquid Limit: forty (40).
   2. Maximum Plasticity Index: twelve (12).
   3. Maximum Lineal Shrinkage: seven (7) (when calculated from volumetric shrinkage at liquid limit).
C. Mixed Materials shall meet the following requirements:
   1. Minimum compressive strength of thirty-five pounds per square inch (35 psi) at zero pounds per square inch (0 psi) lateral pressure and one hundred seventy-five pounds per square inch (175 psi) at fifteen pounds per square inch (15 psi) lateral pressure using triaxial testing procedures.
   2. Grading in accordance with Tex-101-E and Tex-110-E within the limits specified in TABLE 4.1 – SIEVE ANALYSIS in this Section.

PART III: EXECUTION

3.1 EXAMINATION

A. Verify compacted subgrade is ready to support imposed loads.
B. Verify lines and grades are correct.

3.2 PREPARATION

A. Complete backfill of new utilities below future grade.
B. Prepare subgrade in accordance with requirements of Section 02115 – Embankment and Section 02135 – Excavation for Roadway or Section 022720 – Lime-Stabilized Base Subgrade.
C. Correct subgrade deviations in excess of plus or minus one-half inch (1/2 In) in cross section or in sixteen foot (16 Ft) length by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling.
D. Prepare sufficient subgrade in advance of base course operations.

3.3 PLACEMENT

A. Spread and shape in lifts to compacted thickness not to exceed six inches (6 In) in depth. Complete spreading, shaping and compacting on same day material is deposited.
B. Place base so that projecting reinforcing steel from curbs remain at approximate center of base. Secure a firm bond between reinforcement and base.
C. Start rolling operations as soon as possible after placement. Use sheepsfoot, steel or pneumatic rollers as approved. Roll longitudinally with subgrade starting from sides. Overlap successive strips by one-half (1/2) width of each rear wheel.
D. Maintain moisture between optimum and three percent (3%) above optimum moisture.
E. Compact to ninety-five percent (95%) of Proctor density in accordance with ASTM D698, unless otherwise indicated on the Drawings.
F. Finish to grade and compact lift before placing successive lift.
G. Maintain shape by grading throughout operation.
H. Provide total thickness indicated on the Drawings.

3.4 TOLERANCES

A. Completed surface shall be smooth and conform to typical section and established lines and grades.

3.5 FIELD QUALITY CONTROL

A. Testing shall be performed under provisions of Sections 01470 – Testing Laboratory Services and 01475 – Quality Control Testing Procedures.
B. Compaction Testing shall be performed in accordance with ASTM D698 or ASTM D2922 and ASTM 3017 at a random location near each depth determination core.
C. Rework and recompact areas that do not conform to compaction requirements.

3.6 PROTECTION

A. Sprinkle to prevent excessive loss of moisture.
B. Restrict construction traffic on finished base to equipment required to complete the work.

PART IV: TABLES

4.1 SIEVE ANALYSIS

Sieve	Percent Retained
1-3/4 inch	0 to 10
No. 4	45 to 75
No. 40	60 to 85

END OF SECTION

SECTION 02715
HOT-MIX ASPHALT BASE COURSE

PART I: GENERAL

1.1 GENERAL REQUIREMENTS
- A. Foundation course of compacted mixture of coarse and fine aggregates and asphalt binder (Black Base).

1.2 MEASUREMENT AND PAYMENT
- A. Unit Prices:
  1. Payment for hot-mix asphalt base is on a per ton basis.
  2. Payment for hot-mix asphalt base for transitions and base repairs is on a per ton basis.
  3. Payment for hot-mix asphaltic base for temporary driveway, roadway shoulders, etc., is on a per ton basis.
  4. Measurement for utility projects:
     a. Actual pavement replaced but not beyond the maximum pavement replacement limits shown on the Drawings.
     b. Include installed hot-mix asphalt base course material that extends one foot (1 Ft) beyond outside edge of pavement to be replaced, except where proposed pavement section shares common edge with existing pavement section.
  5. Refer to Section 01270 – Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum):
  1. If Contract is Stipulated Price Contract, payment for Work in this Section is included in Total Stipulated Price.

1.3 REFERENCES
- A. AASHO – American Association of State Highway and Transportation Officials.
  1. AASHTO T201 – Standard Specification for Kinematic Viscosity of Asphalts (Bitumens).
  2. AASHTO T202 – Standard Specification for Viscosity of Asphalt by Vacuum Capillary Viscometer.
- B. ASTM – American Society for Testing and Materials.
  1. ASTM C33 – Standard Specifications for Concrete Aggregate.
  2. ASTM C131 – Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
  3. ASTM C136 – Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
  4. ASTM D4402 – Standard Test Method for Viscosity

Determination of unfilled Asphalt Using the Broolfield Thermal Apparatus.

C. CFTS – City of Friendswood Technical Specifications.
D. TxDOT – Texas Department of Transportation.
   1. TxDOT Tex-106-E – Calculating the Plasticity Index of Soils.
   2. TxDOT Tex-126-E – Molding, Testing and Evaluating Bituminous Black Base Material.
   3. TxDOT Tex-200-F – Sieve Analysis of Fine and Coarse Aggregates.
   4. TxDOT Tex-203-F – Sand Equivalent Test.
   5. TxDOT Tex-204-F – Design of Bituminous Mixtures.
   6. TxDOT Tex-207-F – Determining Density of Compacted Bituminous Mixtures.
   7. TxDOT Tex-208-F – Test for Stabilometer Value of Bituminous Mixtures.
   8. TxDOT Tex-227-F – Theoretical Maximum Specific Gravity of Bituminous Mixtures.

1.4 SUBMITTALS
A. Conform to requirements of Section 01330 – Submittal Procedures.
B. Submit certificates that asphalt materials and aggregates meet requirements of Paragraph 2.1, Materials.
C. Submit proposed mix and test data for each type of base course in Work.
D. Submit manufacturer's description and characteristics of mixing plant for approval.
E. Submit manufacturer's description and characteristics of spreading and finishing machine for approval.

1.5 QUALITY ASSURANCE
A. Provide manufacturer's affidavits that material was manufactured in compliance with standards referenced in this Section.

PART II: PRODUCTS

2.1 MATERIALS
A. Coarse Aggregate:
   1. Use crushed gravel or crushed stone or combination retained on No. 10 sieve, uniform in quality throughout and free from dirt, organic or other injurious material occurring either free or as coating on aggregate. Conform aggregate to ASTM C33 except for gradation. Furnish rock or gravel with Los Angeles abrasion loss not to exceed forty percent (40%) by weight when tested in accordance with ASTM C131.
   2. Reclaimed asphalt pavement (RAP) or reclaimed Portland cement concrete pavement (RPCCP) are permitted as aggregates for hot-mix asphalt base course if combined

aggregate criteria, gradation and mixture properties are met.

B. Fine Aggregate: Sand or stone screenings or combination thereof, passing No. 10 sieve. Conform aggregate to ASTM C33 except for gradation. Use sand composed of sound, durable stone particles free from loams or other deleterious foreign matter. Furnish screenings of same or similar material as specified for coarse aggregate. Plasticity index of that part of fine aggregate passing No. 40 sieve shall be not more than six (6) when tested by TxDOT Tex-106-E. Sand equivalent shall have a minimum value of forty-five (45) when tested by TxDOT Tex-203-F.

C. Composite Aggregate: Conform to limits specified in TABLE 4.1 – GRADATION OF COMPOSITE AGGREGATE in this Section when graded in accordance with ASTM C136. Provide either coarse or fine aggregate where designated on the Drawings.

D. Asphalt Binder: Moisture-free homogeneous material meeting requirements as specified in TABLE 4.2 – ASPHALT BINDERS in this Section.

E. Reclaimed asphalt pavement (RAP) and reclaimed Portland cement concrete pavement (RPCCP) may be used at a rate no greater than twenty percent (20%).

2.2 EQUIPMENT

A. Mixing Plant: Weight-batching or drum mix plant with capacity for producing continuous mixtures meeting specifications. With exception of a drum mix plant, the plant shall have satisfactory conveyors, power units, aggregate handling equipment, hot aggregate screens and bins and dust collectors.

B. Provide equipment to supply materials adequately in accordance with rated capacity of plant and produce finished material within specified tolerances. Following equipment is essential:
   1. Cold aggregate bins and proportioning device.
   2. Dryer.
   3. Screens.
   4. Aggregate weight box and batching scales.
   5. Mixer.
   6. Asphalt storage and heating devices.
   7. Asphalt measuring devices.
   8. Truck scales.

C. Bins: Separate aggregate into a minimum of four (4) bins to produce consistently uniform grading and asphalt content in completed mix. One (1) cold feet bin per stockpile is required.

2.3 MIXES

A. Employ certified testing laboratory to prepare design mixes.
   1. Test in accordance with TxDOT Tex-126-E, TxDOT Tex-204-F, TxDOT Tex-208-F and TxDOT Tex-227-F.

2. Verify mixture design properties for plant-produced mixture. Demonstrate that asphalt plant is capable of producing mixture meeting design volumetric and stability requirements before placement begins.

B. Density, Stability and Air Voids Requirements: Select asphalt binder content for base courses to result in three percent (3%) to five percent (5%) air voids in laboratory molded specimens, while meeting a minimum VMA requirement for selected mixture classification as specified in TABLE 4.3 – MINIMUM VMA REQUIREMENTS in this Section.

PART III: EXECUTION

3.1 PREPARATION

A. Complete backfill of new utilities below future grade.

B. Verify lines and grades are correct.

C. Prepare subgrade in accordance with requirements of Section 02115 – Embankment and Section 02135 – Excavation for Roadway or Section 02720 – Lime-Stabilized Base Subgrade and Section 02725 – Portland Cement-Stabilized Base Subgrade. Subgrade preparation may also refer to Section 02145 – Cement-Stabilized Sand or Section 02705 – Crushed Concrete Base Course.

D. Correct subgrade deviations in excess of plus or minus one-quarter inch (1/4 In) in cross section or in sixteen foot (16 Ft) length by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling.

3.2 PLACEMENT

A. Place base when the surface temperature taken in the shade and away from artificial heat is above forty degrees Fahrenheit (40° F) and rising. Do not place asphalt base when temperature of surface to receive base course is below fifty degrees Fahrenheit (50° F) and falling.

B. Haul prepared and heated asphalt base mixture to project in tight vehicles previously cleaned of foreign material. Mixture shall be at temperature between two hundred fifty degrees Fahrenheit (250° F) and three hundred thirty-five degrees Fahrenheit (325° F) when laid.

C. Place hot-mix asphalt base course in compacted lifts no greater than four inches (4 In) thick, unless permitted by the Project Manager.

D. Place courses as nearly continuously as possible: Place material with approved mechanical spreading and finishing machine of screeding or tamping type. Spread lifts to attain smooth course of uniform density to section, line and grades as indicated on the Drawings.

E. In areas with limited space where use of paver or front-end loader is impractical, spread by hand and compact asphalt by mechanical means. Carefully place materials to avoid segregation of mix; do not broadcast material. Remove lumps that do not break down readily.

3.3 JOINTS

A. Transverse Joints: Pass roller over unprotected ends of freshly laid mixture only when mixture has cooled. When work is resumed, cut back placed material to produce slightly beveled edge for full thickness of course. Remove old material which has been cut away and lay new mix against fresh cut.

B. Existing pavement: When new asphalt is laid against existing asphalt pavement, saw cut existing asphalt to full depth creating vertical face. Clean joint and apply tack coat before placement.

3.4 COMPACTION

A. Construct test strip to identify correct type, number and sequence of rollers necessary to obtain specified in-place density or air-voids. Prepare test strip at least five hundred feet (500 Ft) in length, comparable to placement and compaction conditions for the Project.

B. Begin rolling while pavement is still hot and as soon as it shall bear roller without undue displacement or hair line cracking. Keep wheels properly moistened with water to prevent adhesion of surface mixture. Do not use excessive water; do not use petroleum by-products.

C. Compact surface thoroughly and uniformly with power-driven equipment capable of obtaining required compaction. Ensure subsequent compaction by starting at side and rolling longitudinally toward center of pavement, overlapping on successive trips by at least one-half (1/2) width of rear wheels. Make alternate trips slightly different in length. Continue rolling until no further compaction can be obtained and rolling marks are eliminated. Complete rolling before mat temperature drops below one hundred seventy-five degrees Fahrenheit (175° F).

D. Along walls, curbs, headers, similar structures and in locations not accessible to rollers, compact mixture thoroughly with lightly oiled tamps.

E. Compact base course to a minimum density of ninety-one percent (91%) (TxDOT Tex-227-F).

3.5 TOLERANCES

A. Furnish templates for checking surface of finished sections. Maximum deflection of templates, when supported at center, shall not exceed one-quarter inch (1/4 In).

B. Completed surface, when tested with a ten foot (10 Ft) straight edge laid parallel to center line of pavement, shall show no deviation in excess of one-quarter inch (1/4 In) in ten feet (10 Ft). Correct surface not meeting this requirement.

3.6 FIELD QUALITY CONTROL

A. Perform testing under provisions of Sections 01470 – Testing Laboratory Services and 01475 – Quality Control Testing Procedures.

B. For in-place depth and density, take a minimum of two (2) cores at random locations for each one thousand feet (1000 Ft) of single lane of

pavement. On a two (2) lane pavement, take cores at random every five hundred feet (500 Ft) from alternating lanes. Take cores for parking lots every five hundred square yards (500 Sy) of base to determine in-place depth and density. If cul-de-sac or streets are less than five hundred feet (500 Ft), a minimum of two (2) cores [one (1) per lane] shall be taken. On small projects, take a minimum of two (2) cores for each day's placement. For first days placement and prior to coring, a minimum of five (5) nuclear gauge readings shall be performed at each core location to establish correlation between nuclear gauge (wet density reading) and core (bulk density). This process shall continue for each day's placement until the Testing Laboratory's Engineer determines that a good basis has been established for the nuclear gauge.

C. Determine in-place density in accordance with TxDOT Tex-207-F and Tex-227-F from cores or sections of asphaltic base located near each core. Other methods of determining in-place density, which correlate satisfactorily with results obtained from roadway specimens, may be used when approved by the Project Manager.

D. Three (3) additional cores within a five foot (5 Ft) radius of core indicating nonconforming in-place depth may be requested by the Project Manager at no additional cost to the City. In-place depth at these locations shall be average depth of four (4) cores.

E. Fill cores and density test sections with new compacted asphalt base or cold patch material.

3.7 NONCONFORMING PAVEMENT

A. Re-compact and retest nonconforming street sections not meeting surface test requirements. Patch asphalt pavement sections in accordance with procedures established by Asphalt Institute. Retesting is at no cost to the City.

B. Remove and replace areas of asphalt base found deficient in thickness by more than ten percent (10%). Remove and replace areas of asphalt base found deficient in density. Use new asphalt base of thickness shown on the Drawings.

C. Replace or correct nonconforming pavement sections at no additional cost to the City.

3.8 PROTECTION

A. Do not open base to traffic until at least twelve hours (12 Hrs) after completion of rolling or as noted on the Drawings.

B. Maintain asphalt base in good condition until completion of the Work.

C. Repair defects immediately by replacing base to full depth.

PART IV: TABLES

4.1 GRADATION OF COMPOSITE AGGREGATE

GRADATION OF COMPOSITE AGGREGATE Percent Passing by Weight or Volume		
Sieve Size	Type A Coarse Base	Type B Fine Base
1 1/2”	100	-
1 1/4”	95 to 100	-
1”	-	100
7/8”	70 to 90	95 to 100
5/8”	-	75 to 95
1/2”	50 to 70	-
3/8”	-	60 to 80
#4	30 to 50	40 to 60
#10	30 to 34	27 to 40
#40	5 to 20	10 to 25
#80	2 to 12	3 to 13
#200	1 to 6*	1 to 6*
VMA % Minimum	11	12
*2 to 8 when Test Method Tex-200-F, Part II (Washed Sieve Analysis) is used.		

4.2 ASPHALT BINDERS

SPECIFICATION	PG 64 – 22
Average 7-day Maximum Pavement Design Temperature, degrees C[a]	<64
Minimum Pavement Design Temperature, degrees C [a]	>-22
Original Binder	
Flash Point Temperature, T48, Minimum degrees C	230
Viscocity, ASTM D4402, [b] Maximum 3 Pa.s (3000cP), Test Temperature, degrees C	135
Dynamic Shear, TP5, [c] G*/sine[], Minimum, 1.00kPa Test Temperature @ 10rad/sec, degrees C	64
Rolling Thin Film Oven (T240) or Thin Film Oven (T179) Residue	
Mass Loss, Maximum, %	-1.00
Dynamic Shear T5; G*sine[], Minimum, 2.20 kPa Test Temperature @ 10 rad/sec, degrees C	64
Pressure Aging Vessel Residue (PPI)	
PAV Aging Temperature, degrees C [d]	100
Dynamic Shear, TP5; G*/sine[], Maximum 5000 kPa Test Temperature @ 10 rad/sec, degrees C	25
Physical Hardening [e]	Report
Creep Stiffness, TP1; [f] S, Maximum, 300 Mpa; m-value, Minimum, 0.300 Test Temperature @ 60 sec, degrees C	-12
Direct Tension, TP3; [f] Failure Strain, Minimum, 1.0%; Test Temperature @ 1.0 mm/min, degrees C	-12

NOTES:

[a] Pavement temperature can be estimated from air temperature using algorithm contained in TxDOT testing procedures.

[b] The requirement may be waived at the discretion of the Project Manager if supplier warrants that the asphalt binder can be adequately pumped and mixed at temperatures that meet the applicable safety standards.

C For quality control of unmodified asphalt cement production, measurement of viscosity of original asphalt cement may be substituted for dynamic shear measurements of G*/sine[] at test temperature where asphalt is Newtonian fluid. Any suitable standard means of viscosity measurement may be used, including capillary of rotational viscometry (AASHTO T 201 or T 202).

[d] The PAV aging temperature is based on simulated climatic conditions and is one of three (3) temperatures: ninety Centigrade (90° C), one hundred degrees Centigrade (100° C) or one hundred ten degrees Centigrade (110° C). The PAV aging temperature is one hundred

degrees Centigrade (100° C) for PG64 and PG70.

e Physical Hardening – TP 1 is performed on a set of asphalt beams according to Section 13.1, except conditioning time is extended to twenty-four hours (24 Hrs) plus or minus ten minutes (±10 Min) at ten degrees Centigrade (10° C) above minimum performance temperature. The twenty-four hour (24 Hr) stiffness and m-value are reported for information purposes only.

f If creep stiffness is below three hundred Mega Paschals (300 MPa), the direct tension test is not required. If creep stiffness is between three hundred Mega Paschals (300 Mpa) and six hundred Mega Paschals (600 MPa) the direct tension failure strain requirement can be used in lieu of creep stiffness requirement. The m-value requirement must be satisfied in both cases.

4.3 MINIMUM VMA REQUIREMENTS

Percent Density		Percent Optimum	HVEEM Stability Percent Not Less Than	Percent Asphalt Content	
Min.	Max.			Min.	Max.
94.5	97.5	96	35	3.5	7

END OF SECTION

SECTION 02720
LIME-STABILIZED BASE SUBGRADE

PART I: GENERAL

1.1 GENERAL REQUIREMENTS
- A. Foundation course of lime-stabilized subgrade material.
  1. Application of lime slurry to subgrade.
  2. Mixing, compaction and curing of lime slurry, water and subgrade into a stabilized foundation.

1.2 MEASUREMENT AND PAYMENT
- A. Unit Prices:
  1. Measurement and payment for lime-stabilized subgrade is on a square yard basis compacted in place to proper density. Separate measurement shall be made for each required thickness of subgrade course.
     a. Limits of measurement shall be actual pavement replaced, but not beyond the maximum pavement replacement limits shown on the Drawings. Limits for measurement shall be extended to include installed lime-stabilized subgrade material that extends two feet (2 Ft) beyond outside edge of pavement to be replaced, except where proposed pavement section shares common longitudinal or transverse edge with existing pavement section. No payment shall be made for lime-stabilized subgrade in areas beyond these limits.
     b. Limits of measurement and payment shall match pavement replacement limits shown on the Drawings, except as noted in Paragraph 1.2.A.1.a or as approved by the Project Manager.
  2. Measurement and payment for lime is by ton of two thousand pounds (2000 Lbs) dry weight basis. Calculate weight of dry solids for lime slurry based on percentage by dry weight solids.
  3. Refer to Section 01270 – Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum):
  1. If Contract is Stipulated Price Contract, payment for Work in this Section is included in Total Stipulated Price.

1.3 DEFINITION
- A. Moist Cure: Curing soil and lime to obtain optimum hydration.
- B. One Thousand Foot (1000 Ft) Roadway Section: One thousand feet (1000 Ft) per lane width or approximately five hundred square yards (500 Sy) of compacted subgrade for other than full-lane-width roadway

sections.

1.4 REFERENCES

A. ASTM – American Society for Testing and Materials
   1. ASTM D698 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3).
   2. ASTM D2922 – Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
   3. ASTM D4318 – Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

B. CFTS – City of Friendswood Technical Specifications.

C. TxDOT – Texas Department of Transportation.
   1. TxDOT Tex-101-E (Part III) – Preparation of Soil and Flexible Base Material for Testing. TxDOT Tex-140-E – Measuring Thickness of Pavement Layer.
   2. TxDOT Tex-600-J – Sampling and Testing Hydrated Lime, Quicklime and Commercial Lime Slurry.

1.5 SUBMITTALS

A. Conform to requirements of Section 01330 – Submittal Procedures.

B. Submit certification that hydrated lime, quicklime or commercial lime slurry complies with the specifications.

C. Submit weight tickets, certified by supplier, with each bulk delivery of lime to work site.

1.6 DELIVERY, STORAGE AND HANDLING

A. Bagged lime shall bear manufacturer's name, product identification and certified weight. Bags varying more than five percent (5%) of certified weight may be rejected; average weight of fifty (50) random bags in each shipment shall not be less than certified weight.

B. Store lime in weatherproof enclosures. Protect lime from ground dampness.

1.7 QUALITY ASSURANCE

A. Provide manufacturer's affidavits that material was manufactured in compliance with standards referenced in this Section.

PART II: PRODUCTS

2.1 WATER

A. Use clean, clear water, free from oil, acids, alkali or vegetation.

2.2 LIME

A. Type A – Hydrated Lime: Dry material consisting essentially of calcium hydroxide or mixture of calcium hydroxide and an allowable percentage of calcium oxide as listed in chemical composition chart.

B. Type B – Commercial Lime Slurry: Liquid mixture consisting essentially of lime solids and water in slurry form. Water or liquid portion shall not contain dissolved material in sufficient quantity to be injurious or objectionable for purpose intended.
C. Type C – Quicklime: Dry material consisting essentially of calcium oxide. Furnish quicklime in either of the following grades:
   1. Grade DS: Pebble quicklime of gradation suitable for use in preparation of slurry for wet placing.
   2. Grade S: Finely-graded quicklime for use in preparation of slurry for wet placing. Do not use grade S quicklime for dry placing if dry placing is permitted.
D. Conform to the requirements in Table 4.1 – QUICKLIME PROPERTY SPECIFICATIONS in this Section.
E. Deliver lime slurry to job site as commercial lime or prepare at job site by using hydrated lime or quicklime. Provide slurry free of liquids other than water and of consistency that can be handled and uniformly applied without difficulty.
F. Lime containing magnesium hydroxide is prohibited.
G. Lime containing fly ash is prohibited.

2.3 SOIL
A. Soil to receive lime treatment may include borrow or existing subgrade material, existing pavement structure or combination of all three (3). Where existing pavement or base material is encountered, pulverized or scarify material so that one hundred percent (100%) of sampled material passes two inch (2 In) sieve.

PART III: EXECUTION

3.1 EXAMINATION
A. Verify compacted subgrade shall support imposed loads.
B. Verify subgrade lines and grades.

3.2 PREPARATION
A. Complete backfill of utilities prior to stabilization.
B. Cut material to bottom of subgrade using an approved cutting and pulverizing machine meeting following requirements:
   1. Cutters accurately provide smooth surface over entire width of cut to plane of secondary grade.
   2. Provide cut to depth as specified or shown in the Drawings.
C. Alternatively, scarify or excavate to bottom of stabilized subgrade. Remove material or windrow to expose secondary grade. Obtain uniform stability.
D. Correct wet or unstable material below secondary grade by scarifying, adding lime and compacting as directed by the Project Manager.
E. Pulverize existing material so that one hundred percent (100%) passes

a one and three-quarters inch (1-3/4 In) sieve.

3.3 LIME SLURRY APPLICATION

A. Apply slurry with distributor truck equipped with an agitator to keep lime and water in consistent mixture. Make successive passes over measured section of roadway to attain proper moisture and lime content. Limit spreading to an area where preliminary mixing operations can be completed on same working day.
B. Minimum lime content shall be six percent (6%) of dry unit weight of subgrade as determined by ASTM D698.

3.4 PRELIMINARY MIXING

A. Use approved single-pass or multiple-pass rotary speed mixers to mix soil, lime and water to required depth. Ensure homogeneous friable mixture free of clods and lumps.
B. Shape mixed subgrade to final lines and grades.
C. Eliminate following operations and final mixing if pulverization requirements of Paragraph 3.5.C can be met during preliminary mixing:
    1. Seal subgrade as precaution against heavy rainfall by rolling lightly with light pneumatic rollers.
    2. Cure soil lime material for twenty-four hours (24 Hrs) to seventy-two hours (72 Hrs) or as required to obtain optimum hydration. Keep subgrade moist during cure.

3.5 FINAL MIXING

A. Use approved single-pass or multiple-pass rotary speed mixers to uniformly mix cured soil and lime to required depth.
B. Add water to bring moisture content of soil mixture to optimum or above.
C. Mix and pulverize until all material passes one and three-quarters inch sieve (1-3/4 In); a minimum of eighty-five percent (85%), excluding non-slacking fractions, passes three-quarters inch (3/4 In) sieve; and a minimum of sixty percent (60%) excluding non-slacking fractions passes No. 4 sieve. Test according to TxDOT Tex-101-E, Part III using dry method. Sieve analysis shall conform to the requirements of TABLE 4.2 – LIME-STABILIZED SUBRADE SIEVE ANALYSIS in this Section.
D. Shape mixed subgrade to final lines and grades.
E. Do not expose hydrated lime to open air for six hours (6 Hrs) or more during interval between application and mixing. Avoid excessive hydrated lime loss due to washing or blowing.

3.6 COMPACTION

A. Aerate or sprinkle to attain optimum moisture content to three percent (3%) above optimum, as determined by ASTM D698 on material sample from roadway after final mix with lime.
B. Start compaction immediately after final mixing.
C. Spread and compact in two (2) or more equal layers where total

compacted thickness is greater than equipment manufacturer's recommended range of mixing and compaction.

D. Compact with approved heavy pneumatic or vibrating rollers or combination of tamping rollers and light pneumatic rollers. Begin compaction at bottom and continue until entire depth is uniformly compacted.

E. Do not allow stabilized subgrade to mix with underlying material. Correct irregularities or weak spots immediately by replacing material and re-compacting.

F. Compact subgrade to a minimum density of ninety-five percent (95%) of a maximum dry density, according to ASTM D698, at moisture content of optimum to three percent (3%) above optimum, unless otherwise indicated on the Drawings.

G. Seal with approved light pneumatic tired rollers. Prevent surface hair line cracking. Rework and recompact at areas where hairline cracking develops.

3.7 CURING

A. Moist cure for a minimum of three days (3 D) before placing base or surface course or opening to traffic. Subgrade may be opened to traffic after two days (2 D) when adequate strength has been attained to prevent damage. Restrict traffic to light pneumatic rollers or vehicles weighing less than ten tons (10 Tn).

B. Keep subgrade surface damp by sprinkling. Roll with light pneumatic roller to keep surface knit together.

C. Place base or surface within fourteen days (14 D) after final mixing and compaction. Restart compaction and moisture content of base material when time is exceeded.

3.8 TOLERANCES

A. Completed surface: smooth and conforming to typical section and established lines and grades.

B. Top of compacted surface: Plus or minus one-quarter inch (±1/4 In) in cross section or in sixteen feet (16 Ft) of length.

C. Depth of lime stabilization shall be a minimum specified depth for each one thousand foot (1000 Ft) roadway section, unless otherwise noted on the Drawings.

3.9 FIELD QUALITY CONTROL

A. Testing shall be performed under provisions of Sections 01470 – Testing Laboratory Services and 01475 – Quality Control Testing Procedures.

B. Test soils, lime and mixtures as follows:

1. Tests and analysis of soil materials shall be performed in accordance with ASTM D4318, using the wet preparation method.
2. Sampling and testing of lime slurry shall be in accordance with

TxDOT Tex-600-J, except using a lime slurry cup.

3. Sample mixtures of hydrated lime or quicklime in slurry form shall be tested to establish compliance with the specifications.
4. Moisture-density relationship shall be established on material sampled from roadway, after stabilization with lime and final mixing, in accordance with ASTM D698, Moist preparation Method.

C. In-place depth shall be evaluated for each one thousand foot (1000 Ft) roadway section and determined in accordance with TxDOT Tex-140-E in hand excavated holes. For each one thousand foot (1000 Ft) section, three (3) phenolphthalein tests shall be performed. Average stabilization depth for one thousand foot (1000 Ft) section shall be based on average depth for three (3) tests.

D. Perform compaction testing in accordance with ASTM D2922. Three (3) tests shall be performed for each one thousand foot (1000 Ft) roadway section.

E. Pulverization analysis shall be performed as required by Paragraph 3.5.C on material sampled during mixing of each production area. Three (3) tests shall be performed per six hundred foot (600 Ft) roadway section or a minimum one (1) for each day of production.

3.10 REWORK OF FAILED SECTIONS

A. Rework sections that do not meet specified thickness.

B. Perform the following steps when more than seventy-two hours (72 Hrs) have lapsed since completion of compaction:

1. Moist cure for a minimum of three days (3 D) after compaction to required density.
2. Add lime at rate of twenty-five percent (25%) of specified rate at no additional cost to the City.
3. Moisture density test of reworked material must be completed by laboratory before field compaction testing can be completed.

3.11 PROTECTION

A. Maintain stabilized subgrade to lines and grades and in good condition until placement of base or surface course. Protect asphalt membrane from being picked up by traffic.

B. Repair defects immediately by replacing material to full depth.

PART IV: TABLES

4.1 QUICKLIME PROPERTY SPECIFICATIONS

CHEMICAL COMPOSITION	**TYPE**		
	A	**B**	**C**
Active lime content, % by weight Ca(OH)+CaO	90.0 min.[1]	87.0 min.[2]	- -
Unhydrated lime content, % by weight CaO	5.0 max.	- -	87.0 min.
Free water content, % by weight H_2O	5.0 max.	- -	- -
SIZING			
Wet Sieve, as % by weight residue retained:			
No. 6	0.2 max.	0.2 max.[2]	8.0 max.[3]
No. 30	4.0 max.	4.0 max.[2]	- -
Dry Sieve, as % by weight residue retained:			
1-inch	- -	- -	0.0
1/2-inch	- -	- -	10.0 max.

NOTES:
1. Maximum five percent (5%) by weight CaO shall be allowed in determining total active lime content.
2. Maximum solids content of slurry.
3. Total active lime content, as CaO, in material retained on No. 6 sieve shall not exceed two percent (2%) by weight of original Type C Lime.

4.2 – LIME-STABILIZED SUBRADE SIEVE ANALYSIS

SIEVE SIZE	**PERCENT PASSING**
1 3/4” Sieve	100%
3/4" Sieve	85%
Number 4 Sieve	60%

END OF SECTION

SECTION 02725
PORTLAND CEMENT-STABILIZED BASE SUBGRADE

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Foundation course of Portland cement-stabilized natural subgrade material.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. Payment for Portland cement-stabilized subgrade is on a square yard basis compacted in place to proper density. Separate measurement shall be made for each different required thickness of subgrade course.
    a. Limits of measurement shall be actual pavement replaced, but not beyond the maximum pavement replacement limits shown on the Drawings. Limits for measurement shall be extended to include installed Portland cement-stabilized subgrade material that extends two foot (2 Ft) beyond outside edge of pavement to be replaced except where proposed pavement section shares common longitudinal or transverse edge with existing pavement section. No separate payment shall be made for Portland cement-stabilized subgrade beyond these limits.
    b. Limits of measurement and payment shall match pavement replacement limits shown on the Drawings, except as noted in Paragraph 1.2.A.1.a or as approved by the Project Manager.
2. Payment for Portland cement is by the ton of two thousand pounds (2000 Lbs) dry-weight basis.
3. Refer to Section 01270 – Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum):

1. If Contract is Stipulated Price Contract, payment for work in this Section is included in Total Stipulate Price.

1.3 REFERENCES

A. ASTM – American Society for Testing and Materials.

1. ASTM C150 – Standard Specification for Portland Cement.
2. ASTM D558 – Standard Test Method for Moisture-Density Relations of Soil-Cement-Mixtures.
3. ASTM D698 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12.44ft-lbf/ft_3).

4. ASTM D2922 – Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
5. ASTM D4318 – Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

B. CFTS – City of Friendswood Technical Specifications.

1.4 SUBMITTALS

A. Conform to requirements of Section 01330 – Submittal Procedures.
B. Submit certification that Portland cement complies with these Technical Specifications.

PART II: PRODUCTS

2.1 WATER

A. Water: clean, clear and free from oil, acids, alkali or organic matter.

2.2 PORTLAND CEMENT

A. ASTM C150 Type I; bulk or sacked.

2.3 SOIL

A. Provide soil consisting of approved material free from vegetation or other objectionable matter encountered in existing roadbed.

2.4 TESTS

A. Testing shall be performed under provisions of Sections 01470 – Testing Laboratory Services and 01475 – Quality Control Testing Procedures.
B. Tests and analysis of soil materials shall be performed in accordance with ASTM D4318.
C. Soil shall be evaluated to establish ratio of cement to soil to obtain desired stability. Normal range is six percent (6%) to ten percent (10%) by weight.
D. The percentage of moisture in soil, at tome of cement applications, shall be determined by ASTM D558. Moisture shall not be allowed to exceed quantity that shall permit uniform, complete mixture of soil and cement during dry mixing operations nor specified optimum moisture content for soil cement mixture, as determined.

PART III: EXECUTION

3.1 EXAMINATION

A. Verify compacted subgrade is ready to support imposed loads.
B. Verify subgrade lines and grades are correct.

3.2 EQUIPMENT

A. Apply Portland cement treatment with machine or combination of

machines and auxiliary equipment to produce specified results. Mixing may be accomplished by multi-pass traveling mixing plant or single-pass traveling mixing plant. Provide sufficient equipment to enable continuous prosecution of work.

3.3 PREPARATION

A. Backfill for utilities below future grade.

B. Verify subgrade is firm and able to support, without displacement, construction equipment at specified density. Correct soft or yielding subgrade and stabilize by scarifying and aerating or by adding cement and compacting to uniform stability.

C. Grade, shape and compact, as required, to allow construction of Portland cement treatment for in-place materials to lines, grades, thickness and typical cross section on the Drawings. Remove unsuitable soil or material and replace with acceptable material.

D. Pulverize soil so that at completion of moist-mixing, one hundred percent (100%) by dry weight passes one inch (1 In) sieve and a minimum of eighty percent (80%) passes a No. 4 sieve, exclusive of gravel or stone retained on these sieves. Pulverize existing bituminous wearing surfaces so that one hundred percent (100 %) shall pass two inch (2 In) sieve.

3.4 MIXING

A. Do not place and mix cement when the ambient temperature is below forty degrees Fahrenheit (40° F) and falling. Place base when ambient temperature when taken in the shade and away from artificial heat is above thirty-five degrees Fahrenheit (35° F) and rising.

B. Spread cement uniformly on soil at rate specified by laboratory. When bulk cement spreader is used, position it by string lines or other approved method to ensure uniform distribution of cement. Apply cement only in area where operations can be continuous and completed in daylight, within one hour (1 Hr) of application. Amount of moisture in soil at time of cement placement shall not exceed quantity that shall permit uniform mixture of soil and cement during dry mixing operations. Do not exceed specified optimum moisture content for soil-cement mixture.

C. Do not allow equipment other than that used in spreading and mixing, to pass over freshly spread cement until it is mixed with soil.

D. Dry mix cement with soil after cement application. Continue mixing until cement has been sufficiently blended with soil to prevent formation of cement balls when water is applied. Mixture of soil and cement that has not been compacted and finished shall not remain undisturbed for more than thirty minutes (30 Min).

E. Immediately after dry mixing is complete, uniformly apply water as necessary and incorporate it into mixture. Pressurized equipment must provide adequate supply to ensure continuous application of required amount of water to sections being processed within three hours (3 Hrs) of cement application. Ensure proper moisture distribution at all times.

After last increment of water has been added, continue mixing until thorough and uniform mix has been obtained.

F. Ensure percentage of moisture in mixture, based on dry weights, is within two (2) percentage points of specified optimum moisture content prior to compaction. When un-compacted soil-cement mixture is wetted by rain indicating that average moisture content exceeds tolerance given at the time of final compaction, reconstruct entire section in accordance with this Section at no additional cost to the City.

3.5 COMPACTION

A. Prior to beginning compaction, ensure mixture is in loose condition for its full depth. Uniformly compact the loose mixture to specified density, lines and grades.

B. After soil and cement mixture is compacted, apply water uniformly as needed and mix thoroughly. Reshape surface to required lines, grades and cross section and lightly scarify to loosen imprints left by compacting or shaping equipment.

C. Roll resulting surface with pneumatic-tired roller and “skin” surface with power grader. Thoroughly compact mixture with pneumatic roller, adding small increments of moisture, as needed. When aggregate larger than No. 4 sieve is present in mixture, make one (1) complete coverage of section with flat-wheel roller immediately after skinning operation. When approved by the Project Manager, surface finishing methods may be varied from this procedure, provided dense uniform surface, free of surface compaction planes, is produced. Maintain moisture content of surface material at its specified optimum during finishing operations. Compact and finish surface within a period not to exceed two hours (2 Hrs), to produce smooth, tight surface, free of cracks, ridges or loose material, conforming to crown, grade and line shown on the Drawings within the period not to exceed two hours (2 Hrs).

3.6 CONSTRUCTION JOINTS

A. At end of each day’s construction, form straight transverse construction joint by cutting back a total width of completed work to form true two inch (2 In) depth of vertical face free of loose and shattered material. Construct cement treatment for large wide areas in series of parallel lanes of convenient length and width approved in advance by the Project Manager.

3.7 CURING

A. Moist cure for a minimum of three days (3 D) before placing base or surface course or opening to traffic. When open, restrict traffic to light pneumatic rollers or vehicles weighing less than ten tons (10 Tn).

B. Keep subgrade surface damp by sprinkling. Roll with light pneumatic roller to keep surface knit together.

C. Place base and surface within fourteen days (14 D) after the final mixing

and compaction, unless prior approval is obtained by the Project Manager.

3.8 TOLERANCES

A. Completed surface: smooth and conforming to typical section and established lines and grades.

B. Top of compacted surface: Plus or minus one-quarter inch (±1/4 In) in cross section or in sixteen feet (16 Ft) of length.

3.9 FIELD QUALITY CONTROL

A. Testing shall be performed under provision of Sections 01470 – Testing Laboratory Services and 01475 – Quality Control Testing Procedures.

B. In-place density shall be determined in accordance with ASTM D2922 or ASTM D698. A minimum of three (3) tests shall be taken for each one thousand feet (1000 Ft) per lane of roadway or five hundred square yards (500 Sy) of embankment.

3.10 PROTECTION

A. Maintain stabilized subgrade to lines and grades and in good condition until placement of base or surface course.

B. Repair defects immediately by replacing material to full depth.

END OF SECTION

SECTION 02730
PRIME COAT

PART I: GENERAL

1.1 GENERAL REQUIREMENTS
- A. Prime coat for asphalt concrete paving

1.2 MEASUREMENT AND PAYMENT
- A. Unit Prices:
  1. No separate payment shall be made for prime coat under this Section. Include payment in unit price for material being primed.
  2. Refer to Section 01270 – Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum):
  1. If Contract is Stipulated Price Contract, payment for Work in this Section is included in Total Stipulated Price.

1.3 SUBMITTALS
- A. Conform to requirements of Section 01330 – Submittal Procedures.
- B. Submit product data for proposed prime coat.
- C. Submit report of recent calibration of distributor.

1.4 REFERENCES
- A. CFTS – City of Friendswood Technical Specifications.

1.5 QUALITY ASSURANCE
- A. Provide manufacturer's affidavits that material was manufactured in compliance with standards referenced in this Section.

PART II: PRODUCTS

2.1 CUTBACK ASPHALT
- A. Provide moisture-free homogeneous material which shall not foam when heated to three hundred forty seven degrees Fahrenheit (347° F) and which meets the following requirements:
- B. Asphalt material for prime coat shall be MC-30 or MC-70 and shall meet requirements as specified in TABLE 4.1 – ASPHALT MATERIAL FOR PRIME COAT in this Section:
  1. Distillate shall be as specified in TABLE 4.2 – DISTILLATE in this Section, expressed as percent by volume of total distillate to six hundred eighty degrees Fahrenheit (680° F).
  2. Tests on Distillation Residue shall be as specified in TABLE 4.3 – DISTILLATE TEST in this Section.

2.2 EMULSIFIED PETROLEUM RESIN

A. EPR-1 Prime: Slow curing emulsion of petroleum resin and asphalt cement conforming to requirements as specified in TABLE 4.4 – EMULSIFIED PERTROLEUM RESIN PROPERTIES in this Section.
B. For use, EPR-1 may be diluted with water up to a maximum three (3) parts water to one (1) part EPR- 1 in order to achieve desired concentration of residual resin/asphalt to facilitate application.

PART III: EXECUTION

3.1 EXAMINATION

A. Verify base is ready to support imposed loads.
B. Verify lines and grades are correct.

3.2 PREPARATION

A. Thoroughly clean base course surface of loose material by hand brooming or mechanical sweeping prior to application of tack coat.
B. Prepare sufficient base in advance of paving for efficient operations.

3.3 APPLICATION, BASIC

A. Apply prime coat with approved type of self-propelled pressure distributor. Distribute prime coat evenly and smoothly under pressure necessary for proper distribution.
B. Keep storage tanks, piping, retorts, booster tanks and distributors used in handling asphalt materials clean and in good operating condition. Conduct operations so asphalt material does not become contaminated.
C. If yield of asphaltic material appears to be in error, recalibrate distributor prior to continuing the Work.
D. Maintain surface until the Work is accepted by the City.

3.4 APPLICATION, CUTBACK ASPHALT

A. Do not use cutback asphalt during period of April 16th through September 15th.
B. Do not place prime coat when air temperature is below sixty degrees Fahrenheit (60° F) and falling. Materials may be placed when air temperature taken in shade and away from artificial heat is above fifty degrees Fahrenheit (50° F) and rising.
C. Distribute at rate of twenty-five hundredths gallons per square yard (0.25 Gal/Sy) to thirty five hundredths gallons per square yard (0.35 Gal/Sy).
D. Equipment shall accurately determine temperature of asphaltic material in heating equipment and in distributor, for determining rate of application and for obtaining uniformity at junction of two (2) distributor loads. Maintain in accurate working order, including recording thermometer at storage heating unit.
E. Base temperature of application on temperature-viscosity relationship that shall permit application of asphalt with viscosity of one hundred centistokes (100 cSt) to one hundred twenty-five centistokes (125 cSt). Maintain asphalt within fifteen degrees Fahrenheit (15° F) of temperature

required to meet viscosity. Selected temperature shall be within range specified in TABLE 4.5 – TEMPERATURES FOR VISCOSITY in this Section.

F. Do not allow temperature of MC-30 to exceed one hundred seventy-five degrees Fahrenheit (175° F).

G. Do not allow temperature of MC-70 to exceed two hundred degrees Fahrenheit (200° F).

3.5 APPLICATION, EMULSIFIED PETROLEUM RESIN

A. Do not place prime coat when air temperature is below thirty-six degrees Fahrenheit (36° F) and falling.

B. Distribute at rate of fifteen hundredths gallons per square yard (0.15 Gal/Sy) to twenty-five hundredths gallons per square yard (0.25 Gal/Sy).

3.6 PROTECTION

A. Do not allow traffic on or placement of subsequent base or surface courses over freshly applied prime coat until authorized by the Project Manager.

PART IV: TABLES

4.1 ASPHALT MATERIAL FOR PRIME COAT

PROPERTIES	**TYPE – GRADE**			
	MC – 30		**MC – 70**	
	MIN.	**MAX.**	**MIN.**	**MAX.**
Water, Percent	-	0.2	-	0.2
Flash Point, T.O.C., °F	100	-	100	-
Kinematic Viscosity at 140° F, cst	30	60	70	140

4.2 DISTILLATE

TEMPERATURE	**TYPE – GRADE**			
	MC – 30		**MC – 70**	
	MIN.	**MAX.**	**MIN.**	**MAX.**
to 437° F	-	25	-	20
to 500° F	40	70	20	60
to 600° F	75	93	65	90
Residue from 680° F Distillation, Volume, Percent	50	-	55	-

4.3 DISTILLATE TEST

TEST	TYPE – GRADE			
	MC – 30		MC – 70	
	MIN.	MAX.	MIN.	MAX.
Penetration at 77° F, 100g, 5 sec.	120	250	120	250
Ductility at 77° F, 5 cm/min. cms	100*	-	100*	-
Solubility in Trichloroethylene, %	99	-	99	-
Spot Test	All Negative			

* If penetration of residue is more than two hundred (200) and ductility at seventy-seven degrees Fahrenheit (77° F) is less than one hundred centimeters (100 Cm), material shall be acceptable when its ductility is sixty degrees Fahrenheit (60° F) is more than one hundred centimeters (100 Cm).

4.4 EMULSIFIED PERTROLEUM RESIN PROPERTIES

PROPERTIES	MIN.	MAX.
Fural Viscosity at 77° F, Sec	14	40
Residue by Evaporation, % by Weight	60	-
Sieve Test, %	-	0.1
Particle Charge Test	Positive	
Tests on Distillation Residue:		
Flash Point, COC (F)	400	-
Kinematic Viscosity @ 140° F (cst)	190	350

4.5 TEMPERATURES FOR VISCOSITY

PRIME COAT TYPE	MINIMUM °F	MAXIMUM °F
MC – 30	70	150
MC – 70	125	175

END OF SECTION

SECTION 02735
TACK COAT

PART I: GENERAL

1.1 GENERAL REQUIREMENTS
- A. Tack coat for asphalt concrete paving.

1.2 MEASUREMENT AND PAYMENT
- A. Unit Prices:
  1. No separate payment shall be made for tack coat under this Section. Include payment in unit price for asphaltic pavements.
  2. Refer to Section 01270 – Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum):
  1. If Contract is Stipulated Price Contract, payment for Work in this Section is included in Total Stipulated Price.

1.3 REFERENCES
- A. ASTM – American Society for Testing and Materials.
  1. ASTM D244 – Standard Test Methods for Emulsified Asphalts.
- B. CFTS – City of Friendswood Technical Specifications

1.4 SUBMITTALS
- A. Conform to requirements of Section 01330 – Submittal Procedures.
- B. Submit product data for proposed tack coat.
- C. Submit report of recent calibration of distributor.

1.5 QUALITY ASSURANCE
- A. Provide manufacturer's affidavits that material was manufactured in compliance with standards referenced in this Section.

PART II: PRODUCTS

2.1 EMULSION
- A. Provide homogeneous material which shows no separation of asphalt after mixing and meets viscosity requirements within thirty days (30 D) after delivery.
- B. Emulsion material for tack coat.
  1. Emulsified asphalt: SS-1 or SS-1H meeting criteria listed in Table 4.1 – PROPERTIES OF EMULSIFIED ASPHALT SS-1 OR SS-1H in this Section.
  2. Polymer Modified Emulsion, SS-1P, for use where thin overlays [less than or equal two inches (2 In)] are placed on collector or arterial streets and for speed humps, especially over existing

Portland cement concrete pavement, meeting criteria listed in Table 4.2 – PROPERTIES OF POLYMER MODIFIED EMULSION SS – 1P in this Section.

3. For emulsions used for tack coats during period of April 16th through September 15th, volatile organic compound solvents (VOC) shall not exceed twelve percent (12%) by weight when tested in accordance with ASTM D244.

PART III: EXECUTION

3.1 EXAMINATION

A. Verify compacted base is ready to support imposed loads.
B. Verify lines and grades are correct.

3.2 PREPARATION

A. Thoroughly clean base course or concrete surface of loose material by hand brooming or mechanical sweeping prior to tack coat application.

3.3 APPLICATION

A. Apply tack coat uniformly by use of approved distributor at rate not to exceed five hundredths gallons per square yard (0.05 Gal/Sy) of surface depending on texture of underlying surface. Select an application rate that shall provide appropriate asphalt residual.
B. Paint contact surfaces of curbs, structures and joints with thin uniform coat of tack coat.

3.4 PROTECTION

A. Prevent traffic or placement of subsequent courses over freshly applied tack coat until authorized by the Project Manager.

PART IV: TABLES

4.1 PROPERTIES OF EMULSIFIED ASPHALT SS-1 OR SS-1H

PROPERTIES	**SS – 1**		**SS – 1H**	
	MIN.	**MAX.**	**MIN.**	**MAX.**
Furol Viscosity at 77° F, sec.	20	100	20	100
Residue by Distillation, %	60	---	60	---
Oil Portion of Distillate, %	---	1/2	---	1/2
Sieve Test, %	---	0.10	---	0.10
Miscibility (Standard Test)	Passing			
Cement Mixing, %	---	2.0	---	2.0
Storage Stability, 1 Day, %	---	1	---	1
Test on Residue:				
Penetration at 77° F, 100g, 5 sec.	120	160	70	100
Solubility in Trichloroethylene, %	97.5	---	97.5	---
Ductibility at 77° F, 5 cm/min., cms	100	---	100	---

4.2 PROPERTIES OF POLYMER MODIFIED EMULSION SS – 1P

PROPERTIES	**SS – 1P**	
	MIN.	**MAX.**
Furol Viscosity at 77° F, sec.	30	100
Residue by Distillation, %	60	---
Oil Portion of Distillate, %	---	1/2
Sieve Test, %	---	0.10
Miscibility (Standard Test)	Passing	
Cement Mixing, %	---	2.0
Storage Stability, 1 Day, %	---	1
Test on Residue:		
Penetration at 77° F, 100g, 5 sec.	100	140
Solubility in Trichloroethylene, %	97.0	---
Ductibility at 77° F, 5 cm/min., cms	50	---
Viscosity at 140° F, poises	1300	---

END OF SECTION

SECTION 02740
GEOTEXTILE STABILIZATION

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Separation Geotextile (Subgrade CBR≥3).

1. This Section is applicable to the use of a geotextile to prevent mixing of subgrade soil and an aggregate cover material (subbase, base, select fill, etc.).
2. This Section may also apply to situations other that beneath pavements where separation of two (2) dissimilar materials is required, but where water seepage through the geotextile is not a critical function.

A. Separation Geotextile (1 <Subgrade CBR < 3).

1. This Section is applicable to the use of a geotextile in wet, saturated conditions to provide the coincident functions of separation and filtration. In some installations, the geotextile may also provide reinforcement.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. Unit Price shall be by the Linear Foot.

B. Stipulated Price (Lump Sum):

1. If Contract is Stipulated Price Contract, payment for Work in this Section is included in Total Stipulated Price.

1.3 REFERENCES

A. AASHTO – American Association of State Highway and Transportation Officials.

1. AASHTO M288-05 – Standard Specification for Geotextile Specification for Highway Applications.
2. AASHTO T88 – Standard Test Method for Particle Size Analysis of Soils.
3. AASHTO T90 – Standard Test Method for Determining the Plastic Limit and Plasticity Index of Soils.
4. AASHTO T99 – Standard Practice for Determination of Moisture Density Relations of Soils Using a 5.5 lb. hammer and 12 inch drop (Standard Proctor).

B. ASTM – American Society for Testing and Materials.

1. D123 – Standard Terminology Relating to Geotextiles.
2. D276 – Standard Test Method for Identification of Fibers in Textiles.
3. D4354 – Practice for Sampling of Geosynthetics for Testing.
4. D4355 – Test Method for Deterioration of Geotextiles from

Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).

5. D4439 – Terminology for Geotextiles.
6. D4491 – Test Method for Water Permeability of Geotextiles by Permittivity.
7. D4533 – Test Method for Index Trapezoid Tearing Strength of Geotextiles.
8. D4362 – Test Method for Grab Breaking Load and Elongation of Geotextiles.
9. D4759 – Practice for Determining the Specification Conformance of Geosynthetics.
10. D4751 – Test Method for Determining Apparent Opening Size of a Geotextile.
11. D4873 – Guide for Identification, Storage, and Handling of Geotextiles.

C. CFTS – City of Friendswood Technical Specifications.

D. FHWA – Federal Highway Administration.

1. Publication No. FHWA HI-95-038, May 1995 – Geosynthetic Design and Construction Guidelines.

E. GAI-LAP – Geosynthetic Accreditation Institute – Laboratory Accreditation Program.

1.4 DEFINITIONS

A. California Bearing Ratio (CBR): The ratio of (1) the force per unit area required to penetrate a soil mass with a three square inch (3 Sq. In.) circular piston approximately two inches (2 In.) in diameter at the rate of five hundredths of an inch per minute (0.05 In./Min.). To (2) that required for corresponding penetration of a standard material.

B. Minimum Average Roll Value (MARV): Property value calculated as typical minus two (2) standard deviations. Statistically, it yields ninety-seven and seven-tenths percent (97.7 %) degree of confidence that any sample taken during quality assurance testing will exceed value reported.

C. Typical Roll Value: Property value calculated from average of mean obtained from test data.

1.5 SUBMITTALS

A. Conform to requirements of Section 01330 – Submittal Procedures.

B. Certification:

1. The Contractor shall provide the Project Manager a certificate stating the name of the geotextile manufacturer, product name, style, chemical compositions of filaments or yarns, and other pertinent information to fully describe the geotextile.
2. The Manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of this Section. Documentation describing the quality control program shall be made available upon request.

3. The manufacturer's certificate shall state that the furnished geotextile meets MARV requirements of this Section as evaluated under the manufacturer's quality control program. The certificate shall be attested to by a person having legal authority to bind the Manufacturer.

B. Manufacturing Quality Control (MQC) test results shall be provided upon request.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Geotextile labeling, shipping, and storage shall follow ASTM D4873.
B. Product labels shall clearly show the manufacturer of supplier name, style name, and roll number.
C. Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's certificate.
D. Each geotextile roll shall be wrapped with material that will protect the geotextile from damage due to shipment, water, sunlight, and contaminants.
E. The protective wrapping shall be maintained during periods of shipment and storage. If the wrapping is damaged prior to installation, the out wrap of geotextile material shall be discarded before installation.
F. During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from the following:
   1. Site construction damage;
   2. extended exposure to ultraviolet (UV) radiation;
   3. precipitation;
   4. chemicals that are strong acids;
   5. chemicals that are strong bases;
   6. flames;
   7. sparks;
   8. temperatures in excess of one hundred sixty degrees Fahrenheit (160° F); and
   9. any other environmental condition that might damage the geotextile.

1.7 QUALITY ASSURANCE

A. Geotextile:
   1. Geotextiles shall be subject to sampling and testing to verify conformance with this Section. Sampling for testing shall be in accordance with ASTM D4354.
   2. Acceptance shall be in accordance with ASTM D4759 based on testing of either conformance samples obtained using Procedure A of ASTM D4354, or based on manufacturer's certifications and testing of quality control samples obtained using Procedure B of ASTM D4354.
B. Sewn Seams (if required):

1. For seams that are to be sewn in the field, the Contractor shall provide at least a six foot (6 ft.) length of sewn seam for sampling to the Project Manager before geotextile is installed.
2. For seams that are sewn in the factory, the Project Manager shall obtain samples of the factory seams at random from a roll of geotextile that is to be used on the project.
3. If seams are to be sewn in both directions, samples of seams in both directions shall be provided.
4. For seams that are field sewn, the seams sewn for sampling shall be sewn using the same equipment and procedures that will be used for production seams.
5. The seam assembly description shall be submitted by the Contractor along with the sample of the seam. The description shall include seam type, sewing thread, and stitch density.

PART II: PRODUCTS

2.1 MANUFACTURERS:
A. Propex Inc., Chattanooga, TN., or approved equal.

2.2 MATERIALS:
A. Geotextile:
1. The geotextile construction shall be woven split film polypropylene geotextile; individual slit films woven together in a manner to provide dimensional stability relative to each other including selvages.
2. Resistant to UV degradation and environmental and chemical environments normally encountered in soils.
3. Minimum Average Roll Values (MARV) used for light duty roadways and paths:
a. TABLE 4.1 – TYPE I (AASHTO CLASS 3) WOVEN GEOTEXTILE.
b. TABLE 4.2 – TYPE I (AASHTO CLASS 3) NON-WOVEN GEOTEXTILE.
4. Minimum Average Roll Values (MARV) used for paved and unpaved rural roadways and taxiways where the subgrade CBR≥3:
a. TABLE 4.3 – TYPE II (AASHTO CLASS 2) WOVEN GEOTEXTILE.
b. TABLE 4.4 – TYPE II (AASHTO CLASS 2) NON-WOVEN GEOTEXTILE.
3. Minimum Average Roll Values (MARV) used for paved urban roads where subgrade 1<CBR<3, heavy duty haul roads, and runways:
a. TABLE 4.5 – TYPE III (AASHTO CLASS 1) WOVEN GEOTEXTILE.

b. TABLE 4.6 – TYPE III (AASHTO CLASS 1) NON-WOVEN GEOTEXTILE.

2.3 QUALITY CONTROL:

A. Manufacturing Quality Control (MQC): Testing shall be performed at a laboratory accredited GAI-LAP for tests required for the geotextile, at a frequency exceeding ASTM D4354.

B. Sewing thread (if required):

1. Sewing thread shall consist of high strength polypropylene or polyester (Nylon shall not be used).
2. The thread shall be of a contrasting color to the geotextile.

PART III: EXECUTION

3.1 PREPARATION

A. Clear, grub, and excavate/fill installations site to design. Remove topsoil, vegetation, and other unsuitable materials.

B. Soft spots and unsuitable areas shall be identified during site preparation or subsequent proof rolling.

3.2 INSTALLATION

A. The geotextile shall be laid smooth without wrinkles or folds on the prepared subgrade in the direction of construction traffic.

B. Adjacent geotextile rolls shall be overlapped, sewn or joined as required in TABLE 4.7 – GEOTEXTILE OVERLAPPING.

C. When sewn seams are required, the seam strength, as measured by ASTM D4632 shall be equal to or greater than ninety percent (90%) of the specified grab strength.

D. On curves, the geotextile maybe folded or cut to conform to the curves. The fold or overlap shall be in the same direction of construction and held in place by pins, staples, or piles of fill or rock.

E. Prior to covering, the geotextile shall be inspected by a certified inspector or Project Manager to ensure that it has not been damaged during installation.

F. Damaged areas, as identified by the Project Manager, shall be repaired immediately by covering the damaged area with a geotextile patch that extends an equal amount to the required overlap beyond the damaged area.

G. The subbase shall be placed by end dumping onto the geotextile, or over previously placed subbase aggregate such that at least minimum specified lift thickness shall be between the construction equipment tires or tracks and the geotextile at all times.

H. Pretensioning Geotextile:

1. Proof roll with heavily loaded, rubber-tired vehicle. Wheel load of truck should be equivalent to maximum expected for site. Vehicle to make at least four (4) passes over first (1st) lift in each

area of site.

2. Once design aggregate has been placed, use roadway prior to paving to prestress geotextile-aggregate system in key areas.

I. If required, staple or pin geotextile overlaps to maintain position during construction activities. Use nails ten inches (10 In.) to twelve inches (12 In.) in length placed at a minimum of fifty feet (50 Ft.) on cent for parallel rolls and five feet (5 Ft.) on center for roll ends.

J. Do not place overlap along anticipated primary wheel paths. Place overlaps at end of rolls in direction of aggregate placement with previous roll on top.

K. When geotextile intersects an existing pavement area, extend geotextile to edge of old system. For widening or intersecting existing roads where geotextiles have been used, anchor geotextile at roadway edge.

L. Compact first (1st) lift of base aggregate with a tracking dozer and then compact with smooth-drum vibratory roller to obtain minimum compacted density.

M. Compaction of permeable bases shall meet specified requirements.

N. Perform construction parallel to road alignment.

O. Fill ruts formed during construction to maintain adequate cover over geotextile. Do not blade ruts down.

P. Place remaining base aggregate in lifts not exceeding ten inches (1o In.) in loose thickness and compact to specified density.

3.4 PROTECTION

A. Atmospheric exposure of the geotextile to the elements following laydown shall be limit to fourteen days (14 Ds.) to prevent damage.

B. Equipment may operate on roadway without aggregate for geotextile installation under permeable bases if subgrade is of sufficient strength.

1. For extremely soft soils, use lightweight construction vehicles for access on first (1st) lift.
2. Limit construction vehicles in size and weight to limit rutting in initial lift to three inches (3 In.).
3. If rut depth exceeds three inches (3 In.), decrease vehicle size or weight or increase lift thickness.

C. Turning not permitted on first (1st) lift of base aggregate. Construct turnouts at roadway edge to facilitate construction.

PART IV: TABLES

4.1 MINIMUM ROLL VALUES (MARV) FOR TYPE I (AASHTO CLASS 3) WOVEN GEOTEXTILE.

PROPERTY	TEST METHOD	UNITS	PROPERTY REQUIREMENT
Grab Tensile Strength	ASTM D4632	Lbs.	200
Grab Elongation	ASTM D4632	Percent	15
Puncture Strength	ASTM D4833	Lbs.	90
Mullen Burst	ASTM D3786	Psi.	400
Trapezoidal Tear	ASTM D4533	Lbs.	75
Apparent Opening Size	ASTM D4751	In.	0.0167
Permittivity	ASTM D4491	Sec-1	0.05
Water Flow Rate	ASTM D4491	gpm/ft^2	4
UV Resistance (Percent retained at 500 hours)	ASTM D4355	Percent	70

4.2 MINIMUM ROLL VALUES (MARV) FOR TYPE I (AASHTO CLASS 3) NON-WOVEN GEOTEXTILE.

PROPERTY	TEST METHOD	UNITS	PROPERTY REQUIREMENT
Grab Tensile Strength	ASTM D4632	Lbs.	120
Grab Elongation	ASTM D4632	Percent	50
Trapezoidal Tear	ASTM D4533	Lbs.	50
Apparent Opening Size	ASTM D4751	In.	0.0084
Permittivity	ASTM D4491	Sec-1	1.7
Water Flow Rate	ASTM D4491	gpm/ft^2	140
UV Resistance (Percent retained at 500 hours)	ASTM D4355	Percent	70

4.3 MINIMUM ROLL VALUES (MARV) FOR TYPE II (AASHTO CLASS 2) WOVEN GEOTEXTILE.

PROPERTY	TEST METHOD	UNITS	PROPERTY REQUIREMENT
Grab Tensile Strength	ASTM D4632	Lbs.	250
Grab Elongation	ASTM D4632	Percent	12
Puncture Strength	ASTM D4833	Lbs.	110
Mullen Burst	ASTM D3786	Psi.	500
Trapezoidal Tear	ASTM D4533	Lbs.	90
Apparent Opening Size	ASTM D4751	In.	0.0167
Permittivity	ASTM D4491	Sec-1	0.05
Water Flow Rate	ASTM D4491	gpm/ft^2	4
UV Resistance (Percent retained at 500 hours)	ASTM D4355	Percent	70

4.4 MINIMUM ROLL VALUES (MARV) FOR TYPE II (AASHTO CLASS 2) NON-WOVEN GEOTEXTILE.

PROPERTY	TEST METHOD	UNITS	PROPERTY REQUIREMENT
Grab Tensile Strength	ASTM D4632	Lbs.	160
Grab Elongation	ASTM D4632	Percent	50
Trapezoidal Tear	ASTM D4533	Lbs.	60
Apparent Opening Size	ASTM D4751	In.	0.0084
Permittivity	ASTM D4491	Sec-1	1.30
Water Flow Rate	ASTM D4491	gpm/ft^2	110
UV Resistance (Percent retained at 500 hours)	ASTM D4355	Percent	70

4.5 MINIMUM ROLL VALUES (MARV) FOR TYPE III (AASHTO CLASS 1) WOVEN GEOTEXTILE.

PROPERTY	TEST METHOD	UNITS	PROPERTY REQUIREMENT
Grab Tensile Strength	ASTM D4632	Lbs.	315
Grab Elongation	ASTM D4632	Percent	12
Puncture Strength	ASTM D4833	Lbs.	150
Mullen Burst	ASTM D3786	Psi.	600
Trapezoidal Tear	ASTM D4533	Lbs.	113
Apparent Opening Size	ASTM D4751	In.	0.0167
Permittivity	ASTM D4491	Sec-1	0.1
Water Flow Rate	ASTM D4491	gpm/ft^2	4
UV Resistance (Percent retained at 500 hours)	ASTM D4355	Percent	70

4.6 MINIMUM ROLL VALUES (MARV) FOR TYPE III (AASHTO CLASS 1) NON-WOVEN GEOTEXTILE.

PROPERTY	TEST METHOD	UNITS	PROPERTY REQUIREMENT
Grab Tensile Strength	ASTM D4632	Lbs.	205
Grab Elongation	ASTM D4632	Percent	50
Trapezoidal Tear	ASTM D4533	Lbs.	80
Apparent Opening Size	ASTM D4751	In.	0.0071
Permittivity	ASTM D4491	Sec-1	1.50
Water Flow Rate	ASTM D4491	gpm/ft^2	110
UV Resistance (Percent retained at 500 hours)	ASTM D4355	Percent	70

4.7 MINIMUM GEOTEXTILE OVERLAPING.

SUBGRADE CBR	**MINIMUM OVERLAP**
Greater than 3	12 – 18 inches
1 to 3	24 – 36 inches
0.5 to 1	36 inches or sewn
Less than 0.5	Sewn
All Roll Ends	36 inches or sewn

END OF SECTION