TECHNICAL SPECIFICATIONS

FOR

KEOKEA-WAIOHULI DEVELOPMENT PHASE 2B

TECHNICAL SPECIFICATIONS

DIVISION 2 – SITE WORK

SECTION 02100 – CLEARING AND GRUBBING

PART 1 – GENERAL

1.01 GENERAL CONDITIONS: The General Conditions, DHHL Construction General Conditions and Special Conditions in this IFB-24-HHL-012 shall govern this section of the work.

1.02 WORK INCLUDED

A. Furnish all labor, materials, equipment and tools necessary to accomplish all clearing and grubbing work as indicated on the plans and as specified herein.

B. It shall be the responsibility of the Contractor to examine the project site and determine for himself the existing conditions.

C. Obvious conditions of the site existing on the date of the bid opening shall be accepted as part of the work, even though they may not be clearly indicated on the plans and/or described herein or may vary there from.

D. All debris of any kind accumulated from clearing or grubbing shall be disposed of off-site weekly and the whole area left clean. The Contractor shall be required to make all necessary arrangements related to the proposed place of disposal.

E. Burning onsite will not be permitted.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 SEQUENCE OF WORK: All sequence of work shall be subject to the approval of the Engineer.

3.02 PROTECTION

A. Adequate precautions shall be taken before commencing and during the course of the work to insure the protection of life, limb and property.

B. The Contractor shall protect from damage all surrounding structures, trees, plants, grass, walks, pavements, utility boxes, etc. Any damages will be repaired or replaced by the Contractor to the satisfaction of the Engineer.

3.03 PERMITS: The Contractor shall apply for and obtain the necessary permits prior to the commencement of work. The Contractor shall pay for all fees.

3.04 BARRICADE: Erect temporary barricade to prevent people and animals from entering the project area, to the extent as approved by the Construction Manager. Such barricades shall not be less than 5’-0” in height. The extent of barricades may be adjusted as necessary with the approval of the Construction Manager. This work shall be accomplished to the satisfaction of the Department and at no extra cost to the Department. Barricades shall be removed upon completion of work and job site premises left clean.

3.05 MAINTAINING TRAFFIC

A. The Contractor shall conduct operations with minimum interference to streets, driveways, sidewalks, etc. in accordance with the Traffic Control Plan in the construction plans.

B. When necessary, the Contractor shall provide, erect and maintain lights, barriers, etc., as required by traffic and safety regulations with special attention to protection of life.

3.06 CONSTRUCTION LINES, LEVELS AND GRADES

A. The Contractor shall verify all lines, levels and elevations indicated on the plans before any clearing, excavation or construction begins. Any discrepancy shall be immediately brought to the attention of the Construction Manager and any change shall be made in accordance with his instruction. The Contractor shall not be entitled to extra payment if he fails to report the discrepancies before proceeding with any work whether within the area affected or not.

B. All lines and grades shall be established by a Surveyor licensed in the State of Hawaii.

3.07 CLEARING AND GRUBBING

A. The Contractor shall clear off and remove from the entire area within the area to be graded, all rubbish, grass and weeds, stumps, large roots, buried logs, garbage, boulders and other unsuitable material. Where soft wet soils are encountered, light equipment should be used.

B. The Contractor shall grub the ground surface within the area to be graded of all grass and weeds to 8 inches below present grades. This material shall be disposed off site properly.

C. Any stumps and roots larger than 3 inches in diameter shall be removed to a depth not less than 18 inches below the original grade level. Fill voids with onsite material to maintain indicated grade.

D. No excavation or filling shall be undertaken until area has been cleared and grubbed.

3.08 CONTRACT ZONE LIMITS: The Contract Zone Limits shall coincide with the limits of disturbance as shown on the plans. These limits indicate only in general the limits of the work involved. The Contractor, however, is required to perform any and all necessary and incidental work which may fall outside of these demarcation lines.

3.09 VERIFICATION OF EXISTING GRADES: Verify existing grades, inverts, and improvements before any clearing and grubbing work is done. Immediately bring to the attention of the Construction Manager any discrepancy and make any changes in accordance with his instructions. Starting of clearing and grubbing operations will be construed to mean that the Contractor agrees that the existing grades, inverts, and improvements are essentially correct as indicated. No extra compensation will be allowed if existing grades, inverts, and improvements are in error after verification thereof or if he fails to report the discrepancies before proceeding with any work.

3.10 CLEAN-UP: Clean up and remove all debris accumulated from construction operations from time to time, when and as directed by the Construction Manager. Upon completion of the construction work and before final acceptance of work, remove all surplus materials, equipment, etc., and leave entire job site clean and neat.

END OF SECTION

SECTION 02210 – SITE EARTHWORK

PART 1 – GENERAL

1.01 GENERAL CONDITIONS: The General Conditions, DHHL Construction General Conditions and Special Conditions in this IFB-24-HHL-012 shall govern this section of the work.

1.02 WORK INCLUDED: Furnish all labor, materials, services, equipment and related items necessary to excavate, fill, remove, transport, stockpile and dispose of all materials within the limits of the project required to construct the site work improvements in accordance with these specifications, dimensions, sections and details shown on the plans, and the approval of the Department.

1.03 RELATED WORK IN OTHER SECTIONS

Temporary Soil Erosion Control..... Section 02270

1.04 SUBSURFACE SOIL DATA: Subsurface soil investigations have been made at the project site. A copy of the complete reports entitled "Preliminary Geotechnical Exploration Report, Keokea-Waiohuli Development Project, Kula, Keokea, Maui, Hawaii", dated March 31, 2005 and "Preliminary Geotechnical Exploration Report, Keokea-Waiohuli Subdivision Phases 1, 2 and 4A, Kula, Makawao, Maui, Hawaii", dated April 5, 2013, and all supplemental revisions to these reports prepared by PSC Consultants LLC are available on the compact disc (CD) provided with these bid documents. Test pit and boring logs are shown in the soils report.

The Contractor is expected to examine the site and the record of soil investigation and decide for himself the character of materials to be encountered. The Engineer will not assume responsibility for variations of subsoil quality or condition at locations other than places shown and at the time investigations were made.

The soils report and its recommendations are made part of these specifications.

1.05 PROTECTION

A. Erosion Control: The Contractor shall incorporate into his work schedule the Temporary Erosion Control Measures and the Permanent Erosion Control procedures indicated on the plans and as specified in the contract.

B. Dust Control: Every effort shall be made by the Contractor to keep dust to a minimum. Spraying the ground with water or other means of control shall be used wherever possible. The Contractor shall have an adequate supply of water for moisture conditioning of fill material.

Without limiting the generality or applicability of other indemnity provisions of the contract, the Contractor agrees that he shall indemnify and hold harmless the Department from and against all suits, actions, claims, demands, damages, costs and expenses (including but not limited to attorney's fees) arising out of any damage to any property whatsoever or injury to any person whomsoever, in any way caused or contributed to by dust from the Contractor's operations.

C. Existing Utilities and Work Areas: The Contractor shall be responsible for the protection of existing surface and subsurface utilities and poles within and abutting the project site, trench excavations and other work areas.

D. Finished Grades and Subgrades: All subgrades shall be kept at optimum moisture until covered by subbase, base course, or concrete. All finished grades shall be kept moist until covered by landscaping or other permanent groundcover. Where shrinkage cracks are noted after compaction of the finished grade, finished grade shall be re-scarified, moisture-conditioned to above the optimum moisture content, and re-compacted to the specified requirement at no additional cost to the Department. During construction, the Contractor shall properly grade and maintain all excavated surfaces to provide positive drainage and prevent ponding of water. In the event that ponding of water caused softening of the subgrades, the Contractor shall remove the soft soils and shall backfill the excavation with compacted fill at no additional cost to the Department.

PART 2 – PRODUCTS

2.01 MATERIALS

A. General Fill: Materials for general fill purposes should be well-graded, granular soils with no rocks greater than 12 inches in size in the deeper portion of the fill, at least 5 feet below the final grade or below any planned utilities. Materials ranging from 6 to 12 inches should be limited to less than 15 percent of the total general fill. The excavated materials, if less than 12 inches in maximum dimension, may be used as a source of general fill, provided these are processed to meet the gradation requirements for general fill. If the excavated materials do not contain a sufficient amount of fines to produce the desired gradation for general fill, offsite borrow or crusher-run onsite materials may be added to produce a well graded material.

Boulders, cobbles, or fractured rock fragment over 6 inches in size may be used in deeper portions of fills providing they are not nested, and sufficient soils are placed adjacent to them in such a manner that voids are properly filled and compacted, and are below the depths of utility installations.

The onsite soils may be used as general fill and backfill where structural fills are not specifically required, provided that it does not contain organics, debris, and other deleterious materials.

B. Structural Fill. Structural fill shall be granular, free of organic debris, deleterious substances, and particles larger than 3 inches. Structural fill shall be classified as GP, GW, GM, GP-GM, SP, SW, SM, SP-SM and SW-SM, in accordance with ASTM D 2487. Where fill material is used in confined areas such as utility trenches and behind walls, the particles should be less than 2 inches in maximum dimensions. The material shall have a plasticity index less than 12 (ASTM 4318), a liquid limit less than 35, a CBR (ASTM D 1883) of at least 20 when compared to 95% relative compaction at optimum moisture content, and not more than 30% by weight passing the No. 200 sieve (ASTM D 1140).

The onsite basaltic rock may be crushed to meet the above recommendations for use as structural fill.

C. Boulder Fills. A large quantity of boulders will be generated from excavation operations. Boulders at the surface and in the excavations may be used in the deeper fills, provided that the following recommendations are followed:

1. Boulders must not be nested together and shall be placed so that compaction equipment is able to suitably compact the soil around them. Boulder placement and compaction shall be reviewed and monitored by a Geotechnical Engineer.

2. Boulders, 6-inch plus size rocks, can be used below 5 feet from finish grade or below utility lines whichever is at the greater depth; and

Care shall be exercised to avoid placement of boulders in proposed utility alignments to prevent difficulty in later excavations of utility trenches.

D. Imported Borrow: Additional general fill material needed for general filling shall consist of imported borrow materials that have the same general properties as on-site material described above. Borrow material shall be tested by the geotechnical engineer to evaluate its stability for use as general fill and shall be approved by the Engineer.

E. Non-Expansive Select Material: Non-expansive select material to be used for this project shall consist of crushed coral, basalt gravel, or cinder sand. The non-expansive select material shall be well-graded from coarse to fine with no particles larger than 3 inches in largest dimension. It shall have a plasticity index not exceeding 15 as determined by ASTM D-4318-84; and have maximum 20 percent particles passing the No. 200 sieve. The material shall have a laboratory CBR value of 25 or higher. Free draining materials and highly permeable materials shall not be used as select material. Select material shall be tested by the Geotechnical Engineer for conformance with these requirements prior to delivery to the project site for the intended use.

F. Rocks: Rocks greater than 6 inches in diameter may be used at the bottom of deep fills or may be placed in areas suitable for rock disposal in accordance with the recommendations of the Geotechnical Engineer. Rocks not used in an engineered fill shall be disposed of as directed by the Engineer.

G. Organic Topsoil (Stripped Material): Subsequent to acceptable clearing and grubbing, remove the top 8 inches of organic material laden topsoil as required and disposed of properly off-site.

H. Ash Material): Ash material shall be removed and disposed of properly off-site prior to construction of the new improvements as specified by the Geotechnical Engineer.

PART 3 – EXECUTION

3.01 SITE GRADING

A. Notification of Schedule: The Engineer shall be notified by the Contractor after clearing and grubbing and before any fill is placed; and also at least two weeks in advance before grading operations are scheduled to begin. Further, the Contractor shall advise the Engineer of the proposed overall schedule for earthwork operations.

B. General: All cuts and fills to be constructed shall be monitored by a licensed geotechnical consultant (Geotechnical Engineer) retained by the Department, who shall approve all fill material, methods of placing and compaction and perform field density tests during the grading. No deviation from these specifications shall be made except upon the written approval of the Geotechnical Engineer and/or other public agencies having jurisdiction.

C. General Fill. Materials for general fill purposes should be well-graded, granular soils with no rocks greater than 12 inches in size in the deeper portion of the fill, at least 5 feet below the final grade or below any planned utilities. Materials ranging from 6 to 12 inches should be limited to less than 15 percent of the total general fill. The excavated materials, if less than 12 inches in maximum dimension, may be used as a source of general fill, provided these are processed to meet the gradation requirements for general fill. If the excavated materials do not contain a sufficient amount of fines to produce the desired gradation for general fill, offsite borrow or crusher-run onsite materials may be added to produce a well graded material.

Boulders, cobbles, or fractured rock fragment over 6 inches in size may be used in deeper portions of fills providing they are not nested, and sufficient soils are placed adjacent to them in such a manner that voids are properly filled and compacted, and are below the depths of utility installations.

The onsite soils maybe used as general fill and backfill where structural fills are not specifically required, provided that it does not contain organics, debris, and other deleterious materials. Between 2 feet and 5 feet on-site soil, except ash, can be used.

D. Site Preparation:

1. Site Preparation. At the onset of earthwork, the area within the contract grading limits shall be cleared of trees, vegetation, debris, rubbish, boulders, and other deleterious materials. These materials shall be removed and properly disposed of off-site.

2. Competent Soils. Areas to receive fill shall be over-excavated down 2 feet, and shall be scarified to a depth of 6 inches, moisture-conditioned to at least 2 percent above the optimum moisture content, and compacted to a minimum of 90 percent relative compaction. Relative compaction refers to the in-place, dry density of soil expressed as percentage of the maximum dry density of the same soil established in accordance with ASTM Test designation D 1557-78. The optimum moisture content is the moisture content corresponding to the maximum compacted dry density. Soft, yielding areas encountered during site preparation shall be over-excavated to expose firm soil surface and stabilized by backfilling with select material placed in 8-inch thick, loose, lifts and compacted to 90 percent relative compaction or 95 percent of its maximum dry density.

E. Site Grading:

1. General. Boulders may be stockpiled for future use, such as rip rap, gravity walls, landscaping and other purposes.

Materials used for fills placed within the upper 2 feet of the embankments shall be select non-expansive material less than 3 inches in maximum dimension. If additional

off site borrow soil is required, it shall be tested and approved by a Geotechnical Engineer prior to its delivery to the project site.

2. Earthwork and Grading. Soft or loose unsuitable silt/volcanic ash soils encountered within the roadways and driveways shall be stripped to a depth of at least 2 feet below grade or until very stiff or gravelly materials are encountered, and replaced with select granular material. Where the design subgrade encounters silty gravel, gravelly silt with cobbles, and boulders or weathered basalt, over excavation will not be necessary. After grading, scarification and proof rolling, the subbase and base course may be placed directly on top of these gravelly insitu materials. If the clinker gravel is covered in volcanic ash matrix, the use if a geofabric, such as Mirafi 140, is recommended to prevent contamination of the select borrow fill or subbase. Where fresh basalt rocks are encountered, the subbase course may be placed directly over the basalt rocks after grading.

3. Over Excavation. Some of the existing upper silt/volcanic ash soils do not contain, or have very little percentage of coarse material and are not suitable for support of structures such as roadways, house pads, driveways, access/service roads, drainage swales and berms. These soils are porous (susceptible to collapse/settle with increased water content), have a relatively low dry density, are prone to erosions, and should be over-excavated and replaced with select onsite granular soils or borrow. The silt/volcanic ash shall be over-excavated down to at least 2 feet or until very stiff or dense gravelly materials are encountered, replaced with select granular materials.

4. Fill Placement and Compaction. The fill shall be placed in level lifts with a maximum loose thickness of 8-inches and compacted to a minimum of 90 percent at house pads and 95 percent at driveways and access/service roads. Each layer shall be spread uniformly and processed to attain uniformity of the material and water content. Additional fill material shall not be placed on any fill layer which has not been properly compacted and tested.

   Lava tubes, if encountered, shall be filled with select granular material.

F. Slopes. Cut and fill slopes of 2H:1V (horizontal to vertical) may be used.

Steeper cut slopes ratios up to 1H:1V may be used in weathered basalt formations.

Fill slopes shall be constructed by overfilling 2 to 3 feet, then cutting back to the design slope to obtain a well-compacted slope face.

Where the existing ground is steeper than 5H:1V, keying and benching are required to properly bond the new fill to the slope. The filling operations should start at the lowest point up in level compacted layers, as recommended above.

Water shall be diverted away from the top of slopes and slope planting shall be implemented to minimize surface erosion.

G. Excavations: All excavation shall be made to the lines and grades as shown on the project plans. All excavation shall be inspected and approved by the geotechnical engineer. Where conditions encountered require, he shall direct the necessary modifications to be made.

Suitable material from excavation shall be used in the fill, and unsuitable material free of organic material from excavation shall be disposed of offsite.

H. Drainage: Care shall be exercised during grading so that areas involved will drain properly. Water shall be prevented from running over the slopes by the temporary berms or drainage swales. Runoff diversion by ditches shall be completed in the time specified in the bid form.

I. Field Testing: The Construction Manager shall be notified seven (7) days prior to the start of grading. A pre-grading conference shall be held between the parties involved so as to discuss methods of operations, site problems and scheduling. Field density tests shall be taken by the Geotechnical Engineer retained by the Department.

K. Supervision: At all times, the Contractor shall have a responsible field superintendent on the project in full charge of the work with authority to make decisions. He shall cooperate with the Construction Manager in carrying out the work. Any instructions given to him by the Construction Manager shall be considered to have been given to the Contractor personally.

L. Rainy Weather: No fill shall be placed, spread or rolled during unfavorable weather. When the work is interrupted by rain, operations shall not be resumed until field tests by the Engineer indicate that conditions will permit satisfactory results.

M. Unforeseen Conditions: If unforeseen or undetected soil conditions such as soft spots, existing utility trenches, structure foundations, voids or cavities, boulders, seepage water or expansive soil pockets, etc. are encountered, the Contractor shall immediately inform the Construction Manager, the State and the Engineer and determine the extent of the unforeseen anomaly, determine the resolution and negotiate cost of such resolution, whether it be positive or negative. The State retains the right to further negotiate if quantities are determined to be less than designed.

3.02 UNSUITABLE EXCAVATED MATERIAL: The Contractor shall remove from the site all unsuitable excavated material unless specified otherwise by the Engineer. The unsuitable material not containing organic material shall be hauled and disposed of offsite. Unsuitable material containing organic material shall be disposed of off-site, unless otherwise specified.

Removal, including hauling and disposal, of the unsuitable material will not be paid for directly, but shall be considered incidental to the project.

END OF SECTION

SECTION 02221 - TRENCH EXCAVATION AND BACKFILL

PART 1 – GENERAL

1.01 GENERAL CONDITIONS: The General Conditions and Special Provisions preceding these specifications shall govern this section of the work.

1.02 WORK INCLUDED: Furnish all labor, materials, tools, equipment and related items necessary for excavating and backfilling trench for roadway culverts, drain lines, and appurtenances in conformity with the dimensions, profiles, section and details shown on the plans. Work shall be governed by Section 11 of the Standard Specifications as amended herein. The Contractor shall be solely responsible for the means, techniques, procedures, and sequences for dewatering and bracing and shoring the excavation as required.

1.03 RELATED WORK IN OTHER SECTIONS

Potable Water System ..... Section 02713
Storm Drainage System ..... Section 02721

1.04 SUPPLEMENTS: All excavated material shall be unclassified regardless of its composition, whether soil, solid rock, asphalt pavement, concrete, rubbish or other material.

The installation and removal of sheeting shall be done in a manner that will not cause settlement or disturbance of the pipe cradle material.

All existing ground, roadways and other improvements damaged, destroyed or disturbed shall be, at the Contractor's expense, replaced, reconstructed and restored in kind to an equal or better condition satisfactory to the Engineer.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Materials for roads shall be in accordance with the following sections of the Standard Specifications, as revised, except as amended on the plans and/or in the specifications herewith:

Trench Excavation and Backfill ..... Section 11

B. Trench Backfill: Trench backfill shall consist of well-graded processed material generally less than 3 inches in size and no greater than 6 inches in maximum size to reduce the potential of damage to the utility lines.

C. Pipe Cushion: Pipe cushion shall consist of No. 3B fine gravel as described by ASTM C33 (No. 67 gradation).

PART 3 - EXECUTION

3.01 TRENCH BOTTOM: Should the trench bottom be within 2 feet of the clayey site (volcanic ash) material, the trench shall be overexcavated to provide 2 feet of select granular material under the bottom of the trench. Suitable material shall be select granular material or crushed rock required by the particular utility company and installed as specified herein.

3.02 PLACEMENT AND COMPACTION: Trench backfill shall be moisture-conditioned to above the optimum moisture, placed in level lifts not exceeding 8 inches in loose thickness and compacted to a minimum of 90 percent maximum dry density. In pavement areas the upper 2 feet of trench backfill below the pavement subgrade shall be compacted to 95 percent maximum dry density. Compaction shall be in accordance with ASTM D1557-91.

Compaction shall be performed by rolling with equipment well-suited to the soil being compacted. Material shall be moistened or aerated as necessary to provide the optimum moisture content that will readily facilitate obtaining the specified compaction with the equipment used. When subgrades are less than the specified density, the ground surface shall be broken up to a minimum depth of 6 inches, pulverized, and compacted to the specified density. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 6 inches and compacted as specified for the adjacent fill. Each layer shall be compacted as specified for the adjacent fill.

END OF SECTION

SECTION 02230 – FINE GRADING OF ROADWAY PRISM

PART 1 – GENERAL

1.01 GENERAL CONDITIONS: The General Conditions and Special Conditions preceding these specifications shall govern this section of the work.

1.02 WORK INCLUDED: Furnish all labor, materials, services, equipment and related items necessary to excavate and grade the roadway prism necessary to install curbs, gutters, sidewalks and pavement structure. Work shall be governed by Section 12, Roadway Excavation, and Section 30, Select Borrow for Subbase Course, of the Standard Specifications.

1.03 RELATED WORK IN OTHER SECTIONS

Temporary Soil Erosion Control..... Section 02270

1.04 SUBSURFACE SOIL DATA: Subsurface soil investigations have been made at the project site. A copy of the complete reports entitled "Preliminary Geotechnical Exploration Report – Keokea-Waiohuli Development Project, Kula, Keokea, Maui, Hawaii," dated March 31, 2005 and "Preliminary Geotechnical Exploration Report – Keokea-Waiohuli Subdivision Phases 1, 2, and 4A, Kula, Makawao, Maui, Hawaii," dated April 5, 2013 prepared by PSC Consultants LLC are available with these bid documents. Test pit and boring logs are shown in the soils report.

The Contractor is expected to examine the site and the record of soil investigation and decide for himself the character of materials to be encountered. The Engineer will not assume responsibility for variations of subsoil quality or condition at locations other than places shown and at the time investigations were made.

1.05 PROTECTION

A. Erosion Control: The Contractor shall incorporate into his work schedule the Temporary Erosion Control Measures and the Permanent Erosion Control procedures indicated on the plans and as specified in the contract.

B. Dust Control: Every effort shall be made by the Contractor to keep dust to a minimum. Spraying the ground with water or other means of control shall be used wherever possible. The Contractor shall have an adequate supply of water for moisture conditioning of fill material.

Without limiting the generality or applicability of other indemnity provisions of the contract, the Contractor agrees that he shall indemnify and hold harmless the Department from and against all suits, actions, claims, demands, damages, costs and expenses (including but not limited to attorney's fees) arising out of any damage to any property whatsoever or injury to any person whomsoever, in any way caused or contributed to by dust from the Contractor's operations.

C. Existing Utilities and Work Areas: The Contractor shall be responsible for the protection of existing surface and subsurface utilities and poles within and abutting the project site, trench excavations and other work areas.

D. Finished Grades and Subgrades: All subgrades shall be kept moist until covered by subbase, base course, or concrete. All finished grades shall be kept moist until covered by landscaping or other permanent groundcover. Where shrinkage cracks are noted after compaction of the subgrade or finished grade, the subgrade or finished grade shall be rescarified, moisture-conditioned to above the optimum moisture content, and recompacted to the specified requirement at no additional cost to the Department. During construction, the Contractor shall properly grade and maintain all excavated surfaces to provide positive drainage and prevent ponding of water. In the event that ponding of water causes softening of the subgrades, the Contractor shall remove the soft soils and shall backfill the excavation with compacted fill at no additional cost to the Department.

PART 2 – PRODUCTS

2.01 MATERIALS

A. General Fill: On-site material excavated from within the project limits and meeting the requirements for embankment may be utilized as fills unless otherwise recommended by the Geotechnical Engineer during construction.

B. Select Granular Fill: Select granular fill required below roadways shall consist of non-expansive, select granular material, crushed coral to be consistent with the material installed under the separate mass grading contract. The material shall be well-graded from coarse to fine with no particles larger than 3 inches in largest dimension. It shall also contain between 10 and 30 percent particles passing the No. 200 sieve. The material shall have a laboratory CBR value of 25 or higher and a swell potential of 1 percent or less when tested in accordance with ASTM Test Designation D1883. If available, coralline material processed from the designated borrow site may be used. Free-draining materials and highly permeable materials shall not be used as select granular fill. Select granular fill material shall be tested by the Geotechnical Engineer for conformance with these requirements prior to delivery to the project site for the intended use.

PART 3 – EXECUTION

3.01 GRADING ROADWAY PRISM

A. Notification of Schedule: The Construction Manager shall be notified by the Contractor at least two weeks in advance before grading operations are scheduled to begin. Further, the Contractor shall advise the Construction Manager of the proposed overall schedule for the grading operations.

B. General: All cuts and fills to be constructed shall be monitored by a licensed geotechnical consultant (soils engineer) retained by the Department, who shall approve all subgrade preparation, fill material, methods of placing and compaction and perform field density tests during the grading. Written approval shall be issued upon completion of cuts and fills.

C. Preparation of Subgrades for Areas to Receive Fill: Firm Competent Soils: The surface to receive fill shall be scarified to a depth of about 6 inches until free of large clods,

moisture-conditioned to at least 2 percent above the optimum moisture content and compacted to at least 95 percent of the maximum dry density established by ASTM D1557-91.

D. Soil Fill Placement and Compaction: After completion of the subgrade preparation, select granular fill materials shall be brought to at least 2 percent above the optimum moisture content, placed in level lifts not exceeding 8 inches in loose thickness, and compacted to a minimum of 95 percent of the maximum dry density established by ASTM D1557-91.

Each lift of fill shall be thoroughly compacted complete to the edge before the next layer is laid thereon. Compaction shall be obtained with the use of conventional compaction equipment designed for the intended purpose. The incidental compaction achieved by the passage of hauling units over the fill will not be considered adequate.

Each lift of fill material shall be brought to at least 2 percent above the optimum moisture content (above the optimum moisture content for the capping fill) to permit compacting the specified requirements. If the soil moisture content is too high or too low, the soil moisture content shall be adjusted by suitable means before placement. Compaction of each lift of fill shall be continued until the density as determined by field tests reaches a value of at least 95 percent of the maximum indicated by the aforementioned methods. In lieu of compacting the slope faces, embankments may be overfilled past the design slope and then cut back.

The finished subgrade below areas to receive asphalt concrete base course for pavements shall be scarified to a depth of 6 inches, moisture-conditioned to above the optimum moisture content, and compacted to at least 95 percent of the maximum dry density established by ASTM D1557-91.

E. Excavations: All excavation shall be made to the lines and grades as shown on the project plans. All excavation shall be inspected and approved by the Geotechnical Engineer. Where conditions encountered require, he shall direct the necessary modifications to be made.

Suitable material from excavation shall be used in the fill, and unsuitable material free of organic material from excavation shall be disposed of in the designated borrow site to replace material borrowed.

F. Drainage: Care shall be exercised during grading so that areas involved will drain properly. Water shall be prevented from running over the slopes by the temporary berms or drainage swales.

G. Field Testing: The Construction Manager shall be notified at least two days prior to the start of grading. A pre-grading conference shall be held between the parties involved so as to discuss methods of operations, site problems and scheduling. Field density tests shall be taken by the Geotechnical Engineer retained by the Department.

H. Supervision: At all times, the Contractor shall have a responsible field superintendent on the project in full charge of the work with authority to make decisions. He shall

cooperate with the Construction Manager in carrying out the work. Any instructions given to him by the Construction Manager shall be considered to have been given to the Contractor personally.

I. Rainy Weather: No fill shall be placed, spread or rolled during unfavorable weather. When the work is interrupted by rain, operations shall not be resumed until field tests by the Construction Manager indicate that conditions will permit satisfactory results.

3.02 UNSUITABLE EXCAVATED MATERIAL: The Contractor shall remove from the site all unsuitable excavated material unless specified otherwise by the Construction Manager. Unsuitable material containing organic material shall be disposed of off-site.

Removal, including hauling and disposal, of the unsuitable material will not be paid for directly, but shall be considered incidental to the project.

END OF SECTION

SECTION 02270 – TEMPORARY SOIL EROSION CONTROL

PART 1 – GENERAL

1.01 GENERAL CONDITIONS: The General Conditions and Special Conditions preceding these specifications shall govern this section of the work.

1.02 WORK INCLUDED: Submit three (3) sets of the erosion control materials for approval by the Engineer. Furnish all labor, materials, services, equipment and related items necessary to implement the temporary erosion control measures, submitted separately, as required by these specifications and as ordered by the Engineer during the life of the contract to control water pollution through the use of berms, dikes, dams, sediment basins, fiber mats, netting, gravel, mulches, grasses, slope drains, and other erosion control devices or methods.

A. Temporary erosion and siltation control measures as described herein shall be applied to any erodible material within this project, including local material sources and work areas.

B. The Contractor shall be responsible for providing the necessary erosion control measures which are shown on the plans or which may be ordered by the Engineer. All grading operations shall be performed in conformance with the applicable provisions of the "Water Pollution Control and Water Quality Standards" contained in the "Public Health Regulations," State Department of Health.

C. The Contractor shall be responsible for promptly (next day after storms) removing all silt and debris resulting from his work and deposited in drainage facilities, roadways, neighboring lands, and other areas.

1.03 RELATED WORK IN OTHER SECTIONS

Fine Grading of Roadway Prism..... Section 02230

PART 2 – PRODUCTS

2.01 MATERIALS

A. Mulches: To be bagasse, hay, straw, fiber mats, netting, wood cellulose, bark, wood chips, or other suitable material acceptable to the Engineer and shall be reasonably clean and free of noxious weeds and deleterious materials.

B. Slope Drains: To be constructed of fiber mats, plastic sheets, or other materials acceptable to the Engineer.

C. Catch Basin Inlet Filters: "True Dam" sediment filter (by Dandy Products, Inc.) or approved equal.

PART 3 – EXECUTION

3.01 TEMPORARY EROSION CONTROL

A. The Construction Manager has the authority to limit the surface area exposed by clearing and grubbing and to limit the surface area exposed by excavation, borrow and fill operations. The Construction Manager may also direct the Contractor to provide immediate, permanent, or temporary pollution control measures to prevent contamination of streams, drainage channels and pipes, roads, neighboring lands, and other areas.

Except for specified measures which may be shown on the plans, the Contractor shall determine the appropriate erosion control measures to use. Such work may involve the construction of temporary berms, dikes, dams, sediment basins, and slope drains, and the use of temporary mulches, mats, and grassing, or the construction and use of other control devices or methods as necessary to control erosion.

B. The Contractor shall incorporate all erosion control measures shown in the plans. The erosion controls may be modified as necessary to adjust to conditions that develop during construction. All modifications are subject to approval by the Engineer.

C. The Contractor shall limit the surface area exposed by grubbing, stripping of topsoil, and grading to that which is necessary for him to perform the next operation and which is within his capability and progress in keeping the finish grading, mulching, grassing, and other such pollution control measures current.

The grubbing of the vegetative root mat and stumps and the stripping of topsoil shall be confined within the limits of grading which can be actively and continuously prosecuted within 15 calendar days. The area to be graded shall be limited to the minimum area necessary to accommodate the Contractor's equipment and work force and shall not at any time exceed 15 acres, unless otherwise stated on plans, without prior approval of the Construction Manager.

Any area remaining bared or cleared for more than 10 calendar days and which is not within the limits of active construction shall be immediately hydro-mulch seeded or remedied as directed by the Engineer at the Contractor's expense without cost to the Department. All areas where finish grading has been completed shall be grassed within three calendar days after the completion of grading for that area.

D. The Contractor shall, at the end of each work operation in any one day, shape the earthwork in such a manner as to control and direct the runoff to minimize the erosion of soils. He shall construct earth berms along the top edges of embankments or along the property line with adjacent properties, streams and water channels, to intercept any runoff. Temporary slope drains shall be provided to carry runoff from the top of cuts and fills. Temporary facilities for controlled discharges shall be provided for runoff impounded, directed, or controlled by project activities or by any erosion control measure employed.

E. Cut slopes shall be shaped, topsoil added if necessary, and planted as the work progresses. In no case shall the exposed surface be greater than 15 feet in height. Whenever major excavation is suspended or halted and the slope is bared for more than

15 consecutive days, the exposed surfaces shall be hydro-mulch seeded or protected as directed by the Engineer at the Contractor's expense without cost to the Department of Hawaiian Home Lands.

Fill slopes shall be finished as specified and in accordance with the requirements outlined for cut slopes above.

F. Construction of berms, cofferdams, or other such construction in or near the vicinity of streams, ponds, waterways, or other bodies of water shall be with approved materials.

G. The temporary erosion and siltation control measures outlined in these specifications are minimum requirements and shall not preclude the provision of any additional measures which the Contractor may deem necessary. Damages caused by the erosion of soils and the pollution of downstream areas shall be the responsibility of the Contractor and all costs for repairing, correcting, replacing and cleaning damaged or polluted facilities shall be borne by the Contractor.

3.02 FIELD QUALITY CONTROL

Maintain the temporary and permanent vegetation, erosion and sediment control measures, and other protective measures in good and effective operating condition by performing routine inspections to determine condition and effectiveness, by restoration of destroyed vegetative cover, and by repair of erosion and sediment control measures and other protective measures. Use the following procedures to maintain the protective measures.

A. Silt Fence Maintenance

Inspect the silt fences in accordance with paragraph, titled "Inspections," of this section. Any required repairs shall be made promptly. Pay close attention to the repair of damaged silt fence resulting from end runs and undercutting. Should the fabric on a silt fence decompose or become ineffective, and the barrier is still necessary, replace the fabric promptly. Remove sediment deposits when deposits reach one-third of the height of the barrier. Remove a silt fence when it is no longer required. The immediate area occupied by the fence and any sediment deposits shall be shaped to an acceptable grade. The areas disturbed by this shaping shall be seeded.

B. Diversion Dike Maintenance

Inspect diversion dikes in accordance with paragraph, titled "Inspections," of this section. Pay close attention to the repair of damaged diversion dikes and accomplish necessary repairs promptly.

3.03 INSPECTIONS

Inspect disturbed areas of the construction site, areas that have not been finally stabilized used for storage of materials exposed to precipitation, stabilization practices, structural practices, other controls, and area where vehicles exit the site at least once every seven (7) calendar days and within 24 hours of the end of any storm that produces .5 inches or more rainfall at the site. Conduct inspections at least once every month where sites have been finally stabilized.

A. Inspection Details

Inspect disturbed areas and areas used for material storage that are exposed to precipitation for evidence of, or the potential for, pollutants entering the drainage system. Observe erosion and sediment control measures identified in the Storm Water Pollution Prevention Plan to ensure that they are operating correctly. Inspect discharge locations or points to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters. Inspect locations where vehicles exit the site for evidence of offsite sediment tracking.

B. Inspection Reports

For each inspection conducted, prepare a report summarizing the scope of the inspection, name(s) and qualifications of personnel making the inspection, the date(s) of the inspection, major observations relating to the implementation of the Storm Water Pollution Prevention Plan, maintenance performed, and actions taken. Furnish the report to the Contracting Officer within 24 hours of the inspection as a part of the Contractor's daily CQC REPORT. A copy of the inspection report shall be maintained on the job site.

END OF SECTION

SECTION 02271 - SPECIFICATIONS FOR GRASSING

PART I - GENERAL

1.01 GENERAL DESCRIPTION: The Contractor shall provide all materials, equipment and labor necessary to complete the work. Slope control planting shall consist of hydro-mulch seeding with vegetative cuttings as required, fertilizing graded and disturbed areas, and shall include continuous care and maintenance in accordance with these specifications.

1.02 MATERIALS:

Seed: Seed quality shall have a minimum purity of 97 percent, minimum germination of 85 percent and weed content not exceeding 1/2 percent.

Fertilizer: Commercial fertilizer generally used for hydro-mulching shall be 13-34-10 pelletized fertilizer or equal during the grassing operation and the maintenance period. However, it shall be the responsibility of the Contractor to decide the analysis and ratio, quantity, method and frequency of application to ensure sufficient nutrients for the sustained growth of the grasses specified.

Mulch: Mulch for hydro-mulching shall be specially processed fiber containing no growth or germination inhibiting components. After addition and agitation in the hydraulic equipment with fertilizers, grass seed, water and other additives not detrimental to plant growth, the fibers shall form a homogeneous slurry. When hydraulically sprayed on the soil, the fiber shall form a blotter-like ground cover which readily absorbs water and allows infiltration to the underlying soil. Mulch shall be applied at the minimum rate of 1,500 pounds per acre.

Water

A. The Contractor shall furnish and pay for all water required for planting and during period of maintenance.

B. The Contractor shall furnish all labor, materials and equipment necessary to install all temporary water lines, valves, etc., and upon completion of the work shall remove all such equipment.

1.03 PLANTING METHODS:

Soil Preparation

A. The top layer of soil on the slope face shall be fertile and shall permit a normal growth of grass. It shall be free of extraneous materials harmful to plant growth.

B. Slope areas incapable of supporting plant growth shall have topsoil spread and compacted prior to grassing operations.

C. The soil profile shall be wetted to a depth of 4 to 6 inches.

Fertilizing: Apply fertilizer evenly onto the soil surface at the minimum rate as required by analysis.

Planting by Hydro-Mulching

A. Broadcast stolons at a minimum rate of 4 bushels per 1,000 square feet.

B. Apply the seed, fertilizer and mulch with approved hydraulic equipment using seed at a minimum rate of 3 pounds per 1,000 square feet and mulch at a minimum rate of 1,500 pounds per acre.

C. Areas inaccessible to hydro-mulching applications shall be seeded, fertilized and mulched by approved hand methods.

1.04 MAINTENANCE:

Initial: Maintenance shall commence simultaneously with hydro-mulching operations and includes watering, fertilizing, insect and disease control and protection.

Watering

A. After planting, the ground shall be continuously kept moist for the first 14 days.

B. When the grass begins to cover, reduce the frequency of watering and increase the length of the watering period.

C. Watering shall be done in a manner that will prevent erosion due to excessive application of water. Watering equipment shall be of a type that will prevent damage to the planted areas.

D. The Contractor shall repair erosion caused by excessive rainfall or watering, at no cost to the Owner.

Insect and Disease Control: Regular inspections shall be made; if required, suitable insecticide or fungicide treatment shall be applied.

Protection: Planted areas shall be protected against traffic by providing proper safeguards as needed. Repair and replant damaged areas promptly.

Repair: The Contractor shall replant and fertilize areas failing to show sufficient growth to produce a satisfactory stand of grass at the time of final inspection.

1.05 ACCEPTANCE: Maintenance of the plant material shall continue until 90 percent minimum plant coverage is uniformly established and the work is approved and accepted by the Construction Manager and the Department.

END OF SECTION

SECTION 02510 – ASPHALT CONCRETE PAVEMENT

PART 1 – GENERAL

1.01 GENERAL CONDITIONS: The General Conditions and Special Conditions preceding these specifications shall govern this section of the work.

1.02 WORK INCLUDED: Furnish all labor, materials, tools, equipment and related items necessary to complete, in place, asphalt concrete pavement for roads in conformity with the dimensions, profiles, sections and details shown on the plans.

1.03 SUBMITTALS: The Contractor shall submit for approval, the job mix formula for the asphalt concrete to be supplied for the project. The job mix formula shall indicate the source of aggregates and grades of bituminous material to be used in the mix. The total amount of bituminous binder in the mix shall be between 4.5 percent to 8.0 percent by weight depending on the specified Asphalt Concrete Mix. All test data used to develop the job mix formula shall also be submitted. The job mix formula for the mixture shall be in effect until modified in writing by the Engineer. Should a change in sources of materials be made, a new job mix formula shall be established and approved before the new material is used.

The bituminous mixtures shall be designed using procedures contained in Chapter III, Marshall Method of Mix Design, of the Asphalt Institute's Manual Series No. 2 (MS-2), current edition, and shall meet the requirements of Table I below:

TABLE I
REQUIREMENTS FOR MARSHALL METHOD OF MIX DESIGN

Test Property	Mix #2	Mix #3	Mix #4	Mix #5
Number of Blows	75	75	75	75
Stability, lb (minimum number)	2,000	2,000	2,000	2,000
Flow, 0.01 in.	8 - 16	8 - 16	8 - 16	8 - 16
Percent air voids	4 - 6	4 - 6	4 - 6	4 - 6
Percent air voids in mineral aggregate (min.)	13	14	16	18

The job-mix formula for each mixture shall establish a single percentage of aggregate passing each required sieve size and a single percentage of bituminous material to be added to the aggregate.

After the job-mix formula is established, all mixtures furnished for the project shall conform thereto within the following ranges of tolerances in Table II below:

TABLE II
RANGE OF TOLERANCES FOR JOB-MIX FORMULA

Passing No. 4 and larger sieves	± 7 percent
Passing No. 8 to No. 100 sieves (inclusive)	± 4 percent
Passing No. 200 sieve	± 2 percent
Bitumen	± 0.4 percent

Acceptance Sampling and Testing of the Bituminous Mixture.

A. The Contractor shall provide laboratory testing for control and acceptance functions during periods of mixture productions: One (1) field Marshall Test, asphalt content test, gradation analysis, and specific gravity test for each mixture.

B. The compacted mixtures of the in-place pavement shall not be less than 91 percent of the specific gravity (ASTM D2041, commonly called the Rice Method) of the combined mixture without voids.

C. Two (2) core or cut samples per street for the determination of the thickness and density of the completed pavements (or using nuclear gauge for determination of density) shall be obtained and/or tested by the Contractor at no extra cost (including that to restore the affected area). The size and locations of the samples will be directed by the Engineer.

D. All data for the control and the acceptance testing shall be submitted.

PART 2 – PRODUCTS

2.01 MATERIALS: Materials for roads shall be in accordance with the following sections of the Standard Specifications, except as amended on the plans and/or in the specifications herewith:

Roadway Excavation ..... Section 12
Subgrade ..... Section 29
Aggregate Subbase Course ..... Section 30
Aggregate Base Course ..... Section 31
Asphalt Surface Treatments ..... Section 33
Asphalt Concrete Pavement, Mix No. 3 or 4 ..... Section 34
Standard Street Survey Monuments ..... Section 49

Asphalt cement grade shall be PG 64-16.

PART 3 – EXECUTION

3.01 INSTALLATION: Stake out the areas to be paved using wooden stakes on which the final finish elevations, base course and subgrade elevations are clearly marked. All stakes and elevations shall be approved by the Engineer before any work is done.

Contractor shall fine grade the subgrade under the pavement and swales by bringing the subgrade to the proper grade from the mass grade elevations to the proper shape before installing the subbase course.

Install roadways in accordance with the applicable sections noted hereinbefore.

3.02 COMPACTION TESTING: The Contractor shall notify the Engineer at least 5 days prior to the start of fine grading for the roadway subgrade. Field density tests will be taken on the roadway subgrade, and aggregate subbase and base course by the Geotechnical Engineer retained by the Department. The Contractor shall be responsible for any corrective measures required as a result of inadequate compaction.

3.03 CLEANING OF SURFACES: Immediately before applying the prime coat or tack coat, the surface to be treated shall be swept clean of all loose material, dirt, excess dust or other objectionable material. No application shall be permitted when the surface to be treated is appreciably damp or when weather conditions are unsuitable.

Apply asphalt surface treatments at the rates specified in Section 33 of the Standard Specifications.

3.04 ADJUSTMENT OF EXISTING UTILITY STRUCTURES TO FINISHED GRADE: Adjust existing utility structures to finished grade in accordance with Section 36 of the Standard Specifications.

3.05 REPAIRS OF EXISTING ASPHALT CONCRETE PAVEMENTS: Repair to the original conditions and to the satisfaction of the Engineer all existing asphaltic concrete pavements that have been damaged by construction activities, including damage done by heavy equipment.

3.06 PLACING ASPHALT CONCRETE PAVEMENT: Install asphalt concrete pavement as specified in Section 34 of the Standard Specifications.

END OF SECTION

SECTION 02513 - PORTLAND CEMENT CONCRETE PAVEMENT

PART 1 - GENERAL

1.01 GENERAL CONDITIONS: The General Conditions and Special Provisions preceding these specifications shall govern this section of the work.

1.02 WORK INCLUDED: Furnish all labor, materials, tools, equipment and related items necessary to complete, in place, Portland cement concrete pavement for roads in conformity with the dimensions, profiles, sections and details shown on the plans.

PART 2 - PRODUCTS

2.01 MATERIALS: Materials for Portland Cement Concrete Pavements shall be in accordance with the following sections of the Standard Specifications, except as amended on the plans and/or in the specifications herewith:

Roadway Excavation	Section 12
Subgrade	Section 29
Select Borrow for Subbase Course	Section 30
Portland Cement Concrete Pavement	Section 37
Portland Cement Concrete	Section 39
Reinforcing Steel	Section 48

A. Portland cement concrete shall be Class "AA" and conform to the provisions in Standard Specifications stated above.

B. Joint Sealer, ASTM D1190

C. Preformed Filler for Joints, ASTM D994 or D1751.

PART 3 – EXECUTION

3.01 INSTALLATION: Stake out the areas to be paved using wooden stakes on which the final finish elevations, subbase course, and subgrade elevations are clearly marked. All stakes and elevations shall be approved by the Engineer before any work is done.

Contractor shall fine grade the subgrade under the pavement and swales by bringing the subgrade to the proper grade from the mass grade elevations to the proper shape before installing the subbase course.

At the option of the Contractor, the Contractor may construct the pavement using fixed side forms or slip-form paving equipment.

The Contractor shall construct the pavement in accordance with the applicable sections noted hereinbefore.

3.02 COMPACTION TESTING: The Contractor shall notify the Engineer at least 5 days prior to the start of fine grading for the roadway subgrade. Field density tests will be taken on the roadway subgrade, and aggregate subbase course by the Geotechnical Engineer retained by the Department. The Contractor shall be responsible for any corrective measures required as a result of inadequate compaction.

3.03 PLACING PORTLAND CEMENT CONCRETE PAVEMENT: The Contractor shall construct the pavement with longitudinal keyed construction joints with tie bars, or longitudinal weakened plane contraction joints along the centerline and each edge of the travel way.

3.04 JOINTS: Contraction joints, expansion joints, and all longitudinal joints shall be placed as required in the contract or as ordered by the Engineer. Transverse construction joints shall be used as required. Transverse joints shall extend continuously through the pavement and shoulder sections. All joints shall be filled and sealed as required.

A. Transverse Contraction Joints: Transverse contraction joints shall consist of planes of weakness created by forming or cutting grooves in the surface of the pavement. They shall be equal to at least one-fourth the depth of the slab and evenly spaced approximately 15 feet.

B. Transverse Construction Joints: Transverse construction joints shall be placed whenever the placing of concrete is suspended for more than 30 minutes. A butt joint with smooth dowels shall be used if the joint occurs at the location of a contraction joint. Keyed joints with tie bars shall be used if the joint occurs at any other location.

C. Expansion/Isolation Joints:

1. Expansion joints shall be placed at road intersections, around concrete structures (catch basins, water manholes, electrical/telecommunication manholes), and block outs for utility poles and guardrails.

2. Isolation joints around concrete structures and block outs shall have deformed tie bars at each corner diagonally.

3. Expansion joints with dowels shall be located at intersections only.

4. Expansion joints without dowels shall be constructed at junctions of concrete pavement and rectangular structures.

5. Expansion joints shall consist of a vertical expansion preformed joint filler placed in a butt-typed joint. The expansion joint filler shall be continuous from form to form, shaped to the subgrade and to the keyway along the form. Preformed joint filler shall be furnished in lengths equal to the pavement width or equal to the width of the lane. Damaged or repaired joint filler shall not be used unless approved by the Engineer.

6. The expansion joint filler shall be held in a vertical position. An approved installing bar or other devices shall be used if necessary to ensure proper grade and alignment during placing and finishing of the concrete. Finished joints shall not deviate in horizontal alignment more than ¼ inch from a straight line. If joint fillers are assembled in section, there shall be no offsets between adjacent units. No plugs of concrete shall be permitted anywhere within the

expansion space.

D. Longitudinal Joints: Longitudinal joints shall consist of planes of weakness created by formed or cutting grooves in the surface of the pavement. They shall be equal to at least one-quarter the depth of the slab plus ½ inch.

Longitudinal construction joints shall be as required in the contract. Where a key is required, it shall be constructed by forming when the first lane adjacent to the joint is placed. These joints shall be finished with an edger of the radius shown in the Standard Details. When placing the second slab, concrete must not be left overhanging the lip formed in the first slab by the edging tool.

Longitudinal joints shall be located along the centerline of the road and along each edge of travel way.

E. Sealing Joints: All joints shall be sealed as required by the Standard Specifications and Standard Details.

END OF SECTION

SECTION 02577 - PAVEMENT STRIPING AND MARKINGS

PART 1 - GENERAL

1.01 GENERAL CONDITIONS: The General Conditions and Special Conditions preceding these specifications shall govern this section of the work.

1.02 WORK INCLUDED: Furnish all labor, materials and equipment required to accomplish the installation of all white and yellow traffic pavement striping and other markings in conformance to the "Manual on Uniform Traffic Control Devices for Streets and Highways," 2023, the "Traffic Standards Manual" of the Department of Transportation Services, July 1976, and these plans and specifications. This work shall also include the removing of existing pavement markers and removing or eradicating of existing pavement striping and markings when called for in the plans and/or directed by the Traffic Engineer.

1.03 SUBMITTALS: Submit material certifications, test results and brochures for all pavement markers and traffic paint materials to the Traffic Review Branch, Department of Planning and Permitting, City and County of Honolulu. A copy of the submittal shall be submitted to the Construction Manager.

PART 2 - PRODUCTS

2.01 GENERAL: Materials shall conform to the requirements of Pavement Markers, Adhesives for Pavement Markers, and Pre-Mixed Reflectorized White and Yellow Traffic Paint, as specified in these specifications.

2.02 MATERIALS

A. Pavement Markers

1. Description of Markers: The markers shall have the shape, dimensions and tolerances as shown on the plans. The markers shall be of uniform composition and free from surface irregularities, cracks, checks, chipping and other physical damage interfering with appearance or application.

2. Type of Markers

a. Type A - Non-Reflective White Markers and Type J Non-Reflective Yellow Markers.

1) Class III Ceramic Type. For use on Portland cement concrete and asphalt concrete road surfaces.

2) Class IV Ceramic Type. For use only on Portland cement concrete road surfaces.

3) The class of non-reflective white marker to be used shall be at the option of the Contractor, subject to the above limitations.

b. Type B - Two-Way Clear Reflective Markers

c. Type C - Red-Clear Reflective Markers

d. Type D - Two-Way Yellow Reflective Markers

e. Type E - Yellow-Clear Reflective Markers

f. Type G - One-Way Clear Reflective Markers

g. Type H - One-Way Yellow Reflective Markers

3. Markers

a. Non-Reflective Markers: Type A and J pavement markers shall have the following characteristics:

1) Composition of Markers: The composition of finished markers shall conform to the following: The Class III and IV pavement markers shall consist of a heat-fired, vitreous, ceramic base and a heat-fired, opaque, glazed surface to produce the properties required in these specifications. The markers shall be produced from any suitable combination of intimately mixed clays, shales, talcs, flints, feldspars, or other inorganic material which shall meet the properties herein required. The markers shall be thoroughly and evenly matured and free from defects which affect appearance or serviceability.

2) Properties of Markers: The properties of finished markers, Class III and Class IV, shall conform to the following:

a) Finish: The top surface of the marker shall be convex and the radius of curvature shall be between 3-1/2 inches and 6 inches except that the radius of the 1/2 inch nearest the edge may be less. Any change in curvature shall be gradual. The top and sides shall be smooth and free of mold marks, pits, indentations, air bubbles, or other objectionable marks or discolorations.

The bottoms of the ceramic markers shall be free from gloss or glaze and shall have a number of integrally formed protrusions approximately 0.050 inch projecting from the surface in a uniform pattern of parallel rows.

Each protrusion shall have a face parallel to the bottom of the marker. The area of each parallel face shall be between 0.01 and 0.065 square inches and the combined area of these faces shall be between 2.2 and 4.4 square inches.

The protrusions shall be circular in section.

The number of protrusions should be not less than 48 nor more than 200.

To facilitate forming and mold release, the sides of each protrusion may be tapered. This taper shall not exceed 15 degrees from perpendicular to the marker bottom. Markers manufactured with protrusions whose diameter is less than 0.15 inch may have an additional taper not exceeding 30 degrees from perpendicular to the marker bottom and extending not more than one-half the total height of the protrusion.

The overall height of the marker shall be between 0.68 to 0.80 inch.

b) Glaze Thickness: The thickness of the glazed surface shall be not less than 0.007 inch at any point located more than 1/4 inch from the edge of the marker circumference. The glaze thickness shall be measured on a fractured edge with a calibrated reticule of a microscope of at least 25 power.

c) Moh Hardness: The glazed surface of the marker shall have a hardness of a 6 minimum in the Moh hardness scale. This shall be determined relative to the mineral orthoclase which has a hardness of 6. With moderate hand pressure, it must be possible to scratch orthoclase with the marker but not possible to scratch the marker with the orthoclase.

d) Directional Reflectance (Type A markers only): The 45°, 0° directional reflectance of the marker when tested in accordance with ASTM E97, shall have the following values:

Glazed Surface.....75 minimum
Body of Marker .....65 minimum

The test on the glazed surface shall be made on the top of the convex surface of the marker. The test on the body of the marker shall be made on a flat surface of the marker from which the glaze has been removed by grinding with carborundum wheel.

e) Yellowness Index (Type A markers only): The yellowness index of the marker when tested in accordance with ASTM E313 shall have the following values:

Glazed Surface..... 0.07 maximum
Body of Marker ..... 0.12 maximum

The test on the glazed surface shall be made on the top of the convex surface of the marker. The test on the body of the marker shall be made on a flat surface of the marker from which the glaze has been removed by grinding with a carborundum wheel.

f) Color (Type J markers only): The chromaticity of the glazed surface of the marker shall be within the following limits:

Purity ..... 76 to 96 percent

Dominant Wave Length..... 579 to 585 mu

Total Luminous Reflectance
(Y value).....0.41 minimum

Chromaticity measurements shall be made in accordance with California Test Method No. 660.

g) Water Absorption: The average water absorption of the ceramic marker when tested in accordance with ASTM C373 shall not exceed 2.0 percent of the dry weight of the test piece.

h) Autoclave Test: The glazed surface of the marker shall not craze, spall or peel when subjected to one cycle at 100 psi for one hour of the autoclave test when tested in accordance with ASTM C424.

i) Strength Test: A random sample of five markers of each type and/or class used will be selected for the load test. Each Class III marker shall support a minimum load of 1,500 pounds and each Class IV marker shall support a minimum load of 750 pounds when the load is applied in the following manner: The base of the marker shall be made flat using plaster of paris or some other suitable material. Sufficient amount of material shall be applied to the base of the marker to fill the spaces around the protrusions up to the faces of the protrusions. The protrusions shall not protrude from the prepared finished base. The prepared marker shall be centered, base down, over the open end of a vertically positioned hollow metal cylinder. The cylinder shall be 1-inch high, with an internal diameter of 3 inches and a wall thickness of 1/4 inch. A load necessary to break the marker shall be

applied at a speed of 0.2 inch per minute to the top of the marker through a 1-inch diameter solid metal cylinder centered on the top of the marker. Failure shall consist of a breakage of the marker at a load of less than 1,500 pounds when applied to Class III markers or less than 750 pounds when applied to Class IV markers.

j) Sampling: Twenty markers selected at random will constitute a representative sample for each batch consisting of 10,000 markers or less. Forty markers will constitute a representative sample for lots consisting of more than 10,000 markers. The lot size shall not exceed 25,000 markers. However, if a batch represents less than 100 markers, the Engineer may delete sampling and may accept the markers based on certification of compliance and certified test results.

k) Tolerances

(1) Three test specimens shall be randomly selected from the sample for each test except as noted in (i) above, and tested for compliance in accordance with these specifications. Should any one of the specimens fail to comply with the requirements of these specifications, additional samples consisting of double the number of samples originally taken will be tested. The failure of any one of these additional samples shall be cause for rejection of the entire lot or shipment represented by the sample.

(2) At the discretion of the Engineer, a resample may be taken consisting of double the number of samples originally taken. Tolerances for resamples shall be in the same ratio as specified above

l) Packaging: Shipments shall be made in containers which are acceptable to common carriers and packaged in such a manner as to insure delivery in perfect condition. Any damaged shipments shall be replaced by the Contractor. Each package shall be clearly marked as to the name of the manufacturer, type, color, quantity enclosed, lot and/or batch number, and date of manufacture.

b. Reflective Pavement Markers: Reflective pavement markers shall be of the prismatic reflector type consisting of a methyl methacrylate or suitably compounded acrylonitrile butadiene styrene (ABS) shell filled with a mixture of an inert thermosetting compound and filler material.

The exterior surface of the shell shall be smooth and contain one or two methyl methacrylate prismatic reflector faces of the color specified.

The reflective lens shall not contain any voids or air space, and the back of the lens shall be metallized.

The shell shall be fabricated in a manner that will provide a mechanical interlock between the thermosetting compound and the shell. The thermosetting compound shall bond directly to the backside of the metallized lens surface.

The base of the marker shall be flat (the deviation from a flat surface shall not exceed 0.050 inch), rough textured and free from gloss or substances which may reduce its bond to the adhesive. The presence of a soft or resin-rich film on the surface of the base will be cause for rejection.

Reflective markers shall conform to the following requirements:

1) Optical Performance: The specific intensity of each reflective surface, when tested at 0.2 degrees angle of divergence, shall not be less than the following specified values:

Specific Intensity			
	Clear	Yellow	Red
0° Incidence Angle	3.0	1.5	0.75
20° Incidence Angle	1.2	0.60	0.30

NOTE:

a) Angle of Incidence. The angle formed by a ray from the light source to the marker and the normal to the leading edge of the marker face.

b) Angle of Divergence. The angle formed by a ray from the light source to the marker and the returned ray from the marker to the measuring receptor.

c) Specific Intensity. The mean candle power of the reflected light at a given incidence and divergence angle for each foot candle at the reflector on a plane perpendicular to the incidence light.

$$SI = \frac{(R_L)(D^2)}{I_L}$$

Where: SI = Specific Intensity

R_L = Reflected Light

I_L = Incident Light

D = Test Distance

d) Test Method: The markers to be tested shall be located with the center of the reflecting face at a distance of 5 feet from a uniformly bright light source having an effective diameter of 0.2 inch. The photocell receptor width shall be 0.05 inch and shall be shielded to eliminate stray light. The distance from the center of the light source aperture to the center of the photocell shall be 0.2l inch. If a test distance of other than 5 feet is used, the source and receptor shall be modified in the same proportion as the test distance.

2) Color: The color of the reflectors when illuminated by an automobile headlight shall be an approved clear, yellow or red color as required. Off-color reflection will constitute grounds for rejection.

3) Strength Requirements: A random sample of 3 markers shall be selected for the load test. The marker shall support a minimum load of 2,000 pounds as applied in the following manner: The marker shall be centered, base down, over the open end of a vertically positioned hollow metal cylinder. The cylinder shall be 1-inch high, with an internal diameter of 3 inches and a wall thickness of 1/4 inch. A load necessary to break the marker shall be applied at a speed of 0.2 inch per minute to the top of the marker through a 1-inch diameter solid metal cylinder centered on the top of the marker. Failure shall consist of either:

a) breakage or significant deformation of the marker at load of less than 2,000 pounds, or

b) significant delamination of the shell and the filler material regardless of the load required to break the marker.

4) Sampling: Six markers will be selected at random from each batch for testing. However, if a batch represents less than 100 markers, the Traffic Engineer may delete sampling and may accept the markers based on certification of compliance and certified test results.

5) Tolerances: Should any one of the samples selected for strength testing fail to comply with the strength requirements of these specifications, six (6) additional samples will be tested. The failure of any of these additional six (6) samples will be cause for rejection of the entire lot or shipment represented by the samples.

6) Packaging: Shipments shall be made in containers which are acceptable to common carriers and packaged in such a manner as to insure delivery in perfect condition. Any damaged shipments shall be replaced by the Contractor. Each package shall be clearly marked as to the name of the manufacturer, color, type, lot number, quantity enclosed, and date of manufacture.

B. Adhesive for Pavement Markers

1. General: The adhesives shall be furnished as two components. The adhesives are described as Standard Set Type and Rapid Set Type.

All adhesives shall have a white A epoxy component and a black B curing agent component, each packaged separately. The mixing ratio of Component A to Component B shall be one-to-one by volume. The color of the material when mixed shall be approximately that of Color Nos. 26132 to 21652 of Federal Standard No. 595-A. The Standard Set Type is a compositional specification, together with test requirements. The Rapid Set Type is based on laboratory test requirements only. No volatile solvents or thinners shall be present in the epoxy adhesives requirements.

2. Properties of the Adhesives: The adhesive shall have the following properties:

a. Pot Life: The pot life shall be 12 minutes maximum and 7 minutes minimum for Standard Set Type and 5 minutes minimum for Rapid Set Type when tested as follows at 77°F ± 3°F: Mix equal volumes of Components A and B in an 8-ounce, unwaxed paper cut 2 inches ± 1/4 inch at base to give a 170 grams ± 10 grams total mass. Mix 60 seconds ± 5 seconds before timing for pot life. Test with a tongue depressor with minimum stirring. Record the time the material becomes unusable as the pot life. With most materials this shall be approximately the time a hard lump forms in the center.

b. Shear Strength: When tested as follows, the shear strength shall be not less than 1,000 psi for Standard Set Type and 900 psi for Rapid Set Type.

Bond three concrete blocks 2 inch x 3-1/2 inch x 7 inch of 7-sack concrete together with the 7-inch sides parallel forming two areas of contact 3-1/2 inch x 3-1/2 inch by overlapping the blocks. The test specimen then has a base of two blocks and a second surface formed by the center block. Apply the adhesive to the contact surfaces and allow to cure for 24 hours at 77°F ± 3°F. Cap the base of the specimen with an approved capping compound and test at a load rate of 10,000 pounds per minute. A swivel type head must be used at the top of the testing press. Computations are based on a total area of 24.5 square inches (shear strength = total load/24.5).

c. Viscosity: The viscosity of each component when measured in a three-fourths filled standard round quart paint can shall be between 1.0×10^5 and 3.0×10^5 centipoises for Standard Set Type and 0.8×10^5 and 2.2×10^5 centipoises for Rapid Set Type when measured as follows: Stir the components vigorously for 30 seconds with a spatula. Remove entrained air by vigorously tamping and measure viscosity within 10 minutes after stirring. Use Brookfield Viscometer, Model RVT at 5.0 RPM with a Model C Brookfield Helipath Stand and Helipath TD Spindle having a crossarm length of 0.804 inch for Standard Set Type and T.E. Spindle for Rapid Set Type. Use weight included in spindle set. Component and ambient temperature is to be 77°F ± 3°F at time of measurement. Reading shall be taken at approximately the center of the vertical travel of the spindle.

d. Viscosity--Shear Ratio:

$$\frac{\text{Viscosity at 0.5 RPM}}{\text{Viscosity at 2.5 RPM}}$$

This ratio shall be 2.0 minimum for Standard Set Type and 1.8 minimum for Rapid Set Type for Component A and 1.9 minimum for Component B. Take the above viscosities at the same time and conditions as in subsection (C) above.

e. Bond Strength

1) Clean a 4 inch x 4 inch area on a flat surface of a concrete block made with 7-sack concrete and having a tensile strength in excess of 250 psi.

2) Use the equipment and load described in California Test Method No. 420. Condition test equipment, concrete and epoxy at test temperature for 24 hours before test.

3) Mix adhesive on a tin plate with a trowel or spatula for 60 seconds ±5 seconds. Immediately start timing, place adhesive on pipe cap and press firmly in place on concrete. Just before the required test time, insert the dynamometer hook into pipe cap.

4) After curing 3-1/3 hours for Standard Set Type and 25 minutes for Rapid Set Type at 77°F ± 3°F measured from the end of the mixing period, the bond strength shall be at least 200 psi.

f. Weight per Gallon, Pounds at 77°F ± 3°F (Standard Set Type).

Component A 11.5 - 11.8
Component B 11.7 - 12.1

Composition:

STANDARD SET TYPE	
Component A	Parts by Weight
Epoxy Resin[1]	100
Titanium Dioxide, TT-P-422, Type III or IV	7.31
Resin Grade Asbestos[2]	5.00
Talc[3]	37.64
Component B	
N-Aminoethyl Piperazine[1]	23.16
Nonylphenol[5]	52.00
Carbon Black, TT-P-343, Form 1, Class B	0.22
Talc[3]	77.37
Resin Grade Asbestos[2]	1.00

[1]Viscosity, 5-7 poises at 25°C; epoxide equivalent 175-195; Color (Gardner), 5 maximum; manufactured from epichlorohydrin and bisphenol A. The reactive diluent shall be butyl glycidyl ether.

[2]Specific gravity, grams per ml., 2.45; moisture content, % by weight, 2.0 maximum; surface area, square meters per gram, 60 approximately; reflectance, G.E. brightness, 72-76; nature of surface charge, electropositive (cationic); Ph in water, 9.5; bulking value, gallons per 100 lbs., 4.8; oil absorption (DOP), pound per 100 lbs., 120; refractive index, n_d 25°C, 1.54-1.56; wet bulk density in water, after dispersion, 2 grams per liter, settling after 1 hr., 100 ml. clear maximum; dry bulk density, pounds per cubic foot, 4.

[3]Percent passing U. S. No. 325 sieve, 94-96; maximum particle size, 70 microns, oil absorption (Gardner-Coleman), 6-7 ml. per 20 grams; fineness in oil (Hegman) 1-2; specific surface, 0.5-0.6 square meter per gram; consistency (40% suspension in linseed oil) 55-60 KU.

[4]Color (ALPHA) 50 maximum; amine value 1250-1350 based on titration which reacts with the three nitrogens in the molecule; appearance clear and substantially free of suspended matter.

[5]Color (ALPHA) 50 maximum; hydroxyl number 245-255; distillation range, °C at 760 mm first drop 295 minimum, 5% 298 minimum, 95% 325 maximum; water, % (K.F.) 0.05 maximum.

g. Directions for use

Any settling of fillers or pigments in Components A or B shall be completely redispersed to provide a homogeneous mix before the components are used. Just before use, Components A and B shall be mixed in a one-to-one ratio by volume.

When the Rapid Set Type adhesive is used, the components shall be mixed by a 2-component type automatic mixing and extrusion apparatus. The temperature of the Rapid Set Type adhesive shall be maintained at 65°F to 85°F before mixing. The temperature of the Standard Set Type adhesive shall be maintained at 60°F to 100°F before mixing. Any heating of epoxy adhesive shall be done by the application of indirect heat.

Packaging and Labeling of Adhesive: Each adhesive component shall be packaged in containers not larger than 5 gallons in volume. The containers shall be new steel, not less than No. 24 gage and shall otherwise meet Interstate Commerce shipping standards. Each container shall be clearly labeled with designation (Component A or B), type (Standard or Rapid Set), manufacturer's name, date of manufacture, batch number (a batch shall consist of a single charge of all components in a mixing chamber), directions for mixing, and the following warning:

CAUTION

> This material will cause severe dermatitis if it is allowed to come in contact with the skin or eyes. Use gloves and protective creams on the hands. Should this material contact the skin, wash thoroughly with soap and water. Do not attempt to remove this material from the skin with solvents. If any gets in the eyes, flush for 10 minutes with water and secure immediate medical attention.

Sampling: One quart sample of each of the components (A and B) from each batch will be sampled for testing.

Certification: The Contractor shall submit to the Engineer a certificate of compliance indicating that all types of adhesives conform to the requirements of the specifications.

C. Pre-Mixed Reflectorized White and Yellow Traffic Paint

1. General: Qualification of Reflectorized Traffic Paint: Only those traffic paints which have qualified in the latest completed prequalification tests conducted by the State Department of Transportation and having a Weighted Rating (W) of at least 6.5 for reflectorized white and 7.0 for reflectorized yellow at the completion of the road test will be permitted for use on this project. Quick dry paints shall not be used.

   The phrase "latest completed prequalification tests" shall mean either those traffic paints which have been prequalified by the State Department of Transportation at the time this contract becomes effective or those traffic paints which have been listed by the State Department of Transportation as meeting the prequalification tests of the State Department of Transportation at the time the Contractor is doing pavement striping. The Traffic Engineer will furnish a list of prequalified traffic paints upon the request of the Contractor.

   The Contractor may use other materials designed for pavement striping, such as adhesive striping, on temporary detours with the approval of the Traffic Engineer. Such materials shall meet the color and reflection requirements for traffic paints.

2. Pre-Mixed Reflectorized White and Yellow Traffic Paint

   a. General: The pre-mixed reflectorized white and yellow traffic paints shall be composed of a pigment binder and glass spheres and shall be suitable for use as traffic markings on concrete, bituminous macadam and asphalt concrete pavements. These paints shall be ready for use without any subsequent addition of glass spheres or solvent. The white paint shall be pure white and free from tint. The yellow paint shall be within the green and red tolerance limits when compared with U. S. Federal Highways Administration's "Standard Color Chips for Highways Signs."

      The term "pre-mixed reflectorized" shall refer to the finished mixture of pigmented binder and glass spheres. The terms "pre-mixed compound" and "compound" shall mean the same thing. The term "binder" shall refer to the pigment and vehicle alone (not including glass spheres). The term "spheres" shall refer only to the glass spheres incorporated in the compound.

      The pre-mixed reflectorized white and yellow traffic paints shall be mixed at the factory ready for immediate application, using spray machines without thinning, at the normal rate of application used for these purposes by the Department of Transportation Services.

      The traffic paints shall be well-ground and mixed. The paints shall not exhibit any characteristics of skinning, settling, thickening, or livering. The paints shall be readily mixed to a uniform consistency, capable of

being applied through the spray machine without clogging or causing other operational difficulties. The mixing of the paint shall be performed in the normal manner followed by the Department of Transportation Services.

The paint shall be capable of drying to an elastic adherent finish and shall not show appreciable discoloration with age. The volatile material shall have a minimum solvent action on asphalt and be of such character that any gums and nonvolatile components of the vehicle will entirely dissolve therein and not precipitate from the solution on standing. The paints shall be of such quality that a dry film thereof will not darken or otherwise discolor excessively when exposed to sunlight.

b. Tests: In addition to the above-mentioned requirements, the pre-mixed reflectorized white and yellow traffic paints shall conform to the following requirements:

1) Composition: The composition, formulation, and milling of the paints shall in all respect be identical to the sample and manufacturer's certificate of formulation thereof submitted in accordance with the Department of Transportation Services' requirements.

2) Consistency: This test shall be performed in accordance with ASTM D562. The paint, as received, shall have a consistency as determined by the Stormer Viscosimeter and expressed as Krebs units at 77°F between 75 and 90.

3) Wet Hiding Power: When applied with a 0.008 inch Bird Film Applicator on Standard Morest Black and White Hiding Power Chart, Form 05, as supplied by the Leneta Company, P. O. Box 86, Ho-ho-kus, New Jersey 07423, the paint shall completely hide black.

4) No Pickup Time: The paint shall be tested in accordance with ASTM D711, except that the wet film shall be applied to the glass with a 0.005 inch Bird Film Applicator. The drying time for no pickup shall be not less than 5 minutes or more than 40 minutes.)

5) Chemical Analysis: The Department of Transportation Services shall have the option to perform a chemical analysis of said paints to determine if the paints conform with the manufacturer's certificate of formulation and that they are identical with the sample of paint submitted for prequalification test under the latest "Notice to Prospective Bidders for Furnishing Traffic Paint." (The Department of Transportation Services retains the right to check formulation by any approved method.

6) Weight per Gallon: The paint supplied by the successful bidder shall be within ±0.5 Department of Transportation Services prior to installation of materials.

7) Glass Spheres: The glass spheres used in the compound shall be colorless, clean and transparent, free from milkiness and air bubbles. Not more than 20 percent of the glass spheres shall be irregular or fused spheroids when tested in accordance with the method used by the Department of Transportation Services.

8) Glass Spheres Content: There shall not be less than 4.00 pounds of glass spheres per gallon of finished pre-mixed reflectorized traffic paint.

9) Gradation of Spheres: Glass spheres shall meet the following gradation when tested in accordance with ASTM D1214, using U. S. Standard Sieves:

Sieve Size	Percent Passing
#40	100
#50	90 - 100
#100	20 - 75
#200	0 - 15

c. Packing: Marking and Batching: The paints shall be delivered in clean open-head steel drums. Each container shall bear a label with the following information shown thereon: Name and address of the manufacturer, shipping point, trademark or trade name, kind of paint, formula, number of gallons, date of manufacture and batch number.

All paint pails shall have a positive and permanent seal.

d. Sampling and Testing: The Contractor shall furnish paint samples from each paint batch to an independent testing laboratory. At least two samples from each batch consisting of one quart each in sealed containers will be used for testing.

No paint shall be used or paid for except as authorized by the Traffic Engineer until laboratory tests (excluding the laboratory test for settling) are completed, or if the paint fails to meet the requirements of these specifications.

D. Preformed Pavement Markings

1. General: The preformed pavement marking tape shall consist of a film with glass beads on a conformable backing precoated with a pressure sensitive adhesive. The tape shall be capable of being adhered to asphalt concrete or Portland cement concrete without the use of heat, solvents or other additional adhesive means, and shall be immediately ready for traffic after application.

   The size, quality and refractive index of the glass beads shall be such that the performance requirements as specified herein are met. The beads shall not be easily removed when the material surface is scratched with a thumbnail.

   The preformed pavement marking tape shall contain selected pigments blended to provide standard highway colors of white or yellow. The tape shall maintain a uniform color under both daylight and night lighting conditions throughout its expected life.

   Preformed works and symbols shall conform to the applicable shapes and sizes outlined in the latest edition of the FHWA publication, "Manual on Uniform Traffic Control Devices for Streets and Highways" (MUTCD), as amended.

   When stored in a cool, dry area indoors, the tape shall be suitable for use a minimum of one year after the date of purchase.

2. Classification: Preformed pavement marking tape shall be of various types and compositions and for applications as specified as follows:

   a. Temporary Preformed Pavement Marking Tape: Temporary tape shall be capable of performing for the duration of a normal construction period and shall then be capable of being removed intact or in large pieces.

   b. Permanent Preformed Pavement Marking Tape

      1) Type I permanent tape shall be durable and capable of performing as specified herein when subjected to a high traffic volume and severe wear conditions such as repeated shear action from crossover and stop, start, or turn movements. Removal should not be easy.

      2) Type II permanent tape shall be used for highway edge of pavement lines. The tape shall be capable of performing satisfactorily when subjected to low traffic volumes, less severe wear action than for Type I, and primarily free rolling traffic.

      3) Type III permanent tape shall be used for symbols, legends and intersection markings such as stopbars and crosswalks in areas of high wear or as needed.

3. Reflectance: The films shall have the following initial minimum reflectance value of 0.2 degree and 0.5 degree observation angles and at an entrance angle of

86 degrees as measured in accordance with the testing procedure of Federal Test Method Standard 370. The photometric quantity to be measured shall be specific luminance (SL), and shall be expressed as millicandelas per square foot per foot candle (mcd/ft.^{2}/fc).

INITIAL MINIMUM REFLECTANCE VALUE

		Specific Luminance (mcd/ft.^{2}/fc)			
		White		Yellow	
Observation Angle Classification		0.26°	0.5°	0.2°	0.5°
Temporary		1770	1270	1310	810
Permanent	Type I	550	380	410	250
	Type II	960	760	680	510
	Type III	550	380	410	250

The sample size shall be 2.0 feet x 2.5 feet and the test distance shall be 50 feet. The angular aperture of both the photoreceptor and light projector shall be 6 minutes of arc. The reference center shall be the geometric center of the sample, and the reference axis shall be taken perpendicular to the test sample.

4. Skid Resistance: The surface of the preformed pavement marking tapes shall provide an initial minimum skid resistance value of 45 BPN when tested in accordance with ASTM E303.

5. Temporary Preformed Pavement Marking Tape

   a. Composition: The tape shall be a highly reflective, conformable, pliant polymer material intended for marking applications where removability is required.

      The tape shall consist of a mixture of high quality polymer materials and pigments and shall not contain metallic foil. Glass beads shall be distributed throughout the pigmented area and in a reflective layer bonded to the top surface. The performance of the glass beads shall meet the durability and reflectance criteria specified herein.

      The tape shall be reinforced with a non-metallic medium and shall be precoated with a pressure sensitive adhesive.

      The tape shall be capable of adhering to roadway surfaces under climatic and traffic conditions normally encountered in the construction work zone. Newly applied tape shall be capable of being immediately exposed to traffic without pickup or distortion by vehicles.

b. Thickness: The film without adhesive shall have a minimum thickness of 0.03 inch (0.76 mm).

c. Removability: The tape shall be removable from asphalt cement concrete or Portland cement concrete, either manually or with a roll-up device, at temperatures about 40°F (4°C), and without the use of heat, solvents, grinding or sandblasting. The tape shall meet this requirement even after traffic exposure on transverse applications in accordance with the following:

1) Time in place - 632 days
2) ADT per lane - 9,000 (23% trucks, 3.5 axles/unit)
3) Minimum axle hits - 13,000,000

6. Permanent Preformed Pavement Marking Tape

a. Type I

1) Composition: Tape shall consist of a mixture of high quality polymeric materials, pigments and glass beads, with a reflective layer of beads bonded to the top surface.

2) Thickness: The film without adhesive shall have a minimum thickness of 0.06 inch (1.52 mm).

3) Conformability and Patchability: The tape shall be conformable to pavement contours, breaks, faults, etc., through the action of traffic at normal pavement temperatures. Worn or missing areas shall be reparable with butt spliced patches of the same material.

4) Tensile Strength and Elongation: The tape shall have a minimum tensile strength of 40 pounds per square inch and minimum elongation of 75 percent at break when tested in accordance with ASTM D638. The sample size shall be 6 inches x 1 inch and shall be tested at a temperature between 70°F and 80°F with a jaw speed of 10 to 12 inches per minute.

5) Reflectivity Retention: Glass beads shall be strongly bonded and not easily removed by traffic. The tape shall be tested for reflectivity retention as follows:

(a) A sample 2 inches x 6 inches shall be bent around a 1/2-inch diameter mandrel with the 2-inch dimension perpendicular to the mandrel axis. Examination of the area with 5x magnifier shall show less than 10 percent of the beads with 40 percent or less embedment in the binder.

(b) Taber Abraser Simulation Test: Using a Taber Abraser with an H-18 wheel and a 125 gram load, a sample shall

be tested for 200 cycles and then inspected with a magnifier of 5-power or larger.

No more than 15 percent of the beads shall be lost due to popout and bead erosion shall be the major mode of failure.

6) Effective Performance: The tape shall be neat and durable and shall not flow or distort due to temperature or vehicle impacts. The pliant polymer shall provide a cushioned, resilient substrate that shall reduce bead crushing and loss for the life of the marking. The film shall be weather resistant and shall show no appreciable fading, lifting or shrinkage throughout its usage. The tape shall show no significant tearing, roll back, or other signs of poor adhesion during its useful life which shall be a minimum of one year from the date of installation.

Immediately after application, the tape shall be capable of being impacted by vehicles without being picked up or distorted.

b. Type II

1) Composition: The retroreflective pavement marking material shall consist of glass beads embedded in a white or yellow film with a thin, flexible conformable backing which is precoated with a pressure sensitive adhesive.

2) Thickness: The film with adhesive shall have a minimum thickness of 0.025 inch (0.64 mm).

3) Abrasive Resistance: Samples of test material shall not wear through to the conformable backing surface in less than 400 cycles when tested in accordance to Federal Test Method Standard 141, Method 6192, except using an H-22 wheel and a 250 gm load.

4) Acid Resistance: The beads shall show resistance to etching, hazing or delamination of bead surface after exposure to a 1 percent solution of sulfuric acid. The test shall be performed as follows:

Soak one gram of beads in 100 cc of a 1 percent H_2SO_4 solution for 100 hours. Then decant the acid solution and dry the beads at 100°C. Microscopic examination of a sample of the beads shall show no more than 5 percent of the beads altered by the acid.

5) Reflectivity Retention: The requirements shall be as described in 6.a.5).

6) Effective Performance: The requirements shall be as described in 6.a.6).

c. Type III

1) Composition: The retroreflective pavement marking film shall consist of a mixture of high quality polymeric materials, pigments and glass beads distributed throughout its base cross sectional area, with a reflective layer of beads bonded to the top urethane wear surface. The edges of the preformed tape shall be clean cut and true.

2) Thickness: The film without adhesive shall have a minimum thickness of 0.06 inch (1.52 mm).

3) Conformability and Patchability: The tape shall be conformable to pavement contours, breaks, faults, etc., and worn or missing areas shall be reparable with the same materials in accordance with the manufacturer's instructions.

4) Tensile Strength and Elongation. The material shall have a minimum tensile strength of 350 pounds per square inch and a minimum elongation of 50 percent at break when tested in accordance to the provisions of ASTM D638. The sample size shall be 6 inches x 1 inch and shall be tested between 70-80°F with a jaw speed of 10 to 12 inches per minute.

5) Reflectivity Retention: The glass beads shall be strongly bonded and not be easily removed by traffic wear.

The predominant mode of failure shall be "wear down" of the beads at 200 cycles when no more than 15 percent of the beads shall be lost due to popout using a Taber Abraser with an H-18 wheel and a 125 gram load.

6) Glass Bead Retention: When a 2-inch x 6-inch (5.08 x 15.24 cm) sample is bent over a 1/2-inch diameter mandrel (with a 2-inch dimension perpendicular to the mandrel axis), microscopic examination of the area on the mandrel shall show no more than 10 percent of the beads with entrapment by the binder of less than 40 percent.

7) Installation: The markings shall be applied and tamped in accordance with the manufacturer's recommendations.

E. Reflective Thermoplastic Compound Pavement Markings

1. General: Reflective thermoplastic compound pavement markings shall be a substance, free of volatiles, which is machine applied to the pavement surface in a hot molten state and which, after cooling to the ambient temperature, and

without polymerization or other chemical change, forms a traffic marking stripe of the quality and appearance as specified herein.

The material used shall be a product especially compounded for traffic markings.

The installed stripe shall not be slippery when wet.

The compound shall not deteriorate by contact with sodium chloride, calcium chloride, oil content of pavement materials, or from oil droppings from traffic.

In the plastic state, the material shall not give off fumes which are toxic or otherwise injurious to persons or property. The material shall not break down or deteriorate if held at the plastic temperature for a period of 4 hours, or by reason of four reheatings to the plastic temperature.

There shall be no obvious change in color of the material as a result of up to four reheatings, or from batch to batch.

To insure the best possible adhesion, the compound shall be installed in a melted state of a minimum temperature of 375°F, and the material shall not scorch or discolor if kept at temperatures between 380°F to 450°F for up to 4 hours.

The pigmented binder shall be well-dispersed and free from all skins, dirt, foreign objects, or such ingredients as will cause bleeding, staining, or discoloration.

After application and proper drying time, the material shall show no appreciable deformation or discoloration under local traffic conditions, and in an air and/or road temperature ranging from 0° to 120°F.

Under this specification, the term “drying time” shall be defined as the minimum elapsed time, after application, when the stripe shall have and retain the characteristics required by the preceding sections. In addition, the drying time shall be established by the minimum elapsed time after application, after which normal local traffic will leave no impression or imprint on the applied marking.

The drying time shall not exceed a characteristic straight line curve, the lower limits of which are 2 minutes at 50°F, the upper limits of which are 15 minutes of 90°F, both temperatures measured at a maximum relative humidity of 70 percent.

The stripe shall maintain its original dimensions and placement. The exposed surface shall be free from tack. Cold ductility of the material shall be such as to permit normal movement with the road surface without chipping.

The marking shall have a uniform cross section. Pigment shall be evenly dispersed throughout the material. The density and character of the material shall be uniform throughout its thickness.

The material shall not smear or spread under normal traffic conditions at temperatures below 120°F.

The filler to be incorporated with the resins or binders shall be a white calcium carbonate or equivalent filler.

The white thermoplastic shall have a pigment containing not less than 6 percent per Titanium Dioxide, and, after setting, shall be pure white, free from dirt or tint.

Yellow reflectorized thermoplastic compound shall be "Federal Yellow."

The binder shall consist of a mixture of non-drying synthetic resins at least one of which is solid at room temperature. The total binder content of the thermoplastic compound shall be not less than 15 percent nor more than 35 percent by weight.

The material shall not change in its color and brightness characteristics after prolonged exposure to sunlight.

During manufacture, reflectorizing beads shall be mixed into the material to the extent of not less than 20 percent nor more than 50 percent by weight of the material. The beads that are applied to the surface of the material shall be automatically applied at a uniform rate of approximately 3 pounds of glass beads to every 100 square feet of line.

The glass beads used in the formulation shall have a refractive index of not less than 1.51 when tested by the liquid immersion method at 25°C; shall consist of 70 percent min. by count of true spheres; shall be free from air inclusions; and shall have the following graduation:

U. S. Sieve Number	Percent Passing
30	90 -100
40	35 - 100
100	0 -10

Not less than 70 percent of the spheres shall meet the following requirements:

a. The surface of the spheres shall be smooth, lustrous, and free from film scratch and pits.

b. The spheres shall be clear and transparent and shall not be oviate in shape or fused spheroids.

c. The spheres shall show high autocollimating efficiency. Not more than 1 percent shall be black, amber, or milky.

The glass beads dropped on the applied marking shall have a refractive index of not less than 1.51 when tested by the liquid immersion method of 25°C, shall

consist of 70 percent min. by count of true spheres; shall be free from air inclusion; and shall have the following gradation:

U. S. Sieve Number	Percent Passing
20	90 - 100
80	0 - 10

Not less than 70 percent of the spheres shall meet the following requirements:

a. The surface of the spheres shall be smooth, lustrous, and free from film scratch and pits.

b. The spheres shall be clear and transparent and shall not be oviate in shape or fused spheroids.

c. The spheres shall show high autocollimating efficiency. Not more than 1 percent shall be black, amber, or milky.

2. Specifications and Tests

a. Color

1) White: Initially white; as demonstrated by a standard color difference meter such as the Gardner Color Difference Meter manufactured by Gardner Laboratories, Inc., Bethesda, Maryland, the material shall show deviations from a magnesium oxide standard not greater than the following:

Scale Definition	Mag Oxide Standard Sample	
Rd Reflectance	100	70 minimum
a Redness-Greenness	0	-5 to +5
b Yellowness-Blueness	0	-10 to +10

2) Yellow: Initially yellow; equal to standard color chips using Federal test method standard 141 Method 4252.

b. Color Retention: The retention of the initial color shall be determined as follows: Specimens shall be prepared and tested from the samples submitted in accordance with ASTM D620-57T, “Tentative Method of Test for Colorfastness of Plastics.” The ultraviolet light source shall be as specified from the test procedure or optionally may be a General Electric 275 watt sunlamp bulb, type RS, with built-in reflector. After

100 hours of exposure, specimens shall show no perceptible color change when compared visually with an unexposed specimen.

c. Water Absorption: Material shall have not more than 0.5 percent by weight of retained water, when tested by ASTM D570, procedure a.

d. Softening Point: Material shall have a softening point of not less than 90°C, as determined by ASTM E28.

e. Specific Gravity: Specific gravity of compound at 25°C shall be from 1.9 to 2.5.

f. Impact Resistance: The impact resistance shall not be less than 15 inch-pounds at 77°F after the material has been heated for 4 hours at 400°F and cast into bars of 1-inch cross sectional area and 3 inches long and placed with 1-inch extending above the vise in a cantilever beam (Izod Type) tester using the 25-inch pound scale. See ASTM D256 for description of this instrument.

g. Bond Strength: When two concrete blocks 2 inches by 3-1/2 inches by 7 inches are cemented together on the 3-1/2 inch by 7-inch faces with a 1/16 to 1/8-inch layer of the thermoplastic traffic line material and tested according to ASTM C321, the bond strength shall not be less than 150 pounds square inch.

h. Indentation Resistance: The reading of the Shore Durometer, Type A, as described in ASTM D2240 after 15 seconds shall not be less than the amounts herein designated when the material is tested after heating for 4 hours at 400°F, and cooled to the following temperatures:

Temperature	Reading
115°F	65
77°F	95
40°F	95

3. Packaging: Each unit container shall be clearly and adequately marked to indicate the color of the material, the process batch number or similar manufacturer's identification, the manufacturer's name and location of plant, and the date of manufacture.

The material shall be delivered to a designated area in unit containers as processed by the manufacturer. Each unit container when filled shall weigh no less than 24 lbs. or more than 52 lbs.

4. Warranty: Thermoplastic compound pavement marking material furnished and installed under this specification shall be guaranteed by the Contractor against failure due to poor adhesion resulting from defective materials or methods of application.
For approved pavements carrying 30,000 vehicles per day or less, the successful bidder shall guarantee to replace, without cost to the Department, that part of the pavement markings installed under this contract which, in the opinion of the Construction Manager, has not remained to perform useful service as follows:

   a. Crosswalks and Stop Lines:

      90 percent of the total of any one intersection for one year.
      75 percent of the total of any one intersection for 2 years.
      50 percent of the total of any one intersection for less than 3 years.

   b. Lane Lines, Edge Lines, and Center Lines:

      90 percent of a unit for one year.
      80 percent of a unit for 2 years.
      60 percent of a unit for 3 years.

      (A "Unit" is defined as any length of highway having installed thereon 2,000 lineal feet of line of specified width in any combination or pattern.)

      The replacement material installed under this guarantee shall be guaranteed the same as the original material, from the date of the original installation.

5. Equipment: The material shall be applied to the pavement by an extrusion method wherein one side of the shaping die is the pavement and the other three sides are part of the equipment.

   The equipment shall provide continuous mixing and agitation of the material. Conveying parts of the equipment shall be constructed to pavement accumulation and clogging. All parts of the equipment which come in contact with the material shall be easily accessible and exposable for cleaning and maintenance.

   All mixing and conveying parts including the shaping die shall maintain the material at the plastic temperature.

   The equipment shall assure continuous uniformity in the dimensions of the stripe. The thickness of the material on the pavement shall be no less than 3/32 inch and no more than 3/16 inch measured as an average in any 3-foot length.

   The applicator shall cleanly cut off square stripe ends and shall be capable of applying "skip" lines. The use of pans, aprons or similar appliances which the die overruns will not be permitted.

   Beads applied to the surface of the completed stripe shall be applied by an automatic bead dispenser attached to the liner in such a manner that the beads are

dispensed almost instantly upon the completed line. The bead dispenser shall be equipped with an automatic cutoff control synchronized with the cutoff of the thermoplastic material.

The equipment shall be constructed to provide for varying die widths to produce varying widths of traffic markings.

A special kettle shall be provided for melting and heating the composition. The kettle shall be equipped with an automatic thermostatic control device so that heating can be done by controlled heat transfer liquid rather than direct flame, to provide positive temperature control and prevent overheating of the composition.

The applicator and kettle must be equipped and arranged to satisfy the requirements of the National Fire Underwriters.

The applicator shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.

The applicator shall be capable of containing a minimum of 125 pounds of molten material.

6. Application: The Contractor shall clean off dirt, blaze, paint, tape and grease where necessary and as directed by the Engineer.

The material may be installed in variable widths from 2 inches to 12 inches.

On pavements containing less than 6 percent bituminous asphalt and on all concrete pavements, the Contractor shall prestripe the application area with a binder material as recommended by the manufacturer.

The compound shall be installed in a melted state at temperatures of 380°F to 450°F.

The minimum installed thickness of the line as viewed from a lateral cross section shall be not less than 3/32nds of an inch at the edges, nor less than 1/8th of an inch in the center. The measures shall be taken as an average throughout any 36-inch section of the line.

The new line when applied over an old line of compatible material shall bond itself to the old line in such a manner that no splitting or separation takes place during its useful life.

The finished lines shall have well-defined edges and be free of waviness.

PART 3 - EXECUTION

3.01 GENERAL: Pavement markers and markings shall be applied to surfaces that have been thoroughly cleaned and are free of dirt, dust, curing compound, grease, oil, moisture, loose aggregates, unsound layers and any other material which would adversely affect the bond of the adhesive or paint.

In the installation of pavement markers, the cleaning of Portland cement concrete and asphalt concrete surfaces shall be by blast cleaning. Clean, newly placed asphalt concrete need not be blast cleaned unless the surface contains an abnormal amount of asphalt or the surface is contaminated with dirt, grease, oil or any other material which would adversely affect bonding.

Unless otherwise specified, the Contractor shall establish control points, satisfactory to the Traffic Engineer, spaced at intervals that will insure accurate location of pavement markers and striping. Markers, paints and tape shall not be applied when moisture or foreign matter is present on the pavement surface or when wind conditions are such as to cause dust to be deposited on the prepared areas or to prevent satisfactory application of the marker adhesive or paint.

The Contractor shall paint temporary guidelines and outline of arrows, legends and crosswalks with a 2-inch wide brushed line on the day the roadway is opened to traffic which shall be approved by the Traffic Engineer before permanent lines are painted.

The Contractor shall furnish and place all warning and directional signs necessary to direct and control the traffic during marker installation or the striping operations. Warning signs shall be set up before the beginning of each operation and extra signs shall be kept well ahead of the marking or painting equipment.

The Contractor shall install all markers and apply all pavement striping before opening roadways to public traffic except that when connections to existing pavements are made or when temporary detours carry public traffic, the Contractor shall mark or stripe the connecting pavements on the day that the roadway is open to traffic.

If it is necessary to run public traffic over roadways soon after paving, the Contractor shall paint, on the day of each day's paving, temporary guide dashes at the traffic stripe or marker location on the pavement, as guidance for drivers, until the permanent markings can be placed. The Contractor shall maintain and repaint, if necessary, all temporary markings until the permanent striping and/or markers are installed. This work shall be considered incidental to the items of paving, pavement markers and/or pavement striping, and no separate payment will be made therefore.

Permanent pavement markers, striping and markings shall be applied no sooner than 7 calendar days nor later than 14 calendar days after completion of the pavement.

3.02 PAVEMENT MARKERS: Unless otherwise ordered in writing by the Traffic Engineer, markers shall be cemented to the pavement with Standard Set Type adhesive. If ordered by the Traffic Engineer, the Contractor shall use Rapid Set Type adhesive for the Standard Set Type adhesive at no extra cost to the Department.

If the Contractor uses Rapid Set Type adhesive, he shall submit samples of the markers and Rapid Set Type adhesive proposed for use to the Traffic Engineer, for testing and approval, at least 10 days before the date of its intended use.

The adhesive shall be placed uniformly on the cleaned pavement surface or on the bottom of the marker in a quantity sufficient to result in complete coverage of the area of contact of the marker with no voids present and with a slight excess after the marker has been pressed in place. The marker shall be placed in position and pressure applied until firm contact is made with the pavement. Excess adhesive around the edge of the marker, excess adhesive on the pavement, and adhesive on the exposed surfaces of the markers shall be immediately removed. Soft rags moistened with mineral spirits conforming to Federal Specification TT-T-291E or kerosene may be used, if necessary, to remove adhesive from exposed faces of pavement markers. No other solvent shall be used. The marker shall be protected against impact until the adhesive has hardened to the degree designated by the Traffic Engineer.

The adhesive requires that the mixing operation and placing of the markers be done rapidly. When hand mixing or machine mixing the Standard Set Type adhesive, all markers shall be aligned and pressed into place within 5 minutes after mixing is started. When hand mixing Standard Set Type adhesive, not more than one quart shall be mixed at one time. Any mixed batch which becomes viscous so that the adhesive cannot be readily extruded from under the marker on application of slight pressure shall not be used.

When the Rapid Set Type adhesive is used, the components shall be mixed by a two component type automatic mixing and extrusion apparatus, the markers shall be placed within 60 seconds after the adhesive has been mixed and extruded and no further movement of the marker will be allowed.

Automatic mixing equipment for the epoxy adhesive shall use positive displacement pumps and shall properly meter the components in the specific ratio, ±5 percent by volume of either component. At the beginning of each day and at any other time ordered by the Traffic Engineer, the ratio shall be checked by the Contractor in the presence of the Traffic Engineer. This check shall be made by disconnecting the mixing heads, or using suitable bypass valves, and filling two suitable containers with the unmixed components. The mixing head shall properly mix two components so that there is no trace of black or white streaks in the mixed material.

The Standard Set Type adhesive shall not be used when either the pavement or the air temperature is less than 50°F. The Rapid Set Type adhesive shall not be used when either the pavement or the air temperature is less than 30°F. No markers shall be installed if the relative humidity of the air is greater than 80 percent or if the pavement is not surface dry. The Traffic Engineer shall be the judge as to when the adhesive has set sufficiently to bear traffic. The following table may be used as a guide; however, the times shown may vary, depending upon field conditions:

TIME TO BEAR TRAFFIC		
Temperature* (°F)	Standard Set Type (Hours)	Rapid Set Type (Minutes)
100	1-1/2	15
90	2	20
80	3	25
70	4	30
60	5	35
50	7	45
40	No Application Below 50°F	65
30		85
		No Application Below °F

*The temperature indicated is either pavement surface or air temperature, whichever is lower. The hardness of the rim of epoxy around the marker shall not be used as an indication of the degree of cure of the epoxy under the marker.

Types A and J pavement markers that are used to delineate 10-foot lane stripes shall be installed in sets of four markers as called for on the plans. Installation of fractional sets (i. e., one, two or three markers) will not be permitted. The length of the 10-foot stripe and 30-foot gap may vary ±1 foot to properly distribute the spacing of stripes.

No pavement markers shall be installed over longitudinal or transverse joints of the pavement surface.

3.03 PAVEMENT STRIPING AND MARKINGS: Pavement striping and markings shall be of the length, width and placement specified and shall conform to the Department of Transportation Services' Standards.

Traffic paint shall be applied at a nominal film thickness of 0.015 inch, utilizing a wheeled, hand or self-propelled applicator machine. The traffic paint applicator machine shall have appropriate shields of nozzle controls which will permit sharp pavement stripe definition. The traffic paint applicator machine shall have an air stream nozzle which can direct compressed air immediately before the area of paint application for the purpose of cleaning the pavement prior to paint application.

Pavement arrows, legends, and crosswalks shall be applied with appropriate templates (refer to "Traffic Standards Manual" of the Department of Transportation Services, dated July 1976).

No stripe shall be less than the specified width. No stripe shall exceed the specified width by more than 1/2 inch. The length of the 10-foot painted segment for skip stripe may vary ±1 foot and the 30-foot gap between segments may vary ±1 foot. The alignment of the stripe shall not deviate from the intended alignment by more than 1 inch on tangents and on curves up to and

including one degree. On curves exceeding one degree, the alignment of the stripe shall not deviate from the intended alignment by more than 2 inches.

When necessary to correct a deviation which exceeds the permissible tolerance in alignment, that portion of the stripe so affected shall be removed plus an additional 30 feet in each direction, and a new stripe then provided in accordance with these specifications.

All stripes, segments of stripes and markings shall present a clean cut, uniform appearance. All striping and markings which fail to meet the requirements specified herein, or are marred or damaged by traffic or from other causes, shall be corrected prior to acceptance by the City at the Contractor's expense. All misted areas, dripped and spattered paint shall be removed to the satisfaction of the Construction Manager.

The freshly painted stripe shall be protected by cones or other satisfactory devices until the traffic paint is dry and will not transfer to car tires. All stripes damaged by traffic, or pavements marked by traffic crossing wet paint, shall be repaired or corrected as specified below.

The Contractor shall submit to the Traffic Engineer test specimens as requested. Test films shall be applied to a suitable plane rigid surface. The area shall be of sufficient size to permit film thickness measurement to be made at least 1 inch from any edge.

3.04 REMOVING EXISTING PAVEMENT MARKERS, STRIPING AND MARKINGS: Existing pavement markers shall be removed by methods that cause the least possible damage to the pavement or surfacing.

Where specified on the plans and/or directed by the Traffic Engineer, existing pavement striping and markings shall be removed to the fullest extent possible by methods that will not materially damage the surface or texture of the pavement, or leave impressions on the roadway that could be confused with permanent striping during inclement weather or night driving conditions. Any damage to the pavement or surfacing caused by the removal operations shall be repaired by the Contractor at his expense by methods acceptable to the Traffic Engineer.

Painting over the existing striping and markings will not be permitted. Burning off existing striping and markings will be permitted using an approved method using excess oxygen.

Sand or other material deposited on the pavement as a result of removing pavement markers, traffic striping and markings shall be removed as the work progresses. Accumulation of sand or other material which may constitute a hazard to traffic will not be permitted.

Extraneous traffic striping and markings shall be removed before any change is made in the traffic pattern.

3.05 PREFORMED PAVEMENT MARKING TAPE: Preformed pavement marking tape may be applied manually or with the tape applicators approved by the tape manufacturer. All markings shall be applied in accordance with the tape manufacturer’s recommendations and as specified herein.

The Contractor shall install permanent preformed pavement marking tape only at the locations shown on the plans and as specified herein.

Preformed pavement marking tape shall not be applied over other markings or old paint. The Contractor shall remove all old markings and otherwise prepare the surface for tape application as specified.
The minimum temperatures for the application of preformed pavement marking tape shall be 60° (15°C) for air and 70°F (21°C) for roadway surfaces, with both temperatures rising. The maximum temperature shall be 150° (66°C) for roadway surfaces.

The Contractor shall prime existing roadway surfaces with an approved primer immediately prior to the application of permanent preformed pavement marking tape. The Contractor shall apply the primer as recommended by the tape manufacturer and as directed by the Construction Manager.

The Contractor may use tapes of different widths to form a specified stripe width (i. e., two 4-inch wide tapes may be used to form an 8-inch wide stripe); however, 12-inch wide stripe shall be of a single width and payment shall be made for the specified stripe width as shown on the plans and called for in the proposal.

The Contractor shall use butt splices only and shall not overlap the tape material.

All markings shall be thoroughly tamped with approved mechanical tampers. Additionally, the Contractor shall slowly drive on the newly applied markings several times with a truck.

All areas marked with preformed pavement marking tape shall be ready for traffic immediately after application.

3.06 REMOVAL OF TEMPORARY TAPE TRAFFIC MARKINGS: The Contractor shall remove all temporary tape striping placed to delineate traffic lanes, crosswalks, stop bars, etc., prior to the laydown of the finish asphalt concrete mix #4 layer.

3.07 METHOD OF MEASUREMENT: Pavement markings, including lane striping, will not be measured.

Pavement markers will not be measured.

Crosswalk markings will be measured as complete units of painted crosswalk marking as indicated on the plans and in the proposal.

Pavement arrows, legends and words will be measured as complete units of the type and design specified on the plans and in the proposal.

3.08 BASIS OF PAYMENT: The accepted quantities of the various types of pavement markers will be paid for at the contract lump sum price complete in place. The price includes full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved, in furnishing and placing pavement markers complete in place, as shown on the plans, as specified herein or as directed by the Engineer.

Pavement striping, including pavement markings such as stop lines (or stop bars), will be paid for at the lump sum price bid in the proposal which price shall be full compensation for furnishing all labor, materials, tools, equipment and incidentals and for doing all the work involved in furnishing and installing traffic pavement striping complete in place as shown on the plans, including the removal of existing extraneous paint or paint stripe, as specified herein or as directed by the Engineer.

The quantity of pavement striping noted in the proposal is based on the striping plan. If the completed work deviates from the striping plan, the unit price for the adjusted striping work will be determined by dividing the lump sum price bid in the proposal by the quantity noted in the proposal. The lump sum price bid will be adjusted by the amount determined by multiplying the above unit price by the length of striping added or deleted. The adjusted striping work will be measured as follows: pavement stripes 12 inches or less in width (including between line spacing) will be measured as a single stripe; pavement stripes over 12 inches wide will be measured as two stripes; and the unpainted spaces, up to 25 feet, between painted stripe segments will be included in the measurement.

The accepted quantities of crosswalk markings will be paid for at the contract unit price per each thermoplastic or taped crosswalk marking as indicated on the plans and in the proposal, in place complete.

The accepted quantities of pavement arrows, legend and words will be paid for at the contract unit price per each as indicated in the proposal, in place complete.

The contract price shall be full compensation for furnishing all labor, materials, tools, equipment and incidentals and for doing all the work involved as shown on the plans, as specified herein or as directed by the Construction Manager.

Removal of existing pavement markings and markers shall be considered incidental to the various payment items.

END OF SECTION

SECTION 02713 – POTABLE WATER SYSTEM

PART 1 – GENERAL

1.01 GENERAL CONDITIONS: The General Conditions and Special Conditions preceding these specifications shall govern this section of the work.

1.02 WORK INCLUDED: Furnish all labor, materials, tools, equipment and related items necessary to complete, in place, the potable water system in conformity with the dimensions, profiles, sections, and details shown on the plans. Work shall be governed by the "Water System Standards, Department of Water Supply, County of Maui, et al., State of Hawaii, 2002," hereinafter referred to as the DWS Standards.

PART 2 – PRODUCTS

2.01 MATERIALS: All materials shall conform to the DWS Standards. Water mains shall be Ductile Iron, Class 52. Fittings shall be Class 350 ductile iron with mechanical joints. Gate valves shall be cast iron, Class 150, with mechanical joints. Fire hydrants shall be wet-barrel type.

PART 3 – EXECUTION

3.01 INSTALLATION: The installation, testing, disinfection and acceptance of water lines shall be governed by the DWS Standards.

The Contractor shall be responsible for precisely laying out the various utility lines shown on the contract plans as provided elsewhere in these specifications. The location shown on the contract plans of the various existing utility lines which the new lines are to cross over or under or connect to were determined on the basis of the best information available; however, no assurance can be provided that the actual locations will be precisely as shown on the contract plans.

In performing all work, the Contractor shall exercise due care and caution necessary to avoid any damage to and impairment in the use of any existing utility lines. Any damage inflicted on existing lines resulting from the Contractor's operations shall be immediately repaired and restored as directed by the Construction Manager at the Contractor's expense.

Connections to or the lowering or relocation of existing mains shall be done by the Contractor in accordance with the DWS Standards. The Contractor shall furnish all necessary pipe, fittings, appurtenances and other incidental materials.

Trenching, pipe cushion and backfilling for the water main shall be in accordance with the DWS Standards.

The Contractor shall coordinate the connection of the new water line with the Construction Manager. The Contractor shall inform the Construction Manager a minimum of one week prior to the date of the actual connection. The inverts shown on the plans are approximate only, and the Contractor shall adjust the slope of the new water line as necessary to construct a fully functional and acceptable system. The Contractor shall ensure that all piping, fittings, materials, tools, equipment and incidentals are at the site and ready for connection.

END OF SECTION

SECTION 02721 – STORM DRAINAGE SYSTEM

PART 1 – GENERAL

1.01 GENERAL CONDITIONS: The General Conditions and Special Condition preceding these specifications shall govern this section of the work.

1.02 WORK INCLUDED: Furnish all labor, materials, tools, equipment and related items necessary to complete, in place, the storm drainage system in conformity with the dimensions, profiles, sections, and details shown on the plans. Work relating to drainpipes and drainage structures shall be governed by the following sections of the Standard Specifications:

Trench Excavation and Backfill	Section 11
Drain Pipes	Section 24
Drain Manholes	Section 25
Catch Basins and Storm Water Inlets	Section 26
Portland Cement Concrete	Section 39
Concrete Structures	Section 40

1.03 CONTRACTOR SUBMITTALS: Shop drawings shall be submitted for drain pipes, precast manholes, catch basins and storm water inlets and outlets.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Drainpipe: Reinforced Concrete Pipe, Class III, AASHTO M170.

B. Materials for the storm drainage system shall be in accordance with the sections of the Standard Specifications noted hereinbefore.

C. Corrugated Metal Pipe: Corrugated Aluminum Pipe, AASHTO M196.

D. Structural Aluminum Plate for Pipe: Structural Aluminum Plate for Pipe, AASHTO M219.

PART 3 – EXECUTION

3.01 INSTALLATION: Install the storm drainage system in accordance with the sections of the Standard Specifications noted hereinbefore and the Section 603 – Culverts and Storm Drains, Standard Specifications for Road, Bridge, and Public Works Construction.

3.02 The Contractor shall be responsible for precisely laying out the storm drain line shown on the contract plans. The location shown on the contract plans of the various existing utility lines which the new lines are to cross over or under or connect to were determined on the basis of the best information available; however, no assurance can be provided that the actual locations will be precisely as shown on the contract plans.

3.03 In performing all work, the Contractor shall exercise due care and caution necessary to avoid any damage to and impairment in the use of any existing utility lines. Any damage inflicted on existing lines resulting from the Contractor's operations shall be immediately repaired and restored as directed by the Engineer at the Contractor's expense.

END OF SECTION

SECTION 02840 – TRAFFIC SIGNS

PART 1 – GENERAL

1.01 GENERAL CONDITIONS: The General Conditions preceding these specifications shall govern this section of the work.

1.02 WORK INCLUDED: Furnish all materials, labor and equipment required to accomplish the installation of all traffic signs as indicated on the plans and specified herein.

1.03 SUBMITTALS: A list of component parts indicating the description of each part, the material from which it has been fabricated (including ASTM numbers where applicable) and a statement certifying compliance to the material specification.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Asbestos Prohibition: No asbestos containing materia1s or equipment shall be used under this section. The Contractor shall ensure that all materials and equipment incorporated in the project are asbestos-free.

B. Materials shall be in accordance with Section 621 -Traffic Control Signs of the State Standard Specifications, except as shown on the plans or amended in the specifications herewith.

PART 3 - EXECUTION

3.01 INSTALLATION: Installation of signs shall be in accordance with Section 621 - Traffic Control Signs of the State Standard Specifications, except as shown on the plans or amended in the specifications herewith.

END OF SECTION

DIVISION 3 - CONCRETE

SECTION 03300 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 GENERAL CONDITIONS: The General Conditions and Special Conditions preceding these specifications shall govern this section of the work.

1.02 WORK INCLUDED: Cast-in-place concrete and reinforcing steel for concrete slabs and footings. Work shall be in conformance to Section 39 - Portland Cement Concrete and Section 48 - Reinforcing Steel of the Standard Specifications.

1.03 QUALITY ASSURANCE

A. Codes: Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified.

1. Concrete Reinforcing Steel Institute, “Manual of Standard Practice”

2. ACI 318 “Building Code Requirements for Reinforced Concrete”

3. ACI 304, “Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete”

4. ACI 311, “Recommended Practice for Concrete Inspection”

B. Concrete Testing Service

1. The Contractor will employ, at his own expense, a testing laboratory experienced in the testing of concrete materials and mixes to perform material evaluation tests. This laboratory shall be the official testing agency for this project.

2. Materials and installed work may require testing and retesting, as directed by the Engineer, at any time during the progress of the work. Allow free access to material stockpiles and facilities at all times. Test, if not specifically indicated to be done at the Department’s expense, including the retesting of rejected materials and installed work, shall be done at the Contractor‘s expense.

3. Tests shall comply with ASTM Standards whenever applicable.

PART 2 - PRODUCTS

2.01 CONCRETE MATERIALS

A. Portland Cement: ASTM C150, Type I

B. Aggregates: ASTM C33

1. Fine Aggregates: Clean, sharp, natural sand or rocksand as manufactured locally

free from loam, clay, lumps or other deleterious substances.

2. Coarse Aggregates: Clean, uncoated, processed aggregate containing no clay, mud loam or foreign matter.

C. Reinforcing:

1. ASTM A615-51, Grade 60
2. ASTM A185, galvanized welded wire fabric

2.02 CONCRETE ADMIXTURES

A. Air-Entraining Admixtures: ASTM C260

B. Water-Reducing Admixtures: ASTM C494, Type D

C. Set Control Admixtures: ASTM C494, as follows:

1. Type B, retarding
2. Type D, water-reducing and retarding

D. Calcium Chloride: Do not use calcium chloride in concrete.

2.03 PROPORTIONING AND DESIGN OF MIXES

A. Prepare design mixes for each type of concrete; 28-day compressive strengths shall be 3,000 psi (Class A); 2,500 psi (Class B); 2,000 psi (Class C) and in the Standard Specifications.

B. Proportion mixes by either laboratory trial batch or field experience methods, using materials to be employed on the project for each class of concrete required.

C. Unless otherwise noted, Class A concrete shall be used for all electrical ducts, reaction blocks, slabs and walls; Class B concrete for curb and gutter, and sidewalk applications.

2.04 JOINT MATERIALS

A. Premolded Joint Fillers: Premolded material of specified thickness composed of fiberboard impregnated with asphalt.

B. Joint Sealing Compound: Tremco Butyl Sealant or approved equal.

C. Epoxy-Resin Bonding Agent: Two component, mineral filled epoxy polysulfide polymer complying with FS MMM-G-650, Type I or Type II, Grade A.

2.05 MOISTURE BARRIER: Provide moisture barrier over prepared base material where shown on plans. Use only materials which are resistant to decay when tested in accordance with ASTM E154, as follows: Polyethylene sheet not less than 6 mils thick.

2.06 CURING MATERIALS

A. Curing compounds for membrane curing shall conform to ASTM C309.

B. Liquid Curing - Hardening Compound: Aqueous solution of sodium silicate with non-acid penetrating agent, reacting chemically with free lime in concrete to form a hard, non-dusting surface which will not inhibit bonding with future finishes. Products offered by manufacturers to comply with the requirements for liquid curing hardening compounds include the following:

1. Demicon: Castle Chemical Corp.
2. Eucosil: Euclid Chemical Co.
3. Chem Hard: L&M Construction Chemicals

2.07 EPOXY GROUT: Manufactured grout with built-in bonding material subject to approval of the Engineer.

PART 3 - EXECUTION

3.01 PREPARATION: Pre-Placement Inspection -- Before placing concrete, inspect and complete the formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other crafts involved in ample time to permit the installation of their work; cooperate with other trades in setting such work, as required.

3.02 CONCRETE PLACEMENT

A. General: Place concrete in compliance with the practices and recommendations of ACI 304 and as herein specified.

1. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as herein specified. Perform concrete placing at such a rate that concrete which is being integrated with fresh concrete is still plastic. Deposit concrete as nearly as practicable to its final location to avoid segregation due to rehandling or flowing. Do not subject concrete to any procedure which will cause segregation.

2. Screen concrete which is to receive other construction to the proper level to avoid excessive skimming or grouting.

3. Do not use concrete which becomes non-plastic and unworkable, or does not meet the required quality control limits, or which has been contaminated by foreign materials. Do not use retempered concrete. Remove rejected concrete from the project site and dispose of it in an acceptable location.

B. Concrete Conveying

1. Handle concrete from the point of delivery and transfer to the concrete conveying equipment and to the locations of final deposit as rapidly as practicable by

methods which will prevent segregation and loss of concrete mix materials.

2. Provide mechanical equipment for conveying concrete to ensure a continuous flow of concrete at the delivery end. Provide runways for wheeled concrete conveying equipment from the concrete delivery point to the locations of final deposit. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris water, and other deleterious materials.

C. Placing Concrete Slabs

1. Deposit and consolidate concrete slabs in a continuous operation, within the limits of construction joints, until the placing of a panel or section is completed.

2. Consolidate concrete during placing operations using mechanical vibrating equipment, so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.

3. Bring slab surfaces to the correct level with a straightedge and strike off. Use bull floats or darbies to smooth the surface, leaving it free of humps or hollows. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to beginning finishing operations.

4. Maintain reinforcing steel in the proper position continuously during concrete placement operations.

D. Dowel installation where shown. Prepare for bonding of dowels and anchors to existing concrete by using drilled holes and a two-component epoxy which is manufactured for this specific purpose. Install in accordance with manufacturer's requirements to develop strength of dowels.

3.03 CONCRETE SLAB FINISHES

Slabs: Finish by tamping the concrete to force aggregate away from the surface and screen at the proper level. Float the surface and lightly trowel. When concrete has set sufficiently to ring under the trowel, give a second troweling to produce a smooth, dense surface free from trowel marks and sweeps, air bubbles or other imperfections of troweling.

3.04 CONCRETE CURING AND PROTECTION

A. General

1. Protect freshly placed concrete from premature drying and excessive cold or hot temperature, and maintain without drying at relatively constant temperature for the period of time necessary for hydration of the cement and proper hardening of the concrete.

2. Start initial curing as soon as free moisture has disappeared from the concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 72 hours.

3. Begin final curing procedures immediately following initial curing and before the concrete has dried. Continue final curing for at least 7 days and in accordance with ACI 301 procedures. Avoid rapid drying at the end of the final curing period.

B. Curing Methods

1. Perform curing of concrete by moist curing, or by moisture retaining cover curing, by membrane curing, or by combinations thereof, as herein specified for a continuous period of 14 days.

2. Liquid Curing-Hardening Compound: Apply to horizontal surfaces when concrete is dry to touch by means of power spray, hand spray, or hair broom in accordance with manufacturer's directions.

C. Curing Unformed Surfaces

1. Initially cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by moist curing, whenever possible.

2. Moist cure surfaces to receive fluid applied waterproof membranes and composition flooring. Do not cure by membrane curing or curing compounds.

3. All slabs not receiving a finish floor material shall receive a liquid curing-hardening compound in accordance with the manufacturer's recommendations.

4. Final cure unformed surfaces, unless otherwise specified, by any of the methods specified above, as applicable.

D. Protection from Mechanical Injury: During the curing period, protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration, and from damage caused by rain or flowing water. Protect all finished concrete surfaces from damage by subsequent construction operations.

3.05 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures from the passage of work by other trades, unless otherwise shown or directed, after the work or other trades is in place. Mix, place and cure concrete as herein specified, to blend with in-place construction. Provide all other miscellaneous concrete filling shown or required to complete the work.

B. Epoxy Adhesive: For application on corrective work where the ordinary methods of remedy are deemed inadequate by the Engineer. Type of adhesive shall be subject to the approval of the Engineer.

3.06 CONCRETE SURFACE REPAIRS

A. Repair of Unformed Surfaces

1. Test unformed surfaces such as monolithic slabs, for smoothness and to verify surface plane to the tolerance specified for each surface and finish. Correct low and high areas as herein specified.

2. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having the required slope. Correct high and low areas as herein specified.

3. Repair finish unformed surfaces that contain defects which adversely affect the durability of the concrete. Surface defects, as such, include cracks in excess of 0.03 inch wide or which penetrate to the reinforcement or completely through non-reinforced sections regardless of width, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.

4. Correct high areas in unformed surfaces by grinding, after the concrete has cured sufficiently so that repairs can be made without damage to adjacent areas.

5. Correct low areas in unformed surfaces during, or immediately after completion of surface finishing operations by cutting out the low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to the Engineer.

B. Finishing of Formed Surfaces

1. Joint marks and fins shall be removed and surfaces left smooth and dense. Tieholes and honeycombing shall be repaired with cement and sand mortar.

2. Exposed concrete surfaces shall be vigorously and thoroughly rubbed with a sand cement mortar the consistency of a thick paint to fill all voids and provide a smooth surface. There shall be no discernible thickness of mortar on the surface.

END OF SECTION

DIVISION 4 - MASONRY

SECTION 04230 - GROUTED RIPRAP

PART 1 - GENERAL

1.01 GENERAL CONDITIONS: The General Conditions and Special Provisions preceding these specifications shall govern this section of the work.

1.02 DELIVERY, STORAGE AND HANDLING

A. Mortar and Grout Materials: Portland cement, masonry cement, mortar cement, lime and admixtures shall be stored in such a manner as to prevent deterioration or contamination with foreign matter. Cement which has become caked, partially set or otherwise deteriorated, or any material which becomes damaged or contaminated, shall be rejected.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Stone shall be clean, durable, free from seams or other imperfection. When tested under AASHTO Test Method T96, it shall show a wear not to exceed 50%. It shall have a minimum specific gravity of 2.4. The sizes and shapes shall be as shown on the plans.

Stones generated from on-site grading operations shall be initially used as long as it conforms to the criteria hereinabove. If on-site grading operations do not generate an adequate quantity of stones for the grouted rip rap work, stones shall be obtained from the designated borrow site. Stones to be used for this purpose shall be approved by the Geotechnical Engineer.

B. Mortar shall consist of one part cement to three parts fine aggregate and shall meet the requirements as provided in Section 39 "Portland Cement Concrete".

C. Hydrated Lime shall conform to the ASTM C207, Type S. Hydrated lime shall be added to the mortar and the quantity shall not exceed the recommendations of the manufacturer.

D. Water used in mixing mortar or grout shall be clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials or other substances that may be deleterious to either the mortar or reinforcement. Non-potable water shall not be used.

PART 3 - EXECUTION

3.01 GENERAL: The Contractor shall use stones that are available from on-site grading operations. Stones shall be of the shape and size shown on the plans and grouted in place.

The proportioning of materials for grout shall be by volume and done in such manner that the specified proportions can be controlled and accurately maintained. Fine aggregate shall be

measured in a damp loose condition. Mixing shall be by a mechanical batch mixer for at least 5 minutes for grout, but for not more than 10 minutes. Hand mixing shall be permitted only for small batches of 3 cubic feet or less.

3.02 RIPRAP: Riprap shall be placed in a manner to produce a well-graded mass of rock with minim practicable percentage of voids and shall be constructed to the lines and grades shown on the plans.

Weep holes 3 inches in diameter shall be provided in the walls at approximately 8-foot centers. Filter material conforming to the requirements of Section 28 "Subsurface Drains". At least 2 cubic feet in volume shall be placed at each weep hole.

Riprap shall be placed to its full course thickness in one operation and in such a manner as to avoid displacing the filter material. Placement shall begin at the bottom of the areas to be covered and continue up slope. Subsequent loads of material shall be placed against previously placed material in such a manner as to ensure a relatively homogenous mass. The finished riprap shall be free from objectionable pockets of small stones and clusters of larger stones. Placing riprap in layers will not be permitted. Placing riprap by dumping it at the top of the slope and pushing it down the slope will not be permitted. No equipment shall be operated directly on the completed stone protection system. The Contractor shall maintain the stone protection until accepted by the Engineer and any material displaced prior to acceptance and due to the Contractor's negligence shall be replaced at no cost to the State.

3.03 GROUTING OF RIPRAP: Grout shall be batched and mixed in sufficient quantities to prevent cold joints. Rock shall be flushed with water to remove fines from the rock prior to placing the grout. Rock shall be kept moist just ahead of the actual placing, but no flowing or standing water shall be present during the grouting operation.

Grout placement shall not be permitted when weather conditions prevent proper placement.

Grout placed on inverts or other nearly level areas may be placed on one course. On slopes, the grout shall be placed in two (2) courses in successive lateral strips approximately 10 feet in width starting at the toe of the slope and progressing to the top. The flow of the grout shall be directed with brooms, spades or baffles to prevent it from flowing excessively along the same path and to assure that all intermittent spaces are filled. Sufficient barring shall be done to loosen tight pockets of riprap and otherwise aid the penetration of grout so that all voids shall be filled, and the grout fully penetrates the riprap. All brooming shall be uphill and after the grout has stiffened, the entire surface shall be rebroomed to eliminate runs, to fill voids caused by sloughing, and to remove grout from the top surface and pockets or depressions of the upper stones.

Beginning immediately after placement and continuing for at least 7 days, all grout shall be cured and protected from premature drying, mechanical damage and exposure to rain or flowing water. All materials and equipment needed for adequate curing and protection shall be available at the site. After completion of any strip or panel, no workman or other load shall be permitted on the grouted surface for a period of 24 hours. Exposed surfaces shall be kept continuously moist for the entire period, or until curing compound is applied.

END OF SECTION