STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

ADDENDUM NO. 8
FOR

INTERSTATE ROUTE H-3, H-3 FINISH (UNIT VIII)
FEDERAL-AID INTERSTATE PROJECT NO. I-H3-1(75) Unit VIII
AND
INTERSTATE ROUTE H-1 SEISMIC RETROFIT
AUSTIN-BISHOP SEPARATION AND WAIAU INTERCHANGE
FEDERAL-AID INTERSTATE PROJECT NO. BR-H1-1(241)

DISTRICT OF EWA
ISLAND OF OAHU
2003

The following amendments shall be made to the bid documents:

I. Amend the REGULATORY REQUIREMENTS FOR FEDERAL AID PROJECTS REGARDING DISADVANTAGED BUSINESS ENTERPRISES (DBEs) by replacing paragraph VII. Payment, with the following:

"VII **PAYMENT**

A. Monthly Progress Payments.

1. The Department will make an estimate in writing each month based on the items of work performed and materials incorporated in the work and the value therefore at the unit prices or lump sum prices set forth in the contract. All progress estimates and payments will be approximate only and shall be subject to correction at any time prior to or in the final estimate and payment. The Department will not withhold any retainage from any payment to the bidder.

2. The bidder shall pay all subcontractors within ten (10) calendar days after receipt of payment from the Department. This clause applies to both DBE and non-DBE subcontractors, and all tiers of subcontracts. Any retainage held by the bidder on subcontractor payments must be in accordance with Section 103-32.1, HRS.

B. Final Payment of subcontractors. When any subcontractor has met all the terms and conditions of the subcontract, and there are no bona fide disputes, the bidder shall make full payment to the subcontractor of all monies due, including retainage, within ten (10) calendar days from the

receipt of an approved invoice from the subcontractor. The bidder must obtain the prior approval from the Department before it can continue to withhold retainage from any subcontractor who has completed its portion of the work. This clause applies to both DBE and non-DBE subcontractors, and all tiers of subcontracts."

II. Amend the Special Provisions as follows:

A. Amend Subsection 109.09 Progress Payments, subparagraphs (A) and (B) by replacing it with the following:

"(A) Retainage. The Department will not withhold any retainage from any payment to the Contractor unless the Contractor is progressing unsatisfactorily in completing the project work. If the Contractor is progressing unsatisfactorily, the Engineer, upon written notice to the Contractor, may withhold 5% of the progress payments.

If the Contractor refuses or fails to comply with the equal employment opportunity, affirmitive action, non-discrimination, labor compliance, training, and disadvantaged business enterprise requirements, the Engineer at its sole discretion and upon written notice to the Contractor, may withhold the entire portion of the monthly progress payments."

B. Amend Subsection 306.05 Basis of Payment by revising the second paragraph to read as follows:

"The price includes full compensation for preparing the surface; furnishing, applying, and protecting the prime coat; furnishing and installing the permeable separator; spreading the material; furnishing, depositing, and placing the coarse aggregate; disposing the excess material; rolling; compacting; water for compaction; filler for the permeable base; brooming; and furnishing labors, materials, tools, equipment, and incidentals necessary to complete the work."

C. Amend Subsection 511.06(F) Standard Shaft Excavation by revising the second paragraph to read as follows:

"The Engineer will measure the length along the centerline of the shaft. The length shall be the elevation difference between the top of the shaft designated as standard shaft excavation and the bottom of the shaft designated as standard shaft excavation to the nearest foot discounting the depths from which any material that is removed as an obstruction. The Engineer will maintain a drilled shaft log for payment."

D. Amend Subsection 511.06(G) Special Shaft Excavation by revising the second paragraph to read as follows:

"The Engineer will measure the length along the centerline of the shaft. The length shall be the elevation difference between the top of the shaft designated as special shaft excavation and the bottom of the shaft designated as special shaft excavation to the nearest foot discounting the depths from which any material that is removed as an obstruction. The Engineer will maintain a drilled shaft log for payment."

E. Amend Subsection 511.06(H) Rock Excavation by revising the second paragraph to read as follows:

"The Engineer will measure the length along the centerline of the shaft. The length shall be the elevation difference between the top of the shaft designated as rock excavation and the bottom of the shaft designated as rock excavation to the nearest foot discounting the depths from which any material that is removed as an obstruction. The Engineer will maintain a drilled shaft log for payment."

F. Replace Pages 657-1a through 657-21a, dated 10/16/03 with the attached Pages 657-1a through 657-21a, dated 11/19/03

III. Amend the Standard Specifications as follows:

A. Amend Subsection 648.02 Materials to read as follows:

"**648.02 Materials.** Materials shall conform to the following:

Geotextiles For Permeable Separator Applications 716.02"

B. Amend Subsection 648.03 Construction Requirements by deleting 648.03(C)(3) Subbase Placement in its entirety.

C. Amend Subsection 648.04 Method of Measurement to read as follows:

"**648.04 Method of Measurement.** The Engineer will not measure geotextile permeable separator for payment.

D. Amend Subsection 648.05 Basis of Payment to read as follows:

"**648.05 Basis of Payment.** The Engineer will not pay for geotextile permeable separator separately. The Engineer will consider the cost for geotextile permeable separator as included in the contract price of the various contract items. The price shall be full compensation for packaging; storing; preparing the surface; installing the fabric; sewing; overlapping; furnishing labors, equipment, tools, materials, and incidentals necessary to complete the work.

Please acknowledge receipt of this Addendum No. 8 by writing in "Addendum No. 8 _____" and recording the date of its receipt on page P-4 of the Proposal.

for RODNEY K. HARAGA
Director of Transportation

Make the following Section a part of the Standard Specifications:

"SECTION 657 – SOIL STABILIZATION BY JET GROUTING

657.01 Description. This section includes requirements for constructing stabilized soil-cement jet grout columns, consisting of soil mixed with cement grout, by the jet grouting method for support of a portion of the existing highway embankment and the new highway embankment at selected locations shown on the Contract Documents. The work includes drilling test probes, mobilizing specialty equipment for jet grouting, determining suitable jet grouting procedures and grout mixes, performing a test program and evaluating the test results, installing production jet grout columns, installing instrumentation and monitoring settlement, providing traffic control, restoration, and clean up and disposal of waste materials resulting from jet grouting including all labor, equipment, and materials to complete this work as specified herein.

The term "Jet Grouting" refers to the process of creating stabilized soil-cement columns in place utilizing a grout mix delivered at pressure through a special drill bit that has high-speed horizontal jets. High-pressure water or water and air jets are used to excavate columns in the materials to be stabilized. The soil-cement columns are constructed by withdrawing the rotating drill bit at a slow, constant speed; cutting the soil with water and air jets; pumping a tremie cement grout slurry and mixing it simultaneously with soil cuttings through the drill bit; and thoroughly mixing the soil cuttings and grout to produce continuous columns of consistent geometry and quality. Single, double and/or triple fluid methods of jet grouting are acceptable.

The term "Jet Grout Columns" refers to jet-grouted stabilized soil-cement columns constructed to support the weight of the existing and future highway embankment loads to reduce the load transfer of the embankment loads onto the soft foundation soils at the locations designated on the Contract Documents.

The term "Bearing Material" refers to soil or rock deposits with adequate strength and low compressibility to provide support for long-term loads transmitted by the jet grout columns.

657.02 Qualifications of Jet Grouting Contractor. The Jet Grouting Contractor shall be capable of performing the work specified and shall have the following minimum experience requirements below.

Because of the expertise required to successfully complete the soil stabilization by jet grouting according to the contract, a qualified Jet Grouting Contractor shall install the jet grout columns. The Jet Grouting Contractor shall have installed jet grout columns in soft cohesive soils in at least five projects completed in the last three years on which the Contractor has installed a minimum of 2,000 cubic yards of soil stabilization by jet grouting of a diameter and depth similar to those shown in the contract. The Jet Grouting Contractor shall have

supervisory personnel who participated in the construction of jet grout columns similar to the type proposed for a duration of at least three years within the last 10 years. Those supervisory personnel shall be on the project for the entire duration of the jet grouting operation.

657.03 Materials. All materials for soil stabilization by jet grouting shall conform to the following requirements.

(A) Grout. Grout shall be a mixture of Portland cement, water, and bentonite or other admixtures, if required. The grout shall be mixed in a grout plant, which combines dry cement and water in predetermined proportions. Grout mix shall have a consistency that is fluid and pumpable. It shall be proportioned to provide the required strength and mixing consistency. The grout utilized shall provide jet grout columns that meet the requirements specified in this section.

(B) Cement. Portland cement, ASTM C 150, Type I or II. The cement shall be adequately protected from moisture and contamination while in transit and storage at the job site.

(C) Bentonite. Premium grade Wyoming sodium Montmorillonite, or equal, manufactured in accordance with American Petroleum Institute (API) Standard 13A. Grout mix shall not contain more than two (2) percent bentonite, by dry weight and cement, and shall contain an adequate amount of cement to meet the strength requirements specified in this section.

(D) Water. Fresh and potable water shall be used.

(E) Admixtures. Admixtures may be used as necessary to satisfy specified strength and permeability requirements and as required to improve pumpability, to control set time, and to prevent segregation and bleeding. Admixtures shall conform to ASTM C 494 requirements.

(F) Grout Mix. The grout mix utilized shall provide jet grout columns that meet the requirements specified in this section, as confirmed by the test program results specified herein.

Deliver all materials in undamaged and unopened containers bearing the manufacturer's original label. Store and handle grout materials in accordance with the manufacturer's recommendations.

657.04 Equipment.

(A) Drilling Equipment. All jet grouting equipment used for drilling boreholes; lowering, raising, and rotating grout tubes; mixing grout; injecting grout and air-water; and grout tubes shall have proven performance records

for use in performing similar jet grouting work and shall be suitable for the Work.

(B) Mixers. Grout mixers, holding tanks, mixing plan, and associated equipment shall be of a type and capacity for producing a uniform grout mixture at the times, and in the quantities required for the timely prosecution of the work.

(C) Jet Pumps. Pumps shall be high pressure pumps capable of delivering the grout at the flow rates and pressures required for the performance of the work in accordance with this section.

(D) Recording Equipment. Provide automatic recording equipment with a digital readout that will provide instantaneous, simultaneous records of the jet grouting parameters for each jet grout column at vertical intervals no greater than 0.5 feet. As a minimum, the digital drilling and grouting parameter recorder shall provide the following information: Date and time, depth, density of injected grout, cumulative injected volume of grout, grout injection pressure, grout injection rate of flow, air injection pressure, air injection rate of flow, and drill string revolutions per minute. A printed copy of the records shall be provided with the daily shift reports.

(E) Other. Spare parts and/or equipment shall be available on site to maintain jet grouting equipment in satisfactory operating condition at all times during execution of the jet grouting work. Any jet grout hole or column lost or damaged as a result of mechanical failure or equipment, inadequacy of grout, air, or water supplies, or improper drilling or injection procedures or anything that results in the jet grout hole or jet grout column, that in the opinion of the Engineer, does not meet the requirements of the Contract Documents shall be re-grouted, or backfilled with cement grout and/or replaced with another hole or jet grouted column at no additional cost to the State, using a remedial repair that is acceptable to the Engineer.

657.05 Pre-Construction Requirements.

(A) Experience Information. The Jet Grouting Contractor shall submit the following information to the Engineer for review and approval within 30 days after award of contract.

(1) The Jet Grouting Contractor shall submit a project reference list verifying the successful completion of at least five projects utilizing jet grouting in soft cohesive soils during the past three years totaling at least 2,000 cubic yards of soil stabilization by jet grouting. A brief description of each project with the Owner's name, contact person, and current phone number shall be included. Work shall not start nor materials ordered until the Engineer's written acceptance of the Contractor's qualification is given.

(2) The Jet Grouting Contractor shall submit a list identifying the on site superintendent and drill rig operators assigned to the project. A full-time jet-grouting superintendent, who has been in charge of supervising jet grouting operations on at least five similar jet grouting projects, shall be assigned to the project. The personnel list shall contain a summary of each individual's experience, which shall state the person's duties and position title on that particular project, and be complete enough for the Engineer to determine whether each individual satisfies the required qualifications. The Engineer will review and comment on the personnel list submittal. If the submittal is acceptable, then the Engineer will respond in writing on the acceptability of the submittal. If the submittal is not acceptable then the submittal will be returned and the Contractor will address all of the State's comments. The response shall include, if necessary, but shall not be limited to, the replacement of listed personnel. Modification to the personnel list shall be done at no additional cost to the State. No changing of the jet grouting superintendent will be allowed without the submittal and review of the replacement and its acceptance.

(3) The Jet Grouting Contractor shall submit a list identifying the AASHTO accredited independent testing agency to be utilized for the project. All testing shall be performed by an AASHTO accredited independent testing agency, which can certify compliance with the requirements of ASTM E 329. The laboratory shall be able to demonstrate experience performing the laboratory tests required herein.

The Engineer may suspend the Work if the Contractor uses personnel or a testing laboratory for the Work that has not been found acceptable by the Engineer. If work is suspended, the Contractor shall be fully liable for all resulting costs and no adjustment in contract time will result from the suspension.

(B) Work Plans and Grouting Methods. Submit a detailed work plan at least 30 days prior to the work describing the proposed grouting methods and equipment to be used including the following. Provide sufficient detail to allow the Engineer to be the sole judge of whether or not the proposed equipment, materials, and procedures will meet the requirements of this Contract. No jet grouting work shall start until the work plan and grouting method have been accepted in writing by the Engineer.

(1) Description of grout plant, equipment, and manufacturer's literature describing their capabilities.

(2) Methods and equipment proposed for drilling jet grout column holes.

(3) Arrangement and description of grout mixing, recording, and injection equipment, layout of jet grout columns based on the typical layout shown on the Contract Documents, and other details to illustrate the plan for setting up at each location where jet grouting is required.

(4) Schedule and sequence for completing jet grouting test program and production jet grouting work.

(5) Grout mix design, sources of mix materials, admixtures (including manufacturer's literature), and material data demonstrating compliance with requirements specified herein. Grout mix design shall include target range for specific gravity, Marsh Viscosity, and/or bleed that will produce acceptable grout strength. Provide 7 and 28-day design compressive strengths for neat cement grout mix.

(6) Quality control procedures including record keeping, field testing, sampling, and laboratory testing of completed jet grout columns.

(7) Manufacturer's catalogs of the required instrumentation equipment to be supplied and details of the proposed installation methods. The actual locations of the instrumentation required will be determined by the Engineer after evaluating the information from the test probes and the Contractor's submittal showing the exact locations of the production jet grout columns.

(8) NPDES Best Management Practices for all of the Contractor's jet grouting and related work.

(C) Jet Grout Test Program. The Contractor shall perform a test program based on the test jet grout column layout as shown on the Contract Documents. If the Contractor feels that the specified layout of the jet grout test columns does not provide adequate information for the Contractor to evaluate the conditions for the production work, the Contractor shall install additional test columns as part of the test section. Costs for the additional test columns shall be included in the cost of the test section. The Contractor shall demonstrate that the procedures for the test program, such as the proposed jet grouting methods and equipment, will produce acceptable results. Provide details of the sampling and testing programs to determine quality and properties of the jet grout columns installed. Subject to the results of the test program, the Engineer, at its sole discretion, may require the Contractor to modify the jet grout procedures and equipment to achieve acceptable results. Depending on the test program results, and extent of modifications necessary, the Contractor may be required to construct another test section, which shall be at no additional cost to the State. The location will be selected by the Engineer.

(3) Arrangement and description of grout mixing, recording, and injection equipment, layout of jet grout columns based on the typical layout shown on the Contract Documents, and other details to illustrate the plan for setting up at each location where jet grouting is required.

(4) Schedule and sequence for completing jet grouting test program and production jet grouting work.

(5) Grout mix design, sources of mix materials, admixtures (including manufacturer's literature), and material data demonstrating compliance with requirements specified herein. Grout mix design shall include target range for specific gravity, Marsh Viscosity, and/or bleed that will produce acceptable grout strength. Provide 7 and 28-day design compressive strengths for neat cement grout mix.

(6) Quality control procedures including record keeping, field testing, sampling, and laboratory testing of completed jet grout columns.

(7) Manufacturer's catalogs of the required instrumentation equipment to be supplied and details of the proposed installation methods. The actual locations of the instrumentation required will be determined by the Engineer after evaluating the information from the test probes and the Contractor's submittal showing the exact locations of the production jet grout columns.

(8) NPDES Best Management Practices for all of the Contractor's jet grouting and related work.

(C) Jet Grout Test Program. The Contractor shall perform a test program based on the test jet grout column layout as shown on the Contract Documents. If the Contractor feels that the specified layout of the jet grout test columns does not provide adequate information for the Contractor to evaluate the conditions for the production work, the Contractor shall install additional test columns as part of the test section. Costs for the additional test columns shall be included in the cost of the test section. The Contractor shall demonstrate that the procedures for the test program, such as the proposed jet grouting methods and equipment, will produce acceptable results. Provide details of the sampling and testing programs to determine quality and properties of the jet grout columns installed. Subject to the results of the test program, the Engineer, at its sole discretion, may require the Contractor to modify the jet grout procedures and equipment to achieve acceptable results. Depending on the test program results, and extent of modifications necessary, the Contractor may be required to construct another test section, which shall be at no additional cost to the State. The location will be selected by the Engineer.

(1) As part of the test program, the Contractor shall drill the test probes, each extending to depths of about 30 to 90 feet below the ground surface, at the approximate locations shown on the Contract Documents. The drill rig used to perform the test probes (including all sampling and testing equipment) shall have the capability to extend to depths of at least 120 feet below the ground surface. The test probes shall be for the purpose of obtaining additional subsurface information for the soil stabilization by jet grouting and to verify the subsurface conditions at the site. The locations of the test probes are as indicated on the Contract Documents. Soil samples (or continuous core samples using triple tube core barrels) shall be obtained from the test probes generally at 5-foot intervals in accordance with ASTM D 1586 and ASTM D 2113, or whenever directed by the Engineer. The sampling depths and intervals may be modified by the Engineer in the field. The test probes shall be performed in the presence and continuous monitoring of the Engineer. The Contractor shall provide the Engineer a minimum of 7 days advance notice to schedule the observation and logging of the test probes.

(2) The minimum unconfined compressive strength of the jet grout columns shall be 200 and 400 psi at 7 and 28 days, respectively, for the soil-cement material for jet grout columns.

(3) Conduct a test program to evaluate the proposed grouting methods and the ability of the proposed grout mix to produce jet grout columns meeting the diameter, depth, and material property requirements shown on the Contract Documents, the submittals found acceptable by the Engineer, and as specified herein. Test program shall be conducted and evaluated including the results of 28 day strength tests prior to starting production jet grouting work. The location of the test section is as shown on the Contract Documents. The Contractor may re-locate the test section location if found acceptable by the Engineer in writing. The new location shall be within 100 feet (laterally) of available boring data, or the Contractor shall provide pertinent subsurface data to the required test depths. The relocation of the test section and the supplying of the required pertinent subsurface data shall be at no additional cost to the State.

(4) The purpose of the test program shall be for the Contractor to determine appropriate jet grouting systems and grouting parameters for grout mix, grout pressures, rotational speed, lifting rate, grout flow rate, number and size of jet nozzles, and drilling methods, for the anticipated conditions where jet grouting is required. In addition, the test program also shall demonstrate that the Contractor's means and methods will achieve the specified diameter, depth, and material property requirements shown on the Contract Documents. During the

testing program, the Contractor shall utilize the same suitable jet grouting equipment available including water jet, and water/air jet, as it intends to use for its production jet grouting work.

(5) The jet grout test program shall be designed by the Contractor to verify the following items:

(a) The range of jet grout column diameters, inclination angles, jet grouting depths, and strengths that can be achieved.

(b) Maximum pressures that can be used before ground surface heave occurs.

(c) A minimum of one test section with the layout configuration as shown on the Contract Documents shall be performed. The test section shall consist of a minimum of three jet grout columns each 80 feet deep that are constructed using the same procedures and equipment proposed for the production jet grouting work. All test jet grout columns shall be installed from near the existing ground surface to allow for later excavation for physical inspection. Excavation to expose the jet grout columns of the test section (after the jet grout columns have hardened sufficiently) shall not be sooner than 7 days after the jet grout columns have been constructed.

(d) A minimum of six "feeler" pipes consisting of a minimum 1-inch diameter steel pipe shall be installed within the jet grout columns of the test section, as shown on the Contract Documents or as modified by the Engineer prior to jet grouting. The steel "feeler" pipes shall extend to the maximum depth of the jet grout columns of the test section.

(e) Execute the test program in accordance with the submittals found acceptable by the Engineer. The Contractor shall expose the upper 20 feet of the jet grout columns in the test section for physical inspection by the Engineer. Measure the jet grout column diameter and compare with the design parameters. Excavation to expose the jet grout columns of the test section shall be after the jet grout columns have hardened sufficiently and shall not be sooner than 7 days after the jet grout columns have been constructed.

(f) After the test jet grout columns have set up sufficiently, obtain continuous core samples (full depth of the jet grout column) from the jet grout columns of the test section (as shown on the Contract Documents) using the methods

specified in the paragraph entitled "Core Samples." The Engineer will inspect the core samples and check for segregation. Select six samples from each test jet grout column cored and perform compression tests on four of the samples in accordance with ASTM D 1633 or ASTM D 2850, as appropriate. Acceptance or rejection of the unconfined compressive strength of the jet grout column will be based on the average unconfined compressive strength test results of the four core samples obtained from the same jet grout column. The lowest unconfined compressive strength of the four core samples shall not be less than 80 percent of the minimum compressive strength indicated in the contract documents. In addition, only one of the four cores tested shall be below the minimum compressive strength indicated in the contract documents.

(g) If the results of the test program are not satisfactory, the Engineer may require modifications to the jet grout column construction procedures, material and equipment. Depending on the extent of the modifications, the Contractor shall be required to construct another test section, at no additional cost to the State until the Contractor's test program produces satisfactory results. The Contractor shall not start construction of any production jet grout columns until it receives written acceptance from the Engineer of the construction procedures, materials, and equipment developed in the testing program that produced acceptable results.

657.06 Construction Requirements.

(A) General Jet Grouting Procedures. Jet grout injection, grout rod rotation and extraction rates shall be sufficient to produce jet grout columns meeting the minimum diameter of 60 inches, depth and material property requirements specified in the contract documents, i.e., production jet grouting columns shall have the same material property requirements as the test jet grout columns except if noted in this subsection. Use the same equipment, materials, and procedures as those determined in the test program to achieve satisfactory results to perform production jet grouting work. The general procedure for constructing each individual jet grout column shall be as follows:

(1) The jet grout rod shall be advanced to the depth indicated on the drawings and accepted submittals (or as modified by the Engineer based on the test probes).

(2) The grout shall be pumped through the rods and water/air pumped through the nozzles. The rods shall be slowly rotated and

withdrawn in prescribed increments as determined in the test program creating the jet grout column.

(3) Excess grout and soil from jet grouting operations shall be contained in mud tanks or by other methods found acceptable by the Engineer to facilitate rapid cleanup of work area at the end of each shift and to prevent pollution. Dispose of all excess grout and soil at a site located outside project limits. . If encountered, contaminated soil and groundwater shall be disposed of in accordance with the applicable sections of the contract documents.

(4) The drilling and grouting sequence shall allow adequate set time between jet grout columns to complete a properly grouted zone.

(5) The Contractor shall implement best management practices in performing jet grouting work and to avoid any discharge of grout or return slurry into storm drainage structures or waters of Hawaii.

(6) Equipment for mixing, holding, and pumping grout shall be in a secure location and shall be operated to minimize spillage of material and release of dust into the environment. No water, waste, grout, bentonite or soil shall be allowed on the highway, and road pavements, sidewalks or be allowed to enter storm drains or waters of Hawaii.

(7) At the completion of daily jet grouting operations, thoroughly clean site and dispose of all debris, water, waste grout, and spilled material and clean and restore the pavement to allow passage of traffic.

(B) Construction Requirements. Use the same equipment, materials, and procedures as in the test program, which achieved satisfactory results to perform production jet grouting work and was found acceptable by the Engineer. No jet grout columns shall be constructed without all the required instruments and monitoring devices operating accurately and properly. The Contractor shall check all required instruments and monitoring devices at the start of jet grouting to assure that they are operating accurately and properly. No soil stabilization by jet grouting work shall start or continue if the required instruments and monitoring devices are not operating accurately and properly. The general procedure for constructing each individual jet grout column shall be as follows:

(1) Jet Grout Zones. The jet grout zones shall be constructed to the depths and minimum extent as indicated on the drawings or as modified by the Engineer in the submittals found acceptable by the Engineer. The Engineer will modify the depths and lateral extent of the jet grout zones for construction based on the results of the test

probes. The Engineer shall have 20 days after completion of all the test probes to evaluate the test probe data and to provide revised depths and minimum extents of the jet grouting for production work. The jet grout columns shall be vertical and/or inclined as required to avoid existing utilities or other surface features. Inclined columns shall not be flatter than 1:10 (horizontal to vertical).

(2) Unsatisfactory Jet Grout Columns. Additional replacement jet grout columns shall be installed, as directed by the Engineer, at no additional cost to the State, if the performance requirements of the jet grout columns (diameter, depth, and material property requirements) specified in the contract documents are not achieved. The additional replacement jet grout columns may be considered for additional compensation only if the Contractor can demonstrate to the satisfaction of the Engineer that the deficient jet grout column is not due to its means and methods.

(3) Jet Grout Column Locations.

(a) The jet grout column locations shall be drawn to scale based on the typical jet grout layout shown on the Contract Documents and numbered for the entire area requiring soil stabilization and shall be submitted to the Engineer for acceptance. The Engineer will determine the size of the plan sheets and the scale of the drawing. The jet grout column locations shall be surveyed, checked, and marked on the ground by the Contractor before the start of drilling and after installation. The jet grout column layout shall be based on the minimum jet grout column diameter shown on the Contract Documents and the submittal found acceptable by the Engineer. The Engineer may request adjustments to the jet grout column locations or inclination in the field to avoid utilities or other obstructions. The Contractor shall make these adjustments, when accepted by the Engineer, and document these modifications on as-built drawings. The location of each jet grout column shall be noted and recorded on the daily shift report.

(b) Obstructions. If the drill hole cannot be completed to the depth shown on the Contract Documents because of the presence of a man-made obstruction, grouting operations for that hole shall be temporarily suspended and the situation immediately reported to the Engineer. When directed by the Engineer, relocate the hole and install one or more inclined or vertical jet grout columns that provide at least the same zone of treatment as the original drill hole. If the obstruction is not a

live utility or a structural member, and is penetrable by rotary drilling methods, the drilling/grouting operation shall be continued. The presence of obstructions shall be noted and recorded on the daily shift reports. The portion of the jet grout column through an obstruction will not be subjected to the specified diameter and strength requirements. The Contractor will be required to meet the minimum diameter and strength requirements specified in the Contract Documents for the portion of the jet grout column above and below the obstruction.

(5) Jet Grout Column Inclination.

(a) Jet Grout Columns installed shall be vertical. Only when utilities or other man-made obstructions are encountered may the jet grout columns to be inclined to avoid those conflicts. The inclination of each jet grout column shall be noted and recorded on the daily shift report. The maximum inclination of the jet grout column shall not be flatter than 1:10 (horizontal to vertical) and shall also be within the inclination range determined by the test program unless accepted by the Engineer in writing.

(b) Before the start of drilling, the correct inclination of the mast shall be checked using a level by the operator. Measurements shall be made in at least two directions that are 90 degrees apart from each other.

(c) The drilling/grouting rods shall be of sufficient stiffness to ensure that the deviation of jet grout columns from the theoretical axis is maintained at 1:200 (horizontal to vertical) or less.

(6) Jet Column Depth and Height. Jet grout column depth and height shall be as indicated on the Contract Documents and the submittals found acceptable by the Engineer. If the plans and the submittals have a conflict, the Engineer will determine which jet grout column depth and height will be used. To ensure that the correct jet grout column depth elevations are achieved in the jet grouting process, jet grout column depth elevations shall be converted to jet grout column depths on a hole by hole basis by the Contractor. This information will then be provided to the drill operator for use in determining the correct depths to be used in the field.

(a) The jet grout column depth shall be measured with respect to ground level by observing the length of the rods inserted. Markings shall be located on the drill mast in 1-foot

increments to assist the drill operator in determining the exact depth. In addition, the jet grout column depth shall be verified with an electronic depth meter and shall be recorded by the digital drilling and grouting parameter recorder and a printed report of the data shall be included with the daily shift reports.

(b) The depth to the bottom and height of each jet grout column shall be noted and recorded on the daily shift report.

(7) Grout Mixing. A mixing plant shall be used for the preparation of the grout. The mixing plant shall consist of cement silo, high-speed grout mixer, grout agitator, grout pumps and control unit, as required. The plant shall be capable of supplying a uniform grout mixture in the quantities required for timely prosecution of the work.

(a) Mix cement, water, and any admixtures in the proportions indicated in the submittals accepted by the Engineer. If bentonite is used, add bentonite to water and mix thoroughly to fully hydrate prior to adding cement. Time of mixing shall be as required to fully hydrate the cement but not less than 5 minutes. Any grout after 90 minutes of mixing shall not be used and shall be wasted and properly disposed.

(b) The grout mix proportions for each jet grout column shall be noted and recorded on the daily shift reports.

(8) Grout Injection Rate and Pressure.

(a) The grout injection rate shall be monitored by counting the strokes of the piston pump in a fixed period of time and shall be confirmed by using an electronic flow meter.

(b) Use automatic recording equipment to measure the volume of grout injected into each jet grout column.

(c) The grout injection pressure shall be monitored with calibrated pressure gauges mounted on the injection lines. Prior to the start of each jet grout column, the pressure shall be checked to verify that there is no blockage in the jet grout rods. Maintain an adequate supply of backup pressure gauges to replace broken or defective gauges without delaying the work.

(d) The grout injection rate, volumes injected, and injection pressure for each jet grout column shall be noted and recorded on the daily shift reports. The grout injection rate, the volume of grout injected, and injection pressures shall be recorded by the digital drilling and grouting parameter recorder and a

printed report of the data shall be included with the daily shift reports.

(9) Air/Water Pressure. The air pressure shall be checked on the pressure gauges mounted on the compressor and drill rig. The air pressure shall be noted and recorded for each jet grout column on the daily shift reports. The air pressure shall also be recorded by the digital drilling and grouting parameter recorder and a printed report of the data shall be included with the daily shift reports.

(10) Rotation and withdrawal Rate.

(a) The rate of rotation shall be controlled by adjusting the rotary head speed. It shall be checked by counting the number of rotations of the drilling/grouting rods in a fixed period of time and shall be recorded by the digital drilling and grouting parameter recorder and a printed report of the data shall be included with the daily shift reports.

(b) The rate of withdrawal shall be controlled by an electronic sensor mounted on the mast. It shall be checked measuring the length of the drilling/grouting rods extracted in a fixed period of time and shall be recorded by the digital drilling and grouting parameter recorder and a printed report of the data shall be included with the daily shift reports.

(c) The rate of rotation and withdrawal of jet grout rods shall be noted and recorded for each jet grout column on the daily shift reports.

(11) Prevention of Ground Heave. The Contractor is responsible to control ground heave during jet grouting. In order to prevent ground heave during jet grouting, the drilling shall be carried out with an oversize drill bit with respect to the drilling/grouting rods.

The annulus between the rods and the borehole shall be kept free at all times during the grouting. In case the return of the spoil becomes partially blocked, grouting shall be stopped and the blockage shall be cleared by the Contractor before grouting operations are resumed.

(12) Materials and Sampling. During the installation of all production jet grout columns, quality control sheets shall be submitted to the Engineer to document the results of the tests carried out on grout and soil-cement samples. Test results shall be submitted, as they are completed, but no later than seven days after they are completed.

(C) Jet Grouting Reports. Prepare and submit daily shift reports for the jet grouting test program and the production jet grouting. The Contractor's proposed report forms shall be submitted to the Engineer for approval prior to the start of work. As a minimum, the reports shall include the following:

(1) Indicate the equipment used on site, including grout batch plant, drill rig, power supply and drill tooling.

(2) Indicate the location of the jet grouting work by station and indicate on a sketch or drawing.

(3) Jet grout column identification including column number, diameter, length, location, and inclination.

(4) Time and date of beginning and completion of each jet grout column. Note any interruptions or delays and the causes of these interruptions or delays.

(5) Grout mix data, including mix proportions and other materials used in the construction of the jet grout column.

(6) Grout flow rates, grout pressure, density and total grout quantity used to construct each jet grout column.

(7) Water/air jet pumping pressures used to construct each jet grout column.

(8) Rates of rotation and withdrawal of jet rods for each jet grout column including the jet grout column bottom depth.

(9) Number and identification of grout and soil-cement samples obtained.

(10) Other pertinent observation, such as utilities, presence of obstructions, loss of spoil/grout return, grout escape, ground heave, or other unusual behavior during drilling or grouting.

(11) As-built drawings indicating the locations of jet grout columns installed and temporary restoration details for the highway pavement.

(D) Quality Control. All quality control testing for the grout mix, grout and soil-cement samples, core samples etc., mentioned below in this sub-section shall be done by the Contractor's AASHTO accredited independent testing laboratory, which was found acceptable by the Engineer.

(1) Grout Mix. Grout mix uniformity shall be verified by the Contractor by unit weight (density) measurements of the mixed grout

by mud balance, Marsh Viscosity, and/or bleed from samples taken from the grout return line in the presence of the Engineer. Testing shall be performed in accordance with API Standard 13B test method. Testing frequency shall be at least one group of tests for every two hours that grout is mixed and pumped. Complete and accurate records shall be kept to verify that grout mix is acceptable.

(2) Grout and Soil-Cement Samples.

(a) During the execution of the production jet grout columns, the Contractor shall measure the following items daily on the liquid samples of grout:

1. Unit Weight,

2. Marsh Viscosity, or

3. Bleeding at 1 and 2 hours.

(b) The following wet samples shall be taken by the Contractor at locations designated by the Engineer for testing (costs for all testing will be considered incidental to the jet grouting work):

1. Two sets of three samples each (6 samples total) of the cement grout used for the construction of one of the jet grout columns shall be fabricated in accordance with ASTM C 109. The Engineer will select a total of 10 jet grout columns for which samples shall be fabricated and tested by the Contractor.

2. Two sets of three wet samples (6 samples total) of the soil-cement mixture shall be obtained from within the jet grout column before it has reached its initial set. These "wet" samples shall be taken from locations and depths designated by the Engineer by the Contractor. The Engineer will select a total of 10 jet grout columns for which wet samples shall be obtained and tested by the Contractor.

3. Each of these samples shall be stored in a damp environment at constant temperature in accordance with applicable ASTM procedures (ASTM D 1632) by the Contractor's laboratory. Cylinder molds shall be sized accordingly, to provide a representative sample of soil-cement. Pieces of debris, gravel, coral, or clay

balls should be screened off using an appropriate sieve, as determined appropriate by the Engineer.

4. After the samples have cured sufficiently, they shall be taken to the Contractor's AASHTO accredited independent testing laboratory for testing.

5. For each jet grout column being tested two grout samples and two soil-cement samples shall be subjected to a compressive strength test at 7 days in accordance with ASTM C 39 or C 109 and ASTM D 1633, respectively. The remaining samples taken from that jet grout column shall be subjected to compressive strength test at 28 days following the appropriate ASTM testing procedures.

(3) Core Samples. In addition to the wet samples, when the jet grouting has reached sufficient strength, a total of twenty (20) jet grout columns shall have vertical core samples taken from the full depth of the treated zone. The locations will be selected by the Engineer (generally located within the outer one-third of the jet grout column). Recovery of the core within the treated zone shall not be less than 85% or the Contractor shall core additional holes until the recovery requirement is met. This shall be done at no additional cost to the State. The drill hole resulting from the coring operations shall be grouted with sand-cement grout to seal the hole and is incidental to the core samples.

(a) The coring or sampling operations shall be scheduled according to the jet grouting and construction activities schedule and performed with suitable equipment in the presence of the Engineer.

(b) Triple tube core barrels with thin walls shall be employed to obtain a continuous core sample of the jet grout columns. The nominal size of the core barrel shall be 2.5-inch ID or greater. Drilling shall be performed using rotary wash or air rotary methods by an experienced driller familiar with performing triple tube coring of weakly cemented soils or soft rocks.

(c) All cores and samples shall be taken to the Contractor's AASHTO accredited independent laboratory where they shall be stored in a moist environment at constant temperature in accordance with ASTM D 1632. Extreme care shall be exercised in handling the cores at the site, in transport, and at

the laboratory such that the cores do not become disturbed or otherwise damaged prior to testing.

(d) The cores of jet grout columns shall be examined for continuity of the treatment by the Engineer. The Engineer will designate what portion of the core shall be used for the compressive strength test and then those portions of the core shall be subjected to unconfined compressive strength tests at 28 days. A minimum of four unconfined compressive strength tests shall be performed for each cored location. Acceptance of the minimum unconfined compressive strength of the jet grout column will be based on the average unconfined compressive strength test results of the four core samples obtained from the same jet grout column. The lowest unconfined compressive strength of one of the core samples shall not be less than 80 percent of the minimum compressive strength indicated in the contract. The remaining three core samples shall meet or exceed the minimum compressive strength indicated in the contract. All testing results shall be recorded on a quality control sheet.

(e) If samples tested do not meet specified strength requirements or if the unconfined compressive strength of any of the core samples is less than 80 percent of the minimum compressive strength, then additional replacement jet grout columns shall be installed, or other provisions shall be implemented, as accepted by the Engineer, to compensate for the lower strength jet grout columns at no additional cost to the State.

(4) Steel "Feeler" Pipes: To evaluate the diameter of the jet grout columns, a "feeler" pipe consisting of a minimum 1.0-inch diameter steel pipe shall be installed in ten (10) percent of the total number of jet grout columns. The steel 'feeler' pipes shall be installed in jet grout columns designated by the Engineer prior to jet grouting the jet grout column. The steel "feeler" pipes shall extend to the maximum depth of the jet grout columns. The steel "feeler" pipes shall also extend to the maximum radius of the jet grout columns to evaluate the radial extent of the jet grouting. Steel "feeler" pipes shall be installed in predrilled holes (4 to 6 inches in diameter), and the annulus between the steel "feeler" pipe and the predrilled hole does not need to be backfilled. The Contractor shall monitor the steel "feeler" pipes in the presence of the Engineer to evaluate if the jet grouting parameters need to be adjusted to meet the specified requirements.

(E) Instrumentation and Monitoring. The multi-level vibrating wire piezometers, the settlement plates equipped with vibrating wire pressure sensors and the data collection system shall be compatible with each other and work seamlessly with each other without any additional hardware or software not provided with these instruments.

(1) Multi-level Vibrating Wire Piezometers. The Contractor shall retain the services of an experienced Geotechnical Engineer (QUALIFICATIONS?) to furnish and install a minimum of six multi-level vibrating wire piezometers. The six multi-level vibrating wire piezometers shall be installed in accordance with the manufacturer's recommendations in the subsurface prior to production jet grouting work. Piezometers shall utilize vibrating wire pressure transducer technology capable of being installed in a drilled borehole. Vibrating wire piezometers shall be capable of measuring water pressures between -10 and 120 feet of water pressure with an accuracy of plus or minus 0.1%. Cables for the vibrating wire piezometers shall be of sufficient length to extend from the designated depths to a secured shelter or enclosure located beyond the toe of the embankment. Each set of multi-level vibrating wire piezometers shall consist of three individual piezometers with the first level starting at the top of the jet grout column and at depths of about 8 and 20 feet below the top of the jet grout columns. The exact locations of the six multi-level vibrating wire piezometers will be determined by the Engineer based on the test probe information and the submittal showing the actual locations of the production jet grout columns. The locations of the six multi-level vibrating wire piezometers generally will be in the center between three adjacent jet grout columns.

(2) Settlement Plates Equipped with Vibrating Wire Pressure Sensor. The Contractor shall retain the services of an experienced Geotechnical Engineer to furnish and install a minimum of twelve settlement plates equipped with vibrating wire pressure sensors in accordance with the manufacturer's recommendations. The exact locations of the of twelve settlement plates equipped with vibrating wire pressure sensors will be determined by the Engineer. The settlement plates equipped with vibrating wire pressure sensors shall be embedded below the existing ground surface by about 3 feet and shall be backfilled with sand. The settlement plates and associated equipment shall be installed a minimum of 10 days prior to any embankment activities (including RSS and SRW-2) and after the production jet grouting work. Each settlement plate shall be equipped with a vibrating wire pressure sensor attached to the settlement plate and is connected via two liquid filled tubes, extending laterally, to a reservoir placed within a remote readout enclosure or shelter located on stable ground (at least 40 feet away from the toe of the

embankment). The vibrating wire pressure sensor shall be capable of measuring up to 20 feet of elevation differential with an accuracy of plus or minus 0.1%. Cables for the vibrating wire pressure sensors on the settlement plates shall be of sufficient length to extend from the designated depths to a shelter or enclosure located beyond the toe of the embankment (RSS and/or SRW-2).

(3) Instrumentation Monitoring. A data collection system capable of remote data collection, readout, and storage shall be provided and shall be connected to the vibrating wire piezometers and vibrating wire pressure sensors. The data collection system shall be capable of obtaining at least one reading every 10 minutes. The Contractor shall download the data from the data collection system on a weekly basis and shall submit the data to the Engineer in an electronic format and media chosen by the Engineer. Data from the piezometers shall be monitored and downloaded on a weekly basis starting from the jet grouting operations, throughout the construction period and extending at least 4 months after the embankment (RSS and/or SRW-2) has attained the finished subgrade elevation (bottom of pavement structural section). All instrumentation damaged by the Contractor's operations, or in the opinion of the Engineer is not performing as required, shall be replaced at the Contractor's expense within 7 days.

657.07 Method of Measurement.

(A) Furnishing Jet Grouting Equipment. The Engineer will not measure furnishing jet grouting equipment for payment.

(B) Jet Grout Test Program. The Engineer will not measure the jet grout test program (excluding the test probes) for payment.

(C) Test Probes. The Engineer will measure the test probes per linear foot. The Engineer will measure the vertical distance between the ground surface and the final tip elevation accepted by the Engineer of the test probes. The Engineer will maintain a test probe log for payment.

(D) Instrumentation and Monitoring. The Engineer will not measure the instrumentation and monitoring program for payment.

(E) Jet Grout Columns. The Engineer will measure jet grout columns per linear foot. The Engineer will measure the length along the centerline of the jet grout columns. The length shall be the elevation difference between the top of jet grout column and the final tip elevation of the jet grout column that have both been accepted by the Engineer. The Engineer will maintain a log of the jet grout column construction for payment. The Engineer will not

measure any length of jet grout columns constructed due to unauthorized grouting.

657.08 Basis of Payment.

(A) Furnishing Jet Grouting Equipment. The Engineer will pay for the accepted furnishing jet grouting equipment on a lump sum basis complete in place. The price includes full compensation for furnishing and moving the jet grouting equipment and necessary tools and equipment to the project, setting the equipment up at the locations and removing the equipment from the project.

The Engineer will make payment of 60% of the contract amount for this item when all jet grouting equipment and supplies are available at the project site and ready to conduct the Test Program.

The Engineer will make payment for the remaining 40% of the contract amount when all the jet grout columns haves been placed up to the top of the jet grout column elevation and accepted.

(B) Jet Grout Test Program. The Engineer will pay for the accepted jet grout test program on a lump sum basis (excluding the test probes) complete in place.

The price includes full compensation for all laboratory testing, installing the test jet grout columns to the required diameter and depths, excavating to expose the test jet grout columns, coring, sampling, and testing of the core samples, backfilling of the test jet grout column areas and furnishing labor, materials, equipment, tools and incidentals (including quality control and traffic control measures) necessary to complete the work.

(C) Test Probes. The Engineer will pay for the accepted test probes at the contract unit price per linear foot complete in place.

The price includes full compensation for drilling and sampling the test probes to the required depths and backfilled with grout, obtaining all necessary permits and clearance of utility lines, and furnishing all materials, including labor, equipment, and incidentals necessary to complete the work as specified and as shown on the Contract Documents, or designated by the test program or Engineer, including surface restoration, traffic control, and disposal of soils generated from the drilling of the test probes.

(D) Instrumentation and Monitoring. The Engineer will pay for the accepted instrumentation and monitoring on a lump sum basis complete in place.

The price includes full compensation for furnishing and installing all the required instrumentation, in accordance with the manufacturer's recommendations, by an experienced Geotechnical Engineer and taking all the readings at the specified minimum intervals for the duration noted, and furnishing labor, materials, equipment, tools and incidentals necessary to complete the work.

(E) Jet Grout Columns. The Engineer will pay for the accepted jet grout columns at the contract unit price per linear foot complete in place. The Engineer will not pay for unsatisfactory jet grout columns, and the Engineer will not pay for any unauthorized length of additional jet grout columns.

The price includes full compensation for installing the jet grout columns to the required diameter and depths, installing steel "feeler" pipes, coring, sampling, and testing of the core samples, and furnishing all materials, including labor, equipment, and incidentals necessary to complete the work as specified and as shown in the Contract including quality control measures, surface restoration, traffic control, and disposal of all waste grout and excess spoils.

The Engineer will make payment under the following:

Pay Item	**Pay Unit**
Furnishing Jet Grouting Equipment	Lump Sum
Jet Grout Test Program	Lump Sum
Test Probes	Linear Foot
Instrumentation and Monitoring	Lump Sum
Jet Grout Columns (___)	Linear Foot"

END OF SECTION