

R-2206B

Project Special Provisions
Erosion Control

Lincoln County

Seeding And Mulching

(6)

The kinds of seed and fertilizer, and the rates of application of seed, fertilizer, and limestone, shall be as stated below. During periods of overlapping dates, the kind of seed to be used shall be determined by the Engineer. All rates are in pounds per acre (kilograms per hectare).

August 1 - June 1

May 1 - September 1

100# (110kg) Tall Fescue	100# (110kg) Tall Fescue
15# (17kg) Kentucky Bluegrass	15# (17kg) Kentucky Bluegrass
15# (17kg) Hard Fescue	15# (17kg) Hard Fescue
500# (560kg) Fertilizer	25# (28kg) Kobe or Korean Lespedeza
4000# (4500kg) Limestone	500# (560kg) Fertilizer
	4000# (4500kg) Limestone

Approved Tall Fescue Cultivars:

Adventure	Adventure II	Amigo	Anthem
Apache	Apache II	Arid	Austin
Brookstone	Bonanza	Bonanza II	Chapel Hill
Chesapeake	Chieftain	Coronado	Crossfire II
Debutante	Duster	Falcon	Falcon II
Finelawn Petite	Finelawn	Finelawn I	Genesis
Grande	Guardian	Houndog	Jaguar
Jaguar III	Kentucky 31	Kitty Hawk	Monarch
Montauk	Mustang	Olympic	Pacer
Phoenix	Pixie	Pyramid	Rebel
Rebel Jr.	Rebel II	Renegade	Safari
Shenandoah	Tempo	Titan	Tomahawk
Trailblazer	Tribute	Vegas	Wolfpack
Wrangler			

Approved Kentucky Bluegrass Cultivars:

Adelphi	Baron	Bristol	Challenger
Columbia	Fylking	Glade	Kenblue
Merit	Plush	Ram I	Rugby
Sydsport	Touchdown	Vantage	

Approved Hard Fescue Cultivars:

Aurora	Bardur	Crystal	Reliant	Scaldis
Spartan	Valda	Waldina	Warwick	

On cut and fill slopes 2:1 or steeper add 25# (28kg) Rye Grain November 1 - March 1.

On cut and fill slopes 2:1 or steeper add 30# (35 kg) Sericea Lespedeza January 1 - December 31.

Fertilizer shall be 10-20-20 analysis. Upon written approval of the Engineer, a different analysis of fertilizer may be used provided the 1-2-2 ratio is maintained and the rate of application adjusted to provide the same amount of plant food as a 10-20-20 analysis.

Temporary Seeding:

Fertilizer shall be the same analysis as specified for "Seeding and Mulching" and applied at the rate of 400 pounds (450kg) and seeded at the rate of 50 pounds per acre (55kg per hectare). Kobe or Korean Lespedeza, German Millet, or Browntop Millet shall be used in summer months and rye grain during the remainder of the year. The Engineer will determine the exact dates for using each kind of seed.

Fertilizer Topdressing:

Fertilizer used for topdressing shall be 16-8-8 grade and shall be applied at the rate of 500 pounds per acre (560 kg per hectare). Upon written approval of the Engineer, a different analysis of fertilizer may be used provided the 2-1-1 ratio is maintained and the rate of application adjusted to provide the same amount of plant food as 16-8-8 analysis.

Supplemental Seeding:

The kinds of seed and proportions shall be the same as specified for "Seeding and Mulching", and the rate of application may vary from 25# to 75# per acre (28kg to 85kg per hectare). The actual rate per acre (hectare) will be determined by the Engineer prior to the time of topdressing and the Contractor will be notified in writing of the rate per acre (hectare), total quantity needed, and areas on which to apply the supplemental seed. Minimum tillage equipment, consisting of a sod seeder shall be used for incorporating seed into the soil as to prevent disturbance of existing vegetation. A clodbuster (ball and chain) may be used where degree of slope prevents the use of a sod seeder.

Mowing:

The minimum mowing height on this project shall be six inches (150 mm).

Lawn Type Appearance

All areas adjacent to lawns must be hand finished as directed by the Engineer to give a "lawn type appearance". Remove all trash, debris, and stones $\frac{3}{4}$ inch (19 mm) and larger in diameter or other obstructions that could interfere with providing a smooth "lawn type appearance".

Specialized Seeding Under Guiderail and Guardrail (Hard Fescue/Bluegrass):**General:**

Areas under guiderail and guardrail sections shall be seeded in accordance with these provisions and as directed by the Engineer. Perform the work covered by this provision including but not limited to litter and debris removal, mowing, disposal of weeds and other unacceptable growth, grading, soil preparation and amendment, surface smoothing, seed applications, and matting installation.

Materials:

Only approved Hard Fescue and Kentucky Bluegrass seed that complies with Section 1060 of the Standard Specifications shall be used.

Soil Preparation:

Remove litter and other debris. Mow and satisfactorily dispose of weeds or other unacceptable growth on the areas to be seeded.

Prior to seeding, all eroded, uneven and rough areas shall be contour graded and/or filled with soil as directed by the Engineer. The soil shall be scarified or otherwise loosened to a depth of not less than 5 inches (130 mm) with a minimum width of 48 inches (1145 mm) and a maximum width of 52 inches (1320 mm). Clods shall be broken and the top 2 to 3 inches (52 to 78 mm) of soil shall be worked into an acceptable soil bed by the use of soil pulverizers, drags, or harrows.

Soil amendments shall be as follows:

Limestone: Limestone shall be applied at a rate of 4000 pounds (4500 Kg/Hectare) per acre.

Fertilizer: Fertilizer shall be 10-20-20 analysis and applied at a rate of 500 pounds (560kg/Hectare) per acre.

After soil preparation, lime and fertilizer shall be uniformly distributed by mechanical means using a 48 inch (1065 mm) drop type spreader and thoroughly mixed with the top five inches (130 mm) of the soil by discing, harrowing, or other approved methods.

The area shall then be harrowed, dragged, raked, or prepared by other approved methods which will give a lawn type finish. All trash, debris and stones larger than 1-1/2 inch (38 mm) in diameter or other obstructions shall also be removed.

Application:

(Hard Fescue/Bluegrass) seed shall be uniformly distributed at a rate of 75 pounds per acre (85 kilograms per hectare) of Hard Fescue and 20 pounds per acre (28 kilograms per hectare) of Kentucky bluegrass by mechanical means.

Immediately following the placement of seed, the area shall be rolled or tamped carefully and firmly by means acceptable to the Engineer to ensure a smooth surface. Use of rubber tired equipment to roll shall not be allowed.

Matting:

Immediately upon completion of seeding work and herbicidal application, 48 inch wide matting shall be installed over the seeded area in accordance with Section 1631 of the Standard Specifications.

Basis of Payment:

The quantity of "Specialized Seeding Under Guiderail and Guardrail (Hard Fescue/Bluegrass)" to be paid for will be the actual number of acres (hectares) of guiderail and guardrail sections, measured along the surface of the ground, over which acceptable seeding has been performed. The quantity of seeding will be paid for at the contract unit price per acre (hectare) for "Specialized Seeding Under Guiderail and Guardrail (Fescue/Bluegrass)".

No payment shall be made for "Specialized Seeding Under Guiderail and Guardrail (Fescue/Bluegrass)" in which the work has not been satisfactorily completed. Complete work includes but is not limited to soil preparation, surface smoothing, seeding, and matting.

Specialized Hand Mowing:

The work covered by this section consists of specialized hand mowing around or under fixed objects, including but not limited to guardrails, signs, barriers and slopes in a method acceptable to the Engineer.

The work of specialized hand mowing shall be completed with mechanically powered trimmers, string trimmers, hand operated rotary mowers, or self-propelled mowers of sufficient size and quality to perform the work timely and efficiently.

The quantity of mowing to be performed will be affected by the actual conditions which occur during the construction of the project. The quantity of mowing may be increased, decreased or eliminated entirely at the direction of the Engineer. Such variations in

quantity will not be considered as alterations in the details of construction or a change in the character of the work.

The quantity of specialized hand mowing to be paid for will be the actual number of man hours worked while hand mowing along the surface of the ground, at the direction of the Engineer. Where an area has been mowed more than once, at the direction of the Engineer, separate measurement will be made each time the area is mowed.

Payment will be made under:

Specialized Hand MowingHR

Minimize Removal Of Vegetation

The Contractor shall minimize removal of vegetation at stream banks and disturbed areas within the project limits as directed by the Engineer.

Stockpile Areas

The Contractor shall install and maintain erosion control devices sufficient to contain sediment around any erodible material stockpile areas as directed by the Engineer.

Culvert Diversion Channel:

Description:

Provide a culvert diversion channel to detour existing stream around the culvert construction site at locations shown on the plans. Work includes constructing diversion channel, disposing of excess materials, providing and placing filter fabric liner, maintaining diversion area in an acceptable condition, removing filter fabric liner, backfilling diversion channel area with suitable material and providing proper drainage when diversion channel area is abandoned.

Material:

Use local material or material specified on plans.

Provide filter fabric to meet requirements of Section 1056 for Type 2 fabric.

Construction requirements:

Grade channel according to plan with channel surface free of obstructions, debris, and pockets of low density material.

Utilize suitable material and provide disposal area for unsuitable material.

Line channel with fabric unrolled in the direction of flow and lay smoothly but loosely on soil surface without creases. Bury top of slope fabric edge in a trench at least five inches (125mm) deep and tamp.

Make vertical overlaps a minimum of eighteen inches (450mm) with upstream fabric overlapping the downstream fabric.

Secure fabric with eleven gauge (3.05mm) wire staples shaped into a "u" shape with a length of not less than six inches (150mm) and a throat not less than one inch (25mm) in width. Place staples along outer edges and throughout the fabric a maximum of three feet (one meter) horizontally and vertically.

Method of Measurement:

Measurement of excavation will be made by the cubic yard (cubic meter) of excavation as calculated from the typical section throughout the length of the diversion channel as shown on the final approved plans.

Measurement of filter fabric will be made by the number of square yards (square meters) as measured over the surface of the ground over which filter fabric has been acceptably placed.

No measurement will be made for other items or for over excavation or stockpiling.

Basis of Payment:

Payment will be made for the quantities as measured above under the items listed below:

Culvert Diversion ChannelCY (M3)

Filter Fabric for Drainage SY (M2)

Impervious Dike:

The work covered by this section consists of furnishing, installing, maintaining, and removing an impervious dike for the purpose of diverting normal stream flow around the construction site. The Contractor shall construct an impervious dike in such a manner approved by the Engineer. The impervious dike shall not permit seepage of water into the construction site or contribute to siltation of the stream. The impervious dike shall be constructed of an acceptable material in the locations noted on the plans or as directed by the Engineer.

Acceptable materials shall include but not be limited to sheet piles, sandbags, and/or the placement of an acceptable size stone lined with polypropylene or other impervious fabric.

Earth material shall not be used to construct an impervious dike when it is in direct contact with the stream unless vegetation can be established before contact with the stream takes place.

The quantity of impervious dike to be paid for will be the actual number of linear feet (meters) of impervious dike(s) constructed, measured in place from end to end of each separate installation which has been completed and accepted.

The quantity of impervious dikes measured as provided above will be paid for at the contract unit price per linear foot (meter) for "Impervious Dike".

The above prices and payments will be full compensation for all work covered by this section including but not limited to furnishing all of the materials in the impervious dike, construction, maintenance, and removal of the impervious dike.

Temporary Pipe For Culvert Construction:

The work covered by this section consists of furnishing, installing, maintaining and removing any and all temporary pipe used on this project in conjunction with the culvert construction. The Contractor shall install temporary pipe in locations shown on the plans in such a manner approved by the Engineer. The temporary pipe shall provide a passage-way for the stream through the work-site. The minimum size requirements will be as stated on the Erosion and Sediment Control plans.

The quantity of temporary pipe to be paid for will be the actual number of linear feet (meters) of temporary pipe approved by the Engineer and measured in place from end to end.

The quantity of temporary pipe measured as provided above will be paid for at the contract unit price per linear foot (meter) for "___ inch (mm) Temporary Pipe".

The above prices and payments will be full compensation for all work covered by this section including but not limited to furnishing all materials required for installation, construction, maintenance, and removal of temporary pipe.

Reforestation:

Reforestation will be planted within interchanges and along the outside borders of the road, in areas designated by the Engineer. Reforestation is not shown on the plan sheets. See the reforestation detail sheet.

Seasonal limitations: Seedlings shall be planted from November 15 through March 15.

Seedlings shall be planted as soon as practical following permanent Seeding and Mulching. Seedlings shall be planted in a 16 ft. (5 meters) wide swath adjacent to mowing pattern line.

Root dip: The roots of reforestation seedlings shall be coated with a slurry of water, and either a fine clay ("kaolin") or a superabsorbent that is made to be used as a bare root dip. The type, mixture ratio, method of application, and the time of application shall be submitted to the Engineer for approval. With the approval of the Engineer, seedlings may be coated before delivery to the job or at the time of planting, but at no time shall the roots of the seedlings be allowed to dry out. The roots shall be moistened immediately prior to planting.

Streambank Reforestation:

Streambank reforestation will be planted in areas designated on the plans and as directed by the Engineer. See the streambank reforestation detail sheet.

Seedlings shall be planted as soon as practical following permanent seeding and mulching. Type I seedlings shall be planted along both streambanks. Type II seedlings shall be planted in a 26 ft. (8 meters) wide swath from top of bank along both sides of stream.

Seasonal limitations: Seedlings shall be planted from November 15 through March 15.

Root dip: the roots of reforestation seedlings shall be coated with a slurry of water, and either a fine clay ("kaolin") or a superabsorbent that is made to be used as a bare root dip. The type, mixture ratio, method of application, and the time of application shall be submitted to the Engineer for approval.

With the approval of the Engineer, seedlings may be coated before delivery to the job or at the time of planting, but at no time shall the roots of the seedlings be allowed to dry out. The roots shall be moistened immediately prior to planting.

Measurement:

The quantity of streambank reforestation to be paid for will be the actual number of acres (hectares) of land, measured along of the surface of ground, which has been acceptably planted with seedlings in accordance with these specifications.

Payment:

The quantity of streambank reforestation will be paid for at the contract unit price per acre (hectare) for "Streambank Reforestation".

Payment will be made under:

Streambank Reforestation.....ACR (HA)

Rootwads:

The Contractor shall identify and stockpile rootwads encountered during Clearing and Grubbing. These shall be used to stabilize the streambank after its construction.

Rootwads to be used for streambank stabilization should have a trunk diameter of 0.3 to 0.45 meters and should have 3 meters of the trunk length remaining. The Contractor, upon removal of the trunk and root, shall remove soil to the extent acceptable to the Engineer. Care shall be taken to preserve the root structure and shown on the detail in the plans.

Method of Measurement:

The quantity of rootwads measured will be paid for according to the actual number of rootwads each, as installed and accepted by the Engineer.

Basis of Payment:

The quantity of rootwads, measured as provided above, will be paid for at the contract unit price per each for "Rootwads". The above prices and payments will be full compensation for all work covered by this section, including but not limited to excavation, furnishing and installing all rootwads, footer logs, cut-off logs, anchor rocks, and fill material.

Payment will be made under:

Rootwads.....EACH

Coir Fiber Mat

Description

Furnish material, install and maintain coir fiber mat in locations shown on the plans or in locations as directed by the engineer. Work includes providing all materials, excavating and backfilling, and placing and securing Coir Fiber Matting.

Materials

(A) Matting:

Provide matting to meet the following requirements:

- 100 % coconut fiber (coir) twine woven into a high strength matrix.
- Thickness - 0.30 in. minimum. (7.6 mm)
- Tensile Strength - 1348 x 626 lb/ft minimum (1650.5 x 766.5 kg/m)
- Elongation - 34% x 38% maximum
- Flexibility (mg-cm)- 65030 x 29590

Flow Velocity-	Observed 11 ft/sec (3.35 m/s)
Weight -	20 oz/SY (678 g/SM)
Size -	6.6 x 164 ft (120 SY) or (100 SM)
“C” Factor -	0.002
Open Area (measured) -	50%

(B) Staples:

Provide staples made of 0.125 in. (3.05 mm) diameter new steel wire formed into a “U” shape not less than 12 in. (300) mm in length with a throat of 1 in. (25 mm) in width.

Construction Methods

Place the matting immediately upon final grading. Provide a smooth soil surface free from stones, clods, or debris which will prevent the contact of the matting with the soil. Take care to preserve the required line, grade, and cross section of the area covered.

Unroll the matting and apply without stretching such that it will lie smoothly but loosely on the soil surface. Bury the top slope end of each piece of matting in a narrow trench at least 6 in. (150 mm) deep and tamp firmly. Where one roll of matting ends and a second roll begins, overlap the end of the upper roll over the buried end of the second roll so there is a 6 in. (150 mm) overlap. Construct check trenches at least 12 in. (0.3 m) deep every 50 ft. (16 m) longitudinally along the edges of the matting or as directed by the Engineer. Fold over and bury matting to the full depth of the trench, close and tamp firmly. Overlap matting at least 6 in. (150 mm) where 2 or more widths of matting are installed side by side.

Place staples across the matting at ends, junctions, and check trenches approximately 1 ft. (0.3 m) apart.

Place staples along the outer edges and down the center of each strip of matting 3 feet (1 meter) apart. Place staples along all lapped edges 1 ft. (0.3 m) apart. Refer to details in the plan sheets.

The Engineer may require adjustments in the trenching or stapling requirements to fit individual site conditions.

Method of Measurement

The quantity of coir fiber matting measured will be paid for according to the actual number of square yard (square meters) measured along the surface of the ground over which coir fiber matting is installed and accepted.

Basis of Payment

The quantity of Coir Fiber Matting, measured as provided above, will be paid for at the contract unit price per square yard (square meter) for “Coir Fiber Matting.”

Payment will be made under:

Coir Fiber MattingSquare Yard (Square Meter)

Waste Areas And Borrow Sources:

Payment for temporary erosion control measures, except those made necessary by the Contractor's own negligence or for his own convenience, will be paid for at the appropriate contract unit price for the devices or measures utilized in borrow sources and waste areas.

No additional payment will be made for erosion control devices or permanent seeding and mulching in any commercial borrow or waste pit. All erosion and sediment control practices which may be required on a commercial borrow or waste site will be done at the Contractor's expense.

Temporary Diversion:

The work by this section for installation, maintenance, and cleanout of temporary diversions shall be in accordance with Section 1630. The quantity of excavation for installation and cleanout measured as provided in Article 1630-4 will be paid for at the contract unit price per cubic yard (cubic meter) as provided in Article 1630-5 for "Silt Excavation".

Special Sediment Control Fence:

Description:

The work covered by this section consists of the construction, maintenance, and removal of special sediment control fence. Build special sediment control fence according to the detail located on the plans. Place special sediment control fence as shown on the plans or as directed by the Engineer.

Materials:

(A) Posts:

Either wood or steel posts may be used. Wood posts shall be a minimum of 6 feet long (1.8 m), at least 3 inches (75 mm) in diameter, and straight enough to provide a fence without noticeable misalignment. Steel posts shall be at least 5 feet (1.5 m) in length, approximately 1 3/8 inches (35 mm) wide measured parallel to the fence, and have a minimum weight of 1.25 lb/ft (1.86 kg/m) of length. The post shall be equipped with an anchor plate having a minimum area of 14.0 square inches (9000 square millimeters), and shall have a means of retaining wire in the desired position without displacement.

(B) 1/4 inch (6.4mm) Hardware Cloth:

Hardware cloth shall have 1/4 inch (6.4mm) openings constructed from #24 gauge wire. Install hardware cloth according to the detail shown on the plans.

(C) Sediment Control Stone:

Sediment control stone shall meet the requirements of Section 1005. Install stone according to the detail shown on the plans.

Maintenance and Removal:

The Contractor shall maintain the special sediment control fence until the project is accepted or until the fence is removed, and shall remove and dispose of silt accumulations at the fence when so directed by the Engineer in accordance with Section 1630.

Method of Measurement:

The quantity of 1/4 inch (6.4mm) hardware cloth to be paid for will be the actual number of linear feet (meters) measured along the ground, which has been completed and accepted.

The quantity of sediment control stone will be measured according to Article 1610-4.

Basis of Payment:

Payment for special sediment control fence will be as follows:

1/4 inch (6.4mm) Hardware Cloth	LF (M)
Sediment Control Stone	TON (MT)

Special Stilling Basin(s):

Description:

The work covered by this section consists of furnishing, placing, and removing a special stilling basin(s) as directed by the Engineer. The special stilling basin(s) shall be used to filter pumped water during construction of drilled piers.

Materials:

The filter fabric shall meet the requirements of Section 1056 for Type 2 Fabric.

Sediment control stone shall meet the requirements of Section 1005. Install stone according to the detail shown on the plans.

The special stilling basin(s) shall be a water permeable fabric bag that traps sand, silt, and fines as sediment laden water is pumped into it. This device shall be constructed such that it is portable and can be used adjacent to each drilled pier.

The special stilling basin(s) shall be a bag constructed to a minimum size of 10' x 15' made from a nonwoven fabric. It shall have a sewn-in 8 in. (maximum) spout for receiving pump discharge. The bag seams shall be sewn with a double needle machine using a high strength thread. The seams shall have a minimum wide width strength as follows:

Test Method	Minimum Specifications
ASTM D-4884	60 lb/in

The fabric used to construct the bag shall be stabilized to provide resistance to ultra-violet degradation and meet the following specifications for flow rates, strength, and permeability:

Property	Test Method	Units	Minimum Specifications
Weight	ASTM D-3776	oz/yd	8.0
Grab tensile	ASTM D-4632	lb	200.0
Puncture	ASTM D-4833	lb	130.0
Flow rate	ASTM D-4491	gal/min/sf	80.0
Permittivity	ASTM D-4991	1/sec	1.5
UV Resistance	ASTM D-4355	%	70.0

Construction:

The Contractor shall install the special stilling basin in accordance with the details in the plans and at locations as directed by the Engineer.

The special stilling basin(s) shall be placed so the incoming water flows into and through the bag without causing erosion. The neck or spout of the bag shall be tied off tightly to stop the water from flowing out of the bag without going through the walls.

The special stilling basin(s) shall be replaced and disposed of when it is 3/4 full of sediment or when it is impractical for the bag to filter the sediment out at a reasonable flow rate. Prior approval from the Engineer must be received before removal and replacement.

The Contractor shall be responsible for providing a sufficient quantity of bags to contain silt from pumped effluent during construction of drilled piers.

Method Of Measurement:

The quantity of special stilling basin(s) to be paid for will be the actual number of bags used during drilled pier construction as specified and accepted by the Engineer.

Measurement of filter fabric will be made by the number of square yards (square meters) as measured over the surface of the ground over which filter fabric has been acceptably placed.

The quantity of sediment control stone will be measured according to Article 1610-4.

Basis Of Payment:

Payment for special stilling basin will be as follows:

Filter Fabric for Drainage	SY(SM)
Sediment Control Stone	TON (MT)
Special Stilling Basin	EA

Such price and payment will be full compensation for all work covered by this provision, including but not limited to, furnishing all materials, placing and maintaining the special stilling basin(s), and removal and disposal of silt accumulations and bag.

Stream Channel Relocation Limitations:

The following sequence of construction must be followed in the areas designated on the plans as stream relocation. Failure on the part of the Contractor to follow this sequence, and complete each step prior to proceeding in this area as specified, will be just cause for the Engineer to direct the suspension of work in accordance with Section 108-7 of the Standard Specifications.

1. Clear, but do not grub area within the Environmentally Sensitive Area on the existing stream to be relocated.
2. Construct and stabilize, with vegetation or erosion control material, the proposed stream channel relocation as shown on the plans.
3. Divert water into newly constructed channel only after it has been stabilized and approved.
4. Begin grubbing and/or grading within Environmentally Sensitive Area of existing stream.

The above requirements apply to the stream channels being constructed at the following stations:

Sta. 159+00 -LT- & -RT-

Gravel Construction Entrance:

Description:

The work covered by this section consists of furnishing, installing, and maintaining and removing any and all material required for the construction of a Gravel Construction Entrance.

Materials:

The filter fabric shall meet the requirements of Section 1056 for Type 2 Fabric.

Stone shall be Class A Stone and shall meet the requirements of Section 1042 for Stone for Erosion Control, Class A.

Construction:

The Contractor shall install a Gravel Construction Entrance in accordance with the details in the plans and at locations as directed by the Engineer.

Method Of Measurement:

Gravel Construction Entrance will not be measured for payment under this section.

Basis Of Payment:

Payment for installation of Filter Fabric shall be paid for at the contract unit price per square yard "Filter Fabric for Drainage".

Payment for installation of Class A Stone shall be paid for at the contract unit price per ton "Stone for Erosion Control, Class A".

Such price and payment shall be considered full compensation for all work covered by this provision including all materials, construction, maintenance, and removal of Gravel Construction Entrance as directed by the Engineer.