

DIVISION 9 MATERIALS**SECTION 9-00 DEFINITIONS AND TESTS****9-00.1 FRACTURE**

Fractured aggregate is defined as aggregate particles which have one or more fractured faces. A face will be counted as fractured whenever one-half or more of the projected area of the particle is comprised of a fractured face when viewed normal to the fractured face.

9-00.2 WOOD WASTE

Wood waste is defined as all material which, after drying to constant weight, has a specific gravity of less than 1.0.

9-00.3 TEST FOR WEIGHT OF GALVANIZING

At the option of the Engineer, the weight of zinc in ounce per square foot required by the various galvanizing Specifications may be determined by an approved magnetic thickness gage calibrated within last 6 months for accuracy and demonstrated to the approval of the Engineer, in lieu of the other methods specified.

9-00.4 SIEVE ANALYSIS OF AGGREGATES

Sieve analysis for acceptance of aggregate gradation will comply with procedures described in Section 9-03.15.

9-00.5 DUST RATIO

The dust ratio is defined as the percent of material passing the U.S. No. 200 sieve divided by the percent of material passing the U.S. No. 40 sieve.

9-00.6 SAND/SILT RATIO

The sand/silt ratio is defined as the percent of material passing the U.S. No. 10 sieve divided by the percent of material passing the U.S. No. 200 sieve.

9-00.7 GALVANIZED HARDWARE, AASHTO M 232

An acceptable alternate to hot-dip galvanizing in accordance with AASHTO M 232 will be zinc coatings mechanically deposited in accordance with AASHTO M 298, providing the minimum thickness of zinc coating is not less than that specified in AASHTO M 232, and the process does not produce hydrogen embrittlement in the base metal. Sampling and testing will be made by the Engineer in accordance with commonly recognized national standards and methods used in the SPU Materials Laboratory.

SECTION 9-01 PORTLAND CEMENT AND BLENDED HYDRAULIC CEMENT**9-01.1 TYPES OF CEMENT**

Cement shall be classified as portland cement or blended hydraulic cement.

9-01.2 SPECIFICATIONS**9-01.2(1) PORTLAND CEMENT**

Portland cement shall meet the requirements of AASHTO M 85 or ASTM C 150 Types I, II, or III portland cement, except that the cement shall not contain more than 0.75-percent alkalis by weight calculated as Na_2O plus $0.658 \text{K}_2\text{O}$ and the content of Tricalcium aluminate (C_3A) shall not exceed 8-percent by weight calculated as $2.650\text{A}1203$ minus $1.692\text{Fe}_2\text{O}_3$. Processing additions shall meet the requirements of ASTM C 465 and the total amount of processing additions used shall not exceed 1-percent of the weight of Portland cement clinker. Cement kiln dust may be used as a process addition above 1-percent but not exceed 4-percent of the weight of Portland cement clinker. When process additions greater than 1-percent are used, the type and amount of processing additions used shall be shown on mill test reports.

The time of setting shall be determined by the Vicat Test method per AASHTO T 131 or ASTM C 191.

9-01.2(2) RESERVED**9-01.2(3) LOW ALKALI CEMENT**

When it is required by the Engineer that low alkali cement shall be used, the percentage of alkalis in the cement shall not exceed 0.60 percent by weight calculated as Na_2O plus $0.658 \text{K}_2\text{O}$. This limitation shall apply to all types of Portland cement.

9-01.2(4) BLENDED HYDRAULIC CEMENT

Blended hydraulic cement shall be either Type IP or Type IS cement conforming to AASHTO M 240 or ASTM C-595, except that the blended hydraulic cement shall not contain more than 0.75-percent alkalis by weight calculated as Na_2O plus $0.658 \text{K}_2\text{O}$ and the content of Tricalcium aluminate (C_3A) shall not exceed 8-percent by weight calculated as $2.650\text{A}1_2\text{O}_3$ minus $1.692\text{Fe}_2\text{O}_3$ and meet the following additional requirements:

1. Type IP(X), Portland Pozzolan Cement, where (X) dictates pozzolan percentage. Type IP, (X) Portland Pozzolan Cement, shall be Portland Cement and Pozzolan and the pozzolan shall be limited to fly ash or ground granulated blast furnace slag. Fly ash is limited to a maximum of 35-percent by weight of the cementitious material. Ground granulated blast furnace slag is limited to a maximum of 40-percent by weight of the cementitious material.

- 2. Type IS(X), Portland Blast Furnace Slag Cement, where (X) dictates slag percentage. Type IS(X), Portland Slag Cement, shall be Portland cement and ground granulated blast furnace slag. The addition of ground granulated blast furnace slag shall be limited to a maximum of 40-percent by weight of the cementitious material.

The source and weight of the fly ash or ground granulated blast furnace slag shall be certified on the cement mill test certificate and shall be reported as a percent by weight of the total cementitious material. The fly ash or ground granulated blast furnace slag constituent content in the finished cement will not vary more than plus or minus 5 percent by weight of the finished cement from the certified value.

Fly ash shall meet the requirements of Section 9-23.9 of these Standard Specifications.

Ground granulated blast furnace slag shall meet the requirements of Section 9-23.10 of these Standard Specifications.

9-01.3 RESERVED

9-01.4 RESERVED

9-01.5 RESERVED

SECTION 9-02 BITUMINOUS MATERIALS

9-02.1 ASPHALT MATERIAL

9-02.1(1) GENERAL

Asphalt furnished under these Specifications shall not have been distilled at a temperature high enough to injure by burning or to produce flecks of carbonaceous matter, and upon arrival at the Work, shall show no signs of separation into lighter and heavier components.

9-02.1(2) MEDIUM-CURING (MC) LIQUID ASPHALT

CHARACTERISTICS		AASHTO TEST METHOD	MC-70	MC-250	MC-800	MC-3000
Kinematic Viscosity at 140°F (cSt)		T 201	70-140	250-500	800-1600	3000-6000
Flash Point (Tag Open Cup)	Min. °F	T 79	100	150	150	150
Water Content	Min. %	T 55	0.2	0.2	0.2	0.2
Distillation: volume % of total distillate		T 78				
to 680 °F			0-20	0-10	---	---
to 437 °F			20-60	15-55	0-35	0-15
to 500 °F			65-90	60-87	45-80	15-75
to 600 °F			55	67	75	80
Residue of 680°F distillation % volume by difference	Min.					
Properties of residue from distillation to 680 °F Absolute viscosity at 140°F (poise)		T 202	300-1200	300-1200	300-1200	300-1200
¹ Ductility, 5 cm/min. at 77°F	Min.	T 51	100	100	100	100
Solubility in trichloroethylene	Min. %	T 44	99.0	99.0	99.0	99.0

Note 1. If the ductility at 77°F is less than 100, the Material will be acceptable if its ductility at 60°F is more than 100.

The Material shall not foam when heated to the application temperature recommended in 2010 edition WSDOT standard specification section 5-02.3(3).

9-02.1(3) RAPID-CURING (RC) LIQUID ASPHALT

CHARACTERISTICS		AASHTO TEST METHOD	RC-70	RC-250	RC-800	RC-3000
Kinematic Viscosity at 140°F cSt		T 201	70-140	250-500	800-1600	3000-6000
Flash Point (Tag Open Cup)	Min. °F	T 79	---	80	80	80
Water Content	Min. %	T 55	0.2	0.2	0.2	0.2
Distillation: volume % of total distillate		T 78				
to 374°F	Min.		10	---	---	---
to 437°F	Min.		50	35	15	---
to 500°F	Min.		70	60	45	25
to 600°F	Min.		85	80	75	70
Residue of 680°F distillation % volume by difference	Min.		55	65	75	80

Properties of residue from distillation to 680°F						
Absolute viscosity at 140°F	poise	T 202	600-2400	600-2400	600-2400	600-2400
Ductility, 5 cm/min. at 77°F, cm	Min.	T 51	100	100	100	100
Solubility in trichloroethylene	Min. %	T 44	99.0	99.0	99.0	99.0

The Material shall not foam when heated to application temperature recommended in 2010 edition WSDOT standard specification section 5-02.3(3).

9-02.1(4) ASPHALT CEMENT

9-02.1(4)A PAVING ASPHALT

Asphalt cement binder shall meet the requirements of AASHTO M 320 and shall be of the grade specified in the Contract.

9-02.1(4)B PERFORMANCE GRADE (PG) ASPHALT CEMENT

BINDER GRADE	PG 58-			PG 64-			PG 70-			PG 76-	
	-22	-28	-34	-22	-28	-34	-22	-28	-34	-22	-28
ORIGINAL BINDER											
Flash Point Temp., AASHTO T 48	230 °C MIN.										
Rotational Viscosity, AASHTO T 316	3 Pa s Max. @ 135 °C										
Dynamic Shear, AASHTO T 315	G*/Sin δ = 1.00 kPa Min.; Frequency = 10 rad/s										
	Test Temp. (°C)										
	58 °C			64 °C			70 °C			6 °C ⁷	
ROLLING THIN FILM OVEN RESIDUE, AASHTO T 240											
Mass Loss, AASHTO T 240	1.00 Percent Max.										
Dynamic Shear, AASHTO T 315	G*/Sin δ = 2.20 kPa Min.; Frequency = 10 rad/s										
	Test Temp. (°C)										
	58			64			70			6 ⁷	
PRESSURE AGING VESSEL RESIDUE, AASHTO R 28											
PAV Aging Temp., AASHTO R 28	100 °C										
Dynamic Shear, AASHTO T 315	G*/Sin δ = 5,000 kPa Max.; Frequency = 10 rad/s										
	Test Temp. (°C)										
	22	19	16	25	22	19	28	25	22	31	28
Creep Stiffness, AASHTO T 313	S= 300 Mpa Max.; m-value= 0.300 Min.										
	Test Temp. @ 60s (°C)										
	-12	-18	-24	-12	-18	-24	-12	-18	-14	-12	-18

Note: All Performance Grade binders not included in this chart shall meet the requirements of Table 1 contained in AASHTO M 320, "Performance-Graded Asphalt Binder".

9-02.1(5) REJUVENATING (RECYCLING) AGENTS

The rejuvenating agent shall be a liquid emulsion of selected resin petroleum oil approved for use by the SPU Materials Laboratory. Rejuvenating agents shall meet the following Specifications for the grade designated:

HOT MIX RECYCLING AGENTS¹

TEST	ASTM TEST METHOD	RA 5		RA 25		RA 75		RA 250		RA 500	
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.
Original Test											
Viscosity @ 140°F. cSt	D 2170 or D 2171	200	800	1000	4000	5000	10,000	15,000	35,000	40,000	60,000
Flashpoint, COC, °F	D 92	400	---	425	---	450	---	450	---	450	---
Saturates, Wt. %	D 2007	---	30	---	30	---	30	---	30	---	30
Specific Gravity	D 70 or D 1298	Report		Report		Report		Report		Report	
Residue test from RTFC	D 2872 ²										
Viscosity Ratio ³		---	3	---	3	---	3	---	3	---	3
Weight Change ± %		---	4	---	3	---	2	---	2	---	2

¹The final acceptance of recycling agents meeting this Specification is subject to the compliance of the reconstituted asphalt blends with the requirements in Section 9-02 for the class of asphalt mix required.

²The use of ASTM D 1754 has not been studied in the context of this Specification; however, it may be applicable. In cases of dispute, the reference method shall be ASTM D 2872.

³Viscosity Ratio = $\frac{\text{RTFC Viscosity at 140°F, cSt}}{\text{Original Viscosity at 140°F, cSt}}$

9-02.1(6) CATIONIC EMULSIFIED ASPHALTS

See the following Cationic Emulsified Asphalt Table.

CATIONIC EMULSIFIED ASPHALT																	
GRADE	TYPE	RAPID SETTING				MEDIUM SETTING						SLOW SETTING				SPECIAL TRACK	
	AASHTO TEST METHOD	CRS-1		CRS-2		CMS-2S		CMS-2		CMS-2H		CSS-1		CSS-1H		STE-1	
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.
TEST ON EMULSIONS:																	
Viscosity Saybolt Furol S @ 77°F (25°C)	T 59	---	---	---	---	---	---	---	---	---	---	20	100	20	100	---	30
Viscosity Saybolt Furol S @ 122°F (50°C)	T 59	20	100	150	400	50	450	50	450	50	450	---	---	---	---	---	---
Storage stability test 1 day %	T 59	---	1	---	1	---	1	---	1	---	1	---	1	---	1	---	1
Demulsibility 35 m.l. 0.8% sodium dioctyl sulfosuccinate, % ¹	T 59	40	---	40	---	---	---	---	---	---	---	---	---	---	---	---	25
COATING ABILITY & WATER RESISTANCE:																	
Coating, dry aggregate	T 59	---	---	---	---	good	---	good	---	good	---	---	---	---	---	---	---
Coating, after spraying	T 59	---	---	---	---	fair	---	fair	---	fair	---	---	---	---	---	---	---
Coating, wet aggregate	T 59	---	---	---	---	fair	---	fair	---	fair	---	---	---	---	---	---	---
Coating, after spraying	T 59	---	---	---	---	fair	---	fair	---	fair	---	---	---	---	---	---	---
Particle charge test	T 59	positive		Positive		positive		positive		positive		positive ²		positive ²		Positive	
Sieve Test, %	T 59	---	0.10	---	0.10	---	0.10	---	0.10	---	0.10	---	0.10	---	0.10	---	0.10
Cement mixing test, %	T 59	---	---	---	---	---	---	---	---	---	---	---	2.0	---	2.0	---	---
Distillation:																	
Oil distillate by vol. Of emulsions %	T 59	---	3	1.5	3	---	20	---	12	---	12	---	---	---	---	---	5
Residue, %	T 59	60	---	65	---	60	---	65	---	65	---	57	---	57	---	45	---
TESTS ON RESIDUE FROM DISTILLATION TEST:																	
Penetration, 77°F (25°C)	T 49	100	250	100	250	100	250	100	250	40	90	100	250	40	90	100	200
Ductility, 77°F (25°C) 5 cm/min., cm	T 51	40	---	40	---	40	---	40	---	40	---	40	---	40	---	40	---
Solubility in trichlorethylene, %	T 44	97.5	---	97.5	---	97.5	---	97.5	---	97.5	---	97.5	---	97.5	---	97.5	---

- Notes: 1. The demulsibility test shall be made within 30 days from date of shipment.
2. If the particle charge test for CSS-1 and CSS-1h is inconclusive, material having a maximum pH value of 6.7 will be acceptable.

9-02.1(6)A POLYMERIZED CATIONIC EMULSIFIED ASPHALT – CRS-2P

The asphalt CRS-2P shall be a polymerized cationic emulsified asphalt. The polymer shall be milled into the asphalt or emulsion during the manufacturing of the emulsion. The asphalt CRS-2P shall meet the following Specifications:

	AASHTO TEST METHOD	SPECIFICATIONS	
		MINIMUM	MAXIMUM
Viscosity @122°F, SFS	T 59	200	400
Storage Stability 1 day %	T 59	---	Note 1
Demulsibility 35 ml. 0.8% Dioctyl Sodium Sulfosuccinate	T 59	40	---
Particle Charge	T 59	Positive	---
Sieve Test %	T 59	---	0.30
Distillation			
Oil distillate by vol. of emulsion %	T 59 (Note 1)	0	Note 3
Residue	T 59	65	---
Test on the Residue From Distillation			
Penetration @77°F	T 49	100	250
Torsional Recovery % Or Toughness/Tenacity in-lbs	Note 2 Note 3	18 50/25	--- ---

- NOTES:**
1. Distillation modified to use 300 grams of emulsion heated to 350 °F ± 9 F° and maintained for 20 minutes.
 2. The Torsional Recovery test shall be conducted according to the California Department of Transportation Test Method No. 332.
 3. Benson method of toughness and tenacity; Scott tester, inch-pounds at 77 °F, 20 in. per minute pull. Tension head $\frac{7}{8}$ in. diameter.

At the option of the Supplier, the Benson Toughness/Tenacity test can be used in lieu of Torsional Recovery based on type of modifier used. If the Benson Toughness/Tenacity method is used for acceptance, the Supplier shall supply all test data verifying Specification conformance as part of the Manufacturer's Certificate of Compliance.

9-02.1(7) ASPHALT FOR SUB-SEALING

Asphalt for sub-sealing shall conform to the requirements of AASHTO M 238 except that the minimum softening point shall be 170°F.

9-02.1(8) HOT MELT TRAFFIC BUTTON ADHESIVE

The bitumen adhesive Material shall conform to the following requirements:

SPECIFICATION	ASTM TEST METHOD	REQUIREMENT
Flash Point, COC °F	D 92	550 Min.
Softening Point, °F	D 36	200 Min.
Brookfield Viscosity, 400°F	D 2196	7,500 cP, Max.
Penetration, 100g, 5 sec, 77°F	D 5	10 – 20 dmm
Filler Content, % by weight (Insoluble in 1,1,1 Trichloroethane)	D 2371	50 – 75

Filler Material shall be calcium carbonate and shall conform to the following fineness:

SIEVE SIZE	PERCENT PASSING
No. 100	100
No. 200	95
No. 325	75

Hot melt bitumen adhesive shall develop bond pull-off strength greater than 100 psi between 0°F and 120°F.

9-02.1(9) RESERVED**9-02.2 SAMPLING AND ACCEPTANCE****9-02.2(1) CERTIFICATION OF SHIPMENT**

Bituminous materials may be accepted by the Engineer based on the asphalt Supplier's Manufacturer's Certificate of Compliance incorporated in their Bill of Lading. This certification shall include a statement certifying Specification compliance

for each delivery of product shipped. Failure to provide this certification with the shipment shall be cause for rejection of the Material. The following information is required on this Bill of Lading:

1. Date shipped.
2. Project Name and PW No.
3. Grade of Commodity and Manufacturer's Certificate of Compliance.
4. Anti-stripping additive brand, grade, and percentage.
5. Mass (Net Tons).
6. Volume (Gross Gallons).
7. Temperature of Load (°F).
8. Bill of Lading Number.
9. Consignee and Delivery Point.
10. Signature of Supplier's Representative.
11. Supplier (Bill of Lading Generator Business Name).
12. Supplier's Address.

The Bill of Lading shall be supplied at the time of shipment of each load delivered. In addition to the copies the Contractor requires, one copy of the Bill of Lading including the Manufacturer's Certificate of Compliance shall be sent with the shipment for the sole use of Engineer.

9-02.2(2) SAMPLES

When requested by the Engineer, the asphalt Supplier shall submit, by prepaid express or US mail, samples of asphalt binder that represent current production to the SPU Materials Laboratory in accordance with Section 1-05.3(1)C at no cost to the Owner. At the discretion of the Engineer, samples of asphalt binder may be obtained by the Engineer from the Contractor's storage tanks.

9-02.3 TEMPERATURE OF ASPHALT

The temperature of paving asphalts in storage tanks when loaded for transporting shall not exceed the maximum temperature recommended by the asphalt binder manufacturer.

9-02.4 ANTI-STRIPPING ADDITIVE

When the Engineer requires heat-stable anti-stripping additive be added to the asphalt mix, then at the option of the Contractor, the method of adding anti-stripping additive can either be by direct mixing with the liquid asphalt, or by spraying on the aggregate on the cold feed. Once the method and type of anti-stripping additive proposed by the Contractor have been approved by the Engineer, the method, brand, grade, and amount of anti-stripping additive shall not be changed without approval of the Engineer.

The amount of liquid anti-stripping additive designated by the Engineer to be used shall not exceed 1 percent by weight of the liquid asphalt.

When polymer additives are sprayed on the aggregate, the amount will be designated by the Engineer, but shall not exceed 0.67 percent by weight of the aggregate.

The use of another process or procedure for adding anti-stripping additive to the asphalt mix will be considered based on a proposal from the Contractor.

9-02.5 TEMPORARY PAVEMENT PATCH MATERIAL

Four (4) temporary pavement patch Material products approved by the Engineer for use include:

1. Unique Paving Material (UPM) Alpine Products
Phone: (253) 351-9828
E-mail: Skip@alpinetrafficproducts.com
Web-site: www.upm.com
2. Quality Pavement Repair (QPR) Phone: 1-800-388-4338
Web-site: www.qprcoldpatch.com
3. E Z Street Lakeside Industries
PO Box 7016
Issaquah, WA 98027
Phone: (425) 313-2681
E-Mail: ricker@lakesideind.com
Web-site: www.lakesideind.com
4. U.S. Cold Patch. Phone: (425) 244-5000
FAX: (425) 423-9120
Web-site: www.uscoldpatch.com

Other temporary patching products may be submitted to the Engineer for approval.

SECTION 9-03 AGGREGATES**9-03.0 GENERAL**

Mineral Aggregates most commonly used have each been given a Type number to identify a unique Mineral Aggregate blend known as "Mineral Aggregate Type (No.)". See the definition of "Mineral Aggregate" in Section 1-01.3. Requirements for each Mineral Aggregate identified by a Type number are contained in Sections 9-03.1, and 9-03.9 through 9-03.16. Mineral Aggregates shall be composed of clean, uniform (in quality) particulate size groups essentially free from wood waste and other deleterious Materials. They shall be obtained only from sources approved by the Engineer. Written requests for source approval shall be submitted to the Engineer not less than Working 10 Days prior to the intended use of the Mineral Aggregate. Should the proposed source be one that the Engineer has no history of Material performance with, the Engineer reserves the right to take preliminary samples at the proposed source, and make preliminary tests, to first determine acceptability of the new source and then perform the applicable Material approval testing. Continued approval of a source is contingent upon the Mineral Aggregates from that source continuing to meet Contract requirements.

Mineral aggregates shall meet the Standard Specifications for grading and quality for use in the Work; however, allowable exceptions may be specified in Contract. The Engineer shall reserve the right to sample and test Mineral Aggregate at any time including at the source.

Recycled materials to be used as aggregates shall meet the requirements specified in Section 9-3.18(1).

All percentages are by weight unless otherwise specified.

9-03.1 AGGREGATES FOR PORTLAND CEMENT CONCRETE**9-03.1(1) GENERAL REQUIREMENTS**

Portland cement concrete aggregates shall be manufactured from ledge rock, talus, or sand and gravel in accordance with the provisions of Section 3-01. They shall possess the characteristics of shape and size such that the concrete, resulting from a mixture of fine and coarse aggregates in the specified proportions, has workability acceptable to the Engineer. Regardless of compliance with all other provisions of these Specifications, if the concrete is not of a workable character, or does not exhibit a proper surface when finished, either the fine or the coarse aggregate or both, will be rejected, or shall be altered as required by the Engineer.

Prior to approval of any portland cement concrete mix design, results of tests performed in accordance with ASTM C 1293 at an age of 12 months for the proposed coarse and fine aggregates shall be submitted to the Engineer for evaluation of the potential for alkali silica reaction (ASR). The test shall be conducted by a laboratory accredited for the test and the test results shall be no older than 24 months from the date of the submittal. If results of ASTM C 1293 testing are not available, the Engineer may accept results of ASTM C 295 for evaluation in the interim until results of ASTM C 1293 tests are available and submitted for evaluation. In no case shall the interim between the submittal of ASTM C 295 results and the submittal of ASTM C 1293 results exceed 14 months. In the event that the time period between ASTM C 295 evaluation submittal and ASTM C 1293 test results submittal exceeds 14 months, aggregate sources that have been approved for use in mix designs based on the results of ASTM C 295 evaluation shall be rejected, and mix design approvals incorporating those aggregates from those sources shall be rescinded,

It is the intent of this specification that aggregate sources have current ASTM C 1293 test results on file and that those results shall be updated every 24 months at a maximum. The interim ASTM C 295 testing is intended to provide a mechanism to evaluate new aggregate sources until ASTM C 1293 test results can be submitted and not as a means to gain final approval. The 14 month time period between the submittal of ASTM C 295 test results and ASTM C 1293 test results shall not be limited to a single contract and shall begin upon the first submittal of ASTM C 295 test results regardless of project or contract.

If, in the judgment of the Engineer, based on previous experience or on Laboratory tests, concrete aggregates from a given source are detrimentally reactive with alkalies in Portland cement, that source shall not be used. Upon determination of detrimentally reactive aggregates, the Contractor may submit results of testing by ASTM 1567 for each proposed mix design incorporating ASR mitigation measures for evaluation by the Engineer. If the Engineer determines that the Contractor's ASR mitigation is effective for a mix design, the Engineer may approve the mix design for use. Determination of the effectiveness of the proposed mitigation measures for a mix design shall lie with the Engineer.

9-03.1(2) FINE AGGREGATE FOR PORTLAND CEMENT CONCRETE**9-03.1(2)A GENERAL**

Fine aggregate for Portland cement concrete shall consist of sand or other inert Materials, or combinations thereof, approved by the Engineer, having hard, strong, durable particles free from adherent coating. Fine aggregate shall be washed thoroughly to remove clay, loam, alkali, organic matter, or other deleterious matter.

9-03.1(2)B DELETERIOUS SUBSTANCES

The amount of deleterious substances in the washed aggregate shall not exceed the following values:

1. Particles having a specific gravity less than 1.95 shall not exceed 1.0 percent of total weight.
2. Organic matter, by calorimetric test, shall not be darker than the reference standard color (organic plate No. 3) AASHTO T 21 unless other tests prove a darker color to be harmless.

9-03.1(2)C GRADING

Fine aggregate for Portland cement concrete shall be graded to conform to the following requirements expressed as percentages by weight:

SIEVE	TYPE 6		TYPE 7	
	CLASS 1		CLASS 2	
	MAX.	MIN.	MAX.	MIN.
3/8 Square	---	100	---	100
% Passing U.S. No.4	100	95	100	95
% Passing U.S. No.8	86	68	---	---
% Passing U.S. No.16	65	47	80	45
% Passing U.S. No.30	42	27	---	---
% Passing U.S. No.50	20	9	30	10
% Passing U.S. No.100	7	0	10	2
% Passing U.S. No.200 (wet sieving)	2.5	0	2.5	0

For fine aggregate Class 1, individual test variations under the minimum or over the maximum will be permitted as follows, provided the average of three consecutive tests is within the Specification limits:

SIEVE NUMBER	PERMISSIBLE VARIATION IN INDIVIDUAL TESTS
No. 30 and coarser	2.0 percent
No. 50 and finer	0.5 percent

Within the gradation limits for fine aggregate Class 2, uniformity of gradation shall be limited to a range of plus or minus 0.20 of the reference Fineness Modulus. The reference Fineness Modulus shall be determined from a representative sample from the proposed source as submitted by the Contractor.

9-03.1(2)D USE OF SUBSTANDARD GRADINGS

Fine aggregate with more than the maximum percentage passing any sieve may be accepted provided the cement content of the finished concrete is increased, at the Contractor's cost, by 1/3 percent for each 1 percent the fine aggregate passing each sieve is in excess of the maximum.

Under no circumstances shall fine aggregate Class 1 be used which has a grading finer than the following:

SIEVE SIZE	PERCENT PASSING
U.S. No. 8	95
U.S. No. 16	80
U.S. No. 30	60
U.S. No. 50	25
U.S. No. 200	2.5

All percentages are by weight.

9-03.1(2)E USE OF CRUSHED RECYCLED PORTLAND CEMENT CONCRETE

Recycled portland cement concrete shall not be used as fine aggregate for new portland cement concrete.

9-03.1(3) COARSE AGGREGATE FOR PORTLAND CEMENT CONCRETE**9-03.1(3)A GENERAL**

Coarse aggregate for Portland cement concrete shall consist of gravel, crushed stone, or other inert Material or combinations thereof approved by the Engineer, having hard, strong, durable pieces free from adherent coatings. Coarse aggregate shall be washed thoroughly to remove clay, silt, bark, sticks, alkali, organic matter, or other deleterious Material.

9-03.1(3)B DELETERIOUS SUBSTANCES

The amount of deleterious substances in the washed aggregate shall not exceed the following values:

Amount finer than U.S. No. 200	0.5 percent by weight
Pieces with a specific gravity less than 1.95	2.0 percent by weight
Clay lumps	0.5 percent by weight
Shale	2.0 percent by weight
Wood Waste	0.05 percent by weight

9-03.1(3)C DURABILITY

Coarse aggregate shall not have a percentage of wear in the Los Angeles machine in excess of 35 after 500 revolutions in accordance with ASTM C 131. Additionally, when tested in accordance with WSDOT Test Method T 113, coarse aggregate shall not have a Degradation Factor less than 30.

9-03.1(3)D GRADING

Coarse aggregate for Portland cement concrete when separated by means of laboratory sieves shall conform to one or more of the following gradings as called for elsewhere in the Specifications, Special Provisions or in the Drawings:

SIEVE SIZE	PERCENT PASSING											
	AASHTO GRADING NO. 467		AASHTO GRADING NO. 4		AASHTO GRADING NO. 57		AASHTO GRADING NO. 67		AASHTO GRADING NO. 7		AASHTO GRADING NO. 8	
	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.
2" square	100	---	100	---	---	---	---	---	---	---	---	---
1-1/2" square	95	100	90	100	100	---	---	---	---	---	---	---
1" square	---	---	20	55	95	100	100	---	---	---	---	---
3/4" square	35	70	0	15	---	---	90	100	100	---	---	---
1/2" square	---	---	---	---	25	60	---	---	90	100	100	---
3/8" square	10	30	0	5	---	---	20	55	40	70	85	100
U.S. No. 4	0	5	---	---	0	10	0	10	0	15	10	30
U.S. No. 8	---	---	---	---	0	5	0	5	0	5	0	10
U.S. No. 16	---	---	---	---	---	---	---	---	---	---	0	5

All percentages are by weight.

In individual tests, a variation of four percent under the minimum percentages or over the maximum percentages will be allowed. The average of three successive tests shall be within the percentages stated above. Coarse aggregate shall contain no pieces larger than two times the maximum sieve size for the specified grading measured along the line of greatest dimension.

Acceptance of grading and quality of the aggregate will be based on samples taken from stockpiles at the concrete plant. The exact point of acceptance will be determined in the field by the Engineer.

When the Engineer approves, the coarse aggregate may be blended from other sizes if:

1. The resulting aggregate meets all requirements for specified grading;
2. Each size used makes up at least 5 percent of the blend;
3. The Contractor supplies the Engineer with gradings for the proposed sizes, along with their proper proportions. If the aggregate comes from commercial sources, the Contractor shall supply this information and have it approved before proportioning and mixing the concrete.

9-03.1(3)E USE OF CRUSHED RECYCLED PORTLAND CEMENT CONCRETE

With the approval of the Engineer, crushed recycled portland cement concrete may be used as coarse aggregate for classes of concrete with a specified compressive strength of 2,500 psi or less. Crushed recycled portland cement concrete shall meet all of the requirements for coarse aggregate contained in Section 9-03.1(3). Recycled concrete that exhibits effects of alkali silica reaction, carbonate silica reaction, sulfate reaction or any other deleterious condition, shall not be used. The concrete producer shall submit a certification that the crushed recycled concrete was produced from sound stock and is not affected by these or any other deleterious conditions.

In addition to the requirements of Section 9-03.1(3)B, crushed recycled portland cement concrete shall contain an aggregated weight of less than 1 percent of asphalt concrete, brick, porcelain or other deleterious substance(s) not otherwise noted.

Crushed recycled portland cement concrete aggregate shall be in a saturated condition prior to mixing and the water cement ratio of the final mix shall be limited to 0.45 maximum. Should the hardened concrete exhibit excessive cracking, unacceptable compressive strength or other undesirable characteristics, use of the mix shall be discontinued.

9-03.1(4) COMBINED AGGREGATE GRADATION FOR PORTLAND CEMENT CONCRETE

As an option to using Coarse and Fine graded aggregates for Portland Cement Concrete, aggregate gradation may consist of a combined gradation. Aggregates shall consist of sand, gravel, crushed stone, or other inert material or combinations thereof, having hard, strong durable particles free from adherent coatings. Aggregates shall be washed to remove clay, loam, alkali, organic matter, silt, bark, sticks, or other deleterious matter.

9-03.1(4)A DELETERIOUS SUBSTANCES

The amount of deleterious substances in the washed aggregate shall not exceed the following values:

Particles of specific gravity less than 1.95	2.0 percent by weight
Organic matter, by colorimetric test, shall not be darker than the reference Standard color (organic plate No. 3) AASHTO T21 unless other tests prove a darker color to be harmless.	
Percentage of wear in Los Angeles machine for aggregates retained on the No. 4 sieve after 500 revolutions.	35 maximum
Clay Lumps	0.3 percent by weight
Shale	1.00 percent by weight
Wood Waste	0.03 percent by weight
Amount finer than No. 200 Sieve	2.0 percent by weight

9-03.1(4)B GRADING

If a nominal maximum aggregate size is not specified, the Contractor shall determine the nominal maximum aggregate size, using ACI 211.1 as a guide. In no case will the maximum aggregate size exceed one-fifth of the narrowest dimension between sides of the forms, one-third the depth of slabs, nor three-fourths of the minimum clear spacing between individual reinforcing bars, bundles of bars, or pretensioning strands.

The combined aggregate shall conform to the following requirements based upon the nominal maximum aggregate size.

NOMINAL MAXIMUM AGGREGATE SIZE	3	2-1/2	2	1-1/2	1	3/4	1/2	3/8	No. 4
3-1/2"	100								
3"	93-100*	100							
2-1/2"		92-100*	100						
2"	76-90		90-100*	100					
1-1/2"	66-79	71-88		87-100*	100				
1"	54-66	58-73	64-83		82-100*	100			
3/4"	47-58	51-64	55-73	62-88		87-100*	100		
1/2"	38-48	41-54	45-61		57-83		81-100*	100	
3/8"	33-43	35-47	39-54	43-64		60-88		86-100*	100
No. 4	22-31	24-34	26-39	29-47	34-54	41-64	48-73		68-100*
No. 8	15-23	16-25	17-29	19-34	22-39	27-47	31-54	39-73	
No. 16	9-17	10-18	11-21	12-25	14-29	17-34	20-39	24-54	28-73
No. 30	5-12	6-14	6-15	7-18	8-21	9-25	11-29	13-39	16-54
No. 50	2-9	2-10	3-11	3-14	3-15	4-18	5-21	6-29	7-39
No. 100	0-7	0-7	0-8	0-10	0-11	0-14	0-15	0-21	0-29
No. 200	0-2.0	0-2.0	0-2.0	0-2.0	0-2.0	0-2.0	0-2.0	0-2.0	0-2.5
* Nominal Maximum Size									

All percentages are by weight.

Nominal maximum size for concrete aggregate is defined as the smallest standard sieve opening through which the entire amount of the aggregate is permitted to pass. Standard sieve sizes shall be those listed in ASTM C 33.

The Owner may sample each component aggregate prior to introduction to the weigh batcher or as otherwise determined by the Engineer. Each separate component will be sieve analyzed alone per AASHTO Test Method T-11/27. All material components will be mathematically re-combined by proportions (Weighted Average), supplied by the Contractor.

9-03.1(5) COARSE AGGREGATES FOR PERVIOUS CONCRETE

9-03.1(5)A GENERAL

Aggregate for pervious concrete shall meet the requirements of Sections 9-03.1(3)A, 9-03.1(3)B and 9-03.1(3)C.

9-03.1(5)B GRADING

Aggregate for pervious concrete shall conform to one of the following gradations:

% - TOTAL PERCENT PASSING BY WEIGHT	AGGREGATE GRADATION	
	AASHTO NO. 8 SIZE AGGREGATE GRADATION	
SIEVE SIZE	MIN.	MAX.
1/2" Square	100%	---
3/8" Square	85%	100%
U.S. No. 4	10%	30%
U.S. No. 8	0%	10%
U.S. No. 16	0%	5%
U.S. No. 50	---	---
U.S. No. 200	0%	0.5%

In individual tests, a variation of four (4) percent under the minimum percentages or over the maximum percentages will be allowed on sieves size No. 16 and larger. For sieves smaller than No. 16, the maximum percentage passing shall not exceed the limits shown for any single test. The average of three successive tests shall be within the percentages stated above. Coarse aggregate shall contain no pieces larger than two (2) times the maximum sieve size for the specified grading measured along the line of greatest dimension.

Acceptance of grading and quality of the aggregate will be based on samples taken from stockpiles at the concrete plant. The exact point of acceptance will be determined in the field by the Engineer.

When the Engineer accepts, the pervious concrete aggregate may be blended from other sizes if:

The resulting aggregate meets all requirements for the specified grading;

Each size used makes up at least five (5) percent of the blend;

The Contractor supplies the Engineer with the gradation for the proposed sizes, along with their proper proportions before producing the aggregate. If the aggregate comes from commercial sources, the Contractor shall supply this information and have it accepted before proportioning and mixing the concrete.

9-03.2 AGGREGATE FOR BIORETENTION SOIL

9-03.2(1) GENERAL

In general, soil aggregate shall be free of wood, waste, coating, or any other deleterious material, and all aggregate passing the No. 200 sieve size shall be non-plastic.

9-03.2(2) MINERAL AGGREGATE FOR BIORETENTION SOIL

Sieve Analysis. Mineral Aggregate for Bioretention Soils shall be analyzed by an accredited lab using the sieve sizes noted below, and shall meet the following gradation:

Sieve Size	Percent Passing
3/8" Square	100
U.S. No. 4	60 - 100
U.S. No.10	40 - 100
U.S. No. 40	15 - 50
U.S. No. 200	2 - 5

9-03.3 STREAMBED AGGREGATE**9-03.3(1) QUALITY**

Aggregates for streambed construction shall be washed, naturally formed, round to sub angular hard, strong, sound, durable, fracture free pieces of igneous and metamorphic rock. Aggregate shall be free of soft, weathered materials and seams of soft rock, shall not contain any wood and other waste, and shall be free of any coating.

The Contractor shall submit certified test reports indicating streambed aggregate complies with the following requirements:

All sand size aggregate (passing a U.S. No. 4 sieve and retained on a US No. 200 sieve) shall meet the following requirements:

Specific Gravity	AASHTO T 84	Minimum 2.65
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All gravel (passing a 3 inch sieve and retained on a U.S. No. 4 sieve) and cobble (passing a 12 inch sieve and retained on a 3 inch sieve) aggregate shall meet the same requirements for sand size aggregate and the following additional requirements:

Soundness	ASTM C 88	Not greater than 5% loss
L.A. Abrasion	AASHTO T 96	Max 20% loss at 500 revolutions

All boulder size aggregate (retained on a 12 inch screen) shall meet the same requirements for gravel and cobble and the following additional requirements:

Accelerated expansion	CRD-C-148	Not greater than 15% breakdown
Absorption	AASHTO T 85	Not greater than 2%

9-03.3(2) GRADATIONS

Aggregate gradations for streambed construction shall be on a weight basis and shall be as follows:

STREAMBED AGGREGATE TYPE 1	
SIEVE SIZE	PERCENT PASSING
8 inch	95 – 100
3" square	45 – 60
1 ½" square	30 – 40
¾" square	10 – 20
U.S. No. 4	0 – 3

The portion passing the U.S. No. 4 sieve size shall have a minimum sand equivalent of 60.

STREAMBED AGGREGATE TYPE 2	
SIEVE SIZE	PERCENT PASSING
16 inch	95 - 100
8 inch	55 - 75
3 inch	20 - 35
1 ½ inch	0 - 15
¾ inch	0 - 5

STREAMBED AGGREGATE TYPE 3	
SIEVE SIZE	PERCENT PASSING
32 inch	95 - 100
24 inch	60 - 75
16 inch	40 - 55
8 inch	10 - 20

3 inch	0 - 10
¾ inch	0 - 2

9-03.4 AGGREGATE FOR BITUMINOUS SURFACE TREATMENT**9-03.4(1) GENERAL REQUIREMENTS**

Aggregate for bituminous surface treatment shall be manufactured from ledge rock, talus, or gravel, in accordance with Section 3-01, which meets the following test requirements:

Los Angeles Wear, 500 Rev.	35% max.
Degradation Factor	30 min.

9-03.4(2) GRADING AND QUALITY

Aggregate for bituminous surface treatment shall conform to the requirements in the following table for grading and quality. The particular type or grading to be used shall be as shown on the Drawings. All percentages are by weight.

The Material shall meet the requirements for grading and quality when placed in hauling vehicles for delivery to the roadway, or during manufacture and placement into a temporary stockpile. The exact point of acceptance will be determined by the Engineer.

SIEVE SIZE	PERCENT PASSING					
	CRUSHED COVER STONE	¾" - 1/2"	5/8" - U.S. NO. 4	1/2" - U.S. NO. 4	3/8" - #10	U.S. NO. 4-0"
1" square	100	100	---	---	---	---
¾" square	100	95-100	100	---	---	---
5/8" square	95-100	---	95-100	100	---	---
1/2" square	---	0-20	---	95-100	100	---
3/8" square	---	0-5	---	---	90-100	100
U.S. No. 4	20-45	---	0-10	0-15	30-56	76-100
U.S. No. 10	---	---	0-3	0-3	0-10	30-60
U.S. No. 200	0-7.5	0-1.0	0-1.0	0-1.0	0-1.0	0-10.0
% fracture, by weight, min.	90	90	90	90	90	90
Sand equivalent min.	40	---	---	---	---	---
Static Stripping Test	Pass	Pass	Pass	Pass	Pass	Pass

The fracture requirement shall be at least one fractured face and applies to Material retained on each sieve size U.S. No. 4 and above if that sieve retains more than 5 percent of the total sample.

The finished product shall be clean, uniform in quality, and free from wood, bark, roots, clay, any organic material, and other deleterious materials.

Crushed screenings shall be substantially free from adherent coatings. The presence of a thin, firmly adhering film of weathered rock shall not be considered as coating unless it exists on more than 50 percent of the surface area of any size between successive laboratory sieves.

The portion of aggregate for bituminous surface treatment retained on the U.S. No. 4 sieve shall not contain more than 0.1 percent deleterious materials by weight.

9-03.5 RESERVED**9-03.6 AGGREGATES FOR ASPHALT TREATED BASE (ATB)****9-03.6(1) GENERAL REQUIREMENTS**

Aggregates for asphalt treated base shall be manufactured from ledge rock, talus, or gravel, in accordance with the provisions of Section 3-01 that meet the following test requirements:

Los Angeles Wear, 500 Rev.	30% max.
Degradation Factor, Wearing Course	15 min.

9-03.6(2) GRADING

Aggregates for asphalt treated base shall meet the following requirements for grading:

SIEVE SIZE	PERCENT PASSING
2" square	100
½" square	56-100
U.S. No. 4	32-72
U.S. No. 10	22-57
U.S. No. 40	8-32
U.S. No. 200	2.0-9.0

9-03.6(3) TEST REQUIREMENTS

When the aggregates are combined within the limits set forth in Section 9-03.6(2) and mixed with the designated grade of asphalt, the mixture shall be Capable of meeting the following test values:

% of Theoretical Maximum Specific Gravity (G_{MM}) (approximate)	93 @ 100 gyrations
Tensile Strength Ratio Test	50 min. / no visual damage

The sand equivalent value of the Mineral Aggregate for asphalt treated base shall not be less than 35.

9-03.7 RESERVED**9-03.8 AGGREGATES FOR HOT MIX ASPHALT (HMA)****9-03.8(1) GENERAL REQUIREMENTS**

Aggregates for hot mix asphalt shall be manufactured from ledge rock, talus, or gravel, in accordance with the provisions of Section 3-01, shall meet the following test requirements:

Los Angeles Wear, 500 Rev.	30% max.
Degradation Factor, Wearing Course	30 min.
Degradation Factor, Other Courses	20 min.

The aggregate shall be uniform in quality, and shall be free from wood, roots, bark, extraneous materials, and adherent coatings. The presence of a thin, firmly adhering film of weathered rock will not be considered as coating unless it exists on more than 50 percent of the surface area of the aggregate retained on any size sieve.

Aggregate removed from deposits contaminated with various types of wood waste shall be washed, processed, selected, or otherwise treated to remove sufficient wood waste so that the oven dried material retained on a U.S. No. 4 sieve shall not contain more than 0.1 percent by weight of material with a specific gravity less than 1.0.

9-03.8(2) HMA TEST REQUIREMENTS

Aggregate for HMA shall meet the following test requirements:

- The aggregate shall meet the Flat and Elongated shape requirements, measured as percent by weight of flat-elongated in accordance with ASTM D 4791. The percent shall not exceed 10 percent and the ratio shall be 5:1.
- The fracture requirements for the combined coarse aggregate in the table below shall apply to the aggregate retained on each sieve U.S. No. 4 and larger when tested in accordance with AASHTO T 335:

"DESIGN ESALS" (MILLIONS)	NO. FRACTURED FACES	% FRACTURE
<10	1	90
≥ 10	2	90

- The uncompacted void content for the combined fine aggregate is tested in accordance with Test Method for AASHTO T 304, Method A. The minimum voids shall be 45%.
- The minimum sand equivalent shall be 45.

During verification by the Laboratory, the mix design shall produce HMA mixtures that when combined within the limits set forth in Section 9-03.8(6) and mixed with the designated grade of asphalt binder, using the Superpave gyratory compactor in accordance with AASHTO T 312, and at the required gyrations for N design with the following properties:

	HMA CLASS							
	3/8 INCH		1/2 INCH		3/4 INCH		1 INCH	
HMA MIX CRITERIA	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.
Voids in Mineral Aggregate (VMA), %	15.0		14.0		13.0		12.0	
ESAL'S (MILLIONS)	VOIDS FILLED WITH ASPHALT (VFA), %							
< 0.3	70	80	70	80	70	80	67	80
0.3 to < 3	65	78	65	78	65	78	65	78
3 to < 10	73	76	65	75	65	75	65	75
10 to < 30	73	76	65	75	65	75	65	75
≥ 30	73	76	65	75	65	75	65	75
Dust / Asphalt Ratio	0.6	1.6	0.6	1.6	0.6	1.6	0.6	1.6
Tensile Strength Ratio	80 min. / no visible damage							
	ESAL'S (MILLIONS)		N _{INITIAL}		N _{DESIGN}		N _{MAXIMUM}	
% G _{mm}	< 0.3		≤ 91.5		96.0		≤ 98.0	
	0.3 to < 3		≤ 90.5		96.0		≤ 98.0	
	≥ 3		≤ 89.0		96.0		≤ 98.0	
Gyratory Compaction (number of gyrations)	< 0.3		6		50		75	
	0.3 to < 3		7		75		115	
	3 to < 30		8		100		160	
	≥ 30		9		125		205	

During the production run of each approved JMF, the HMA will not be evaluated for VMA or VFA for quality assurance purposes. The fine aggregate angularity, flat and elongated particles, fracture and sand equivalent requirements shall apply at the time of HMA production.

9-03.8(3) GRADING

9-03.8(3)A GRADATION

The Contractor may furnish aggregates for use on the same Contract From a single stockpile or from multiple stockpiles, as long as all aggregate is from the same source. The gradation of the aggregates, including any use of RAP, mineral filler, and blending sand, shall be such that the completed mixture complies in all respects with the pertinent requirements of Section 9-03.8(6).

Acceptance of the aggregate gradation will be based on samples taken from the final mix.

9-03.8(3)B RECYCLED ASPHALT PAVEMENT (RAP)

Asphalt concrete planings or old asphalt concrete utilized in the production of asphalt concrete shall be sized prior to entering the mixer so that a uniform and thoroughly mixed asphalt concrete is produced in the mixer. If there is evidence of the old asphalt concrete not breaking down during the heating and mixing of the asphalt concrete, the Engineer may elect to modify the maximum size entering the mixer. No contamination by deleterious materials will be allowed in the old asphalt concrete used.

RAP may be added to the mix in the proportions described in Section 5-04.2(1). The gradation for the new aggregate used in the production of the asphalt concrete shall be the responsibility of the Contractor, and when combined with recycled material, the combined material shall meet the gradation specification requirements for the specified class of HMA as listed in Section 9-03.8(6) and 9-03.8(7) unless the Contract specifies otherwise. The new aggregate shall meet the general requirements listed in Section 9-03.8(1) and shall meet the appropriate fracture requirements specified in Section 9-03.8(2) item 2 for coarse aggregate, and sand equivalent requirements specified in Section 9-03.8(2) and in Section 9-03.8(4) for blending sand.

9-03.8(3)C RECYCLED PORTLAND CEMENT CONCRETE RUBBLE AND STEEL FURNACE SLAG

Recycled portland cement concrete rubble and/or steel furnace slag may be blended with virgin aggregates in the proportions shown in Section 9-03.18(1)E. The proportion of each of these materials in the mix will be considered independently and not cumulatively. The final mix shall meet all of the requirements of Section 9-03.8. Recycled portland cement concrete rubble and steel furnace slag shall meet the requirements of Sections 9-03.18(1)B and 9-03.18(1)D respectively.

The Contractor shall indicate on the mix design submittal the percentage of each in the proposed mix design.

9-03.8(4) BLENDING SAND

Blending sand shall be clean, hard, sound material, either naturally occurring sand or crusher fines, and must be material which will readily accept an asphalt coating. The exact grading requirements for the blending sand shall be such that, when it is mixed with an aggregate, the combined product shall meet the requirements of Section 9-03.8(6) for the class of HMA involved. Blending sand shall meet the following quality requirement:

Sand Equivalent 30 min.

9-03.8(5) MINERAL FILLER

Mineral filler, when used in HMA, shall conform to the requirements of AASHTO M 17.

9-03.8(6) HMA PROPORTIONS OF MATERIALS

The materials of which HMA is composed shall consist of such sizes, grading, and quantity that when proportioned and mixed together, produce a well graded mixture meeting the requirements that follow.

The Contractors HMA mix design shall be between the control points.

HMA AGGREGATE GRADATION CONTROL POINTS				
	PERCENT PASSING			
SIEVE SIZE	HMA CLASS 3/8 INCH	HMA CLASS 1/2 INCH	HMA CLASS 3/4 INCH	HMA CLASS 1 INCH
1 1/2" square				100
1" square			100	90-100
3/4" square		100	90-100	90 Maximum
1/2" square	100	90 – 100	90 Maximum	
3/8" square	90 – 100	90 Maximum		
U.S. No. 4	90 Maximum			
U.S. No. 8	32 – 67	28 - 58	23 – 49	19-45
U.S. No. 200	2.0 – 7.0	2.0 – 7.0	2.0 – 7.0	1.0-7.0

The aggregate percentage refers to completed dry mix, and includes mineral filler when used.

9-03.8(7) HMA TOLERANCES AND ADJUSTMENTS

1. **Job Mix Formula Tolerances.** After the JMF is determined as required in 5-04.3(7)A, the constituents of the mixture at the time of acceptance shall conform to the following tolerances:

AGGREGATE, PERCENT PASSING¹	TOLERANCE
1", 3/4", 1/2" and 3/8" sieves	± 6% each sieve
U.S. No. 4 sieve	± 6%
U.S. No. 8 sieve	± 6%
U.S. No. 200 sieve	± 2.0%
Asphalt binder	± 0.5%
VMA ²	1% below minimum value in Section 9-03.8(2)
VFA ²	min. and max. as listed in Section 9-03.8(2)
V _a ³	2.5% minimum and 5.5% maximum

Notes:

1. The tolerance limit for aggregate shall not exceed the limits of the control points specified in Section 9-03.8(6), except the tolerance limits for sieves designated as 100% passing shall be 99-100. The tolerance limits on sieves shall only apply to sieves with control points.
 2. The tolerances for VMA and VFA are for mix verification only.
 3. The tolerance for V_a is for mix verification and acceptance.
2. **Job Mix Formula Adjustments:** Adjustments beyond the limits below require approval by the Engineer and shall require the development of a new mix design.
- A. **Aggregates:** The Engineer may approve the Contractor's written request to adjust the JMF. The maximum adjustment from the approved mix design shall be 2 percent for the aggregate retained on the U.S. No. 8 sieve and above, 1 percent for aggregate passing the U.S. No. 8 sieve, and 0.5 percent for the aggregate passing the U.S. No. 200 sieve. These field adjustments to the JMF will only be considered if the changes produce material of equal or better quality. The adjusted JMF and allowed tolerances shall be within the range of the control points listed in Section 9-03.8(7). V_a of the adjusted JMF shall remain within the limits shown above.
 - B. **Asphalt Binder Content:** The Engineer may order the Contractor, or may approve the Contractor's written request, to change the JMF asphalt binder content a maximum of 0.3 percent from the approved mix design.

9-03.9 AGGREGATES FOR BALLAST AND CRUSHED SURFACING

9-03.9(1) BALLAST

Roadway ballast shall be manufactured from ledge rock or talus obtained from sources approved by the Engineer. Roadway ballast shall meet the requirements of Section 9-03.16 for Mineral Aggregate Type 14.

That portion of roadway ballast retained on a 1/4 inch square sieve shall not contain more than 0.2 % wood waste.

The Material from which ballast is to be manufactured shall have a Degradation Value not less than 15 when tested in accordance with WSDOT Test Method T 113.

Mineral Aggregate Type 1 or Type 2 may be substituted for roadway ballast in lieu of Mineral Aggregate Type 14 when specified in the Contract.

Ballast shall be a crushed Material with no naturally occurring surfaces. The term, "ballast" shall apply to Material retained on each sieve size U.S. No. 4 and above if that sieve retains more than 5 percent of the total sample.

9-03.9(2) SHOULDER BALLAST

Shoulder ballast shall meet the requirements of Section 9-03.9(1) for ballast except the gradation shall meet the requirements of Section 9-03.16 for Mineral Aggregate Type 13. The sand equivalent and dust ratio requirements shall not apply; however, the L. A. Abrasion and Degradation Factor requirements shall apply.

9-03.9(3) CRUSHED ROCK

Except as otherwise specified in the remainder of this Section, crushed rock shall be manufactured from ledge rock or talus and shall meet the grading, sand equivalent, and L. A. Abrasion requirements of Section 9-03.16 for Mineral Aggregate Type 1, Type 2, and Type 3.

Crushed rock shall have a Degradation Value of not less than 25 when tested in accordance with WSDOT Test Method T 113.

Crushed rock shall be a totally crushed Material with no naturally occurring faces and shall apply to Material retained on each sieve size No. 10 and above if that sieve retains more than 5 percent of the total sample. Crushed rock material retained on a No. 4 sieve shall contain no more than 0.15 percent by weight of wood waste.

See Section 4-04.2 for possible use of other Mineral Aggregates in lieu of Crushed Rock, Mineral Aggregates Type 1 and Type 2.

9-03.9(4) MAINTENANCE ROCK

Maintenance rock shall meet all requirements of Section 9-03.9(3) for crushed surfacing top course except that it shall meet the specifications for grading shown for Mineral Aggregate Type 3 in Section 9-03.16.

9-03.9(5) SAND FILLER

Sand filler shall be natural deposit angular grains complying with Mineral Aggregate Type 11 per Section 9-03.16.

9-03.10 AGGREGATE FOR GRAVEL BASE

Gravel base shall meet the requirements of Section 9-03.12(2) for Mineral Aggregate Type 17.

9-03.11 CRUSHED GRAVEL

Crushed gravel shall be manufactured from mechanically crushed clean, washed gravel, and shall meet the grading, sand equivalent, and L. A. Abrasion requirements of Section 9-03.16 for Mineral Aggregate Types 1G, 2G, and 21 through 24.

MINERAL AGGREGATE TYPE	NUMBER OF FRACTURED SURFACES	MINIMUM PERCENT REQUIRED
1G	2 or more	90%
2G	2 or more	90%
21	1 or more	75%
22	2 or more	90%
23	1 or more	75%
24	2 or more	95%

These fracture requirements shall apply to aggregates retained on all sieves sized U.S. No. 4 and larger, retaining at least 5 percent of total Mineral Aggregate weight.

See Section 4-04.2 for possible use of other Mineral Aggregates in lieu of Crushed Gravel, Mineral Aggregates.

Crushed gravel and crushed rock shall be substantially free from adherent coatings. The presence of a thin, firmly adhering film of weathered rock shall not be considered as coating unless it exists on more than 50 percent of the surface area of any size between successive laboratory sieves.

The combined portion of Mineral Aggregate retained on the U.S. No. 4 sieve shall not contain more than 0.1 percent wood waste by weight. The portion of Material passing a U.S. No. 10 sieve shall not have wood waste that results in more than 250 parts per million of organic matter by calorimetric tests when tested. The color shall be measured after the sample has been in the test solution for 1 hour.

If Mineral Aggregates Type 1R and Type 2R is used as base course under asphalt concrete pavement or other non-rigid pavement, then the Mineral Aggregate shall have a minimum CBR (California Bearing Ratio) of 70 per AASHTO T 193 (ASTM D1883).

9-03.12 PIT RUN SAND, WASHED SAND, AND GRAVEL BACKFILL

Gravel backfill shall consist of crushed, partially crushed, or naturally occurring granular Material depending on the Type of Mineral Aggregate specified in the Contract.

9-03.12(1) GRAVEL BACKFILL FOR FOUNDATIONS**9-03.12(1)A CLASS A BACKFILL**

Class A gravel backfill for foundations shall meet the requirements of Section 9-03.9 and 9-03.16 for Type 2 or Type 14 Mineral Aggregates. When not specified in the Contract, Class A gravel backfill shall be Mineral Aggregate Type 2.

9-03.12(1)B CLASS B BACKFILL

Class B gravel backfill for foundations shall be Mineral Aggregates Type 17 or Type 27 per Section 9-03.16.

9-03.12(2) GRAVEL BACKFILL FOR WALLS

Gravel backfill for walls shall consist of free draining sand and gravel from naturally occurring or screened sources; have such characteristics of size and shape that it readily compacts; and meets the requirements of Section 9-03.16 for Mineral Aggregate Type 17.

The combined portion of Material retained on a U.S. No. 4 sieve shall contain no more than 0.20 percent by weight of wood waste.

Gravel backfill for Mechanically Stabilized Earth (MSE) walls shall be as specified in the Contract.

9-03.12(3) GRAVEL AND SAND BACKFILL FOR PIPE BEDDING

The Contract specified class of Sewer and Storm Drain pipe bedding shall comply with both Standard plan no. 285 and Section 7-17.3(1)B, and shall be Mineral Aggregate Type 9 and Type 22 as specified in this Section and Section 9-03.16.

Water Main distribution pipe bedding Material shall meet the requirements of Section 9-03.16 for Mineral Aggregates Type 6 or Type 7 and Section 9-03.1(2). Water Main transmission pipe bedding shall meet the requirements of Section 9-03.16 for Mineral Aggregate Type 9 as shown on Standard Plan no. 350 and this Section. The bedding Class specified on the Drawings shall be as shown on Standard Plan no. 350.

Pea gravel bedding, Mineral Aggregate Type 9, shall consist of screened sand, gravel, or other inert Materials, or combinations thereof, from sources approved by the Engineer, and shall have hard, strong, durable particles free from adherent coatings. The Material shall be washed thoroughly to remove clay, loam, alkali, organic matter, or other deleterious

substances. The amount of deleterious substances remaining in the washed pea gravel shall not exceed values specified in Section 9-03.1(2)B.

Crushed gravel bedding, Mineral Aggregate Type 22 shall be manufactured from screened crushed gravel. The finished product shall be clean, uniform in quality, and free from wood, bark, roots, and other deleterious Materials. The crushed screenings shall be substantially free from adherent coatings. The presence of a thin, firmly adhering film of weathered rock shall not be considered as coating unless it exists on more than 50 percent of the surface area of any size between successive laboratory sieves. The portion of Mineral Aggregate Type 22 retained on a U.S. No. 4 sieve shall not contain more than 0.1 percent deleterious Materials by weight.

9-03.12(4) GRAVEL BACKFILL FOR DRAINS

Gravel backfill for drains shall meet the requirements for Mineral Aggregate Type 26 in Section 9-03.12(6).

9-03.12(5) PIT RUN SAND AND GRAVEL

Pit run sand and gravel shall consist of free draining granular Materials obtained from naturally occurring deposits or manufactured from screened gravel.

Pit run sand shall meet the requirements of Section 9-03.16 for Mineral Aggregate Type 10.

Pit run sandy gravel shall meet the requirements of Section 9-03.16 for Mineral Aggregate Type 15.

9-03.12(6) WASHED SAND AND GRAVEL

Washed sand and gravel shall meet the gradation requirements of Section 9-03.16 for Mineral Aggregate Types 4, 5, 6, 7, 26, and 28, whichever is specified in the Contract.

Washed sand and gravel shall consist of screened sand, gravel or other inert Materials, or combinations thereof, from sources approved by the Engineer, having hard, durable particles free from adherent coatings. The Materials shall be washed thoroughly to remove clay, loam, alkali, organic matter, or other deleterious substances. The amount of deleterious substances in the washed sand or gravel shall not exceed the values specified in Section 9-03.1(2)B for Mineral Aggregate Types 6, 7, 26, and 28 and Section 9-03.1(3)B for Mineral Aggregate Types 4 and 5.

9-03.12(7) QUARRY RUN CRUSHED ROCK

Quarry run crushed rock shall:

1. be Mineral Aggregate Type 27 meeting the gradation, sand equivalent, dust ratio, and L.A. abrasion requirements of Section 9-03.16,
2. be 100% crushed,
3. have a plasticity index of 4 maximum, and
4. be free of wood and organic matter.

Mineral Aggregate Type 27 may be used as specified in the Contract as a select fill. Also see Section 9-03.12(1)B.

9-03.13 BACKFILL FOR SAND DRAIN

9-03.13(1) SAND DRAIN BACKFILL

Sand drain backfill shall conform to the following gradation (Note - not a Mineral Aggregate Type in Section 9-03.16):

SIEVE SIZE	PERCENT PASSING
1/2" square	90 – 100
U.S. No. 4	58 – 100
U.S. No. 10	40 – 100
U.S. No. 50	3 – 30
U.S. No. 100	0 – 4
U.S. No. 200	0 - 3.0

9-03.13(2) SAND DRAINAGE BLANKET

Aggregate for the sand drainage blanket shall consist of granular Material, free from wood and other extraneous Material and shall meet the following requirements for grading (Note – not a Mineral Aggregate Type in Section 9-03.16):

SIEVE SIZE	PERCENT PASSING
2-1/2" square	90 – 100
U.S. No. 4	23 – 100

The portion passing the U.S. No. 4 sieve shall meet the following requirements for grading:

SIEVE SIZE	PERCENT PASSING
U.S. No. 10	50 - 100
U.S. No. 50	0 - 30
U.S. No. 100	0 - 7.0
U.S. No. 200	0 - 3.0

That portion of backfill for sand drains and sand drainage blanket retained on the U.S. No. 4 sieve shall contain not more than 0.05 percent by weight of wood waste.

9-03.14 GRAVEL BORROW

Unless otherwise specified in the Contract, gravel borrow shall meet the requirements of Section 9-03.12(2) and the grading requirements in Section 9-03.16 for Mineral Aggregate Type 17.

If requested by the Contractor, the screen size may be increased if it is determined by the Engineer that larger size aggregate will be acceptable for the specified backfilling or embankment construction.

9-03.15 TEST METHODS FOR AGGREGATES

Material properties in these Specifications shall be determined in accordance with the following test methods:

TITLE	TEST METHOD
Sampling of Aggregates	AASHTO T 2
Organic Impurities in Fine Aggregate for Concrete	AASHTO T 21
Clay Lumps and Friable Particles in Aggregates	AASHTO T 112
Resistance to Degradation of Small-Size Coarse Aggregates by Abrasion and Impact in the Los Angeles Machine	AASHTO T 96
Material Finer than U.S. No. 200 Sieve in Aggregates	AASHTO T 11
Percent Fracture in Coarse Aggregates	AASHTO T 335
Sieve Analysis of Fine and Coarse Aggregates	AASHTO T 27
Method of Test for Determination of Degradation Value	WSDOT T 113
Lightweight Pieces in Aggregates	AASHTO T 113
Flat and Elongated Particles in Coarse Aggregate	ASTM D 4791
Sand Equivalent	AASHTO T 176
Determination of Length Change of Concrete Due to Alkali-Silica Reaction	ASTM C 1293
Petrographic Examination of Aggregates for Concrete	ASTM C 295
Determining the Potential Alkali-Silica Reactivity of Combination of Cementitious Materials and Aggregate (Accelerated Mortar Bar Method)	ASTM C 1567
Specific Gravity and Absorption of Coarse Aggregate	AASHTO T 85
Specific Gravity and Absorption of Fine Aggregate	AASHTO T 84
Determining the Liquid Limit of Soils	AASHTO T 89
Determining the Plastic Limit and Plasticity Index of Soils	AASHTO T 90
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	AASHTO T 104
Method of Testing Stone for Expansive Breakdown on Soaking in Ethylene Glycol	CRD-C 148
Resistance of Compacted Hot Mix Asphalt (HMA) to Moisture Induced Damage	AASHTO T 283
Uncompacted Void Content of Fine Aggregate	AASHTO T 304
Preparing and Determining the Density of the Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyrotory Compactor	AASHTO T 312
Theoretical Maximum Specific Gravity and Density of Hot Mix Asphalt (HMA)	AASHTO T 209

Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method	AASHTO T 308
Standard Test Method for Potential Expansion of Aggregates from Hydration Reactions	ASTM D 4792

9-03.16 MINERAL AGGREGATE CHART

Commonly used mineral aggregates can be found in the following Mineral Aggregate Chart. The "No." indicated at the top of column 1 is commonly referred to as Mineral Aggregate "Type" number. Gradation requirements for Mineral Aggregates Type 6 and Type 7 indicated on the following Mineral Aggregate Chart require additional sieves. These Mineral Aggregate Types are noted with a "*" in the first column labeled "No.". See the specified "Standard Specification Section" for these noted additional required sieves.

MINERAL AGGREGATE CHART

NO.	Aggregate Type	Use	Standard Specification Section	SIEVE SIZES																	Sand Equivalent (Min.)	Dust Ratio (Max.)	L.A. Abrasion (Max.) %	
				200 (wet sieving)	50	40	10	8	6	4	3/8	1/2	5/8	3/4	1	1-1/4	1-1/2	2	2-1/2	3				
1.	3/4" Minus Crushed Rock	Top Course & Keystone	9-03.9(3)	0-10	....	8-24	....	....	....	46-66	....	....	....	100	....	....	....	....	....	....	40	....	35
1G.	3/4" Minus Crushed Gravel	Top Course & Keystone	9-03.11	0-10	....	8-24	....	....	....	46-66	....	....	....	100	....	....	....	....	....	....	40	....	35
2.	1-1/4" Minus Crushed Rock	Base Course	9-03.12(1)A	0-7.5	....	3-18	....	....	....	25-45	....	....	50-80	....	80-100	100	....	....	....	....	40	....	35
2G.	1-1/4" Minus Crushed Gravel	Base Course	9-03.11	0-7.5	....	3-18	....	....	....	25-45	....	....	50-80	....	80-100	100	....	....	....	....	40	....	35
3.	Maintenance Rock		9-03.9(3) 9-03.9(4)	0-7	....	10-25	....	....	....	45-66	....	90-100	100	....	....	....	....	....	....	....	40	....	35
4.	1-1/2" Washed Gravel	Drain Rock AASHTO #4	9-03.12(6)	0-0.5	....	....	....	....	....	0-5	....	....	0-15	20-55	....	90-100	100	....	....	....	....	....	35
5.	1" Washed Gravel	Drain Rock AASHTO #57	9-03.12(6)	0-0.5	0-1	....	....	0-5	....	0-10	....	25-60	....	....	95-100	....	100	....	....	....	....	....	35
6.	Washed Sand		9-03.12(6)	0-2.5	9-20	....	....	68-86	....	95-100	100	....	....	....	....	....	....	....	....	....	....	....	....
7.	Building Sand		9-03.12(6)	0-2.5	10-30	....	....	....	....	95-100	100	....	....	....	....	....	....	....	....	....	....	....	....
9.	3/8" Washed Gravel	Pipe Bedding AASHTO #8	9-03.12(3)	0-1	....	....	....	0-10	....	10-30	80-100	....	....	....	....	....	....	....	....	....	....	....	35
10.	Pit Run Sand	Backfill Embankment	9-03.12(5)	0-10	10-60	....	....	40-100	....	75-100	100	....	....	....	....	....	....	....	....	....	....	....	....
11.	Sand Filler		9-03.9(5)	0-15	....	15-40	40-75	....	....	80-100	100	....	....	....	....	....	....	....	....	....	....	....	....
13.	2-1/2" Minus Crushed Rock	Shoulder Ballast	9-03.9(2)	0-1	....	....	....	....	....	0-5	....	....	....	40-80	....	....	....	65-100	100	....	....	....	40
14.	2-1/2" Crushed Rock	Roadway Ballast	9-03.12(1)A	0-9	....	0-16	....	....	....	26-44	....	....	....	....	50-85	....	....	65-100	100	....	35	2/3	40
15.	Pit Run Sandy Gravel	Backfill Embankment	9-03.12(5)	0-10	....	....	....	....	....	19-38	....	....	....	100	....	....	....	....	....	....	....	....	30
17.	Bank Run Gravel	Selected Backfill	9-03.12(2)B	0-5	24-71	95-100	60	2/3
21.	1-1/2" Crushed Gravel		9-03.11	0-3	....	....	....	....	....	0-24	....	45-70	85-100	....	....	....	100	....	....	....	....	....	30
22.	3/4" Crushed Gravel	VCP, PVC & CMP Pipe	9-03.11 9-03.12(3)	0-3	....	....	....	....	....	0-24	....	45-100	....	100	....	....	....	....	....	....	....	....	....

		Bedding																						
23.	1/2" Minus Crushed Gravel	Cover Rock	9-03.11	2-12	....	....	40-75	....	....	63-100	....	100	....	....	....	....	....	....	....	....	....	....	....	30
24.	1/2" Minus Crushed Gravel	Chip Rock	9-03.11	0-3	....	0-5	0-10	....	0-20	25-85	90-100	100	....	....	....	....	....	....	....	....	....	....	....	30
26.	3/4" Washed Sandy Gravel	Filter Material	9-03.12(6)	0-1	3-12	....	....	20-50	....	28-56	....	....	....	100	....	....	....	....	....	....	....	....	....	35
27.	Quarry Run Crushed Rock	Select Fill	9-03.12(1)B	0-15	....	0-50	....	....	....	20-70	....	....	....	70-100	....	....	....	....	100	....	....	25	2/3	35
28.	3/4" Washed Gravel	Drain Rock AASHTO #67	9-03.12(6)	0-1	....	....	....	0-5	....	0-10	20-55	....	....	90-100	100	....	....	....	....	....	....	....	....	35

9-03.17 ROCK FACING MATERIAL

Rock for constructing new rock facing shall be large, broken pieces of igneous and metamorphic rock types. Each rock shall be rectangular, intact, fracture free, sound and durable Material, resistant to weathering and free of soft weathered Material and seams of soft rock susceptible to deterioration.

The size categories for rock shall be as follows:

SIZE	APPROX. WEIGHT	MIN. APPROX. DIMENSIONS	APPROX. VOLUME
One-man rock	200 – 400 lbs.	12 inches	2 cf
Two-man rock	500 – 800 lbs.	13 inches	4 cf
Three-man rock	900 – 1200 lbs.	16 inches	6.6 cf
Four-man rock	1300 - 2000 lbs.	18 inches	12.5 cf
Five-man rock	2000 – 4000 lbs.	24 inches	18.5 cf
Six-man rock	4100 – 6000 lbs.	30 inches	31 cf

Rocks less than 1.5 cubic foot (cf) in volume shall not be used.

The Contractor shall provide the services of an ASTM or AASHTO accredited testing laboratory approved by the Engineer to sample the rock from the quarry source, ensuring that rock samples are representative of the rock anticipated for use on the project, and to perform the following laboratory tests:

Specific Gravity	ASTM C 127	Minimum 2.65
Soundness	AASHTO T 104 (section 5.2.2)	Not greater than 5 % loss
Accelerated Expansion	CRD-C-148	Not greater than 15% breakdown
Absorption	ASTM C 127	Not greater than 2%
L. A. Abrasion	ASTM C 131	Maximum 20% loss @ 500 revolutions

All rock to be delivered to and incorporated into the project where rock facing is over 6 feet high, shall meet the minimum testing requirements noted above; the rock shall be stockpiled in a separate pile at the quarry prior to delivery to the Project Site and shall be protected from contamination with other, untested rock sources.

9-03.18 RECYCLED MATERIAL**9-03.18(1) GENERAL REQUIREMENTS**

Recycled materials that are identified below may be used in lieu of, or blended uniformly with, naturally occurring materials for aggregates in the percentages shown in Section 9-03.18(1)E. The final blended product shall meet the requirements for the specified type of aggregate. In addition, each recycled material component included in a blended product, shall meet the specific requirements listed below. The Contractor shall provide a certification that the recycled materials are in conformance with the requirements of the Standard Specifications prior to delivery. The certification shall include the percent by weight of each recycled material.

For recycled materials that are imported to the job site, the Contractor shall certify that the recycled material is not a Washington State Dangerous Waste per the Dangerous Waste Regulations contained in WAC 173-303. Upon request of the Engineer, the Contractor shall provide results of testing supporting the certification.

9-03.18(1)A RECYCLED HOT MIX ASPHALT

For aggregates incorporating recycled hot mix asphalt, the Contractor shall verify the maximum bitumen content for the blended mix. The Contractor shall use AASHTO T 308 (0.70 may be used as a calibration factor) and AASHTO T 329 or other tests approved by the Engineer to determine the total bitumen content.

9-03.18(1)B RECYCLED PORTLAND CEMENT CONCRETE RUBBLE

Portland cement concrete rubble to be recycled into construction aggregates shall not have been painted or exposed to dangerous or hazardous substances. Steel reinforcing shall be removed and the concrete rubble shall be separated from other debris before processing.

Recycled portland cement concrete rubble shall not be used in the following situations:

1. Where it will be exposed to the elements.
2. Where free drainage is required.
3. As structural fill, including pavement base or subbase, where wet conditions exist or are anticipated to exist.

Recycled portland cement concrete rubble used as base course, fill or bedding material may contain an aggregated maximum of 20 percent by weight of asphalt concrete, brick or porcelain rubble. If used as or included in coarse aggregate for portland or hydraulic cement concrete, the recycled portland cement concrete rubble shall be free of asphalt concrete, brick or porcelain and shall meet the requirements for deleterious materials in Section 9-03.1(4)A. If used as an aggregate for hot mix asphalt, it shall have no more than five percent by weight of asphalt concrete, brick or porcelain and shall otherwise meet the requirements for deleterious substances specified in Section 9-03.8(1).

9-03.18(1)C RECYCLED GLASS CULLET

Recycled glass cullet shall be from stock composed primarily of glass food and beverage containers (soda-lime-silica) and shall not contain medical, toxic or hazardous materials. Unless otherwise stipulated in the Special Provisions, recycled glass cullet shall not be placed in whole or in any blended product within three (3) feet of any final graded surface.

The maximum debris level of the cullet shall be 5 percent. Debris is defined as any deleterious material which impacts the performance of the engineered fill and includes all non-glass constituents of the glass feedstock. The percentage of debris in cullet shall be quantified using the following visual method: Between 1 and 3 pounds of processed cullet shall be placed in a flat pan or plate, 8 to 10 inches in diameter and 1 to 2 inches in depth. The percentage of debris shall be estimated using American Geological Institute (AGI) Data Sheets 15.1 and 15.2, "Comparison Charts for Estimating Percentage Composition", 1982.

Total lead content testing shall be performed quarterly by the product supplier. Tests shall include a minimum of 5 samples. Sample collection shall be conducted according to ASTM D75. The mean of these tests shall not exceed 80 ppm. Total lead content testing will be conducted according to EPA Method 3010/6010. All test results shall be kept on file by the product supplier.

9-03.18(1)D RECYCLED STEEL FURNACE SLAG

Recycled Steel Furnace Slag shall consist of furnace or tap slag as a direct byproduct of a primary steel furnace and shall not contain dust or sludge from electric arc emission controls systems. Ladle slag, raker slag, synthetic slag, pit slag, clean out slag, or any other slag not produced in a primary steel furnace, shall not be used.

Recycled Steel Furnace Slag aggregate shall have an expansion less than 0.50 percent at 7 days when tested in accordance with ASTM D 4792. If expansion test results exceed 0.50 percent at 7 days, the Contractor shall wet condition the stockpile for a period of 6 months at a minimum moisture content of 6 percent.

Testing for expansion shall be conducted on samples at the rate of one each per 5,000 tons of material produced or once for every six months of production, whichever is more numerous. Test data and wet conditioning documentation shall be retained by the producer and relevant test data or documentation shall be submitted to the Engineer for all material proposed for incorporation into the project.

Recycled steel furnace slag shall not be used in the following situations:

1. Where it will be exposed to the elements.
2. Where free drainage is required.
3. As pavement base or subbase, where wet conditions exist or are anticipated to exist.
4. As structural fill.
5. As an aggregate for portland cement concrete.

The Contractor shall provide to the Engineer the steel furnace slag blends that will be used in the final product prior to use. No recycled steel furnace slag shall be incorporated into the project without prior approval of the Engineer.

9-03.18(1)E ALLOWABLE RECYCLED MATERIAL CONTENT

The maximum percent by weight of recycled materials that may be used to replace naturally occurring aggregates is shown in the following table:

TYPE	MATERIAL	SPECIFICATION	MAXIMUM ALLOWABLE PERCENT OF RECYCLED MATERIAL BY WEIGHT			
			HOT MIX ASPHALT	CONCRETE RUBBLE	RECYCLED GLASS CULLET	STEEL FURNACE SLAG
	Fine Aggregate for Portland Cement Concrete	9-03.1(2)	0	0	0	0
	Coarse Aggregate for Portland Cement Concrete	9-03.1(3)	0	See 9-03.1(3)E	0	0

	Bituminous Surface Treatment Aggregate	9-03.4	0	0	0	0
	Aggregate for Asphalt Treated Base	9-03.6	See 5-04.2	50	0	0
	Aggregates for Hot Mix Asphalt	9-03.8	See 5-04.2	50	0	20
1.	3/4" Minus Crushed Rock	9-03.9(3)	0	0	15	20
1G.	3/4" Minus Crushed Gravel	9-03.11	20	100	15	20
2.	1-1/4" Minus Crushed Rock	9-03.12(1)A	0	0	15	20
2G.	1-1/4" Minus Crushed Gravel	9-03.11	20	100	15	20
3.	Maintenance Rock	9-03.9(3) 9-03.9(4)	20	100	15	20
4.	1-1/2" Washed Gravel	9-03.12(6)	0	0	0	0
5.	1" Washed Gravel	9-03.12(6)	0	0	0	0
6.	Washed Sand	9-03.12(6)	0	0	0	0
7.	Building Sand	9-03.12(6)	0	0	0	0
9.	3/8" Washed Gravel	9-03.12(3)	0	0	0	0
10.	Pit Run Sand	9-03.12(5)	0	0	0	0
11.	Sand Filler	9-03.9(5)	0	0	0	0
13.	2-1/2" Minus Crushed Rock	9-03.9(2)	20	100	15	20
14.	2-1/2" Crushed Rock	9-03.12(1)A	20	100	15	20
15.	Pit Run Sandy Gravel	9-03.12(5)	20	100	100	20
17.	Bank Run Gravel	9-03.12(2)B	20	100	100	20
21.	1-1/2" Crushed Gravel	9-03.11	0	0	15	0
22.	3/4" Crushed Gravel	9-03.11 9-03.12(3)	0	0	100	0
23.	1/2" Minus Crushed Gravel	9-03.11	20	100	15	20
24.	1/2" Minus Crushed Gravel	9-03.11	0	0	0	0
26.	3/4" Washed Sandy Gravel	9-03.12(4) 9-03.12(6)	0	0	100	0
27.	Quarry Run Crushed Rock	9-03.12(7) 9-03.12(1)B	0	0	100	20
28.	3/4" Washed Gravel	9-03.12(6)	0	0	0	0

None of the values presented in this table shall be construed to be overriding any provision restricting the use of recycled materials included elsewhere in these specifications.

SECTION 9-04 JOINT AND CRACK SEALING MATERIALS**9-04.1 PREMOLDED JOINT FILLERS****9-04.1(1) FILLER FOR CONTRACTION JOINTS IN CEMENT CONCRETE PAVEMENT**

Premolded joint filler for use in cement concrete transverse and longitudinal contraction joints shall consist of a suitable asphalt mastic encased in asphalt-saturated paper or asphalt-saturated felt. It shall be sufficiently rigid for easy installation in summer months and not too brittle for handling in cool weather. It shall meet the following test requirements:

When a strip 2 inches wide and 24 inches long is freely supported 2 inches from each end and maintained at a temperature of 70°F, it shall support a weight of 100 grams placed at the center of the strip without deflecting downward from a horizontal position more than 2 inches within a period of 5 minutes.

The thickness and width of joint filler shall be as shown in the Standard Plans unless the Contract specifies otherwise. Where no premolded joint filler thickness is indicated, the premolded filler thickness shall be 3/8 inch.

9-04.1(2) FILLER FOR THROUGH (EXPANSION) JOINTS IN CEMENT CONCRETE PAVEMENT

Premolded joint filler for through (expansion) and isolation joint applications shall conform to the specifications for "Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction", AASHTO M 213, except the requirement for water absorption is not applicable, or ASTM D 7174 Specifications for "Preformed Closed-Cell Polyolefin Expansion Joint Fillers for Concrete Paving and Structural Construction." The thickness and width of premolded joint filler for through (expansion) joints shall be as indicated on the Standard Plans unless otherwise specified in the Contract. Where no premolded filler thickness is indicated, the thickness shall be 3/4 inch.

9-04.1(3) ELASTOMERIC EXPANSION JOINT SEALS

Premolded elastomeric expansion joint seals shall conform to the requirements of AASHTO M 220 and shall be formed by an extrusion process with uniform dimensions and smooth exterior surfaces. The cross-section of the seal shall be shaped to allow adequate compressed width of the seal, as approved by the Engineer.

9-04.2 JOINT SEALANTS**9-04.2(1) HOT POURED JOINT SEALANTS**

Hot poured joint sealants shall meet the requirements of AASHTO M 324 Type IV, except that the Cone Penetration at 25°C shall be 130 max. Hot poured joint sealants shall be sampled in accordance with ASTM D 5167 and tested in accordance with ASTM D 5329. The hot poured joint sealant shall have a minimum Cleveland Open Cup Flash Point of 205°C in accordance with AASHTO T 48.

9-04.2(2) POURED RUBBER JOINT SEALER

The physical properties of the joint sealer, when mixed in accordance with the manufacturer's recommendations, shall be as follows:

1. Color: Gray or black.
2. ¹Viscosity: Shall be pourable and self-leveling at 50°F.
3. ¹Application Life: Not less than 3 hours at 72°F and 50 percent relative humidity.
4. Set to Touch: Not more than 24 hours at 72°F and 50% relative humidity.
5. Curing Time: Not more than 96 hours at 72°F and 50% relative humidity.
6. Non-Volatile Content: Not less than 92 percent.
7. Hardness Rating (Durometer "Shore A"): 5-35.
8. Resiliency: Not less than 80 percent.
9. Bond test methods shall be in accordance with WSDOT Test Method No. 412A.

¹Viscosity and application life may be waived providing the Material is mixed and placed by a pump and mixer approved by the Engineer, or if the Contract requires fast cure.

Suitable primer, if required by the manufacturer, shall be furnished with each joint sealer. The primer shall be suitable for brush or spray application at 50°F or higher and shall cure sufficiently at 50°F to pour the joint within 24 hours. It shall be considered as an integral part of the sealer system. Any failure of the sealer in the test described herein, attributable to the primer, shall be grounds for rejection of the sealer.

Acceptance of joint sealing compound for use on a project shall be on the basis of Laboratory tests of samples representative of each batch of Material to be used on the job. A period of at least two weeks shall be allowed for completion of these tests. Each container of the compound shall be clearly identified as to manufacturer and batch number.

9-04.2(3) POURED JOINT SEALER FOR WALKWAYS

Poured joint sealer used to seal sawed joints in sidewalks, stairs, plazas, and other walkways shall be a polyurethane sealer conforming to Federal Specification TT-S-00227E Type I (self-leveling) Class A or Type II (non-sag) Class A.

9-04.3 MORTAR AND NON-SHRINK CEMENT SAND GROUT**9-04.3(1) JOINT MORTAR**

Mortar for hand mortared joints shall conform to Section 9-20.4(3) and consist of one part portland cement, three parts fine sand, and sufficient water to allow proper workability.

Cement shall conform to the requirements of AASHTO M 85, Type I or Type II.

Sand shall conform to the requirements of AASHTO M 45.

Water shall conform to the requirements of Section 9-25.1.

The mortar mix shall be approved by the Engineer before use.

9-04.3(2) NON-SHRINK CEMENT SAND GROUT**9-04.3(2)A GENERAL**

Prior to placing the grout, the contact surface shall be thoroughly cleaned, roughened and wetted with water. The grout shall be covered with burlap sacks after the initial concrete set, promptly wetted, and maintained continuously moist until the required strength is obtained.

9-04.3(2)B GROUT FOR ANCHOR BOLTS, BRIDGE BEARINGS, AND DRAINAGE STRUCTURE

Non-shrink cement sand grout used for grouting anchor bolts and bridge bearings, curb section to pavement anchors, and for use in drainage Structures other than pipe connections, shall meet the requirements of section 9-20.3(2) grout type 2 for nonshrink applications.

9-04.3(2)C GROUT FOR PIPE CONNECTIONS AND POLES & PEDESTALS

Non-shrink cement sand grout for pipe connections to maintenance hole, catch basins, inlets, and similar utility appurtenances; installing tees; grouting under poles and pedestals; and similar uses shall meet the following requirements:

1. 1-part, by weight, Type III (H.E.S.) cement;
2. 2-parts, by weight, clean fine aggregate Class 1 or Class 2 (see Section 9-03.1(2)); and
3. Sufficient water complying with Section 9-25.1 to obtain a stiff consistency. The use of calcium chloride will not be allowed.

Unpolished aluminum powder shall be added to the dry cement in the proportion of one heaping teaspoonful per sack of cement no more than 30 minutes before the grout mixture reaches its final in-place position. The required compressive strength shall be a minimum 4,000 psi @ 7 Days.

9-04.3(2)D GROUT TYPE 1 FOR POST-TENSIONING APPLICATIONS

Grout type 1 for post-tensioning applications shall meet the requirements of Section 9-20.3(1).

9-04.4 RUBBER GASKETS**9-04.4(1) RUBBER GASKETS FOR CONCRETE PIPES AND PRECAST MAINTENANCE HOLES**

Rubber gaskets for use in joints of concrete Culvert or storm Sewer pipe and precast maintenance hole sections shall conform to the applicable requirements of ASTM C 443.

9-04.4(2) RESERVED**9-04.4(2)A SEALS FOR VITRIFIED CLAY PIPE (COMPRESSION)**

Compression seals for vitrified clay pipe shall conform to the requirements of ASTM C 425. Each load of pipe delivered to the job site shall be accompanied by a certificate of compliance stating that the compression seals conform to the applicable provisions ASTM C 425 and showing test results of the lot from which the load of pipe was chosen.

Prior to shipment of pipe, the manufacturer shall submit shop drawings illustrating the proposed joint sealing system and results of testing required by ASTM C 425. The Engineer may require that testing be performed in his presence prior to acceptance of any joint sealing system. Pipe shall not be shipped without receiving the Engineer's approval of the jointing system.

9-04.4(2)B SEALS FOR VITRIFIED CLAY PIPE (FLEXIBLE COUPLINGS)

Flexible couplings shall meet the requirements of ASTM C 1173, Type B, including the requirements of Figure 2 and Table 3. Prior to use, a catalogue cut and manufacturer's certification stating that the flexible coupling conform to the requirements of this specification shall be submitted to the Engineer. This submittal shall be made separately for every size and configuration of coupling to be used.

9-04.4(3) RUBBER GASKETS FOR ALUMINUM OR STEEL CULVERT OR STORM SEWER PIPE

Gaskets for use with metal Culvert or storm Sewer pipe shall be continuous closed cell, synthetic expanded rubber gaskets conforming to the requirements of ASTM D 1056, Grade 2B3.

9-04.4(4) RUBBER GASKETS FOR ALUMINUM OR STEEL DRAIN PIPE

Gaskets for metal drain pipe shall be self-adhering, butyl-based scrim-supported type. When specified, the gaskets shall be as described in the Standard .

9-04.4(5) PROTECTION AND STORAGE

Rubber gasket Material shall be stored in a clean, cool place, protected from contaminants. They shall be protected from direct sunlight at all times except during actual installation. Pipes with gaskets affixed shall be installed in the line within 28 Days of date of delivery from the manufacturer. Rubber gaskets found on-site more than 28 Days after delivery from the manufacturer will be rejected. The Contractor shall submit an invoice from the manufacturer stating date of delivery.

9-04.5 FLEXIBLE PLASTIC GASKETS

The gasket Material shall be produced from blends of refined hydrocarbon resins and plasticizing materials reinforced with inert mineral filler and shall contain no solvents. It shall not depend on oxidizing, evaporating, or chemical action for adhesive or cohesive strength. It shall be supplied in extruded rope-form of such cross-section and size as to adequately fill spaces between the precast sections.

The gasket Material shall be protected by a suitable removable two piece wrapper so designed as to permit removing one half, longitudinally, without disturbing the other. Its composition and properties shall conform to those set forth as follows:

PROPERTY	TEST METHOD	MINIMUM	MAXIMUM
Bitumen (Petroleum plastic content)	ASTM D 4	50	70
Ash-inert Mineral Matter	AASHTO T 11	30	50
Penetration	ASTM D 217		
32°F (300gm) 60 sec		75	---
77°F (150gm) 5 sec		50	120
115°F (150gm) 5 sec		---	150
Softening Point	ASTM D 36	320°F	---
Specific Gravity at 77°F	ASTM D 71	1.20	1.35
Weight per gallon, lb.		10.0	11.3
Ductility at 77°F (cm)	ASTM D 113	5.0	---
Flash Point COC, °F	ASTM D 93	600	---
Fire Point COC, °F	ASTM D 92	625	---
Volatile Matter	ASTM D 6	---	2.0

9-04.6 EXPANDED POLYSTYRENE

Expanded polystyrene shall be of a cellular molded type with a density of 1.5 ± 0.25 pounds per cubic foot.

9-04.7 EXPANDED RUBBER

Closed cell expanded rubber joint filler shall conform to ASTM D 1056, Grade No. 2B3.

9-04.8 RESERVED**9-04.9 SOLVENT CEMENTS**

Solvent Cements for PVC underdrain pipe shall conform to the requirements of ASTM D 2564.

9-04.10 CRACK SEALING - RUBBERIZED ASPHALT

Rubberized asphalt for crack sealing asphalt concrete pavement shall conform to AASHTO M 173 (ASTM D 1190) and have a COC flash point (AASHTO T 48) of 400°F minimum. AASHTO M 173 (ASTM D 1190) is modified to delete the Bond Test requirement. AASHTO T 48 is modified to require careful agitation of the rubberized asphalt sample during testing to prevent local overheating.

SECTION 9-05 STORM DRAIN AND SANITARY SEWER STRUCTURES, CULVERTS, AND CONDUITS**9-05.0 ACCEPTANCE BY MANUFACTURER'S CERTIFICATION**

Certain drainage Materials may be accepted by the Engineer based on a Manufacturer's Certificate of Compliance meeting the requirements of Section 1-06.3. These Materials are as follows:

- Metal drain and underdrain pipe,
- PVC drain pipe and underdrain pipe,
- Polypropylene pipe
- Corrugated Polyethylene pipe
- Metal Culvert, Storm Drain pipe and pipe arch less than 30 inches in diameter,
- Metal Culvert end sections,
- Corrugated metal structural plate pipe, pipe arch, and under passes,
- Ductile iron pipe, Vitrified clay pipe compression seals, and

- Vitrified clay pipe flexible couplings

9-05.1 CONCRETE PIPE

9-05.1(1) GENERAL

Concrete pipe shall be manufactured by plants certified by the National Precast Concrete Association (NPCA). Concrete pipe shall meet the requirements of ASTM C 14 Class 3 for pipe less than 12 inches in diameter; ASTM C 76 Class IV for 12 and 15 inch diameter pipe; and ASTM C 76 Class III wall B for pipe 18 inches in diameter and larger. Exceptions may be specified in the Contract.

Pipe ends of reinforced concrete pipe shall be bell and spigot, modified bell and spigot, or tongue and groove unless otherwise specified in the Contract.

The identification of the minor axis of elliptical reinforcement shall be in accordance to Section 7-02.3(1)B4.

9-05.1(2) BASIS FOR ACCEPTANCE OF CONCRETE PIPE

9-05.1(2)A GENERAL

The basis for acceptance of non-reinforced concrete pipe shall be based on load bearing tests, material tests including absorption tests per ASTM C 497, inspection of the product at all stages of fabrication, and a Manufacturer's Certificate of Compliance indicating acceptable results of three edge bearing tests performed at the Supplier within the 90-Day period immediately preceding shipment of the pipe to the Project Site. Acceptance of the concrete pipe based on criteria other than these Specifications shall require a submittal to the Engineer for approval at least 10 Working Days in advance of delivery, specifying the "other criteria" in detail and how it is equivalent or better than the Specifications; a Manufacturer's Certificate of Compliance stating the pipe shall perform as specified in these Specifications; allow for the Engineer to visit the Supplier and observe the "other criteria", and shall allow the Engineer to have a minimum three (3) pipe samples provided to a location specified by the Engineer for the Engineer to conduct tests.

The basis for acceptance of reinforced concrete pipe 60 inches in diameter and smaller shall be determined by the results of the **three edge bearing test** per ASTM C 76 for the load to produce a 0.01 inch crack. Testing to the ultimate load will ordinarily not be required, except as necessary to obtain samples for making the absorption test. In lieu of broken pieces of pipe obtained as before mentioned, 4 inch diameter cores from pipe sections selected by the Engineer, shall be furnished to the Engineer for performing the absorption test. Sections of pipe which have been tested to the 0.01 inch crack limit will ordinarily not be further load tested; and such sections, if found without defect, meeting or exceeding the required Specifications will be accepted for use on the project.

Permeability test shall be conducted as follows:

The pipe selected by the Engineer for testing shall be placed plumb with either end down on a soft rubber impermeable pad and filled with water. The pipe shall be kept full of water for a period of 20 minutes. At the end of 20 minutes, the outer surface of the pipe will be examined for leaks.

A leak is herein defined as a moist spot as determined by the Engineer.

The Engineer may test up to 2 percent of all sections in a size and class of pipe; however, no less than 5 pipe sections of any pipe size and class will be tested.

Concrete pipe larger than 27 inch and no larger than 60 inch in diameter will be inspected by the Engineer during its manufacture and if found acceptable, the Engineer will issue a "Certification of Inspection". Pipe delivered for the Work shall be delivered with this "Certificate of Inspection". The Contractor shall notify the Engineer a minimum 15 Working Days prior to delivery to arrange for this inspection by the Engineer.

Acceptance of reinforced concrete pipe larger than 60 inch diameter will be based on inspection of the size and placement of the reinforcing steel, the absorption test and, at the option of the Engineer, on compressive strength tests of 4 inch diameter cores cut from the pipe, or on compressive strength of representative test cylinders cast with and cured with the pipe.

The Contractor shall provide a Manufacturer's Certificate of Compliance stating that the gaskets for all concrete pipe meet the requirements of ASTM C 443, and that the pipe age at shipment meets the requirements of Section 9-05.1(3). The Contractor shall also submit actual shop drawings detailing pipe reinforcement and joint design.

9-05.1(2)B PIPE ACCEPTANCE REPORT (PAR)

Concrete pipe with diameters of 27 inch and smaller shall be accompanied with a Pipe Acceptance Report when delivered to the Project Site. A PAR can be prepared either by WSDOT or by the SPU Materials Laboratory for a specific size and class of concrete pipe. Pipe delivered for incorporation into the Work shall meet all Contract requirements. Approval of the pipe upon delivery by the SPU Materials Laboratory does not constitute acceptance of the pipe at any time.

9-05.1(3) AGE AT SHIPMENT

Concrete pipe may be shipped when it complies with all specified test requirements. Unless it is tested and accepted at an earlier age, it shall not be considered acceptable and ready for delivery to the Work sooner than 28 Days after manufacture when made with Type II Portland cement, nor sooner than 7 Days after manufacture when made with Type III Portland cement.

9-05.1(4) RESERVED**9-05.1(5) BEVELED CONCRETE END SECTIONS**

Beveled concrete end sections shall be plain concrete conforming to AASHTO M 86 or reinforced concrete conforming to the applicable sections of AASHTO M 170 with the design requirements as listed in Table 2, Wall B, Circular Reinforcement in circular pipe, and WSDOT Standard Plan no. B-70.20.

9-05.1(6) CONCRETE PIPE JOINTS AND TESTING**9-05.1(6)A GENERAL**

All concrete pipe shall be joined with rubber gaskets. The joints and gasket material shall meet the requirements of ASTM C 443. Gasket Material shall be protected as specified in Section 9-04.4(5).

Both bell and spigot shall be reinforced in all pipe 30 inch or larger in diameter.

9-05.1(6)B TESTING CONCRETE PIPE JOINTS**9-05.1(6)B1 GENERAL**

When a particular type of pipe joint design, joint Material, and/or joining method has not previously been tested and approved by the Engineer, the following tests shall be made on one test length of the assembled concrete pipe, or test length assembly as defined in Section 9-05.1(6)B2, to qualify the design, joint Material, and/or joining method for acceptance. As determined by the Engineer, additional testing may be required if subsequent field testing of installed pipe indicates difficulty in verifying acceptable joined pipe performance. The tests shall be conducted at the Supplier and the Contractor shall make available space and facilities to accommodate the testing in an efficient and workmanlike manner.

9-05.1(6)B2 HYDROSTATIC PRESSURE ON PIPES IN STRAIGHT ALIGNMENT

Hydrostatic pressure tests on pipes in straight alignment shall be made in accordance with the procedure outlined in paragraph 8(a) of AASHTO M 198, except that they shall be performed on a test length assembly consisting of not less than three nor more than five pipe sections selected from stock by the Engineer and assembled in accordance with Contract requirements. The end sections shall be bulkheaded and restrained to prevent leakage.

9-05.1(6)B3 HYDROSTATIC PRESSURE TESTS ON PIPES IN MAXIMUM DEFLECTED POSITION

Upon completion and acceptance by the Engineer of testing in accordance with Section 9-05.1(6)B2, the test length assembly shall be deflected until at least two of the pipe joints are deflected to the maximum as indicated in the manufacturer's installation instruction. When thus deflected, the test length assembly shall be braced and the end sections shall be bulkheaded and restrained to prevent leakage. The test length assembly shall then be pressurized to an internal hydrostatic pressure of 5 psig minimum, and no leakage at any joint for a 15 minute test duration will indicate acceptance by the Engineer.

9-05.1(6)B4 HYDROSTATIC PRESSURE TEST ON 15 INCH DIAMETER AND LARGER PIPE UNDER DIFFERENTIAL LOAD

For concrete pipe 15 inch or larger, upon completion and acceptance of testing in accordance with Section 9-05.1(6)B3, the test length assembly shall be suitably supported so that one of the pipes of the test assembly is suspended freely between adjacent pipes, be supported only by the joint connections. The suspended pipe shall then be loaded at its midpoint with an additional "point load" in accordance with the following schedule:

PIPE DIAMETER	LOAD
15 inches	7,400 lbs.
18 inches	8,800 lbs.
21 inches	10,000 lbs.
24 inches and larger	11,000 lbs.

"Point load" shall be interpreted as not more than two (2) linear feet spread over not more than one (1) linear foot beyond the midpoint of the pipe section supported.

While under this load, the test length assembly shall be braced and the end sections shall be bulkheaded and restrained to prevent leakage. The stressed joints, or joints at each end of the supported test section, shall show no leakage when subjected to an internal hydrostatic pressure of 5 psi for a 15 minute time duration. At the option of the Supplier or Contractor, 1/2 of the specified load may be applied on the bell end of the suspended pipe in lieu of the full load at the midpoint of the suspended pipe if the total half-load is applied over not more than an 18 inch length measured from the end of the pipe.

9-05.1(7) PERFORATED CONCRETE SUBSURFACE DRAIN PIPE

Perforated concrete subsurface drain pipe shall meet the requirements of AASHTO M 175, Type I, except that the perforations shall be approximately 1/2 inch in diameter. Strength requirements shall be as shown in Table I of AASHTO M 86.

9-05.2 DUCTILE IRON PIPE

Ductile iron pipe shall conform to ANSI A21.51 or AWWA C151 and shall be cement mortar lined, push-on joint, or mechanical joint. The ductile iron pipe shall be Class 50 unless indicated otherwise in the Contract.

Joints for ductile iron pipe shall be rubber gasketed conforming to the requirements of ANSI A21.11 or AWWA C111.

Cast iron fittings may be used with ductile iron pipe with Engineer's approval, and require the Contractor to submit a minimum of 10 Working Days in advance, the proposed fittings including a Manufacturer's Certificate of Compliance stating the fitting meets or exceeds the performance of the Material specified.

Saddles fastened to pipe with external bands will not be acceptable on any new ductile iron pipe installation (see Section 7-17.3(2)C3 item 3.). All fittings shall be the same material as the pipe being connected.

9-05.3 POLYVINYL CHLORIDE (PVC) PIPE

PVC pipe shall conform to the requirements of ASTM D 3034 for diameter sizes 4-inch through 15-inch, and of ASTM F 679 for diameter sizes 18-inch through 48-inch. The minimum pipe stiffness shall be 46 lb/in/in.

Joints for PVC pipe shall conform to ASTM D 3212 using an elastomeric gasket conforming to ASTM F 477.

Fittings for PVC pipe shall conform to ASTM D 3034, ASTM F 679, or ASTM F 1336. All fittings shall be the same material as the pipe being connected except that fittings using other materials or constructed with more than one material may be used subject to the approval of the Engineer. The Contractor shall submit at least 10 Working Days in advance, the proposed alternate material(s) and shall include a Manufacturer's Certificate of Compliance stating the alternate material meets or exceeds the handling and load stress performance of that specified.

9-05.3(1) SLOTTED PVC SUBSURFACE DRAIN PIPE

Perforated polyvinyl chloride sub-surface drain (SSD) pipe and fittings shall be ASTM D1785 Schedule 40 with rubber gasket joints. Pipe shall have slotted perforations 0.064 inches wide by 1.00 inch long and spaced 0.3 inch apart on center. The slotted perforations on the pipe shall be oriented as indicated in the Contract. Pipe size shall not exceed 8 inch diameter unless indicated otherwise in the Contract.

9-05.4 VITRIFIED CLAY PIPE (VCP)

Vitrified clay pipe shall conform to ASTM C 700, and all joints shall be factory manufactured in conformance with Section 9-04.4(2)A Vitrified clay pipe shall be installed as specified in Section 7-17.

Vitrified Clay Pipe shall be load tested in accordance with ASTM C301 for 3 edge bearing. Vitrified Clay Pipe shall withstand the minimum following loads:

MINIMUM TEST LOADS

EXTRA STRENGTH		HIGH STRENGTH	
NOMINAL SIZE (IN.)	LOAD (LBS./FT.)	NOMINAL SIZE (IN.)	LOAD (LBS./FT.)
4	2000	4	2200
6	2000	6	2200
8	2200	8	2400
10	2400	10	2600
12	2600	12	2900
15	3100	15	3400
18	3600	18	4000
21	4200	21	4600
24	4800	24	5300
27	5200	27	5700
30	5500	30	6100
33	5800	33	6400
36	6300	36	6900
39	6600	39	7300
42	7000	42	7700

9-05.4(1) PIPE ACCEPTANCE REPORT (PAR)

Vitrified clay pipe shall be inspected by the SPU Materials Laboratory at the point of delivery. When delivered, vitrified clay pipe shall be accompanied by all specified certifications and test results. No vitrified clay pipe shall be incorporated into the Work that has not been inspected and approved by the SPU Materials Laboratory. A pipe acceptance report will be completed by SPU Materials Laboratory personnel upon inspection of the pipe. Approval of pipe upon delivery by the SPU Materials Laboratory does not constitute acceptance of the pipe at any time.

9-05.5 POLYETHYLENE PIPE**9-05.5(1) CORRUGATED POLYETHYLENE DRAINAGE TUBING PIPE****9-05.5(1)A CORRUGATED POLYETHYLENE DRAINAGE TUBING DRAIN PIPE**

Corrugated polyethylene drainage tubing drain pipe shall meet the requirements of AASHTO M 252. The maximum size pipe allowed shall not be larger than 10 inch diameter.

9-05.5(1)B PERFORATED CORRUGATED POLYETHYLENE DRAINAGE TUBING SUBSURFACE DRAIN PIPE

Perforated corrugated polyethylene drainage tubing subsurface drain pipe shall meet the requirements of AASHTO M 252 Type 5. The maximum size pipe shall be 10 inch in diameter.

9-05.5(2) CORRUGATED POLYETHYLENE DRAIN PIPE**9-05.5(2)A GENERAL**

Corrugated polyethylene drain pipe shall be high density polyethylene (HDPE) meeting the requirements of AASHTO M 294, Type S. The size of pipe allowed shall range from a minimum 12 inch diameter through a maximum 48 inch diameter. All HDPE pipe delivered and used shall be certified through the Plastic Pipe Institute (PPI) Third Party Certification program and shall bear the Third Party Administered PPI seal.

9-05.5(2)B COUPLING BANDS

Joints for corrugated polyethylene drain pipe shall be made with a bell/bell or bell and spigot coupling using elastomeric gaskets conforming to ASTM F 477. Joints for Storm Drain pipe shall be made with a bell/bell or bell and spigot coupling and shall conform to ASTM D 3212 using elastomeric gaskets conforming to ASTM F 477. All gaskets shall be factory installed on the pipe in accordance with the Material Person's recommendations.

9-05.5(3) RESERVED**9-05.5(4) PERFORATED CORRUGATED POLYETHYLENE SUBSURFACE DRAIN PIPE****9-05.5(4)A GENERAL**

Perforated corrugated polyethylene subsurface drain pipe shall be high density polyethylene (HDPE) meeting the requirements of AASHTO M 294, Type S. The size of pipe allowed shall range from a minimum 12 inch in diameter through a maximum of 48 inch diameter. Perforations shall be in accordance with AASHTO M 294. All HDPE pipe delivered and used shall be certified through the Plastic Pipe Institute (PPI) Third Party Certification program and shall bear the Third Party Administered PPI seal.

9-05.5(4)B COUPLING BANDS

Joints for perforated corrugated polyethylene subsurface drain pipe shall be made with a bell/bell or bell and spigot coupling using elastomeric gaskets conforming to ASTM F 477. All gaskets shall be factory installed on the coupling or on the pipe by the Material Person.

9-05.5(5) POLYETHYLENE END SECTIONS

High density polyethylene (HDPE) end sections shall be manufactured out of polyethylene resin complying with ASTM D 3350.

9-05.6 ALUMINUM PIPE**9-05.6(1) GENERAL**

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

Corrugated aluminum drain pipe, aluminum culvert pipe, and aluminum pipe without perforations shall conform to the applicable requirements of AASHTO M 196.

The protective coating for aluminum pipe shall be Treatment 5 as specified in Section 7-02.3(1)C3a, and the pipe shall be constructed of helically corrugated lock seam aluminum pipe. An exception is allowed when gasketed helically corrugated lock seam aluminum pipe is specified in the Contract and Treatment 5 is not required.

Aluminum surfaces that are to be in contact with any Portland cement product (controlled density fill (CDF), concrete, grout, mortar, etc.) shall be protected by first cleaning the aluminum surface in contact with Portland cement product with solvent and then painting this surface with two coats of paint extending a minimum two feet beyond the area of contact with the Portland cement product. The paint shall conform to Federal Specification TT-P-645 (Primer, Paint, Zinc Chromate, Alkyd Vehicle).

9-05.6(1)A BASIS FOR ACCEPTANCE FOR ALUMINUM PIPE

The basis for acceptance of aluminum pipe will be the same as specified in Section 9-05.0, except when gasketed helically corrugated lock seam aluminum pipe is specified in the Contract. A qualification test, conducted by the Engineer, will be required of the Material Person for gasketed helically corrugated lock seam aluminum pipe, as the Engineer is required to identify specific pipe sizes and gasket materials that perform acceptably and reliably with confidence in specific applications.

9-05.6(1)B COUPLING BANDS**9-05.6(1)B1 COUPLING BANDS FOR DRAIN PIPE**

Coupling bands for corrugated aluminum alloy drain pipe shall meet the requirements of coupling bands for Type I pipe of AASHTO M 196, except that bands using projections (dimples) will not be allowed. The bands shall be fabricated of the same material as the pipe.

Coupling bands for aluminum corrugated pipe shall be 24 inch, two-piece half-circle corrugated pipe held together with angles and bolts. A neoprene gasket shall be placed between the pipe and the bands. The bands shall be made of the same material and have the same corrugation as the pipe, and shall meet the requirements of Section 9-05.6(1)B2.

9-05.6(1)B2 COUPLING BANDS FOR CULVERT PIPE

Coupling for bands shall meet applicable requirements of AASHTO M 196. Bands having projections in lieu of corrugations will not be allowed.

Steel bolts and nuts for coupling bands shall meet the requirements of ASTM A 307 and shall be galvanized in accordance with AASHTO M 232 or AASHTO B 633.

Aluminum angles shall be of the same material as the coupling bands.

Rods, when required, shall meet the requirements of ASTM B 221, Alloy 6061-T6.

Asphalt coating shall not be used on coupling bands.

Coupling bands and aluminum pipe shall be the product of the same Material Person.

9-05.6(1)B3 COUPLING BANDS FOR ALUMINUM PIPE

Section 9-05.7(4)B shall apply to aluminum pipes, except the band shall have a range of thicknesses from not less than 0.60 inch to not larger than 0.105 inch.

Coupling bands and aluminum pipe shall be the product of the same Material Person.

9-05.6(1)C MITERED ENDS

Section 7-02.3(1)C2c shall apply to aluminum pipe.

9-05.6(1)D ALUMINUM END SECTIONS

The applicable provisions of AASHTO M 196 shall apply to the construction of end sections and toe plate extensions for aluminum pipes. In addition, they shall conform to the requirements of Section 9-05.7(2)G.

Asphalt coating shall not be used on aluminum end sections.

9-05.6(2) PERFORATED CORRUGATED ALUMINUM SUBSURFACE DRAIN PIPE**9-05.6(2)A GENERAL**

Perforated corrugated aluminum subsurface drain pipe shall meet the requirements of AASHTO M 196, except that the perforations may be located at any location on the tangent of the corrugations providing the other perforation spacing meet Specifications.

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

9-05.6(2)B COUPLING BANDS

Coupling bands for corrugated aluminum subsurface drain pipe shall meet the requirements of coupling bands for Type III pipe of AASHTO M 196. The bands shall be fabricated of the same material as the pipe, if metallic bands are used.

Acceptable coupling bands are two-piece, helically-corrugated with nonreformed ends and integrally formed flanges; universal bands (dimple bands); a smooth sleeve-type coupler; and those bands meeting the requirements of Section 9-05.6(1)B2. Smooth sleeve-type couplers may be either plastic or aluminum, suitable for holding the pipe firmly in alignment without the use of sealing compound or gaskets.

9-05.6(3) ALUMINUM SPIRAL RIB PIPE**9-05.6(3)A GENERAL**

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

Aluminum spiral rib pipe shall meet the requirements of AASHTO M 196 and these Specifications. The size, alloy, and protective treatment shall be as indicated in the Contract.

The Material Person of spiral rib pipe shall submit to the Engineer a Manufacturer's Certificate of Compliance stating that the Material furnished complies in all respects with these Specifications. The Engineer may require additional information or tests to be performed by the Contractor, at no expense to the Owner.

Unless indicated otherwise in the Contract, spiral rib pipe shall be furnished with pipe ends cut perpendicular to the longitudinal axis of the pipe. Pipe ends shall be cut evenly. Spiral rib pipe shall be fabricated by using a continuous helical lock seam with a seam gasket.

For spiral rib pipe, helical ribs shall project outwardly from the smooth pipe wall and shall be fabricated from a single uniform thickness material. The ribs shall be 3/4 inch wide by 3/4 inch deep with a nominal spacing of 7-1/2 inches center to center. Pipe shall be fabricated with ends that can be acceptably jointed with coupling bands.

For narrow pitch spiral rib pipe, helical ribs shall project outwardly from the smooth pipe wall and shall be fabricated from a single thickness of material. The ribs shall be 3/8 inch \pm 1/8 inch wide (measured outside to outside) and a minimum of 0.4375 inch high (measured as the minimum vertical distance from the outside of pipe wall to top surface of the rib). The maximum spacing of ribs shall be 4.80 inch center to center (measured normal to the direction of the ribs). The radius of bend of the metal at the corners of the ribs shall be a minimum of 0.0625 inch with an allowable tolerance of plus or minus 10 percent.

For wide pitch spiral rib pipe, helical ribs shall project outwardly from the smooth pipe wall and shall be fabricated from a single thickness of material. The ribs shall be 3/4 inch \pm 1/8 inch wide (measured outside to outside) and a minimum of 0.95 inch high (measured as the minimum vertical distance from the outside of pipe wall to top surface of the rib). The maximum spacing of ribs shall be 11.75 inches center to center (measured normal to the direction of the ribs). The radius of bend of the metal at the corners of the ribs shall be 0.0625 inch with an allowable tolerance of + 10 percent.

9-05.6(3)B CONTINUOUS LOCK SEAM PIPE

Pipes fabricated with continuous helical lock seam parallel to the rib may be used for full circle pipe. The lock seam shall be formed in the flat between ribs and shall conform to Section 13.2.1 through 13.2.5 of AASHTO M 196.

9-05.6(3)C BASIS FOR ACCEPTANCE FOR ALUMINUM SPIRAL RIB PIPE

The basis for acceptance will be a qualification test conducted by the Engineer for the Material Person of helically corrugated spiral rib, narrow pitch spiral rib or wide pitch spiral rib lock seam pipe, as the Engineer is required to identify specific pipe sizes and gasket materials that perform acceptably and reliably with confidence in specific applications.

Continuous lock seam pipe shall be sampled and tested in accordance with AASHTO T 249 and a Manufacturer's Certificate of Compliance stating the results shall be submitted to the Engineer.

9-05.6(3)D COUPLING BANDS

Coupling bands shall be of the same material as the pipe. Coupling bands and gaskets shall conform to Section 9-05.7(4)B.

9-05.6(4) ALUMINUM PIPE FOR DETENTION

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

Aluminum detention pipe shall be helical or annular corrugated aluminum pipe, meeting the requirements of AASHTO M 196, Type I with the gauge as indicated on the Drawings. The end plate and all end plate reinforcement shall be aluminum alloy 6061-T6 structural plate with the thickness as indicated on the Drawings.

Coupling bands for corrugated aluminum detention pipes shall be Type "D" per WSDOT Standard Plan no. B-60.40.

9-05.7 STEEL PIPE

9-05.7(1) GALVANIZED STEEL DRAIN PIPE

Galvanized steel pipe shall be 4 inch inside diameter, Schedule 40 pipe meeting the requirements of ASTM A 53.

9-05.7(2) STEEL CULVERT PIPE AND PIPE ARCH

9-05.7(2)A GENERAL

Steel Culvert pipe and pipe arch shall meet the requirements of AASHTO M 36, Type I and Type II. Welded seam aluminum coated (aluminized) corrugated steel pipe and pipe arch with metallized coating applied inside and out following welding is acceptable.

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

9-05.7(2)B ELLIPTICAL FABRICATION

When elongated pipes are specified, circular pipes shall be fabricated 5 percent out of round to form an elliptical section. The vertical or longer axis of the elliptical section shall be clearly marked before shipping.

9-05.7(2)C COUPLING BANDS

Coupling bands shall be flange bands or corrugated bands as shown on the Drawings, WSDOT Standard Plan no. B-60.40 Type D or as specified in the Contract, and shall be fabricated of the same material as the pipe and with the same metallic protective treatment as the pipe. The corrugated bands shall conform to the pipe and shall meet all applicable requirements of AASHTO M 36 except that coupling bands for all sizes of steel pipe arch with 3 inch x 1 inch corrugations shall be 24 inches wide. Bands having projections in lieu of corrugations will not be allowed.

Steel bolts and nuts for coupling bands shall meet the requirements of ASTM A 307 and shall be galvanized in accordance with ASTM A 153.

Steel angles, when required for coupling bands, shall meet the requirements of AASHTO M 36.

Asphalt coating shall not be used on coupling bands.

Coupling bands meeting the requirements of Section 9-05.7(4)B will also be acceptable.

Coupling bands and pipe shall be made by the same Material Person.

9-05.7(2)D STEEL CULVERT PIPE ARCH

Steel pipe arch shall meet the requirements for steel pipe and pipe arch of these Specifications except in the method of fabrication. Circular pipe shall be fabricated in two semi-circles, and the pipe arch shall be fabricated in two separate sections, the upper portion or arch, and the bottom section including the connecting arcs.

Both longitudinal edges of the lower section of the pipe arch shall be notched to provide interlocking seams which form the two segments into the full section when it is erected in the field. Hook and eye bolts, or other approved means, shall be provided to hold the segments firmly together.

Individual plates shall be a minimum of 2 feet in length except for short or half sections required to complete the end section of the Culvert.

When protective treatment is specified on the Drawings, pipe arch shall be coated with one of the treatments as provided in Section 7-02.3(1)C3a.

9-05.7(2)E STEEL END SECTIONS**9-05.7(2)E1 GENERAL**

The applicable provisions of AASHTO M 36 shall apply to the construction of steel end sections, except that the end sections shall be fabricated of the same material with the same metallic protective treatment as the pipe.

Asphalt coating shall not be used on steel end sections.

9-05.7(2)E2 FABRICATION

The shape, thickness, dimensions, and number of pieces shall conform to WSDOT Standard Plan no. B-70.60 for the size and shape of pipe shown on the Drawings. They shall be manufactured as integral units or so formed that they can be readily assembled and erected in place. When bolts are used for assembly, they shall be 3/8 inch diameter or larger and shall be galvanized. No field welding or riveting will be permitted.

9-05.7(2)E3 GALVANIZED HARDWARE

Bolts, nuts, and miscellaneous hardware shall be galvanized in accordance with the provisions of AASHTO M 232.

9-05.7(2)E4 TOE PLATE EXTENSIONS

Toe plate extensions shall be furnished only when so specified in the Contract. When required, the toe plate extensions shall be punched with holes to match those in the lip of the skirt and fastened with 3/8 inch or larger galvanized nuts and bolts. Toe plate extensions shall be the same material and thickness as the end section and shall be fabricated of the same material with the same metallic protective treatment as the end section.

9-05.7(3) STEEL SPIRAL RIB DRAIN PIPE**9-05.7(3)A GENERAL**

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

Steel spiral rib drain pipe shall meet the requirements of AASHTO M 36 and these Specifications. The size, coating, metal and protective treatment shall be as specified in the Contract.

The Material Person of spiral rib drain pipe shall furnish to the Engineer a Manufacturer's Certificate of Compliance stating that the Material furnished complies in all respects with these Specifications. The Engineer may require additional information or tests to be performed by the Contractor, at no expense to the Owner.

Unless otherwise specified in the Contract, spiral rib drain pipe shall be furnished with pipe ends cut perpendicular to the longitudinal axis of the pipe and shall be cut evenly. Spiral rib pipe shall be fabricated either by using a continuous helical lock seam with a seam gasket or a continuous helical welded seam paralleling the rib.

Spiral rib drain pipe shall have helical ribs that project outwardly, shall be formed from a single thickness of material, and shall conform to one of the following configurations:

1. AASHTO M 36, Section 7.2.2.
2. 0.375 inch, $\pm 1/8$ inch wide by 0.4375 inch (minimum) deep at 4.80 inch center to center.
3. 3/4 inch wide by 5/8 inch deep at 12 inch center to center.

Pipe shall be fabricated with ends that can be acceptably jointed with coupling bands.

When required, spiral rib pipe shall be bituminous treated or paved. The bituminous treatment for spiral rib pipe shall conform to the requirements of Sections 7-02.3(1)C3a and 9-05.7(2)C.

9-05.7(3)B CONTINUOUS LOCK SEAM PIPE**9-05.7(3)B1 GENERAL**

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

Pipes fabricated with a continuous helical seam parallel to the rib may be used for full circle pipe. The lock seam shall be formed in the flat between ribs and shall conform to Sections 7.5.1 through 7.5.3 of AASHTO M 36.

For narrow pitch spiral rib pipe, the lap width specified in AASHTO M 36, Section 7.5.1 shall be 1/4 inch.

For use in applications without bituminous treatment, the continuous lockseam shall require prior acceptance by qualification testing conducted by the Engineer. The Contractor shall provide the Engineer at least 3 Working Days advance notice to arrange for this testing.

9-05.7(3)B2 BASIS FOR ACCEPTANCE

The basis for acceptance will be a qualification test conducted by the Engineer for each Material Person of helically corrugated, gasketed spiral rib, or narrow pitch spiral rib lock seam steel pipe as the Engineer is required to identify specific pipe sizes and gasket materials that perform acceptably and reliably with confidence in specific applications.

Continuous lock seam pipe shall be sampled and tested in accordance with AASHTO T 249 and a Manufacturer's Certificate of Compliance shall be submitted to the Engineer indicating compliance of the pipe with these Specifications.

9-05.7(3)C CONTINUOUS WELDED SEAM PIPE

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

Pipes fabricated with a continuous helical welded seam parallel to the ribs may be used for full circle pipe. The welding process for galvanized steel pipe shall be so controlled that the combined width of the weld and adjacent spelter coating burned by the welding does not exceed three times the thickness of the metal. If spelter is burned outside these limits, the weld and burned spelter shall be acceptably repaired for damaged galvanizing. Testing for welded seam quality control shall conform to AASHTO T 241. Welded pipe fabricated from aluminized steel pipe shall have the coating of the welded area repaired by flame-sprayed metallizing inside and out after welding.

Repair of Damaged Galvanizing: When the galvanized (zinc coated) surface has welding burn, all surfaces of the welded connections shall be thoroughly cleaned by wire brushing and all traces of the welding flux and loose or cracked galvanizing removed, after which the areas shall be repaired by flame spray metallizing both inside and out.

9-05.7(3)D COUPLING BANDS

Coupling bands shall be of the same material as the pipe. Coupling bands and gaskets shall conform to Section 9-05.7(4)B.

9-05.7(5) STEEL PIPE FOR DETENTION

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

Steel detention pipe shall be galvanized helical or annular corrugated steel pipe, meeting the requirements of AASHTO M 36, Type 1, asphalt coated to requirements of AASHTO M 190, Type A with the gauge as indicated in the Contract. The end plate and all end plate reinforcement shall be structural steel plate of the type and thickness as designated in the Contract. Coupling bands for steel detention pipes shall be Type "D" per WSDOT Standard Plan no. B-60.40 unless the Contract specifies otherwise.

9-05.9 PIPE COATINGS**9-05.9(1) ALUMINUM COATED (ALUMINIZED) CORRUGATED IRON OR STEEL DRAIN PIPE****9-05.9(1)A GENERAL**

Aluminum coated (aluminized) corrugated iron or steel drain pipe shall meet the requirements of AASHTO M 36. The aluminized sheet thickness shall be 0.052 inch for 6 inch diameter drain pipe, and 0.064 inch for 8 inch and larger diameter drain pipe. Welded seam aluminum coated (aluminized) corrugated iron or steel drain pipe with metallized coating applied both inside and outside after welding is acceptable.

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

9-05.9(1)B COUPLING BANDS

Coupling bands for aluminum coated (aluminized) corrugated iron or steel drain pipe shall meet the requirements of coupling bands for Type I pipe of AASHTO M 36, except that bands using projections (dimples) shall not be permitted. The bands shall be fabricated of the same material as the pipe, and with the same metallic protective treatment as the pipe.

Acceptable coupling bands for corrugated metal pipe shall be made using a 2-piece, 24 inch wide corrugated coupling band, held together with angles and bolts. A neoprene gasket between the pipe and the band shall be of the same material and corrugations as the pipe, and meet the requirements of Section 9-05.7(2)E.

9-05.9(2) ALUMINUM COATED (ALUMINIZED) CORRUGATED IRON OR STEEL SUBSURFACE DRAIN PIPE**9-05.9(2)A GENERAL**

Aluminum coated (aluminized) corrugated iron or steel subsurface drain pipe shall meet the requirements of AASHTO M 36, except that perforations required in Class I, Class II, and Class III pipe may be located anywhere on the tangent of the corrugations provided the other perforation spacing requirements meet Specifications. Welded seam aluminum coated (aluminized) corrugated iron or steel subsurface drain pipe with metallized coating applied both inside and outside after welding is acceptable.

The pipe may conform to any one of the Type III pipes specified in AASHTO M 36, and perforations in Class I, Class II, and Class III pipe may be drilled or punched. The aluminized sheet thickness shall be 0.052 inch for 6 inch diameter subsurface drain pipe, and 0.064 inch for 8 inch and larger diameter subsurface drain pipe.

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

9-05.9(2)B COUPLING BANDS

Coupling bands for aluminum coated (aluminized) corrugated iron or steel subsurface drain pipe shall meet the requirements of coupling bands for Type III pipe of AASHTO M 36. The bands shall be fabricated of the same material as the pipe and with the same metallic protective treatment as the pipe, if metallic bands are used.

Acceptable coupling bands are the two-piece, helically-corrugated band, with nonreformed ends and integrally formed flanges, universal bands (dimple bands), a smooth sleeve-type coupler, and those bands meeting the requirements of Section 9-05.7(2)E. Smooth sleeve-type couplers may be either plastic or steel suitable for holding the pipe firmly in alignment without the use of sealing compound or gaskets.

9-05.10 PLASTIC FOAM (ETHAFOAM)

Polyethylene plastic foam used in underground utility separation shall meet the Federal Specification Cid A-A 59136 Type 1, Class 1, Grade A (Ethafom).

9-05.11 ABS COMPOSITE PIPE

ABS (acrylonitrile butadiene styrene) material shall not be used unless specified in the Contract or permitted by the Engineer.

ABS composite pipe shall meet the requirements of AASHTO M 264.

ABS composite pipe shall be provided with Type OR (flexible gasketed) joints. Rubber gasketed joints shall conform to applicable provisions of ASTM C 443.

Fittings for ABS composite pipe shall be specifically designed for connection to ABS composite pipe with solvent cement. Normally, all fittings shall be the same material as the pipe being connected, except that fittings using other materials or constructed with more than one material may be used subject to advance approval of the Engineer. Fittings shall have sufficient strength to withstand handling and load stresses encountered.

9-05.12 SAFETY BARS FOR CULVERT PIPE

Steel pipe used as safety bars and steel pipe used as sockets shall conform to the requirements of ASTM A 53, Grade B. Steel tubing used as safety bars shall conform to ASTM A 500, Grade B. Steel plate shall conform to ASTM A 36.

9-05.13 FLOW CONTROL STRUCTURE

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

The flow control Structure shall be made from a standard maintenance hole section as shown on Standard Plan no. 270 with diameter as indicated on the Drawings.

Where surface water is to enter directly through the cover of the flow control Structure, the frame and grate shall be as shown on Standard Plan no. 264, and the precast slab shall be as shown on Standard Plan nos. 243a and 243b with opening details to fit the diameter of the chamber. In all other cases, standard ring and cover (see Standard Plan no. 230) shall be used with a precast slab conforming to 200 Series Standard with a 24 inch round opening. Maintenance hole sections, castings and slabs shall meet the requirements of Section 7-05.

The flow control device and connection shall consist of a PVC pipe cross with an orifice, a pipe connection, and shear gate with a galvanized steel chain. The diameters of the control device and connection shall be the same as the diameter of the outlet pipe as indicated in the Contract. The PVC pipe used for the cross and connection shall comply with ASTM D 1785, Schedule 40. The PVC material used for the orifice plate and the shear gate shall be plate material in compliance with ASTM D 1784, PVC Class 12454-B. The orifice plate material shall be 1/4 inch thick and the shear gate material shall be 1/2 inch thick. The shear gate pin shall be of the same PVC material as the shear gate. The sheargate chain shall be 1/8" diameter Type 304 stainless steel straight link chain permanently attached to the Structure.

9-05.14 GALVANIZED IRON PIPE

Galvanized iron pipe 4 inch diameter and smaller shall be ASTM A 53 schedule 40 pipe.

9-05.15 CEMENT SLURRY - ABANDONING PIPE OR FILLING ANNULAR SPACE BETWEEN 2 PIPES

Cement slurry used to fill the annular space between an inner and outer pipe shall be pumpable, flowable, and shall completely fill the annular space. Materials shall have the following properties:

MATERIAL REFERENCE	MATERIAL PROPERTY
Cement, ASTM C 150	Type I / II
Slurry Density, ASTM C 138	65 pcf (minimum)
Foamed Slurry Density, ASTM C 138	45 pcf (minimum)
Water / Cement Ratio	0.90 (maximum)
Flow, ASTM C 939	18 seconds (maximum)
Shrinkage, ASTM C 827	non-shrink
Bleeding, ASTM C 232	no bleed
Set Time, ASTM C 403	3 - 6 hours ¹
COMPRESSIVE STRENGTH	
ASTM C 403 @ 24 hours	75 psi (minimum)
ASTM C 495 @ 7 Days	150 psi (minimum)
ASTM C 495 @ 28 Days	250 psi (minimum)

¹Set time depends on temperature and site conditions.

9-05.16 SIDE SEWER AND SERVICE DRAIN

Sanitary side Sewer and service drain side Sewer Material shall be in accordance with the SMC Title 21 and other current Director's Rules, as applicable.

9-05.17 POLYPROPYLENE PIPE

Polypropylene Pipe, corrugated, single wall and double wall for diameter sizes 12 inch through 30 inch shall conform to the requirements of ASTM F2736. Third party certification that it meets ASTM F2764 shall accompany all delivered pipe.

Triple wall polypropylene pipe for diameter sizes 30 inch through 60 inch diameter shall conform to ASTM F2764. Third party certification that it meets ASTM F2764 shall accompany all delivered pipe.

SECTION 9-06 STRUCTURAL STEEL AND RELATED MATERIALS**9-06.1 STRUCTURAL CARBON STEEL**

Structural carbon steel shall conform to the requirements of AASHTO M 270, Grade 36, Structural Steel For Bridges, unless the Contract specifies AASHTO M 183, Structural Steel.

9-06.2 STRUCTURAL LOW ALLOY STEEL

Structural low alloy steel shall conform to the requirements of AASHTO M 270, Grades 50 or 50W as specified in the Contract, unless the Contract specifies AASHTO M 223 or AASHTO M 222.

9-06.3 STRUCTURAL HIGH STRENGTH STEEL

Structural high strength steel shall be high yield strength, quenched and tempered structural steel conforming to the requirements of AASHTO M 270, Grades 70W, 100, or 100W as called out in the Contract, unless the Contract specifies AASHTO M 244.

9-06.4 RESERVED**9-06.5 BOLTS****9-06.5(1) UNFINISHED BOLTS**

Unfinished bolts (ordinary machine bolts) shall conform to the specification requirements of ASTM A 307, Grade A or B. Nuts shall comply with ASTM A 563, Grade A requirements. Washers, unless otherwise specified in the Contract, shall meet ASTM F 844 specifications.

The Contractor shall submit a Manufacturer's Certificate of Compliance for the bolts, nuts, and washers prior to installing any of them.

9-06.5(2) RESERVED**9-06.5(3) HIGH STRENGTH BOLTS**

High-strength bolts for structural steel joints shall conform to either ASTM A 325 Type 1 or 3 or ASTM A 490 Type 1 or 3, as specified on the Drawings or in the Project Manual. Tension control bolt assemblies, meeting all requirements of ASTM F 1852 may be substituted where ASTM A 325 high-strength bolts and associated hardware are specified.

When bolts are specified to be galvanized, tension control bolt assemblies shall be galvanized after fabrication in accordance with ASTM B 695 Class 55 Type I.

Bolts conforming to ASTM A 490 shall not be galvanized.

Bolts for unpainted and nongalvanized structures shall conform to ASTM A 325 Type 3, ASTM A 490 Type 3, or ASTM F 1852 Type 3, as specified on the Drawings or in the Project Manual.

Nuts for high-strength bolts shall meet the following requirements:

ASTM A 325 Bolts

Type 1 (black)	ASTM A 563 Grade C, C3, D, DH, and DH3 AASHTO M 292 Grade 2H
Type 3 (black weathering)	ASTM A 563 Grade C3 and DH3
Type 1 (hot-dip galvanized)	ASTM A 563 Grade DH AASHTO M 292 Grade 2H

ASTM A 490 Bolts

Type 1 (black)	ASTM A 563 Grade DH and DH3 AASHTO M 292 Grade 2H
Type 3 (black weathering)	ASTM A 563 Grade DH3

Nuts that are to be galvanized shall be tapped oversized the minimum required for proper assembly. The amount of overlap shall be such that the nut will assemble freely on the bolt in the coated condition and shall meet the mechanical requirements of ASTM A 563 and the rotational capacity test specified in ASTM A 325.

Galvanized nuts shall be lubricated in accordance with ASTM A 563 including supplementary requirement S2. Documentation shall include the name, method of application, and dilution of the lubricant applied to the nuts.

Washers for ASTM A 325 and ASTM A 490 bolts shall meet the requirements of ASTM F 436 and may be circular, beveled, or extra thick, as required. The surface condition and weathering characteristics of the washers shall be the same as for the bolts being specified.

Direct Tension Indicators shall conform to the requirements of ASTM F 959 and may be used with either ASTM A 325 or M 253 bolts. Direct tension indicators shall be galvanized by mechanical deposition in accordance with ASTM B 695 class 55. Hot-dip galvanizing will not be allowed.

All bolts, nuts, and direct tension indicators shall be marked and identified as required in the pertinent Specifications.

Lock-pin and collar fasteners which meet the materials, manufacturing, and chemical composition requirements of ASTM A 325 or ASTM A 490, and which meet the mechanical property requirements of the same Specification in full size tests, and which have a body diameter and bearing areas under lock-pin head and collar not less than those provided by a bolt and nut of the same nominal size may be used. The Contractor shall submit a detailed installation procedure to the Engineer for approval. Approval from the Engineer to use a lock-pin and collar fasteners shall be received by the Contractor prior to use.

The Contractor shall provide Manufacturer's Certificate of Compliance for all bolts, nuts, washers, and load indicators. The Manufacturer's Certificate of Compliance shall include certified mill test reports and test reports performed on the finished bolt confirming that all of the materials provided meet the requirements of the applicable AASHTO or ASTM Specification. The documentation shall also include the name and address of the test laboratory, the date of testing, the lot identification of the bolts and nuts, and coating thickness for galvanized bolts and nuts. Shipping containers (not lids) shall be marked with the lot identification of the item contained therein.

Bolts shall be sampled prior to incorporating into a structure. For the purposes of selecting samples, a lot of bolts shall be the quantity of bolts of the same nominal diameter and same nominal length in a consignment shipped to the project site. The minimum number of samples from each lot shall be as follows:

LOT SIZE	SAMPLE SIZE ^{1,2}
0 to 50	Note 3
51 to 150	4
151 to 1,200	6
1,201 to 10,000	10
10,001 to 35,000	16
35,001 and over	24

- Notes**
1. If bolts are galvanized, increase the sample size by 1.5 times the table value for the number of bolts being sampled.
 2. Nuts, washers, and load indicator devices shall be sampled at the same frequency as the bolts.
 3. Manufacturer's Certificate of Compliance required — samples not required.

All testing of bolts, nuts, washers, and load indicating devices shall be performed on specimens as they are to be installed.

All samples shall include a Manufacturer's Certificate of Compliance for each lot of bolts provided as defined in Section 1-06.3.

9-06.5(4) ANCHOR BOLTS

Anchor bolts shall meet the requirements of ASTM F 1554 and, unless otherwise specified, shall be Grade 105 and shall conform to Supplemental Requirements S2, S3, and S4.

Nuts for ASTM F 1554 Grade 105 black anchor bolts shall conform to ASTM A 563, Grade D or DH. Nuts for ASTM F 1554 Grade 105 galvanized bolts shall conform to either ASTM A 563, Grade DH, or AASHTON M 292, Grade 2H, and shall conform to the overtapping, lubrication, and rotational testing requirements in Section 9-06.5(3). Nuts for ASTM F 1554 Grade 36 or 55 black or galvanized anchor bolts shall conform to ASTM A 563, Grade A. Washers shall conform to ASTM F 436.

The bolts shall be tested by the manufacturer in accordance with the requirements of the pertinent Specification and as specified in these Specifications. Anchor bolts, nuts, and washers shall be inspected prior to shipping to the Project Site. The Contractor shall submit to the Engineer for approval a Manufacturer's Certificate of Compliance for the anchor bolts, nuts, and washers, as defined in Section 1-06.3. If the Engineer deems it appropriate, the Contractor shall provide a sample of the anchor bolt, nut, and washer for testing.

All bolts, nuts, and washers shall be marked and identified as required in the pertinent Specification.

9-06.6 RESERVED

9-06.7 RESERVED

9-06.8 STEEL CASTINGS

Steel castings shall conform to the requirements of AASHTO M 103, Mild to Medium Strength Carbon-Steel Castings for General Application, grade 70-36, unless otherwise designated in the Contract.

9-06.9 GRAY IRON CASTINGS

Gray iron castings shall conform to the requirements of AASHTO M 105. The class of castings to be furnished shall be as designated in the Contract.

9-06.10 MALLEABLE IRON CASTINGS

Malleable iron castings shall conform to the requirements of ASTM A 47.

9-06.11 STEEL FORGINGS AND STEEL SHAFTING

Steel forgings shall conform to the requirements of AASHTO M 102. The classes of forgings to be furnished shall be those specified in the Contract.

Steel shafting shall conform to the requirements of AASHTO M 169, Grade Designation 1016 to 1030 inclusive, unless otherwise specified in the Contract.

9-06.12 BRONZE CASTINGS

Bronze castings shall conform to the requirements of AASHTO M 107, Bronze Castings for Bridges and Turntables.

9-06.13 COPPER SEALS

Copper sheets for seals shall conform to the requirements of AASHTO M 138. They shall be UNS C12500, light cold rolled, and furnished in flat sheets each not less than 0.018 inch in thickness.

All splices or joints shall be carefully brazed or soldered to produce a continuous watertight seal for the full length of each unit.

9-06.14 DUCTILE IRON CASTINGS

Ductile iron castings shall conform to the requirements of ASTM A 536, Grade 80-55-06, unless otherwise specified in the Contract.

9-06.15 WELDED SHEAR CONNECTORS

Welded shear studs shall be made from cold drawn bar stock conforming to the requirements of AASHTO M 169, Grades 1010 through 1020, inclusive, either semi-killed or killed deoxidation.

The Material shall conform to the following mechanical properties:

Tensile Strength	60,000 psi min.
Yield Strength	50,000 psi min.
Elongation	20% min.
Reduction of Area	50% min.

Mechanical properties shall be determined in accordance with AASHTO Methods and Definitions T 244.

At the manufacturer's option, mechanical properties of the studs shall be determined by testing either the steel after cold finishing, or the full diameter finished studs.

9-06.16 ROADSIDE SIGN STRUCTURES

Materials in this Section apply to Division 6 Structures. See Section 9-28 for signing Materials and fabrication.

All bolts shall conform to AASHTO M 164. Washers for bolts shall be per AASHTO M 293.

Posts for single post sign structures shall meet the requirements of ASTM A 500, Grade B or ASTM A 53, Grade B.

Posts for multiple post sign structures shall meet the requirements of AASHTO M 183. Posts meeting the requirements of AASHTO M 222 or AASHTO M 223, Grade 50 may be used as an acceptable alternate to the AASHTO M 183 posts. All steel not otherwise specified shall conform to AASHTO M 183.

Triangular base stiffeners for one-directional multi-post sign posts shall meet the requirements of AASHTO M 222 or AASHTO M 223, Grade 50.

Base connectors for multiple directional steel breakaway posts shall conform to the following:

Bracket	Aluminum Alloy 6061 T-6
Bosses for Type 2B Brackets	ASTM A 582
Coupling Bolts	AASHTO M 164
Anchor Bolts	Type 304 stainless steel for threaded portion, AISI 1038 steel rod and AISI 1008 coil for cage portion.

Anchor couplings for multiple directional steel breakaway posts shall have a tensile breaking strength range as follows:

Type 2A	17,000 to 21,000 lb.
Type 2B	47,000 to 57,000 lb.

For multi-directional breakaway base connectors, shims shall be fabricated from pregalvanized sheet steel. For one-directional breakaway base connectors, single post or multi-post, shims shall be fabricated from brass conforming to ASTM B 36.

9-06.17 RESERVED**9-06.18 METAL BRIDGE RAILING**

Metal bridge railing shall conform to the type and Material Specifications set forth in the Contract.

Section 8, part (b) of the Aluminum Association Standard Specifications for Aluminum Railing Posts Alloy A 344-T4 is hereby revised to provide that no X-ray inspection will be required after a foundry technique has been established for each mold which ensures production of castings that are free from harmful defects. Inspection for approval of castings will be made by the Engineer after the finished castings have been anodized as noted on the Drawings.

Welding of aluminum shall be in accordance with Section 6.9 of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, Fourth Edition-2001.

9-06.19 RESERVED**9-06.20 RESERVED****9-06.21 RESERVED****9-06.22 BOLTS, WASHERS, AND OTHER HARDWARE**

Ordinary machine bolts and flat head bolts shall be made from commercial bolt stock meeting the specifications of ASTM A 307, and shall be grade A. Drift bolts and dowels may be either wrought iron or medium steel. Washers may be cast iron or malleable iron or may be cut from medium steel or wrought iron plate.

All bolts and other hardware which are to be galvanized and which require bending or shaping shall be hot forged to the required shape before galvanizing. Cold bending of such Material will not be permitted because of the tendency toward embrittlement during the galvanizing process. Galvanizing shall be in accordance with AASHTO M 232.

Split rings for log cribbing of 4 inches inside diameter shall be manufactured from hot rolled, low-carbon steel conforming to ASTM A 711 AISI, Grade 1015. Each ring shall form a true circle with the principle axis of the cross-section of the ring metal parallel to the geometric axis of the ring. The thickness of the metal section shall be 0.195 inch plus or minus 0.010 inch and the section shall be beveled from the central portion toward the edges to a thickness of 0.145 inch plus or minus 0.010 inch. It shall be cut through in one place in its circumference to form a tongue and slot. Split ring connectors shall be galvanized in accordance with AASHTO M 232.

Spike-grid timber connectors shall be manufactured according to ASTM A 47 for malleable iron castings. They shall consist of 4 rows of opposing spikes forming a 4-1/8 inch square grid with 16 teeth which are held in place by fillets which are diamond shaped in cross-section.

Nails shall be round wire of standard form. Spikes shall be wire spikes or boat spikes, as specified on the Drawings. Bolts, dowels, washers, and other hardware, including nails, shall be black or galvanized as specified on the Drawings, but if not so specified shall be galvanized when used in treated timber Structures.

SECTION 9-07 REINFORCING STEEL**9-07.1 GENERAL**

Deformed steel bar shall be free from loose mill scale, dirt, grease, or other defects affecting the strength of bond with concrete. Deformed steel bar coated with rust shall be vigorously wire brushed clean. Size numbers shall be taken to represent the diameter of the bar in 1/8 inch units, except where standard wire gauge sizes are indicated in the Contract.

9-07.1(1) ACCEPTANCE BY MANUFACTURER'S CERTIFICATION

Reinforcing steel may be accepted by the Engineer based on the Manufacturer's Certificate of Compliance.

9-07.1(1)A ACCEPTANCE OF MATERIALS

Steel reinforcing bar manufacturers use either English or a Metric size designation while stamping rebar. The actual size of the bar, whether stamped with an English or a Metric size designation is acceptable. The Drawings and the Standard Plans will continue to use an English size designation. The table below shows the comparable reinforcing steel bar size designations in the both units of measure:

ENGLISH DESIGNATION	BAR DIAMETER	METRIC DESIGNATION
#3	(0.375-inches)	#10
#4	(0.500-inches)	#13
#5	(0.625-inches)	#16
#6	(0.750-inches)	#19
#7	(0.875-inches)	#22

#8	(1.000-inches)	#25
#9	(1.128-inches)	#29
#10	(1.270-inches)	#32
#11	(1.410-inches)	#36
#14	(1.690-inches)	#43
#18	(2.260-inches)	#57

9-07.1(2) BENDING

Steel reinforcing bars shall be cut and bent by careful and competent workmen. They shall be bent cold to templates, which shall not vary appreciably from the shape and dimension shown on the drawings.

Hooks and bends of steel reinforcing bars shall be bent to the following inside diameters unless shown otherwise on the drawings:

BAR SIZE	STIRRUPS AND TIES	ALL OTHER BARS
No. 3	1-1/2 "	6 bar diameters
No. 4	2"	6 bar diameters
No. 5	2-1/2 "	6 bar diameters
No. 6	4-1/2 "	6 bar diameters
No. 7	5-1/4"	6 bar diameters
No. 8	6"	6 bar diameters
No. 9 through No. 11	---	8 bar diameters
No. 14 through No. 18	---	10 bar diameters

The supplementary requirements of AASHTO M 31 for bend tests shall apply to size No. 14 and No. 18 steel reinforcing bars which have hooks or bends.

Hooked ends of steel reinforcing bars shall be standard hooks unless shown otherwise in the Drawings. Standard hooks shall consist of a 90, 135, or 180-degree bend as shown in the Drawings plus a minimum bar extension at the free end of the bar shown in the table below. Seismic hooks shall consist of a 135-degree bend plus a minimum bar extension at the free end of the bar shown in the table below.

MINIMUM BAR EXTENSIONS FOR STANDARD AND SEISMIC HOOKS						
BAR SIZE	180° HOOK		135° HOOK		90° HOOK	
	ALL BARS	SEISMIC	ALL	STIRRUP	ALL	
No. 3	2 1/2"	3"	2 1/4"	2 1/4"	4 1/2"	
No. 4	2 1/2"	3"	3"	3"	6"	
No. 5	2 1/2"	3 3/4"	3 3/4"	3 3/4"	7 1/2"	
No. 6	3"	4 1/2"	4 1/2"	9"	9"	
No. 7	3 1/2"	5 1/4"	5 1/4"	10 1/2"	10 1/2"	
No. 8	4"	6"	6"	12"	12"	
No. 9	4 3/4"				13 3/4"	
No. 10	5 1/4"				15 1/4"	
No. 11	5 3/4"				17"	
No. 14	7"				20 1/2"	
No. 18	9 1/4"				27 1/4"	

9-07.1(3) LENGTHS

Net lengths of bent bars shown in the "length" column of the bar list on the drawings are rounded to the nearest inch. Net length is the length of bar after all bend deductions are subtracted from the gross length.

9-07.2 DEFORMED STEEL BARS

Deformed steel bars for concrete reinforcement shall conform to either AASHTO M 31 Grade 60, or ASTM A 706, except as otherwise noted. Steel reinforcing bar for the cast-in-place components of bridge structures (excluding sidewalks and barriers but including shafts and concrete piles), and for precast substructure components of bridge structures, shall conform to ASTM A 706 only. However, in computing the ultimate unit tensile stress from test data, the area may be corrected for mass per linear foot of the bar within the weight tolerances listed. No such correction for mass shall be used in calculating the yield stress; the nominal area of the bar, as given in Table 1 of AASHTO M 31 or ASTM A 706, shall be used in this computation.

Deformed steel bars are referred to in the Drawings and Specifications by number: for example, No. 3, No. 4, No. 5, etc.

9-07.3 EPOXY-COATED STEEL REINFORCING BARS

Epoxy-coated rebar shall be coated according to AASHTO M 284 with the additional following modifications:

1. The list of steel reinforcing bars acceptable for coating shall include ASTM A 706.
2. The Contractor shall furnish a written certification that properly identifies the material, the number of each batch of coating material used, quantity represented, date of manufacture, name and address of manufacturer, and a statement that the supplied coating material meets the requirements of AASHTO M 284.
3. The Contractor shall supply to the Engineer an 8 ounce representative sample of the coating material from each batch of coating material. The sample shall be packaged in an airtight container and identified as epoxy coating material by batch number.
4. Prior to coating the bars, the Contractor shall submit to the Engineer for review, the coating material manufacturer's recommendation on the proper use and application requirements of the coating material.
5. A Manufacturer's Certificate of Compliance stating that all bars have been coated in accordance with the coating material manufacturer's recommendations and these Specifications shall be furnished with each shipment. This certification shall include for each bar size the preheat temperatures, cure times, thickness checks, holidays detected, and test results.
6. The Contractor shall give advance notice to the Engineer of the coating schedule at the coating plant so that Engineer inspection for approval may be provided.
7. The patching material, compatible with the coating material and inert in concrete, shall be supplied with each shipment.
8. For projects where epoxy-coated steel reinforcing bars are used in the top mat of bridge decks only, the maximum amount of damage to the coating shall not exceed 0.25 percent of the surface area of each bar.
9. The thickness of epoxy-coating shall be 10 mils \pm 2 mils.
10. All samples shall be submitted to the SPU Materials Laboratory (see Section 1-05.3(1) C).

9-07.4 PLAIN STEEL BARS

Where plain steel bars are specified, they shall conform to the chemical and physical properties of AASHTO M 31, Grade 60, unless specifically noted otherwise. Plain steel bars are indicated in the Contract by fractions of an inch; for example, 3/8 inch \emptyset , 1/2 inch \emptyset , 5/8 inch \emptyset , etc.

9-07.5 DOWEL BARS (FOR CEMENT CONCRETE PAVEMENT)

Epoxy coated dowel bars shall be round plain steel bars of the dimensions shown in the Standard Plans. They shall conform to AASHTO M 31, Grade 60 or AASHTO M 255, Grade 60 and shall be coated in accordance with ASTM A 934. The thickness of the epoxy coating shall be 10 mils plus or minus 2 mils. In addition, the requirements of Section 9-07.3, Items 2, 3, 4, 5, 6, 7, and 10 shall apply.

9-07.6 TIE BARS (FOR CEMENT CONCRETE PAVEMENT)

Tie bars shall conform to the requirements of the Standard Specifications for Deformed Billet-Steel Bars for Concrete Reinforcement, AASHTO M 31, Grade 60 and shall be coated in accordance with AASHTO M 284. Deformed bar shall be 5/8 inch diameter and 30 inch long.

The form of the deformed bar shall be subject to approval by the Engineer.

Tie bars shall be free from dirt, grease, or other defects affecting the strength or bond with the concrete. Tie bars shall be epoxy encapsulated.

9-07.7 WIRE MESH

Wire mesh for concrete reinforcement shall conform to the requirements of AASHTO M 55, Welded Steel Wire Fabric for Concrete Reinforcement or AASHTO M 221, Welded Deformed Steel Wire Fabric for Concrete Reinforcement. All wire mesh shall be of an approved kind and quality of manufacture.

9-07.8 DEFORMED WIRE

Deformed wire shall conform to the requirements of AASHTO M 225, Deformed Steel Wire for Concrete Reinforcement.

Deformed wire is noted in the Contract by the letter D, followed by a number indicating the cross-sectional area of the wire; for example, D2, D5, D20, etc.

9-07.9 COLD DRAWN WIRE

Cold drawn wire shall conform to the requirements of AASHTO M 32, Cold Drawn Steel Wire for Concrete Reinforcement.

Cold drawn wire is noted in the Contract by the letter W followed by a number indicating the cross-sectional area of the wire; for example, W2, W5, W20, etc.

9-07.10 PRESTRESSING REINFORCEMENT STRAND

Prestressing reinforcement shall be ½-inch diameter for precast-prestressed concrete piles and ½-inch or 0.6-inch diameter for pretensioned concrete girders, post-tensioned segmental precast concrete girders, or cast-in-place prestressed concrete.

Prestressing reinforcement shall be mill bright high tensile strength seven wire low relaxation strand conforming to the requirements of AASHTO M 203, Grade 270.

All prestressing reinforcement furnished for a given structural member shall have a maximum elongation differential of 3 percent at stress of 0.8 of the ultimate strength of the prestressing steel. Each reel of prestressing reinforcement shall be accompanied by a Manufacturer's Certificate of Compliance, a mill certificate, and a test report. The mill certificate and test report shall include the yield and ultimate strengths, elongation at rupture, modulus of elasticity, and the stress strain curve for the actual prestress reinforcing intended for use. All values certified shall be based on test values and actual sectional areas of the material being certified.

For every five reels furnished, one sample, not less than 5½-feet long, shall be sent to the SPU materials lab for testing; see Section 1-05.3. Samples of the furnished reels with Manufacturer's Certificate of Compliance, a mill certificate, and test report may be shipped directly by the manufacturer to the Engineer. An independent inspector, approved by the Owner, shall be present during sampling and shall provide a written certification to the Engineer.

9-07.11 PRESTRESSING REINFORCEMENT BAR

High-strength steel bars shall conform to AASHTO M 275, Type II.

Nuts shall conform to either ASTM A 29 Grade C1045, or ASTM A 536 Grade 100-70-03, and shall be capable of developing the larger of either 100 percent of the minimum ultimate tensile strength (MUTS), or 95 percent of the actual ultimate tensile strength (AUTS), of the bar. The anchor nuts shall conform to the specified strength requirement while permitting a maximum 5 degree misalignment between the nut and the bearing plate. A minimum of three tests, each from a different heat, are required.

Couplers, if required, shall be AASHTO M 169 Grade 1144, or equivalent steel, developing the larger of either 100 percent of the MUTS, or 95 percent of the AUTS, of the bar. The test shall be performed with the coupler having a one inch unengaged segment between the two coupled bars. A minimum of three tests, each from a different heat, are required.

For unbonded bars under dynamic loading, the connections shall withstand at least 500,000 cycles from 60 percent to 66 percent MUTS followed by at least 50 cycles between 40 percent MUTS and 80 percent MUTS. A minimum of three tests, each from a different heat, are required.

SECTION 9-08 PAINTS AND RELATED MATERIALS**9-08.1 PAINT****9-08.1(1) DESCRIPTION**

Paints shall be made from materials meeting the requirements of the applicable Federal and State Paint Specifications, Department of Defense (DOD), American Society on Testing of Materials (ASTM), and Steel Structures Painting Council (SSPC) specifications in effect at the time of manufacture. The colors, where designated, shall conform to Section 9-08.1(8).

9-08.1(2) PAINT TYPES**9-08.1(2)A VINYL PRETREATMENT**

Vinyl pretreatment shall be a two-component basic zinc chromate-vinyl butyral wash primer conforming to DOD-P-15328 (Formula 117 for Metals) and SSPC Paint 27. Zinc chromate shall be the insoluble type. The paint shall be supplied as two components that are mixed together just prior to use.

9-08.1(2)B GALVANIZING REPAIR PAINT, HIGH ZINC DUST CONTENT

Galvanizing repair paint shall conform to Federal Specification MIL-P-21035B.

9-08.1(2)C INORGANIC ZINC-RICH PRIMER

Inorganic zinc-rich primer shall be a two-component, self-curing, inorganic zinc-rich paint, conforming to either AASHTO M 300 or SSPC Paint 20 Type I.

9-08.1(2)D ORGANIC ZINC-RICH PRIMER

Organic zinc-rich primer shall be a high-performance two-component epoxy conforming to SSPC Paint 20 Type II.

9-08.1(2)E EPOXY POLYAMIDE

Epoxy polyamide primer shall be a two-component, VOC-compliant epoxy system, conforming to MIL-DTL-24441.

9-08.1(2)F PRIMER, ZINC-FILLED, SINGLE-COMPONENT, MOISTURE-CURED POLYURETHANE

Zinc-rich primer shall meet the following requirements:

Vehicle Type: Moisture-cured polyurethane.

Pigment Content: 80 percent minimum zinc by weight in dry film.

Volume Solids: 60 percent minimum.

Minimum wt./gal. 22.0 pounds.

9-08.1(2)G INTERMEDIATE AND STRIPE COAT, SINGLE COMPONENT, MOISTURE-CURED POLYURETHANE

Vehicle Type: Moisture-cured polyurethane.

Pigment: A minimum of 3.0 lbs. of micaceous iron oxide per gallon.

Intermediate and any stripe coat shall meet the following requirements:

Minimum volume solids 50 percent.

A minimum of 3.0 lbs/gal. of micaceous iron oxide.

The intermediate coating shall be certified by the manufacturer to be able to be recoated by the top coat in a minimum of 4 days.

9-08.1(2)H TOP COAT, SINGLE-COMPONENT, MOISTURE-CURED POLYURETHANE

Vehicle Type: Moisture-cured aliphatic polyurethane.

Color: As specified in the Drawings or Special Provisions.

The Top Coat shall meet the following requirements:

The resin must be an aliphatic urethane.

Minimum-volume solids 50 percent.

The top coat shall be a semi-gloss.

9-08.1(2)I RUST-PENETRATING SEALER

Rust-penetrating sealer shall be a two-component, chemically-cured, 100 percent solids epoxy with maximum VOC 1.7 pounds/gallon.

9-08.1(2)J BLACK ENAMEL

The enamel shall conform to Federal Specification MIL PRF 2463D Type II Class II.

9-08.1(2)K ORANGE EQUIPMENT ENAMEL

The enamel shall be an alkyd gloss enamel conforming to Federal Specification TT-E-489, except that the Sag Index shall be seven minimum. The color, when dry, shall match that of Federal Standard 595, color number 12246.

For factory application to individual items of new equipment, samples and testing of the enamel shall not be required; however, the equipment manufacturer shall match the color specified and shall certify the quality of enamel used.

9-08.1(2)L EXTERIOR ACRYLIC LATEX PAINT-WHITE

This paint shall conform to Federal Specification TT-P-96, Paint, Acrylic Emulsion, Exterior, except that the viscosity shall be 75-85 K.U.

This paint may be used self-primed in multiple coats over salts-treated wood and on interior and exterior masonry surfaces.

9-08.1(3) WORKING PROPERTIES

The paint shall contain no caked material that cannot be broken up readily by stirring. When applied to a clean vertical surface, the paint shall dry without running, streaking, or sagging.

9-08.1(4) STORAGE PROPERTIES

Paints manufactured under these Specifications shall show no skin over the surface after 48 hours in a filled container, when tested as outlined in Federal Test Method Standard No. 141D. A slight amount of skin or gel formation where the surface of the paint meets the side of the container may be disregarded. Variable percentages of anti-skinning agents are shown in those formulas set forth above that are susceptible to undesirable skin formation. The manufacturer will be allowed to vary the amount of anti-skinning agent given in the formulas provided the above results are accomplished and provided the paint does not dry to a nonuniform or nonelastic film.

9-08.1(5) FINENESS OF GRINDING

The paint shall be ground so that all particles of pigment will be dispersed and be coated with vehicle, and the residue on a 325 sieve will not exceed 1 percent by weight of the pigment. Paint shall be homogeneous, free of contaminant, and of a consistency suitable for use under intended application. Finished paint shall be well ground, and the pigment shall be properly dispersed in the vehicle, conforming to the requirements of the paint. Dispersion in the vehicle shall be such that the pigment does not settle excessively, does not cake or thicken in the container, and does not become granular or curdled.

9-08.1(6) TEST METHODS

Except as otherwise specified, all paints shall be sampled and tested in the ready-mixed form. The test methods shall be as specified in Federal Test Method Standard No. 141D or as specified under AASHTO R 31, as applicable.

9-08.1(7) ACCEPTANCE

Except for batches of paint in total project quantities of 20 gallons or less that are accepted upon the manufacturer's certificate of compliance, the manufacturer shall not ship any batch of paint until the paint has been tested and released by the Materials Laboratory. This release will not constitute final acceptance of the paint. Final acceptance will be based on inspection or testing of job site samples as determined by the Engineer.

Project quantities of 20 gallons or less of the above paint types will be accepted without inspection upon the manufacturer's notarized certificate of compliance. This certificate shall contain a statement by the manufacturer to the effect that the material meets the paint type Specification, and it shall include a list of materials and quantities used. One copy of the certificate shall accompany the paint when shipped and one copy with a drawdown sample of the paint shall be sent to the Materials Laboratory. The paint may be used at once without further release from the Materials Laboratory.

9-08.1(8) STANDARD COLORS

When paint is required to match a Federal Standard 595 color, the paint manufacturer or the Contractor may obtain a sample of the required color through the following internet link: www.colorserver.net. For the City of Seattle, the following colors are defined:

- Black - 27030
- Seattle Safety Yellow – 23594
- Seattle Narrows Green - 34227

Unless otherwise specified, all top or finish coats shall be semigloss, with the paint falling within the range of 35 to 70 on the 60-degree gloss meter.

The Contractor shall submit two minimum 4-inches by 6-inch paint chip samples to the Engineer at least 10-Working Days prior to the scheduled application in accordance with Section 1-05.3. The color of the paint when dry shall match the color of a Standard 595 color chip.

Commission Internationale de l'Eclairage (CIELAB) color system has determined standard values that are used worldwide to measure color. The values used by CIE are called L*, a* and b* and the color measurement method is called CIELAB.

The calculated Delta E shall not exceed 1.0 deviation from the Commission Internationale de l'Eclairage (CIELAB) color measurement analysis method for each color.

For the City of Seattle, the following colors are defined:

Color	III/Obs	L*	a*	b*
Washington Gray	D65/10-degrees	62.59	0.98	5.23
	A/10-degrees	63.06	1.80	5.70
	CWF/10-degrees	63.02	0.73	6.08
Cascade Green	D65/10-degrees	36.62	-6.53	-0.89
	A/10-degrees	35.82	-7.15	-2.53
	CWF/10-degrees	36.34	-5.09	-1.18
Mt. Baker Gray	D65/10-degrees	45.94	1.38	4.46
	A/10-degrees	46.40	1.70	5.05
	CWF/10-degrees	46.46	1.07	5.48
Mt. St. Helens Gray	D65/10-degrees	56.07	2.15	6.68
	A/10-degrees	56.76	3.08	7.52
	CWF/10-degrees	56.67	1.64	7.85

Seattle Railroad Green	D65/10-degrees	27.32	-0.97	0.01
	A/10-degrees	27.22	-1.14	-0.22
	CWF/10-degrees	27.35	-0.73	0.14

The Contractor shall submit the specified and spectrophotometer or colorimeter readings taken in accordance with ASTM D 2244 to the Engineer at least 10-Working Days prior to the scheduled application in accordance with Section 1-05.3. The Contractor shall not begin applying until receiving the Engineer's written approval of the color samples.

One-quart wet samples (Engineer's Option)

When requested by the Engineer, the Contractor shall submit a one-quart wet sample companion drawdown color sample for each batch of material.

The 1-quart wet sample shall be submitted in the manufacturer's labeled container with product number, batch number, and size of batch. The companion drawdown color sample shall be labeled with the product number, batch number, and size of batch. The Contractor shall submit the specified samples to the Engineer at least 10-Working Days prior to the scheduled application or upon request by the Engineer with in accordance Section 1-05.3. The Contractor shall not begin applying until receiving the Engineer's written approval of the samples.

9-08.2 POWDER COATING MATERIALS FOR COATING GALVANIZED SURFACES

The powder coating system shall consist of two components: an epoxy primer coat and a polyester finish coat. The epoxy primer coat and the polyester finish coat materials shall be from the same manufacturer.

The epoxy primer coat shall be an epoxy powder primer conforming to the following requirements:

Property	Specification	Performance Requirement
Adhesion	ASTM D 3359 Method B	5B (no failure)
Flexibility	ASTM D 522 Method B	Pass 1/8" mandrel bend
Pencil Hardness	ASTM D 3363	H Plus
Specific Gravity	ASTM D 792	1.25 minimum

The polyester finish coat shall conform to American Architectural Manufacturers Association (AAMA) Specification 2604.

Degassing additives may be added as necessary to prevent pin holes in the finish coat. The degassing additives shall be added in accordance with manufacturer's recommendations.

The color of the powder coating system polyester finish coat shall be as specified in the Drawings or Special Provisions.

9-08.3 PIGMENTED SEALER MATERIALS FOR COATING OF CONCRETE SURFACES

The pigmented sealer shall be a semi-opaque, colored toner containing only methyl methacrylate-ethyl acrylate copolymer resins, toning pigments suspended in solution at all times by a chemical suspension agent, and solvent. Toning pigments shall be laminar silicates, titanium dioxide, and inorganic oxides only. There shall be no settling or color variation. Tinting shall occur at the factory at the time of manufacture and placement in containers, prior to initial shipment. Use of vegetable or marine oils, paraffin materials, stearates, or organic pigments in any part of coating formulation shall not be permitted. The Contractor shall submit a 1-quart wet sample, a drawdown color sample, and spectrophotometer or colorimeter readings taken in accordance with ASTM D 2244, for each batch. The calculated Delta E shall not exceed 1.0 deviation from the Commission Internationale de l'Eclairage (CIELAB) color measurement analysis method for each pigmented sealer color.

The 1-quart wet sample shall be submitted in the manufacturer's labeled container with product number, batch number, and size of batch. The companion drawdown color sample shall be labeled with the product number, batch number, and size of batch. The Contractor shall submit the specified samples and readings to the Engineer at least 14 calendar days prior to the scheduled application of the sealer. The Contractor shall not begin applying pigmented sealer until receiving the Engineer's written approval of the pigmented sealer color samples.

9-08.4 ABRASIVE BLAST MATERIALS

9-08.4(1) ABRASIVE BLAST MEDIA

Material used for field abrasive blasting shall conform to Military Specification MIL-A-22262B(SH) as listed on QPL-22262-28 as maintained by the Department of the Navy. The Contractor shall provide the Engineer with certified test results from the abrasive blast media manufacturer showing that the abrasive blast material meets the Military Specification. The Contractor shall select the type and size of abrasive blast media to produce a roughened, sharp, angular surface profile conforming to the surface requirements specified by the manufacturer of the selected paint system.

9-08.4(2) LEAD ABATEMENT ADDITIVE

Lead abatement additive shall be a granular chemical abrasive additive consisting of a complex calcium silicate designed to stabilize lead through multiple mechanisms, including, but not limited to, ph adjustment, chemical reactions, and encapsulation. The additive shall be specifically designed and manufactured for lead paint abatement.

9-08.5 SURFACE CLEANING MATERIALS

9-08.5(1) BIRD GUANO TREATMENT

Bird guano treatment shall consist of a 5.25 percent sodium hypochlorite solution.

9-08.5(2) FUNGICIDE TREATMENT

Fungicide treatment shall consist of a 5.25 percent sodium hypochlorite solution.

9-08.5(3) WATER

Water used for water jetting steel surface cleaning operations shall be clean, fresh water only, without any detergents, bleach, or any other cleaning agents or additives. Recycling of rinse water for water jetting operations is not allowed.

9-08.6 FILTER FABRIC

Filter fabric for water jetting operations shall be a polypropylene, nonwoven, needle-punched geosynthetic or equivalent material conforming to the following requirements:

Property	Specification	Performance Requirement
Grab Tensile Strength	ASTM D 4632	100 pounds minimum
Apparent Opening Size	ASTM D 4751	#70 sieve
Permittivity	ASTM D 4491	1.0 sec-1 or better

9-08.7 SINGLE-COMPONENT URETHANE SEALANT

Single-component urethane sealant shall conform to ASTM C 920 Grade NS Class 25.

9-08.8 FOAM BACKER ROD

Foam backer rod shall be closed-cell expanded polyethylene or polyurethane foam.

SECTION 9-09 TIMBER AND LUMBER

9-09.1 GENERAL REQUIREMENTS

All timber and lumber for Structures shall be Douglas Fir-Larch, unless specified otherwise in the Contract. The allowable species of timber and lumber for guardrail posts shall be Douglas Fir-Larch or Hem Fir. Timber and lumber for sign posts, mileposts, sawed fence posts, and mailbox posts, shall be Western Red Cedar, Douglas Fir-Larch, or Hem Fir.

9-09.2 GRADE REQUIREMENTS

Timber and lumber shall conform to the grades and usage as follows. Grades shall be determined by the current standards of the West Coast Lumber Inspection Bureau (WCLIB) or the Western Wood Products Association (WWPA).

Structures

Timber and lumber, unless specified otherwise in the Contract, shall conform to the following:

Materials 2" to 4" nominal thick, 5" nominal and wider (Structural Joists and Planks)	No. 1 and better, grade (Section 123-b of WCLIB) or (Section 62.11 of WWPA)
Materials 5" nominal and thicker (Beams and Stringers)	No. 1 and better, grade (Section 130-b of WCLIB) or (Section 70.11 of WWPA)

Timber lagging for soldier pile walls shall be Douglas Fir-Larch, grade No. 2 or better.

Guardrail Posts

Timber and lumber for guardrail posts (classified as Posts and Timbers) shall conform to the grades as follows.

Douglas Fir	No. 1 and better, grade (Section 131-b WCLIB) or (Section 80.11 WWPA)
Hem Fir	Select Structural, grade (Section 131-a WCLIB) or (Section 80.10 WWPA)

Mileposts, Sawed Fence Posts, and Mailbox Posts

Mileposts, sawed fence posts, and mailbox posts shall conform to the grades listed in the following table:

4x4	Construction grade (Light Framing, Section 122-b WCLIB) or (Section 40.11 WWPA)
4x6	No. 1 and better, grade (Structural Joists and Planks, Section 123-b WCLIB) or (Section 62.11 WWPA)
6x6, 6x8, 8x10	No. 1 and better, grade (Posts and Timbers, Section 131-b WCLIB) or (Section 80.11 WWPA)
6x10, 6x12	No. 1 and better, grade (Beams and Stringers, Section 130b WCLIB) or (Section 70.11 WWPA)

Sign and parking meter posts shall meet the Material requirements specified in Section 9-28.2.

9-09.2(1) SURFACING AND SEASONING

All timber and lumber shall be sized as indicated on the Drawings.

All timber and lumber to be painted shall be surfaced on all sides. All timber and lumber to be painted shall be thoroughly air or kiln dried to an equilibrium moisture content and shall be stored in such a manner as to remain in a thoroughly dry condition until placed into the Work.

9-09.2(2) RESERVED**9-09.2(3) INSPECTION**

Timber and lumber shall be marked with a certified lumber grade stamp provided by one of the following agencies:

West Coast Lumber Inspection Bureau (WCLIB)
Western Wood Products Association (WWPA)
Pacific Lumber Inspection Bureau (PLIB)
Any lumber grading bureau certified by the American Lumber Standards Committee

A grading certificate shall accompany each order of timber and lumber for use in Structures as specified in Section 9-09.2. In consideration of being acceptable, the certificate shall be issued by either the grading bureau whose stamp is shown on the material, or by the lumber mill which is under the supervision of one of the grading bureaus listed above. The grading certificate shall include the following:

1. Name of the mill performing the grading,
2. The grading rules being used,
3. Name of the person doing the grading with current certification,
4. Signature of a responsible mill official,
5. Date the lumber was graded at the mill, and
6. Grade, dimensions, and quantity of the timber or lumber.

When the Material is delivered to the project, the Engineer will check the order for the appropriate grade stamp. The invoice and grading certificate accompanying the order shall be accurate and complete with the information listed above. The grading certificate and grade markings will not constitute final acceptance of the Material. The Engineer may reject any or all of the timber or lumber that does not comply with the Specifications or has been damaged during shipping or upon delivery.

9-09.3 PRESERVATIVE TREATMENT

All timber and lumber requiring preservative treatment shall be treated in accordance with AASHTO M 133. As specified by AASHTO M 133, the American Wood-Preservers' Association (AWPA) standards shall govern the Specifications. These Specifications include: storing and curing the timber and lumber, the wood preservatives, the preservative treatment process, documenting the results of the treatment, inspection, testing, and the identification of properly treated timber. Unless otherwise specified in the Contract, all timber and lumber shall be treated in accordance with Sections U1 and T1 of the latest edition of the AWPA standards.

All cutting, boring, chamfering, routing, surfacing, and trimming shall be done prior to treating. Any field drilling or cutoffs shall be treated by two liberal applications of a compatible preservative. The applications shall be in accordance with the requirements of AWPA Standard M-4 entitled, "Standard for the Care of Pressured Treated Wood Products".

All charges shall consist of pieces of the same species that are similar in form, size, moisture content, and receptivity to treatment. The pieces in the charge shall be separated to ensure contact of treating medium with all surfaces. The method of determining the retention of the preservatives shall be by assay.

As specified in the Contract, all orders of treated timber and lumber will be accompanied by a Certificate of Treatment record.

The Certificate of Treatment shall include the following information:

- Name and location of the wood preserving company
- Customer identification
- Date of treatment and charge number
- Type of chemical used and amount of retention
- Treating process and identification of the Specification used
- Description of material that was treated
- Signature of a responsible plant official

In addition to the Certificate of Treatment, all orders of treated timber or lumber shall be accompanied by a Grading Certificate in accordance with Section 9-09.2(3). Such certification or approved for shipment tag shall not constitute final acceptance of the material. The Engineer may reject any or all of the timber or lumber that does not comply with the Specifications or has been damaged during prolonged storage, shipping, or upon delivery.

All timber and lumber to be used in aquatic environments, unless specified otherwise in the Contract, shall be chemically treated using Best Management Practices (BMPs). The producer of the chemically treated products shall supply a written certification that the BMPs were utilized, including a description and appropriate documentation of the BMPs used. This information may be included on the Certificate of Treatment record.

SECTION 9-10 PILES

9-10.1 TIMBER PILES

9-10.1(1) GENERAL

Timber piles shall be untreated or treated with the preservatives specified on the Drawings and completely described in Section 9-09.3.

Timber piles shall have the following limiting diameters:

LENGTH IN FEET	MIN. BUTT DIA. 3 FT. ABOVE BUTT (INCH)	MAX. BUTT DIA. 3 FT. ABOVE BUTT (INCH)	MIN. TIP DIA. (INCH)
Under 40	12	20	7
40 – 54	12	20	7
55 – 74	13	20	7
Over 74	14	20	7

Timber piles shall be strapped with at least three straps: one approximately 18 inches from the butt, one approximately 24 inches from the butt, and one approximately 12 inches from the tip. Additional straps shall be provided at approximately 15-foot centers between the butt and tip. Strapping shall encircle the pile once and be tensioned as tightly as possible. Straps shall be 1-1/4 inches wide, 0.031 inch thick, cold rolled, fully heat treated, high tensile strapping, painted, and waxed, with an ultimate tensile strength of 5,100 pounds. The seal shall be 2-1/4 inches long, 20 gage, crimped with a notch type sealer to furnish a joint yielding 80 percent of the strap tensile strength. Treated timber piles shall be strapped after treatment.

9-10.1(2) UNTREATED PILES

Except where specifically provided otherwise, untreated timber piles shall be Douglas fir, Western red cedar, or larch. Piles for foundations shall be Douglas fir. Piles shall be cut from sound, live trees and shall contain no unsound knots. Sound knots will be permitted, provided the diameter of the knot does not exceed 4 inches, or 1/3 of the small diameter of the pile at the point where they occur, whichever is smaller. Any defect or combination of defects that impair the strength of the pile more than the maximum allowable knot will not be permitted.

Piles shall be cut above the butt swell and shall have a uniform taper from butt to tip. A line drawn from the center of the tip to the center of the butt shall not fall outside the center of the pile at any point more than 1 percent of the length of the pile. A spiral grain or twist in excess of 1/4 turn in 10 feet of length will be cause for rejection.

Untreated timber trestle piles shall have an average of at least five annual rings per inch measured radially over a distance of 3 inches at the butt, beginning at a point 3-1/2 inches from the heart. At least 9 inches of heartwood shall show at the butt.

Ring count requirements for untreated timber foundation piles and detour trestle piles will be waived.

9-10.1(3) CREOSOTE TREATED PILES

For creosote treated piles, Douglas fir timber shall be used. All other requirements shall be the same as for untreated piles except that the ring count requirement will be waived.

9-10.1(4) TIMBER COMPOSITE PILES

Timber composite piles shall consists of a pile made up of two timber sections. The lower section shall be untreated, and the upper section shall be creosote treated.

The treated and untreated sections of timber composite pile shall meet the respective requirements specified above for full length of treated and untreated timber piles.

9-10.1(5) PEELING

Untreated and creosote treated piles shall be peeled by removing all of the rough bark and at least 80 percent of the inner bark. No strip of inner bark remaining on the pile shall be over 3/4 inch wide or over 8 inches long, and there shall be at least 1 inch of clean wood surface between any two such strips. Not less than 80 percent of the surface on any circumference shall be clean wood. All knots shall be trimmed close to the body of the pile.

9-10.2 CONCRETE PILES

9-10.2(1) CONCRETE

Portland cement meeting the requirements of Section 9-01 shall be used in all precast concrete piles.

The concrete for precast-prestressed piles shall conform to the requirements of Section 9-19. The concrete for prestressed piles shall have a minimum compressive strength of 6,000 psi at the age of 28 Days. The minimum compressive strength of concrete at the transfer of prestress shall be 3,300 psi.

The concrete for all other precast piles shall be Class 4000P. Mixing, transporting, and placing concrete shall be in accordance with the provisions of Section 6-02.3.

The Contractor shall mold and test a sufficient number of concrete test cylinders to determine the strength of the concrete as required by the Specifications. Under the surveillance of the Engineer, the test cylinders shall be molded, cured, and tested in accordance with the procedures established by the Laboratory.

In the event that a sufficient number of concrete test cylinders are not molded to satisfy all testing required on any one pile, cores measuring 4 inches in diameter by 5 inches in height shall be taken and tested by the Contractor. If the strength of the core meets the required compressive strength of the concrete, the pile may be accepted. The coring and testing of the core shall be done under the surveillance of the Engineer.

9-10.2(2) REINFORCEMENT

Reinforcement shall meet the requirements of Section 9-07.

9-10.3 CAST-IN-PLACE CONCRETE PILES

9-10.3(1) REINFORCEMENT

Reinforcement for cast-in-place concrete piles shall conform to the requirements of AASHTO M 31, Grade 60.

9-10.4 STEEL PILE TIPS AND SHOES

Steel pile tips and shoes shall be fabricated of cast steel conforming to ASTM A 148, Grade 90-60 [620-415] or ASTM A 27, Grade 65-35 [450-240] and be free from any obvious defects. Pile tips shall be accompanied by a mill test report stating the chemical and physical properties (tensile and yield) of the steel.

9-10.5 STEEL PILES

The Material for steel piles and pile splices shall conform to ASTM A 36, except the Material for steel pipe piles, and splices shall conform to the requirements of ASTM A 252, Grade 2. All steel piles may be accepted by the Engineer based on the Manufacturer's Certificate of Compliance.

SECTION 9-11 WATERPROOFING

9-11.1 ASPHALT FOR WATERPROOFING

Asphalt for waterproofing shall conform to the requirements of ASTM D 312, Type 4.

The Material used as primer shall conform to the requirements of ASTM D 41, "Primer for Use with Asphalt in Dampproofing and Waterproofing".

Acceptance shall be as provided in Section 9-02.2(1).

9-11.2 WATERPROOFING FABRIC

Waterproofing fabric shall be a saturated cotton fabric meeting the requirements of ASTM D 173, "Woven Cotton Fabrics Saturated with Bituminous Substances for Use in Waterproofing".

9-11.3 PORTLAND CEMENT MORTAR

Portland cement and fine sand for the mortar protection course shall conform to the following requirements:

Portland Cement	Section 9-01
Sand	Section 9 03.1(2)C
Mortar	Section 9-20.4

SECTION 9-12 MAINTENANCE HOLES, CATCH BASINS, AND INLETS

9-12.1 REINFORCED CONCRETE

9-12.1(1) GENERAL

Reinforced concrete shall consist of Portland cement, fine and coarse aggregates and water, in which steel has been embedded in such manner that the steel and concrete act together.

All cast-in-place concrete placed under these Standard Specifications shall be Class 4000 (see Sections 6-02.3(1) and 6-02.3(2)). Strength determination shall be in accordance with ASTM C 39. Precast components shall conform to the strength requirements of ASTM C 478.

The use of admixtures shall require prior approval of the Engineer. Concrete with air-entraining admixture shall comply with ASTM C 175.

9-12.1(2) CEMENT

Portland cement shall conform to the requirements of Section 9-01.

9-12.1(3) STEEL REINFORCEMENT

Reinforcement shall consist of wire conforming to ASTM A 82 or ASTM A 496, or wire fabric conforming to ASTM A 185 or ASTM A 497, or Grade 60 steel bars conforming to ASTM A 615 or Grade 80 steel bars conforming to ASTM A 306.

9-12.1(4) AGGREGATES

Aggregates for cast-in-place concrete shall conform to ASTM C 33.

9-12.2 STEPS, HANDHOLDS, AND LADDERS**9-12.2(1) GENERAL**

The Material for maintenance hole steps, ladders, and handholds shall be the same material in any individual drainage Structure. See Section 7-05.3(1)Q for submittal requirement. Sizes of components, dimensions and layout shall conform to Standard Plan no. 232.

9-12.2(2) POLYPROPYLENE ENCAPSULATED REINFORCING STEEL

Polypropylene steel reinforced steps shall be made of copolymer polypropylene plastic that encapsulates a 1/2 inch diameter grade 60 steel reinforcing steel. Steel reinforcing shall conform to the requirements of ASTM A 615, and copolymer polypropylene plastic shall conform to requirements of ASTM D 4101. Steps shall have serrated tread, measure 13 inches center to center between legs of the step, and be designed to withstand pullout forces of 1500 pounds.

The Contractor may, with the Engineer's approval, use "Plastic Maintenance Hole Steps" manufactured by Lane International Corporation, or "Steps" manufactured by M.A. Industries, Inc.

9-12.3 RESERVED**9-12.4 MORTAR AND GROUT FOR SEWER AND DRAINAGE STRUCTURES****9-12.4(1) MORTAR FOR JOINTS**

Mortar for jointing precast or masonry maintenance hole, catch basin, or inlet units shall be one part Portland cement to not less than one part nor more than two parts plaster sand, mixed with the least amount of clean water necessary to provide a workable mortar. Joints between precast maintenance hole elements shall also be rubber gasketed as noted in Section 7-05.3(1)K.

9-12.4(2) MORTAR FOR PLASTER-COATING

Mortar for plaster-coating or lining masonry unit maintenance holes shall be proportioned according to either of the two alternates tabulated as follows:

ALTERNATE	PARTS BY VOLUME PORTLAND CEMENT	PARTS BY VOLUME MASONRY CEMENT	VOLUME HYDRATED LIME OR LIME PUTTY	PLASTER SAND MEASURED IN DAMP LOOSE CONDITION
1	1	1 (Type II)	0	Not less than 2-1/4 and not more than 3 times the sum of volumes of cement and lime
2	1	0	¼	

9-12.4(3) GROUT

Grout for filling the void in Sewer and Drainage Structures where pipe connections are made shall be non-shrink cement sand grout complying with the requirements of Section 9-04.3(2).

9-12.5 CONCRETE MASONRY UNITS

Concrete masonry unit (also called concrete masonry block) shall conform to ASTM C 139, "Specification for Concrete Masonry Units for Construction of Catch Basins and Maintenance Holes", except that nominal horizontal thickness shall be 6 inches measured radially, and blocks shall have semicircular mortar grooves approximately 1 inch radius at the ends.

9-12.6 CONCRETE BRICK

Concrete brick shall conform to the Specifications for Concrete Building Brick ASTM C 55, Grade S.

9-12.7 CLAY BRICK

Clay brick shall conform to ASTM C 32, Grade MM unless otherwise specified in the Contract.

9-12.8 METAL CASTINGS**9-12.8(1) MAINTENANCE HOLE RING AND COVER**

Ring and cover casting dimensions shall conform to the Standard. Rings and ring extensions shall be manufactured from gray iron ASTM A 48, Class 30 or ductile iron ASTM A 536, Grade 80-55-06. Covers shall be manufactured from ductile iron ASTM A 536, Grade 80-55-06. Rings and covers shall be free of defects such as porosity, pittings, shrink cavities, cold shuts, cracks, and other surface defects which would impair serviceability. Repair of defects by welding or by the use of "smooth-on plasticized metals" or similar Material will not be accepted. Manufacturer shall certify that the product conforms to the requirements of these Specifications. In accordance with Section 1-06.1, where source of Material is different from manufacturer, the Contractor shall also provide the name and location of the manufacturer

Castings shall be bare metal. Artificially coated or painted castings will be cause for rejection.

Castings shall be machine finished on the horizontal seating surface and the vertical facing surface common to the ring and cover, so as to assure full bearing (nonrocking) for the entire width and circumference of the bearing surface, and

permit interchangeability with other castings of the same design, no matter what the source. The vertical face common to the ring and cover shall be beveled as shown on the Standard. Upon request of the Engineer, the manufacturer shall furnish at the foundry standard ring and covers for use by Inspectors in testing fit and seating.

All covers shall be labeled with the following information:

1. Name or symbol of the manufacturer;
2. Owner's name (City of Seattle, min. 1/2 inch letters recessed flush with adjacent surface);
3. Material label "DUC" for Ductile Iron;
4. Identification of its use in 3 inch high lettering (Sewer, Drain, etc.); and
5. Country of manufacture/origin.

Items 2. and 4. shall be on the exposed face of the cover. Items 1., 3., and 5. shall be located at the manufacturer's option. If located on the exposed face of the cover, item 1. and 3. shall be adjacent to each other and shall be set in at least 1/2 inch high recessed letters. Where lock-type castings are called for, a locking device shall permit the cover to be readily released from the ring. Movable parts shall be made of non-corrosive metals and be designed to avoid possible binding. Upon request by the Engineer, the manufacturer shall furnish testing apparatus at the foundry Capable of applying uplift pressure on the lid of at least 20 foot head of water which the assembly needs to withstand without failure.

All maintenance hole rings shall be labeled with the name or symbol of the manufacturer and the type of Material.

9-12.8(2) METAL FRAME AND GRATE AND METAL COVER FOR CATCH BASINS OR INLETS

The frame may be made of gray iron, ASTM A 48, Class 30, or ductile iron, ASTM A 536, Grade 80-55-06, at the manufacturer's option. The grate and cover shall be made of ductile iron only. Other applicable provisions of Section 9-12.8(1) shall apply, except item (4) for identification marking.

Catch Basins, Type 242A and 242B and Inlets, Type 250A and 250B shall be furnished with a vaned grate as indicated on Standard Plan nos. 265 and 266.

9-12.8(3) CAST METAL INLETS

The castings for cast metal inlets shall be cast steel or ductile iron as specified in Section 9-06.8 or Section 9-06.14. Substitutions may be accepted (see Section 1-06.1). Vaned grates shall be embossed as indicated on Standard Plan no. 264.

9-12.9 JUNCTION BOX

Junction box shall comply with Standard Plan no. 277 and reinforcing shall be per WSDOT Standard Plan for Type 1 catch basin.

9-12.10 SHOP FABRICATED CORRUGATED METAL MAINTENANCE HOLES

Where corrugated metal maintenance holes are specified, they shall conform to the details as indicated in the Contract. All pipe connections to the maintenance hole stubs shall be made with a standard band type as shown on the Drawings.

See Section 7-16.2 for restrictions on the use of corrugated metal pipe.

9-12.11 MONOLITHIC CONCRETE MAINTENANCE HOLES

Monolithic concrete maintenance holes shall conform to the Standard Plans.

9-12.12 OUTLET TRAPS

Catch Basin outlet traps shall be constructed in accordance with Standard Plan no. 267.

9-12.13 GRATE INLETS AND DROP INLETS

Steel in grates, angles, and anchors for grate inlets and drop inlets shall conform with AASHTO M 183, except structural tube shall conform with ASTM A 500, Grade B. After fabrication, the steel shall be hot-dip galvanized with a minimum coating of 2 ounces of zinc per square foot in accordance with AASHTO M 111 or galvanized with a hot-sprayed (plasma flame applied) 6 mil minimum thickness zinc coating.

Steel grating shall be fabricated by weld connections. Bearing bars and cross bars shall be resistance welded at the intersecting joints. Welds, welding procedures, and welding Materials shall conform to Standard Specifications for Welding issued by the American Welding Society.

Vaned grates shall be embossed as indicated on Standard Plan no. 264.

Substitution of grate designs will be permitted with the approval of the Engineer if:

- 1 - the hydraulic capacity is not decreased,
- 2 - the overall dimensions are the same allowing the grate to be interchangeable,
- 3 - the strength is at least equal to the grate shown in the Standard, and
- 4 - a Manufacturer's Certificate of Compliance is submitted indicating compliance with items 1, 2, and 3.

The Contractor has the option of furnishing either cast-in-place or precast inlets unless otherwise shown in the Contract. Alternate designs are acceptable provided they conform to fabricator's Shop Drawings approved by the Engineer for projects prior to Award of Contract.

SECTION 9-13 RIPRAP, QUARRY SPALLS, AND SLOPE PROTECTION**9-13.1 GENERAL**

The stone for riprap and quarry spalls shall be hard, sound and durable. It shall be free from segregation, seams, cracks, and other defects tending to destroy its resistance to weather. Riprap and quarry spalls used for new rock facing or slope stabilization shall meet requirements in Section 9-03.17.

9-13.2 LOOSE RIPRAP

Loose riprap shall be free of rock fines, soil, or other extraneous material.

Should the riprap contain insufficient 4" to 8" spalls, as defined in Section 9-13.7, the Contractor shall furnish and place supplementary spall material from a source approved by the Engineer, at the Contractor's sole expense.

The grading of the riprap will be determined by the Engineer by visual inspection of the load before it is dumped into place, or, if so ordered by the Engineer, by dumping individual loads on a flat surface and sorting and measuring the individual rocks contained in the load.

9-13.2(1) HEAVY LOOSE RIPRAP

Heavy loose riprap shall meet the following requirements for grading:

	MINIMUM SIZE	MAXIMUM SIZE
40% to 90%	1 ton (1/2 cubic yd.)	
70% to 90%	300 lbs. (2 cu. ft.)	
10% to 30%	3 inch	50 lbs. (spalls)

9-13.2(2) LIGHT LOOSE RIPRAP

Light loose riprap shall meet the following requirements for grading:

	SIZE RANGE	MAXIMUM SIZE
20% to 90%	300 lbs. to 1 ton (2 cu. ft. to ½ cu. yd.)	
15% to 80%	50 lbs. to 1 ton (1/3 cu. ft. to ½ cu. Yd.)	
10% to 20%	3 inch	50 lbs. (spalls)

9-13.3 HAND PLACED RIPRAP

Hand placed riprap shall be as nearly rectangular as possible, 60 percent shall have a volume of not less than 1 cubic foot. No stone shall be used which is less than 6 inches thick, nor which does not extend through the wall.

9-13.4 SACK RIPRAP

Sack riprap shall consist of concrete placed in sacks made of at least 10 ounce burlap and having a capacity of approximately 2.5 cubic feet. Each sack shall be filled with approximately 1 cubic foot of concrete having a consistency in conformance with Section 6-02.3(3)D for non-vibrated concrete.

For sack riprap exposed to fresh water, the concrete shall be unreinforced Class 3000; and for sack riprap exposed to salt water, the concrete shall be Class 3000 as specified in Section 6-02.3.

The Portland cement and fine and coarse aggregates shall conform to the requirements for Portland cement and fine and coarse aggregate of Sections 9-01 and 9-03.1, respectively.

9-13.5 RESERVED**9-13.6 CONCRETE SLOPE PROTECTION****9-13.6(1) GENERAL**

Concrete slope protection shall consist of reinforced Portland cement concrete poured or pneumatically placed upon the slope with a rustication joint pattern or semi-open concrete masonry units placed upon the slope closely adjoining each other.

9-13.6(2) SEMI-OPEN CONCRETE MASONRY UNITS SLOPE PROTECTION

Precast cement concrete blocks shall conform to the requirements of ASTM C 90, Type II.

9-13.6(3) Poured PORTLAND CEMENT CONCRETE SLOPE PROTECTION

Cement concrete for concrete slope protection shall be Class 3000 in conformance with Section 6-02.3.

Wire mesh reinforcement shall conform to Section 9-07.7.

9-13.6(4) PNEUMATICALLY PLACED PORTLAND CEMENT CONCRETE SLOPE PROTECTION

Cement: This Material shall be Portland cement as specified in Section 9-01.

Aggregate: This Material shall meet the requirements for fine aggregate as specified in Section 9-03.1. The moisture content of the fine aggregate at the time of use shall be between 3 percent and 6 percent by weight.

Reinforcement: Wire mesh reinforcement shall conform to the provisions of Section 9-07.7.

Water: Water shall conform to the provisions of Section 9-25.1.

9-13.7 QUARRY SPALLS

The spall shall be hard, sound, and durable. It shall be free from fracture, seams, cracks, and other discontinuities tending to adversely impact its resistance to weathering. The quarry spall shall meet the 5 test requirements listed in Section 9-03.17. Quarry spalls shall meet the following gradation requirements:

2 INCH TO 4 INCH QUARRY SPALL

SIEVE SIZE	PERCENT PASSING
4 inch	100
2 inch	40 max.
1-1/4 inch	5 max.

4 INCH TO 8 INCH QUARRY SPALL

SIEVE SIZE	PERCENT PASSING
8 inch	100
4 inch	40 max.
2 inch	5 max.

All percentages are by weight.

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SECTION 9-14 EROSION AND LANDSCAPE MATERIALS**9-14.1 SOILS**

The following soils and soil mixes are specified on Drawings or by the Engineer, according to project needs, and are all subject to the General Testing and Submittal Requirements of 9-14.1(A):

1. **Topsoil Type A - Imported.** A general purpose mix of Sandy Loam and compost as needed to meet minimum organic matter content requirements. Similar to Washington State Department of Transportation's Topsoil Type A specification.
2. **Reused Amended Site Soil.** Soil from the Project Site that is either amended in place or moved/stockpiled during grading operations and then amended with compost as needed to meet minimum organic matter content requirements.
3. **Bioretention Soil.** An imported mix made of Mineral Aggregate and compost specified to meet the infiltration and filtration requirements of stormwater management structures. For Project Sites located within the City limits of Seattle; Bioretention Soil shall be procured only from approved sources as specified by the City of Seattle, City Purchasing and Contracting Services (<http://www.seattle.gov/contracting/construction.htm>).
4. **Planting Soil.** An imported soil mix for planting beds, planted medians and planting strips.
5. **General Turf Area Soil.** An imported soil mix for passive-recreation turf areas.
6. **High Performance Turf Mixes.** An imported soil mix for intensive-use turf areas, including three different mixes of sand and compost to optimize drainage and fertility in different sites and uses.

9-14.1A GENERAL TESTING AND SUBMITTAL REQUIREMENTS

At least 10 Working Days prior to placement of any soils specified in Section 9-14, the Contractor shall submit to the Engineer the following in accordance with Section 1-05.3. All test results shall be from samples sampled and tested less than 90 days prior to date of submittal.

1. **Aggregate and Loam Analysis.** Grain size analysis results of the Mineral Aggregate or Sandy Loam portion of each soil mix, performed by an accredited laboratory in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
2. **Compost Analysis.** Quality analysis results for the compost portion of each soil mix performed in accordance with STA standards, as specified in Section 9-14.4(8).
3. **Mix Analysis.** Test results from an accredited soil laboratory, including the following parameters:
 - a. Total Nitrogen and Soluble Nitrogen (NO₃ + NH₃)
 - b. Phosphorous
 - c. Potassium
 - d. pH
 - e. Organic Matter % (Loss on Ignition method)
 - f. Conductivity
 - g. Calcium
 - h. Sulfur
 - i. Boron
 - j. Weed seed (for General Turf Area Soil and High Performance Turf Mixes)
4. **Recommendations.** Fertilizer and amendment recommendations for the specified plant type (turf, shrubs/groundcovers, or annuals: with special provisions for Bioretention applications) and soil application depth; from the accredited laboratory, an accredited Soil Scientist or Agronomist.
5. **Mix Samples.** Two one (1) gallon samples of each soil mix (two five (5) gallon samples for Bioretention and High Quality Turf Mixes).
6. **Manufacturer.** The Manufacturer's Certificate(s) of Compliance per Section 1-06.3 from the Supplier of the soil mix, and (if different) the Suppliers of the compost, including their name(s) and address(es).
7. **Laboratory Information.** Include the following information about the testing laboratories:
 - a. name of laboratory(ies) including contact person(s),
 - b. address(es),
 - c. phone contact(s),
 - d. e-mail address(es),
 - e. qualifications of laboratory and personnel including date of current certification by STA, ASTM, AASHTO, or approved equal.
8. **Acceptance of Soils Prior to Placement.** The Contractor shall not place any soils or soil mixes specified in Section 9-14 until the Engineer has reviewed and confirmed the following:
 - a. **Soil mix delivery ticket(s).** Delivery tickets shall show that the full delivered amount of soil matches the product type, volume and Manufacturer named in the submittals.
 - b. **Visual match with submitted samples.** Delivered product will be compared to the submitted sample, to verify that it matches the submitted sample.

The Engineer may inspect any loads of soil on delivery and stop placement if it is determined that the delivered soil does not appear to match the submittals; and require sampling and testing of the delivered soil, before authorizing soil placement. All testing costs shall be the responsibility of the Contractor.

9-14.1(1) TOPSOIL TYPE A - IMPORTED

1. **Source.** Topsoil Type A shall consist of an imported Sandy Loam as defined by the United States Department of Agriculture Classification System, and documented by a Particle Size Analysis performed by an accredited laboratory.
2. **Organic Content.** Topsoil Type-A shall have an organic matter content of at least 5% by dry weight where turf will be installed, and at least 10% by dry weight for all other landscape areas. Organic matter shall be determined by Loss-on-Ignition test (ASTM D2974, or TMECC 05.07A). If additional organic content is needed meet these requirements, soil shall be amended with Compost meeting requirements in 9-14.4(8). Compost amendment requirements may be added at default rates of 22% by volume for turf or 38% for planting beds (1.75" amendment tilled to 8" depth for turf, 3" amendment tilled to 8" depth for beds); or calculated based on tests of the soil and compost, using the Soil Amendment Rate Calculator at <http://your.kingcounty.gov/solidwaste/compost-calculator.htm> or similar calculator available at http://www.soilsforsalmon.org/excel/Compost_Calculator.xls.
3. **Sieve.** In addition to meeting the particle size requirements of USDA Sandy Loam, Topsoil Type-A shall meet the following sieve specifications:

Sieve Size	Percent Passing (weight)
1"	100%
1/2"	>90%
No.10	>70%

4. **Contaminants.** Topsoil Type-A shall be free from: Materials toxic to plant growth; visible seeds, rhizomes or roots; any King County-listed noxious weeds, or invasive root-propagating plants including but not limited to horsetail, ivy, clematis, knotweed, etc. Soil found to contain these prohibited viable plant materials shall be removed and replaced at the Contractor's expense
5. **Testing and Submittals.** Testing and submittals shall comply with all provisions of 9-14.1.

9-14.1(2) REUSED AMENDED SITE SOIL

1. **Source.** Reused Amended Site Soil shall be native topsoil taken from within the Project Site, either from areas where construction excavation is to be performed; from borrow, pit, or quarry sites strippings; or other designated sources. The general limits of the Material to be utilized for topsoil will be indicated in the Contract. The Engineer will make the final determination of the areas where the most suitable Material exists within these general limits, and depth of excavation. The Contractor shall reserve this Material for the specified use.
2. **Unwanted Vegetation.** In the production of Reused Amended Site Soil, all vegetative matter shall become a part of the topsoil, except large brush and trees over 4 feet in height, Prior to removal, the Contractor shall mow or otherwise reduce the height of the native vegetation such to a height not exceeding 1 foot. Plants on the King County Noxious Weed Lists or invasive root-propagating plants including but not limited to horsetail, ivy, clematis, knotweed, etc., shall not be incorporated in the topsoil. Such plants shall be removed and disposed.
3. **Organic content.** The final Reused Amended Site Soil shall have a minimum organic matter content by dry weight of 5% for areas where turf will be installed, and 10% for all other landscape areas. Organic matter shall be determined by Loss-on-Ignition test (ASTM D2974, or TMECC 05.07A). Native site topsoil shall be amended with Compost as described in 9-14.4(8), if more organic content is needed to meet these requirements. Compost amendment requirements may be added at default rates of 22% by volume for turf or 38% for planting beds (1.75" amendment tilled to 8" depth for turf, 3" amendment tilled to 8" depth for beds); or calculated based on tests of the soil and compost, using the Soil Amendment Rate Calculator at <http://your.kingcounty.gov/solidwaste/compost-calculator.htm> or similar calculator available at http://www.soilsforsalmon.org/excel/Compost_Calculator.xls.
4. **Stockpiling.** Designated Material shall be placed at locations approved by the Engineer that do not interfere with the construction of the Project. The Contractor shall take all precautions to avoid disturbing the existing ground beyond the Project Site or other areas designated by the Engineer.
5. **Testing and Submittals.** Testing and submittals shall comply with all provisions of 9-14.1

9-14.1(3) BIORETENTION SOIL

1. **Procurement.** For Project Sites located within the City limits of Seattle; the Contractor shall procure bioretention soil Materials from only approved sources as specified by the City of Seattle, City Purchasing and Contracting Services (<http://www.seattle.gov/contracting/construction.htm>).
2. **Mix Components.** Bioretention Soil shall be a well-blended mixture of Mineral Aggregate and compost measured on a volume basis. Bioretention Soil shall consist of approximately two parts fine compost (approximately 35 to 40 percent) by volume meeting the requirements of Section 9-14.4(8) and three parts Mineral Aggregate (approximately 60 to 65 percent), by volume meeting the requirements of Section 9-03.2(2). The mixture shall be well blended to

produce a homogeneous mix, and have an organic matter content of 4% to 8% determined using the Loss on Ignition Method.

9-14.1(4) PLANTING SOIL

1. **Mix.** Planting soil shall consist of a mix of 2 to 3 parts Sandy Loam soil and 1 part compost by volume. The resulting mix shall contain approximately 8-15% organic matter by weight, tested by the Loss on Ignition method.
2. **Sandy Loam.** Shall be imported and shall be as defined by the United States Department of Agriculture Classification System, and documented by a Particle Size Analysis performed by an accredited laboratory. The sandy loam fraction of mix shall be screened through a 1/2" mesh, to remove all rocks, plant parts and other debris.
3. **Compost.** Compost used shall meet the definition of Compost in 9-14.4(8).
4. **Contaminants.** Sandy Loam shall be free from: Materials toxic to plant growth; visible seeds, rhizomes or roots; for any King County-listed noxious weeds, or invasive root-propagating plants including but not limited to horsetail, ivy, clematis, knotweed, etc.
5. **Testing and Submittals.** Testing and submittals shall comply with all provisions of 9-14.1.

9-14.1(5) GENERAL TURF AREA SOIL

General. General Turf Area Soil is for general-use and passive recreation lawn areas, in areas where year-round maintenance and positive drainage are important. For sports fields or high-traffic lawn areas such as Seattle Center, the Contractor shall use High Performance Turf Mix, per 9-14.1(5).

1. **Mix.** General Turf Area Soil shall consist of 2 parts sand meeting the requirements below, and 1 part Compost by volume. The resulting mix shall contain approximately 4-6% organic matter by weight, tested by the Loss on Ignitions method.
2. **Sand.** Sand used shall meet the following particle distribution.

Screen Size	Percent Retained
3/8 inch	0
#4	<3%
#6	<5%
#10	<20%
#18	<20%
#20	25-50%
#30	
#35	
#40	>20%
#60	
#100	<10%
#200	<5%
#270	<5%
2um	<5%
<2um	<3%

3. **Compost.** Compost used shall meet the definition of Compost in 9-14.4(8) and be certified in compliance with the US Composting Council STA program.
4. **Testing and Submittals.** Testing and submittals shall comply with all provisions of 9-14.1
5. **Weed Seeds and Propagules.** General Turf Area Soil shall not contain any viable seeds or roots capable of sprouting of any State-listed noxious weed, or invasive root-propagating plants including but not limited to horsetail, ivy, clematis, knotweed, etc. Soil found to contain these prohibited viable plant materials shall be removed and replaced at the Contractor's expense.

9-14.1(6) HIGH PERFORMANCE TURF SOIL

General: High Performance Turf Soil is for athletic fields or high traffic lawn areas such as those used for events, with sub-surface drainage and in-ground irrigation.

1. **Mix.** High Performance Turf Soil shall consist of 80% - 95% quartz based sands, uniformly blended with 5% - 20% compost by volume. The ratio of sand to organic amendment shall be determined by the Engineer, depending on the intended turf use:
 - a. High Performance - Standard Mix: 90% sand plus 10% compost
 - b. High Performance - Fertility Mix: 80% sand plus 20% compost
 - c.. High Performance - Drainage Mix: 95% sand plus 5% compost

2. **Mineral Aggregate.** Sand shall be free of weed seeds and propagules; and meet the following particle size distribution with a Coefficient of Uniformity between 2.5 and 4.5:

Size Fraction	Particle Size Range	Screen	Incremental % retained	
Gravel	3/8"	3/8"	0%	
Gravel	>4.75 mm	#4	<3%	<30% combined

Gravel	3.4 to 4.75 mm	#6	<5 %	>60% of sand
Fine gravel	2.0 to 3.4 mm	#10	<20 %	
Very coarse sand	1.0 to 2.0 mm	#18	<20 %	
Coarse sand	0.5 to 1.0 mm	#35	25 to 50 %	
Medium sand	0.25 to 0.5 mm	#60	>20 %	
Fine sand	0.15 to 0.25 mm	#100	<10 %	<15% combined
Very fine sand	0.05 to 0.15 mm	#270	<5 %	
Silt	0.002 to 0.05 mm	By Hydrometer	<5 %	
Clay	<0.002 mm		<3 %	

3. **Compost Amendment.** Compost used shall be free of weed seeds and propagules, and meet the definition of Compost in 9-14.4(8).
4. **Offsite Blending.** Sand and organic amendment shall be thoroughly blended off site, after samples of sand and amendment have been submitted for testing and approval.
5. **Test Submittals.** At least 10 Working Days prior to placement of High Performance Turf Soil, the Contractor shall submit to the Engineer the following in accordance with Section 1-05.3:
 - a. **Compost.** Analysis performed in accordance with STA standards, as specified in Section 9-14.4(8);
 - b. **Sand.** Grain size analysis results of the Mineral Aggregate performed by an independent laboratory in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
 - c. **Mix.** Report the following parameters, from an accredited independent lab. Testing and recommendations shall be at the Contractor's expense.
 - i. **pH**
 - ii. **Organic Matter.** Using the Walkley-Black Method.
 - iii. **Nutrients:** Total Nitrogen, NO-3 and NH-3; Phosphorus, Potassium, Calcium, Sulfur, Magnesium, Boron.
 - iv. **Conductivity.**
 - v. **Weed Seeds.** High Performance Turf Mixes shall be free of viable weed seeds or propagules, as determined by bioassay using TMECC 05.09-A, Shields Rinse Method.
 - vi. **Amendment Recommendations.** Fertilizer and amendment recommendations for turf, from an accredited Agronomist or Soil Scientist.
 - vii. **Laboratory Information.** Name, address, phone and e-mail contact information; and qualifications of laboratory and personnel including a copy of current certification by STA, AAHTO, or approved equal.
6. **Mix Samples.** At least 10 Working Days prior to placement of High Performance Turf Soil, the Contractor shall submit to the Engineer two five (5) gallon samples of the High Performance Turf Mix, along with the following information:
 - a. The Manufacturer's Certificate(s) of Compliance per Section 1-06.3 accompanying the test results from the Supplier of the High Performance Turf Mix, and (if different) the Suppliers of the mineral aggregate and compost components, including their name(s) and address(es);
 - b. A description of the equipment and methods to mix the Mineral Aggregate and compost to produce High Performance Turf Mix.
7. **Acceptance of Mix Prior to Placement.** The Contractor shall not place High Performance Turf Soil until the Engineer has reviewed and confirmed the following:
 - a. **Soil mix delivery ticket(s).** Delivery tickets shall show that the full delivered amount of High Performance Turf Soil matches the product and Manufacturer named in the submittals.
 - b. **Visual match with submitted samples.** Delivered product will be compared to the submitted 5-gallon sample, to verify that it matches the submitted sample.

The Engineer may inspect the High Performance Turf Soil on delivery and stop placement if (s)he determines that the delivered soil does not appear to match the submittals; and require sampling and testing of the delivered soil, before authorizing soil placement. All testing shall be conducted at the Contractor's expense.

9-14.2 SEED

9-14.2(1) GENERAL

1. **Grade.** Grasses, legumes, or cover crop seed of the type specified shall conform to the standards for "Certified" grade seed or better as outlined by the State of Washington Department of Agriculture "Rules for Seed Certification", current edition.
2. **Package and Labels.** Seed shall be furnished in standard sealed containers and shall include the following information:
 1. Common name of seed,
 2. Name of variety, when applicable
 3. Lot number,
 4. Net weight,
 5. Percentage of purity,

6. Percentage of germination (in case of legumes percentage of germination to include hard seed), and
 7. Percentage of weed seed content and inert material clearly marked for each kind of seed in accordance with applicable State and Federal law.
 8. Germination test date.
3. **Test Certification.** Upon request, the Contractor shall furnish to the Engineer duplicate copies of a statement signed by the Materialperson certifying that each lot of seed has been tested by a recognized and accredited seed testing laboratory within six months before the date of delivery to the Project Site. Seed which has become wet, moldy, or otherwise damaged in transit or storage will not be accepted.
 4. **Approved Turf Seed Varieties:** Turf varieties shall include only those ranked "Best" by the 2011 or most current succeeding year's WSU "Turfgrass Cultivars Evaluated In Western Washington/Oregon In Recent Years" list. (Puyallup.wsu.edu/turf)

9-14.2(2) SEED MIX #1 (EROSION MIX)

1. **Seed Mix.** The seed mixture and rate of application shall be as follows:

Kind and Variety of Seed in Mixture	Percent by Weight
Turf-type Perennial Rye Blend (2 or more varieties)	50%
Creeping Red Fescue	20%
Chewings Fescue	20%
Hard Fescue	10%

2. **Seeding Rate.** The rate of application shall be 5 pounds per 1000 square feet.
3. **Seed Quality.** The seed mixture shall be no less than 98% pure, shall have a minimum germination rate of 90%, and contain less than 1.5% inert material. No noxious weeds will be permitted. Seed shall be certified grown in Washington, Oregon or Idaho and tagged with the information required in 9-14.2(1)

9-14.2(3) SEED MIX #2 (NON-IRRIGATED LAWN SEED MIX)

1. **Seed Mix.** The seed mixture and rate of application shall be as follows:

Kind and Variety of Seed in Mixture	Percent by Weight
Turf-type Perennial Rye (2 or more varieties)	50%
Chewings Fescue	30%
Hard Fescue	20%

2. **Seeding Rate.** The rate of application shall be 6 pounds per 1000 square feet.
3. **Seed Quality.** The seed mixture shall be no less than 98% pure, and shall have a minimum germination rate of 90%, and contain less than 1.5% inert material. No noxious weeds will be permitted. Seed shall be certified grown in Washington, Oregon or Idaho and tagged with the information required in 9-14.2(1)

9-14.2(4) SEED MIX #3 (IRRIGATED LAWN OR ATHLETIC TURF AREA)

1. **Seed Mix.** The seed mixture and rate of application shall be as follows:

Kind and Variety of Seed in Mixture	Percent by Weight
Turf-type Perennial Rye (3 approved varieties)	100%

2. **Seeding Rate.** The rate of application shall be 6 pounds per 1000 square feet.
3. **Seed Quality.** The seed mixture shall be no less than 98% pure, and shall have a minimum germination rate of 90%, and contain less than 1.5% inert material. No noxious weeds will be permitted. Seed shall be certified grown in Washington, Oregon or Idaho and tagged with the information required in 9-14.2(1)

9-14.2(5) SEED MIX #4 (BIOFILTRATION SWALE MIX)

1. **Seed Mixes.** The seed mixture and rate of application shall be as follows:

Wet Biofiltration Swale Mix		Biofiltration Swale Mix	
Kind and Variety	Percent by Weight	Kind and Variety	Percent by Weight
Tall fescue or meadow fescue <i>Festuca arundinacea</i> or <i>Festuca elatior</i>	60-70 percent	Tall or meadow fescue <i>Festuca arundinacea</i> or <i>Festuca elatior</i>	75-80 percent

Seaside/Colonial bentgrass <i>Agrostis palustris</i>	10-15 percent	Seaside/Colonial bentgrass <i>Agrostis palustris</i>	10 -15 percent
Meadow foxtail <i>Alepecurus pratensis</i>	10-15 percent	Redtop bentgrass <i>Agrostis alba</i> or <i>A. gigantea</i>	5-10 percent
Alsike clover <i>Trifolium hybridum</i>	6-10 percent		
Redtop bentgrass <i>Agrostis alba</i>	1-6 percent		

*Modified Briargreen, Inc Hydroseeding Guide Wetlands Seed Mix

2. Seeding Rate.

The rate of application shall be:

- Wet Biofiltration Swale Mix: 4 pounds per 1000 square feet.
- Biofiltration Swale Mix: 6 pounds per 1000 square feet.

- Seed Quality.** The seed mixture shall be no less than 98% pure, and shall have a minimum germination rate of 90%, and contain less than 1.5% inert material. No noxious weeds will be permitted.

9-14.2(6) SEED MIX #5 (LOW GROWING, DROUGHT TOLERANT GRASS AND HERBACEOUS MIX)

- Seed Mix.** The seed mixture and rate of application shall be as follows:

Kind and Variety	Percent by Weight
Dwarf Perennial Rye	50-70%*
Hard Fescue	0-20%*
Strawberry Clover (<i>Trifolium fragiferium</i>)	5%
Dutch White Clover (<i>Trifolium repens</i>)	5%
Microclover	5%
Dwarf Yarrow, <i>Achillea millefolium</i> or <i>Achillea X Lewisii</i> vars.	5%
Sweet Alyssum, <i>Lobularia maritima</i>	5%
English Daisy, <i>Bellis perennis</i>	5%

* Dwarf Perennial Rye and Hard Fescue shall make up a combined 70% of mix.

- Seed Quality.** The seed mix shall be no less than 98% pure and shall have a minimum germination rate of 90%, and contain less than 1.5% inert material. Seed shall be tagged with the information required in 9-14.2(1).
- Application Rate and Method.** The Contractor shall submit, and receive approval from the Engineer at least 3 Working Days before ordering, all species included in the wildflower mix and the Materialperson's written directions on how to apply the seed mix. Written directions shall include rate of application and the incorporation of specific species of grass seed components when appropriate to achieve adequate erosion control protection while maximizing flower display and regeneration.
- Prohibited Species.** Noxious weeds (Chapter 16-750 WAC), and invasive species listed by the Washington State Noxious Weed Control Board, will not be allowed.

9-14.3 FERTILIZER

9-14.3(1) GENERAL

- Type and Application Rates.** Fertilizers shall be applied in a form and at a rate recommended by a Certified Agronomist or Soil Scientist, based on soil analysis by an independent accredited laboratory, as specified in 9-14.1(A) General Testing and Submittal Requirements.
- Slow-Release Nitrogen.** A minimum of 50% of nitrogen fertilizer shall be applied in a slow- or controlled-release form; such as sulfur- or polymer-coated urea, IBDU, trinitromethane (Nitroform), or organic forms.

3. **Package and Labeling.** All fertilizers shall be furnished in standard sealed and unopened containers with weight, name of plant nutrients and manufacturer's guaranteed statement of analysis clearly marked, all in accordance with State and Federal law.
4. **Submittals.** The Contractor shall submit to the Engineer for approval at least 5 Working Days in advance, an analysis of the proposed fertilizer, a 5 pound sample, and Manufacturer's Certificate of Compliance indicating all Specifications are met.

9-14.3(2) LIME

1. **Analysis.** Lime composition (dolomitic or non-dolomitic) shall be determined based on laboratory analysis and recommendations submitted per 9-14.1(3 and 4).
2. **Application rate.** Lime application rate shall be determined based on laboratory analysis and recommendations submitted per 9-14.1(3 and 4).
3. **Form.** Lime form (prill type or flour) will be determined based on laboratory analysis and recommendations submitted per 9-14.1(3 and 4).

9-14.4 MULCHES AND AMENDMENTS

The following mulches and amendments are specified on the Drawings or by the Engineer, according to project needs, and may be subject to testing needs as specified in other sections:

1. **Straw Mulch.** 9-14.4(1). Generally used as a temporary mulch to cover seed for erosion control seeding.
2. **Wood Fiber Mulch.** 9-14.4(2). Used to protect seed and soil in turf and erosion control hydroseeding applications.
3. **Bark Mulch.** 9-14.4(3). Used in woody plant beds to protect soil, conserve moisture, and provide long-term nutrients.
4. **Arborist Wood Chip Mulch.** 9-14.4(4). Clean recycled wood chip from tree-trimming, composting operations or wood reclamation operations; used as the standard mulch for woody plants. For Project Sites located within the City limits of Seattle; arborist wood chip mulch shall be procured only from approved sources as specified by the City of Seattle, City Purchasing and Contracting Services (<http://www.seattle.gov/contracting/construction.htm>).
5. **Peat.** 9-14.4(5). An amendment typically only used for moisture management in potting mixes and container plantings. More widespread use of peat has been replaced with compost and related products.
6. **Vermiculite, Perlite and Pumice.** 9-14.4(6). Specialty materials typically only used to improve moisture management in potting mixes, container plantings, and green roofs.
7. **Tackifier.** 9-14.4(7). An amendment used in hydroseeding mixtures to hold seed and mulch in place.
8. **Compost.** 9-14.4(8). An amendment used in all types of soil mixes to supply organic matter, nutrients, and moisture management properties. Also used in mulches, potting soils, and erosion control applications such as socks and berms. For Project Sites located within the City limits of Seattle; compost shall be procured only from approved sources as specified by the City of Seattle, City Purchasing and Contracting Services (<http://www.seattle.gov/contracting/construction.htm>).

9-14.4(1) STRAW MULCH

1. **Quality.** All straw mulch Material shall be in an air-dried condition free of noxious weeds and other materials detrimental to plant life. Straw shall be seasoned before baling or loading and shall be suitable for spreading with mulch blower equipment.

9-14.4(2) WOOD FIBER MULCH

1. **Quality.** Wood fiber mulch shall be specially processed 100 percent wood fiber in which 30% of the fibers shall be 0.15 inches long or longer and which shall have tackifier added to the mulch during the manufacturing process. Mulch shall contain no growth or germination-inhibiting ingredients and shall be dyed a suitable color to facilitate inspection of placement of the Material. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the Material become uniformly suspended to form a homogenous slurry. When hydraulically sprayed on the ground, the Material shall allow the absorption and percolation of moisture. Each package of cellulose fiber shall be marked by the manufacturer to show the air dry weight content.
2. **Application.** Tackifier shall not be applied at temperatures below 50°F nor in wet or rainy weather. A minimum of 4 to 6 hours of curing time is required for acceptance of the application. See Section 9-14.2(5) for condition where the addition of tackifier is required for biofiltration swale seed mix.
3. **Terrain** that is steeper than 2H:1V, areas that exceed 10,000 square feet, and areas having a vertical drop greater than 15 feet shall be treated with a supplemental tackifier in accordance with Section 9-14.4(7).
4. **Application Rate.** Mulch shall be applied at the following rates depending on the slope of the terrain:
 - a. 35 pounds per 1000 square feet, or 1500 pounds per acre, for areas having zero to 4H:1V slope.
 - b. 50 pounds per 1000 square feet, or 2000 pounds per acre, for areas having between 2H:1V and 4H:1V slope.
 - c. 60 pounds per 1000 square feet, or 2500 pounds per acre, for areas having a slope greater than 2H:1V.

9-14.4(3) BARK MULCH

1. **Quality.** Bark mulch shall consist of freshwater Douglas fir, pine, or hemlock bark. It shall be ground so that on a loose volume basis, a minimum of 95 percent passes a 1-1/2 inch sieve and no more than 55 percent passes a 1/4

inch sieve. The bark mulch shall not contain salts, resin, tannin, or any other deleterious material in quantities that would be detrimental to plant life.

2. **Wood Chip Alternative.** Wood chips salvaged from clearing and grubbing activity may be approved as a substitute for bark mulch, if found acceptable by the Engineer prior to application. Arborist wood chip mulch, 9-14.4(4), may also be used as a substitute for bark mulch when approved by the Engineer.

9-14.4(4) ARBORIST WOOD CHIP MULCH

1. **Procurement.** For Project Sites located within the City limits of Seattle; the Contractor shall procure arborist wood chip mulch Materials from only approved sources as specified by the City of Seattle, City Purchasing and Contracting Services (<http://www.seattle.gov/contracting/construction.htm>).
2. **Quality.** Arborist Wood Chip Mulch (AWCM) shall be coarse ground wood chips (approximately 1/2" to 6" along the longest dimension) derived from the mechanical grinding or shredding of the above-ground portions of trees. It may contain wood, wood fiber, bark, branches, and leaves; but may not contain visible amounts of soil. It shall be free of weeds and weed seeds Including but not limited to plants on the King County Noxious Weed list available at: www.kingcounty.gov/weeds, and shall be free of invasive plant portions capable of resprouting, including but not limited to horsetail, ivy, clematis, knotweed, etc. It may not contain more than 1/2% by weight of manufactured inert material (plastic, concrete, ceramics, metal, etc.).
3. **Gradation.** Arborist Wood Chip Mulch, when tested, shall meet the following loose volume gradation:

Sieve Size	Percent Passing	
	Minimum	Maximum
2"	95	100
1"	70	100
5/8	0	50
1/4"	0	40

No particles may be longer than eight inches.

4. **Submittals.** At the Engineer's request, prior to delivery the Contractor shall provide the following:
 - a. The source of the product and species of trees included in it;
 - b. A sieve analysis verifying the product meets the above size gradation requirement;
 - c. A 5 gallon sample of the product, for the Engineer's approval.

9-14.4(5) PEAT

1. **Quality.** Peat shall be derived from 100% sphagnum, and shall conform to ASTM D 2607 unless otherwise specified in the Contract. Peat shall be shredded and granulated to pass a 1/2 inch sieve and conditioned in storage piles for at least six months after excavation. The peat shall not contain substances harmful to plant life.

9-14.4(6) VERMICULITE / PERLITE / PUMICE

1. **Quality.** Vermiculite, perlite, and pumice shall be horticultural grade and free of any toxic materials.

9-14.4(7) TACKIFIER

1. **Quality.** Tackifier used to stabilize mulch shall provide a liquid soil bonding agent which gives immediate erosion protection and remains effective for a minimum of one full year on an undisturbed site.

9-14.4(8) COMPOST

1. **Procurement.** For Project Sites located within the City limits of Seattle; the Contractor shall procure compost Materials from only approved sources as specified by the City of Seattle, City Purchasing and Contracting Services (<http://www.seattle.gov/contracting/construction.htm>).
2. **Quality.** Compost production and quality shall comply with Chapter 173-350 WAC, and meet the criteria below:
3. **Regulatory Standards.** Compost products shall be the result of the biological degradation and transformation of feedstocks as specified below, under controlled conditions designed to promote aerobic decomposition, per WAC 173-350-220, which is available at <http://apps.leg.wa.gov/wac/default.aspx?cite=173-350-220>
4. **Submittals.** The Contractor shall submit the following information to the Engineer for approval:
 - a. A copy of the Solid Waste Handling Permit issued to the supplier by the Jurisdictional Health Department as per WAC 173-350 (Minimum Functional Standards for Solid Waste Handling).
 - b. The Supplier shall verify in writing, and provide lab analyses that the Materials comply with the processes, testing, and standards specified in WAC 173-350 and these Specifications. An independent STA Program certified laboratory shall perform the analysis.
 - c. A list of the feedstock by percentage present in the final compost product.
 - d. A copy of the producer's current STA certification as issued by the U.S. Composting Council.
 - e. Acceptance shall be based upon a satisfactory Test Report from an independent STA program certified laboratory and the sample(s) submitted to the Engineer.
5. **Testing Requirements.** The compost Supplier shall test all compost products within 90 Calendar Days prior to application, at the Suppliers expense. Samples shall be collected using the Seal of Testing Assurance (STA) sample collection protocol, available from the U.S. Composting Council, Phone: 631-737-4931, www.compostingcouncil.org.

The sample shall be tested by an independent STA Program certified laboratory. A copy of the approved independent STA Program laboratory test report shall be submitted to the Engineer prior to initial application of the compost.

6. **Gradation.** Compost shall meet the following size gradations when tested in accordance with the U.S. Composting Council "Testing Methods for the Examination of Compost and Composting" (TMECC) Test Method 02.02-B, "Sample Sieving for Aggregate Size Classification":

a. **Fine Compost.** Fine Compost, typically used for soil amendment, shall meet the following gradation by dry weight:

	Min.	Max.
Percent passing 2"	100%	
Percent passing 1"	99%	100%
Percent passing 5/8"	90%	100%
Percent passing 1/4"	75%	100%

b. **Coarse Compost.** Coarse Compost, typically used for erosion control or surface mulching, shall meet the following gradation by dry weight:

	Min.	Max.
Percent passing 3"	100%	
Percent passing 1"	90%	100%
Percent passing 3/4"	70%	100%
Percent passing 1/4"	40%	60%

- 7. **pH.** The pH shall be between 6.0 and 8.5 when tested in accordance with TMECC 04.11-A; "1:5 Slurry pH".
- 8. **Physical Contaminants.** Manufactured inert material (concrete, ceramics, metal, etc.) shall be less than 1.0 percent by weight as determined by TMECC 03.08-A "percent dry weight basis". Film plastics shall be 0.1% or less, by dry weight.
- 9. **Organic Content.** Minimum organic matter content shall be 40 percent by dry weight basis as determined by TMECC 05.07A; "Loss-On-Ignition Organic Matter Method".
- 10. **Salinity.** Soluble salt contents shall be less than 5.0 mmhos/cm tested in accordance with TMECC 04.10-A; "1:5 Slurry Method, Mass Basis".
- 11. **Maturity.** Maturity shall be greater than 80% in accordance with TMECC 05.05-A; "Germination and Vigor". The Engineer may also evaluate compost for maturity using the Solvita Compost Maturity Test at time of delivery. Fine Compost shall score a number 6 or above on the Solvita Compost Maturity Test. Coarse Compost shall score a 5 or above on the Solvita Compost Maturity Test.
- 12. **Stability.** Stability shall be 7 or below in accordance with TMECC 05.08-B; "Carbon Dioxide Evolution Rate".
- 13. **Feedstocks.** The compost product shall contain a minimum of 65 percent by volume from recycled plant waste as defined in WAC 173-350-100 as "Yard waste", "Crop residues", and "bulking agents". A maximum of 35 percent by volume of "post-consumer food waste" as defined in WAC 173-350-100 may be substituted for recycled plant waste. A minimum of 10% food waste in compost is required. The Engineer may approve compost products containing up to 35% biosolids or manure feedstocks for specific projects or soil blends, but these feedstocks are not allowed unless specified, and not allowed in compost used for Bioretention Soils.
- 14. **C:N.** Fine Compost shall have a carbon to nitrogen ratio of less than 25:1 as determined using TMECC 04.01 "Total Carbon" and TMECC 04.02D; "Total Kjeldhal Nitrogen". The Engineer may specify a C:N ratio up to 35:1 for projects where the plants selected are entirely Puget Sound native species. Compost may be mixed with fir or hemlock bark meeting requirements of 9-14.4(3) to raise the C:N ratio above 25:1. Coarse Compost shall have a carbon to nitrogen ratio between 20:1 and 45:1.

9-14.5 MATTING AND STAKES

9-14.5(1) JUTE MATTING

9-14.5(1)A JUTE MATTING FOR NON-STREAM APPLICATIONS

- 1. **Quality.** Jute matting shall be of a uniform open plain weave of unbleached, single jute yarn treated with a fire retardant chemical. The yarn shall be of a loosely twisted construction and shall not vary in thickness by more than 1/2 of its nominal diameter. Jute matting shall be furnished in rolled strips approximately 50 yards in length. Matting width shall be 48 inches with an average weight of 0.92 pound per square yard. A tolerance of ±1 inch in roll width and ±5 percent in weight per square yard will be allowed.

9-14.5(1)B JUTE MATTING FOR IN-STREAM APPLICATIONS

- 1. **Quality.** Jute matting shall be of a uniform open plain weave of unbleached 100% jute yarn. Plastic, or any geosynthetic netting shall not be used for stream bank construction or restoration.
- 2. **Application.** The following table specifies acceptable product applications:

Slope	Minimum Criteria	Test Method
Slope ≥ 1:1	25 oz/sy <40% open area	ASTM D-3776 Corp of Engineers COE CW002215

3:1 < slope < 1:1	14 oz/sy <60% open area	ASTM D-3776 Corp of Engineers COE CW002215
4:1 < slope < 3:1	9 oz/sy <65% open area	ASTM D-3776 Corp of Engineers COE CW002215
Slope < 4:1	No matting required unless otherwise specified in the Contract.	

9-14.5(2) COIR MATTING FOR IN-STREAM APPLICATIONS

- Quality.** Coir matting shall be of a uniform open plain weave of unbleached 100% coir fabric from coconut husk. Plastic, or any geosynthetic netting shall not be used for stream bank construction or restoration.
- Application.** Coir matting shall meet and be installed in accordance with the following table:

Slope Application	Minimum Criteria	Test Method
Slope ≥ 1:1	25 oz/sy <40% open area	ASTM D-3776 Corp of Engineers COE CW002215
3:1 < slope < 1:1	14 oz/sy <60% open area	ASTM D-3776 Corp of Engineers COE CW002215
4:1 < slope < 3:1	9 oz/sy <65% open area	ASTM D-3776 Corp of Engineers COE CW002215
Slope < 4:1	No matting required unless otherwise specified in the Contract	

9-14.5(3) EXCELSIOR MATTING

- Quality.** Excelsior matting shall be a machine produced mat of wood excelsior covered on one side with a biodegradable plastic netting or twisted paper composition. The excelsior matting shall have a wood fiber minimum dry weight of 0.8 pound per square yard ± 5 %, and shall be of uniform thickness with the fiber evenly distributed over the entire area of the mat.

The width of a single roll of matting and net shall be a minimum 36 inches, and the length of the roll shall be approximately 150 feet.
- Approval.** The Contractor shall submit to the Engineer for approval at least 10 Working Days in advance of proposed Material application, Manufacturer's Certificate of Compliance stating that the excelsior matting is environmentally safe and acceptable. This submittal shall be accompanied by a sample at least 3 square feet in area.

9-14.5(4) CLEAR AND BLACK PLASTIC COVERING

Quality. Plastic covering shall meet the requirements of the NIST Voluntary Product Standard, PS 17-69, for polyethylene sheeting having a minimum thickness of 6 mil.

9-14.5(5) STAKES FOR EROSION CONTROL MATTING

- Materials.** Stakes may be wire staples, steel pins, steel spikes, or wooden stakes.
- Size.** Stakes for securing erosion control matting to earth surfaces shall be a minimum 12 inches in length, and shall have sufficient strength to withstand pounding the stakes into soil flush with the surface.

9-14.6 PLANT MATERIALS**9-14.6(1) DEFINITIONS**

- Bareroot** plants are grown in the ground and harvested without soil or growing medium around their roots. Roots shall be protected in transit with moist media such as peat or sawdust
- Container** plants are grown in pots or flats that prevent root growth beyond the sides and bottom of the container.
- Balled and burlapped** plants are grown in the ground and harvested with soil around a core of undisturbed roots. This rootball is wrapped in burlap and tied or placed in a wire basket or other supportive structure.
- Live cuttings** or live stakes are freshly cut stems (sometimes roots) taken from live plant material without a previously developed root system. Cuttings produce clones that are (usually) nearly identical to the source plants. Source plants for cuttings shall be vigorous, disease-free specimens. Acceptable sources, lengths and diameters of cuttings shall be as specified on the Drawings or plant schedules.
- Rhizomes** are a prostrate or subterranean stem, usually rooting at the nodes and becoming erect at the apex. Rhizomes shall have a minimum of two growth points. Tubers shall be a thickened and short subterranean branch having numerous buds or eyes.
- Whips** are bareroot trees, generally unbranched, and are sized typically in 1-foot height increments ranging from 2 feet to 6 feet not including the root.
- Seedlings** are plants propagated from seeds. Seedlings of woody plants demonstrate variability in appearance, size and other growth characteristics that are not acceptable in many landscape situations. Seedling variability is often desirable in native and low-maintenance landscapes where diversity may provide disease resistance.

9-14.6(2) QUALITY

1. **Standards.** All plant Material furnished by the Contractor shall conform to the requirements of the current issue of "American Standard for Nursery Stock" (ANSI).
2. **Plant Health and Regulation.** All plant Material shall meet State and Federal requirements with respect to plant health and absence of diseases and insect infestation. Inspection certificates required by law shall accompany each shipment of plant Material and shall be filed with the Engineer prior to planting. All plant Material specified shall be first-class representatives of their normal species or varieties in healthy growing condition with normal well-developed branch system and vigorous root systems. They shall be free from disease and insect infestation, disfiguring knots, sun-scalds, abrasions of the bark, broken tops and torn roots.
3. **Approved sources.** All plants shall be nursery grown stock unless otherwise indicated in the Contract.
4. **Integrity.** Plants shall not have cuts over 3/4 inch diameter which are not satisfactorily callusing over. Leader shall be intact on each plant. Large plants cut back to meet specified sizes will not be accepted. Trees shall be self-supporting, with straight trunks and with single straight leaders. Trees having damaged or missing leader, multiple leaders, or "Y" crotches will be rejected.
5. **Acclimation.** Plants furnished in pots or other containers shall be acclimated to outside conditions and equal to field grown stock.
6. **Collected Plant Material.** Collected Plant Material (including cuttings) shall come from approved legal locations. Contractor is responsible for securing any required permits and permissions from property owners. Collected plant material shall conform in quality, size, and grade to standards for nursery stock and shall be listed along with source location (Section 1-06.1) for approval at least 5 Working Days in advance of digging by the Supplier or Contractor.
7. **Replacements.** Any plant Material that is to be replaced shall be of the same species, cultivar, and equal size to the specified plant Material.
8. **Ball and Burlap.** Root balls shall be solidly held together by a fibrous root system and shall be composed only of the soil in which the plant has been actually growing. Broken or "Made" balls will not be accepted. The ball shall be securely wrapped with non-treated jute burlap or other packing Material not injurious to the plant life. Root balls shall be free of weed or foreign plant growth.
9. **Containers.** Container grown plants shall be plants transplanted into a container and grown in that container sufficiently long for new fibrous roots to have developed so that the root mass retains its shape and holds together when removed from the container. Plant Material which is rootbound will be rejected. Container sizes for plant Material of a larger grade than provided for in the container grown specifications of the American Standard for Nursery Stock (ASNS) shall be determined by the volume of the root ball specified in the ASNS for the same size plant Material.
10. **Bare Root.** All bare root plant Materials shall have a heavy fibrous root system. All plants shall be dormant at the time of planting. Roots shall be protected from drying in transit by wrapping, and stored in moist media in a shaded location if not planted immediately upon receipt. Additional environmental controls may be required to prevent drying or breaking dormancy if plants must be scored more than 48 hours.
11. **Form.** Average height to spread proportions and branching shall be in accordance with the applicable sections, illustrations, and accompanying notes of the American Standard for Nursery Stock. Plants, which have suffered damage as the result of girdling of the roots, stem, or a major branch; have deformities of the stem or major branches; have a lack of symmetry; have dead or defoliated tops or branches; or have any defect, injury, or condition which renders the plant unsuitable for its intended use, will be rejected.
12. **Street Trees.** Trees intended for installation as street trees shall have been grown with sufficient spacing to allow for symmetrical branch development which reflects the natural characteristics of the species. Trunks shall not be noticeably imperfect in vertical alignment, and there shall be no "included bark" in the crotches between the trunk and side branches.

9-14.6(3) HANDLING AND SHIPPING

- General.** Handling and shipping shall be done in a manner that is not detrimental to the plants. The root system of all plant Material shall not be permitted to dry out at any time.
1. **Acclimation.** To acclimate plant Materials to Northwest conditions, all plant Materials used on a Project shall be grown continuously outdoors north of the 42nd Latitude (Oregon-California Border) for 60 days prior to delivery.
 2. **Packing and Shipping.** Plant Material shall be packed for shipment in accordance with prevailing practice for the type of plant being shipped, and shall be protected at all times against drying, sun, wind, heat, freezing, and similar detrimental conditions both during shipment and during related handling. When transported in closed vehicles, plants shall receive adequate ventilation. When transported in open vehicles, plants shall be protected by tarpaulins or other suitable cover Material.
 3. **Ball and Burlap.**
 - a. **Handling Root Balls.** Balled and burlapped plants shall be handled by the ball of earth and not the plant. Unless otherwise specified in the Contract, plants may be supplied in suitable containers acceptable to the Engineer should the Contractor so desire.
 - b. **Removal of Fabric and Wire Cages.** Balled and burlapped trees shall, as a minimum, be installed with all wrapping material, wire cages, twine, burlap and other material reinforcement removed from the top 2/3 of root ball. Unless deemed detrimental to the stability of the rootball and health of the tree all wrappings and support materials should be removed.

4. **Containers.** All container grown plants shall be handled only by the container.

9-14.6(4) RECORDS.

1. **Shipping List.** The nursery shall furnish a notice of shipment in triplicate at the time of shipment of each carload or other lot of plant Material. The original copy shall be mailed to the Engineer, the second copy to the consignee and the third copy shall accompany the shipment to be furnished to the Engineer at the Project Site. The notice shall contain the following information:
 - a. Name of shipper.
 - b. Date of shipment.
 - c. Name of commodity (including all names as specified in the Contract).
 - d. Consignee and delivery point.
 - e. Owner Contract number.
 - f. Point from which shipped.
 - g. Quantity contained.
 - h. Manufacturer's Certificate of Compliance of grade (statement that Material conforms to the Specifications).
 - i. Size (height, runner length, caliper, etc. as required).
 - j. Statement of root pruning (date pruned and size of pruning).
 - k. Signature of shipper by authorized representative.
 - l. Growing history of plant.
2. **Tagging.** All plants shall have legible labels attached to each individual plant delivered as a separate unit or to each box, bundle, bale or container containing one or more plants. Plant Material with illegible or missing tags will be rejected by the Engineer.
 - a. **Content.** Labels shall give the necessary detailed information as to horticultural name, size, age, caliper or other data required to identify as conforming to Specifications.
 - b. **Placement.** When the label is attached to a bundle, box, container, etc., containing more than one plant, information on the label shall show the quantity together with the other required information. Exception: All trees, whether furnished singly or bundled, shall be individually tagged with names, size or caliper, etc., needed as shown above. Contractor may refer to State of Washington Department of Agriculture, Orders 1229 and 1230, Nursery Stock Standards, regarding labeling of plant Material.
 - c. **Patented and Trademarked Varieties.** All plants that are patented or trademarked shall have an individual tag on each plant.
 - d. **Field Tagged Specimens.** Plant Material tagged in the field (nursery) by the Landscape Architect shall be delivered with tags in place.

9-14.6(5) INSPECTION

1. **Approval of Source.** The Contractor shall, as soon as practical, inform the Engineer as to the source of plant Materials for the Project (See Section 1-06.1).
2. **Delivery Notification.** The Contractor shall notify the Engineer not less than 48 hours in advance of delivery of plants from the nursery to allow inspection at the nursery before delivery.
3. **Pre-Planting Inspection.**
 - a. **Trees.** All trees will be inspected by the Engineer at the Project Site prior to planting. Plants not meeting the requirements herein specified shall be immediately removed from the Project and replaced by the Contractor at the Contractor's sole expense.
 - b. **Container Stock.** Root condition of plants furnished in containers shall be determined by removal of the plant from the container. Plants not fully rooted through media to create an intact rootball, and rootbound plants with circling roots, shall be removed from the project site and replaced with acceptable specimens of the same variety.
 - c. **Timing.** Plant Material delivered, inspected and approved for planting shall be planted immediately. Plants not immediately planted by the Contractor may be temporarily stored after receiving approval from the Engineer (see Section 9-14.6(7)).

9-14.6(6) SUBSTITUTION OF PLANTS

No substitution of plant Material, species or variety, will be permitted unless evidence is submitted in writing to the Engineer that a specified plant cannot be obtained and has been unobtainable since the Award of the Contract. Substitution can be made only with written approval by the Engineer in accordance with Section 1-05.3(6). The nearest variety, size, and grade as approved by the Engineer shall then be furnished.

9-14.6(7) TEMPORARY STORAGE

1. **Storage Methods.** Plant Material delivered and accepted shall be planted immediately. Plants that cannot be planted within 1 Day after arrival shall be "heeled-in" in accordance with accepted horticultural practice, as follows:
 - a. **Bare Root.** Bare root plants shall be placed in trenches with roots covered with moist earth, sawdust or other acceptable material and be kept moist. All bare root Material supplied in bundles shall have the bundle broken and the plants placed in the trenches separately.
 - b. **Ball and Burlap.** Balled and burlapped plants shall have the root ball protected by earth, sawdust, or other material acceptable to the Engineer and the material shall be kept continuously moist.

c. **Cuttings.** Live cuttings may be stored for up to seven Days, provided they are protected against loss of moisture by a minimum six inch thick layer of earth, sawdust, or other acceptable material and be kept moist. Adequate ventilation with an ambient temperature maintained at or near 40°F shall be provided above the cuttings to prevent fungus growth. Cuttings taken in November, December or January may be stored if wrapped to produce an airtight condition with temperature maintained between 33°F and 40°F.

2. **Responsibility for Stored Plants.** Plants stored under temporary conditions shall be the responsibility of the Contractor.
3. **Protection.** Plants stored in any location for use on the Project shall be protected at all times from extreme weather conditions by insulating the root balls with sawdust, soil, or other approved Material and by keeping the roots moist at all times.

9-14.6(8) SOD

1. **Quality.** Sod shall be mature, densely rooted grass; free of weeds and objectionable grasses. All sod shall comply with State and Federal law, including guaranty, with respect to inspection, plant diseases and insect infestation. Sod shall be cut to a 1 inch mowing height prior to lifting from the field.
2. **Netting.** Plastic netting is not allowed. If netting is required, it shall be biodegradable.
3. **Source.** Sod shall be grown in Western Washington or Oregon. Sod shipments shall have a certificate of origin and certification of approved treatment when shipment originates in known infected areas.
4. **Varieties.** Turf varieties should include only those ranked "Best" by the 2011 or most current succeeding year's WSU "Turfgrass Cultivars Evaluated In Western Washington/Oregon In Recent Years" list. (Puyallup.wsu.edu/turf). Alternative varieties may be substituted only if evidence is provided by Contractor that sod made up of these varieties is not available from local sources.
5. **Turf Types.** Turf type shall be determined by the Engineer, depending on the intended turf use:
 - a. High Performance – 100% perennial rye. Three or more varieties from approved list.
 - b. Ornamental and Passive Recreation. Three or more varieties from approved list, in a mix meeting the following proportions:

Turf-type perennial rye grass	>50%
Kentucky bluegrass	<30%
Fine fescue	>20%

9-14.7 TREE STAKES, GUYS, AND WRAPPING

1. **Stakes.**
 - a. **Standard.** Stakes shall be 8 foot long 2 inch diameter pressure-treated lodgepole pine wood stakes, with chamfered tops and 6 inch long conical points (see Standard Plan no. 100a).
 - b. **Alternative for Grates.** The Contractor shall be prepared to provide No. 5 deformed steel reinforcing bar as a substitute stake for compatibility with tree grates.
 - c. **Installation.** The stakes shall be installed as shown in the Standard Plans unless the Contract indicates otherwise.
2. **Guys.**
 - a. **Material.** Guys shall be pre-manufactured adjustable ties made of plastic Material such as No. 2 Chainlock or approved equal.
 - b. **Installation.** The guys shall be installed as shown in the Standard Plans unless the Contract indicates otherwise.
 - c. **Adjustment and Removal.** Guys shall be adjusted at the end of the first growing season to prevent constriction of growth, bark ringing, or other conditions detrimental to optimal growth of the trees. Guys shall be removed one year after planting, except when noted otherwise in the Contract.
3. **Wrap.** Tree wrap shall be as indicated in the Contract.

9-14.8 SHEAR BOARDS

Shear boards shall be 2 inch x 8 inch x 8 foot non-treated, rough finished lumber. When conditions require a length less than 8 feet, the Contractor shall plan the layout so that no individual length of cut shear board is less than 4 feet.

9-14.9 PAVER BLOCKS AND INTERLOCKING CONCRETE PAVERS

9-14.9(1) PAVER BLOCKS

1. **Material.** Paver blocks shall be exposed aggregate concrete of the size indicated on the Drawings. Pavers shall be made from the following mix:

Material	Quantity per cubic yard
gray cement	564 pounds
5/8 inch minus gravel	2,400 pounds
building sand	1,030 pounds

A sample of exposed aggregate showing the desired amount of exposure is available at the Seattle Public Utilities' Materials Laboratory at 707 South Plummer Street.

2. **Sealant.** Exposed aggregate surface of all concrete paver units shall be sealed with a heavy-duty concrete enamel containing a 10% methylacrylate solution or approved equal. On request by the Engineer, the Contractor shall provide a 1 pint sample of sealant for testing. Sealant Material shall be approved by the Engineer prior to application.
3. **Submittal.** The Contractor shall submit two sample paver blocks, which are representative of those to be used in the Project, for the Engineer's approval.

9-14.9(2) INTERLOCKING CONCRETE PAVERS

1. **Quality.** The manufactured product shall meet the following Specifications in color, materials, physical properties configuration, and tolerances:
 - a. **Color.** The color of the unit concrete paver shall be natural conforming to samples available from the Engineer.
 - b. **Dimensions.** The nominal dimensions shall be:

length	9 inches
width	4-1/2 inches
thickness	2-3/8 inches

- c. **Shape.**
 - i. The length sides of the paver shall have two projections and two recessions per side. The projection on one side shall correspond to a recession on the opposite side. The projections and recessions shall be 3/8 inch when measured from the extension of the nominal width lines for the length of the paver.
 - ii. The width sides of the paver shall have one projection and one recession per side. The projection on one side shall correspond to a recession on the other side. The projections and recessions shall be 3/8 inch when measured from the extension of the nominal length lines for the width of the paver.
 - iii. The top and bottom surfaces shall be flat and parallel. The top side edge shall be chamfered 1/4 inch. The sides shall be perpendicular to the top and bottom surfaces. Full size edging pavers shall have one width side flat. Half size edging pavers shall be 1/2 the nominal length with one width side flat.
 - iv. Length or width of paver unit shall not differ by more than 0.059 inches and heights shall not differ by more than 0.11 inches from the specified dimensions.

9-14.9(3) CEMENTITIOUS MATERIALS

Materials shall conform to the following:

Material	Standard
Portland Cement	ASTM C 150
Blended Cement	ASTM C 595, Type 1S or 1P
Hydrated Lime	ASTM C 207, Type S
Pozzolan	ASTM C 618

9-14.9(4) AGGREGATES AND OTHER CONSTITUENTS

Aggregates shall conform to the following, except that grading requirements may not necessarily apply:

Normal weight	ASTM C 33, for Concrete Aggregates
Lightweight	ASTM C 331, for Lightweight Aggregates for Concrete Masonry Units

Air-entraining agents, color pigments, integral water repellents, finely ground silica, etc., shall be previously established as suitable by the Engineer for use in concrete, and shall conform to ASTM Standards where applicable, or shall be shown by test or experience not be detrimental to concrete.

9-14.9(5) PHYSICAL REQUIREMENTS

1. **Compressive Strength.** At the time of delivery to the Project Site, the average compressive strength of test samples shall not be less than 8000 psi with no individual paver unit less than 7200 psi.
2. **Absorption.** The average absorption shall not be greater than 5%, with no individual unit greater than 7%.
3. **Freeze – Thaw.** The manufacturer shall satisfy the Owner by proven field performance of the laboratory freeze-thaw test that the paving units have adequate durability when subject to a freeze-thaw environment. See freeze thaw test in this Section.
4. Acceptable field performance is achieved when units similar in composition and produced by the same manufacturing process exhibit no objectionable deterioration for at least 3 years. The paver units used as the basis for proven field performance shall have been exposed to the same general type of environment, temperature, range, and traffic volume.
5. **Breakage.** When tested in accordance with Section 8 of ASTM C 67, specimens shall not have breakage or, greater than 1.0% loss on dry weight of any individual paver unit when subjected to 50 cycles of freezing and thawing. This test shall be conducted not more than 12 months prior to delivery of units. When tested in accordance with ASTM C 418. "Abrasion Resistance of Concrete By Sandblasting" specimens shall not have volume loss greater then 0.915 cubic inch per 7.75 square inch. The average thickness loss shall not exceed 1/8 inch.

9-14.9(6) PERMISSIBLE TOLERANCE IN DIMENSIONS

Length or width of paver unit shall not differ by more than 0.059 inches and heights shall not differ by more than 0.11 inches from the specified dimensions.

9-14.9(7) VISUAL INSPECTION

All paver units shall be sounded and free of defects that would interfere with the proper placing of unit; or impair the strength of the construction. Minor cracks or chips due to the usual method of manufacture and customary method of handling in shipment and delivery may be allowed subject to the discretion of the Engineer. Paver units identified as unacceptable by the Engineer shall be replaced.

9-14.9(8) SAMPLING AND TESTING

The Contractor shall submit three (3) samples of the paver unit to the SPU Material Laboratory for approval. Sample units will be tested in accordance with ASTM C 140.

9-14.9(9) BASE COURSE

The base course shall be 6 inches in depth, shall conform to the requirements of Section 9-03.9(3) Crushed Surfacing, and shall consist of Mineral Aggregate Type 2, 1-1/4 inch minus crushed rock, as describe in Section 9-03. 20% "ISOLITE" CG2 shall be incorporated into the base course in paver areas extending the width of the sidewalk adjacent to tree pits (a 8' x 7" surface area per pit).

9-14.9(10) TOP COURSE OR KEYSTONE

The Top Course shall be 2 inch in depth and shall conform to the requirements of Section 9-03.9(3) Crushed Surfacing and shall consist of Mineral Aggregate Type 1, 5/8" inch minus crushed rock, as describe in Section 9-03. 20% "ISOLITE" CG2 shall be incorporated into the base course in paver in areas extending the width of the sidewalk adjacent to tree pits (an 8' x 7" surface area per pit).

9-14.9(11) LEVELING COURSE

The Leveling Course shall conform to the requirements of Section 9-03.11 Crushed Gravel, as modified herein. The Material shall be 3/8 inch minus chip rock with the following gradation:

Sieve Size	% Passing
3/8 inch	98
1/4 inch	50 – 90
No. 4	25 – 55
No. 6	0 – 20
No. 10	0 – 10
No. 40	0 – 5
No. 200	0 – 3

Material passing the No. 200 sieve size shall be brought to the Project Site bagged and dry.

9-14.9(12) BEDDING SAND

The Bedding Sand shall conform to the requirements of Section 9-03.12(6) Washed Sand and Gravel and shall consist of Mineral Aggregate Type 6, washed sand, as described in Section 9-03.

9-14.9(13) JOINT FILLING SAND

The joint filling sand shall have the following grading:

Sieve Size	% Passing
US No. 8	95 - 100
US No. 16	60 - 70
US No. 30	15 - 25
US No. 50	0 - 5
US No. 100	0 - 2
US No. 200	0 - 1

The fracture shall be 100%. This Material is crushed sand.

9-14.9(14) EDGING

Edging shall be installed to separate all unit paver installations from adjacent planting or turf areas. Product shall be specified on Drawings and approved by Engineer.

9-14.10 TURF REINFORCEMENT

Turf reinforcement product shall be as specified on the Drawings and approved by Engineer.

9-14.11 CEDAR EDGING

Material for edging shall be 2 inch x 4 inch cedar, construction grade or better with tight knots.

9-14.12 BOLLARDS

9-14.12(1) WOOD BOLLARDS

Bollards shall be nominal 8 inch x 8 inch, 90 Day stack dry, select Douglas Fir. Bollards shall be pressure-treated (by closed cylinder method) with Pentachlorophenol after cutting and predrilling. Tops and four sides of bollards shall be painted (above the notch) with 2 coats of white marine enamel as manufactured by Inter-Lux or approved equal applied per manufacturer's recommendations.

All metal parts (bolts, nuts, washers, etc.) shall be hot-dipped galvanized.

9-14.12(2) CONCRETE BOLLARDS

Concrete bollards shall be made of Class 3000 cement concrete (see Section 6-02), reinforced with four No. 4 deformed steel bars placed one inch clear below the concrete surface and held in place with No. 8 gauge wire ties. After forms are removed, concrete shall show a smooth dense face. Any surface irregularities showing above grade shall be scraped or stoned off; the surface shall then be washed and a 1:1 mortar shall be brushed on. After the initial set but before the final set, the excess mortar shall be rubbed off using burlap sacking or pieces of carpeting. The bollards shall then be cured by being kept damp with water for not less than 2 Days.

9-14.12(3) RESERVED

9-14.12(4) PADLOCKS FOR REMOVABLE BOLLARDS

The padlock shall be as manufactured by Best Lock Company, Lock number 2B672 with bronze body, 2 inch stainless steel shackle, and equipped with construction core or approved equal.

9-14.13 BENCHES

Benches shall be of the type indicated in the Contract.

9-14.14 TREE GRATES

1. **Metal Tree Grates.** Tree grates shall be manufactured in 2 equal sized sections made of gray iron conforming to ASTM A 536, GR80-56-06. Grates shall have a 3/4 inch nominal thickness and cover an area not less than 24 square feet. To accommodate tree growth, the grates shall have 3 or 4 centrally located concentric break-out rings allowing a 12 inch minimum to 30 inch maximum opening in diameter. Break out rings shall have no more than 6 points of attachment per grate section and shall be scored to allow ease of expansion for tree growth. Grates shall be designed to not fail under a wheel load of up to 4000 pounds except at the break-out rings.
2. **Alternatives.** Alternative material use in the design and manufacturing of tree grates is subject to approval by the Engineer based on a submittal provided by the Contractor providing data on performance standards adequate to meet the public safety, sustainability, functional, and visual objectives of the project. Submittals shall include documentation of product use and performance over a minimum of 3 years on installations for public use in areas with comparable climactic conditions typical in the Pacific Northwest.

9-14.15 IN-STREAM LOGS

1. **Form.** In-stream logs shall consist of tree shoot with or without limb, and tree root and rootwad. In-stream log may include the use of on-site tree identified for removal. The shoot portion of the tree shall not contain any root and may have any alignment unless the Contract specifies otherwise. The logs shall not be limbed; however, may require trimming of limbs to dimensions as specified in the Contract.
2. **Species.** In-stream log shall be cedar, Douglas fir, or other species tree as specified in the Contract.
3. **Quality.** Logs shall be of sound quality, shall not be split or cracked, and shall be clean and free of insects, rot, decay, soil, rock, and other deleterious material.

4. **Dimensions.** The Contract will specify log length(s) and diameter(s), and may specify a range of butt and tip diameters. The root section dimension will contain a minimum and/or maximum diameter and may require trimming approximating a plane.

9-14.16 WATTLES OR COMPOST SOCKS

Wattles shall act as a screen or filter and shall consist of biodegradable plant material such as any combination of twigs, wicker, bamboo, other withes, straw, coir, and wood shavings, or for Compost Socks, in the shape of cylinders typically ranging from 8 inch to 16 inch diameter and of any length. The wattle shall be encased within biodegradable netting. Where not otherwise specified, Compost Socks shall be used.

9-14.16 WATTLES

Wattles shall act as a screen or filter and shall consist of biodegradable plant material such as any combination of twigs, wicker, bamboo, other withes, straw, coir, and wood shavings in the shape of cylinders typically ranging from 10 inch to 16 inch diameter and of any length. The wattle shall be encased within biodegradable netting.

9-14.17 VERTICAL ROOT BARRIER.

Root barriers shall be an injection molded or extruded modular component made of high density polypropylene or polyethylene plastic with a minimum of 30% recycled materials. Panels shall have a minimum thickness of 0.080" (2 mm). Each panel shall have molded vertical ribs (four minimum) and locking strips, integral male/female sliding locks, intergraded zipper joining system. Vertical root-deflecting ribs or channels shall be between 1/2-inch (12.7 mm) and 0.008" (0.2 mm) high, perpendicular to the panel, and between 5.91-inches (150 mm) to 7.87-inches (200 mm) apart. Panels shall be a minimum of 24-inches wide by 18 or 24-inches deep, or as shown on Drawings. The Contractor shall submit for approval a catalogue cut for the material and installation.

SECTION 9-15 IRRIGATION SYSTEM

9-15.1 PIPE AND FITTINGS

9-15.1(1) GENERAL

Pipe shall be galvanized iron, PVC, or polyethylene, as specified in the Contract.

9-15.1(2) GALVANIZED PIPE AND FITTINGS

Pipe shall be standard weight, hot-dipped galvanized iron or steel pipe, threaded and coupled. Pipe shall meet the requirements of ASTM A 120.

9-15.1(3) POLYVINYL CHLORIDE PIPE AND FITTINGS

PVC pipe upstream of the control valves shall be schedule 40 and conform to all requirements of ASTM D 1785.

PVC pipe downstream of the control valves shall be pressure rated for 200 psi and conform to all requirements of ASTM D 2241, SDR 21.

Fittings shall be of the solvent weld type except where risers, valves, etc., require threaded transition fittings. Fittings shall conform to the requirements of ASTM D 2466.

PVC pipe and fittings shall be non-toxic, free from taste and odor, and self-extinguishing.

Pipe shall be homogenous throughout and free of defects cracks, holes, foreign Materials, wrinkles, dents and blisters.

PVC pipe shall be continuously and permanently marked with the following information: manufacturer's name, kind of pipe, National Sanitation Foundation (NSF) approval and schedule number.

9-15.1(4) POLYETHYLENE PIPE

Polyethylene pipe shall be Class 80, SDR 15, medium density polyethylene pipe, meet the requirements of ASTM D 2239, conform to U.S. Commercial Standard CS-255, and be National Sanitation Foundation (NSF) approved.

9-15.2 CONTROL TUBING

Control tubing shall be copper refrigerator tubing meeting the current requirements of ASTM B 280 in the size specified on the Drawings. Tubing and fittings shall be capable of withstanding a 300 psi operating pressure, and shall be of the size indicated on the Drawings.

9-15.3 SLEEVE

Pipe sleeves shall be PVC schedule 40. Sizes and installation shall be in accordance with the Drawings and Standard Plan no. 128.

Conduit shall meet the requirements of Section 9-34.

9-15.4 IRRIGATION AUTOMATIC CONTROLLERS

Automatic controllers shall be installed in electrical controller cabinets on a concrete base as shown on Standard Plan no. 129. The dimensions and details of the controller cabinet shall be as shown on Standard Plan no. 129 unless otherwise dimensioned and detailed in the Contract. A manufacturer of acceptable irrigation controller cabinets is Skyline Electric and Manufacturing Co., Seattle, Washington.

The controller shall be an electrically timed device for automatically opening and closing control valves for predetermined periods of time and mounted so that all normal adjustments are conveniently located for use by the operator. Controllers shall be enclosed in a weatherproof metal enclosure. The Contractor shall submit a Shop Drawing of the padlock secured enclosure sized adequately to hold all specified equipment. The enclosure shall include a modified free-standing shelf measuring 12 inches x 12 inches x 15 inches high to hold the Controller, and one GFCI outlet with 15 amp circuit breaker (10,000 amp AIC) located in the upper right hand corner. All 120 volt wiring shall be behind a dead front panel. The controller shall be solid state and capable of operating the irrigation system as designed and constructed and shall include the following operating features:

1. Each controller station shall be adjustable for setting to remain open for any desired period of time - from five minutes or less to at least one hour.
2. Adjustments shall be provided whereby any number of Days may be omitted and whereby any one or more positions on the controller can be skipped. When adjustments are made, they shall continue automatically within a 14 Day cycle until the operator desires to make new adjustments.
3. Controls shall allow any position to be operated manually both on or off whenever desired.
4. Controls shall provide for resetting the start of the irrigation cycle at any time and advancing from one position to another.
5. Controllers shall contain an on-off switch and fuse assembly.
6. Controller adjustments shall be such that the open cycle may be doubled or repeated not less than 3 times during the complete watering cycle.
7. Controller shall have a power failure cutout.
8. Controller shall be UL approved and marked accordingly.

Contractor shall provide an outdoor rated padlock by Best Manufacturing Company with a removable blue core.

9-15.5 SPRINKLER HEADS

Sprinkler heads shall be of the type, pattern, and coverage shown on the Drawings at rated operating pressure specified, discharging not more than the amount of gallons per minute specified.

Sprinkler heads shall be designed so that spray adjustments can be made by either an adjustment screw or interchangeable nozzles. Watering cores shall be easily removed without removing the housing from the pipe.

All turn heads shall be designed with turf flanges having 2 gripping holes to facilitate removal of the head.

When the Contract does not specify irrigation system spacing, or does not specify irrigation head make or model, then the Contractor shall submit the missing information to the Engineer for approval at least 10 Working Days in advance of ordering Materials. Approval, and request for approval of substitution, of sprinkler heads will be based on compatibility of Materials with other Owner systems at the Project Site (see Sections 1-02.4(1) and 1-05.3(6)). The Contractor shall design the layout of such systems incorporating efficient and adequate coverage without overspray.

9-15.6 ELECTRICAL WIRE

Wire from controller to valves shall be #14 UF direct burial (UL approved), red or black for the hot side, white for neutral (solid copper). The auxiliary wires, where required, shall be any third color (except green). UF and UL designations shall be clearly marked on the insulation jacket of all wires.

9-15.7 IRRIGATION VALVES

9-15.7(1) GATE VALVES

Gate valves, when called for on the Drawings, shall be heavy duty bronze conforming to the requirements of ASTM B 62. Valves shall be of the same size as the pipes on which they are placed and shall have union or flange connections. Service rating (for non-shock cold water) shall be 300 psi. Valves shall be of the double disk, taper seat type, with rising stem, union bonnet and handwheel. Manufacturer's name, type of valve and size shall be cast on the valve.

9-15.7(2) CONTROL VALVES

9-15.7(2)A MANUAL CONTROL VALVES

Manual valves shall be bronze or brass, angle type with hex brass union. Service rating shall be not less than 150 psi nonshock cold water. Valves shall be designed for underground installation with suitable cross wheel for operation with a standard key. The Contractor shall furnish three suitable operating keys per Contract. Valves shall have removable bonnet and stem assembly with adjustable packing gland and shall house long acme threaded stem to ensure full opening and closing. Valve discs shall be full floating with replaceable seat washers.

9-15.7(2)B AUTOMATIC CONTROL VALVES

Automatic remote control valves shall be globe pattern with flanged or screwed connections as required. The valve shall be constructed so as to allow all internal parts to be removable from the top of the valve without disturbing the valve installation. Screwed valves shall be provided with union connections.

Valves shall be of a "normally closed" design and shall be electric solenoid operated, having maximum rating of 6.5 watts utilizing 24 volts AC power. Solenoids shall be directly attached to the valve bonnets or body with all control parts and ports completely internal. Valves shall be of 150 psi brass or bronze, or iron body bronze-mounted combination. The time interval for valve closing operation shall be a minimum of 5 seconds for complete closure at constant rate of closing and a minimum of 3 seconds to completely open at a constant rate of opening. A manual control bleed cock shall be included on the valve to operate the valve without electric current. A manual shutoff stem with cross handle for wrench operation is required

for manual adjustment from fully closed to wide open. Once the manual adjustment is set, the valve can be operated automatically in the adjusted position. Water flow shall be completely stopped when the control valve is closed either manually or automatically. Automatic control valves and automatic controllers need not be of the same manufacturer.

All automatic control valves shall be pressure reducing valves unless otherwise specified in the Contract.

9-15.7(2)C AUTOMATIC CONTROL VALVES WITH PRESSURE REGULATOR

The automatic control valve with pressure regulator shall be similar to the automatic control valve and shall also reduce the inlet pressure to a constant lower pressure regardless of supply fluctuations. The regulator shall be fully adjustable.

9-15.7(3) QUICK COUPLER VALVES

Quick coupler valves shall have a service rating not less than 125 psi for nonshock cold water. The body of the valves shall be of cast leaded semi-red brass alloy No. C84400 conforming to ASTM B 584. The base of the valve shall have standard female pipe threads. The design of the valve shall be such that it opens only upon inserting a coupler key and closes as the coupler is removed from the valve. Leakage of water between the coupler and valve body when in operation will not be accepted. The valve body receiving the coupler shall be designed with double worm slots to allow smooth action in opening and closing of the valve with a minimum of effort. Slots shall be notched at the base to hold the coupler firmly in the open position. Couplers shall be of the same material as the valve body with stainless steel double guide lugs to fit the worm slots. Couplers shall be of one piece construction with steel reinforced side handles attached. All couplers shall have standard male pipe threads at the top. Couplers shall be furnished with all quick coupler valves unless otherwise specified in Contract. See Standard Plan no. 121.

9-15.7(4) DRAIN VALVES

The Contractor shall install a 3/4 inch male automatic ball check drain valve at the low point in the system. The drain valve shall be drained to a pocket containing a minimum of 1/2 cubic yard of Mineral Aggregate Type 4. See Standard Plan no. 122.

9-15.7(5) CHECK VALVES

Check valves shall be heavy duty bronze or steel. The valves shall function by means of a hinged disc suspended from the body and able to close of its own weight. Valves shall be of the size as the pipes on which they are placed, unless otherwise specified in the Contract, and shall have union or flanged connections. Service rating (for non-shock cold water) shall be 300 psi. Manufacturer's name, type of valve and size shall be cast on the valve.

9-15.7(6) PRESSURE REDUCING VALVES

Pressure reducing valves shall have a minimum of 150 psi working pressure with an adjustable outlet range of 20 to 70 psi. The valves shall be factory set as shown on the Drawings.

Pressure reducing valves shall be rated for safe operation at 175 psi non-shock cold water.

9-15.7(7) THREE WAY VALVES

Three way valves shall be tight closing, three port, ball or plug type, constructed to permit straight through and 90 degree flow only. The valve shall be of bronze or approved corrosion resistant body Materials and shall have a minimum of 150 psi working pressure. The head of the valve, or handle when applicable, shall be permanently marked to indicate port position. Whenever handles are included as an integral part of the valve, the Contractor shall remove the handles and give them to the Engineer for ultimate distribution to the Maintenance Division.

9-15.7(8) FLOW CONTROL VALVES

Valve body materials shall be plastic or metal. Internal parts shall be stainless steel. Valves shall be factory set to design flows. Valves shall have no external adjustment and be tamper proof when installed. One-quarter inch and smaller flow control valves shall have a minimum pressure absorption range of 2 to 32 psi. One and one half inch and larger flow control valves shall have a minimum pressure absorption range of 3 to 50 psi.

Flow shall be controlled to 5 percent of design volumes.

9-15.7(9) AIR RELIEF VALVE

The air relief valve shall automatically relieve air and break a vacuum in the serviced pipe. Body Materials shall be installed exactly at all high points.

9-15.8 VALVE BOXES

All automatic control valves, flow control valves, and pressure reducing valves shall be provided with valve boxes. Valve boxes shall be sized as appropriate to allow efficient access to components and shall be approved by the Engineer prior to installation. Valve boxes shall be extendable to obtain the depth required. Where 1 inch diameter Schedule 80 PVC braces are required for quick coupler valves as indicated on Standard Plan no. 121, the box shall have holes adequately sized to securely snug fit the brace. All manual drain valves and manual control valves shall be equipped with a protective sleeve and cap as shown in the Standard Plans.

9-15.9 BACKFLOW PREVENTION ASSEMBLIES

Backflow prevention assemblies shall be as specified in Section 9-30.16.

9-15.10 HOSE BIBS

Hose bibs shall be constructed of bronze or brass, angle type threaded to accommodate a 3/4 inch hose connection, and shall be key operated. Design shall be such as to prevent operation by wrench or pliers.

9-15.11 DETECTABLE MARKING TAPE

Detectable marking tape shall consist of inert polyethylene plastic that is impervious to all known alkalis, acids, chemical reagents, and solvents likely to be encountered in the soil, with a metallic foil core to provide the most positive detection and pipeline locators.

The tape shall be color coded and shall be imprinted continuously over its entire length in permanent black ink. The message shall convey the type of line buried below and shall also have the word "Caution" prominently shown. Color coding of the tape shall be as follows:

UTILITY	TAPE COLOR
Water	Blue
Sewer	Green
Electrical	Red
Gas-Oil	Yellow
Telephone-CATV	Orange
Non-Potable Water	Purple

The width of the tape shall be as recommended by the manufacture for the depth of installation.

SECTION 9-16 FENCE AND GUARDRAIL**9-16.1 CHAIN LINK FENCE AND GATES****9-16.1(1) GENERAL**

All Material used in the construction of chain link fence and gates shall be new. Iron or steel Material shall be galvanized; however, exceptions to galvanizing are listed in various Standard Plans and other Standard Specifications. Imperfectly galvanized Material or Material upon which serious abrasions of galvanizing occur will not be acceptable.

The base Material for the manufacture of steel pipes used for posts, braces, top rails, and gate frames shall conform to the requirements of ASTM F 1083. The base Material for the manufacture of steel H columns shall meet the requirements of ASTM A 663 or ASTM A 675.

Roll-formed posts, braces, and rails shall be made from sheet steel and shall conform with the details as shown on the Drawings or Standard Plan no. 450b. The Material for end, corner, and pull posts shall have a minimum yield strength of 35,000 psi. The minimum yield strength for Alternate A roll-formed line posts shall be 40,000 psi and for Alternate B roll-formed line posts 45,000 psi. Top rail and braces to be used with Alternate A or B line posts shall conform to the minimum yield strength as required for either post respectively.

All posts, braces, top rails, and gate frames shall be hot-dip galvanized. They shall have a minimum average of 1.8 ounces zinc coating per square foot of surface area with no individual test being below 1.6 ounces zinc coating per square foot of surface area. In the case of members made from pipe, this area is defined as the total area inside and outside. A sample for computing the average weight of coating is defined as a 12 inch piece cut from each end of the galvanized member. Fittings shall be galvanized in accordance with the requirements of ASTM F 626. Other Materials shall be galvanized in accordance with the requirements of ASTM A 153.

9-16.1(2) POSTS

All posts for chain link fence shall be of the shape, size, and weight per foot shown on Standard Plan no. 450b. Roll-formed end, corner, and pull posts shall be made from 0.1345 inch minimum thickness sheet steel and shall have integral fastening loops to connect to the fabric for the full length of each post. Roll-formed line posts shall be made from 0.110 inch minimum thickness sheet steel for Type 3 and Type 4 fences and shall be made from 0.120 inch minimum thickness sheet steel for Type 1 and Type 6 fences.

An acceptance tolerance for posts for chain link fence allows for deviation from the weight per linear foot specified in the Standard Plans. This tolerance shall be applied on an individual post basis and shall be plus or minus 5 percent for tubular and H-section posts and plus or minus 6 percent for roll form sections. Materials that exceed the weight per foot or wall thickness Specification may be accepted, providing they do not interfere with the proper construction of the fence.

9-16.1(3) TOP RAIL, BRACES, AND TRUSSES

Top rail and compression braces shall be of the type and size shown on Standard Plan no. 450b. Tension truss rods shall be 3/8 inch round galvanized rods with drop forged turnbuckles, or other approved type of adjustment. Couplings for tubular sections shall be outside sleeve type and at least 6 inches long. Roll-formed top and brace rails shall be made from 0.0747 inch thick sheet steel and shall be an open rectangular section with internal flanges. The acceptable thickness tolerance for sheet steel members shall be ± 0.006 inch.

9-16.1(4) TENSION WIRE AND ATTACHMENTS

Top and bottom wire shall be 7 gage coil spring steel wire of good commercial quality and shall have a zinc coating averaging 0.8 ounce per square foot of surface area. All tension wire attachments shall be hot-dip galvanized steel. Eye bolts shall be 3/8 inch diameter and of sufficient length to fasten to the type of posts used.

9-16.1(5) RESERVED**9-16.1(6) FITTINGS**

All fittings and miscellaneous hardware shall be malleable cast iron or pressed steel. Fittings shall be galvanized in accordance with ASTM F 626. Galvanizing of miscellaneous hardware not covered by ASTM F 626 shall be in conformance with ASTM A 153. Fittings for any particular fence shall be those furnished by the manufacturer of the fence.

9-16.1(7) CHAIN LINK FENCE FABRIC

Chain link fabric shall consist of 11 gage wire (0.120 inch diameter) for Types 3, 4, and 6 fence; and 9 gage wire (0.148 inch diameter) for Type 1 fence. The fabric wire may be one of the following Materials provided that only one type shall be selected for use in any one Contract:

1. Galvanized steel wire conforming to ASTM A 392.
2. Galvanizing shall be Class I performed by the hot-dip process.
3. Aluminum coated steel wire conforming to ASTM A 491.
4. Class II aluminum wire conforming to 6061-T94 alloy.

The wire shall be woven into approximately 2 inch diamond mesh. The width and top and bottom finish of the fabric shall be as shown in Standard Plan nos. 450a and 450c.

9-16.1(8) FABRIC BANDS AND STRETCHER BARS

Fabric bands shall be 1/8 inch by 1 inch nominal and stretcher bars 3/16 inch by 3/4 inch nominal. Nominal shall be construed to be the area of the cross-section of the shape obtained by multiplying the specified width by thickness. A variation of plus or minus 5 percent from this theoretical area shall be construed as "nominal" size. Both shall be hot-dip galvanized to meet the requirements of ASTM F 626.

9-16.1(9) TIE WIRE

Tie wire shall be 9 gage aluminum wire complying with the ASTM B 211 or 9 gage galvanized wire meeting the requirements of AASHTO M 279. Galvanizing shall be Class 1. Hog rings shall meet the requirements of AASHTO M 279. Galvanizing shall be Class 1.

9-16.1(10) CHAIN LINK GATES

Gate frames shall be constructed of not less than 1-1/2 inch inside diameter hot-dip galvanized pipe with nominal weight of 2.72 pounds per linear foot. The corners of the gate frame shall be fastened together and reinforced with a malleable iron or pressed steel fitting designed for the purpose, or they may be welded. Welding shall conform to the requirements of Section 6-03.3(25). All welds shall be ground smooth and painted with a high zinc dust content paint meeting the requirements of MIL-P-21035. The paint shall be applied in one or more coats to provide a dry film thickness of 3.5 mils minimum.

Cross trussing shall be 3/8 inch galvanized steel adjustable rods.

Chain link gate fence fabric Material shall be the same as used for the chain link fence (see Section 9-16.1(7)).

Each gate shall be furnished complete with necessary hinges, latch, and drop bar locking device designed for the type of gate posts and gate used on the Project. Gates shall have positive type latching devices with provisions for padlocking.

Gate frames constructed of steel sections, other than pipe, that are fabricated in such a manner as to form a gate of equal or better rigidity may be used provided they are approved by the Engineer.

9-16.1(11) MISCELLANEOUS

All concrete shall be Class 3000 as specified in Section 6-02.3.

9-16.2 WIRE FENCE AND GATES**9-16.2(1) GENERAL**

All materials used in the construction of the wire fence shall be new. All iron or steel material shall be galvanized. Imperfectly galvanized material or material upon which serious abrasions of galvanizing occur shall not be used.

9-16.2(2) STEEL FENCE POSTS AND BRACES

All posts for chain link fence shall be of the shape, size, and weight per foot shown in Standard Plan no. 450b. Roll-formed end, corner, and pull posts shall be made from 0.1345 inch minimum thickness sheet steel and shall have integral fastening loops to connect to the fabric for the full length of each post. Roll-formed line posts shall be made from 0.110 inch minimum thickness sheet steel for Type 3 and Type 4 fences and shall be made from 0.120 inch minimum thickness sheet steel for Type 1 and Type 6 fences.

Line posts may be channel, T, U, Y, or other approved shape, manufactured solely for use as fence posts. One type of line post shall be used throughout the Project. Line posts shall be studded, slotted, or properly adapted for attaching either wire or mesh in a manner that does not damage the galvanizing of posts, wire, or mesh during the fastening. Line posts shall 2014 Edition City Of Seattle Standard Specifications For Road, Bridge and Municipal Construction

have a minimum weight of 1.33 pounds per linear foot and shall be provided with a tapered steel anchor plate attached securely having a minimum weight of 0.67 pounds and having a surface area of 20 square inches \pm 2 square inches.

End, corner, gate, and pull posts shall meet the requirements specified for line posts, except that the posts shall have a minimum weight of 3.1 pounds per linear foot and anchor plates and special studs, slots, or adapters for the attachment of wires will not be required.

Braces shall have a minimum weight of 3.1 pounds per linear foot.

All posts, braces, anchor plates, and hardware not covered by ASTM F 626 shall be galvanized in accordance with the requirements of ASTM A 123, or ASTM A 153.

A tolerance of minus 5 percent on the weight of individual posts, braces, or anchor plates will be permitted.

9-16.2(3) WOOD FENCE POSTS AND BRACES

Douglas fir, Western red cedar, hemlock, or larch shall be used in the construction of wood fence posts and braces. The material shall be of good quality and approved by the Engineer before use. Peeler cores shall not be used for round posts. Wood fencing materials shall have sufficient sapwood in the outer periphery to obtain the specified penetration of preservative. Western red cedar will not require preservative treatment. Fencing materials shall be cut to the correct length before pressure treatment.

Line posts shall be 3-inch minimum diameter round posts or nominal 3-inch by 3-inch square sawed posts. If the posts are to be pointed for driving, they shall be pointed before treatment. Line posts shall be at least 7-feet in length.

Pull posts and brace posts shall be 6-inch diameter round posts or nominal 6-inch by 6-inch material not less than 7-feet in length.

End, gate, and corner posts, and posts at an intersecting fence shall be 6-inch diameter round posts or nominal 6-inch by 6-inch material not less than 7-feet 10-inches in length.

All sawed posts and timbers shall meet the requirements in the table under Section 9-09.2.

The preservatives used to pressure treat wood fencing materials shall meet the requirements of Section 9-09.3.

The retention and penetration of the preservative shall be as follows:

MINIMUM RETENTION IN POUNDS PER CUBIC FOOT		
PRESERVATIVE	SAWED POSTS	ROUND POSTS
ACA	0.40	0.40
ACZA	0.40	0.40

MINIMUM PENETRATION	
for material 5" or less	0.40-inches penetration and 90% of sapwood
for material 5" or greater	0.50-inches penetration and 90% of sapwood

9-16.2(4) BRACE WIRE

Brace wire shall be 9 gage galvanized wire meeting the requirements of ASTM A 116, galvanizing Class 3.

9-16.2(5) STAPLES AND WIRE CLAMPS

The staples used to attach the wire fencing to wood posts shall be galvanized 9 gage, 1-1/2 inches long meeting the requirements of AASHTO M 279, galvanizing Class 1.

The wire clamps used to attach the wire fencing to steel posts shall be galvanized 11 gage wire meeting the requirements of AASHTO M 279, galvanizing Class 1.

9-16.2(6) BARBED WIRE

Barbed wire shall conform to the requirements of AASHTO M 280, and shall consist of two strands of 12-1/2 gage wire, twisted with four point 14 gage barbs with the barbs spaced an average of 5 inches apart. Galvanizing shall be Class 3.

9-16.2(7) WIRE MESH

Wire mesh shall conform to the requirements of AASHTO M 279, and shall consist of seven horizontal wires with vertical stays spaced 6 inches apart. The top and bottom wires shall be 10 gage, and the intermediate wires and vertical stays shall be 12-1/2 gage. The mesh shall have a total width of 26 inches (Design No. 726-6-12-1/2). Galvanizing shall be Class 3. The zinc-coated wire as represented by the test specimens shall be capable of being wrapped in a close helix at a rate not exceeding 15 turns/minute around a cylindrical steel mandrel having a diameter the same as the specimen being tested, without cracking or flaking the zinc coating to such an extent that any zinc can be removed by rubbing with the bare fingers.

9-16.2(8) VERTICAL CINCH STAYS

Vertical cinch stays shall be 9-1/2 gage galvanized wire meeting the requirements of AASHTO M 279, except that the minimum weight of zinc coating shall be 0.3 ounce per square foot of uncoated wire surface.

9-16.2(9) WIRE GATES

Gate frames shall be constructed of galvanized standard weight pipe with a nominal diameter of not less than 1 inch. The pipe shall conform to the requirements of ASTM A 53. Wire gates shall be not less than 48 inches in height and shall be designed to fit openings of the widths called for in the Contract. Each gate shall be provided with two upright braces of the same material as the frame, spaced at 1/3 points in the gate. All gates shall be provided with adjustable 3/8 inch diameter diagonal truss rods from corner to corner.

The gate frame shall be provided with wire mesh conforming to the requirements specified in Section 9-16.2(7), except that it shall consist of 10 horizontal wires and have a total width of 47 inches (Design No. 1047-6-12-1/2).

Each gate shall be furnished complete with necessary hinges and latch designed for use with the type of gate posts used on the Project. The hinges shall be so designed as to be securely attached to the gate post and to enable the gate to be swung back against the fence.

Double gates shall be hinged in the same manner as single gates and shall be provided with an approved drop bar locking device.

9-16.2(10) MISCELLANEOUS

Bolts, nuts, and hinges used in the construction of fence and gates shall be galvanized in accordance with AASHTO M 232.

All concrete shall be Class 3000 in accordance with Section 6-02.3.

9-16.3 NON-WEATHERING STEEL BEAM GUARDRAIL**9-16.3(1) RAIL ELEMENT**

The W-beam or thrie beam rail elements, backup plates, reducer sections, and end sections shall conform to "A Guide to Standardized Highway Barrier Hardware" published by AASHTO, AGC, and ARTBA. All rail elements shall be formed from 12-gage steel except for thrie beam used for bridge rail retrofit and Design F end sections, that shall be formed from 10 gage steel.

The rail splices shall have a minimum total ultimate strength of 80,000 pounds at each joint.

The 6 inch channel rails and splice plates shall conform to ASTM A 36. All fabrication shall be complete before galvanizing.

The holes in the plate shall be slotted to facilitate erection and to permit expansion and contraction. The edges of the rail shall be rolled or rounded so they present no sharp edges. Where the rail is on a curve, the plates at the splice shall make contact throughout the area of splice. When the radius of curvature is less than 150 feet, the rail shall be shaped in the shop.

9-16.3(2) POSTS AND BLOCKS

Posts and blocks may be of ammoniacal copper arsenate (ACA), or ammoniacal copper zinc arsenate (ACZA), treated timber or galvanized steel; except only treated timber posts and blocks may be used for weathering steel beam guardrail. Blocks made from alternate materials that meet the NCHRP Report 350 criteria may be used in accordance with the manufacturer's recommendations. Except for terminal or anchor assemblies, all posts for any one project shall be of the same type (wood or steel). Posts and blocks shall be of the size and length shown in the Drawings and meet the requirements of these Specifications. Posts and blocks may be S4S or rough sawn.

Timber posts and blocks shall conform to the grade specified in Section 9-09.2, except pine lumber No. 1 grade may be used for the blocks. Timber posts and blocks shall be fabricated as specified in the Drawings before being treated. Timber posts and blocks shall be treated by the empty cell process to provide a minimum retention, depending on the treatment used, according to the following:

- ACA 0.50 lbs. pcf.
- ACZA 0.50 lbs. pcf.

Treatment shall be in accordance with Section 9-09.3.

Steel posts, blocks, and base plates, where used, shall conform to either ASTM A 36 or ASTM A 992, and shall be galvanized in accordance with AASHTO M 111. Welding shall conform to Section 6-03.3(25). All fabrication shall be completed prior to galvanizing.

9-16.3(3) GALVANIZING

Beam rail elements and terminal sections shall be galvanized in accordance with AASHTO M 180, Class A, Type 2, except that the rail shall be galvanized after fabrication, with fabrication to include forming, cutting, shearing, punching, drilling, bending, welding, and riveting. In addition, the minimum average weight of zinc coating shall be 2 ounces per square foot of surface (not sheet), the average to be determined on the basis of three individual tests, no one of which may be less than 1.8 ounces per square foot of surface (not sheet). The aluminum content of the zinc bath during actual galvanizing operations shall not exceed 0.01 percent. Channel rails, splice plates, WF steel posts, and base plates shall be galvanized in accordance with ASTM A 123. Anchor cables shall be galvanized in accordance with Federal Specification RR-W-410, Table II, galvanized at finished size. Bolts, nuts, washers, plates, rods, and other hardware shall be galvanized in accordance with ASTM A 153.

9-16.3(4) HARDWARE

Bolts, unless otherwise specified in other Standard Specifications or in the Standard Plans, shall comply with ASTM A 307, Grade A specifications. High strength bolts shall conform to the requirements of AASHTO M 164. Nuts shall comply with ASTM A 563, Grade A specifications. Washers, unless otherwise specified in other Standard Specifications or in the Standard Plans, shall meet ASTM F 844 specifications. The Contractor shall submit a Manufacturer's Certificate of Compliance for the bolts, nuts, and washers prior to installing any of the hardware.

9-16.3(5) ANCHORS

Welding shall conform to Section 6-03.3(25).

All welding shall be at least equal in strength to the parent metal.

All fabrication shall be complete and ready for assembly before galvanizing. No punching, drilling, cutting, or welding will be permitted after galvanizing unless authorized by the Engineer.

Foundation tubes shall be fabricated from steel conforming to the requirements of ASTM A 500, Grade B, or ASTM A 501.

The anchor plate assembly shall develop a minimum tensile strength of 40,000 pounds.

The anchor plate, W200 x 27 and metal plates shall be fabricated of steel conforming to the specifications of ASTM A 36.

Anchor cable shall be ¾-inch preformed, 6 x 19 wire strand core or independent wire rope core (IWRC), galvanized, right regular lay manufactured of improved plow steel with a minimum breaking strength of 42,800 pounds. Two certified copies of mill test reports of the cable used shall be furnished to the Engineer.

Swaged cable fittings shall develop 100 percent of the specified breaking strength of the cable. One swaged fitting attached to 3 feet of cable shall be furnished to the Engineer for testing.

The swaged fitting and stud assembly shall be of steel conforming to the requirements of American Iron and Steel Institute C-1035 and shall be annealed and galvanized suitable for cold swaging.

Welded wire fabric for Type 1 anchor shall conform to ASTM A 185.

All metal components of the anchor and cable assembly and not less than the top 14 inches of the W8 x 17 for the Type 2 anchor shall be hot-dip galvanized in accordance with Section 9-16.3(3).

Cement concrete, of the class specified, shall conform to the applicable requirements of Section 6-02.3.

Cement grout shall consist of one part Portland cement and two parts sand.

9-16.3(6) INSPECTION AND ACCEPTANCE

The Contractor shall give at least 3 Working Days advance notice to the Engineer before the rail elements are fabricated in order that inspections may be provided. The Contractor shall arrange for all facilities necessary for the inspection of material and workmanship at the point of fabrication of the rail element, and Inspectors shall be allowed free access to necessary parts of the premises.

The Inspector shall have the authority to reject materials or workmanship which do not fulfill the requirements of these Specifications. In cases of dispute, the Contractor may appeal to the Engineer, whose decision will be final.

The Inspector may accept a mill test report certifying that the steel used in fabricating the rail element meets the requirements of the Specifications. The Owner reserves the right, however, to require the Contractor to furnish samples of the steel proposed for use and to determine to its satisfaction that the steel meets the Specification requirements. Steel rail elements, fittings, terminal section hardware, and bolts may be accepted by the Engineer based on the Manufacturer's Certification of Compliance.

9-16.4 WIRE MESH SLOPE PROTECTION**9-16.4(1) GENERAL**

All metal material used in the construction of wire mesh slope protection shall be new and galvanized. Imperfectly galvanized material or material upon which serious abrasion of galvanizing occurs will not be acceptable.

9-16.4(2) WIRE MESH

The galvanized wire mesh shall consist of No. 9 gage (0.148 inch diameter) commercial quality zinc coated steel wire, 3-1/2 inches x 5-1/2 inches diamond mesh chain link conforming to the requirements of AASHTO M 181. Galvanizing shall conform to the requirements of ASTM A 392 except the weight of zinc coating shall be 0.80 ounce per square foot minimum, of uncoated wire surface. Galvanizing shall be done before weaving.

The wire mesh fabric shall have knuckled selvages.

Alternate wire mesh for slope protection shall be double twisted mesh. The mesh shall be of nonraveling construction and consist of a uniform double twisted hexagonal mesh of hot-dip galvanized steel wire having a diameter of 0.120 inch after galvanization. The wire shall be galvanized prior to weaving into the mesh and shall conform to ASTM A 641, Class 3, Finish 5, Soft temper. The minimum tensile strength shall be 60,000 psi when tested in accordance with ASTM A 370. Openings shall be hexagonal in shape and uniform in size measuring not more than 3-1/4 inches by 4 ½ inches, approximately 9 square inches. Lacing wire shall be the same specifications as the wire used in the wire mesh except that its diameter shall be 0.0866 inch after galvanization.

Edges shall be mechanically selvaged in such a manner as to prevent unraveling, and shall develop the full strength of the mesh. The wire used for the selvage shall have a nominal diameter of 0.1535 inch.

9-16.4(3) WIRE ROPE

Wire rope shall be 5/8 inch diameter zinc coated steel structural wire rope conforming to the requirements of ASTM A 603, Class A.

9-16.4(4) HARDWARE

All rings shall be drop-forged steel, heat treated after forging. Lightweight wire rope thimbles weighing approximately 13.8 pounds per hundred shall be used with the 1/2-inch diameter wire rope. Wire rope clips may be drop-forged steel or cast steel for use with 1/2-inch wire rope. All rings, thimbles, wire rope clips, and U-bolts shall be galvanized in accordance with AASHTO M 232, Class C, except castings shall be Class A, and forgings shall be Class B.

9-16.4(5) HOG RINGS AND TIE WIRE

Hog ring fasteners and tie wire shall be manufactured of 9 gauge steel wire meeting federal specification QQ-W-461 (AISI numbers 1010 and 1015) finish 5; medium hardness and tensile strength; Class 3 coating.

9-16.4(6) GROUT

When required, grout for anchors shall consist of one part Portland cement and three parts of clean sand. The Portland cement shall conform to the requirements of Section 9-01.2(1).

9-16.4(7) ANCHOR RODS

Anchor rods shall be of good quality steel. The eye may be drop forged or formed with a full penetration weld and shall develop 100 percent of the rod strength. The anchor rod shall be galvanized in accordance with ASTM A 153.

9-16.5 RESERVED

9-16.6 GLARE SCREEN

9-16.6(1) GENERAL

All material used in the construction of the fence shall be new. Iron or steel material shall be galvanized or aluminum coated as specified. Imperfectly galvanized or aluminum coated material, or material upon which serious abrasions of galvanizing or aluminum coating occur, will not be acceptable.

9-16.6(2) GLARE SCREEN FABRIC

Glare screen fabric shall consist of diamond woven wire mesh. The fabric wire may be 0.148 inch diameter aluminum alloy complying with the Aluminum Association requirements for alloy 6061T94, or it may be 0.148 inch diameter (9 gage) iron or steel wire which shall meet all of the requirements of ASTM A 392 galvanized or A 491 for aluminum coated, except that galvanizing of Type 2 glare screen fabric shall be not less than 0.8 ounce per square foot and shall be done before weaving. Aluminum coating shall be Class II.

Type 1 glare screen mesh size shall be approximately a 1 inch diamond. Type 2 glare screen mesh size shall be a maximum of 3-1/2 inch vertical and 5-1/2 inch horizontal. The design shall permit the slats to be installed in a vertical position as shown in WSDOT Standard Plans without distortion of the slats.

9-16.6(3) POSTS

Line posts for Type 1 glare screen shall be 1.5 inches by 1.875 inches hot-dip galvanized steel H column with a minimum weight of 2.8 pounds per linear foot. Line posts for Type 2 glare screen shall be 1.95 inches by 2.25 inches hot-dip galvanized steel H column with a minimum weight of 4.0 pounds per linear foot, or 2 inch inside diameter hot-dip galvanized steel pipe with a nominal weight of 3.65 pounds per linear foot provided only one type shall be used on any one Project.

End, corner, brace, and pull posts shall be 2 inch inside diameter hot-dip galvanized steel pipe with nominal weight of 3.65 pounds per linear foot. Intermediate pull posts (braced line posts) shall be H column as specified for line posts. Brace post sleeves shall be 2-1/2 inch inside diameter hot-dip galvanized steel pipe with nominal weight of 5.79 pounds per linear foot.

The base material for the manufacture of steel pipes used for posts shall conform to the requirements of ASTM A 53, except the weight tolerance on tubular posts shall be applied as follows. The base material for the manufacture of steel H columns shall meet the requirements of ASTM A 675.

Posts provided for glare screen will have an acceptance tolerance on the weight per linear foot, as specified, equal to plus or minus 5 percent for tubular and H-section posts. This tolerance applies to each individual post.

All posts, braces, and top rails shall be hot-dip galvanized. They shall have a minimum average of 1.8 ounces zinc coating per square foot of surface area with no individual test being below 1.6 ounces zinc coating per square foot of surface area. In the case of members made from pipe, this area is defined as the total area inside and outside. A sample for computing the average of weight of coating is defined as a 12 inch piece cut from each end of the galvanized member.

9-16.6(4) TENSION WIRE

Top and bottom tension wire shall be 7 gage coil spring steel wire of good commercial quality and shall have a zinc coating averaging 0.8 ounces per square foot of surface area.

9-16.6(5) CABLE

The tension cable shall be 1/4 inch diameter aluminum coated or hot-dip galvanized, 7 wire strand steel cable conforming to the requirements of ASTM A 474 for aluminum coated or ASTM A 475 for galvanized, High-Strength Grade. Galvanizing shall be Class A.

9-16.6(6) CABLE AND TENSION WIRE ATTACHMENTS

All tension wire and cable attachments shall be hot-dip galvanized steel conforming to the requirements of AASHTO M 232 unless otherwise specified in the Contract. Eye bolts shall have either a shoulder or a back-up nut on the eye end and be provided with an eye nut where needed or standard hex nut and lock washer and be 5/8 inch diameter for tension cable and 3/8 inch diameter for tension wire and of sufficient length to fasten to the type of posts used. Where the eye bolt is to be installed through a pipe section, two lead washers and one steel washer shall also be provided. Turnbuckles shall be of the shackle end type, 1/2 inch diameter, with standard takeup of 6 inches and provided with 3/8 inch diameter pins. Thimbles shall be light weight wire rope thimbles for use with 1/4 inch diameter cable. Wire rope clips shall have a U-bolt diameter of 5/16 inch for use with 1/4 inch diameter cable. Anchor shackles shall be 3/8 inch diameter with a minimum distance between eyes of 1-1/16 inch and a pin diameter of 7/16 inch. Seizing shall be 0.032 inch diameter galvanized annealed iron wire.

9-16.6(7) SLATS**9-16.6(7)A WOOD SLATS**

Wood slats shall be 3/8 inch by 2-3/8 inch by the height designation of the fence. Material shall be finished and treated cedar or redwood and shall be free from loose knots, cracks, and other imperfections. A dimensional tolerance of $\pm 1/16$ inch in width or thickness is allowed provided that the maximum space between slats does not exceed 3/4 inch.

9-16.6(7)B PLASTIC SLATS

Plastic slats shall be 3/8 inch by 2-3/8 inch by the height designation of the fence. They shall be manufactured from tubular polyethylene color pigmented material consisting of high density virgin polyethylene and color pigments, designed to retard ultraviolet penetration. The material shall have a minimum wall thickness of 0.0030 inch \pm 0.0003 inch and shall remain flexible without distortion and without becoming brittle through a temperature range of -70°F to + 250°F. Tensile strength shall be at least 3600 psi and the melt index shall not exceed 0.25.

Plastic slats shall be retained in place by means of U-shaped retainer members at the bottom and top of the fence. Retainer members shall be of the same material as the slats.

The color for plastic slats will be approved by the Engineer from samples submitted by the Contractor.

9-16.6(8) FITTINGS

Fittings shall be malleable cast iron or pressed steel and galvanized in accordance with the requirements of AASHTO M 232.

Fittings for any particular fence shall be those furnished by the manufacturer of the fence.

9-16.6(9) FABRIC BANDS AND STRETCHER BARS

Fabric bands shall be 1/8 inch by 1 inch nominal and stretcher bars 3/16 inch by 3/4 inch nominal. Nominal shall be construed to be the area of the cross-section of the shape obtained by multiplying the specified width by thickness. A variation of minus 5 percent from this theoretical area shall be construed as "nominal" size. Both shall be hot-dip galvanized to meet the requirements of ASTM F 626.

9-16.6(10) TIE WIRE

Tie wire shall be 9 gage aluminum wire complying with the ASTM B 211 for alloy 1100 H14 or 9 gage galvanized wire meeting the requirements of AASHTO M 279. Galvanizing shall be Class 1.

9-16.7 RESERVED**9-16.8 WEATHERING STEEL BEAM GUARDRAIL****9-16.8(1) RAIL AND HARDWARE**

Steel for rail elements and terminal sections shall conform to ASTM A 606 or ASTM A 607. Bolts, nuts, and washers for installation of the weathering steel shall be manufactured from steel conforming to ASTM A 242M and shall not be galvanized. If required, 6 inch channels and fittings shall conform to ASTM A 242. In addition, all steel for the guardrail components shall conform to one of the following chemical compositions, percent (ladle):

Composition

	C	Mn	P	S	Si	Cu	Cr	Ni	Zr
No. 1	0.12 Max.	0.20 to 0.50	0.07 to 0.15	0.05 Max.	0.25 to 0.75	0.25 to 0.55	0.30 to 1.25	0.65 Max.	-----
No. 2	0.12 Max.	0.50 to 1.00	0.12 Max.	0.05 Max.	0.20 to 0.90	0.50 Max.	0.40 to 1.00	1.00 Max.	0.10 Max.

Blast cleaning or pickling to remove mill scale will not be required. All fabricated steel parts shall be handled with care to avoid gouges, scratches, and dents. The steel shall be kept clean of all foreign material, such as paint, grease, oil,

chalk marks, crayon marks, concrete spatter, or other deleterious substances. Natural oxidation of the steel will not be considered foreign material. Storage in transit, in open cars and trucks, for an extended period will not be permitted. Steel parts stored outside in yards or at Job Sites shall be positioned to allow free drainage and air circulation.

9-16.8(2) ANCHORS

Guardrail anchors may either be furnished as provided in Section 9-16.3(5) or they may be nongalvanized and fabricated from steel conforming to ASTM A 242 with the exception that all Type 1 anchors shall have galvanized cable and fittings as specified in Section 9-16.3(5).

9-16.8(3) POSTS AND BLOCKS

Posts and blocks for weathering steel beam guardrail shall comply with the requirements of Section 9-16.3(2).

SECTION 9-17 FLEXIBLE GUIDE POSTS

9-17.1 GENERAL

See Section 8-10 for flexible delineator posts.

Flexible guide posts shall be made of a flexible, nonwarping, nonmetallic, durable plastic material; shall be resistant to damage due to impact, ultraviolet light, ozone, hydrocarbons, and other effects of atmospheric weathering; shall resist stiffening with age; and shall be designed for a minimum life equaling 60 months of outdoor service.

The post system shall be designed for permanent installation to resist overturning, twisting, and displacement from wind and impact forces.

Each flexible guide post shall be permanently identified with the manufacturer's name, the month and year of fabrication and a mark indicating the recommended burial depth. The letters shall be solvent resistant, a minimum of 1/4 inch in height, and permanently affixed to the post unless otherwise specified in the Contract, the color of the guide post shall be white or brown as indicated on the Drawings. Guide post length shall be in accordance with Section 8-10.3.

The reflective panel on a flat or elliptical guide post shall have a minimum width of 3 inches facing traffic. The reflective sheeting shall have a minimum area of 24 square inches (3 inches by 8 inches). The reflective panel on a round guide post shall have a 9 inch minimum band of reflective sheeting visible for 360 degrees.

9-17.2 LABORATORY TESTS

Ten guide posts of each model shall be conditioned in an oven for two hours at $120^{\circ}\text{F} \pm 3\text{F}^{\circ}$. After conditioning, the guide post shall be bent backwards at 90 degrees from the vertical to simulate a field impact. The guide post shall, without cracking, recover to within 10 degrees of its original position within five minutes. Color shall remain unchanged. Any appreciable change in color, cracking on more than one face, or not returning to within 10 degrees of vertical, is considered a failure. At least 70 percent of the posts must pass to be considered for preapproval.

The same ten guide posts tested for heat resistance shall be tested for cold resistance. The guide posts shall be conditioned for 24 hours at $-20^{\circ}\text{F}, \pm 3\text{F}^{\circ}$, then subjected to the same testing as for heat resistance. The guide posts shall conform to the same cracking, color, and recovery standards as for heat resistance. At least 70 percent of the posts must pass to be considered for preapproval.

Three guide posts of each model shall be subjected to deflection testing. The guide posts shall be fixed near the base in such a way that 4 feet of the post is cantilevered. The guide posts shall then be loaded 1/2 inch from the free end until collapse is observed. (Collapse is defined as the point at which the guide post can no longer resist any further loading.) The stress at collapse shall be calculated as follows:

$$P = K(Q/b)$$

Where:

- P is the equivalent stress in pounds per square foot.
- Q is the load at collapse in pounds.
- b is the post width (diameter of major axis) in inches.
- K is constant equal to 6 inches per square foot.

The value of P shall be no less than 3.43 pounds per square foot for round guide posts and 5.30 pounds per square foot for flat or elliptical guide posts. Any load below these values or cracking of more than one face, of any of the guide posts is considered a failure.

The three guide posts subjected to deflection testing shall be subjected to cyclic loading with an amplitude of 2 inches at the tip, with a cycle testing machine. Each guide post shall be cycled 30,000 times at 60 cycles per minute. When the cyclic tests are completed, the three guide posts shall again be subjected to deflection testing. The average load of the posts after cyclic loading shall be a minimum of 80 percent of the average load of the posts tested before cyclic loading. A value below this limit is considered a failure.

Three guide posts of each model shall be subjected to a 5.5-pound deflection test. The guide posts shall be fixed near the base in such a way that 4 feet of the post is cantilevered. The guide post shall then be loaded 1/2 inch from the free end with a 5.5-pound weight. A deflection greater than 29 inches is considered a failure.

A 9 inch specimen from the unreflectorized portion of each of three guide posts shall be prepared. The specimens shall be cycled at 1000 hours in a weatherometer in accordance with ASTM G 53 (3 hr. 60C UV, 3 hr. 50C CON). The

specimens shall show no signs of delamination, distress, or discoloration. Physical properties of tensile strength and rigidity shall be maintained within 80 percent of the unconditioned values.

9-17.3 FIELD TESTS

Ten guide posts of each model, supplied in accordance with Section 9-17.4, shall be installed by the manufacturer's representative at the SPU Materials Laboratory designated test site. Anchoring Materials shall be driven such that the anchor is flush with, or below, the ground level. The test temperature shall be at or below 50°F.

The ten guide posts shall be struck seven times at 35 mph, then two times at 55 mph, by a car or equivalent hood and bumper device with an 18 inch height. After each impact, the delineators shall be inspected for the following criteria:

1. A minimum of 50 percent of the reflective sheeting shall be retained undamaged. An area of damage greater than 50 percent is considered a failure.
2. If the guide post leans more than 10 degrees from vertical it is considered a failure.
3. Any cracking, other than surface cracking evident on only one face of the post, is considered a failure.
4. Pullout in excess of 3 inches is considered a failure.

If an individual guide post fails any one of the above criteria in the 35 mph series of impacts, the product is unacceptable. At least 70 percent of the guide posts must pass each criteria in the 55 mph series of impacts to be acceptable.

9-17.4 APPROVAL

The Contractor shall submit a Manufacturer's Certificate of Compliance stating all materials meet or exceed Contract requirements. See Section 1-06.3.

SECTION 9-18 PRECAST TRAFFIC CURB AND BLOCK TRAFFIC CURB

9-18.1 PRECAST TRAFFIC CURB

9-18.1(1) AGGREGATES AND PROPORTIONING

The cement, fine and coarse aggregate, and reinforcing steel to be used in the manufacture of precast concrete traffic curb shall meet the following requirements and be submitted to the SPU Materials Laboratory for approval:

1. Aggregates shall conform to the requirements of Section 9-03 except that they shall be uniformly graded up to a maximum size of 3/8 inch and shall contain sufficient fine fractions to permit securing the type of surface finish specified herein. The aggregate shall be approved by the SPU Materials Laboratory before it is used.
2. Reinforcing steel shall conform to the requirements of Section 9-07.
3. The cement concrete mix shall be composed of not less than 1 part Portland cement to approximately 2 parts of fine concrete aggregate and 3-1/4 parts of coarse concrete aggregate adjusted to secure proper workability. The Contractor will be allowed to use a different concrete mix if approved by the Engineer, provided that it develops not less than 4,000 psi compressive strength when tested at the age of 28 Days.

9-18.1(2) MIXING

The mixers shall be kept in good repair and shall be equipped with an automatic timing device, and a positive device for regulating the quantity of water added to each batch. The latter device must be approved by the Engineer before use.

After all Materials, including water, have been placed in the mixer, the Materials shall be mixed for a period of not less than 1-3/4 minutes, or as long as necessary to produce a uniform concrete mix. No water shall be added to any batch after completion of the mixing period. Each batch of concrete shall be completely emptied from the mixer before placing more Materials in it. A batch which has not been placed within 30 minutes from the time water was first added shall not be used.

The amount of water in the concrete shall be kept to a minimum, consistent with the manufacture of a dense mix, free from air bubbles and surface defects in excess of the tolerance limits specified.

9-18.1(3) FORMS

Forms for precast traffic curbs shall be steel or special concrete mold. The use of forms or molds made of plaster of paris, wood, or other absorptive Material will not be permitted.

Bulkheads shall be tight fitting so that there is no leakage of mortar between the bulkhead and form.

The Materials and methods used for lubricating the forms shall be such that they do not result in discoloration of the curb at any time. A minimum quantity of lubricant shall be used and all excess lubricant shall be removed.

9-18.1(4) PLACING CONCRETE

The concrete shall be consolidated by external vibration, or by other means if approved by the Engineer, to produce a dense concrete throughout, having a minimum of air bubbles and honeycombing.

Reinforcing steel shall be placed and maintained in its proper position as shown in the Standard Plans.

Curb or buttons shall not be manufactured in an atmospheric temperature of less than 50°F.

9-18.1(5) REMOVAL OF FORMS

The curb shall be removed from the molds or forms with instructions, or by some other identified method, acceptable to the Engineer.

The loosening of the curb from the molds shall be carefully performed to avoid excessive shock and straining of the curb. When, in the opinion of the Engineer, undue shock is required to remove the curb from the molds, the stripping operation shall be deferred until such time as the curb may be removed without breakage.

9-18.1(6) CURING CONCRETE

Immediately after the concrete has been placed and consolidated in the mold, each unit shall be placed in a curing room fitted with water sprays and maintained at a relative humidity of not less than 90 percent and a temperature of not less than 60°F, nor more than 100°F. Each unit shall remain in the curing room for a period of not less than 10 Days, except that if Type III cement is used, the period in the curing room may be reduced to 5 Days.

9-18.1(7) FINISH

The curb shall have a smooth, glassy finish on all exposed surfaces.

Excess honeycombing in the back of the curb may be cause for rejection of the curb. Honeycombing areas in the back of the curb which, in the opinion of the Engineer, are not detrimental to the curb need not be patched. The workmanship of the bottom finish shall be such that no mechanical interlocking of the mortar bed and the curb bottom or anchor groove occurs.

9-18.1(8) SURFACE TREATMENT

As soon as the units have been taken out of the curing room and thoroughly surface dried to a depth of at least 1/4 inch, two coats of a water-repellent compound, meeting the requirements of Section 9-18.4, shall be brush applied. When the first coat has dried, the second coat of water-repellent compound shall be applied.

9-18.1(9) DIMENSIONS AND SHAPE

The curb shall conform to the dimensions and shape shown on the Standard Plans within a tolerance of 1/4 inch in length and 1/8 inch in alignment.

9-18.1(10) CURB LENGTHS AND ANCHOR HOLES

413a and 413b curb shall be made in 3'-0" maximum length sections. Circular curbing shall be made only for such radii as called for in the details on the Drawings.

Each 413b curb section shall have two (2) one (1) inch diameter holes as shown in Standard Plan no. 413a.

9-18.1(11) DEFECTIVE CURB

Not more than 2 percent of the top area in any one piece of curb shall be defective, and not more than 5 percent of the total length of the top corners of reflecting faces in any one piece of curb shall be broken or rounded. There shall be not more than 30 air holes in any linear foot of curb, nor more than 50 air holes in any 3 linear feet of curb. All curb having defects in excess of any of the listed defects in this Section will be considered defective in accordance with Section 1-05.7. Failure to reject such curb at the time of form removal may be waived if and only if 90 percent of the curb laid has less than 10 percent of the maximum allowable number of each type defect specified in this paragraph; however, all defects shall be immediately repaired. The Contractor agrees that its refusal to repair defects is grounds for the Engineer to declare the curb defective.

An air hole shall be defined as any hole 1/8 inch or larger in diameter or depth.

The sum of the length of the lines of discoloration caused by a cracked mold in any one piece of curb shall not exceed 50 percent of the length of the curb, and the maximum length of any single line of discoloration shall not exceed 18 inches. 75 percent of the curb laid shall be entirely free from lines of discoloration. The employment of heat to obliterate lines of discoloration will not be permitted. The process used to obliterate lines of discoloration shall be subject to the approval of the Engineer.

The repairing of molds which are chipped or broken shall be done in a manner that the broken or chipped areas are not apparent on the curb made in those molds.

All curb in which surface checking develops during the first five Days after manufacture will be rejected.

Hidden air holes at or immediately below the exposed surface of the curb which are in excess of the limits specified and are disclosed by testing the surface by means of a rubber hammer, will be considered defective in accordance with Section 1-05.7.

All curb in which cracking is in evidence immediately after removal from the molds will be considered defective. A crack is defined as any continuous separation of the concrete greater than 3 inches in length.

All curb which varies in dimensions, alignment, or surface contour in excess of the tolerance specified will be considered defective.

9-18.1(12) REPAIRING CURB

Curb having defects which are not sufficient cause for its rejection shall be neatly repaired immediately after removal from the molds in a manner subject to the approval of the Engineer. However, no patching or other repairs shall be made without the permission of the Engineer. Patches shall be undercut if, in the opinion of the Engineer, this operation is necessary to achieve an acceptable patch.

All holes larger than 1/16 inch diameter in the exposed surface of acceptable curb or buttons shall be filled with cement mortar.

9-18.1(13) IDENTIFICATION MARKING

The date of manufacture, the length, and identification number corresponding to the detail layout shall be marked in black paint on the back or end of each piece of curb.

Rejected curb shall be marked on the back or end surfaces in a practical and semi-permanent manner to identify each cause of rejection.

9-18.1(14) SHIPPING

No unit of curb shall be shipped from the manufacturing plant prior to 21 Days after manufacture, except that if Type III cement has been used, the units may be shipped 14 Days after manufacture.

9-18.1(15) SAMPLING AND INSPECTION

The Contractor shall submit, for the approval of the Engineer, an advance sample of curb which shall be at least equivalent in color, surface texture, and bottom finish to the standard as set forth in these Specifications. No repairing of any kind shall be done on the advance sample. Upon approval, the advance sample shall be stored at the plant or site of manufacture in a location readily accessible to the Inspector where there is adequate daylight for examination. The advance sample shall be protected from damage and discoloration and shall be used as a standard of comparison for color, surface texture, and bottom finish for all curb manufactured. All curb furnished shall be equivalent in the foregoing respects.

The inspection at the plant will be made just prior to shipment, at which time examination will be made of the alignment, contour, color, cracks, surface damage or discoloration, broken corners or edges, and any other defects which may have developed, and to check the laboratory test reports for strength. However, intermediate inspections may be made to determine surface checking and hidden air holes if it is impractical to examine for these defects at the final inspection.

9-18.2 RESERVED**9-18.3 BLOCK TRAFFIC CURB**

Block traffic curb shall be as shown on Standard Plan no. 413b.

The curb units shall be made from Portland cement and high quality sand and gravel, the proportions of which shall be left to the discretion of the producer as long as the unit develops a minimum compressive strength of 1,600 psi at 28 Days when tested for end loading.

The proportions of sand, gravel, and cement, the type of forms used, and the method of compacting the concrete in the forms shall all be such that as dense, smooth, and uniform a surface as is practicable for a concrete masonry unit is obtained on the finished curb units. The faces that are to be exposed shall be free from chips, air holes, honeycomb, or other imperfections, and cracks shall be tight, with the following exceptions: not more than 5 percent of each curb unit contains cracks, contains small chips which are not larger than 1/4 inch in any dimension, and air holes which are not larger than 1/4 inch in diameter or depth. The units used in any contiguous line of curb shall have approximately the same color and surface characteristics.

9-18.4 WATER-REPELLENT COMPOUND

The water-repellent compound shall be a clear, penetrating type, silicone resin base compound containing no filler or other Material which leaves a film on the surface of the masonry after it is applied, and bonds securely to the masonry. It shall be of such consistency that it can be applied readily by brush or spray to the masonry at atmospheric temperature down to minus 20°F.

The average absorption of three test specimens treated with the water-repellent compound, when tested in accordance with the methods used in the Laboratory shall not exceed 2 percent after being partially immersed in water for 72 hours immediately after curing.

The average moisture vapor transpiration (breathing) of three test specimens, when tested in accordance with the methods used in the Laboratory, shall be not less than 50 percent at seven Days.

The water-repellent compound shall be approved by the Laboratory before it is used.

9-18.5 SODIUM METASILICATE

Sodium metasilicate shall comply with ASTM D 537.

SECTION 9-19 PRESTRESSED CONCRETE GIRDERS**9-19.1 CONCRETE AGGREGATES AND PROPORTIONING**

The concrete for prestressed girders shall have the minimum compressive strengths as specified on the Drawings. Aggregates used in the mix shall conform to the following:

1. Coarse aggregate shall be in accordance with Section 9-03.1(3).
2. Fine aggregate shall be in accordance with Section 9-03.1(2), Class 1 or Class 2.
3. The manufacturer may revise the grading of the coarse aggregate provided that the concrete mix design is qualified with the modified gradation. An alternative combined gradation conforming to Section 9-03.1(4) may also be used.

The Contractor shall submit for review a proposed mix design for each design strength. Included shall be evidence acceptable to the Engineer that the proposed mix design meets design requirements. The mix design review will not preclude any requirements for the concrete placed in the girders.

The concrete mix shall be prepared and placed in accordance with the appropriate sections of Section 6-02.

Water used in mixing the concrete shall conform to the requirements of Section 9-25.1.

Portland cement and hydraulic cement shall conform to the requirements of Section 9-01.

Chemical admixtures and pozzolans shall conform to the provisions of Section 9-23.6.

The total chloride ion (C1-) content of the mixed concrete, expressed as a percent by mass of cement, shall not exceed 0.06 percent.

9-19.2 REINFORCEMENT

Reinforcement shall meet the requirements of Section 9-07 and shall be placed in accordance with the requirements of Section 6-02.3(24).

SECTION 9-20 CONCRETE PATCHING MATERIAL, GROUT AND MORTAR FOR STRUCTURES

9-20.1 PATCHING MATERIAL

Concrete patching material will be prepackaged mortar extended with aggregate. The amount of aggregate for extension shall conform to the manufacturer's recommendation.

9-20.2 SPECIFICATIONS

Patching mortar and patching mortar extended with aggregate shall contain cementitious material and meet the requirements of Sections 9-20.2(1) and 9-20.2(2). The Manufacturer shall use the services of an independent laboratory that has an equipment calibration verification system and a technician training and evaluation process per AASHTO R-18 to perform all tests specified in Section 9-20.

9-20.2(1) PATCHING MORTAR

Patching mortar shall conform to the following requirements:

	ASTM TEST METHOD	SPECIFICATION
COMPRESSIVE STRENGTH		
at 3 hours	C 39	Minimum 3,000 psi
at 24 hours	C 39	Minimum 5,000 psi
LENGTH CHANGE		
at 28 Days	C 157	0.15 percent maximum
Total Chloride Ion Content	C 1218	1 lb/yd ³ maximum
BOND STRENGTH		
at 24 hours	C 882 (As modified by C 928, Section 8.5)	Minimum 1,000 psi
Scaling Resistance (at 25 cycles of freezing and thawing)	C 672 (As modified by C 928, Section 8.4)	1 lb/ft ² maximum

9-20.2(2) PATCHING MORTAR EXTENDED WITH AGGREGATE

Patching mortar extended with aggregate shall meet the following requirements:

	ASTM TEST METHOD	SPECIFICATION
COMPRESSIVE STRENGTH		
at 3 hours	C 39	Minimum 3,000 psi
at 24 hours	C 39	Minimum 5,000 psi
LENGTH CHANGE		
at 28Days	C 157	0.15 percent maximum
BOND STRENGTH		

at 24 hours	C 882 (As modified by ASTM C 928, Section 8.5)	Minimum 1,000 psi
Scaling Resistance (at 25 cycles of freezing and thawing)	C 672	2 Maximum Visual Rating
Freeze thaw	C 666	Maximum expansion 0.10% Minimum durability 90.0%

9-20.2(3) AGGREGATE

Aggregate used to extend the patching mortar shall meet the requirements of Section 9-03.1(3) and be AASHTO Grading No. 8. A Manufacturers Certificate of Compliance shall be required showing the aggregate source and the gradation.

9-20.2(4) WATER

Water shall meet the requirements of Section 9-25.1. The quantity of water shall be within the limits recommended by the manufacturer

9-20.3 GROUT

Grout is a mixture of Portland or blended hydraulic cement and water with or without aggregates and with or without admixtures. Grout may also contain pozzolans and/or concrete admixtures. Grout may be a Contractor's submitted mix design or a Manufacturer's prepackaged grout product.

All prepackaged grouts shall be used in accordance with the manufacturer's recommendations, including but not limited to, shelf life, mixing, surface preparation, and curing.

Where required, all 2-inch cube specimens fabricated in the field shall be made in accordance with WSDOT TM-813. All 2-inch cube specimens fabricated in a laboratory shall be made in accordance with AASHTO T-106. All 2-inch cube specimens shall be tested in accordance with AASHTO T-106.

When coarse aggregate is used, specimens shall be fabricated in accordance with AASHTO T-23 and tested in accordance with AASHTO T-22.

9-20.3(1) GROUT TYPE 1 FOR POST-TENSIONING APPLICATIONS

Grout Type 1 shall be a Class C prepackaged, pumpable, nonbleed, nonshrink, and high-strength material conforming to the requirements of AASHTO LRFD Bridge Construction Specifications, Section 10.9.3. The water/cement ratio shall not exceed 0.45.

9-20.3(2) GROUT TYPE 2 FOR NONSHRINK APPLICATIONS

Grout Type 2 shall be a nonshrink, prepackaged material meeting the requirements of ASTM C-1107. The minimum compressive strength shall be 4000-psi at 7-Days.

9-20.3(3) GROUT TYPE 3 FOR UNCONFINED BEARING PAD APPLICATIONS

Grout Type 3 shall be a prepackaged material meeting the requirements of ASTM C 928 – Table 1, R2 concrete or mortar.

9-20.3(4) GROUT TYPE 4 FOR MULTIPURPOSE APPLICATIONS

Grout Type 4 shall be a multipurpose grout material for structural and nonstructural applications. The grout shall be produced using Portland Cement Type I/II. The water to cementitious material ratio shall not exceed 0.45 and water-reducing admixtures may be used. Multipurpose grout may be extended up to three parts fine aggregate to one part cement. The minimum compressive strength shall be 4000-psi at 7-Days. Substitution of fly ash for cement is allowed up to 20-percent.

9-20.4 MORTAR

Mortar shall be material made from Portland or blended hydraulic cement, water, and fine aggregate.

9-20.4(1) FINE AGGREGATE FOR MORTAR

Fine Aggregate for mortar shall conform to the requirements of ASTM C 144.

9-20.4(2) MORTAR TYPE 1 FOR CONCRETE SURFACE FINISH

Mortar Type 1 for concrete surface finishing shall be either prepackaged or a Contractor-recommended blend of Portland Cement Type I/II and fine aggregate conforming to Section 9-20.4(1). If the Class 1 concrete surface finishing mortar is a Contractor-recommended blend, it shall conform to the sand-to-cement ratios specified in Section 6-02.3(14)A.

9-20.4(3) MORTAR TYPE 2 FOR MASONRY APPLICATIONS

Mortar Type 2 for masonry shall be either prepackaged or a Contractor-recommended blend of Portland Cement Type I/II and fine aggregate conforming to 9-20.4(1).

9-20.4(4) MORTAR TYPE 3 FOR CONCRETE REPAIR

Mortar Type 3 shall be a prepackaged material that does not include expansive admixtures. Aggregate extension and mixing procedures shall be in accordance with the manufacturer's recommendation. The minimum compressive strength shall be 4000-psi at 7-Days.

SECTION 9-21 PLASTIC TRAFFIC BUTTONS AND LANE MARKERS**9-21.1 PLASTIC TRAFFIC BUTTON AND LANE MARKER TYPE 1****9-21.1(1) GENERAL**

Plastic Traffic Button and Lane Marker Type 1 shall be composed of thermosetting resins, pigments and inert ingredients and shall be of uniform composition throughout. The color shall be yellow or white to correspond to the delineation line color.

9-21.1(2) PHYSICAL AND CHEMICAL PROPERTIES

The traffic buttons and lane markers shall be of uniform composition and free from surface irregularities, cracks, checks, chipping, peeling, spalling, crazing, and other physical defects impairing their appearance, application, or durability.

The molding process shall be such that coarse aggregate particles on the curved surface are covered by not less than 1/16 inch of pigmented Material.

The lane marker Type 1 shall meet the following requirements (see Standard Plan no. 700):

LANE MARKER/TRAFFIC BUTTON (DESCRIPTION)	LANE MARKER TYPE 1
Diameter	3-7/8 inch to 4-1/8 inch
Weight (pounds)	0.275 min.
State Reflectance	80% min.
Impact Resistance (Inch-pounds)	15 min.
Planeness of Base:	
Concavity (Inches)	0.02 max.
Convexity (Inches)	0.05 max.
Titanium Dioxide (% by weight)	21 min.
Resin Content (% by weight)	20 min.

9-21.1(3) TEST METHODS

Test methods shall be as follows:

- Reflectance:** Reflectance will be measured with a photovolt Reflectance Meter or its equivalent by comparing the buttons to a 75 percent brightness standard.
- Impact Resistance:** Impact resistance will be measured by allowing a 1 pound steel ball to fall 15 inches (free fall) onto the lane marker, supported by but not bonded to a steel base plate.
- Titanium Dioxide Content:** The titanium dioxide content will be determined by ashing representative portions of the lane marker, treating the ash with a boiling $(\text{NH}_4)_2\text{SO}_4 \cdot \text{H}_2\text{SO}_4$ solution, filtering, and measuring the absorbance of the filtrate at about 410 millimicrons. Calibration shall be with known samples using ASTM D 921.
- Resin Content:** Resin content will be determined by ashing and igniting representative portions of the marker.

Additional information on the test methods is available from the Seattle Public Utilities' Materials Laboratory.

9-21.2 LANE MARKERS TYPE 2A AND TYPE 2B

The markers shall consist of an acrylic plastic shell filled with a tightly adhering potting compound. The shell shall contain prismatic reflective faces as shown in Standard Plan no. 700 to reflect incident light from opposite directions.

9-21.2(1) PHYSICAL PROPERTIES

The shell shall be molded of methyl methacrylate or acrylonitrile butadiene styrene (ABS).

Filler shall be a potting compound selected for strength, resilience, and adhesion adequate to pass physical requirements as outlined herein.

The outer surface of the shell shall be smooth except for purposes of identification and shall contain methyl methacrylate reflective faces in the color specified. As an option, thin untempered glass may be bonded to the prismatic reflective faces to provide an abrasion resistant surface.

The base of the marker shall be substantially free from gloss or substances that may reduce its bond to adhesive. This shall be done by embedding sand or inert granules on the surface of the potting compound prior to its curing.

The markers shall be fabricated as follows:

LANE MARKER (DESCRIPTION)	LANE MARKER TYPE 2A	LANE MARKER TYPE 2B
Dimensions of Plastic Shells	4 inch x 4 inch x 0.65 inch or octagonal w/4 inch across flats	4.7 inch x 2.3 inch x 0.52 inch
Slope of Reflecting Face	20 deg. to 30 deg.	20 deg. to 30 deg.
Area of Each Reflecting Surface	3.0 to 3.25 square inches	1.87 square inches

9-21.2(2) OPTICAL REQUIREMENTS

1. Definitions:

Horizontal entrance angle shall mean the angle in the horizontal plane between the direction of incident light and the normal to the leading edge of the marker.

Observation angle shall mean the angle at the reflector between observer's line of sight and direction of the light incident on the reflector.

Specific intensity (S.I.) shall mean candlepower of the returned light at the chosen observation and entrance angles for each foot-candle of illumination at the reflector on a plane perpendicular to the incident light.

2. Optical Requirements:

The specific intensity of each crystal reflecting surface at 0.2 degrees observation angle shall be not less than the following when the incident light is parallel to the base of the marker:

Hor. Ent. Angle	S.I.
0°	3.0
20°	1.2

Yellow reflectors shall be not less than 60 percent and red reflectors not less than 25 percent of the above values.

3. Optical Testing Procedure:

A random lot of markers will be tested. 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 width shall be 0.05 inch. It shall be shielded to eliminate stray light. The distance from light source center to the photocell center shall be 0.21 inch. If a test distance of other than 5 feet is used, the source and receiver dimensions and the distance between source and receiver shall be modified in the same proportion as the test distance.

Failure of more than 4 percent of the samples shall be cause for rejection of the lot.

9-21.2(3) STRENGTH REQUIREMENTS

Markers shall support a load of 2,000 pounds as applied in the following manner:

1. A marker shall be centered 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 wall thickness of 1/4 inch. The load shall be slowly applied to the top of the marker through a 1 inch diameter by 1 inch high metal plug centered on the top of the marker.
2. Failure occurs with either a breakage or a significant deformation of the marker at any load of less than 2,000 pounds.

SECTION 9-22 MONUMENT FRAMES AND COVERS

9-22.1 GENERAL

Monument castings shall conform to the requirements of ASTM A 48, Class 30 and shall be free of porosity, shrink cavities, cold shuts or cracks, or any surface defects which would impair serviceability. Repair of defects by welding, or by the use of "smooth-on" or similar Material, will not be permitted. The manufacturer shall certify that the product conforms to the requirements of these Specifications.

Monument castings shall be machine finished or ground on seating surfaces to assure non-rocking fit in any position, and interchangeability. The foundry shall make standard frames and covers available to the Engineer to test fit and seating.

SECTION 9-23 CONCRETE CURING MATERIALS, POZZOLANS AND ADMIXTURES

9-23.1 SHEET MATERIALS FOR CURING CONCRETE

Sheet materials for curing concrete shall meet the requirements of AASHTO M 171, Sheet Materials for Curing Concrete, except that only white reflective type shall be used.

9-23.2 LIQUID MEMBRANE-FORMING CONCRETE CURING COMPOUNDS

Liquid membrane-forming compounds for curing concrete shall conform to the requirements of AASHTO M 148 (ASTM C 309) Type 1D or 2, Class A or B.

Each lot of liquid membrane-forming curing compound shall be sampled at the project site and tested for acceptance. Liquid membrane-forming curing compound shall not be used in the absence of satisfactory test results.

9-23.3 RESERVED

9-23.4 RESERVED

9-23.5 BURLAP CLOTH

Burlap cloth shall meet the requirements of AASHTO M 182, Class 4.

9-23.6 CHEMICAL ADMIXTURES FOR CONCRETE

Acceptance of chemical admixtures will be based on Manufacturer's Certificate of Compliance. If required by the Engineer, admixtures shall be sampled and tested before they are used. A 1-pint (500-milliliter) sample of the admixture shall be submitted to the Materials Laboratory for testing 10-days prior to use. Chemical Admixtures shall contain less than 1-percent chloride ion (Cl-) by weight of admixture.

9-23.6(1) AIR-ENTRAINING ADMIXTURES

Air-Entraining admixtures shall meet the requirements of AASHTO M 154 or ASTM C 260.

9-23.6(2) TYPE A WATER-REDUCING ADMIXTURES

Type A Water-Reducing admixtures shall conform to the requirements of AASHTO M 194 Type A or ASTM C 494 Type A.

9-23.6(3) TYPE B RETARDING ADMIXTURES

Type B Retarding admixtures shall conform to the requirements of AASHTO M 194 Type B or ASTM C 494 Type B.

9-23.6(4) TYPE C ACCELERATING ADMIXTURES

Type C Accelerating admixtures shall conform to the requirements of AASHTO M 194 Type C or ASTM C 494 Type C, and only nonchloride accelerating non-corrosive admixtures shall be used.

9-23.6(5) TYPE D WATER-REDUCING AND RETARDING ADMIXTURES

Type D Water-Reducing and Retarding admixtures shall conform to the requirements of AASHTO M 194 TYPE D OR ASTM C 494 TYPE D.

9-23.6(6) TYPE E WATER-REDUCING AND ACCELERATING ADMIXTURES

Type E Water-Reducing and Accelerating admixtures shall conform to the requirements of AASHTO M 194 Type E or ASTM C 494 Type E, and only nonchloride accelerating admixtures shall be used.

9-23.6(7) TYPE F WATER-REDUCING, HIGH RANGE ADMIXTURES

Type F Water-Reducing, High Range admixtures shall conform to the requirements of AASHTO M 194 Type F or ASTM C 494 Type F.

9-23.6(8) TYPE G WATER-REDUCING, HIGH RANGE, AND RETARDING ADMIXTURES

Type G Water-Reducing, High Range, and Retarding admixtures shall conform to the requirements of AASHTO M 194 Type G or ASTM C 494 Type G.

9-23.6(9) TYPE S SPECIFIC PERFORMANCE ADMIXTURES

Type S Specific Performance admixtures shall conform to the requirements of ASTM C 494 Type S. When a Type S admixture is used, a report on the performance characteristics of the Type S admixture shall be submitted along with the concrete mix design. The report shall describe the performance characteristics and provide data substantiating the specific characteristics of the Type S admixture in accordance with ASTM C 494.

9-23.7 RESERVED

9-23.8 WATERPROOFING

Concrete made with waterproofing admixtures shall have a percent absorption after immersion and boiling of less than 5.0 percent at seven days and a volume of permeable voids less than 11.0 percent at seven days per ASTM C 642. The Contractor shall submit evidence in the form of test results showing compliance with these specifications, when they submit their concrete mix design.

If the concrete requires air entrainment, the Contractor shall also submit evidence to the Engineer that the admixture will not adversely affect the air void system of the hardened concrete. Test results complying with ASTM C 457 shall be provided as evidence to satisfy this requirement.

9-23.9 FLY ASH

Fly ash shall conform to the requirements of AASHTO M 295 Class C or F including optional chemical requirements as set forth in Table 2 and with a further limitation that the loss on ignition shall be a maximum of 1.5 percent.

9-23.10 GROUND GRANULATED BLAST FURNACE SLAG (GGBFS)

Ground granulated blast furnace slag shall meet the requirements of AASHTO M 302, Grade 100 or Grade 120. The grade of the ground granulated blast furnace slag, the source, and type of manufacturing facility shall be certified on the cement mill test certificate.

9-23.11 MICROSILICA FUME

Microsilica Fume shall conform to the requirements of AASHTO M 307. The optional physical requirement for Reactivity with Cement Alkalies set forth in Table 3 will be required when Microsilica Fume is being used as an ASR mitigation measure.

9-23.12 METAKAOLIN

Metakaolin shall conform to the requirements of AASHTO M 295 Class N, including optional chemical requirements as set forth in Table 2 and with a further limitation that the loss on ignition shall be a maximum of 1.5 percent.

SECTION 9-24 PLASTIC WATERSTOP**9-24.1 MATERIAL**

Waterstops shall be fabricated from a plastic compound, the basic resin of which shall be polyvinyl chloride. The compound shall contain such additional resins, plasticizers, inhibitors, or other material that when the Material is compounded, it shall meet the performance requirements given in this Specification.

Single-pass reworked Material of the same composition generated from the fabricator's waterstop production may be used. No reclaimed polyvinyl chloride shall be used.

All waterstops shall be molded or extruded in such a manner that any cross section is dense, homogeneous, and free from porosity and other imperfections.

Waterstops shall be symmetrical in shape, nominally 4 inches in width by 3/16 inch thick, and have a minimum of four ribs on each side of the bulb. The bulb thickness and diameter shall be as noted on the Drawings.

9-24.1(1) TESTS OF MATERIAL

The waterstops shall meet all of the physical and other test requirements of this material as defined in the Corps of Engineers Specifications for Polyvinyl Chloride Water Stop CRD-C572, except that the tear resistance of the material shall be not less than 160 pounds per inch. The Contractor shall furnish such sample material as required by the Engineer for the purpose of making tests.

SECTION 9-25 WATER**9-25.1 WATER FOR CONCRETE**

Water for mortar or concrete, grout, and mortar shall be clear, apparently clean, and suitable for human consumption (potable). As determined by the Engineer, if the water contains substances that cause discoloration, unusual or objectionable smell or taste, or other suspicious content, the Engineer may require the Contractor to provide test results documenting that the water meets the physical test requirements and chemical limits described ASTM C1602 for nonpotable water.

Water from mixer washout operations may be used in concrete provided it meets or exceeds the above criteria as well as the following additional requirements:

1. Concrete with water from mixer washout operations shall not be used in bridge roadway deck slabs, flat slab bridge superstructures, modified concrete overlays, or prestressed concrete,
2. Specific gravity shall not exceed 1.07,
3. Alkalies, expressed as $[\text{Na}_2\text{O} + 0.658 \text{K}_2\text{O}]$ shall not exceed 600 ppm,
4. Shall be free of coloring agents,
5. If the wash water contains admixtures from different manufacturers, the Contractor shall provide evidence that the combination of admixtures are compatible and do not adversely affect the air void system of the hardened concrete as per Section 6-02.3(3), and
6. All tests to verify that the physical and chemical requirements are met, shall be conducted on the following schedule:
 - a. The physical requirements shall be tested on weekly intervals for four weeks and thereafter on monthly intervals,
 - b. The chemical requirements shall be conducted on monthly intervals, and
 - c. The specific gravity shall be determined daily in accordance with ASTM D 1429, Test Method D.

The Contractor shall use the services of a laboratory that has equipment calibration/verification system, and a technician training and evaluation process per AASHTO R-18 to conduct all tests. The laboratory shall use testing equipment that has been calibrated / verified at least once within the past 12 months to meet the requirements of each test procedure in accordance with the appropriate section of AASHTO R-18. Documentation of tester qualifications and equipment verification

records shall be maintained and be available for review by the Engineer upon written notice. The Engineer's review of the laboratory facility, testing equipment personnel, and all qualification, calibration, and verification records will be conducted at the Engineer's discretion.

9-25.2 WATER FOR IRRIGATION

Water for irrigation shall not contain dissolved or suspended matter which is harmful to the plant Material on which it is to be used.

SECTION 9-26 EPOXY RESINS

9-26.1 EPOXY BONDING AGENTS

9-26.1(1) GENERAL

Epoxy bonding agents shall be 2-component epoxy resin-base systems that meet the requirements of ASTM C 881, shall be furnished in the type, grade, and class specified, and shall meet the requirements below. When not specified, an appropriate grade and class shall be selected for the particular application. Epoxy bonding agents for patching external concrete shall be concrete-gray in color.

9-26.1(1)A TYPE I AND TYPE IV

Epoxy bonding agents used for bonding hardened concrete to hardened concrete and other materials shall be Type I for non-load bearing applications and Type IV for load bearing applications.

9-26.1(1)B TYPE II AND TYPE V

Epoxy bonding agents used for bonding freshly mixed concrete to hardened concrete shall be Type II for non-load bearing applications and Type V for load bearing applications.

9-26.1(1)C TYPE III

Epoxy bonding agents used for bonding skid-resistant materials to hardened concrete and as a binder in epoxy mortars and epoxy concretes used on traffic bearing surfaces shall be Type III.

9-26.1(2) PACKAGING AND MARKING

The components of the epoxy system furnished under these Specifications shall be supplied in separate containers that are non-reactive with the materials contained. The contents of each container shall be such that when the container contents are combined, a properly proportioned final mixture results.

Containers shall be identified as "Component A" (Contains the Epoxy Resin) and "Component B" (Contains the Curing Agent) and shall show the type, grade, class and mixing directions as defined by these Specifications. Each container shall be marked with the name of the manufacturer, the lot or batch number, the date of packaging, and the quantity contained in pounds or gallons.

Potential hazards shall be so stated on the package in accordance with the Federal Hazardous Products Labeling Act and State of Washington, Department of Labor and Industries Regulations for Shipment of Hazardous Products.

9-26.1(3) CERTIFICATION

If requested by the Owner, the manufacturer of the epoxy system shall certify that components A and B meet the requirements of this Specification before a sample will be accepted for testing by the Owner. The Manufacturer's Certificate of Compliance shall be furnished in accordance with Section 1-06.3.

9-26.1(4) REJECTION

Except as noted otherwise, the entire lot of both components may be rejected if samples submitted for test fail to meet any requirements of this Specification.

9-26.1(5) ACCEPTANCE

Acceptance of the Epoxy Bonding Agents for use on the project shall be based on a passing test report from the Materials Laboratory.

9-26.2 EXPOXY ADHESIVE FOR LANE MARKERS

9-26.2(1) GENERAL

Epoxy adhesives for lane markers shall meet the requirements of AASHTO M 237 for Type II - Standard Setting, High Viscosity, Epoxy Adhesive. In lieu of the square base test specimen molds for the Slant Shear Strength test specified in AASHTO M 237, cylindrical molds in accordance with ASTM C 882 may be used.

9-26.2(2) PACKAGING AND MARKING

Packaging and Marking of Epoxy Adhesive for Lane Markers shall meet the requirements of Section 9-26.1(2).

9-26.2(3) CERTIFICATION

Certification of Epoxy Adhesive for Lane Markers shall meet the requirements of Section 9-26.1(3).

9-26.2(4) REJECTION

Rejection of Epoxy Adhesive for Lane Markers shall meet the requirements of Section 9-26.1(4).

9-26.2(5) ACCEPTANCE

Acceptance of each lot of the Epoxy Adhesive for Lane Markers for use on the project shall be based on a Manufacturer's Certificate of Compliance.

9-26.3 EPOXY GROUT/MORTAR/CONCRETE**9-26.3(1) GENERAL**

This Specification shall apply to epoxy grout, epoxy mortar and epoxy concrete for traffic and non-traffic bearing applications. Epoxy grout/mortar/concrete shall consist of an epoxy bonding agent and an aggregate component.

Prepackaged epoxy grout/mortar/concrete shall be prepared from a ready-to-mix epoxy bonding agent/aggregate system supplied by a manufacturer in kit form.

Non-prepackaged epoxy grout/mortar/concrete shall be prepared from an epoxy bonding agent and an aggregate component that is clean, surface dry and inert and that is of a quality and gradation suitable for Portland cement mortar or concrete. Aggregate meeting the requirements of Section 9-03.1(2) will be satisfactory. Epoxy grout/mortar/concrete for patching external concrete shall be concrete-gray in color.

9-26.3(1)A TRAFFIC BEARING APPLICATIONS

Epoxy grout/mortar/concrete for traffic bearing applications shall have a seven-day compressive strength of not less than 4000 psi when tested in accordance with ASTM C579. Epoxy bonding agent shall be Type III as described in Section 9-26.1(1)C.

9-26.3(1)B NON-TRAFFIC BEARING APPLICATIONS

Epoxy grout/mortar/concrete for non-traffic bearing applications shall have a seven-day compressive strength of not less than 4000 psi when tested in accordance with ASTM C579. Epoxy bonding agent shall be Type I, II, IV, or V as appropriate for intended use as described in Section 9-26.1(1)A and Section 9-26.1(1)B.

9-26.3(2) PACKAGING AND MARKING

Packaging and Marking of the epoxy bonding agent component of epoxy grout/mortar/concrete shall meet the requirements of Section 9-26.1(2).

9-26.3(3) CERTIFICATION

Certification of the epoxy bonding agent component of epoxy grout/mortar/concrete shall meet the requirements of Section 9-26.1(3).

9-26.3(4) REJECTION

Rejection of the epoxy bonding agent component of epoxy grout/mortar/concrete shall meet the requirements of Section 9-26.1(4).

9-26.3(5) ACCEPTANCE

Acceptance of the epoxy grout/mortar/concrete material for use on the project shall be based on a passing test report from the Materials Laboratory.

SECTION 9-27 CRIBBING**9-27.1 RESERVED****9-27.2 RESERVED****9-27.3 GABION CRIBBING****9-27.3(1) GABION FABRIC**

Gabions may be fabricated from either hexagonal twisted wire mesh or from welded wire mesh. Only one type of mesh and protective coating shall be used throughout a structure.

Baskets shall be furnished in the required dimensions with a dimensional tolerance of $\pm 5\%$.

Wire for construction of gabions shall be either galvanized steel wire conforming to ASTM A 641, Class 3, Soft Temper, or aluminized steel wire conforming to ASTM A 809, Soft Temper. The wire shall have a minimum tensile strength of 60,000 psi when tested in accordance with ASTM A 370.

9-27.3(2) GABION BASKETS

Gabion baskets 1 foot or greater in the vertical dimension shall have mesh openings with nominal dimensions not to exceed 4-1/2 inches and the maximum area of any mesh opening shall not exceed 10 square inches.

1. Hexagon Twisted Wire Mesh

- a. Wire for galvanized or aluminized hexagonal twisted wire mesh shall be nominal sized 0.120 inch galvanized steel wire or aluminized steel wire.
- b. Hexagonal wire mesh be formed from galvanized or aluminized wire in a uniform hexagonal pattern with nonraveling double twist. The perimeter edges of the mesh for each panel shall be tied to a selvage wire of the same composition as the body mesh and have a minimum diameter of 0.150 inch so that the selvage is at least the same strength as the body of the mesh.

2. Welded Wire Mesh
 - a. Welded wire mesh shall be fabricated from galvanized steel wire having a diameter of 0.106 inch. Wire shall be galvanized prior to fabrication.
 - b. Welded wire mesh shall be formed in a uniform square pattern with openings 3 inches by 3 inches with a resistance weld at each connection in accordance with ASTM A 185.
 - c. If required, a PVC coating shall be fusion bonded onto the welded wire mesh to provide a nominal coating thickness of 0.0216 inch per side with a minimum of 0.0150 inch.
3. PVC Coating (for welded wire mesh only).

Acceptance of PVC coating material shall be by certified test reports of an independent laboratory. The initial properties of PVC coating material shall have a demonstrated ability to conform to the following requirements:

 - a. Specific Gravity — In the range of 1.2 to 1.4, when tested according to ASTM D 792.
 - b. Tensile Strength — Not less than 2,275 psi, when tested according to ASTM D 638.
 - c. Modulus of Elasticity — Not less than 1,980 psi at 100 Strain, when testing according to ASTM D 638.
 - d. Hardness — Shore "A" not less than 75 when tested according to ASTM D 2240.
 - e. Brittleness Temperature — Not higher than 15°F when tested according to ASTM D 746.
 - f. Resistance to Abrasion — The percentage of the mass loss shall be less than 12 percent when tested according to ASTM D 1242, Method B at 200 cycles, CSI-A Abrader Tape, 80 Grit.
 - g. Salt Spray Exposure and Ultraviolet Light Exposure — The PVC shall show no effect after 3,000 hours of salt spray exposure according to ASTM B 117. The PVC shall show no effect of exposure to ultraviolet light with test exposure of 3,000 hours using apparatus Type E and 63°C, when tested according to Practice D 1499 and Practice G 23. After the salt spray test and exposure to ultraviolet light as specified above, the PVC coating shall not show cracks, blister, split, nor show a noticeable change of color. In addition, the specific gravity, tensile strength, modulus of elasticity, and resistance to abrasion shall not change more than 6, 25, 25, and 10 percent respectively from their initial values.

9-27.3(3) GABION MATTRESSES

Gabion baskets less than 1 foot in the vertical dimension shall have mesh openings with nominal dimensions not to exceed 3.3 inches, and the maximum area of any mesh opening shall not exceed 6 square inches.

1. Hexagonal Twisted Wire Mesh:
 - a. Wire for galvanized or aluminized hexagonal twisted wire mesh shall be nominal sized 0.086 inch galvanized steel wire or aluminized steel wire.
 - b. Hexagonal wire mesh shall be formed from galvanized or aluminized wire in a uniform hexagonal pattern with nonraveling double twisted. The perimeter edges of the mesh for each panel shall be tied to a selvage wire of the same composition as the body mesh and have a minimum diameter of 0.1062 inch so that the selvage is at least the same strength as the body of the mesh.
2. Welded Wire Mesh:
 - a. Welded wire mesh shall be fabricated from galvanized steel wire having a diameter of 0.080 inch. Wire shall be galvanized prior to fabrication.
 - b. Welded wire mesh shall be formed in a uniform rectangular pattern with openings 1-1/2 inches by 3 inches with a resistance weld at each connection in accordance with ASTM A 185.
 - c. If required, a PVC coating shall be fusion bonded onto the welded wire mesh to provide a nominal coating thickness of 0.0216 inch per side with a minimum of 0.0150 inch. The PVC coating shall be in conformance with Section 9-27.3(2).

9-27.3(4) FASTENERS FOR BASKET ASSEMBLY

The lacing wire shall be a nominal sized 0.0866 inch galvanized steel wire or aluminized steel wire. Lacing wire shall have the same coating as the basket mesh.

Spiral binders, if used for joining welded wire panels shall be formed from 0.106 inch nominal diameter steel wire with a 3 inch pitch having the same specifications and coating as the wire mesh. Lacing wire may be used in lieu of spiral binders.

Alternate fasteners for basket assembly shall remain closed when subjected to a 600 pound tensile force when confining the maximum number of wires to be confined. Installation procedures and test results for alternate fasteners shall be submitted for approval.

Internal connecting wires shall be the same as required for lacing wire. Alternate stiffeners acceptable to the gabion manufacturer may be used if found acceptable to the Engineer.

9-27.3(5) NONRAVELING CONSTRUCTION

The wire mesh shall be fabricated in a manner to be nonraveling. This is defined as the ability to resist pulling apart at any of the connections forming the mesh when a single strand in a section of mesh is cut.

9-27.3(6) STONE

Stone for filling gabions shall have a Degradation Factor of at least 30. The stone shall be dense enough to pass the unit-weight test described in Section 6-09.3(6)F. Stone shall meet the following requirements for gradation:

SIEVE SIZE	PERCENT PASSING
8" square	100
6" square	75-90
4" square	0-10
% Fracture	75 min.

All percentages are by weight.

SECTION 9-28 SIGNING MATERIALS AND FABRICATION

9-28.1 SIGNS

9-28.1(1) GENERAL

Signs to be mounted on wood utility poles (other than Seattle City Light poles) and signs installed overhead shall be aluminum. Other signs shall be either High Density Overlay plywood or sheet aluminum.

Parking and pedestrian control signs shall be nonreflectorized. All other traffic signs shall be reflectorized.

STOP and YIELD sign backs and edges shall be painted with one coat of red enamel to match the red on the sign face.

Regulatory and warning signs shall have rounded corners with the exception of STOP signs. All other signs shall have square cut corners. Borders for signs having square cut corners shall have a corner radius approximately 1/8 of the lesser side dimension of the sign up to a maximum radius of 12 inches. For signs with rounded corners, the borders shall be concentric with the rounded corners.

9-28.1(2) PLYWOOD

Plywood signs shall be constructed of High Density Overlay plywood, meeting the requirements of "Products Standard PS 1-83 for Softwood Plywood, Construction and Industrial" published by the Product Standards Section of the U.S. Department of Commerce. The plywood shall be free of contaminants which would adversely affect the application or life of the sheeting to be applied. Face veneers shall be Grade B or better.

Core and crossband veneers shall be solid. Core veneers shall be jointed, and core gaps shall not exceed 1/8 inch in width. The entire area of each contacting veneer surface shall be bonded with a waterproof adhesive that meets the requirements of the U.S. Department of Commerce for exterior type plywood.

The overlay shall be of the high density type. It shall have a minimum weight of 60 pounds per thousand square feet of surface and shall be at least 0.012 inches thick before pressing. The overlay shall have a sufficient resin content to bond itself to the plywood, with a minimum resin content of 45 percent based on the dry weight of the impregnated fiber.

Thickness - Single Panel Plywood Signs:

Up to 18 inches inclusive in width	3/8 inch
Over 18 inches to 36 inches inclusive in width	5/8 inch
Over 36 inches in width	3/4 inch
Overhead signs	3/4 inch

Street designation signs and signs mounted on span wires or mast arms shall have the sign back and edges primed with 1 coat of white exterior enamel undercoat and finished with 1 coat of International Green (Forest Green) exterior enamel. All other plywood signs shall have only the edges primed with 1 coat of white exterior enamel undercoat and finished with 1 coat of white exterior enamel. The primer shall be as recommended by the Supplier of the finish coat. The finish enamel shall meet the requirements of Federal Specification TT-E-489.

9-28.1(3) SHEET ALUMINUM SIGNS

Sheet aluminum signs shall be constructed of Material conforming to ASTM B209, alloy 6061T6, or alloy 5052-H36 or H38. Alloy 50D5-H34 may be used for sign refacing.

After the aluminum sheet panel has been fabricated, the surface of each panel shall be protected from corrosion. The corrosion protection shall meet the requirements of ASTM B-449 Class II Specification for Chromates on Aluminum. Aluminum signs over 12-feet wide by 5-feet high shall be comprised of vertical panels in increments of 2, 3, or 4-feet wide. No more than one 2-foot and/or 3-foot panel may be used per sign. The Contractor shall use the widest panels possible. All parts necessary for assembly shall be constructed of aluminum, galvanized steel, or stainless steel in accordance with the Drawings. Sheet thickness shall be as follows:

MAXIMUM HORIZONTAL DIMENSION	SHEET ALUMINUM THICKNESS
Overlay panels	0.050-inch
Up to 20-inches	0.063-inch
20-inches to 36-inches,	0.080-inch

inclusive	
Over 36-inches (Permanent Signs)	0.125-inch

The side dimension for a diamond shaped warning sign is considered to be the maximum horizontal dimension.

Before placing aluminum in contact with untreated steel, the steel surfaces shall be protected by proper cleaning and painting with one coat of paint conforming to Section 9-08.2 Item 3 Formula A-9-73 and two coats of aluminum paint.

Metal shall be handled by device or clean canvas gloves between all cleaning and etching operations and the application of reflective sheeting.

Sheet aluminum edges shall be filed smooth to eliminate sharp edges and burrs.

9-28.1(4) REFLECTIVE SIGN FACE SHEETING

Reflective sheeting shall consist of spherical lens elements embedded within a transparent plastic or adhered to a synthetic resin and encapsulated by a transparent plastic. The sheeting shall have a flat, smooth outer surface, be weather resistant, and have a pre-coated adhesive backing with a protective liner.

The sheeting shall have the following minimum brightness values expressed as average candle power per foot candle per square foot of Material. Measurements shall be conducted in accordance with standard testing procedures for reflex-reflectors in Federal Specification L-S-300.

The brightness of the reflective sheeting, totally wet by rain, shall be not less than 90 percent of the above values. Wet performance measurements shall be conducted in conformance with the Standard Rainfall Test specified in Federal Specification L-S-300C.

The diffuse day color of the reflective sheeting shall be visually evaluated by comparison with the applicable Highway Color Tolerance Chart. Color comparisons shall be made under north daylight or a scientific daylight having a color temperature of from 6500 degrees to 7500 degrees Kelvin. Color shall be illuminated at 45 degrees and viewed at 90 degrees.

The sheeting surface shall be smooth and facilitate cleaning and wet performance and exhibit 85 degree glossmeter rating of not less than 50 (ASTM D 523). The sheeting surface shall be readily processed and compatible with transparent and opaque process colors and show no loss of the color coat with normal handling, cutting, and application. The sheeting shall permit cutting and color processing at temperatures of 60°F to 100°F and 20 to 80 percent relative humidity.

The sheeting surface shall be solvent resistant such that it may be cleaned with gasoline, VM&P Naptha, mineral spirits, turpentine, methanol, or xylol.

The embedded lens sheeting, when applied according to manufacturer's recommendations to cleaned and etched 0.020 inch x 2 inch x 8 inch aluminum, conditioned 24 hours, and tested at 72°F and 50 percent relative humidity, shall be sufficiently flexible to show no cracking when bent around a 3/4 inch diameter mandrel.

Conditioned for 48 hours, the tensile strength of the embedded lens sheeting shall be 5 to 20 pounds per inch width when tested in accordance with ASTM D 828. Following liner removal, the sheeting shall not shrink more than 1/32 inch in 10 minutes nor more than 1/8 inch in 24 hours in any dimension per 9 inch square at 75°F and 50 percent relative humidity.

The encapsulated lens sheeting, with liner removed, conditioned for 24 hours at 72°F and 50 percent relative humidity, shall be sufficiently flexible to show no cracking when bent around a 1/8 inch diameter mandrel with adhesive side contacting the mandrel.

The protective liner attached to the adhesive shall be easily removable by peeling without soaking in water or other solvents.

The pre-coated adhesive backing shall be a tack free heat activated type or a pressure sensitive type, either of which shall adhere to the sheeting without the necessity of additional coats of adhesive.

The adhesive shall form a durable bond to smooth the corrosion-resistant and weather-resistant surfaces and permit the reflective sheeting to adhere securely 48 hours after application at temperatures of 30°F to 200°F. The adhesive bond shall be sufficient to render the applied sheeting vandal-resistant and prevent its shocking off when jabbed with a spatula at 10°F. The sheeting shall resist peeling from the application surface when a 5-pounds per inch width force is applied as outlined in ASTM D 903.

WITH EMBEDDED LENS ELEMENTS:									
	DIV. ANG.			DIV. ANG.			DIV. ANG.		
	0.2deg	0.5deg	1.50	0.2.	0.5deg	1.5deg	0.2deg	0.50	1.5deg
INC. ANG.	SILVER-WHITE #1			SILVER-WHITE #2			YELLOW		
-4deg	70.0	30.0	4.0	80.0	41.0	4.0	50.0	25.0	5.0
40deg	14.5	8.5	1.5	16.5	9.5	2.0	11.5	7.0	1.5
INC. ANG.	RED			BLUE			GREEN		
-4deg	14.5	7.5	1.0	4.0	2.0	0.6	9.0	4.5	1.0
40deg	3.0	1.5	0.3	0.9	0.4	0.08	1.8	1.5	0.2
INC. ANG.	ORANGE			BROWN			-----		
-4deg	25.0	13.5	1.5	1.0	0.35	0.1			
40deg	1.0	0.8	0.1	0.2	0.1	0.01			

WITH ENCAPSULATED LENS ELEMENTS:						
	Div. Ang.			Div. Ang.		
	0.2deg	0.5deg	1.5deg	0.2deg	0.5deg	1.5deg
INC. ANG.	SILVER WHITE			YELLOW		
-4deg	250.0	95.0	4.0	170.0	62.0	3.0
40deg	120.0	54.0	2.0	80.0	35.0	1.5
INC. ANG.	ORANGE			GREEN		
-4deg	70.0	25.0	1.1	30.0	12.0	0.5
40deg	33.0	14.0	0.5	14.0	6.8	0.2
INC. ANG.	RED			-----		
-4deg	35.0	13.0	0.7			
40deg	16.0	7.4	0.3			

9-28.1(5) NON-REFLECTIVE SIGN FACE SHEETING

The non-reflective sheeting shall consist of a white plastic film having a smooth, flat outer surface. The sheeting shall be weather-resistant and have a protected pre-coated adhesive backing.

9-28.1(6) SHEETING APPLICATION

Plywood sign faces shall be cleaned with lacquer thinner, heptane, benzene, or solvent recommended by the sheeting manufacturer. The surface shall be sanded with light sandpaper or steel wool and wiped dry and clean with clean cloth. Aluminum sign faces shall be cleaned with a solvent recommended by the sheeting manufacturer.

Sign face sheeting shall be applied by a vacuum applicator recommended by the sheeting manufacturer, or by a continuous roll applicator.

Heat-activated adhesive backed sheeting shall be applied by the vacuum method. The adhesive on the back of the sheeting shall be activated by a minimum temperature of 185°F and with a minimum vacuum pressure of 25 inches of mercury. This operation shall be in effect for a minimum of 3 minutes on plywood and 5 minutes on metal. After aging for 48 hours at 75°F, the adhesive shall form a bond equal to or greater than the strength of the sheeting.

Pressure sensitive adhesive backed sheeting shall be applied by a continuous roll applicator. The process shall be in conformance with the recommendation of the sheeting manufacturer.

Edges and splices of sign face sheeting shall be coated with an edge sealer recommended by the sheeting manufacturer.

9-28.1(7) LETTERS, ARROWS, AND SYMBOLS

Letters, arrows, and symbols shall be of the type, size, and color specified on the Drawings, in the Specifications or WSDOT Sign Fabrication Manual, and the "Standard Highway Signs" by United States Department of Transportation.

Letters, arrows, and symbols shall be of Material compatible with the sign surface Material, as recommended by the sign surface manufacturer or approved by the Engineer.

9-28.1(8) HARDWARE

Bolts, nuts, and washers shall be of the same Material for each attachment. All parts necessary for assembly shall be constructed of the following Materials:

HARDWARE	SPECIFICATION
Bolts	ASTM B 209, 2024-T4 Aluminum
	ASTM A 307 Steel
	ASTM F 593 Stainless Steel
Washers	ASTM B 209, 2024-T4 Aluminum
	ASTM A 36 Steel
	ASTM A 240 Stainless Steel
Nuts	ASTM B 209, 6061-T6 Aluminum
	ASTM A 307 Steel
	ASTM F 594 Stainless Steel
Locknuts	ASTM B 211, 2017-T4 Aluminum
	ASTM A 307 Steel
	ASTM F 594 Stainless Steel
Rivets	ASTM B 209, 6061-T6 Aluminum
	ASTM B 316, 6053-T61 Aluminum
Post Clips	ASTM B 179, 356-T6 Aluminum
Wind Beams	ASTM B 209, 6061-T6 Aluminum
Angle and Z-Bar	ASTM B 209, 6061-T6 Aluminum
	ASTM A 36 Steel
Strap and Mounting Bracket	ASTM A 276 Stainless Steel

All steel parts shall be galvanized per ASTM A 123. Steel bolts and related connecting hardware shall be galvanized per ASTM A 153.

9-28.2 POSTS

9-28.2(1) RESERVED

9-28.2(2) PARKING METER POST

9-28.2(2)A GENERAL

Parking meter post mounted with a parking meter and with no sign attached to the post shall have a 2-1/2 inch nominal ASTM A 53, Schedule 40 galvanized standard steel pipe sleeve fitted loosely over the exposed meter post full length. On the bottom, the sleeve shall make contact with the canopy for surface mounted posts or with the finished grade for direct burial posts. On the top, the sleeve shall make contact with the parking meter base. Standard Plan no. 629 shows the sleeve on a direct burial post. Direct burial and surface-mounted meter posts not used for a parking meter and used only for parking sign or other type sign, shall have a 2-3/8 inch galvanized steel cap securely fitted over the top of the post as shown on Standard Plan nos. 627 and 628.

9-28.2(2)B DIRECT BURIAL PARKING METER POST

See Standard Plan no. 629. Direct burial parking meter post shall be fabricated from 2 inch nominal diameter standard ASTM A 53, schedule 40 galvanized pipe, 46 inches in length, and with the bottom 3 inches flattened. Two 1/4 inch weep holes are required. The buried post base shall be backfilled, and mounded for drainage, with very quick setting and very strong cement grout, such as "jet-set cement", having the following properties:

Compressive Strength	ASTM C 109	8,000 psi. min. in 28 days
Bond Strength	ASTM C 1042	500 psi. min. in 1 day
Shrinkage	ASTM C 596	Less than 0.10%
Set-time	ASTM C 191	Initial set in 8 to 10 minutes Final set in 15 to 20 minutes

Cement grout meeting these requirements is "jet-set cement" and can be obtained from Jet Set Northwest Inc., Seattle, Wa., or approved equal.

9-28.2(2)C SURFACE MOUNTED PARKING METER POSTS

Bolted-down parking meter and parking sign posts shall be fabricated from 2 inch nominal diameter standard ASTM A 53, schedule 40 galvanized steel pipe, 40 inches in length, with 5/16 x 5 x 5 inch ASTM A 36 steel base plate. The meter post base "canopy", also known as "collar", shall be made of 0.062 inch 2-5-0 aluminum as shown on Standard Plan no. 627.

9-28.2(3) TELES PAR QWIK-PUNCH SIGN POST AND POST ANCHOR

Unless otherwise specified, Sign Posts shall be Telespar Qwik-Punch® or approved equal, Tube Size 2-inches by 2-inches, Gauge 14. Unless otherwise specified, the length of the post shall be specified in the Standard Plans with a length tolerance of +/- 0.25 inch. The finished members shall be straight and have a smooth uniform finish. Post shall be in-line galvanized per AASHTO M-120.

Unless otherwise specified, Light Duty and Heavy Duty Post Anchors shall be Telespar Qwik-Punch® or approved equal, one size larger than the sign post, with gauge and length as specified on Standard Plan 621b.

Surface Mounted Post Anchors shall be gauge 12 Telespar Qwik-Punch® or approved equal, galvanized tube welded to a ¼-inch thick, 7-inch by 7-inch steel base plate. Four, ¾-inch holes shall be drilled in the base plate, one at each corner centered 1.06-inches from each edge of the plate; centered 4.88 inches apart. The tube length as specified on Standard Plan 621b, one size larger than the sign post. The tube shall be tube centered on the plate as shown on Standard Plan 621b and fillet welded on all four sides where the tube meets the plate. All welds shall develop the full strength of the parent metal. After fabrication, the base plate and welds of the anchors shall be hot-dip galvanized in accordance with AASHTO M111 or ASTM 123. The tube portion of the anchors shall not be hot-dipped as not to impede the insertion of the sign post.

Telespar Qwik-Punch® or approved equal Sign Post and Post Anchor shall have 7/16-inch prepunched holes on 1-inch centers.

Corner bolts, nuts, and washer for attaching post to anchors shall be Telespar Qwik-Punch® or approved equal recommended. Surface mounting bolts shall be as shown on Standard Plan 621b.

9-28.2(4) STREET NAME SIGN POST

Street name sign post shall be 2-1/2 inch inside diameter x 10 feet 6 inches standard weight galvanized steel pipe, with the bottom 6 inch end section flattened to form a wedge. For details, see Standard Plan no. 622.

9-28.3 RESERVED**SECTION 9-29 PAVEMENT MARKING****9-29.1 GENERAL**

Pavement marking materials in this Section consist of paint, plastic, tape or raised pavement markers as described in Sections 8-22 and 8-23 as listed below:

- Low VOC Solvent Based Paint
- Low VOC Waterborne Paint Temporary Pavement Marking Paint
- Type A – Liquid Hot Applied Thermoplastic
- Type B – Pre-Formed Fused Thermoplastic
- Type C – Cold Applied Pre-Formed Tape
- Type D – Liquid Cold Applied Methyl Methacrylate Glass Beads
- Temporary Pavement Marking Tape
- Temporary Raised Pavement Markings

9-29.2 PAINT

White and yellow paint shall comply with the Specifications for low VOC (volatile organic compound) solvent-based paint or low VOC waterborne paint. Blue paint for "Access Parking Space Symbol with Background" and black paint for contrast markings shall be chosen from a WSDOT QPL-listed manufacturer for white and yellow paint.

Blue and black paint shall comply with the requirements of yellow paint in Section 9-29.2(4) and Section 9-24.2(5), with the exception that blue and black paints do not need to meet the requirements for titanium dioxide, directional reflectance, and contrast ratio.

9-29.2(1) VACANT**9-29.2(2) COLOR**

Paint draw-downs shall be prepared according to ASTM D 82. For white, the color shall closely match Federal Standard 595, color number 37875. For yellow, the color shall closely match Federal Standard 595, color number 33538. For blue, the color shall closely match Federal Standard 595, color number 35180. For black, the color shall closely match Federal Standard 595, color number 37038.

9-29.2(3) PROHIBITED MATERIALS

Traffic paint shall not contain mercury, lead, chromium, toluene, chlorinated solvents, hydrolysable chlorine derivatives, ethylene-based glycol ethers and their acetates, nor any other EPA hazardous waste material over the regulatory levels per CFR 40 Part 261.24.

9-29.2(4) LOW VOC SOLVENT BASED PAINT

Paint Properties	Test Method	Low VOC Solvent-Based Paint			
		White		Yellow	
		Min.	Max.	Min.	Max.
Density of Paint (lb/gal)	ASTM D 1475	11.8		11.8	
Viscosity, KU	ASTM D 562				
@35°F					
@50°F			105		105
@77°F		75	85	75	85
@90°F					
@120°F		65		65	
Nonvolatile Content, % by weight	ASTM D 2369	65		65	
Pigment Content, % by weight	ASTM D 2698		53		53
Titanium Dioxide Content (lb/gal), Rutile Type II	ASTM D 5381	1.0			0.2
Volatile Organic Content (VOC) lbs/gal	ASTM D 3960		1.25		1.25
Directional Reflectance %, @ 15 mils wet	WSDOT T 314	80		50	
Package Stability	ASTM D 1849	6		6	
Bleeding, %	ASTM D 868 ¹	90		90	
Flexibility	ASTM D 522 ²	No cracking, flaking, or loss of adhesion			
Settling Properties during Storage, Inch	ASTM D 1309 ³		8		8
Skinning	ASTM D 154	The paint shall not skin within 48 hours in a ¾ filled, tightly closed container			

¹The reflectance of the paint over asphalt paper shall be a minimum of 90 percent of the reflectance measurement of the paint over a taped (nonbleeding) surface.

²The paint shall be applied at a wet film thickness of 6 mils to a 3 by 5 inch panel that has been solvent cleaned and lightly buffed with steel wool. With the panel kept in a horizontal position, the paint shall be allowed to dry for 18 hours at 77° ± 2°F, and then baked for 3 hours at 140° ± 2°F. The panel shall be cooled to 77° ± 2°F for at least 30 minutes, bent over a 0.25 inch mandrel, and then examined without magnification. The paint shall show no cracking, flaking, or loss of adhesion.

³The sample shall show no more than 0.5 inch of clear material over the opaque portion of the paint and there shall be no settling below a rating of eight.

9-29.2(5) LOW VOC WATERBORNE PAINT

Paint Properties	Test Method	Standard Waterborne Paint			High-Build Waterborne Paint			Cold Weather Waterborne Paint			Yellow		
		White Min.	White Max.	Yellow Min.	White Min.	White Max.	Yellow Min.	White Min.	White Max.	Yellow Min.	White Min.	White Max.	Yellow Max.
Density of Paint (lb/gal)	ASTM D 1475	Within ± 0.3 of qualification sample											
Viscosity, KU	ASTM D 562	Within ± 0.3 of qualification sample											
@35°F													
@77°F													
@90°F		80	95	80	95	80	95	80	95	80	95	80	95
Nonvolatile Content, % by weight	ASTM D 2369	75		75		77		77		70		70	
Pigment Content, % by weight	ASTM D 3723		68		68		62		62		50		50
Nonvolatile Vehicle (NVV), % by weight	ASTM D 2369 ASTM D 3723 ¹	40		40		43		43		40		40	
Volatile Organic Content (VOC) lbs/gal	ASTM D 3960		1.25		1.25		1.25		1.25		1.25		1.25
Fineness of Grind, (Hegman Scale)	ASTM D 1210	3		3						3			3
Contrast Ratio, @ 15 mils wet	ASTM D 2805	0.98		0.96		0.98		0.96		0.99		0.98	
Directional Reflectance %, @ 15 mils wet	WSDOT T 314	88		50		90		50		87		50	
Flash Point, °F	ASTM D 93	100°		100°									
pH	ASTM E 70	9.5		9.5		9.5		9.5		9.5		9.5	
Laboratory Dry Time (Minutes)	ASTM D 711		10		10							10	
Vehicle Composition	ASTM D 2621	100% acrylic emulsion or approved equal											
Freeze-Thaw Stability, KU	ASTM D 2243 and D 562	@ 5 cycles show no coagulation or change in viscosity greater than ± 5 KU			@ 5 cycles show no coagulation or change in viscosity greater than ± 5 KU			@ 5 cycles show no coagulation or change in viscosity greater than ± 5 KU			100% acrylic emulsion or approved equal @ 3 cycles show no coagulation or change in viscosity greater than ± 10 KU		
Heat Stability	ASTM D 562 ²	± 10 KU from the initial viscosity			± 10 KU from the initial viscosity			± 10 KU from the initial viscosity			± 10 KU from the initial Viscosity		
Low Temperature Film Formation	ASTM D 2805 ³										No Cracks		

¹Use the following formula for calculating nonvolatile in vehicle (NVV): $NVV = (N-P/100-P) \times 100$. Where: N = % of nonvolatile content as determined by ASTM D 2369 and P = % of pigment content as determined by ASTM D 3723.

²Put approximately 15-fluid ounces of paint in a 1-pint lined container, close the container, seal it with tape, and put it in an oven maintained at 140° ± 2°F for 7 days. Equilibrate the paint at 77° ± 2°F and mix thoroughly with gentle stirring. Perform consistency test as specified in ASTM D 562. Consistency shall not vary by ± 10 KU from the initial viscosity.

³Apply paint at 15 mils wet per ASTM D 2805 over a 2A Leneta Chart. Immediately and carefully lay the applied film horizontally in a refrigerator that maintains a temperature of 35°F. After 24 hours, remove the applied film and inspect. Paint film should show no cracks when held at arm's length and observed by the naked eye.

9-29.2(6) TEMPORARY PAVEMENT MARKING PAINT

Paint used for temporary pavement marking shall conform to the requirements of Section 9-29.2.

9-29.3 PLASTIC

White and yellow plastic pavement marking materials shall comply with the Specifications for:

- Type A – Liquid hot applied thermoplastic
- Type B – Pre-formed fused thermoplastic
- Type C – Cold applied pre-formed tape
- Type D – Liquid cold applied methyl methacrylate

For black, the color shall closely match Federal Standard 595, color number 37038, and shall be chosen from a WSDOT QPL-listed manufacturer for white or yellow plastic. Black plastic shall comply with Sections 9-29.3(2), 9-29.3(3), and 9-29.3(4) for yellow, except for retroreflectance.

9-29.3(1) TYPE A – LIQUID HOT APPLIED THERMOPLASTIC

Type A material consists of a mixture of pigment, fillers, resins and glass beads that is applied to the pavement in the molten state by extrusion or by spraying. The material can be applied at a continuously uniform thickness or it can be applied with a profiled pattern. Glass beads, intermixed and top dress, shall conform to the manufacturer's recommendations necessary to meet the retroreflectance requirements. Type A material shall conform to the requirements of AASHTO M 249 and the following:

Resin – The resin shall be alkyd or hydrocarbon.

Retroreflectance – ASTM E 1710

Newly applied pavement markings shall have a minimum initial coefficient of retroreflective luminance of 250 $\text{mcd}\cdot\text{m}^{-2}\cdot\text{lx}^{-1}$ for white and 175 $\text{mcd}\cdot\text{m}^{-2}\cdot\text{lx}^{-1}$ for yellow in accordance with ASTM E 1710 when measured with a 30-meter retroreflectometer. Retroreflectivity will be measured for compliance with a Delta LTL-X retroreflectometer.

Skid Resistance – ASTM E 303

45 BPN units minimum

The material will have a thickness of 125 mils. A thickness tolerance not exceeding 10-percent will be allowed.

9-29.3(2) TYPE B – PRE-FORMED FUSED THERMOPLASTIC

Type B material consists of a mixture of pigment, fillers, resins and glass beads that is factory produced in sheet form. The material is applied by heating the pavement and top heating the material. The material shall contain intermixed glass beads. The material shall conform to AASHTO M 249, with the exception of the relevant differences for the materials being applied in the pre-formed state and the following:

Resin – The resin shall be alkyd or hydrocarbon.

The sample material submitted for approval shall be fused to a suitable substrate prior to performing the following tests.

Retroreflectance – ASTM E 1710

The fused samples shall have a minimum initial coefficient of retroreflective luminance of 250 $\text{mcd}\cdot\text{m}^{-2}\cdot\text{lx}^{-1}$ for white and 175 $\text{mcd}\cdot\text{m}^{-2}\cdot\text{lx}^{-1}$ for yellow in accordance with ASTM E 1710 when measured with a 30-meter retroreflectometer. Retroreflectivity will be measured for compliance with a Delta LTL-X retroreflectometer.

Skid Resistance – ASTM E 303

60 BPN units minimum

The blue color shall match Federal Standard 595, color number 35180, and the tolerance of variation shall match that shown in the FHWA "Highway Blue Color Tolerance Chart".

The red color shall match Federal Standard 595, color number 11136, and the tolerance of variation shall match that shown in the FHWA "Highway Red Color Tolerance Chart".

All Type B material pavement markings shall have a thickness of 125 mil and include heat indicators. Heat indicators shall be included on the top surface of the material (bead side) and shall have regularly spaced indents. These indents will act as indicators for determining the correct amount of heat application and will close upon application when heated to the proper molten state. Type B material shall be slip resistant. The approved Type B Material Supplier is:

1. PreMark[®] material with ViziGrip[®], manufactured by Ennis-Flint, 115 Todd Court, Thomasville, NC 27360

9-29.3(3) TYPE C – COLD APPLIED PRE-FORMED TAPE

Type C material consists of plastic pre-formed tape that is applied cold to the pavement. The tape shall be capable of adhering to new and existing hot mix asphalt or cement concrete pavement. If the tape manufacturer recommends the use of a surface primer or adhesive, use a type approved by the pavement marking manufacturer. The tape shall also be capable of being inlaid into fresh hot mix asphalt during the final rolling process. The material is identified by the following designations:

Type C-1 tape has a surface pattern with retroreflective elements exposed on the raised areas and faces and intermixed within its body and shall conform to ASTM D 4505, Reflectivity Level I, Class 2 or 3, Skid Resistance Level A.

Type C-2 tape has retroreflective elements exposed on its surface and intermixed within its body and shall conform to the requirements of ASTM D 4505, Reflectivity Level II, Class 2 or 3, Skid Resistance Level A.

9-29.3(4) TYPE D - LIQUID COLD APPLIED METHYL METHACRYLATE

Type D material consists of a two part mixture of methyl methacrylate and a catalyst that is applied cold to the pavement. The material can be applied at a continuously uniform thickness or it can be applied with profiles (bumps). The material is classified by Type designation, depending upon the method of application. Type D-1 material is to be applied by hand operated extrusion device, pouring or hand troweling. Type D-2 and D-5 material shall be applied by spraying. Type D-3 and D-4 material shall be applied by machine extrusion.

Glass beads shall conform to the manufacturer's recommendations necessary to meet the retroreflectance requirements. Type D-1, D-2, D-3, D-4, and D-6 material shall have intermixed glass beads in the material prior to application. Type D-5 material shall have glass beads injected into the material at application and a second coating of top dressing beads applied immediately after material application.

Type D materials shall conform to the following:

Type D – Liquid Cold Applied Methyl Methacrylate Properties					
Property	Test Method	White		Yellow	
		Min.	Max.	Min.	Max.
Adhesion to PCC or HMA, psi	ASTM D4541 ¹	200 or substrate failure		200 or substrate failure	
Chemical Resistance	²	No Effect		No Effect	
Hardness	ASTM D2240 ³	50		50	
No Track Time	ASTM D711 ⁴		30		30
Skid Resistance, BPN	ASTM E303	45		45	
Tensile Strength, psi	ASTM D638	125		125	

¹Part A and B mixed, applied at 60 mils thickness.

²Cured markings shall be resistant to calcium chloride, sodium chloride, fuels, oils, and UV effects. Cure three days for motor oil, gas, diesel, ATF, salt, and anti-freeze.

³Shore Durometer Type D and measurement made after 24 hours.

⁴Sample applied at 40 mils.

Type D liquid cold-applied methyl methacrylate shall meet the following formulations:

4:1 Formulation Type D – Liquid Cold Applied Methyl Methacrylate

Type D-1 – One-gallon of methyl methacrylate and 3-fluid ounces of benzoyl peroxide powder (by weight).

Type D-2, D-3, D-4, and D-5 – Four parts methyl methacrylate and one part liquid benzoyl peroxide (by volume).

98:2 Formulation Type D – Liquid Cold Applied Methyl Methacrylate

Type D-1 – One-gallon of methyl methacrylate and 3-fluid ounces of benzoyl peroxide powder (by weight).

Type D-2, D-3, D-4, D-5, and D-6 – Ninety-eight parts methyl methacrylate and two parts liquid benzoyl peroxide (by volume).

Type D liquid cold applied methyl methacrylate shall meet the following requirements for viscosity:

4:1 Formulations Type D – Liquid Cold Applied Methyl Methacrylate													
Property	Test Method	D-1		D-2		D-3		D-4		D-5 White		D-5 Yellow	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Viscosity cP @ 77°F, 50-rpm, spindle #7	ASTM D2196 Method B, LV Model	11,000	15,000	26,000	28,000	17,000	21,000						
Viscosity cP @ 77°F, 50-rpm, spindle #4	ASTM D2196 Method B, LV Model							8,000	10,000	5,000	8,000	7,000	11,000

98:2 Formulations Type D – Liquid Cold Applied Methyl Methacrylate													
Property	Test Method	D-1		D-2		D-3		D-4		D-5		D-6	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Viscosity Daniel Scale	Daniel Method ¹	12	14	6	12	12	14	13	15				
Viscosity cP @ 77°F, 50-rpm, spindle #4	ASTM D2196 Method B, LV Model									100	118		

¹Follow Daniel Gauge method; measure flow at 60-seconds.

9-29.4 GLASS BEADS FOR PAVEMENT MARKING MATERIALS

Glass beads for traffic marking paint shall be coated with silicone for moisture resistance and a silane to promote adhesion. The beads shall be transparent, clean, colorless glass; smooth and spherically shaped; and free from milkiness, pits, or excessive air bubbles.

Glass beads used with plastic traffic markings shall be per the manufacturer's recommendations.

The glass beads for paint and plastic traffic markings shall not contain any metals in excess of the following established total concentration limits when tested in accordance with the listed test methodology:

Metal Concentration Limits		
Element	Test Method	Max. Parts Per Million (ppm)
Arsenic	EPA SW846 6010C	5.0
Barium	EPA SW846 6010C	100.0
Cadmium	EPA SW846 6010C	1.0
Chromium	EPA SW846 6010C	5.0
Lead	EPA SW846 6010C	50.0
Selenium	EPA SW846 6020A	1.0
Silver	EPA SW846 6010C	5.0
Mercury	EPA SW846 7471B	0.20

Glass beads for pavement marking materials shall meet the following requirements for quality:

Glass Bead Property	Test Method	Type A		Type B ¹	
		Min.	Max.	Min.	Max.
Refractive Index @ 77 ± 9°F	AASHTO M 247 Section 5.2.3	1.50	1.55	1.50	1.55
Moisture Resistances	AASHTO M 247 Section 5.3.2	Flow Without Stopping		Flow Without Stopping	
Adherence	AASHTO M 247 Section 5.3.4	Pass		Pass	
Roundness, %	ASTM D1155	70		80 ²	
	FLHT 520			80 ³	
Appearance	TT-B-1325D Section 4.3.1			Beads shall be transparent, clean, dry, and free from bubbles and foreign matter.	
Resistance to Acid	TT-B-1325D Section 4.3.6			Beads shall not develop any surface haze or dulling.	
Resistance to Calcium Chloride	TT-B-1325D Section 4.3.7			Beads shall not develop any surface haze or dulling.	
Resistance to Sodium Sulfide	TT-B-1325D Section 4.3.8			Sodium sulfide should not darken the beads.	
Water Resistance	TT-B-1325D Section 4.3.9			Water shall not produce haze or dulling of the beads.	

¹WSDOT Type B Glass Beads are high-performance glass beads for improved retroreflectivity and durability for high-performance pavement markings. A minimum of 50 percent of the glass beads shall be made from the direct-melt molten kiln process.

²Roundness will be determined on material < No. 30 sieve.

³Roundness will be determined on material ≥ No. 30 sieve.

Glass beads for pavement marking materials shall meet the following requirements for grading when tested in accordance with ASTM D1214:

Sieve Size	Percent Passing			
	Type A ¹		Type B	
	Min.	Max.	Min.	Max.
No. 14			100	
No. 16	100			
No. 18			65	80
No. 20	95	100		
No. 30	75	95	30	50
No. 50	15	35	0	5
No. 100	0	5		

¹Same gradation as AASHTO M 247 Type 1.

9-29.5 TEMPORARY PAVEMENT MARKING TAPE

Temporary pavement marking tape shall be pressure sensitive, reflective type, conforming to ASTM D 4592, designed for application on asphalt or concrete pavement. Biodegradable tape with paper backing shall not be allowed. Surface preparation and application shall be in conformance with all the manufacturer's recommendations.

9-29.6 TEMPORARY RAISED PAVEMENT MARKERS

Temporary flexible raised pavement markers shall consist of an L-shaped body with retroreflective tape on the top of one face for one-way traffic and reflective tape on the top of both faces for two-way traffic. The marker body shall be made from 0.060-inch minimum thick polyurethane. The top of the vertical leg shall be between 1.75 and 2.0 inches high and shall be approximately 4 inches wide. The base width shall be approximately 1.125 inches wide. The base shall have a pressure sensitive adhesive material, a minimum of 0.125 inch thick with release paper. The reflective tape shall be a minimum of 0.25 inch high by 4 inches wide. The reflective tape shall have a minimum reflectance of 3.5 candlepower per foot-candle for white and 2.5 candlepower per foot-candle for yellow measured at 0.2-degree observation angle and 0-degree entrance angle.

Temporary raised pavement markers other than temporary flexible raised pavement markers shall conform to the requirements of Section 8-09.2.

9-29.7 FIELD TESTING

9-29.7(1) REQUIREMENTS

Field performance evaluation is required for low VOC solvent-based paint per Section 9-29.2(4), standard waterborne paint and high-build water borne paint per Section 9-29.2(5), Type A – liquid hot applied thermoplastic per Section 9-29.3(1), Type B – preformed fused thermoplastic per Section 9-29.3(2), Type C – cold applied preformed tape per Section 9-29.3(3), and Type D – liquid applied methyl methacrylate per Section 9-29.3(4).

Testing on a northern AASHTO National Transportation Product Evaluation Program (NTPEP) pavement marking test deck is recommended. Test decks conducted by other public entities may be considered provided they produce data similar to a northern NTPEP test deck. Retroreflectivity, Durability, and Auto No-Track shall conform to the following requirements after being installed on a northern NTPEP test deck for a minimum of 12 months.

Successful use of a product in five other States may be considered in lieu of the field test requirement.

Cold weather waterborne traffic paint per Section 9-29.2(5) will be accepted based solely on the laboratory testing.

9-29.7(1)A RETROREFLECTIVITY

Retroreflectivity is measured as a coefficient of retroreflective luminance (RL) in accordance with the requirements of ASTM E 1710 for 30-meter geometry. The minimum initial retroreflectivity is 250 mcd·m⁻²·lx⁻¹ for white and 175 mcd·m⁻²·lx⁻¹ for yellow, except Type C preformed tape shall meet the minimum initial values in ASTM D 4505. The minimum retroreflectivity after 12 months is 150 mcd·m⁻²·lx⁻¹ for white and 100 mcd·m⁻²·lx⁻¹ for yellow, when measured in the skip line area. However, the Department will review the results of each test deck to determine the minimum value in effect for that deck, in order to approve only the better-performing materials.

9-29.7(1)B DURABILITY

Durability rating shall be a minimum of seven in the skip line area and six in the wheel paths after 12 months. The rating system used will be as indicated by NTPEP procedures. However, the department will review the results for each test deck to determine the minimum value in effect for that deck, in order to approve only the better-performing materials.

9-29.7(1)C AUTO NO-TRACK TIME

Auto No-Track Time will only be required for low VOC solvent-based paint per Section 9-29.2(4), and standard waterborne paint and high-build water borne paint per Section 9-29.2(5).

No-track time shall be determined in accordance with NTPEP procedures by passing over an applied test line with a standard size passenger car without tracking of the line when viewed from a distance of 50 feet. Standard paint shall have a no-track time of 90 seconds or less when applied at a wet film thickness of 15 ±1 mil, with glass beads applied at a minimum rate of 6 pounds per gallon of paint. High-build paint shall have a no-track time of 120 seconds or less when applied at a wet film thickness of 20 to 30 mils, with glass beads applied at a minimum rate of 10 pounds per gallon of paint. The maximum no-track time shall not be exceeded when the pavement temperature is between 50°F and 120°F, with relative humidity less than 85 percent, and the pavement is dry.

9-29.7(1)D APPROVAL

The Department will evaluate the results of laboratory and test deck data. This information will be reviewed for each material by color and roadway surface to determine compliance with this Specification. Approved product formulas will remain active for a period of approximately 5 years after completion of the NTPEP evaluation; afterwards, the product will need to be reevaluated.

SECTION 9-30 WATER DISTRIBUTION AND TRANSMISSION MATERIALS

9-30.0 GENERAL

All Materials for water distribution and transmission shall be new. Materials used for temporary Water Main and for temporary service connection purposes may be either new or previously used materials and shall be subject to Seattle Public Utilities' Water Operation's inspection and approval prior to installation.

Prior to ordering any pipe to be used in a potable water supply, the Contractor shall submit the Material source as required by Section 1-06.1 and shall obtain the Engineer's approval.

All direct and indirect drinking water system components which come in contact with potable water shall have National Sanitation Foundation certification.

9-30.1 PIPE

All pipe and fittings shall be clearly marked with the manufacturer's name, type, class, and thickness as applicable and shall be marked on the component at the place of manufacture. Marking shall be legible and permanent under normal conditions of handling and storage.

9-30.1(1) DUCTILE IRON PIPE

1. Ductile iron pipe shall be centrifugally cast in 18 or 20 foot nominal lengths and shall be marked conforming to AWWA C151. Ductile iron pipe shall have a double thick cement-mortar lining conforming to AWWA C104. Ductile iron pipe shall be Standard Thickness Class 52. Flanged ductile iron pipe shall be CL 53 per AWWA C115. Thicker Classes are acceptable.
2. Non-restrained joints shall be rubber gasket, push-on type, or mechanical joint conforming to AWWA C111.
3. Restrained joints shall be as specified in Section 9-30.2(6).
4. Special coatings shall comply with Section 9-30.1(6).
5. Ductile Iron pipe shall meet SPU's taste and odor test requirements.

9-30.1(2) RESERVED**9-30.1(3) RESERVED****9-30.1(4) STEEL PIPE****9-30.1(4)A STEEL PIPE LESS THAN 4 INCHES DIAMETER**

Steel pipe less than 4 inches in diameter shall conform to ASTM A 53, schedule 40 and shall be hot dip galvanized inside and out, including the couplings. The pipe sections shall be coupled by malleable iron screw coupling in accordance with ANSI Specification B16.3.

9-30.1(4)B STEEL PIPE 4 INCH DIAMETER AND LARGER

Steel pipe 4 inches in diameter and larger shall conform to AWWA C200. The type of protective coating and lining and other supplementary information required by AWWA C204 will be included in the Contract.

9-30.1(5) PLASTIC PIPE AND ASBESTOS CEMENT PIPE

Polyvinyl chloride (PVC), polyethylene, polybutylene, and asbestos cement material pipe shall not be used as Water Main to convey potable water.

9-30.1(6) PIPE COATINGS**9-30.1(6)A SPECIAL PIPE COATINGS**

Special pipe coatings shall be in accordance with the Contract.

9-30.1(6)B MULTI-LAYERED POLYETHYLENE TAPE COATING (MULTI-LAYERED POLYETHYLENE ENCASEMENT)

See Section 9-30.1(6)D for polyethylene (film wrap) encasement.

Acceptable Suppliers of multi-layered polyethylene tape coating shall be Polyken YGIII as manufactured by Kendall Company, or Tapecoat CT 10/40 W as manufactured by Tapecoat Company, or approved equal. The multi-layered polyethylene tape coating shall conforming to AWWA C214, and shall meet the following requirements:

1. The multi-layered polyethylene tape coating system shall consist of the following components:
 - a. One layer of pipeline coating primer and 20 mil inner wrap.
 - b. One layer of pipeline wrap coating, 30 mils minimum thickness.
 - c. One additional layer of outer wrap coating, 30 mils minimum thickness.
2. The primer shall be fast drying and shall form an instantaneous, firm bond when the adhesive on the tape coating comes in contact with the primed pipe surface. Coating primer shall be compatible with the adhesive and shall be from the same manufacturer.
3. The inner wrap coating shall consist of polyethylene backing with a butyl-based adhesive laminated to one side of the backing. The polyethylene backing and adhesive shall be made by the calendaring process in order to ensure the maximum bonding of the adhesive to the backing. The adhesive shall be formulated so that it forms a firm bond upon contact with the primed pipe surface.
4. The pressure sensitive adhesive outer wrap shall consist of a polyethylene backing with a butyl-adhesive laminated to one side of the backing. The pressure sensitive adhesive on the outer wrap shall form a firm continuous bond to the backing of the tape coating.
5. Cutbacks on the spigot end shall be 6 inches or less and shall be made with a cutting device that is guided from the end of the pipe to ensure a straight, uniform cutback. No cutback shall be made on the bell end of the pipe.
6. Following the application of the outer wrap, the coating shall be electrically tested for holidays with a pulse tape holiday detector. The detector voltage range for this coating is 7000-9800 volts. The testing shall conform to NACE RP-02-74.
All defects electrically detected shall be repaired by priming and patching with a suitable primer and tape as specified by the manufacturer and approved by the Engineer.
7. Accessory Tape. Accessory tape for fittings and specials shall be YG III as manufactured by Kendall Co., or approved equal. The accessory tape shall conform to AWWA C209, and shall meet the following requirements:
 - a. One layer of pipeline coating primer and 50 mil inner wrap.
 - b. One layer of 35 mil outer wrap.

The primer shall be fast drying and shall form an instantaneous, firm bond when the adhesive on the tape coating comes in contact with the primed pipe surface.

The pressure sensitive adhesive outer wrap shall consist of a polyethylene backing with a butyl-adhesive laminated to one side of the backing. The pressure sensitive adhesive on the outer wrap shall form a firm continuous bond to the backing of the tape coating.

9-30.1(6)C THERMOPLASTIC POWDER COATING

9-30.1(6)C1 GENERAL

The powdered thermoplastic Material shall consist of acid modified polyolefin elastomer to which any stabilizers, pigments, or other additives necessary to meet the performance requirements of this Specification have been added by extrusion compounding. The thermoplastic powder shall be suitable for factory application by fluid bed dipping, and or elastic/flock deposition method. For on-site application, other application methods such as controlled flame spraying are acceptable if carried out by an approved applicator. When applied to a substrate in accordance with the guidelines agreed by the manufacturers and approved applicators, the powder shall form a coating which meets or exceeds all requirements of this Specification.

9-30.1(6)C2 QUALITY OF DUCTILE IRON PIPE

Surface preparation, application and curing of powder coating, and testing and touch-up of coating shall be performed by an "experienced applicator". "Experienced applicator" shall be defined as having working knowledge of and experience with:

1. Surface preparation/blasting of ductile iron pipe,
2. Application and curing of thermoplastic powder coating,
3. Quality assurance testing including:
 - a. mil thickness measurement,
 - b. profile measurement,
 - c. anchor and adhesion testing,
 - d. holiday testing, and
 - e. temperature monitoring, and
4. manufacturer approved touch-up repairs.

9-30.1(6)C3 SURFACE PREPARATION

The pipe and fittings shall be prepared for coating by blasting the pipe surface to remove impurities and imperfections. The existing pipe surface profile shall not change by more than 2 to 3 mils. Preparation shall consist of the following:

1. Before blast cleaning, remove all visible grease, asphalt coating, oil, slag, burs, and other protrusions resulting in a smooth substrate conforming to curvature. When a solvent is used, all solvent residue shall be removed;
2. Bevel all sharp edges and corners;
3. Do not use steel shot or other non-angular blast material; and
4. Use clean, dry, oil-free air for nozzle blasting.

When surface preparation is complete and the surface is viewed without magnification, staining, oil, grease, dirt, dust, rust, pre-existing coating, loose oxides, and any other contaminant shall not be visible. The prepared Material shall be maintained clean for the coating.

9-30.1(6)C4 APPLICATION OF POWDER COATING

Powder Coating

PPA 571 thermoplastic powder coating, as manufactured by Plascoat Systems Limited or an approved equal.

Masking and Plugging

All masking, where required, shall be done using a high powder coating masking tape. The ends of pipe and fittings shall be plugged both during heating in the oven, and during the coating process to keep the interior mortar lining cooler and to keep the powder coating from passing beyond the groove where the gasket is to be installed in the bell end of the pipe or fitting.

Preheating

All parts shall be preheated to a maximum temperature of 240°F before coating is applied.

A Raytek RAYNGER ST SERIES noncontact infrared temperature measurement tool or similar device shall be used for determining coating temperature.

Preheating shall be done using a gas fired convection oven or equivalent.

Coating With Electrostatic Deposition

After the part has been preheated to the 240°F temperature followed by the powder application to the surface of the part using a corona powder coating discharge gun, a negative polarity is required and a voltage of 30kv is recommended. The powder is applied across the total surface of the part, taking care that the powder is applied in a level and homogenous build. The coating shall be applied to a dry film thickness of 20 to 25 mil and be totally free of holidays/pinholes.

It is then necessary to convey the part to the oven which shall be set between 285°F and 385°F in order to complete flowing out of powder.

The coating shall be smooth, even and free of runs, sags, streaks and overspray.

Coating With Fluid Bed Dip System

After the part has been preheated to 240°F, the part is then dipped into a fluidized bed of powder and left for a prescribed time to accomplish a coating thickness of 20 to 25 mil.

The part shall be conveyed to the oven for a complete flowing of the powder.

The coating shall be smooth, even, and free of runs, sags, streaks and overspray.

9-30.1(6)C5 TESTING

Holidays

After completing the coating process, the part shall be cooled to ambient temperature and then electrically tested for holidays with a Tinker & Razor AP/S1 holiday detector or equivalent. The voltage should not exceed 6kv for a 25 mil coating. The testing shall conform to NACE RP-02-74. All defects electrically detected shall be repaired by the following method. Clean the area around the holiday/pinhole using mineral sprits, acetone or alcohol. Immediately after cleaning, heat should be applied to the coating surrounding the pinhole to re-melt and flow the coating over the holiday/pinhole repair.

Thickness

Each coated part shall be tested for coating thickness using an electronic coating thickness gauge such as Qua Nix 1500 or equivalent and the test results in accordance with Section 1-06.5 shall be submitted to the Engineer within 3 Working Days of the testing.

9-30.1(6)C6 FIELD REPAIR AND TOUCH-UP

Damaged coating or repair of cutback areas may be repaired after proper substrate preparation. Exposed substrate should be thoroughly cleaned of corrosion products and contamination to expose bare metal. Abrasive techniques (wire brush, sandpaper, sandblast, etc.) followed by cleaning with mineral sprits, acetone or alcohol are recommended. Immediately after cleaning heat should be applied to the coating adjacent to the damaged area to re-melt and flow the coating over the damaged area. If required, additional PPA571 powder may be added and melted to insure proper installation of a homogenous protective coating of sufficient thickness.

Major repairs (large areas) may require a specialized Subcontractor with proper training and equipment to complete a fault holiday-free field repair. If that Subcontractor or the Contractor determine, or if the Engineer determines, that the level of damage is such that a fault holiday-free repair cannot be attained, then the Contractor shall remove and replace the damaged item.

9-30.1(6)C7 MATERIAL REQUIREMENTS

Test Conditions

Unless otherwise specified in the Contract, the testing conditions shall be in accordance with ASTM D 3924 at standard Conditions: 73.5°F ±3.5F°, 50% ±5% relative humidity.

Specific Gravity

Specific gravity of the powder thermoplastic coating Material shall be between 0.90 and 0.97. Specific gravity shall be determined in accordance with method B specified in ASTM D 729.

Color

Color of the thermoplastic powder coating shall be specified by the purchaser and evaluated for conformance in accordance with ASTM D 1729.

Flexibility

The thermoplastic powder coating shall exhibit no cracking, peeling, or loss of adhesion when bent (coated side in tension) 180 degrees over a conical mandrel in accordance with ASTM D 522, Test Method B. Panels shall be examined immediately after bending.

Adhesion

The thermoplastic powder coating shall exhibit a minimum of 1000 psi adhesion to the aluminum and steel substrates in accordance with ASTM D 4541.

Thermal Shock Resistance

The applied thermoplastic powder coating shall withstand 10 temperature cycles without cracking, checking, or disbonding. Cycles should be from +104 °F to -40 °F.

Impact Resistance

The applied thermoplastic powder coating shall resist minimum direct and reverse impacts of 36 inch-pounds without cracking, disbonding or holiday formation as determined by visual inspection. Test panels shall be impacted in accordance with ASTM D 2794 using a 2 pound weight with a 0.5" diameter indenter dropped from a height of 18".

Abrasion Resistance

Weight loss from the applied thermoplastic powder shall not exceed 90 milligrams. Test panels shall be tested for 1000 cycles using a Taber Abrader apparatus with CS-17 wheels and 1000 gram weights in accordance with ASTM D 4060. Weight loss shall be determined immediately after test to three significant figures.

Salt Spray Resistance

Unscribed: There shall be no blisters, wrinkles or loss of adhesion nor any general surface corrosion or pitting after 1000 hours of salt spray exposure.

Scribed: There shall be no blisters, wrinkles nor any general surface corrosion or pitting after 1000 hours of salt spray exposure. There shall be no more than 10mm loss of adhesion from a scribed line after 1000 hours of salt spray exposure.

Fluid Resistance Properties

The applied thermoplastic powder coatings shall exhibit no objectionable alteration to the surface such as discoloration, change in gloss, blistering, softening, loss of adhesion, formation of holidays or special phenomena after immersion for 7 Days in accordance with ASTM D 1308 in the following fluids.

1. Distilled water.
2. Type III hydrocarbon (per Federal Spec. TT-S-735).
3. Hydraulic fluid (per Mil-H-83282).

Chemical Resistance

The applied thermoplastic coating shall exhibit no objectionable alteration to the surface such as discoloration, change in gloss, blistering, softening, loss of adhesion, formation of holidays or special phenomena after immersion for 7 Days in accordance with ASTM D 1308 in the following chemical solutions:

1. 3M aqueous CaCl₂.
2. 3M aqueous NaOH.
3. Saturated aqueous Ca(OH)₂.
4. Aqueous solution of H₂SO₄ (specific gravity = 1.29 ±0.02).

Dielectric Strength

The applied thermoplastic coating shall have a dielectric strength of 900 ±100 v/mil at 15 mil in accordance with ASTM D 149.

Weathering Properties

The applied thermoplastic coating shall exhibit the following resistance to weathering:

1. **Accelerated weathering.** The applied thermoplastic powder coating shall show no cracking, significant color change (fade), chalking, Blistering, wrinkling or loss of adhesion, nor shall there be any evidence of substrate corrosion after 2000 hours exposure to accelerated weathering in accordance with ASTM G 53 using UVB-313 fluorescent lamps. The coating, shall exhibit no more than 30% loss in 60 degree specular gloss after exposure.
2. **Humidity resistance.** Test panels shall be exposed to a 120°F ±2F°, 100% relative humidity environment in accordance with ASTM D 2247 for 30 Days. The coating shall show no blistering, wrinkling or loss of adhesion nor shall there be any evidence of substrate corrosion after humidity exposure.
3. **Holidays.** The applied thermoplastic powder coating shall be free of holidays at an application thickness of 20-25 mil. holiday detection shall be performed with a low voltage (75-100 volts) direct current detector.
4. **Shelf life.** Powder coating Materials shall meet the requirements of the Owner, with a minimum of 2 years from the date of manufacture when stored below 85°F, 50% relative in the unopened original container.

Material Safety Data Sheets (MSDS)

Material Safety Data Sheets shall be provided to the Engineer.

9-30.1(6)D POLYETHYLENE ENCASUREMENT (FILM WRAP)

Plastic film wrap for polyethylene encasement shall be 8 mil polyethylene conforming to AWWA C105.

See Section 9-30.1(6)B for multi-layered polyethylene encasement.

9-30.1(6)E HEAT SHRINK JOINT SLEEVE

The sleeve shall be Aqua Shield, or approved equal. The sleeve shall be a wrap around type with a joint closure and shall contain a thermal indicator.

9-30.1(6)F WAX TAPE COATINGS

Petrolatum-impregnated wax tape coating shall conform to AWWA C217. Acceptable products are 1) - #1 Wax-Tape as manufactured by The Trenton Corporation, Ann Arbor, MI, or 2) - Densyl Tape as distributed by Denso North America Inc., Houston, TX, or 3) - approved equal.

See Section 7-12.3(8) for field application construction requirements.

9-30.2 FITTINGS**9-30.2(1) DUCTILE IRON PIPE**

Fittings for ductile iron pipe shall be ductile iron conforming to AWWA C110, and AWWA C111 or AWWA C153 and shall be cement-mortar lined conforming to AWWA C104.

Except where restrained joint systems are required, fitting joints shall be mechanical joint.

Where restrained joint pipe is required, threaded flanges by restrained joint adapters shall not be longer than three pipe diameters. Threaded flanges and pipe shall conform to AWWA C115. The exterior flange lip overlapping the pipe barrel shall be sealed with a bituminous mastic.

Sleeves less than 12 inches in diameter shall be 12 inches minimum length and shall be mechanical joint.

Sleeves greater than 12 inches in diameter shall be of the long body type and shall be 15 inches minimum length and shall be mechanical joint.

Where ductile iron pipe is to be joined to existing cast iron pipe of the same nominal size, and electrical isolation is not required at the connection, and the outside diameter of the existing cast iron pipe varies 0.05 inches or less from the specified outside diameter of the ductile iron pipe being joined, the pipe shall be joined with a mechanical joint sleeve.

Where 10 inch through 24 inch diameter ductile iron pipe is to be joined to existing cast iron pipe of the same nominal size, and electrical isolation is not required at the connection, and the outside diameter of the existing cast iron pipe conforms to AWWA 1908 classifications A, B, C, or D, the pipe shall be joined with a transition mechanical joint sleeve having a single-piece body.

Where 8 inch or smaller diameter ductile iron pipe is to be joined to existing cast iron pipe of the same nominal size, and electrical isolation is not required at the connection, and the outside diameter of the existing cast iron pipe conforms to AWWA 1908 classifications A, B, C, D, E, or F, the pipe shall be joined with a transition mechanical joint sleeve having a single-piece body.

Hub-by-flange fitting length shall conform to AWWA C110 or AWWA C153. The body of hub-by-flange fittings shall be a single-piece casting. Threaded pipe and flange combinations shall not be used.

9-30.2(2) RESERVED**9-30.2(3) RESERVED****9-30.2(4) STEEL PIPE**

Fittings for steel pipe 3-1/2 inches in diameter and smaller shall be malleable iron threaded type with a pressure rating of 150 psi. Dimensions shall conform to ANSI B16.3. Threading shall conform to ANSI B2.1. Material shall conform to ASTM A 47, Grade 32510. All fittings shall be banded and hot-dip galvanized inside and out.

Unions shall be malleable iron with a pressure rating of at least 150 psi. Material shall conform to ASTM A 47, Grade 32510. Unions shall be ground joint, bronze to iron type.

Steel fittings for pipe 4 inches in diameter and larger shall be in accordance with AWWA C208. The class of the fittings shall be at least the same as that of the pipe. Coatings for couplings and fittings shall be factory applied. Field couplings shall be compression type. When flanges are required, they shall conform to AWWA C207. Buried couplings, bolts and followers shall be coated with wax tape per Section 7-11.3(8)A.

9-30.2(5) RESERVED**9-30.2(6)A RESTRAINED JOINTS**

Restrained joints, where required on the Drawings, shall be flexible after assembly and be able to be disassembled. Restrained joints shall meet the following criteria:

1. The restrained joint shall have a positive metal to metal contact locking system without the use of gripping teeth,
2. The joint restraint system for the pipe shall be the same as the joint restraint system for the pipe fittings, except as provided in item 4. below.
3. The joint restraint system for the pipe shall be boltless if the Drawings show joint bonding and,
4. Where restrained jointed fittings required on the Drawings cannot be furnished, or where restrained jointed fittings are required in areas that are known to be subject to location adjustments, the Contractor may submit a lay plan showing mechanically jointed fittings with Wedge Restraint Glands for approval. Mechanically jointed pipe with Wedge Restraint Glands shall not be substituted for restrained jointed pipe.

9-30.2(6)B WEDGE RESTRAINT GLANDS

Wedge Restraint Glands shall conform to AWWA C111, ASTM A 536-80 Grade 65-45-12. All bolts and wedges shall be ductile iron. Wedges shall be heat-treated to a minimum 370 BHN. Wedge Restraint Glands shall be rated for 350 psi for pipe 12 inch in diameter and smaller. All Wedge Restraint Glands shall be wax tape encased. Wedge Restraint Glands shall be electrically joint bonded if installed on coated Water Main.

9-30.2(7) TRANSITION REDUCING, AND INSULATING FLEXIBLE COUPLINGS

Transition couplings, reducing couplings, transition reducing couplings, sleeves, and flexible insulating couplings for Water Main shall be compression type by pipe manufacturer: Romac or Ford or approved equal. Bolts and nuts shall be corrosion resistant per AWWA C111. Stainless steel bolts require anti-seize compound. The long body pattern with a

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minimum center ring or center sleeve length of 12 inches for pipe less than 12 inches in diameter and equal to or greater than the pipe diameter for pipe greater than 12 inches in diameter. Solid sleeves (greater than 12 inch diameter) shall be a 15 inch minimum length. Factory finish shall be fusion bonded epoxy or Plascoat PPA 571 thermoplastic coating.

9-30.2(7)A INSULATING COUPLINGS

Insulating couplings and flange kits shall be required at any point of connection of two dissimilar metallic Material pipes (i.e., ductile iron to cast iron) as shown on the Drawings. The insulating coupling body shall be coated with either thermoplastic powder coating Plascoat PPA 571 fusion-bonded epoxy conforming to AWWA C213, or high-build polyamide epoxy conforming to AWWA C210, and shall be a liquid coating, portable water grade, capable of 4 to 8 mil dry film thickness per coat, or thermoplastic powder coat per Section 9-30.1(6)C; insulating boot shall cover the pipe end to prevent metal contact between pipe sections being joined. The insulating boots and rubber gaskets shall be virgin synthetic butyl rubber compatible for potable water service. The nuts and bolts shall be stainless steel ASTM F 593, Type 316. The insulating coupling shall be manufactured by Romac Industries, Inc., or approved equal.

9-30.2(7)B INSULATING FLANGE KITS

Insulating flange kits shall consist of a full-face neoprene faced phenolic, type "E" O-ring gasket; insulating sleeves and washers manufactured from glass reinforced epoxy design; and 1/8 inch thick plated, hot rolled steel washers. Acceptable Suppliers are Pipeline Seal and Insulator (PSI) Inc., Houston, Tx.; Central Plastics Co., Shawnee, OK.; or approved equal.

9-30.2(8) RESTRAINED FLEXIBLE COUPLINGS AND SLEEVES

Restrained flexible couplings or sleeves shall be as indicated on the Drawings. Lengths shall meet minimum requirements per Section 9-30.2(7).

9-30.2(9) SPECIAL FITTINGS

Special fittings shall be as indicated on the Drawings.

9-30.2(10) TWO-INCH BLOWOFF ASSEMBLY

Two inch blowoff assembly shall be as indicated on Standard Plan nos. 340a and 340b at the locations shown on the Drawings.

Two inch service tube shall be Type K copper. Two inch gate valve shall be of iron-body construction, having bronze seat rings and stem, an o-ring stem seal system, shall be fitted with a 2 inch square operating nut, F.I.P.T. inlet and outlet threading conforming to ANSI B2.1, and shall be minimum 150 pounds working water pressure rated. Plastic foam Material shall conform to Section 9-30.2(11). Frame and cover shall conform to Section 9-30.3(12)H. Meter Box shall conform with Section 9-30.6(8).

9-30.2(11) PLASTIC FOAM (ETHAFOAM)

Plastic foam shall be in accordance with Section 9-05.10.

9-30.2(12) CEMENT CONCRETE

Cement Concrete for pipe support saddles and cradles and for thrust blocking shall be Class 3000 (see Section 6-02).

9-30.2(13) RESERVED

9-30.2(14) STEEL CASING PIPE

Steel casing pipe shall have a diameter and wall thickness as specified on the Drawings. Pipe shall be smooth and bare.

9-30.2(15) SEALS AND SPACERS FOR STEEL CASING PIPE

9-30.2(15)A SEALS

Casing end seals shall be used to completely seal the annular space between the casing and the Water Main at each end of the casing. Casing end seals shall provide a moisture-proof seal that is resistant to heat, cold, vibration, impact, abrasion, disbonding, expansion and contraction, and shall be impermeable. Acceptable seals are standard pull-on model S, or custom pull-on model C as manufactured by Pipeline Seal and Insulator, Inc., or approved equal.

9-30.2(15)B SPACERS

Casing spacers shall be bands at least 12 inch in width, and shall be either stainless steel or heavy duty fusion bonded epoxy coated steel. Runners shall be 2" wide glass reinforced plastic securely bonded to the spacer, and shall be aligned on the spacer along the axis of insertion of Water Main into casing pipe. Runner length shall approximate the width of the spacer. Securing the spacer to the Water Main shall be in accordance with the manufacturer's instruction.

Acceptable spacers are Pipeline Seal and Insulator, Inc. (PSI) model S12G-2 for stainless steel and model C12G-2 for coated steel, or approved equal.

9-30.3 VALVES**9-30.3(1) GENERAL - MANUFACTURE AND MARKING**

The valves shall be a standard pattern of a manufacturer whose products are approved by the Engineer and shall have the name or mark of the manufacturer, year valve casting was made, size, and working pressure plainly cast in raised and legible letters on the valve body. All valves shall be NSF approved and valve bodies shall be ductile iron. All valves shall be stamped with both "NSF APPROVED" and "DI".

Where a valve is required to operate in a higher pressure environment than the Class of valve specified in Section 9-30.3, the class of valve shall be as specified in the Contract.

9-30.3(2) GATE VALVES**9-30.3(2)A GATE VALVES - DOUBLE DISC**

In addition to 9-30.3(1), gate valves 3 inch through 12 inch shall conform to AWWA C500, be equipped with non-rising stems and "O" ring stuffing box, and with double disc gates having a bronze wedging device.

All gate valves shall have a ductile iron body.

Valves shall open counterclockwise when viewed from above, and shall be equipped with a standard AWWA 2 inch square operating nut. Valves shall be double disc-bronze seated valves if they have iron bodies.

Three (3) Manufacturer's Certificates of Compliance copies demonstrating performance tests comply with AWWA C500 shall be submitted to the Engineer.

Valve ends shall be mechanical joint. Where restrained joints are called out, valve ends shall be flanged with appropriate flange by restrained joint adapters per Section 9-30.2(1).

The valves shall be as manufactured by Clow, M & H, American Flow Control (ACIPCo), Pratt/Mueller, M&H/Kennedy, or approved equal in sizes 12 inches or less.

Gate valves 2-1/2 inch and smaller shall be of ductile iron body construction having bronze seat rings and stem, o-ring seal system, F.I.P.T. (female iron pipe thread) inlet and outlet conforming to ANSI B2.1, a standard AWWA 2 inch operating nut, and shall be minimum 150 pounds water working pressure.

The 2 inch and smaller valves shall be manufactured by Kennedy, Nibco-Scott, Stokum, or approved equal.

9-30.3(2)B GATE VALVES RESILIENT SEAT

Gate valves 3 inch through 12 inch shall conform to AWWA C509 and Section 9-30.3(1).

9-30.3(3) RESERVED**9-30.3(4) BUTTERFLY VALVES**

In addition to the requirements of section 9-30.3(1), Water Main butterfly valves shall conform to AWWA C504 and shall be Class 150B. The valve shall be short-body type and shall have flanged ends. Flanged ends shall be sized and drilled in conformance with ANSI B16.1 Class 125. Valve shall be suitable for direct burial installation; however butterfly valves 12 inch and larger shall be installed within an access vault sized to permit removal and replacement of the valve.

All butterfly valve bodies and discs shall be ductile iron.

Butterfly valves other than AWWA C504 Class 150 and butterfly valves installed on water transmission pipeline shall be as indicated in the Contract.

Where butterfly valves are installed on restrained joint Water Mains, the valve ends shall be flanged with flanged by restrained joint adapters per Section 9-30.2(1).

Valves shall be mounted on the Water Main or pipeline such that the operating nut is accessible and operable from above.

Operator shall be manual, fully enclosed, and suitable for buried service. It shall open left (counterclockwise when viewed from above), and shall be equipped with a standard AWWA 2 inch square operating nut.

Operators for 16 inch and larger valves shall be equipped with external indicators, visible from above, which show the position of the valve disc.

Unless otherwise indicated in the Contract, the minimum number of turns from fully open to fully closed on Class 150 butterfly valves shall be as follows:

DIAMETER	TURNS, MIN.
4 inch to 8 inch	16 turns
10 inch to 12 inch	28 turns
14 inch to 18 inch	30 turns
20 inch	60 turns
24 inch	100 turns
30 inch	150 turns
36 inch and larger	200 turns

A Manufacturer's Certificate of Compliance stating that the valves to be furnished fully comply with AWWA C504 and the modifications contained herein shall be submitted to the Engineer before incorporation of the valve into the Work.

Unless the Contract specifies otherwise, bolting and torquing for the valve connection to the Water Main shall be as recommended by the manufacturer including any connection coating requirement when buried in soil. Wearing surfaces shall be bronze or other approved noncorrosive Material and there shall be no moving bearing or contact surface of iron in contact with iron. Rubber seat shall be retained in the body and shall mate against a stainless steel surface mounted on the disc. Contact surfaces shall be machined and finished in the best workmanlike manner, and all wearing surfaces shall be easily renewable.

The butterfly valves shall be manufactured by Henry Pratt Company, Mueller, DeZurick, Mosser Valve Division of Olsen Technologies, or approved equal.

The valve manufacturer shall provide a non-corrosive durable metal tag, measuring 4 inches by 6 inches, or other size as approved by the Engineer, with the number of turns to fully open/close the valve permanently stamped on the tag. A non-corrosive high strength durable cord, approximately 18 inches in length, shall permanently attach the tag to either the bottom end of the valve box or the lower section of the valve chamber frame, as applicable.

9-30.3(5) VALVE BOXES

Valve boxes shall be installed on all buried valves. The box and lid shall be cast iron, 2-piece slip type with cast iron extension as necessary, conforming to requirements and dimensions of the current Seattle Public Utilities - Water Utility Standards.

The cover shall have the word "WATER" or the letter "W" cast in it.

Valve boxes, lids and extensions of the following manufacturers are approved for use:

Olympic Foundry, Inc.

045 Valve Box; Standard Base and Extension
Lid Section # 13-5010
Top Section # 13-5020
Base Section # 13-5021

EJCO Part Numbers

24" Valve Box Complete Assembly - 00366420A01
30" Valve Box Complete Assembly - 00366420A02
36" Valve Box Complete Assembly - 00366420A03.
Lid Section – 00366420
Top section – 00366412
Base Sections:
24 inch – 85556024
30 inch – 85556030
36 inch – 85556036

Each top and lid section shall be tested for accuracy of fit and shall be marked in sets for delivery.

Valve box extension pieces shall be provided for valves with ground cover in excess of the depth of the standard valve box (see Standard Plan nos. 315a and 315b).

9-30.3(6) RESERVED

9-30.3(7) COMBINATION AIR RELEASE / AIR VACUUM VALVES

Combination air release/air vacuum valves shall comply with the requirements of ANSI / AWWA C512.

9-30.3(8) END CONNECTIONS

The dimensions of hub or bell end connections shall conform to the dimensions of AWWA C100. The dimensions for the mechanical joint connections shall conform to the ANSI A21.11.

The end flanges of flanged valves shall conform in dimensions and drilling to the standard ANSI B16.1 for cast iron flanges and flanged fittings, Class 125, unless specifically provided otherwise in the Contract. The bolt holes shall straddle the vertical center line.

9-30.3(9) RESERVED

9-30.3(10) OPERATING NUT EXTENSIONS

An operating nut extension conforming to Standard Plan no. 315b shall be furnished and installed by the Contractor on all valves where the finished grade is more than 30 inches above the valve operating nut.

9-30.3(11) PLASTIC FOAM RINGS

Valve boxes shall have a 2 inch thick plastic foam cushion installed between the base flange of the valve box bottom section ring conforming to the dimensions shown on Standard Plan no. 315b installed between the base and the valve casting. The plastic foam shall conform to the requirements of Section 9-05.10.

9-30.3(12) VALVE CHAMBERS**9-30.3(12)A PRECAST VALVE CHAMBER**

Size, shape, and Materials shall be as indicated on the Drawings.

The chambers shall be furnished in precast concrete sections with sufficient strength to withstand HS 20 traffic loading together or as specified on the Drawings with ladder and access frames and covers to provide the minimum clearance dimensions shown on the Drawings.

The chambers shall be watertight after assembly. Gasket Material shall be installed in the groove of the keyway of each chamber section as it is installed. There shall be no evidence of moisture seeping into the chambers through the walls, floor, or joints.

9-30.3(12)B CONCRETE BLOCKS FOR VALVE CHAMBERS

Portland cement concrete blocks shall be solid, and shall conform to the requirements of ASTM C 139. Overall thickness of block shall be 6 inches with optional lengths and widths. Curved maintenance hole blocks shall be used for round valve chambers.

9-30.3(12)C CONCRETE BRICK FOR VALVE CHAMBERS

Concrete brick shall be solid and conform to ASTM C 55, Grade A.

9-30.3(12)D CLAY BRICK FOR VALVE CHAMBERS

Clay brick shall conform to ASTM C 62, Grade SW.

9-30.3(12)E MORTAR

Portland cement mortar shall be 1 part Portland cement to not less than 1-1/2 parts nor more than 3 parts of plaster sand, mixed with the least amount of water necessary to provide a workable mix. Dehydrated lime, in an amount not exceeding 50 percent of the Portland cement by weight, may be added to the mix at the option of the Contractor.

9-30.3(12)F CEMENT CONCRETE

Cement Concrete for chamber foundation shall be Class 3000 (see Section 6-02).

9-30.3(12)G CAST-IN-PLACE CONCRETE VALVE CHAMBER

The design, size, shape, and Materials for cast-in-place concrete valve chambers shall be in accordance with the Drawings. The Contractor shall submit Shop Drawings of the chamber indicating all features to the Engineer per Section 1-05.3.

9-30.3(12)H FRAME AND COVER AND VALVE BOX CASTINGS

Castings for cast iron frame and cover and for cast iron parts of valve boxes shall conform to the requirements of ASTM A 48, Class 30 and shall conform to the Standard Plans unless specified otherwise in the Contract.

The word "WATER" shall be cast in the cover in 3 inch letters as indicated on the Standard Plans.

Each ring and cover section shall be tested for accuracy of fit and shall be marked in sets for delivery.

An acceptable Supplier is Olympic Foundry Type SM29 standard box and lid, EJ Type EJ3761 Series or other approved equal.

See Section 9-30.3(4) regarding the permanent connection of the tag, indicating the number of turns to fully open/close the butterfly valve, to the valve box or to the valve chamber.

9-30.3(12)I MORTAR FOR PLASTER-COATING

Mortar for plaster-coating masonry unit maintenance holes shall be proportioned according to either of the two following tabulated alternates:

	PARTS BY VOLUME PORTLAND CEMENT	PARTS BY VOLUME MASONRY CEMENT	PARTS BY VOLUME HYDRATED LIME OR LIME PUTTY
alternate 1	1	1 (Type II)	0
alternate 2	1	0	1/4

Plaster sand for either alternate 1 or alternate 2 above shall be measured in a damp, loose condition, and shall be not less than 2-1/4 and not more than 3 times the sum of volumes of cement and lime.

A bituminous coating shall be applied to all surfaces after plastering.

9-30.3(12)J LADDERS

Ladder shall be made of steel, and shall be galvanized after fabrication. They shall be made of 1 inch deformed steel bar conforming to ASTM A 615, intermediate or standard grade, hot bent at least 1600°F. Galvanization shall conform to ASTM A 123.

9-30.3(13) PAINTING AT FACTORY

After the factory test and inspection, all ferrous parts of the valves except finished or bearing surfaces shall be painted inside and out with two coats of asphalt varnish, Federal Specification TT-V-51A or approved equal.

9-30.3(14) WATER PRESSURE REGULATING VALVES**1. Water Pressure Regulating Valves, 3 inch through 12 inch Sizes:**

Valve shall be flanged at both ends, Class 150 ASA drilling, with ductile iron body. Valve shall be a diaphragm operated, single seat, globe valve with stainless steel trim. It shall be spring loaded and hydraulically operated. Seat ring shall be replaceable. The diaphragm shall be fully guided top and bottom. All necessary repairs shall be possible without removing the valve from the line. Packing glands are not permitted. Disc shall be synthetic rubber and have a rectangular cross section. The stem shall be guided by a bearing in the valve cover and an integral bearing in the valve seat. There shall be no piston operating the main valve.

Valves shall be designed to maintain a constant downstream pressure regardless of varying inlet pressure. They are to be used in handling clean, cold water.

No control pilots or optional equipment is to be furnished. Valves shall be CLA Valve No. 90 or approved equal.

2. Water Pressure Regulating Valves, 2 inch Size:

Valves shall be Mueller No. H-9310 2 inch Water Pressure Reducing Valves or approved equal.

9-30.3(15) COATINGS FOR VALVES

Special coatings, thermoplastic powder coating, and polyethylene encasement shall be per Section 9-30.1(6).

9-30.4 RESERVED**9-30.5 HYDRANTS****9-30.5(1) GENERAL**

Fire hydrants shall conform to AWWA C502 and shall be of standard manufacture and of a pattern approved by SPU Water Operations. The name or mark of the manufacturer, size of the valve opening and year made shall be plainly cast in raised letters on the hydrant barrel to be visible after the hydrant is installed.

Hydrants of the following manufacture and pattern have been approved for use by the City of Seattle:

1. Pacific States
2. Clow Model 5110 (Iowa)
3. Mueller "Centurion" Model A-423
4. American-Darling Model B-62B
5. Kennedy K81D "Guardian"

9-30.5(2) END CONNECTIONS

The end connection shall be 6 inches, standard flange, Class 125 drilling conforming to ANSI B16.1.

9-30.5(3) HYDRANT DIMENSIONS

The dimensions and details of hydrant and nozzles shall be as follows:

1. Hydrant connection pipe size inside diameter: 6 inches.
2. Standpipe, minimum inside diameter: 7 inches.
3. Valve opening, minimum diameter: 5-1/4 inches.
4. Size of auxiliary gate valve: 6 inches.
5. Hose nozzles, number and size: two 2-1/2 inches.
6. Thread (National Board of Fire Underwriters): 7-1/2 per inch.
7. Total length of threaded male nipple: 1 inch.
8. Streamer nozzle, number and size: one 4 inch.
9. Hydrants shall be furnished with one pumper nozzle with size and threads conforming to dimensions as identified on the current City of Seattle Standard Plans for Fire Hydrants.
10. Drain Valve: Drain valve shall be automatic with outlet tapped with 1/4 to 3/4 inch female iron pipe threads. The threads on the drain valve outlet holes shall be protected with temporary pipe plugs until the hydrant is ready for installation.
11. Breakaway flange (ring) to center of pumper nozzle: 14 inches or more.
12. Face: Pumper port toward the street.

All nozzles shall be fitted with cast iron threaded caps with operating nut of the same design and proportions as the hydrant stem nut. Caps shall be threaded to fit the corresponding nozzles and shall be fitted with suitable neoprene gaskets for positive water tightness under test pressures.

9-30.5(4) OPERATING NUTS

The operating nuts on hydrant stem and nozzle caps shall be as follows:

Pattern of nut	Tapered pentagonal
Height	1-1/6 inch
Size of pentagon	1.35 inch at bottom of nut
	1.23 inch at top of nut (measured from point to flat)

The direction of opening shall be clearly marked on the operating nut or hydrant and shall be counter clockwise

9-30.5(5) HYDRANT RESTRAINT

9-30.5(5)A RESTRAINT SYSTEM FOR SHACKLE RODS

Shackling rods shall be 3/4 inch diameter with threaded ends, and shall meet ASTM A 36. "All-thread" rod is not acceptable. If a tie bolt restraint system is used, it shall be "COR-TEN Steel Star National Products Super Star Tie Bolt #SST7" or approved equal. If a mechanical joint- gland-with-lugs restraint system is used, it shall conform dimensionally as shown on the hydrant detail, and shall be ductile iron conforming to ASTM A 536 Class 80-55-06. Coating for shackling rods shall be in accordance with Section 9-30.15.

9-30.5(5)B RESTRAINT SYSTEM FOR WEDGE RESTRAINT GLANDS

If a wedge restraint system is used in lieu of shackle rods, mechanical joint (MJ) pipe shall be used rather than slip joint (SJ) pipe. The wedge restraint system shall conform to the requirements of Section 9-30.2(6)B.

9-30.5(6) BREAKAWAY FLANGE CONSTRUCTION

Hydrants shall be provided with a breakaway flange assembly and be equipped with breaking devices at the sidewalk flange which allow the hydrant barrel to separate at this point with a minimum breakage of hydrant parts in case of damage. There shall also be provided at this point, a safety stem coupling on the operating stem that shears at the time of impact. Unless otherwise specified in the Contract, all hydrants shall be equipped with O-ring stem seals.

9-30.5(7) HYDRANT PAINTING

9-30.5(7)A HYDRANT SHOP PAINTING

All iron parts of the hydrant shall be thoroughly cleaned and painted at the factory. All inside surfaces and the outside surfaces below the ground line shall be coated with asphalt varnish, Federal Specification TT-V-51a or J.A.N.P-450, unless otherwise specified in the Contract. They shall be covered with two coats, the first having dried thoroughly before the second is applied.

9-30.5(7)B HYDRANT FIELD TOUCH-UP PAINTING

All iron parts of the hydrant shall be thoroughly cleaned and painted at the factory. All inside surfaces and the outside surfaces below the breakaway flanges shall be coated with asphalt varnish, Federal Specification TT-V-51a or J.A.N.P-450, unless otherwise specified in the Contract. They shall be covered with two coats, the first having dried thoroughly before the second is applied.

The hydrant curb stand section, including all exposed surfaces of the breakaway flange, shall receive two coats of oil based gloss enamel paint (Kelly-Moore Luxlite or approve equal) in Caterpillar yellow. Based on the elevation of the hydrant within the surrounding pressure zone, if the maximum static pressure at the hydrant is less than 60 psi, the engine port cap on the hydrant shall be painted with two coats of oil based gloss enamel paint (Kelly-Moore Luxlite or approve equal) with the final coat being Red.

9-30.5(8) HYDRANT FACTORY HYDROSTATIC TEST

All hydrants shall be tested by the manufacturer, as required in AWWA C502. The Contractors shall furnish to the Owner an affidavit of compliance from the manufacturer for all tests.

9-30.5(9) HYDRANT CONNECTION PIPE

Pipe connections from the hydrant to the Water Main shall be 6 inch Ductile Iron Pipe, Class 52, in accordance with Section 9-30.1(1).

9-30.5(10) HYDRANT VERTICAL EXTENSIONS

Hydrant barrel extensions shall have a 7 inch minimum inside diameter and shall be gray cast iron or Ductile Iron and shall conform to the AWWA Standards for such castings. The drillings of the connecting flanges on the extensions shall match the drillings of the flanges on the hydrant.

Hydrant vertical extensions shall also include the necessary hydrant operating stem extension, complete with safety stem couplings.

Extensions with threaded flanges shall be ductile iron and shall conform to AWWA C115. The exterior flange lip overlapping the barrel pipe shall be sealed with a bituminous mastic.

Vertical extensions shorter than 18 inches shall be installed at the bottom of the factory supplied barrel pipe.

9-30.5(11) HYDRANT BLEEDER

The hydrant bleeder assembly, as shown on the hydrant detail, shall be constructed of 3/4 inch copper tubing Type K, conforming to Section 9-30.6(4).

9-30.5(12) POLYETHYLENE ENCASEMENT AND SPECIAL TAPE COATING FOR HYDRANTS AND CONNECTIONS

Refer to Section 9-30.1(6).

9-30.6 SERVICE CONNECTIONS AND SERVICE PIPE OR TUBING**9-30.6(1) GENERAL**

Service piping standards shall be used, and modified when indicated on the Drawings, for 2 inch blowoff assembly and hydrant bleeder assembly.

9-30.6(2) SADDLES

Saddles shall be ductile iron, or bronze, double straps with thread standard outlet tapping. Saddles shall be of a size designed by the manufacturer to fit the pipe called for on the Drawings.

9-30.6(3) CORPORATION STOPS

Corporation stops for use with saddle shall be of bronze alloy with inlet M.I.P. (male iron pipe) standard thread and outlet thread compatible with connection piping, with no special adapters. Corporation stops for direct tapping shall be bronze alloy with AWWA tapered inlet. Outlets shall be on 3/4 inch and 1 inch direct tap corporation stops shall be copper tubing size compression, with an external clamping or anti-pullout feature. Outlets on 1-1/2 inch and 2 inch direct tap corporation stops shall be male iron pipe or tubing to be connected.

9-30.6(4) SERVICE PIPE**9-30.6(4)A COPPER TUBING**

Copper tubing shall conform to the requirements of ASTM B 88, Type K, annealed. The tubing shall be coupled using compression fittings having a positive external gripping feature to prevent tubing pull-out, conforming to the requirements of AWWA C800, minimum 150 psi working pressure.

9-30.6(5) COMPRESSION COUPLINGS

Compression couplings for use in connecting plain end water service pipes shall be applicable for the type of pipe being coupled. Compression couplings shall have armored gaskets when similar metal pipes are being joined.

9-30.6(6) RESERVED**9-30.6(7) METER STOPS AND SETTERS**

Meter stops and setters shall be in accordance with the SPU Water Operation Standards.

9-30.6(8) METER BOX AND LID

Meter Box and Lid shall be in accordance with the current SPU Water Operation Standards. The Meter Box casting shall conform to ASTM A 48, Class 30 for gray cast iron. The Lid casting shall conform to ASTM A 536, Grade 80-55-06 for ductile iron. Castings shall be brushed or dipped with a bituminous coating. Meter Box and Lid shall be Olympic Foundry (1984) Inc. SM-29, or approved equal.

9-30.6(9) VALVES

Valves shall conform to Section 9-30.3.

9-30.7 BEDDING, FOUNDATION MATERIAL AND GRAVEL

When the Mineral Aggregate is specified by a "Type" designation, it shall conform to the requirements in Section 9-03. See Section 7-10.3(9) for bedding requirements.

9-30.8 RESERVED**9-30.9 RESERVED****9-30.10 JOINT BOND CABLE**

General joint bond cable shall be single-conductor No. 2 AWG stranded copper wire with 600-volt, 7/64" thick high molecular weight polyethylene (HMWPE) insulation. Supply all joint bonds complete with a formed copper sleeve on each end of the wire, as specified under THERMITE WELD MATERIALS, this Section.

9-30.11 THERMITE WELD MATERIALS**9-30.11(1) GENERAL**

Thermite weld Materials shall consist of wire adapter sleeves, welders, and weld cartridges according to the weld manufacturer's recommendations for each wire size and pipe or fitting size and Material. All welding Materials and equipment shall be the product of a single manufacturer. Interchanging Materials of different manufacturers will not be acceptable.

Molds shall be made of graphite. Ceramic "one-shot" molds will not be acceptable.

Steel thermite weld cartridges shall be used for steel pipe and fittings. Cast iron thermite weld cartridges shall be used for all cast and ductile iron pipe and fittings. Maximum cartridge sizes for steel thermite welds shall be: 15 grams for wire sizes #14 AWG through #4 AWG stranded, and 32 grams for #2 AWG stranded.

Maximum sizes for cast iron thermite welds shall be: 25 grams for #14 AWG through #6 AWG stranded, and 45 grams for #4 AWG solid through #2 AWG stranded.

Thermite weld Material may be obtained from the following Suppliers: Erico Products Inc. (Cadweld), Cleveland, Ohio; or Continental Industries, Inc. (Thermoweld), Tulsa, Oklahoma; or approved equal.

9-30.11(2) ADAPTER SLEEVES

Provide Adapter Sleeves for all No. 12 AWG through No. 2 AWG test station and joint bond wire. Prefabricated factory sleeve joint bonds or bond wires with formed sleeves made in the field are acceptable. Field-formed joint bond sleeves shall be attached with the appropriate size and type of hammer die provided by the thermite weld manufacturer.

9-30.11(3) THERMITE WELD CAPS AND PRIMER

Thermite Weld caps shall be prefabricated weld caps with coating and suitable primer, such as Handy Cap II with Royston Primer 707, as manufactured by Royston Laboratories, Inc., or equal.

9-30.11(4) COATING REPAIR AT THERMITE WELD

Repair of coating of pipe and fittings for spot damage at thermite weld connections not included in standard pipeline coating repair procedure, shall be 100% solid epoxy that cures in submerged or buried conditions. Repair of thermoplastic powder coating shall be as specified in Section 9-30.1(6)C6.

9-30.12 ELECTROLYSIS TEST STATION

9-30.12(1) GENERAL - NON-TRAFFIC AREA

An electrolysis test station shall consist of a standard meter box and lid as specified in Section 9-30.6(8) providing a housing for a test box as specified in Section 9-30.12(2).

9-30.12(2) TEST BOX

Test box requirements shall be as follows:

The 4" (10 cm) deep test box shall provide a single piece enclosure 8" by 6" (20 cm by 15 cm) with a removable, hinged lid. The test box shall be Hoffman No. 864CHQRF6 or approved equal.

The lid shall be manufactured from molded fiberglass reinforced Material, and fitted with a one-piece oil resistant "O" ring gasket. The lid shall be attached to the test box with a monel hinge pin and secured by quick release latches.

The test box shall comply with NEMA 4X standards, to supply protection against corrosion, windblown dust, rain, splashing water, and hose direct water.

A watertight connector consisting of a heat-shrinkable cable entry system, shall be used for passage of test wires into the enclosure. The entry system shall be a three part assembly consisting of a rigid plastic nut, a rubber O-ring, and molded heat-shrinkable cable entry seal including tape sealant. The cable entry system shall be type CES-2 or CES-3, with SFTS-1 or SFES-3 tape sealant as manufactured by Sigmaform Corporation; or approved equal.

9-30.12(3) TEST STATION WIRES

Test station wires shall be single conductor, No. 10 AWG and No. 6 AWG stranded copper with 600 volt XHHW insulation. Color of insulation per Drawings.

9-30.12(4) WIRE CONNECTORS INSIDE TEST BOX

Wire connectors inside the test box shall be one-piece, tin-plated crimp-on lug connector as manufactured by Burndy Co., Thomas and Betts, or equal.

9-30.12(5) ZINC REFERENCE ELECTRODES

The electrode shall be a 5 pound 99.9% pure zinc ingot packaged in a thoroughly mixed backfill material consisting of 75% gypsum, 20% bentonite clay and 5% sodium sulfate or a 50% gypsum and 50 % bentonite mix. The package shall be water permeable and of sufficient size to ensure complete envelopment of the reference electrode and shall include 50 feet of 12 gauge yellow RHW lead wire.

9-30.12(6) ELECTRICAL CONDUIT AND FITTINGS

PVC electrical conduit and fittings shall be schedule 40 and UL listed for direct burial. Conduit and fittings shall meet the requirements of NEMA TC and TC3, federal specification W-C-1094, UL and NEC.

9-30.13 TURBINE METERS (METER, COLD WATER, MAGNETIC DRIVE TURBINE TYPE, SIZES 2" - 12")

9-30.13(1) GENERAL

These requirements apply to Magnetic Drive Turbine Type Cold Water Meters 2 inch through 12 inch in size, manufactured for use on customer water services. Turbine Meters shall consist of a cast bronze case containing the measuring mechanism with a strainer housing attached.

Meters shall meet the requirements of AWWA C701, current edition, Class II type, except as modified herein.

9-30.13(2) REGISTER AND REGISTER BOX

Registration shall be in cubic feet.

9-30.13(3) RESERVED**9-30.13(4) MEASURING MECHANISM**

The measuring mechanism shall be the inline type, and so designed that it can be readily removed from the main case as a complete unit. The measuring mechanism shall be capable of operating within the accuracy limits specified under "Normal Flow Limits" in Section 9-30.13(7) without recalibration when transferred from one turbine meter case to another.

9-30.13(5) INTERMEDIATE GEAR TRAIN

If an intermediate gear train is utilized, it shall operate in a dry, hermetically sealed compartment, separated from the water passage by a bronze wall.

9-30.13(6) CAPACITY AND ACCURACY

The turbine meter shall register all rates of flow through it with an accuracy of 100% ± 2% at rates of flow within the limits specified under "Normal Flow Limits" in Section 9-30.13(7).

9-30.13(7) NORMAL FLOW LIMITS

SIZE	NORMAL FLOW LIMIT
2-Inch	5 - 160 GPM
3-Inch	10 - 350 GPM
4-Inch	15 - 800 GPM
6-Inch	30 - 1800 GPM
8-Inch	50 - 3500 GPM
10-Inch	55 - 5500 GPM
12-Inch	70 - 7000 GPM

NOTE: Above flow limit shall be for continuous flows, all turbine meters shall have a 25% overspeed capacity for intermittent flows.

9-30.13(8) HEAD LOSS

Maximum loss of head shall not exceed 7 psi at the flow rates listed under "Normal Flow Limits" in Section 9-30.13(7).

9-30.13(9) CONNECTIONS

All main case connections shall be flanged. The flanges for 2 inch meters shall be of the two bolt oval type. Meters shall be furnished without companion flanges.

9-30.13(10) INTERCHANGEABLE PARTS

All parts of turbine meters of the same size, make and model shall be interchangeable.

9-30.13(11) STRAINER

Turbine meters shall be supplied with a strainer attached. Strainers shall be short pattern, 125 lb. ANSI, iron body, with heavy gauge 1/4 inch perforated, stainless steel screen having an effective straining area at least double that of the meter main case inlet.

9-30.13(12) REMOTE READING

Turbine meters shall be compatible with existing SPU Automated Meter Reading and Demand Recording Hardware and/or switches. Manufacturer, type, and style of switch shall be submitted for approval by the Engineer before ordering.

9-30.13(13) MANUFACTURE AND APPROVAL

Only meters manufactured by a well established firm will be considered. Only those meters of a specific model and manufacturer, samples of which have been submitted to SPU Water Meter Shop for inspection and approval, and carrying a minimum 1 year guarantee will be acceptable.

9-30.13(14) INSPECTION

All turbine meters purchased under this Specification will be subject to inspection and testing by SPU Water Meter Shop upon receipt, and if any meter is found not to conform with these Specifications, the lot or any portion thereof may be rejected.

9-30.13(15) GUARANTEE

All turbine meters shall be guaranteed for a period of 1 year after installation. This guarantee shall be against defects in Materials, workmanship, and construction.

9-30.13(16) TEST REPORT

All turbine meters purchased under this Specification shall be accompanied by a notarized test report of the factory accuracy test.

9-30.14 LOCATING WIRE

Locating wire shall be 14 gauge solid copper with neoprene coating. Connections and splices shall be made with Penn Wilson split Bolt Wire Connectors, catalog No. 5-8-5, or approved equal.

9-30.15 COATING FOR ALL BOLTS AND SHACKLE RODS

On corrosion protected Water Mains, all shackle rods, concrete blocking anchor rods, and shackle clamps shall have a factory applied protective coating with fusion bonded epoxy in accordance with ASTM A 755. After threading and assembly, the threaded ends, nuts, and washers shall be coated with a wrapping of Trenton wax tape #1 or approved equal.

9-30.16 BACKFLOW PREVENTION ASSEMBLIES (BPAs)**9-30.16(1) GENERAL**

All backflow prevention assemblies (formerly called backflow prevention devices or BPDs) shall be on the Washington State Department of Health current list of approved backflow prevention assemblies, and both temporary and permanent installations of such assemblies shall be verified acceptable by the Engineer. The list of Washington State Approved assemblies is available at 1-503-246-5845.

All backflow prevention assemblies, whether temporary or permanent, are subject to inspection by SPU Inspection Services before connection with any Water Main. See Section 1-07.28 item 7D regarding BPA inspection notification requirements. After initial inspection and acceptance, annual testing is required.

Backflow prevention assemblies installed on premises, or not installed for premise isolation purposes, shall be inspected by Seattle King County Health Department Plumbing Inspection.

9-30.16(2) ATMOSPHERIC VACUUM BREAKERS (AVBs)

Atmospheric vacuum breakers shall be of a type included in the Washington State Department of Health current listing of "Acceptable Atmospheric (Non-Pressure) Type Vacuum Breaker" or other types with IAPMO approval. AVBs shall be installed downstream of the last shutoff valve and a minimum of 6 inches above the highest outlet or overflow level of the irrigation system. AVBs shall be installed above ground.

An atmospheric vacuum breaker shall be attached to each hose bib. An AVB shall not be operated for more than 12 hours in any 24 hour period. AVBs shall not be used on systems with chemical additions.

9-30.16(3) PRESSURE VACUUM BREAKER ASSEMBLIES (PVBAs)

Pressure vacuum breakers shall be of a type included in the Washington State Department of Health current listing of "Acceptable Pressure Type Vacuum Breaker" or other types with IAPMO or University of Southern California approval. PVBAs shall be installed a minimum of 12 inches above the highest outlet or overflow level of the irrigation system and located so that adequate room is available for maintenance and testing. PVBAs shall be inspected and tested annually during the life of the Contract by backflow device testers certified by the Washington State Department of Health. PVBAs shall not be installed below ground. PVBAs shall not be used for systems with chemical additions.

9-30.16(4) DOUBLE CHECK VALVE ASSEMBLIES (DCVAs)

Double check valve assemblies shall be of a type included in the Washington State Department of Health current listing of "Approved Double Check Valve Assemblies".

Installations shall be according to procedures outlined in the current edition of "Accepted Procedure and Practice in Cross-Connection Control Manual" published by the Pacific Northwest Section, American Water Works Association. DCVAs shall be inspected and tested annually during the life of the Contract by backflow device testers certified by the Washington State Department of Health.

DCVAs can be installed below ground only if enclosed in an approved irrigation vault, chamber, or other approved enclosure. DCVAs shall not be used for systems with chemical additions.

9-30.16(5) REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTION ASSEMBLIES (RPBAs)

Reduced pressure principle backflow prevention assemblies will be required for any system using chemical additions or proposed to use chemical additions. Such systems include irrigation systems with fertilizer or other chemical addition. These units shall be of a type included in the Washington State Department of Health current listing of "Approved Reduced Pressure Backflow Assemblies". Inspection of the installation, to insure proper operation, will be conducted by SPU Inspection Services. RPBAs shall be inspected and tested annually during the life of the Contract by backflow device testers certified by the Washington State Department of Health.

Installation shall be according to procedures outlined in the current edition of "Accepted Procedure and Practice in Cross-Connection Control Manual" published by the Pacific Northwest Section, American Water Works Association.

RPBAs shall not be installed below ground.

9-30.16(6) RESERVED

SECTION 9-31 ILLUMINATION AND ELECTRICAL MATERIALS**9-31.1 LUMINAIRES****9-31.1(1) GENERAL**

Luminaires shall have attached to the housing, an ANSI approval decal (3 inches square) which shall be readily visible from the ground, indicating lamp type by color code (i.e., white for Light-Emitting Diode (LED), blue for Mercury Vapor, gold for High Pressure Sodium, red for Metal Halide); and lamp wattage by numerical code, i.e.:

Legends shall be a minimum of 2 inches in height and weather resistant.

External labels for (LED) luminaires shall conform to ANSI C136.15.

The Contractor shall be prepared to provide a sample luminaire for testing when requested by the Engineer.

9-31.1(2) ROADWAY LIGHTING LUMINAIRE

LED luminaires shall meet the requirements of the following SCL Material Standards:

For residential LED luminaires refer to SCL Material Standard 5723.47.

For collector-arterial LED luminaires refer to SCL Material Standard 5723.61.

For principal-arterial LED luminaires refer to SCL Material Standard 5723.71.

HPS luminaires shall meet the requirements of SCL Material Standard 5723.10.

Glare control shall be accomplished by use of a field-installable, house-side shield. For house-side shields, refer to above SCL Material Standards.

9-31.1(3) LAMPS

High pressure sodium lamps shall meet the requirements of SCL Material Standard 5722.45.

9-31.1(4) PHOTOELECTRIC CONTROLS

Photoelectric controls shall be used with all luminaires and shall meet the requirements of SCL Material Standard 5693.00 for standard applications, and SCL Material Standard 5693.10 for 20-year design life applications.

9-31.1(5) RESERVED**9-31.1(6) UNDERDECK MOUNTED UNDERCROSSING LUMINAIRE**

For underdeck mounted undercrossing luminaires, refer to SCL Stock Catalog stock class 57.

Underdeck luminaires shall be pendant-mounted as called for on the Drawings. The ballast shall be integral with the luminaire. Ballast housing and structural parts shall be of cast aluminum. Mounting devices shall provide positive, vibration-proof locking. Luminaires shall be UL listed as "Enclosed and Gasketed" and shall be suitable for wet locations. All exposed screws and/or rivets shall be of stainless-steel Material.

All exposed cast aluminum parts are to be furnished with a baked-enamel paint.

The ballast housing and optical assembly shall be provided with easy-to-read moisture-proof nameplates that can be read without disturbing the luminaire when installed.

Ballast and optical assemblies shall include provision for field mounting of safety chains.

Luminaires shall have a wiring compartment with a single fuse holder.

Mounting of the optical assembly to the ballast assembly or pendant cap shall be secured by positive vibration-proof means. The optical and ballast or pendant cap assemblies shall include a positive aligning electrical disconnect allowing the socket to be shipped factory assembled in the optical assembly.

The luminaire shall be enclosed and gasketed and shall include an activated charcoal filter to permit passage of air.

Heat-resistant polycarbonate plastic shall be used for the refractor. The optical assembly shall be hinged and latched for lamp access. An automatic disconnect shall ensure that optical assembly is electrically cold when servicing. The optical assembly shall be removable from the ballast without tools.

The filter assembly shall be factory installed, but easily removable and shall be located to prevent accidental dislodgement when the luminaire is installed.

The unit shall provide at least 3% uplight dispersed widely across the surrounding area.

Luminaire shall be suitable for continuous service in an ambient temperature of 40.8C. The unit shall be weatherproof and dustproof.

Ballasts shall be multi-tap, high power factor, regulator type.

9-31.1(7) WALL-PACK LUMINAIRE

For wall-pack luminaires, refer to SCL Stock Catalog stock class 57.

The luminaire shall consist of a rear die-cast back housing which encloses the ballast, lamp socket and reflector, and a refractor frame assembly. The back casting assembly shall mount against the wall (or pole) and the refractor housing assembly shall fasten to it by means of concealed hinges and a single point, positive acting latch. There shall be plated steel

retaining chain attached between the main housing and refractor frame. Overall dimensions shall be approximately 16 inches square by 10-3/8 inches deep.

Units shall be prewired and equipped to be wall mounted directly on conduit for surface wiring without bending the conduit or to a recessed outlet box, and shall require no tools for lamp replacement.

The optical train shall consist of the lamp, fluted specular aluminum reflector, and molded prismatic borosilicate thermal shock-resistant glass refractor. The dimensions of the refractor shall be approximately 16 inches square by 4 inches deep and shall have internal splitting prisms and external dispersing prisms. The refractor frame color shall be anodized aluminum.

The integral ballast shall operate the high-pressure sodium 55-volt lamp at the wattage shown on the Drawings, and provide reliable starting at temperatures as low as -20 °F. The ballast shall be multi-tap to allow field adjustments of voltage.

All insulation shall be UL listed Class H; core, coil, and capacitors shall be positioned for maximum heat dissipation. Supply wires to the unit are to be of proper temperature rating for the type of entry used. The housing shall be finished with a black polyester powder paint coating. The complete unit shall be UL listed as "Suitable for Wet Locations". The unit shall be Moldcast catalog no. PCL-1 or approved equal, to be furnished with photocontrol, wireway conduit adapter, and polycarbonate shield.

The wall-pack luminaire shall be furnished with photocontrol, wireway conduit adapter, and polycarbonate shield.

9-31.2 RESERVED

9-31.3 WIRE

Street light wire size and type shall be constructed per the Drawings.

Street light wire in conduits shall meet the requirements of SCL Material Standard 6122.30. Wire size shall be indicated on the Drawings.

Wire used inside of poles and bracket arms (including wood pole mounted bracket arms) or bonded to signal spanwires shall meet the requirements of SCL Material Standard 6404.40.

Duplex wire shall meet the requirements of SCL Material Standard 6404.40.

Triplex wire shall meet the requirements of SCL Material Standard 6007.50. Color coding shall not be required for triplex wire.

Multiple conductors shall be color coded in accordance with the NEC. Wire shall be continuously color coded. Neutral wire shall always be white. Grounding conductors shall be green and insulated. The first hot conductor shall be black, the second hot conductor shall be red, and the third hot conductor shall be blue.

Trench ground wire shall conform to SCL Material Standard 6102.20.

Plastic molding for covering wire attached to the side of wood poles shall be in accordance with SCL Material Standard 5820.50.

9-31.4 RESERVED

9-31.5 WIRE SPLICES

This standard applies to wire connections made in above grade or below grade installations except where the wires are attached directly to the terminal board. All connectors shall be U.L. or equivalent, labeled and approved for the intended use.

1. **Above Grade Installations** (Including connections in pole handholes):
 - a. Copper to Copper Connector - The connector shall be a high strength bronze alloy of the split bolt type specified in SCL Material Standard 6688.7.
 - b. Copper to Aluminum Connector - The connector shall be of the one or two bolt type labeled CO/ALR and include an approved spacer bar.
 - c. Aluminum to Aluminum Connector - The connector shall be of the 1 or 2 bolt type and meet the requirements of SCL Material Standard 6693.5.
 - d. Split bolt connections shall be insulated in accordance with Section 8-30.3(5).
2. **Below Grade Installations** (Including on Structures):
 - a. Below grade splices shall be made in a 2 piece rigid body transparent moisture proof spliced enclosure. The body shall be webbed to ensure centering of the splice and even distribution of the encapsulant. The body and encapsulant shall be composed of Material which do not support fungi or mold. The encapsulant shall be a reenterable (gel like), transparent type. (Non-reenterable encapsulant may be approved if each splice is approved by the Engineer prior to installing encapsulant.)
 - b. Connectors shall be as described in "a" above, or a copper mechanical crimp type may be used when submitted to, and allowed by, the Engineer at least 3 Working Days in advance of proposed use, or when indicated on a submitted and reviewed by the Engineer Shop Drawing. Mechanical crimp splices shall be made with an approved crimping tool.
3. **Inside Cabinets and Panels:** Wire nuts may be used only inside cabinets and panels. Copper or silver plated terminals shall be used at terminal blocks.

9-31.6 FUSES AND FUSE HOLDERS

Fuses shall be of the voltage and amperage specified on the Drawings.

Fuses shall meet the requirements of SCL Material Standard 6855.50

Fuse holders and insulating boots shall meet the requirements of SCL Material Standards 6857.05. Fuse holders shall be crimp-type terminations and be sized appropriately for wire and fuse size.

Fuse, fuse holders, and insulating boots shall be UL-listed for the intended application.

9-31.7 GROUND RODS, CLAMPS, AND HARDWARE

Ground rods, couplings, and driving studs shall meet the requirements of SCL Material Standard 5642.10, and the dimension shall be 3/4-inch by 10-feet.

Ground rod clamps shall meet the requirements of SCL Material Standard 5640.32.

Ground plates shall be a minimum of 2 square feet surface area copper plate.

9-31.8 ENCLOSURES

Enclosures located outside shall be weather-proof type, NEMA Type 3R. All doors and covers shall be gasketed. All enclosure metal shall be formed of stainless steel or aluminum as noted on the Standard Plans, and shall be constructed to the dimensions shown on the Drawings. All doors shall be provided with a heavy duty hasp suitable for padlocking.

All joints shall be seam welded. Enclosures shall be fabricated to allow for anchor bolt mounting.

A permanent sign shall be attached to the exterior of the enclosure cover or door. The sign shall be engraved into a 2 inch x 6 inch stainless steel plate with a minimum thickness of 18 gauge. The lettering shall be in 3 lines as follows:

**DANGER
HIGH VOLTAGE
KEEP OUT**

The letters shall be 1/2 inch high with a stroke width of 3/32 inch, and shall be filled with a red paint.

The completed sign shall be coated with a clear polyurethane enamel with exterior catalyst and attached to the enclosure cover with a minimum of 6 stainless steel drive rivets.

9-31.9 RECEPTACLES

Festoon receptacles shall meet the requirements of SCL Material Standard 7330.00. Festoon receptacle shall be 20 amp, 125 volt, AC, GFCI, Hospital Grade receptacles NEMA configuration 5-20R, to be UL listed "Hospital Grade" under UL No. 498.

SECTION 9-32 TRAFFIC SIGNALS SYSTEM**9-32.1 RESERVED****9-32.2 RESERVED****9-32.3 SIGNAL HEADS, VEHICLE****9-32.3(1) GENERAL****9-32.3(1)A SIGNAL HEAD COMPONENTS**

Signal heads shall be in accordance with the "Institute of Transportation Engineers" publication, current edition of "ADJUSTABLE FACE VEHICLE TRAFFIC CONTROL SIGNAL HEAD STANDARD" and the following additional requirements:

The equipment shall be designed for operation under temperature and humidity conditions encountered in the Pacific Northwestern United States.

Materials and workmanship shall conform to the best commercial standards of the industry.

Signal hanger pins shall include a stainless steel washer between each cotter key and the signal hanger.

A terminal block of an approved type shall be mounted inside at the back of each signal head. It shall have sufficient studs to terminate six (6) lamp wires independently to six (6) field wires. The screws shall be of sufficient length to easily accommodate 14 AWG field wires without having to remove the screws. The terminals to which field wires are attached shall be permanently tagged to facilitate field work. Lamp socket wires shall consist of a white wire and a wire of the same color as the lens connected to the terminal block.

All signal heads shall be installed as indicated on the Drawings.

The housing, door, visor exterior and mounting hardware/framework shall be dark green in color. The visor interior and both sides of the back plate shall be optical black or flat black in color. The paint shall be of the best quality synthetic resin enamel.

Adjustable signal heads shall consist of separate signal sections, expandable type, for vertical or horizontal mounting, rigidly and securely fastened together into one weather-tight signal assembly. The signal sections shall be 8 inches or 12 inches in diameter, as indicated on the Drawings.

Each section shall consist of a housing, door assembly, Light Emitting Diode (LED) technology module optical unit and backplate and shall be so constructed as to provide complete interchangeability of parts.

Weather-resistant mildew-proof gasketing shall be provided between the housing and door assembly and between the lens and LED module, which shall exclude dust and moisture.

9-32.3(1)B HOUSING

The housing shall be cast aluminum alloy, free of flaws, cracks, blowholes and other imperfections.

Each vehicular signal head shall have a 1/4 inch drain hole in the bottom of the head.

Each section shall house 1 individual optical unit complete with 1-piece hinged square door, mounting for the lens and other parts of the optical system and a simple noncorrodible door-locking device.

Sections shall be interchangeable and so constructed that sections can be added or removed. The top and bottom shall be drilled for 1-1/2 inch supporting pipe fittings. Hexagonal heavy plumbers lock nuts 2-1/2 inches across flats for 1-1/2 inch pipe shall be provided for top and bottom.

The 4 backplate mounting holes (2 in the top of the backplate and 2 in the bottom of the backplate) shall be a maximum distance of 1-1/4 inches on 8 inch signal and 2-1/2 inches on 12 inch signals from the top or bottom edge of the signal housing.

9-32.3(1)C DOOR ASSEMBLY

The door assembly shall consist of the door, lens and visor.

The door of each section shall be made of aluminum alloy and shall be hinged to the housing so as to permit access or removal. The door shall be secured to the housing by a single finger type locking device. The door-locking device shall be easily removable to allow door removal.

Each section shall have a visor made from aluminum alloy sheet of a tunnel design attached to the door by means of 4 panhead screws. The mounting holes shall be slotted. Visor length shall be 8 inches for 8 inch signals and 12 inches for 12 inch signals.

The lens shall be glass, circular in shape of the color, type and size specified. The lens shall be designed to give an outward distribution of light with a minimum above the horizontal. Each lens shall be true to color and shall conform to the current ITE Standard. The lenses shall have a minimum visible diameter of 7-3/4 inches (eight inches nominal) or 11-1/2 inches (12 inches nominal).

9-32.3(1)D OPTICAL UNIT

All vehicle signal head sections shall be provided with an expanded view Light Emitting Diode (LED) technology rather than incandescent unless otherwise specified in the Contract. A sample of the LED module to be used, the manufacturer's specifications, and a Manufacturer's Certificate of Compliance to the VTCSH specifications shall be provided to the Engineer for approval. If approved, the LED sample submitted will then be used as the basis for accepting all further units to be installed. Written approval by the Engineer will be required prior to the first installation.

LED modules shall fit into traffic signal housings built to the VTCSH standards without modification to the housing and shall not require special tools for installation. It shall be weather tight and fit securely in the housing and shall connect directly to the electrical wiring terminals.

The lens Materials to enhance ON/OFF contrasts shall not affect luminous intensity or chromaticity and shall be uniform across the face of the lens and shall be UV stabilized. The lens shall be a replaceable part without the need to replace the complete module.

The module shall be a single, self-contained device, not requiring on site assembly for installation and with its power supply packaged within the module enclosure and shall be completely protected against dust and moisture intrusion as per NEMA Standard 250-1991 requirements, for Type 4 enclosures to protect all internal LED, electronic, and electrical components.

The LED signal module shall be rated for use in the ambient operating temperature range of -40°C (-40°F) to +74°C (+165°F).

The LED signal modules when operated at nominal voltage and 25°C (77°F) shall provide a power factor of 0.90 or greater and a total harmonic distortion not to exceed 20 percent on modules with power consumption of 15 watts or greater, and 40 percent for modules with power consumption of less than 15 watts.

All electronic components shall be adequately supported to withstand mechanical shock and vibration from high winds and other sources. Materials used for the module enclosure shall be made of UL94VO flame retardant with the exception of the lens. The lens shall have no scratches (abrasions), cracks, chips, discoloration, or other defects. Any such defects shall be cause for rejection.

Each individual LED signal module shall be identified for warranty purposes, nominal operating voltage, power consumption, volt-ampere and a vertical indexing indicator for correct orientation.

The minimum luminous intensity throughout its useful life and at the end of the warranty period, shall not be less than the values shown in Table 1 Section 4.1 of the latest edition of the ITE Specifications for LED traffic signal modules. When operating within the temperature range specified in Section 3.3.1 during the warranty period, the maximum luminous intensity shall not exceed 800 candelas for the red.

The electrical, wiring and terminal blocks shall meet the requirements of section 13.02 of the VTCSH standard. Fluctuations in line voltage over the range of 80VAC to 135VAC shall not affect luminous intensity by more than ±10 percent. The circuitry shall prevent perceptible flicker and include voltage surge protection to withstand high-repetition noise transients

and low-repetition high-energy transients as stated in Section 2.1.6, NEMA Standard TS-2, 1992. A catastrophic failure of one LED light source shall result in the loss of not more than 5 percent of the signal module light output. The module shall be operationally compatible with NEMA (TS-1 or later) load switches. All LEDs shall be of the AllnGap technology or proven equal in brightness and bulb life.

Manufacturers shall replace or repair an LED module that fails to function as intended due to workmanship or Materials defects, or if it exhibits luminous intensity of less than the minimum values specified within the first 60 months from the date of installation.

Written Warranty: In addition to the requirements of Section 1-05.10, the manufacturer shall provide a written warranty against defects in materials and workmanship for the LED vehicle signal modules for a period of 60 months, and against loss of intensity below 50% of original values for a period of 36 months. This warranty shall become effective after installation of the modules and acceptance by the Engineer.

9-32.3(1)E BACKPLATE

The signal, with backplate, shall be designed to meet or exceed the load requirements in accordance with Section 2 of the current edition of AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals". Back plates shall be furnished and attached to each signal head assembly. Back plates shall be louvered type to reduce wind loading, constructed of anodized, 3-S half-hard aluminum sheet, 0.058 inches minimum thickness. The back plates shall be attached with stainless steel hardware. Back plates shall not interfere with either the operation of the door or the mounting of the signal. Mounting hole pattern shall match pattern on signal head housing. The front and back of the back plates shall be finished with 2 coats of flat black enamel.

Back plates shall be permanently attached so as to provide a 5 inch border for either 8 inch or 12 inch signal heads. On combination heads (i.e., 12 inch and 8 inch sections) the back plate shall have a 5 inch border relative to the 8 inch head. Therefore, the border on the 12 inch head shall be approximately 3 inches.

Back plates shall be provided with a minimum of 2 mounting holes per signal section, one on each side. The 2 top and 2 bottom backplate mounting holes shall be a maximum distance of 1-1/4 inch from the corners of an 8 inch signal housing, and 2-1/2 inch from the corners of a 12 inch signal housing.

Backplates shall have a 1" yellow, diamond grade retroreflective tape applied to the outside border.

9-32.3(2) BI-MODAL VEHICLE SIGNALS SECTION

The signal section shall display both yellow and green arrow indications from the same face and shall use a fail-safe 2-lamp system to direct light of either color into a fiberoptic display. The section shall be adaptable to conventional 12 inch vehicle signal heads.

9-32.3(3) RESERVED

9-32.3(4) DIRECTIONAL LOUVERS

Where so indicated on the Drawings, louvers shall be furnished and installed in signal visors. Directional louvers shall be so constructed as to have a snug fit in the signal visor. The outside cylinder shall be constructed of No. 22 U.S. gauge sheet steel, and the vanes shall be constructed of No. 27 U.S. gauge sheet steel. Dimensions and arrangement of vanes shall be as indicated on the Drawings.

Louvers shall be galvanized after fabrication by the hot dipped process in conformance with ASTM A 153 and painted flat black.

9-32.3(5) RESERVED

9-32.4 SIGNAL HEADS, PEDESTRIAN

9-32.4(1) GENERAL

Pedestrian signal heads shall conform to the current version of "Pedestrian Traffic Control Signal Indications" published in the "Equipment and Materials Standards of the Institute of Transportation Engineers", ("PTCSI") and in the Applicable Sections of the current version of the "Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)," as modified and adopted by the Washington Department of Transportation (WSDOT); see Section 4E. Current versions are the versions in effect on the Day the Work was advertised for Bids by the Owner.

Pedestrian signal head shall consist of a Light Emitting Diode (LED) message module, case, eggcrate visor, and directional louvers.

The maximum overall dimension of the signal shall be 19-1/2 inches wide, 19 inches high and 9 inches deep, not including eggcrate visor and hinges. In order to facilitate installation and maintenance, the signal shall be designed so that all components are readily accessible from the front by merely opening the signal door.

Written Warranty: In addition to the requirements of Section 1-05.10, the manufacturer shall provide a written warranty against defects in materials and workmanship for the entire pedestrian signal including LED message module, and all Acrylonitril Butadiene Styrene (ABS) or polycarbonate plastic parts for a period of 60 months from the date of delivery.

9-32.4(2) MESSAGE MODULE

Light Emitting Diode (LED) Pedestrian Traffic Signal with Countdown Feature.

The Pedestrian Signal Display shall consist of a Light Emitting Diode (LED) message module, case, eggcrate visor, and directional louvers; and shall be in conformance with the PTCSI and MUTCD. The case, sun shield and mounting hardware shall be painted dark green in color. The eggcrate visor interior and directional louvers shall be painted flat black in color.

Pedestrian signals shall display international symbols (Portland orange "Hand" and the lunar white "Walking Person") and numerical countdown (Portland orange "digit portion") LED's encased in a molded plug-in plastic message module. The LED module shall have a visual appearance of the display shall be similar to that of an incandescent lamp (i.e., smooth and non-pixelated). The Hand & Walking Person symbols shall be a minimum of 12 inches in height and 7 inches in width.

LED pedestrian and countdown signal module shall be made of UL94 flame-retardant Materials. The lens is excluded from this requirement. The lens of the LED pedestrian and countdown signal module shall be polycarbonate UV stabilized and the exterior of the lens shall be uniform and frosted to reduce sun phantom effect.

All pedestrian and countdown signal display modules shall be the Light Emitting Diode (LED) type. Pedestrian and countdown LED traffic signal modules shall be designed such that they can be used as a retrofit replacement for optical units in Standard Plan no. 520 pedestrian signal housing and shall not require special tools for installation. The installation of an LED pedestrian and countdown signal module shall not require modification to the City of Seattle standard housings built to PTCSI standards.

The Walking Person, Hand icons and Countdown digits (16" x 18" module size) shall be incandescent looking and fit within a traffic signal housing built to the Pedestrian Traffic Control Signal Indication (PTCSI) standards. The numbers 00 to 99 on the numerical display shall be side by side, not offset, and shall have a 7" wide x 9" high area for the countdown numerals.

LED pedestrian and countdown signal modules shall be weather tight, fit securely in the housing and shall connect directly to existing electrical wiring. Installation of a replacement LED module into the existing pedestrian housing shall only require the removal of the existing optical unit components, i.e., lens, lamp, gaskets, and reflector. Each LED pedestrian and countdown signal module shall be a single, self-contained device, not requiring on-site assembly for installation into any City of Seattle standard pedestrian signal housing; and shall include an insulated gasket. However, the power supply for the LED pedestrian signal module may be packaged as a separate module. The LED pedestrian and countdown signal modules shall be operationally compatible with the traffic signal controllers and conflict monitors existing at the Project Site

The LED pedestrian and countdown signal module shall be rated for use in the ambient operating temperature range of -40° F to 165° F. Each LED pedestrian signal module shall be protected against dust and moisture intrusion in compliance with MIL-STD-810F Procedure 1, Rain & Blowing Wind. The assembly, manufacturing, and mounting of the LED pedestrian signal module shall be designed to assure all internal LED and electronic components are adequately supported to withstand mechanical shock and vibration from high winds and other live loading sources in compliance with MIL-STD-883 Test Method 2007.

LED pedestrian and countdown signal modules shall operate at a maximum power consumption of 11 Watts for Hand, 8 watts for Walking Person and 6 watts for Countdown (Display "88"). Each LED pedestrian and countdown signal module shall operate from a 60±3 Hz AC line over a range of 80VAC to 135VAC. Nominal operating voltage for all measurement shall be 120±3 volts rms. The LED circuitry shall prevent flicker at less than 100 Hz over the specified voltage range. Fluctuations in the specified line voltage shall not affect luminous intensity by more than ±10%. The signal module on-board circuitry shall include voltage surge protection to withstand high-repetition noise transients and low-repetition high-energy transients as stated in Section 2.1.6, NEMA Standard TS-2, 1992. The individual LED light sources shall be wired so that catastrophic failure of one LED shall not result in the loss of more than the light from that one LED. The LED pedestrian and countdown signal modules shall provide a power factor of 0.90 or greater when operated at nominal voltage and at 77 degrees F. Total harmonic distortion induced into an AC power line by the LED pedestrian and countdown signal module shall not exceed 20% when operated at nominal voltage and at 77 degrees F.

LED Countdown modules shall have two separate power supplies for power the Walking Person and Hand icons. The circuitry shall be unrelated to power the LED Walking Person and Hand icons in order to substantially eliminate the risk of displaying the wrong icon.

A sample of the LED module to be used, the manufacturer's specifications, the warranties specified in this Section, a Manufacturer's Certificate of Compliance indicating Specifications are met, and the Requirements Checklist by Manufacturer chart below, shall be submitted to the Engineer for approval. Included in the submittal shall be the manufacturer's recommendations for how the Contractor permanently marks the date of installation on the outside plate. If approved, the sample will then be held for comparison to the remainder of the units to be installed. The approved sample will be allowed for use as the last LED installation.

Requirements Checklist to be filled out by Manufacturer to demonstrate compliance

REQUIREMENT	COMPLY
The LED module (16" x 18") shall have a visual appearance similar to that of an incandescent lamp (ie, Smooth and Non-Pixelated).	

The numbers 00 to 99 on the numerical display shall be side by side, not offset, and shall have a 7" wide x 9" high area for the countdown numerals.	
The display of seconds remaining shall begin only at the beginning of the clearance interval. After zero, the display shall remain dark until next countdown.	
Manufacturer shall warrant the product with replacement or repair of a pedestrian signal including LED message module that fails due to workmanship or materials within five years from date of delivery.	
For a period of five years, the maintained minimum luminance values for the module shall not be: 2,200 cd/SqM for Walking Person, and 1,400 cd/SqM for Hand & Countdown displays.	
Default condition: for abnormal conditions when nominal voltage to the unit across the two phase wires (rather than being applied to the phase & neutral wires) the unit shall default to the Hand display.	
The Maximum power consumption: 11 watts for Hand, 8 watts for Walking Person, and 6 watts for Countdown (when display is "88").	
The units shall not have any external attachments, dip switches, or options that will allow the mode to be changes from counting the clearance cycle to the full walk/don't walk cycle.	
Provide Model Number	

The manufacturer's name, trademark, operating characteristics, i.e., rated voltage, power consumption, and volt-ampere, and serial number shall be permanently marked on the outside surface of the back of the LED pedestrian and countdown signal module including a permanently attached label or extra blank space that can be permanently marked with the date of installation of the module by the Contractor.

The LED pedestrian and countdown signal modules shall be manufactured in accordance with a Vendor quality assurance (QA) program including both design and production quality assurance. All QA process and test result documentation shall be kept on file for a minimum of five years.

9-32.4(3) CASE

The case shall consist of a housing and door each made from 1 piece, aluminum alloy die casting. It shall be dustproof, weatherproof and corrosion resistant and shall provide for easy access to and replacement of all components. The housing shall have an integral cast top, bottom, sides, and back. Four integrally cast hinge lug pairs shall be provided for operation of a swing down door.

The housing shall be suitable for left or right hand (with pre-drilled holes and rubber plugs) clamshell mounting hardware, post-top mounting, or bracket mounting.

The top and bottom of the housing shall have an opening to accommodate 1-1/2 inch pipe brackets. The bottom opening of the signal housing shall have a standard 72 tooth locking boss integrally cast into the case. The teeth shall be clean and sharp and provide full engagement. The radial angular grooves of the boss shall provide positive positioning of the entire signal to eliminate rotation or misalignment of the signal.

The door shall be attached to the case by means of 2 stainless steel spring pins. 2 stainless steel hinged bolts with captive stainless steel wingnuts and washers shall be attached to the case with the use of stainless steel spring pins. Hence, latching or unlatching of the door shall require no tools.

A 1/4 inch drain hole shall be provided in the bottom of the case. All unused openings shall be capped with corrosion-resistant metal caps, and weatherproofed with approved washers.

Clamshell mounting shall be a two-piece cast aluminum alloy assembly. One piece shall be the pole "half", the other piece the signal housing "half". The clamshell assembly shall have two integrally cast hinge lug pairs so, that when the clamshell is mounted in final position for pedestrian traffic, the clamshell shall rotate horizontally to the open position for easy access to the control wiring inside the clamshell.

9-32.4(4) EGGCRATE VISOR

Each signal shall be provided with an eggcrate type visor designed to eliminate sun phantom.

The eggcrate type visor shall be installed parallel to the face of the Hand - Person message lens and shall be held in place by stainless steel screws. The eggcrate assembly shall consist of vertical members and horizontal members. The completed assembly shall be approximately 1-1/2 inches deep.

The basic Material used in construction of the eggcrate shall be nominally 0.030 inches thick polycarbonate plastic. Additional members may be employed outside the two legend areas but are not required unless needed to develop the full potential structural strength attainable through the particular assembly technique employed.

The assembly shall be enclosed in a mounting frame constructed of 0.040 inches minimum thickness aluminum or polycarbonate plastic. This frame shall be approximately 1-1/2 inches deep and may contain alternate mounting holes for use on alternate types of pedestrian signals.

9-32.4(5) RESERVED

9-32.4(6) RESERVED

9-32.5 PEDESTRIAN PUSHBUTTON ASSEMBLY

The complete pushbutton assembly shall include the following components:

1. The frame assembly shall consist of an integral pushbutton mount and the sign platform. It shall be cast aluminum and powder coat finished with the manufacturer's specified black color. The frame assembly shall consist of a backplate to accept a 5-inch by 7-inch sign secured with metal screws, and a round housing with pre-drilled holes to mount the pushbutton assembly.
2. The pushbutton housing shall be die-cast aluminum, round body of approximately 3-inches diameter, and powder coat finished with the manufacturer's specified black color.
3. The pushbutton shall be stainless steel, with a raised tactile directional arrow on the pushbutton. The manufacturer shall provide arrow options of: Left, Right, Up, and bi-directional Left and Right.
4. The pushbutton assembly shall include a Latching Mode with an LED indicator light that will stay "ON" and a percussive beeper for audible feedback. The LED and beeper shall be actuated each time the pushbutton is pressed and shall terminate at the beginning of the pedestrian walk phase.
5. The central control unit shall be available in both rack mounted and shelf mounted systems. The central control unit shall be rack mounted for TS2 traffic control units and shelf mounted for all other traffic control unit types.
6. The sign shall be an MUTCD R10-3 and size shall be 5 inch by 7 inch.

The complete pushbutton assembly shall have the following characteristics:

- 1) Vandal resistant construction;
- 2) NEMA 250-6P or IP-68 enclosure protection rating;
- 3) NEMA TS-2 compliance for temperature and humidity, transient voltage protection, and mechanical shock and vibration rating;
- 4) IEC 61000-4-4 and IEC 61000-4-5 compliance for transient suppression;
- 5) A minimum call pulse length shall be 240 milliseconds.
- 6) Constant call fail safe.
- 7) 3-year minimum warranty.

9-32.5(1) ACCESSIBLE PEDESTRIAN SIGNAL SYSTEM

An Accessible Pedestrian Signal (APS) system shall be provided and installed at the intersection as specified as an APS system as shown on the Drawings. The APS System shall consist of all components from the Standard Specifications from Section 9-32.5 and include the additional components and features:

1. Confirmation of button push via a latching sunlight visible red LED indication, audible tone, and vibrating indication;
2. The audible sound shall be emitted from a weather proof and vandal resistant speaker within the pushbutton assembly. All sounds should automatically adjust for ambient noise;
3. The pushbutton assembly shall come programmed to emit a rapid tick. It shall also have the capability to record custom voice messages and custom sounds during the walk or clearance interval or if the button is held for three seconds or more;
4. Standard and customized locating tone and message features;
5. In addition to the standard locate sounds, ability for custom locate sounds and location messages;
6. Capability for extended pushbutton press customized functions;
7. And all sounds are synchronized.

The complete APS system shall have the characteristics as described in Section 9-32.5 with the addition of the following:

- 1) Volume Over Ambient Noise: adjustable up to a minimum of 10dB;
- 2) Locate Tone Volume: -24dB to +6dB Ambient (shall meet or exceed);

- 3) Maximum Volume: 100 dB@ 1m.

9-32.6 DETECTOR LOOPS

Detectors shall be used for actuating traffic-actuated controllers and sample stations. A complete detector loop installation shall consist of loop wire and lead-in cable from the loop to the amplifier. Loop wires and lead-in cables shall be 600 volt rated.

Loop wire in concrete pavement shall be either #14 AWG USE or IMSA 51-3. Loop wire in asphalt pavement shall be IMSA 51-7 with either black PVC or polyethylene tube.

The lead-in from the detector junction box to the controller cabinet or remote amplifier cabinet shall be either three pair #16 AWG 7x24, or 6 pair #16 AWG 7x24 stranded tinned copper, polyvinyl chloride/nylon individual insulated, overall PVC jacketed, twisted pair cable(s) with aluminum foil-polyester shield. The three pair and the six pair lead-in cables shall have a #18 AWG stranded tinned-copper drain wire. The conductors shall be twisted together approximately 3 turns per foot. Connections of the loop wire to the lead-in wire shall be made only in a handhole with a waterproof splice as indicated on the Drawings.

9-32.7 ILLUMINATED SIGN

The equipment shall be designed and manufactured for operation under temperature and humidity conditions encountered in the Pacific Northwestern United States.

The sign, when mounted, shall be designed to meet or exceed the load requirements in accordance with Section 2 of "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals", AASHTO current edition.

The sign size shall be as indicated on the Drawings. The housing shall be a double faced design made of extruded aluminum alloy or polyvinyl, dark green in color or with a brushed aluminum finish. The interior shall be painted white.

Standard signal mounting hardware shall be used to mount illuminated signs to all street furniture. The sign shall be fitted with a 1-1/2 inch iron pipe (IP) with tapped straight thread hub on top, for mast arm and span wire mount, and on top and bottom for bracket mount.

The front message panel shall be translucent white Rohm and Haas Plexiglass, or Tufflite white fiberglass, or equal. The back message panel shall be constructed of aluminum alloy or polyvinyl, colored dark green or brushed aluminum finish to match the housing, unless the sign is double faced in which case it shall be the same as the front message panel. Sign message shall be as indicated on the Drawings.

A terminal block for power input hookup shall be accessible by opening either message panel.

Signs shall be completely wired and assembled.

Unless otherwise indicated in the Contract, the sign shall be equipped with 4-24 inch T12-CW fluorescent tubes with weatherproof tube type sockets and ballast transformer. The ballast transformer shall be non-flashing 425 mil-amp type, 0°F starting, 120 VAC, 60 Hz.

Hardware (i.e., rivets, screws, bolts, nuts, etc.) and non-aluminum parts shall be stainless steel.

Each interior illuminated sign assembly shall be fused. All fuses shall be accessible by opening either of the message panels. Both message panels shall be of the sliding type with stop bars to prevent total removal, and for ease of maintenance.

9-32.8 EMERGENCY VEHICLE PREEMPTION

All emergency vehicle preemption detectors shall be Opticom™, without substitution. All detector wiring shall be Opticom™, Model 138, shielded detector cable, without substitution, and shall meet International Municipal Signal Association (IMSA) specification 51-5.

9-32.8(1) OPTICOM DISCRIMINATORS

The Contractor shall furnish and install Opticom™, Model 752, discriminators, without substitution, in the control cabinets when called for on the Drawings.

9-32.9 INTERCONNECT CABLE

9-32.9(1) UNDERGROUND

Interconnect cable (UIC) shall be #19 or #22 solid aerial/duct communication cable and shall conform to REA Specification PE-39 or I.M.S.A. Specification No. 20-2. The number of pairs and size shall be as indicated on the Drawings.

9-32.9(2) AERIAL ("FIGURE 8")

Interconnect cable (AIC) shall be #19 or #22 solid "figure 8" communication cable and shall conform to REA specification PE-38, or I.M.S.A. specification no. 20-4. The number of pairs and size shall be as indicated on the Drawings.

9-32.9(3) INDOOR

Interconnect cable shall be #19 or #22 multiple pair communications cable and conform to REA specification PE-22, or I.M.S.A. specification no. 20-2. The number of pairs and size shall be as indicated on the Drawings.

9-32.10 SERVICE CABINET

The service cabinet shall serve a 200 A, 120/240 VAC (or 120/208 VAC for SCL Network area), 1 phase, 3-wire system. The service cabinet shall be rated for 22K ampere interrupting capacity (AIC). The service cabinet shall accommodate a ring-type socket with test/bypass blocks in accordance with EUSERC 308.

The service cabinet shall be constructed of .125" thick natural mill finish aluminum. The service cabinet shall be rated NEMA 3R. The service cabinet shall have separate sealable and lockable utility termination section, separate sealable and lockable metering section, and separate sealable and lockable customer section. Metering section shall be a 180 degree hinged hooded section. The cabinet shall be pad mounted per the standard plan. A separate mounting base shall be cast into the concrete foundation pad and secured with 4 – 5/8-11 x 18" anchor bolts.

The service cabinet load center shall be "always on". The load center shall have a main circuit breaker and a minimum of 9 blank breaker spaces. Additional breakers shall be added per the Drawings. Signal, ITS, and auxiliary breakers shall be attached to line 1 and lighting breakers shall be attached to line 2. Compatible breakers shall be specified by the service cabinet manufacturer. A documentation holder shall be attached to the customer door with a circuit directory. Circuit labels shall be provided using phenolic labels with white background and black lettering. Labels shall be permanently adhered in load center. Tape and chemical adhesives shall not be considered permanent. For traffic signal loads the label shall be ascending beginning with "SG1". For lighting loads the label shall be ascending beginning with "SL1". For ITS loads the label shall be ascending beginning with "ITS1". For auxiliary loads the label shall be ascending beginning with "AUX1".

9-32.11 SIGNAL WIRING**9-32.11(1) TRAFFIC SIGNAL CABLE**

Signal Cable shall have stranded #14 or #16 AWG copper conductors and shall conform to IMSA specification 20-1).

9-32.11(2) PEDESTRIAN PUSHBUTTON CABLE

Pedestrian pushbutton cable shall be single pair #16 AWG 19x29 stranded copper, polyethylene insulated, PVC jacketed, twisted pair cable with copper or aluminum-polyester shield and a No. 18 AWG stranded tinned-copper drain wire. The conductors shall be twisted together approximately 3 turns per foot.

9-32.11(3) ELECTRICAL SERVICE CONNECTIONS

For underground service conductors, THWN shall be used. Conductors shall be sized per the Drawings. Color coding shall be per industry standard for voltage.

For overhead service conductors, SCL Standard Material specification 6007.50 shall be used.

9-32.11(4) OVERCURRENT PROTECTION

Circuit breakers in service cabinets shall meet the requirements of the service cabinet manufacturer.

9-32.11(5) TERMINAL CABINETS

Junction boxes or terminal cabinets shall conform to NEMA 4X requirements.

1. Junction boxes or terminal cabinets shall be constructed of welded 14 gage (minimum) hot-dipped galvanized sheet steel, 14-gage, minimum type 316 stainless steel or 0.125 inch, minimum 5052 alloy aluminum H32 ASTM designator minimum.
2. Nominal Junction boxes or terminal cabinets dimensions shall be:

	Depth	Height	Width
a.	8"	16"	12"
b.	8"	24"	18"
3. The doors shall have two stainless steel piano hinges. The door shall also be provided with a spring loaded construction core lock capable of accepting a Best six pin CX series core. The locking mechanism shall provide a tapered bolt. The Contractor shall supply construction cores with two master keys. The keys shall be delivered to the Engineer.
4. All seams shall be continuously welded.
5. Junction boxes or terminal cabinets shall provide a gasketed door flange.
6. One spare 12-position terminal block shall be installed.
7. Each Junction box or terminal cabinet shall have 1/8-inch drain holes in back corners.

9-32.11(6) GROUND RODS, CLAMPS AND BONDING

See Section 9-31.7.

9-32.11(7) SQUEEZE CABLE FITTINGS

Cable fittings for entry of cable through metal walls of poles, signs and signals shall be squeeze-type cable fittings with water-tight neoprene bushings. Size shall be carefully chosen to match the cable diameter to assure a water-tight fitting without damaging the cable.

9-32.12 SPAN WIRE

Span wire shall be 5/16 inch, 7-strand aluminum covered steel span wire conforming to ASTM B 415 with rated breaking strength of 10,270 lbs. in accordance with SCL Material Standard No. 5664.1.

Catenary span wire shall be 7/16 inch, 7-strand aluminum covered steel span wire conforming to ASTM B 415 with rated breaking strength of 20,800 lbs. in accordance with SCL Material Standard No. 5664.1.

9-32.13 POLE LINE HARDWARE

Strain insulators shall be wet process, porcelain, conforming to EEI-NEMA TDJ-54 as follows:

5/16 inch wire	Class 54-2
7/16 inch wire	Class 54-3

Tether wire shall be 1/8 inch galvanized steel stranded wire conforming to ASTM A 475, extra high strength grade (rated at 1500 pounds minimum), Class A galvanized.

Bull rings (purse seine rings) shall be low carbon steel with an ultimate strength of 25,000 pounds. The ring shall be closed with a weld equal to or greater than 90 percent of the unwelded steel. The ring shall be galvanized with at least 2 ounces of zinc per square foot, which is equivalent to 3 mils of thickness. The steel shall be 3/4 inches in diameter and shall form a ring with a 3 inch ID. Higher strength steel shall be used when more than 4 signal heads are being supported.

All pole hardware, bolts, plate rods, hangers, clamps, wire guards and pole bands shall be hot-dipped galvanized in conformance with the requirements of ASTM A 153, or shall be stainless steel.

All miscellaneous pole line hardware required to complete the Project as planned shall be standard Material manufactured for pole line construction.

Pole band assembly shall consist of four (4) band sections and shall be four (4) way adjustable mounting connection on four (4) sides. Each band shall have four (4) 3/4-inch diameter all threaded studs and four (4) 3/4-inch regular nuts per stud (total 16 nuts per assembly). Pole band assembly shall have 20,000 pounds ultimate tensile strength. All parts of the pole band shall be hot-dipped galvanized in conformance with the requirements of ASTM A153. .

9-32.14 GALVANIZING REPAIR PAINT

Field repair of galvanized surfaces shall be a coating of heated zinc alloy solder to a minimum thickness of 2 mils in accordance with ASTM A 780.

SECTION 9-33 POLES, PEDESTALS, AND FOUNDATIONS**9-33.1 GENERAL****9-33.1(1) POLES, MAST ARMS, AND BRACKET ARMS**

All metal poles, mast arms and bracket arms shall be designed and fabricated to conform with the requirements of AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals", current edition (hereinafter referred to as "AASHTO"), and EEI-TDJ 135 and 139. All load requirements shall be accommodated as indicated on the Standard Plans.

Poles shall be galvanized steel, timber, or aluminum in accordance with the Drawings.

Poles not meeting the requirements of the Drawings and Specifications will be rejected.

9-33.1(2) ANCHOR BOLTS

Anchor bolts for light poles (steel or aluminum) shall conform to ASTM A 307 or ASTM A 576, unless otherwise specified in the Contract. Anchor bolts for steel strain poles Type T, and mast arm poles shall conform to ASTM A 576 (Type 1040 or 1045), ASTM A 675 (Gr. 90), or ASTM A 36 Mod, with $F_y = 55$ ksi minimum. Anchor bolts for steel strain poles Types V, X, Z shall conform to ASTM F 1554-99, Grade 105, Class 2A including supplementary requirements S2, S3 and S5. Each anchor bolt shall have a hexagonal leveling nut with a washer for leveling and a hexagonal nut with a flat washer and a lock washer for the top of the anchor base plate. All anchor bolts (full length), nuts and washers shall be galvanized in accordance with ASTM A 153. Anchor bolts shall not be bent or cut after fabrication. Bending of anchor bolts shall be cause of rejection and removal of entire foundation.

Anchor bolt extenders (sleeve nuts), where required, shall be of a strength greater than the existing anchor bolts. The bolt extenders shall have a hexagonal tightening nut, and shall be galvanized in accordance with ASTM A 153.

9-33.1(3) GALVANIZING

Before galvanizing, all sharp edges on welds and cut-ins inside the pole shaft, mast arm and luminaire arms shall be removed or filed smooth to prevent damage to the wires in the pole.

Structural Material shall be zinc-coated by hot-dip process in accordance with ASTM A 123 and the final coating shall measure 0.003 inches or more in thickness as determined by a magnetic thickness gauge. Hardware and appurtenances

shall be coated in accordance with ASTM A 153. Threads shall be re-cut after galvanizing without exposing base metal. Galvanizing certification of compliance with the applicable ASTM Standards signed by an ASTM accredited independent testing laboratory shall be submitted to the Engineer before shipment.

The finished pole shall be straight and free from injurious defects. Poles distorted by the galvanizing process shall be straightened without damage to the galvanizing coating. The finish coating shall be smooth and free of dross. After galvanizing, the interior of the pole and arms shall be free from sharp edges to prevent damage to wiring.

9-33.1(4) GROUND LUGS

Metal poles shall have a 3/8 inch tapped hole in the bottom edge of the handhole inside the pole. A 3/8 inch stainless steel bolt with stainless steel lock washer suitable for grounding shall be provided.

9-33.1(5) NUT COVERS

On light poles, the Contractor shall furnish and install separate nut covers to cover anchor bolts and nuts only (not the base flange). Nut covers shall fit snugly to the bolt. Nut covers shall be made of the same Materials as the pole and shall be provided by the pole manufacturer. Nut covers are not required on steel strain or Chief Seattle base type poles unless specified on the Drawings.

9-33.1(6) CONCENTRICITY

Unless otherwise noted on the Drawings, poles, mast arms, and luminaire extensions shall be within plus or minus 1/16 inch of perfect round with a constant taper of approximately 0.14 inches per foot and of uniform thickness.

9-33.1(7) GROUT

Grout shall conform to the requirements of Section 9-04.3(2) for non-shrink cement sand grout.

9-33.2 STEEL POLES, MAST ARMS, BRACKET ARMS, AND LUMINAIRE EXTENSIONS

9-33.2(1) GENERAL

Poles shall be inspected for Material compliance and acceptance by the Engineer prior to installation.

The term "steel strain pole" as used herein refers to any steel pole subjected to a span wire load (including METRO trolley loads) or mast arm load. Luminaires or other street lighting appurtenances may be mounted on a "steel strain pole". The term "steel lighting pole" refers to any steel pole which carries a luminaire but does not carry a span wire or mast arm load.

The length of the mast arm, height of pole, and size and type of bracket extension shall be as indicated on the Drawings. An aluminum or stainless steel pole identification plate shall be securely attached immediately above the handhole, and shall indicate gauge, manufacturer, bolt circle, design principle moment in kip-feet, length, and date of manufacture.

Outside diameter of pole shafts shall be as indicated in the Standard Plans.

9-33.2(2) STRENGTH AND DEFLECTION REQUIREMENTS

The pole shaft shall have strength sufficient to support all indicated loads.

The following design loads shall be used: Dead load shall consist of the weight of the signals, luminaires and bracket arms, signs and supporting structure, and associated appurtenances; wind and ice loads shall be as indicated by AASHTO. The signal head mast arm shall be of such size and gauge as to resist the bending moment.

The design of steel strain poles that support overhead trolley loads shall be governed by King County METRO Transit design standards as detailed on the Drawings.

Structural steel having a yield point of 33,000 psi or more shall be used for all structural parts. Silicon content of the steel shall be no more than 0.04 percent or 0.15 to 0.25 percent to prevent discoloration during galvanizing.

The total deflection at the top of metal poles resulting from all dead loads applied shall not exceed 2.5 percent of pole height.

The deflection of the mast arm after loading shall not cause the end of the mast arm to extend below a horizontal line from the center of the arm flange. The maximum rise of the mast arm after loading from a horizontal line shall be 2 degrees.

The tenon for the luminaire shall be between 1 and 4 degrees above horizontal with the luminaire installed and all other loads applied to the pole.

9-33.2(3) BOLT CIRCLE

Mast arm flange and pole base bolt circles shall be as indicated on the Standard Plans.

9-33.2(4) WELDS

Circumferential butt welds shall have permanent back-up rings and full penetration for 100 percent of the circumference. All exposed butt welds shall be ground flush. All welds shall conform to the requirements of Section 6-03.3(25).

9-33.2(5) HANDHOLES, FESTOONS, AND CABLE OUTLETS ON POLES

Steel poles shall have one oval 4 inch x 6-1/2 inch handhole, as shown in the Standard Plans, reinforced so as to result in no loss of shaft strength. The handhole shall have matching cover attached with stainless steel bolts. The cover shall be rain tight and removable. The handhole shall be fabricated into the pole in a position 90 degrees clockwise from the side on which the bracket or mast arm is attached.

Festoon outlets, when required, shall be as indicated in the Standard Plans.

Cable outlets (on poles) as shown on Standard Plan no. 563b shall be schedule 40 steel pipe extending perpendicularly from the pole. Both ends of the pipe shall be rounded for wire protection. The cable outlet shall be installed, drilled and edges rounded before galvanizing.

9-33.2(6) RESERVED

9-33.2(7) ANCHOR BASE PLATES

A one-piece steel anchor base plate shall be secured to the lower end of the shaft by continuous electric arc welds as shown in the Standard Plans. The welded connection shall develop the full strength of the adjacent shaft section.

9-33.2(8) POLE AND MAST ARM CAPS

All metal poles (except davit poles) and mast arms shall be equipped with a rain-tight pole cap constructed of the same Material as the pole, and attached with stainless steel bolts.

9-33.2(9) BRACKET ARMS

Bracket arms shall be per SCL Material Standard 5705.1 or 5705.2 or manufactured as indicated on the Standard Plans and in accordance with AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals", current edition, to support a luminaire of 50 pounds, a 1.2 square foot effective projected area for an 80 mph wind and a coefficient of height of 1.10.

Bracket arm hardware shall include the bolts, nuts and washers galvanized for wood and steel poles and stainless steel for aluminum pole types. Bracket arms shall be the same style as depicted on the Drawings. Small differences in dimensions may be acceptable to the Engineer when structural calculations accompany these indicated dimension differences on the Shop Drawings (see Section 1-05.3(12)).

Bracket arms shall accommodate the luminaire slipfitter attachment. The terminal end of the arm shall be a straight, tubular section with external dimensions of 2 inches NPS by 6-1/2 inches long.

Bracket arms mounted on metal poles shall be constructed of the same Material as the poles. If the bracket arm and metal pole are of dissimilar metals, they shall be separated by an approved plastic dielectric pad of 5 mils minimum thickness.

The longitudinal axis at the end of the bracket arm shall be not less than 1 degree nor more than 4 degrees above the horizontal with the luminaire installed under load (see Std Plan no. 572).

All tubing used for aluminum bracket arm members shall be seamless, Alloy 6063 - heat treated to T-6 after fabrication. Aluminum bracket arms shall meet the requirements of ANSI C136.13.

9-33.3 ALUMINUM POLES

9-33.3(1) ROADWAY

Aluminum street light poles for cobra-head style fixtures shall meet the requirements of SCL Material Standard 5750.03, except as modified herein and in the Contract. Aluminum street light poles for pedestrian and decorative style fixtures shall meet the requirements of SCL Material Standard 5752.05, 5754.07, and/or 5756.09, as appropriate.

Anchor bolts for aluminum poles shall be the same as required for steel poles.

9-33.3(2) PEDESTRIAN ROUND

Round aluminum street light poles for post-top style fixtures shall meet the requirements of SCL Material Standard 5752.05.

9-33.3(3) PEDESTRIAN SQUARE

Square aluminum street light poles for shoe-box style fixtures shall meet the requirements of SCL Material Standard 5754.07.

9-33.3(4) DECORATIVE

Decorative aluminum street light poles for decorative post-top style fixtures shall meet the requirements of SCL Material Standard 5756.09.

9-33.4 WOOD POLES

9-33.4(1) GENERAL

Strain poles shall be either Douglas Fir, class 1, or Western Red Cedar, class 1.

Street light poles shall be Western Red Cedar, class 3.

Poles shall be framed (notched) before treatment with a 1/2 inch deep by 2 inch high setting gain on the pole face, 12 feet from the pole butt.

Poles shall be branded by burning the pole face, as specified by ANSI 05.1, 12 feet, 6 inches above the pole butt. Metal marking tags will not be accepted.

Poles shall be butt-treated in accordance with AWPA C7, and the entire butt section of the pole shall be incised. After framing and roofing, the cuts shall be well brushed with the hot preservative.

9-33.4(2) DOUGLAS FIR

Douglas fir wood poles shall meet SCL Material Standard 5082.00.

9-33.4(3) WESTERN RED CEDAR

Western red cedar wood poles shall meet SCL Material Standard 5072.00.

9-33.5 RESERVED**9-33.6 STEEL PEDESTALS AND ALUMINUM PEDESTALS****9-33.6(1) STEEL PEDESTALS**

Shafts shall be constructed of welded structural steel, open-hearth lap welded steel or standard steel pipe conforming to the requirements of ASTM A 53. Shafts shall be 4 inch schedule 40 galvanized steel pipe with threaded end for mounting to the base. The overall height of the shaft and base shall be as indicated on the Drawings.

Pedestal base shall be of cast iron conforming to the requirements of ASTM A 48, Class 40 and made in accordance to the configuration on the Standard Plans. Bases for pedestals shall be threaded, square cast iron equipped with an access door for wiring. A 13-1/2 inch diameter bolt circle size shall be used. The base shall have a grounding lug inside which is accessible from the handhole. The base shall be silver in color.

9-33.6(2) ALUMINUM PEDESTALS

Shafts shall be 4 inch schedule 80 aluminum pipe with one threaded end for mounting to the base. The overall height of the shaft and base shall be as indicated on the Drawings.

Pedestal base shall be of cast aluminum conforming to the configuration on the Standard Plans. Bases for pedestals shall be threaded, square, aluminum and equipped with an aluminum access door for wiring. A 13-1/2 inch diameter bolt circle size shall be used. The base shall have a grounding lug inside which is accessible from the handhole. The base shall be aluminum in color.

9-33.7 PEDESTRIAN PUSHBUTTON POSTS

Pedestrian pushbutton posts shall be constructed of 2 inch I.D. schedule 40 galvanized steel pipe with length as indicated on the Drawings. The post collar, pipe flange, bolts, nuts and washers shall conform to the details of the Drawings.

9-33.8 BACK GUY ASSEMBLIES AND GUY WIRE

Unless otherwise indicated in the Contract, guy wire shall be 5/16 inch, aluminum covered steel strand wire.

Guy assembly components including the deadend grips, the porcelain strain insulator, and the automatic feed-thru deadend shall be sized so as to meet or exceed the rated breaking strength of guy wire.

Anchors for back guys shall consist of one of the following types:

1. A 4-way or 8-way steel expanding anchor, having a minimum of 300 square inches, made of pressed steel, coated with asphalt or similar preservative and fitted with 3/4 inch minimum guy eye anchor rod 8 feet long.
2. Plate anchor fitted with 3/4 inch minimum guy eye anchor rod 8 feet long.
3. An approved steel screw, such as a power installed steel helix anchor with extension rods, extension rod coupling, and strand eye nut. The steel screw shall be sized based upon its load and soil conditions by the Engineer.

The following components shall conform with the requirements of SCL Material Standards:

COMPONENT	SCL MATERIAL STANDARD
Guy Wire	5664.1
Guy Hook with Integral Spurs	5651.15
Deadend Grip	5651.4
Porcelain Strain Insulator	6901.1
Plastic Wire Guard	5651.8
Automatic Feed-Through Deadend	5650.3
Plate Anchor	5622.17
Single Strand Eye Nut	5652.1
Sidewalk Pipe Guy Fittings	5650.1

The pipe brace shall be galvanized extra strong steel pipe.

SECTION 9-34 ELECTRICAL AND SIGNAL CONDUITS**9-34.1 GENERAL**

Conduit shall be PVC coated galvanized rigid steel, galvanized rigid steel, or schedule 80 PVC conforming to Articles 346 (rigid metal conduit) or 347 (rigid nonmetal conduit) of the NEC type and size as indicated on the Drawings. All conduit, elbows, fittings, and accessories shall be UL listed.

Factory bends and elbows shall be utilized in all cases where they provide the required deflection.

Field bends, when required, shall be performed so as to result in no flattening of conduit or damage to the galvanizing or PVC coating.

9-34.2 RIGID STEEL CONDUIT

9-34.2(1) GENERAL

Exterior and interior surfaces of all steel conduit, including threads, except field cut threads, shall be uniformly and adequately zinc coated by a hot dip galvanizing process. The average weight of zinc coating shall not be less than 0.80 ounces of zinc per square foot of single surface area as determined by tests on 12 inch samples taken from a standard length of conduit of each size. The weight of zinc coating on any individual test specimen shall be not less than 0.7 ounces of zinc per square foot of single surface area. The weight of zinc coating will be determined in accordance with AASHTO T 65. Determinations and nominal weights shall conform to the requirements of the Underwriters Laboratory Publication No. 6 (current edition). In addition, the exterior as well as the interior conduit samples shall withstand 4 dips in the PREECE test in accordance with ASTM A 239.

Every length of rigid metal conduit shall bear the label of Underwriters Laboratories, Inc., or the label of the Canadian Standards Association, if affected items of Canadian manufacture are approved for use on the project as indicated in the Contract. Installation shall conform to appropriate articles of the NEC.

Rigid steel conduit may be substituted where PVC is indicated on the Drawings at the Contractor's option when approved by the Engineer at no additional expense to the Owner, except on pole risers.

Fittings for field and factory bends shall be identical and interchangeable.

9-34.2(2) THREADS

The exposed thread ends of rigid steel conduit shall be hot dipped galvanized in accordance with the foregoing. Field cut threads shall be painted with galvanized repair paint acceptable to the Engineer.

9-34.2(3) COUPLINGS AND FITTINGS

Couplings and fittings for rigid steel type conduits shall be hot-dip galvanized, with the same quantities of zinc noted above. Couplings shall withstand 4 dips in the PREECE test as specified above.

9-34.2(4) PVC COATING

All galvanized rigid steel conduit shall be PVC (polyvinyl chloride) coated with dark gray, and U.V. resistant type plastic where indicated on the Drawings.

The zinc surface prior to plastic coating shall be conditioned with chromic acid to provide an anchor for the plastic coating.

Both interior and exterior shall be coated with an epoxy acrylic primer not to exceed 0.0005 inches thick prior to the application of the PVC coating.

A PVC coating shall be bonded to the outside of the pipe (excluding the threads) with a thickness between 0.035 inch and 0.045 inch. The PVC coating shall be applied by the plastisol dip method and shall contain ultraviolet inhibitors.

A urethane coating of a nominal 2 mil thickness shall be applied to the interior of all conduits.

A coupling with the same PVC coating shall be furnished loose with each length of conduit and shall have a plastic sleeve extending 1 pipe diameter or 2 inches (whichever is less) beyond the end of the coupling. The inside diameter of the plastic sleeve shall be the same as the outside diameter of uncoated pipe of the same nominal size. The wall thickness of the plastic sleeve shall be the same as the plastic coating on the pipe. The bond between the metal and the PVC coating shall be equal to or greater than the tensile strength of the PVC coating.

All conduit fittings which are hollow and serve as part of the raceway shall be coated with the same coatings on the outside and inside as described above. The fittings shall have PVC sleeves at all female openings similar to the sleeves on the couplings. The coated conduit shall conform to NEMA Standard No. RNI-2005.

All coated conduit brackets, supports, clamps, NEMA 4 junction boxes, drains, breathers, expansion/deflection fittings, seals, etc., shall be PVC coated by the producer of the conduit. Field repair and touch-up shall be made with Materials approved by the Engineer.

9-34.2(5) RESERVED

9-34.2(6) EXPANSION/DEFLECTION FITTINGS IN NON-HAZARD AREAS

Expansion/deflection fittings shall be installed in all structural expansion joints. The expansion portion of the set shall provide for 4 inches of movement, 2 inches in each direction, unless specified otherwise on the Drawings. The deflection portion of the set shall provide for a movement of 3/4 inch in all directions, and an angular deflection of 30 degrees from normal in any direction. Fittings shall be O.Z. Gedney Type AXDX or approved equal.

9-34.3 PVC CONDUIT

Plastic conduit and fittings shall be rigid PVC Type EPC schedule 80.

PVC rigid non-metallic conduit may be used for all installations except the first 10 feet above ground on a pole riser and the adjacent bend, unless specified otherwise in the Contract.

Rigid PVC shall meet the requirements of ASTM D 1785 and ASTM D 2466. The conduit shall be suitable for use above ground, for direct burial, and for corrosive atmosphere areas.

Rigid PVC shall comply with SCL Material Standard 7020.05.

9-34.4 CONDUIT RISER

Refer to Section 8-33.3(3).

9-34.5 PULL CORD

Pull cords shall be 1/4 inch polypropylene meeting the requirements of Seattle City Light Material Standard 7272.2.

9-34.6 HANDHOLES

Handholes shall comply with SCL Material Standard 7203.10.

Installation of polymer concrete handholes must be approved by the Engineer and shall comply with SCL Material Standard 7203.20.

SECTION 9-35 ELASTOMERIC BEARING PADS

Elastomeric bearing pads shall conform to the requirements of AASHTO M 251. The elastomer shall not contain any form of wax.

All bearing pads shall be individually cast with fully molded edges. Corners and edges of molded pads may be rounded at the option of the Contractor. Radius at corners shall not exceed 3/8 inch, and radius of edges shall not exceed 1/8 inch.

Shims contained in laminated bearing pads shall be mill rolled steel sheets not less than 20 gage in thickness with a minimum cover of elastomer on all edges of:

1/8-inch for pads up to 3 inches thick

1/4-inch for pads over 3 inches thick, and

1/2-inch for pads greater than 7-inches thick.

Steel shims shall conform to ASTM A 1011, Grade 36, unless otherwise noted.

The shims shall be spaced to divide the pad thickness into equal laminations. The bond between the elastomer and metal shims shall be such that, when a sample is tested for separation, failure shall occur within the elastomer and not between the elastomer and the metal shim.

The shear modulus at 73°F or the durometer hardness of the bearing pads shall be as noted in the Contract. If durometer hardness is noted, the following shear modulus shall be applicable for shear modulus testing purposes: 50 durometer - 112 psi, 60 durometer-165psi, 70 durometer - 250psi. Elastomer shall be Grade 3.

Elastomeric bearing pads shall be manufactured with the following tolerances:

OVERALL VERTICAL DIMENSIONS:	
Design thickness 1 1/4 inches or less	-0, + 1/8 inch
Design thickness over 1 1/4 inches	-0, + 1/4 inch
OVERALL HORIZONTAL DIMENSIONS:	
36 inches and less	-0, + 1/4 inch
Over 36 inches	-0, + 1/2 inch

SECTION 9-36 DETECTABLE WARNING

9-36.1 GENERAL

The detectable warning plate (cast in place with curb ramp or surface) and the detectable warning plate retrofit (surface applied to existing curb ramp or surface) shall meet the requirements for tactile warning surfaces established by the ADA (Americans with Disability Act) Accessibility Guidelines (ADAAG).

Detectable warnings shall consist of a surface of truncated domes and shall comply with the following:

1. Dome Size: Truncated domes in a detectable warning surface shall have a base diameter of 0.9 inch (23 mm) minimum and 1.4 inches (36 mm) maximum, a top diameter of 50 percent of the base diameter minimum to 65 percent of the base diameter maximum, and a height of 0.2 inch (5.1 mm).
2. Dome Spacing: Truncated domes in a detectable warning surface shall have a center-to-center spacing of 1.6 inches (41 mm) minimum and 2.4 inches (61 mm) maximum, and a base-to-base spacing of 0.65 inch (17 mm) minimum, measured between the most adjacent domes on a square grid.

See Standard Plan Number 422a for truncated domes detail.

Unless the Contract specifies otherwise, the detectable warning shall extend the full width of the curb ramp (exclusive of flared sides) and shall extend either the full depth of the curb ramp or 24 inches (610 mm) deep minimum measured from the back of the curb on the ramp surface. The truncated dome pattern shall be perpendicular to the long axis of the ramp.

The detectable warning plate shall meet the following requirements:

1. "Federal Safety Yellow" (Federal Standard 595 Color FS 33538) in color;
2. ASTM Compressive strength of 10,000 psi unless otherwise approved;
3. Slip resistance¹, wet and dry of 0.80 minimum (ASTM C 1028);
4. resistant to breakage, fading, permanent deformation, and loss due to abrasion;
5. durable, high impact resistant, and possess thermal and moisture stability; and,
6. Approval by the Engineer.

¹ coefficient of friction on top of domes and on field area.

9-36.2 DETECTABLE WARNING PLATE – CAST-IN-PLACE

Acceptable cast-in-place Materials are:

1. CASTinTACT®3 by Masons Supply Company, pre-stained and sealed with Miracote® Mirastain II "Federal Safety Yellow" and Mascoseal Silane 40. A local Supplier of CASTinTACT is MASCO; 425-487-6161 (www.masco.net);
2. Cast-In-Place System by Armor-Tile™ Tactile Systems. A Seattle Supplier is White Cap Construction Supply; (206) 783-8400 (www.armor-tile.com);
3. Step-Safe® as manufactured by Castek, Inc. a subsidiary of Transpo Industries; (914) 636-1000 (www.transpo.com);
4. Cast-In-Place Composite Paver Tiles by ADA Solutions, (800) 372-0519 (www.adatale.com);
5. ADA Replaceable (Wet-Set) Composite Tactile by ADA Solutions, (800) 372-0519 (www.adatale.com); or,
6. Alertcast by AlertTile.
7. An approved equal; for products other than named above, the Contractor shall provide the Engineer with a submittal on the alternate Material as specified in Section 9-36.4. See Section 8-14.3(7)B.

9-36.3 DETECTABLE WARNING PLATE RETROFIT – SURFACE APPLIED

The warning pattern shall be capable of being bonded to an existing cement concrete surface. The surface of the warning pattern, excluding the domes, shall not be more than 3/8-inch above the surface of the concrete after installation.

Acceptable surface applied Materials are:

1. Surface Applied Systems by Armor-Tile™ Tactile Systems. A Seattle Supplier is White Cap Construction Supply; (206) 783-8400 (www.armor-tile.com);
2. Surface-Mount / Retrofit Detectable Warning Tiles by ADA Solutions, (800) 372-0519 (www.adatale.com);
3. TopMark® as manufactured by Flint Trading, Inc; (336) 475-6600 (www.flintrading.com); or,
4. An approved equal; for products other than named above, the Contractor shall provide the Engineer with a submittal on the alternate Material as specified in Section 9-36.4. See Section 8-14.3(7)B.

9-36.4 "APPROVED EQUAL" REQUIREMENTS

Should the Contractor propose an "or equal" Material to those Materials named in Sections 9-36.2 and 9-36.3, the Contractor shall make the following submittal to the Engineer for approval at least 5 Working Days in advance in accordance with Section 1-05.3:

1. All information required in Section 8-14.3(7)B;
2. Two (2) rectangular or square samples of the "or equal" material with minimum 6 inch by 6 inch dimensions; color acceptance will be based on Engineer comparison to "Federal Safety Yellow" comparison chip (SPU lab).
3. For the detectable warning retrofit plate, include information on the bonding material and its performance.
4. Documentation of the testing laboratory accreditation by a testing standards organization recognized by ASTM, the National Cooperation for Laboratory Association (NACLA) or approved by the Engineer.
5. At least 5 hard copies of the installation instruction or manual.

SECTION 9-37 CONSTRUCTION GEOTEXTILES**9-37.1 GEOTEXTILE AND THREAD FOR SEWING**

The material shall be a geotextile consisting only of long chain polymeric fibers or yarns formed into a stable network such that the fibers or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the material shall be polyolefins or polyesters. The material shall be free from defects or tears. The geotextile shall also be free of any treatment or coating which might adversely alter its hydraulic or physical properties after installation. The geotextile shall conform to the properties as indicated in Tables 1 through 6 for each use specified in the Contract. Specifically, the geotextile uses included in this Section and their associated tables of properties are as follows:

GEOTEXTILE APPLICATION	APPLICABLE PROPERTY TABLES
Underground Drainage, Low Survivability, Classes A, B, and C	Tables 1 and 2
Underground Drainage, Moderate Survivability, Classes A, B, and C	Tables 1 and 2
Separation	Table 3
Soil Stabilization	Table 3
Permanent Erosion Control, Moderate Survivability, Classes A, B, and C	Tables 4 and 5
Permanent Erosion Control, High Survivability, Classes A, B, and C	Tables 4 and 5
Ditch Lining	Table 4
Temporary Silt Fence	Table 6

Thread used for sewing shall consist of high strength polypropylene, polyester, or polyamide. Nylon threads will not be allowed. The thread used to sew permanent erosion control geotextiles shall be resistant to ultraviolet radiation. The thread shall be of contrasting color to that of the geotextile itself.

9-37.2 GEOTEXTILE PROPERTIES**TABLE 1**

Geotextile for underground drainage strength properties for survivability.

GEOTEXTILE PROPERTY	TEST METHOD ²	GEOTEXTILE PROPERTY REQUIREMENTS ¹	
		LOW SURVIVABILITY WOVEN / NONWOVEN	MODERATE SURVIVABILITY WOVEN / NONWOVEN
Grab Tensile Strength, min. in machine and x-machine direction	ASTM D 4632	180 lbs. / 115 lbs. min.,	250 lbs. / 160 lbs. Min
Grab Failure Strain, in machine and x-machine direction	ASTM D 4632	<50% / /50%	<50% / /50%
Seam Breaking Strength	ASTM D 4632 ³	160 lbs. / 100 lbs. min.	220 lbs. / 140 lbs. Min.
Puncture Resistance	ASTM D 4833	67 lbs. / 40 lbs. min.	80 lbs. / 50 lbs. Min.
Tear Strength, min. in machine and x-machine direction	ASTM D 4533	67 lbs. / 40 lbs. min	80 lbs. / 50 lbs. Min.
Ultraviolet (UV) Radiation stability	ASTM D 4355	50% strength retained min., after 500 hrs. in weatherometer	50% strength retained min., after 500 hrs. in weatherometer

See Notes after Table 6, this Specification.

TABLE 2

Geotextile for underground drainage filtration properties.

GEOTEXTILE PROPERTY	TEST METHOD ²	GEOTEXTILE PROPERTY REQUIREMENTS ¹		
		CLASS A	CLASS B	CLASS C
AOS	ASTM D 4751	.43 mm max. (No. 40 sieve)	.25 mm max. (No.60 sieve)	.18 mm max. (No.80 sieve)
Water Permittivity	ASTM D 4491	.5 sec ⁻¹ min.	.4 sec ⁻¹ min.	.3 sec ⁻¹ min.

See Notes after Table 6, this Specification.

TABLE 3
Geotextile for separation or soil stabilization.

		GEOTEXTILE PROPERTY REQUIREMENTS¹	
GEOTEXTILE PROPERTY	TEST METHOD²	SEPARATION WOVEN/NONWOVEN	SOIL STABILIZATION WOVEN/NONWOVEN
AOS	ASTM D 4751	.60 mm max. (No. 30 sieve)	.43 mm max. (No. 40 sieve)
Water Permittivity	ASTM D 4491	.02 sec ⁻¹ min.	.10 sec ⁻¹ min.
Grab Tensile Strength, min. in machine and x-machine direction	ASTM D 4632	250 lbs. / 160 lbs. min.	315 lbs./200 lbs. Min.
Grab Failure Strain, in machine and x-machine direction	ASTM D 4632	<50% / /50%	<50% / /50%
Seam Breaking Strength	ASTM D 4632 ²	220 lbs. / 140 lbs. min.	270 lbs./180 lbs. Min.
Puncture Resistance	ASTM D 4833	80 lbs. / 50 lbs. min.	112 lbs./79 lbs. Min.
Tear Strength, min. in machine and x-machine direction	ASTM D 4533	80 lbs. / 50 lbs. min.	112 lbs./79 lbs. Min.
Ultraviolet (UV) Radiation stability	ASTM D 4355	50% strength retained min., after 500 hrs. in weatherometer	50% strength retained min., after 500 hrs. in weatherometer

See Notes after Table 6, this Specification.

TABLE 4
Geotextile for permanent erosion and ditch lining.

		GEOTEXTILE PROPERTY REQUIREMENTS¹		
		PERMANENT EROSION CONTROL		DITCH LINING
GEOTEXTILE PROPERTY	TEST METHOD²	MODERATE SURVIVABILITY WOVEN / NONWOVEN	HIGH SURVIVABILITY WOVEN / NONWOVEN	WOVEN / NONWOVEN
AOS	ASTM D 4751	See Table 5	See Table 5	.60 mm max (No. 30 sieve)
Water Permittivity	ASTM D 4491	See Table 5	See Table 5	.02 sec ⁻¹ min.
Grab Tensile Strength, min. in machine and x-machine direction	ASTM D 4632	250 lbs. / 160 lbs. min	315 lbs. / 200lbs.min.	250 lbs. / 160 lbs. min.
Grab Failure Strain, in machine and x-machine direction	ASTM D 4632	15%- 50% / > 50%	15%- 50% / > 50%	<50% / ≥ 50%
Seam Breaking Strength	ASTM D 4632 ³	220 lbs./ 140 lbs. min.	270 lbs. / 180 lbs. min.	220 lbs. / 140 lbs. min.
Burst Strength	ASTM D 3786	400 psi/ 190 psi min.	500 psi / 320 psi min.	-----
Puncture Resistance	ASTM D 4833	80 lbs./ 50 lbs. min.	112 lbs. / 79 lbs. min.	80 lbs. / 50 lbs. min.
Tear Strength, min. in machine and x-machine direction	ASTM D4533	80 lbs./ 50 lbs. min.	112 lbs. / 79 lbs. min.	80 lbs. / 50 lbs. min.
Ultraviolet (UV) Radiation stability	ASTM D 4355	70% strength retained min., after 500 hrs. in weatherometer	70% strength retained min., after 500 hrs. in weatherometer	70% strength retained min., after 500 hrs. in weatherometer

See Notes after Table 6, this Specification.

TABLE 5
Filtration properties for geotextile for permanent erosion control.

		GEOTEXTILE PROPERTY REQUIREMENTS¹		
GEOTEXTILE PROPERTY	TEST METHOD²	CLASS A	CLASS B	CLASS C
AOS	ASTM D4751	0.43 mm max. (No.40 sieve)	0.25 mm max. (No.60 sieve).	0.22 mm max. (No. 70 sieve)
Water Permittivity	ASTM D4491	0.7 sec ⁻¹ min.	0.4 sec ⁻¹ min.	0.2 sec ⁻¹ min.

See Notes after Table 6, this Specification.

TABLE 6
Geotextile for temporary silt fence.

GEOTEXTILE PROPERTY	TEST METHOD ²	GEOTEXTILE PROPERTY REQUIREMENTS ¹	
		UNSUPPORTED BETWEEN POSTS	SUPPORTED BETWEEN POSTS WITH WIRE OR POLYMERIC MESH
AOS	ASTM D 4751	for slit film wovens .60 mm max. (No. 30 sieve) for all other geotextile types .30 mm max. (No. 50 sieve) .15 mm min. (No. 100 sieve)	for slit film wovens .60 mm max. (No. 30 sieve) for all other geotextile types .30 mm max. (No. 50 sieve) .15 mm min. (No. 100 sieve)
Water Permittivity	ASTM D 4491	.02 sec ⁻¹ min.	.02 sec ⁻¹ min.
Grab Tensile Strength, min. in machine and x-machine direction	ASTM D 4632	180 lbs. min. in machine direction, 100 lbs. min. in x-machine direction	100 lbs. Min
Grab Failure Strain, min. in machine direction only	ASTM D 4632	30% max. at 180 lbs. or more	-----
Ultraviolet (UV) Radiation Stability	ASTM D 4355	70% Strength retained min., after 500 hrs. in weatherometer	70% Strength retained min., after 500 hrs. in weatherometer

Notes ¹ All geotextile properties in Tables 1 through 6 are minimum average roll values (i.e., the test result for any sampled roll in a lot shall meet or exceed the values shown in the table).

²The test procedures used are essentially in conformance with the most recently approved ASTM geotextile test procedures, except for geotextile sampling and specimen conditioning, which are in accordance with WSDOT Test Methods 914 and 915, respectively.

³With seam located in the center of 8-inch long specimen oriented parallel to grip faces.

9-37.3 AGGREGATE CUSHION FOR PERMANENT EROSION CONTROL GEOTEXTILE

Aggregate cushion for permanent erosion control geotextile, Class A shall meet the requirements of Section 9-03.9(2). Aggregate cushion for permanent erosion control geotextile, Class B or Class C, shall meet the requirements of Section 9-03.9(3) and 9-03.9(2).

9-37.4 GEOTEXTILE APPROVAL AND ACCEPTANCE

9-37.4(1) SOURCE APPROVAL

For each geotextile application, the Contractor shall submit to the Engineer for approval, the manufacturer's name, address, the geotextile full product name, and the geotextile structure including fiber/yarn type.

If the geotextile source has not been previously evaluated, a sample of each proposed geotextile shall be submitted to the Engineer for evaluation. After the sample and required information for each geotextile type has been received by the Engineer, a maximum of 14 calendar Days will be required for this testing. Source approval will be based on conformance to the applicable values from Tables 1 through 6 in Section 9-37.2.

Source approval shall not be the basis of acceptance of specific lots of Material unless the lot sampled can be clearly identified and the number of samples tested and approved meet the requirements of WSDOT Test Method 914.

9-37.4(2) GEOTEXTILE SAMPLES FOR SOURCE APPROVAL AND ENGINEER TESTING

Each sample shall have minimum dimensions of 5 feet by the full roll width and shall be a minimum 6 square yards. The machine direction shall be marked clearly on each sample and is defined as the direction perpendicular to the axis of the geotextile roll. Source approval for temporary silt fences will be by Manufacturer's Certificate of Compliance (Section 1-06.3).

Samples shall be cut from the geotextile roll by a suitable method that produces a smooth geotextile edge without edge ripping or tearing. The samples shall not be taken from the outer wrap of the roll nor the inner wrap of the core.

9-37.4(3) ACCEPTANCE SAMPLES

Samples will be taken by the Engineer at the Project Site to confirm the geotextile meets the specified properties.

Approval will be based on testing of samples from each lot. A "lot" shall be defined for the purposes of this Specification as all geotextile rolls within the consignment (i.e., all rolls sent to the Project Site) which were produced by the same manufacturer during a continuous period of production at the same manufacturing plant and have the same product name. After receipt of the samples by the Engineer, a maximum of 14 calendar Days will be required for testing. If the results of the testing show that a geotextile lot, as defined, does not meet the properties required for the specified use as indicated in Tables 1 through 6 in Section 9-37.2, the roll or rolls which were sampled will be rejected. Two additional rolls for each roll found defective from the lot tested will then be sampled at random by the Engineer for retesting. If retesting shows that any of the additional rolls tested do not meet the required properties, the entire lot will be rejected. If the test results from all the rolls retested meet the required properties, the entire lot minus the roll(s) which failed will be accepted. All geotextile with defects, deterioration, or damage will be rejected and shall be replaced shall be replaced at no expense to the Owner.

9-37.4(4) ACCEPTANCE BY CERTIFICATE OF COMPLIANCE

When the quantities of geotextile proposed for use in each geotextile application are less than or equal to the following amounts, acceptance shall be by Manufacturer's Certificate of Compliance:

APPLICATION	GEOTEXTILE QUANTITY
Underground Drainage	600 sq. yards
Soil Stabilization and Separation	1,800 sq. yards
Permanent Erosion Control	1,200 sq. yards
Temporary Silt Fence	All quantities

The Manufacturer's Certificate of Compliance shall include the manufacturer's name, current address, full product name, geotextile structure including fiber/yarn type, geotextile roll number, proposed use(s), and certified test results.

9-37.4(5) APPROVAL OF SEAMS

If the geotextile seams are to be sewn in the field, the Contractor shall provide a section of sewn seam which can be sampled by the Engineer before the geotextile is installed.

The seam sewn for sampling shall be sewn using the same equipment and procedures as are to be used to sew the production seams. If production seams are to be sewn in both the machine and cross-machine directions, the Contractor shall provide sewn seams for sampling which are oriented in both the machine and cross-machine directions. The seams sewn for sampling shall be at least 2 yards in length in each geotextile direction. If the seams are sewn in the factory, the Engineer will obtain samples of the factory seam at random from any of the rolls to be used. The seam assembly description shall be submitted by the Contractor to the Engineer and are to be included with the seam sample obtained for testing. This description shall include the seam type, stitch type, sewing thread type(s), and stitch density.

SECTION 9-38 TEMPORARY TRAFFIC CONTROL MATERIALS**9-38.0 GENERAL REQUIREMENTS**

Temporary traffic control materials in this section consist of various traffic communication, channelization and protection items described in Section 1-10 and listed below:

1. Stop/Slow Paddles
2. Construction Signs
3. Wood Sign Posts
4. Sequential Arrow Signs
5. Portable Changeable Message Signs
6. Barricades
7. Traffic Safety Drums
8. Barrier Drums
9. Traffic Cones
10. Tubular Markers
11. Warning Lights and Flashers
12. Truck-Mounted Attenuator
13. Portable Temporary Traffic Control Signal
14. Tall Channelizing Devices

The Contractor's TCM and TSC shall be responsible for assuring that temporary traffic control devices and materials comply with these specifications. Certification for crashworthiness according to NCHRP 350 will be required as described in Section 1-10.2(5)B .

"MUTCD," as used in this section, shall refer to the latest WSDOT adopted edition of the Manual on Uniform Traffic Control Devices for Streets and Highways. The Revised Code of Washington (RCW) 47.36, Traffic Control Devices, requires traffic control devices along city streets to conform to the WSDOT adopted standards to the extent possible. In the event of conflicts between the MUTCD, and the Contract Documents, then the Contract Documents shall govern.

9-38.1 STOP/SLOW PADDLES

Paddles shall conform to the requirements of the MUTCD, except that the minimum width shall be 24-inches.

9-38.2 CONSTRUCTION SIGNS

Construction signs shall conform to the requirements of the MUTCD and shall meet the requirements of NCHRP Report 350 for Category 2 devices. Any sign/sign stand combination that satisfies these requirements will be acceptable. Post mounted Class A construction signs shall conform to the requirements of this section and additionally shall conform to the requirements stated in Section 9-28.

All Class A and Class B signs shall utilize materials and be fabricated in accordance with Section 9-28. All regulatory signs having a red background (i.e. Stop, Yield, etc.) and all other regulatory information signs (i.e. Speed Limit, Traffic Fines Double in Work Zones, etc) shall have Type III or IV sheeting in urban areas. All signs having a green background (i.e. Exit arrow, etc.) shall have Type II sheeting for the background and Type III or IV sheeting for the letters, border, and symbols.

9-38.3 WOOD SIGN POSTS

Post sizes for construction signs shall be as follows:

ONE POST INSTALLATION		
POST SIZE	MIN. SIGN SQ. FT.	MAX. SIGN SQ. FT.
4 x 4	-	16
4 x 6	17	20
6 x 6	21	25
6 x 8	26	31

TWO POST INSTALLATION		
POST SIZE	MIN. SIGN SQ. FT.	MAX. SIGN SQ. FT.
4 x 4	-	16
4 x 6	17	36
6 x 6	37	46
6 x 8	47	75*

* The Engineer shall determine post size for permanent signs greater than 75 square feet.

Sign posts shall conform to the grades and usage listed below. Grades shall be determined by the current standards of the West Coast Lumber Inspection Bureau (WCLIB) or the Western Wood Products Association (WWPA).

- | | | |
|----|----------------------|---|
| A. | 4 x 4 | Construction grade (Light Framing, Section 122- b WCLIB) or (Section 40.11 WWPA) |
| B. | 4 x 6 | No. 1 and better, grade (Structural Joists and Planks, Section 123-b WCLIB) or (Section 62.11 WWPA) |
| C. | 6 x 6, 6 x 8, 8 x 10 | No. 1 and better, grade (Posts and Timbers, Section 131-b WCLIB) or (Section 80.11 WWPA) |
| D. | 6 x 10, 6 x 12 | No. 1 and better, grade (Beams and Stringers, Section 130-b WCLIB) or (Section 70.11 WWPA) |

9-38.4 SEQUENTIAL ARROW SIGNS

Sequential Arrow Signs shall meet the requirements of the MUTCD supplemented with the following:

1. Sequential arrow signs furnished for stationary lane closures on this project shall be Type C.
2. The color of the light emitted shall be yellow.
3. The dimming feature shall be automatic, reacting to changes in light without a requirement for manual adjustment.

9-38.5 PORTABLE CHANGEABLE MESSAGE SIGNS

Portable Changeable Message Signs (PCMS) shall meet the requirements of the MUTCD and the following:

- A. The PCMS shall employ one of the following technologies:
 1. Fiber optic/shutter
 2. Light emitting diode
 3. Light emitting diode/shutter
 4. Flip disk
- B. Regardless of the technology, the PCMS shall meet the following general requirements:
 1. Be light emitting and shall not rely solely on reflected light. The emitted light shall be generated using fiber optic or LED technology.
 2. Have a display consisting of individually controlled pixels no larger than 2½-inch by 2½-inch. If the display is composed of individual character modules, the space between modules shall be

minimized so alphanumeric characters of any size specified below can be displayed at any location within the matrix.

3. When activated, the pixels shall display a yellow or orange image. When not activated, the pixels shall display a flat black image that matches the background of the sign face.
4. Be capable of displaying alphanumeric characters that are a minimum of 18-inches in height. The width of alphanumeric characters shall be appropriate for the font. The PCMS shall be capable of displaying three lines of eight characters per line with a minimum of one pixel separation between each line.
5. The PCMS message, using 18-inch characters, shall be legible by a person with 20/20 corrected vision from a distance of not less than 800-feet centered on an axis perpendicular to the sign face.
6. The sign display shall be covered by a stable, impact resistant polycarbonate face. The sign face shall be non-glare from all angles and shall not degrade due to exposure to ultraviolet light.
7. Be capable of simultaneously activating all pixels for the purpose of pixel diagnostics. Any sign that employs flip disk or shutter technology shall be programmable to activate the disks/shutters once a day to clean the electrical components. This feature shall not occur when the sign is displaying an active message.
8. The light source shall be energized only when the sign is displaying an active message.
9. Primary source of power shall be solar power with a battery backup to provide continuous operation when failure of the primary power source occurs.
10. The sign controller software shall be NTCIP compliant.

The PCMS panels and related equipment shall be permanently mounted on a trailer with all controls and power generating equipment.

The PCMS shall be operated by a controller that provides the following functions:

1. Select any preprogrammed message by entering a code.
2. Sequence the display of at least five messages.
3. Blank the sign.
4. Program a new message, which may include animated arrows and chevrons.
5. Mirror the message currently being displayed or programmed.

9-38.6 BARRICADES

Barricades shall conform to the requirements of the MUTCD supplemented by the further requirements of the Contract Drawings or Standard Plans when provided.

9-38.7 TRAFFIC SAFETY DRUMS

Traffic safety drums shall conform to the requirements of the MUTCD and shall have the following additional physical characteristics:

- | | | |
|----|---------------|---|
| 1. | Material | Fabricated from low-density polyethylene that meets the requirements of ASTM D 4976 and is UV stabilized. |
| 2. | Overall Width | 18-inch minimum regardless of orientation. |
| 3. | Shape | Rectangular, hexagonal, circular, or flat-sided semi-circular. |
| 4. | Color | The base color of the drum shall be fade resistant safety orange. |

The traffic safety drums shall be designed to accommodate at least one portable light unit. The method of attachment shall ensure that the light does not separate from the drum upon impact.

Drums and light units shall meet the crashworthiness requirements of NCHRP 350 as described in Section 1-10.2(5)B.

When recommended by the manufacturer, drums shall be treated to ensure proper adhesion of the reflective sheeting. Retroreflective bands shall be fabricated from Type III or Type IV reflective sheeting as described in Section 9-38.15.

9-38.8 BARRIER DRUMS

Barrier drums shall be small traffic safety drums, manufactured specifically for traffic control purposes to straddle a concrete barrier and shall be fabricated from low density polyethylene that meets the requirements of ASTM D 4976 and is UV stabilized.

The barrier drums shall meet the following general Specifications:

2014 Edition City Of Seattle Standard Specifications For Road, Bridge and Municipal Construction

Total height	22 in., ± 1 in.
Cross-section	hollow oval 10 in. X 14 in., ± 1 in.
Formed support legs length	3 in., ± 1 in.
Space between legs (taper to fit conc. barrier)	6¼ in. min.
Weight	33 lb. ± 4 lb. with legs filled with sand.
Color	Fade resistant safety orange.

Barrier drums shall have three 4-inch retro-reflective white bands, (one complete and two partial). Bands shall be fabricated from Type III or Type IV reflective sheeting as described in Section 9-38.15.

9-38.9 TRAFFIC CONES

Cones shall conform to the requirements of the MUTCD, except that the minimum height shall be 28-inches.

Retroreflective bands shall be fabricated from Type III or Type IV reflective sheeting as described in 9-38.15.

9-38.10 TUBULAR MARKERS

Tubular markers shall conform to the requirements of the MUTCD, except that the minimum height shall be 28-inches.

The devices shall be stabilized by affixing them to the pavement by using either weighted bases or adhesive. Adhesive used to glue the device to the pavement shall meet the requirements of Section 9-26.2. Retroreflective bands shall be fabricated from Type III or Type IV reflective sheeting as described in Section 9-38.15.

9-38.11 WARNING LIGHTS AND FLASHERS

Warning lights and flashers shall conform to the requirements of the MUTCD.

9-38.12 TRUCK-MOUNTED ATTENUATOR

The Truck-Mounted Attenuator (TMA) shall be selected by the Contractor as required, or as indicated in the Contract Documents. The TMA shall be mounted on a vehicle with a minimum weight of 15,000 pounds and a maximum weight in accordance with the manufacturer's recommendations. Ballast used to obtain the minimum weight requirement, or any other object that is placed on the vehicle shall be securely anchored such that it will be retained on the vehicle during an impact. The Contractor shall provide certification that the unit complies with NCHRP 350 Test level 3 requirements.

The TMA shall have an adjustable height so that it can be placed at the correct elevation during usage and to a safe height for transporting. If needed, the Contractor shall install additional lights to provide fully visible brake lights at all times.

The TMA unit shall have a chevron pattern on the rear of the unit. The standard chevron pattern shall consist of 4-inch yellow stripes, alternating non-reflective black and retro-reflective yellow sheeting, slanted at 45 degrees in an inverted "V" with the "V" at the center of the unit.

9-38.13 TALL CHANNELIZING DEVICES

Tall channelizing devices shall meet the requirements of the MUTCD Part VI for channelizing devices and shall conform to these general Specifications:

1. Fabricated of fade resistant, safety orange color, low-density polyethylene that is resistant to deformation upon impact and meets the requirements of ASTM D 4976 and is UV stabilized.
2. Forty-two inches in height minimum, using a tapered cone type shape of consistent dimensions regardless of orientation to traffic.
3. Four-inches in width minimum at the top and 8-inches in width minimum at the base, which incorporates a separate ballast that is designed to resist overturning or other movement from wind gusts or other external forces.
4. Four retroreflective 6" wide horizontal bands, alternating orange and white beginning 6" from the top of the device. Retroreflective bands shall be fabricated from Type III or Type IV reflective sheeting as described in Section 9-38.15.
5. Warning lights are not required unless specifically shown on the traffic control Plan but provisions for securely attaching a warning light are required. The method of attachment shall ensure that the light does not separate from the device upon impact and light units shall meet the crashworthiness requirements of NCHRP 350 as described in Section 1-10.2(5)B.
6. Devices shall be regularly maintained to ensure that they are clean and the reflective sheeting is in good condition.

Except for the Specifications and requirements specifically listed above, Tall Channelizing Devices are defined to be Traffic Cones. All non-conflicting Contract provisions related to "Cones" shall apply to Tall Channelizing Devices.

9-38.14 PORTABLE TEMPORARY TRAFFIC CONTROL SIGNAL

Portable traffic control signals shall meet the requirements of the MUTCD and these specifications.

The portable temporary traffic control signal shall be fully operational for two-phase traffic actuated, pre-timed, or manual control. The portable temporary traffic control signal shall conform to the following requirements:

1. Controllers shall demonstrate conflict-monitoring capability, consistent with the requirements of Section 9-38.14(A), with a flashing red display in both directions. The portable traffic control signal shall be capable of terminating the movement one (1) or movement two (2) all red clearance, in order to repeat the previous movements operation.
2. Signal head displays shall be either hard wired or controlled by radio signal. Manual operation will not require hardwiring or radio control except for the use of two-way radio communication by manufacturer trained qualified operators.
3. The system shall be equipped with a means of informing the operator of signal indications, such as a light on the back of each signal head that illuminates when the signal displays a red indication, during manual operation.
4. A vehicle detection system is required. The system shall be capable of operating either as fixed time or traffic actuated controller. The detection system shall provide presence detection (continuous call to the controller) while there is a vehicle in the detection zone.
5. Signal supports used with portable traffic control signals shall provide a minimum of two signal displays, spaced a minimum of 8 feet apart. When trailer mounted portable traffic signals are used to provide alternating one-way control, a minimum of one of the signal displays shall be suspended over the traveled way. The minimum vertical clearance to the traveled way for this signal display is 16.5 feet. Vehicular signal heads shall be of the conventional type with standard ITE approved, 12-inch ball LED display. Tunnel visors shall be provided for all indications. The system shall include a countdown display capable of a 199 second countdown clock for motorist information when there is no direct line of sight between the stop bar locations.
6. Back plates shall be furnished and attached to the signal heads. Back plates shall be constructed of 5 inch wide .050 inch thick corrosion resistant louvered aluminum, with a flat black finish. A highly retroreflective strip, 3-in wide, shall be placed around the perimeter of the face of all vehicle signal backplates to project a rectangular image at night towards oncoming traffic.
7. Trailers shall have a leveling jack installed at all four corners. The crank for the leveling jacks and trailer hitch shall be locked. The signal pole and mast arm assemblies shall be of the collapsible type, which can be erected and extended at the job site. The mast arm assemblies shall be firmly attached to the trailer to form a stable unit, which can withstand an 80 mph design wind speed with a 1.3 gust factor.
8. The portable temporary traffic control signal shall be powered using a self-contained battery system capable of providing over 12 Days of continuous operations without solar array assistance. A solar panel array will be allowed.

9-38.14(A) FLASHING OPERATIONS

All temporary traffic signals shall be equipped for flashing operation of signal displays. Controllers shall be programmed for flashing red displays for all approaches. During flash display, all pedestrian circuits shall be de-energized.

Actuated traffic signal control mechanisms shall be capable of entry into flash operation and return to normal operation as follows:

1. Terminal Strip Input (Remote Flash). When called as a function of a terminal strip input, the controller shall provide both sequenced entry into flash and sequenced return to normal operation consistent with the requirements of the latest edition of the Manual on Uniform Traffic Control Devices.
2. Police Panel Switch. When the flash-automatic switch located behind the police panel door is turned to the flash position, the signals shall immediately revert to flash; however, the controller shall "STOP TIME." When the switch is placed on automatic, the signals shall immediately time an 8-10 second all red period then resume normal cyclic operations at the beginning of major street green.
3. Controller Cabinet Switches. When the flash-automatic switch located inside the controller cabinet is placed in the flash position, the signals shall immediately revert to flash; however, the controller shall continue to function. When the flash-automatic switch is placed in the automatic position, the controller shall immediately resume normal cyclic operation at the beginning of the artery green. Adjacent to the flash-automatic switch shall be a controller on-off switch. If the flash-automatic switch is in the automatic position and the controller on-off switch is placed in the OFF position, the signals shall immediately revert to flash.

4. Power Interruption. On "NEMA" controllers any power interruption longer than 475 plus or minus 25 milliseconds, signals shall re-energize consistent with No. 2 above to ensure an 8-second flash period prior to the start of major street green. A power interruption of less than 475 plus or minus 25 milliseconds shall not cause resequencing of the controller and the signal displays shall re-energize without change. Type 170 controllers shall re-energize consistent with No. 2 above after a power interruption of 1.75 plus or minus 0.25 seconds. The 8-second flash period will not be required.
5. Conflict Monitor. Upon sensing conflicting signals or unsatisfactory operation voltages, the conflict monitor shall immediately cause the signal to revert to flash; however, the controller shall stop time at the point of conflict. After the conflict monitor has been reset, the controller shall immediately take command of the signal displays at the beginning of major street green.

9-38.15 TYPE III OR TYPE IV REFLECTIVE SHEETING

Type III and Type IV reflective sheeting shall consist of spherical or prismatic lens elements adhered to a synthetic resin and encapsulated by a flexible, transparent, weatherproof plastic having a smooth outer surface. All sheeting shall be weather resistant and have a protected pre-coated adhesive backing.

The reflective sheeting shall have the following minimum coefficient of retroreflection values at 0.2 degrees and 0.5 degrees observation angle expressed as average candelas per foot-candle, per square foot of material. Measurements shall be conducted in accordance with ASTM E 810.

TYPE III GLASS BEAD RETROREFLECTIVE ELEMENT MATERIAL

OBS. ANGLE	ENTRANCE ANGLE	SILVER WHITE	YELLOW	ORANGE	GREEN	RED	BLUE	BROWN
0.2°	-4°	250	170	100	45	45	20	12
0.2°	+30°	150	100	60	25	25	11	8.5
0.5°	-4°	95	62	30	15	15	7.5	5.0
0.5°	+30°	65	45	25	10	10	5.0	3.5

TYPE IV MICRO PRISMATIC RETROREFLECTIVE ELEMENT MATERIAL

OBS. ANGLE	ENTRANCE ANGLE	WHITE	YELLOW	GREEN	RED	BLUE	BROWN
0.2°	-4°	250	170	35	35	20	7.0
0.2°	+30°	80	54	9	9	5.0	2.0
0.5°	-4°	135	100	17	17	10	4.0
0.5°	+30°	55	37	6.5	6.5	3.5	1.4

1. The standard rainfall test specified in Federal Specification LS 300C and the brightness of the reflective sheeting totally wet by rain shall not be less than 90 percent of the above values.
2. Samples shall be submerged in a tank of clean water (approximately 72°F) for a period of 5 minutes. Reflex-reflective performance of the sheeting shall be viewed in a darkened room by reflected light through the surface of the water or through a transparent plane surface of the tank parallel to the sample surface. Light source shall be such as a hand flashlight held close to the eye. The wet sheeting shall show no apparent loss of reflective performance as compared to dry material.

The diffuse day color of the reflective sheeting shall be visually evaluated by comparison with the applicable Highway Color Tolerance Chart. Color comparison shall be made under north daylight or a scientific daylight having a color temperature from 6500 degrees to 7500 degrees Kelvin. Daytime color evaluation shall be illuminated at 45 degrees and viewed at 90 degrees. There shall be no significant color shift when viewed under nighttime (retroreflective) conditions.