

Mixing shall be done with a twin shaft pug mill-type mixer and shall be operated at the speed recommended by the manufacturer. The paddles shall be of sufficient size and quantity to deliver a uniform mixture.

The weight of the material that may be mixed per batch shall not exceed the manufacturer's rated capacity of the mixer, nor exceed an amount that will permit complete mixing of all the materials. Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected by reduction in the volume of materials or by repairs to the mixing equipment before any further production will be allowed.

The entire batch shall be mixed until all the materials are thoroughly blended. The batch mixing time will begin on the charging stroke of the weight hopper dump mechanism and conclude when discharge from the mixer has started. The mixer shall be equipped with a time lock which locks the mixer discharge gate for the mixing period and actuates an indicator light visible from the operator's platform.

The aggregate and liquid asphalt drop time into the mixer shall not exceed ten seconds and the time for mixing materials will not be less than thirty seconds per batch. If the City's Representative determines that the mixture is not thoroughly blended, and all aggregate properly coated with asphalt cement, the mixing time will be increased to produce a homogeneous material.

The weight-box housings and mixer platform shall provide safe and convenient access with properly sized gates and tracks for sampling the discharged materials.

4.5.13.3 DRIER-DRUM METHOD. When a drier-drum is used, aggregate shall be fed directly to the mixer drum at a uniform rate, and monitored for combined aggregate moisture and gradation by taking belt cut samples. A minimum of one moisture content check and gradation test per day and one moisture and gradation test per five hundred tons (551 tonne), or as conditions require, shall be made. The results of these tests shall be kept on logs for review by the City's Representative. Sampling and testing may be performed by the manufacturers properly trained and equipped staff or by an approved testing lab. If sampling is performed by the manufacturer, five percent of the samples shall be split and a testing firm approved by the City shall verify that the test results accurately represent the product being tested by the manufacturer. The

sample to be split may be selected at random by the manufacturer's quality control team, or the City's Representative.

If the cold feed material gradation is outside the allowable mean of deviations of the approved mix design as determined in Section 4.5.24, production shall be stopped until the necessary corrections are made. If the moisture content of the cold feed reaches five percent, production shall be stopped until certified by an approved independent materials testing firm under the direction of a Registered Professional Engineer, licensed in the state of Utah. This firm shall then be employed to provide continuous plant quality control and testing, and production may be resumed.

All production shall be prohibited if the cold feed material reaches seven percent moisture, without exception. During lay down operations, if in the opinion of the City's Representative excess moisture is present in the asphalt material, it shall be sampled and tested for moisture under AASHTO T-164-94 Note-6 or ASTM D 2172-93 Note 3. Asphalt found to contain excess moisture shall be removed in its entirety and properly disposed of.

The drier-drum shall be equipped with a calibrated thermometer to determine the temperature of the mixed materials leaving the drum. The thermometer shall be accurate to the nearest 10°F (5.5°C), and shall be installed in such a manner that changes of 10°F (5.5°C) in temperature of the mixed material will be shown within one minute and be clearly read from the operators station.

Asphalt cement shall be measured through a meter under constant pressure with a gage indicating the pressure and temperature at all times. This metering system shall be calibrated and certified for accuracy every six months, or whenever the plant is moved.

During any day's run, the temperature of asphalt cement shall not vary more than 50°F (10°C). If the meter loses pressure the operator's computer shall be equipped to warn the operator or automatically shut down the system.

The aggregate feeders for each material in the mixture and for the combined aggregates shall be equipped with devices by which the rate of feed can be determined while the plant is in full operation. The combined aggregate shall be weighed on a belt scale. The scale shall be of such accuracy that, when the plant is operating between thirty

percent and one hundred percent of belt capacity, the average difference between the indicated weight of the material delivered and the actual weight delivered will not exceed one percent of the actual weight for three two-minute runs. For any of the three individual two-minute runs, the indicated weight of material delivered shall not vary more than two percent from the actual weight delivered.

The belt scale for the combined aggregate, the other proportioning devices for additives and the asphalt cement proportioning meter shall be interlocked so that the rates of feed will be automatically adjusted to maintain the proper material ratios as designated by the approved mix design. The plant shall not be operated unless this automatic system is operable and in good working condition.

The asphalt cement meters, additive feeders and aggregate belt scales used for metering the aggregate additives and asphalt cement into the mixer shall be equipped so that the actual quantities of asphalt cement, additives and aggregate introduced into the mixture can be determined.

Mixing shall be performed for sufficient time, and at a sufficiently high temperature, so that at discharge from the mixer, the sizes of aggregates are uniformly distributed throughout the completed mixture and all particles are thoroughly and uniformly coated with asphalt cement.

Temperature of the completed mixture at discharge from the drum shall not exceed 325°F (163°C) for all dense-graded mixes using AC-10, AC-20 and AC-30 grades of asphalt cements. Maximum temperatures for open-graded mixes using AC-20 and AC-30 shall not exceed 275°F (135°C). Open-graded mixes using AC-20R shall not exceed 325°F (163°C).

The mixed material shall be discharged from the drum into a surge silo of not less than forty tons in capacity. The manufacturer shall also provide a means of diverting the flow of material away from the silo, when starting and stopping the plant production, to prevent incompletely or improperly mixed portions of the mixture from entering.

Paving grade asphalts shall be added to the aggregates, in both batch and drier-drum plants, at a temperature between 285°F (140°C) and 350°F (177°C). The temperature of the aggregates at the time of adding the asphalt cement shall not be less than 265°F (130°C), nor more than 325°F (163°C). A thermometer with a 500°F (260°C)

capacity, and accurate to 10°F (5.5°C) will be fixed in the asphalt cement feed line or storage tank at a suitable location to view when sampling the asphalt. The manufacturer will provide a suitable sampling outlet in the asphalt cement feed lines connecting the storage tank(s) to the asphalt cement meter. The sampling valve shall consist of a one-half inch (12.7 mm) or three-quarter inch (19 mm) valve constructed in such a manner that a one quart (.95 liter) sample may be withdrawn slowly at any time during plant operations. The sampling valve shall be placed in the least hazardous location that is readily accessible. A drainage receptacle shall be provided for flushing the valve prior to sampling. One gallon (3.8 liters) shall be drawn from the sampler prior to taking the sample.

4.5.14 ASPHALT CONCRETE SURGE AND STORAGE SILOS. The type of conveying equipment used to deliver the hot-mix asphalt from the discharge chute on the drier-drum mixer or from the hopper under the pugmill may be either a variable or constant speed - bucket elevator, drag slat conveyor or hot material belt conveyor.

The manner in which the mix exits from the conveyor or elevator and enters the top of the silo, shall be such as to prevent segregation of the completed asphalt mixture. Properly installed, maintained and operated systems such as rotating spreader chutes, batchers and gob hoppers are all acceptable segregation prevention systems. Splitter systems, or a series of baffles, may be used providing they are approved by the City's Representative.

Silos shall be cylindrical with conical bottoms providing a minimum angle of 55° and maximum angle of 70°. The gate opening in the bottom shall be sized to work with the angle of the cone to prevent center draw down resulting in material segregation.

Heated or insulated surge silos are not required, however, a heated discharge cone is preferred.

The asphalt mixture that develops lumps, hardening or chills below 250° (120°C) while the mix heats the silo and discharge cone shall not be used. All surge silos shall be emptied of mix at the end of each production day.

Storage silos shall be well insulated and equipped with heated discharge cones and well sealed discharge gates. Dense-graded asphalt may be stored up to forty eight hours in silos with heated cones, and seventy two hours with heating of the silo vertical walls and cone.

Storage silos may be used for storage or surge purposes, but under no circumstance may a surge silo be used for storage. Either silo must be equipped with high and low indicator systems.

4.5.15 SHIPPING ASPHALT MIXTURES. Trucks used for hauling mix shall have tight, clean, smooth beds which are treated to prevent the mix from adhering to the bed. Amounts of solution that form visible pools in the truck bed shall be removed prior to loading asphalt mix.

Asphalt mix shall be deposited in a mass into the haul truck or loading hopper from the silo. The gates on the bottom of the silo cone shall open and close quickly. To prevent segregation, it is also necessary for the gates to open completely so that the flow of mix is unrestricted. The mix shall be delivered in evenly divided drops into the length of the truck bed. In no case shall the truck be loaded continuously by the truck driver moving forward under the silo as the mix is being discharged. Multiple drops of small quantities or dribbling mix into the haul vehicle at the end of the main delivery should be avoided to prevent segregation.

4.5.16 SURFACE PREPARATION FOR ASPHALT OVERLAYS. Prior to placing asphalt overlays, all manholes, utility covers, monuments and other items affected by the paving operations shall be located, referenced and protected. The existing asphalt surface shall be thoroughly cleaned of all deleterious materials and brought to a uniform grade by spot leveling or by the application of a bituminous leveling course to the surface. A bituminous tack coat shall be applied to the existing prepared surface immediately prior to placing the finish asphalt course in accordance with Section 4.5.9 of these specifications.

4.5.17 ADJUSTMENT OF MANHOLE AND UTILITY COVERS. Prior to paving and after roadbase is placed, all manholes and utility covers shall be brought to the base grade. Damaged valve boxes, covers, grade rings, cones, flattops, risers, etc. replaced. Manhole cones or flattops that are more than eighteen inches below finish grade shall be raised by using risers etc. under the cone or flattop. Existing roadbase shall not be contaminated with soil or subbase. Backfill material around adjusted manholes and utilities shall comply with roadbase standards meeting Section 4.5.7 of these specifications, and be compacted to ninety five percent as determined by ASTM D-1557-78 or AASHTO T-180 Method D. When paving is complete, all manhole and utility covers shall be raised to finished grade, including concrete collars, in accordance with standard requirements.

4.5.18 ASPHALT PAVING EQUIPMENT. A self-propelled paver with a screed unit that provides a smooth, steady pull on the screed arms shall be used. The

screed unit shall strike off, partially compact, and iron the surface of the mat at least twelve feet (3.7 m) wide. The screed unit shall be equipped with automatic controls and heaters and vibrators. The screed plate must be smooth and not excessively worn. All screed extensions shall be ridged, or hydraulically extendable. The screed extensions shall maintain the proper elevation and angle of attack to the main screed at all times and shall also be heated and provide vibration. Augers shall adequately feed all areas of the extended screed.

The automatic screed controls shall be full contact electronic or non-contact ultrasonic grade control systems. These systems shall be adaptable to a floating-beam system a minimum of thirty feet long. The floating-beam shall be equipped with shoes that are allowed to rotate and can be individually displaced by isolated disruptions in the existing surface without changing the height of the whole beam. The automatic grade sensor shall be set at the midpoint of the floating beam.

Ultrasonic grade control systems may be used without the floating beam on all Traffic Category II streets unless otherwise directed. The ultrasonic grade control system must meet the following conditions in order to be used without the floating beam.

4.5.18.1 The system shall be equipped with a “self diagnostic” function that continuously monitors all system functions and shuts the system down if an error in the system occurs. It shall also be equipped with a “reference bail” to electronically compensate for differences in air and ground temperature with a minimum operating range not less than zero to 160 degrees F. (-18 to 71 degrees C.).

4.5.18.2 The system shall perform to a minimum of the following specifications:

Ultra sonic grade controller:

- On-grade tolerance ± 0.01 foot
- Resolution 0.001 foot
- Operating range 10 in. to 42 in.
- Mat thickness control - 0.01 foot

Slope controller:

- Correction window - 1.0%
- On-grade tolerance - 0.1%
- Resolution - 0.01%
- Operating range $\pm 0.0\%$

to 100%.

The systems meeting the above requirements must be properly installed on a “tight,” properly maintained self-propelled paver with a screed unit. A “tight” system shall meet the equipment manufacturer's service specification tolerances for all controlling surfaces and connecting points that affect the ability of that specific type of equipment to provide proper grade control.

The City's Representative has the right to prohibit the use of such equipment if in his opinion the equipment has not been properly maintained or is not being properly operated.

If the automatic grade control becomes inoperative, the Contractor may finish the day's work using manual controls provided the required grade, thickness and smoothness tolerances are met. Paving shall not continue on the project, or any new project, until the automatic control system has been repaired.

4.5.19 ROLLERS. Rollers shall be vibratory, steel-wheeled double-drum with a static weight of not less than 10 tons (9.10 tonnes) for breakdown rolling. Pneumatic-tired rollers with a minimum operating weight of two thousand pounds (907 kg) per tire shall be used for intermediate rolling and leveling course compaction. The roller shall be in good condition, and capable of reversing without backlash. The number of rollers shall be sufficient to compact the asphalt mixture before it cools below 175°F (80°C). Finish rolling may be performed with the breakdown roller in the static mode, or with a steel-wheeled roller of sufficient size to remove the roller marks in the finished surface. If a roller breaks down and a back-up roller is not available, paving operations shall stop until adequate rollers are available.

4.5.20 WEATHER AND DATE LIMITATIONS. Asphalt shall not be placed during the period from December 1st through February 15th unless otherwise approved by the City Engineer. Paving approved during this time shall conform to winter paving requirements and policies. Minor repairs and patching will be allowed during winter months.

The asphalt mixture shall not be placed upon any wet surface, or when the air and surface temperature of the underlying course is less than specified in Table 4.8. The temperature requirements may be modified, but only when so approved and directed by the City Engineer. Open-graded asphalt mix shall be placed only when the air temperature is 70°F (21°C) and rising, and the surface temperature is a minimum of 60°F (16°C). Air and roadbed temperature shall be measured in the shade. Asphalt mixtures shall not be placed during adverse weather conditions such as rain, wind, hail, etc.

TABLE 4.8 CLIMATE LIMITATIONS		
Mat Thickness Wind of 5 MPH or less	Minimum Air and Surface Temperature	
	F	C
3 inches or greater	40°	4°
Greater than 2 inches, but less than 3 inches	45°	7°
2 inches or less	50°	10°
Open graded asphalt mix	70°	21°

4.5.21 SPREADING AND FINISHING. The asphalt mix shall be placed upon an approved surface, by a self-propelled paver meeting the requirements in Section 4.5.18. The travel rate of the paving machine shall be regulated to a speed dependent upon the capacity of the mixing plant and/or trucking service to supply the mixture. The paving machine shall be operated so that material does not accumulate and cool below 250° F (121° C) along the sides of the receiving hopper.

Where unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture may be spread, raked with hand tools, and mechanically compacted. For such areas, the mixture shall conform to the required mix design, density, compacted thickness, grade and cross section.

The asphalt mix may be windrowed in front of the self-propelled paver properly equipped to transfer the asphalt mix directly into the hopper, provided that the following conditions and requirements are strictly adhered to.

4.5.21.1 The windrow is properly sized, thereby insuring the delivery of the correct amount of material to the paving machine at all times.

4.5.21.2 The asphalt mixture shall be transferred from the windrow to the paving machine in such a manner that the materials in the paver will be a uniform mixture. The base, upon which the windrow was formed, shall not be disturbed. There shall be a minimum amount of asphalt mixture remaining on the base between the pickup device and the paving machine.

4.5.21.3 The material in the hopper of the paving machine shall meet with the temperature requirements. Asphalt mixture that does not meet the minimum specified temperatures shall not be used, and shall be properly disposed of.

When it is determined by the City Representative that the asphalt course being placed by use of a windrow is inferior to that being placed by direct transfer of the asphalt from the hauling vehicle to the spreading machine, the use of the windrow method shall be discontinued.

The asphalt mixture placed by the use of a paving machine during one day's operation shall come from a single plant manufacturer. Intermixing from more than one source shall not be allowed. Intermixing is defined as when more than one plant is used as a routine supply source to a single operation.

The asphalt mixture shall have a temperature not less than 270°F (132°C) nor more than 325°F (163°C), at the time the paving machine places the asphalt mixture on grade. Depending on environmental conditions and compaction requirements, the City's Representative may specify more strict temperature requirements.

Asphalt pavement courses of more than three inches in total compacted thickness shall be placed in two or more courses. One course shall not be placed over another course until the compaction requirements have been met and the mat temperature has cooled to 160°F (71°C) at mid-depth.

Placing of the asphalt pavement shall be as continuous as possible. Rollers should not pass over the unprotected edge of the freshly laid asphalt mixture. Transverse joints shall be formed by cutting back on the previous run to expose the full depth and proper grade of that course. A tack coat meeting Section 4.5.9 of these specifications shall be applied on the contact surface of the prepared transverse joints just before the new asphalt mixture is placed.

Longitudinal joints shall be spaced in such a manner that joints in succeeding courses will be offset at least twelve inches horizontally from joints in any preceding course. Lanes will be evened up each day to minimize cold longitudinal joints and to provide proper transverse joints. Where possible, the top course longitudinal joints shall be placed a minimum of one foot either side of the lane line.

Transverse joints shall be spaced in such a manner that joints in succeeding passes will be a minimum of five feet horizontally from joints in any adjacent pass.

Existing roadway pavements to be widened shall be sawcut far enough into the roadway to provide the proper grade, cross-section and thickness with a straight vertical longitudinal or transverse joint. These joints shall have a tack coat meeting Section 4.5.9 of these specifications applied on the contact surface immediately prior to paving.

Longitudinal joints on previously compacted passes should have an overlap of new asphalt mixture one to one and one-half inches over the existing mat. Raking should be merely to "bump" the joint, pushing the asphalt mixture off the previous pass and onto the new pass directly over the joint. If the adjacent mat is overlapped too far and too much asphalt mixture is deposited on the existing mat, the excess material shall be pulled away from the new mat rather than being pushed onto the new mat. Excess mix shall never be broadcast across the newly laid asphalt. The excess mix shall be picked up and recycled.

4.5.22 ROLLING AND COMPACTING. Compaction equipment shall meet the requirements of Section 4.5.19 of these specifications, unless otherwise approved or required by the City's Representative.

A pass shall be one movement of a roller in either direction. A coverage shall be as many passes as are necessary to cover the entire width being paved. Overlap of passes during any coverage, made to ensure compaction without displacement of material shall be in accordance with good rolling practice.

The breakdown rolling shall consist of one or more complete coverages of the asphalt mat with a vibratory steel-wheeled roller. Initial rolling shall commence at the lowest edge and shall progress toward the highest portion of the asphalt mat. Initial rolling shall not commence on the interior portion of any mat.

The breakdown rolling shall be followed immediately by additional rolling with a pneumatic-tired roller that will provide uniform density throughout the depth of the course being compacted. A minimum of two rollers, one steel-wheeled, and one pneumatic-tired, shall be used. However, the total number of rollers used beyond the minimum of two shall be sufficient to obtain the required compaction while the asphalt mixture is above 175°F (80°C).

The final rolling of the asphalt mixture shall be performed by a steel wheel roller of sufficient size to remove all roller marks caused during the compaction of the asphalt mixture. The vibratory roller used for breakdown rolling may be used as the finish roller provided it is operated with the vibratory unit turned off.

The rollers shall be kept in continuous motion while rolling so that all parts of the asphalt mixture will receive as close to equal compaction as possible. The roller speed shall be slow enough at all times to avoid displacement of the pavement. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected immediately by use of rakes and fresh asphalt mixture when required.

To prevent adhesion of the asphalt mixture to the rollers, the wheels/tires, bars, pads and release agent pumps shall be kept properly maintained. The use of diesel oil on pneumatic-tired rollers shall be kept to a minimum and used only in conjunction with coca pads to prevent the asphalt mixture from adhering until the tires heat enough to prevent mix adherence.

The completed surface shall be thoroughly compacted, smooth and free from ruts, humps, depressions, or irregularities. Any ridges, indentations or other objectionable marks left in the surface of the finished pavement shall be eliminated by rolling or other means. The use of any equipment that leaves ridges, indentations, or other objectionable marks in the asphalt surface shall be discontinued, and acceptable equipment shall be furnished.

Compacting the longitudinal joint shall be performed by placing the roller on the hot uncompacted mat and overlapping the joint by a distance of approximately six inches over the cold compacted mat. For proper compaction, the level of the uncompacted mix at the longitudinal joint must be above the elevation of the compacted mix by an amount equal to one-quarter inch for each one inch of compacted pavement. This ratio is "rule of thumb" and may vary slightly depending on the type of asphalt mix and the supplier. A test strip is advisable.

A good source of information for rolling asphalt is a document by AASHTO, FAA, Federal Highway Administration and the National Asphalt Pavement Association entitled "AC 150/5370-14, Appendix 1, July 31, 1991". The following information is taken from that document.

1. Rolling From The Cold Side - It was common practice in the past to do the initial rolling of the longitudinal joint from the cold (previously placed mat) side of the joint. The major portion of the weight of the roller was supported by the cold, compacted mat. Only six inches or so of the width of the roller hung over the fresh mat, compressing the mix along the joint. The majority of the compactive effort was wasted because the roller essentially was applying its compactive effort to an already-compacted asphalt material.

During the time that the roller was operating on the cold side of the longitudinal joint, the mix on the hot side of the joint, and the rest of the mix in the course being laid, was cooling. Depending on the environmental conditions and the thickness of the mix

being placed, the process of compacting the joint from the cold side often proved to be detrimental to the ability to obtain density on the whole pavement layer.

The reason often given for rolling the joint from the cold side of the joint was that this compaction method allowed the rollers to "pinch" the joint and obtain a higher degree of density. There is no evidence that this is true.

2. Rolling From The Hot Side - The most efficient way to compact the longitudinal joint is to put the roller on the hot mat and overlap the joint by a distance of approximately six inches over the cold mat. This places the majority of the weight of the compaction equipment where it is needed. The mix at the joint is still pushed into the joint area by the roller as long as the elevation of the new mix at the joint is proper. The longitudinal joint can be compacted effectively by keeping the roller on the new mix, instead of on the previously compacted mix. Any type of roller used for the breakdown rolling of the mix can be employed to compact the longitudinal joint as long as the elevation of the mix at the joint is above the level of the cold mat and the mix is still hot.

Sometimes the first pass of the roller is completed with the edge of the machine about six inches inside of the longitudinal joint. The theory behind this method of compaction is that the mix will be shoved toward the joint by the roller, and better compaction will be obtained. If the mix being placed is stable enough, the roller should not be able to move the material laterally to any significant degree. If the mix design is proper, this method of compacting the joint does not provide any advantage over moving the first pass of the roller outward one foot (from six inches inside the joint to six inches outside the joint). Rolling the mat by lapping the roller over the adjacent old pavement typically is the more efficient way to provide roller coverage for the whole pavement width.

4.5.23 OPEN-GRADED WEARING COURSE.

4.5.23.1 WEARING COURSE. An open-graded wearing course shall be placed over a dense-graded asphalt course. The dense-graded asphalt shall be true to line and grade, cleaned and tacked.

The following specifications shall be complied with:

<u>Item</u>	<u>Section</u>
Dense-graded asphalt	4.5.10
Tack Coat	4.5.9
Asphalt Cement for (existing road) Overlays	Table 4.10
Asphalt Cement for New Construction	4.5.10.2
Hydrated Lime	4.5.11
Other related requirements	

Aggregate gradation shall conform to Table 4.9 when tested under AASHTO T-30.

The percent passing the No. 200 (.075 mm) sieve will be determined by using AASHTO T-11, test procedures.

That portion of aggregate retained on the No. 4 (4.75 mm) sieve shall have no more than ten percent rounded particles when tested in accordance with UDOT Test Procedure 8-929.

TABLE 4.9 OPEN-GRADED ASPHALT AGGREGATE GRADATION			
SIEVE SIZE		IDEAL GRADATION PERCENT PASSING	IDEAL GRADATION TOLERANCE
AMERICAN	METRIC		
½ inch	12.5 mm	100	0
3/8 inch	9.5 mm	96	93-100
No. 4	4.75 mm	40	35-45
No. 8	2.36 mm	17	13-21
No. 200	.075 mm	3	1.3-4.7

**TABLE 4.10
RUBBERIZED LIQUID ASPHALT REQUIREMENTS**

AC-20R:			
Property	ASTM	Specification	
		Min.	Max.
Viscosity @ 140°F, poise	D-2171	1,600	2,400
Viscosity @ 275°F, cs	D-2170	325	
Pen @ 77°F (100 g, 5 sec)	D-5	70	
Flash Point, °F, C.O.C.	D-92	450	
Duct. @ 39.2°F, (5 cm/min)	D-113	50	
cm		2.0	
Rubber, weight %	*	110	
Toughness, in-lb	*	75	
Tenacity, in-lb	D-2872		
Rolling Thin-Film Oven Test	**		
Tests on Residue:		8,000	
Viscosity @ 140°F, poise	D-2171	25	
Duct. 39.2°F, (5 cm/min)	D-113		
cm			
<p>* Benson Method of Toughness and Tenacity: Scott Tester, inch-pounds @ 77°F, 20 inches per minute pull. Tension head 7/8-inch diameter.</p> <p>** TFOT ASTM D-1754 may be used. The Rolling Thin-Film Circulating Oven Test is the preferred method.</p>			

4.5.23.2 SUITABILITY OF AGGREGATE. The following requirements shall be used to determine the suitability of the aggregate during the mix design:

- Wear shall not exceed thirty percent when tested in accordance with AASHTO T-96.
- The weighted loss shall not exceed twelve percent by weight when subjected to five cycles of sodium sulfate tested in accordance with AASHTO T-104.
- Aggregates consisting mainly of carbonate type rocks shall not be used unless approved by UDOT as satisfactory long-term friction values for comparable traffic volumes when tested in accordance with AASHTO T-242 or ASTM E-274-79.

Aggregates shall be separated into two or more sizes and stored separately.

Stockpiling or handling methods that cause segregation, degradation or the combining of materials of different sizes when placing the aggregate in storage or moving it from storage to the cold bins shall not be used. Any segregated or degraded material shall be re-screened.

4.5.23.3 MIX DESIGN. Annual mix designs shall be submitted in writing to the City Engineer for approval two weeks prior to the first job each calendar year, or upon selection of new aggregate sources. Any revisions to the approved mix design shall fall within the requirements listed above. Open-graded wearing courses that do not meet the tolerances shown in Section 4.5.24 shall be removed and replaced with material meeting the required gradation. The asphalt cement shall be within 0.10 percent of the mix design. At no time shall the asphalt cement content be such that asphalt slicks form on the surface of the roadway.

Based on the mix design, the open-graded wearing course shall have a tensile strength ratio of seventy (70) percent, or greater, in accordance with AASHTO T-283 UDOT modified. Hydrated lime or anti-stripping agent may be added to the asphalt mix to meet the minimum tensile strength of seventy (70) percent.

4.5.23.4 MIXING. The mixing shall be done as specified in Section 4.5.13. The mineral aggregate will be considered satisfactorily coated with asphalt when all particles are coated. During mixing the viscosity of asphalt shall be maintained between four hundred and nine hundred centistokes. The viscosity of polymer-modified asphalt, when used,

shall be maintained between one hundred fifty and three hundred (150-300) centistokes.

If a drier-drum mixing process is used, the temperature of the mixture shall not be less than 220°F (104°C), or more than 275°F (135°C), when discharged from the mixer. When using a polymer-modified asphalt the temperature of the mixture when discharged from the mixer, shall be maintained between 270°F (132°C) and 320°F (160°C). Viscosity will be determined in accordance with ASTM T-201.

4.5.23.5 SURFACE PLACEMENT. Tack coat shall be applied in accordance with Section 4.5.9.

Self-propelled asphalt paving equipment and automatic screed controls meeting the requirements of Section 4.5.18 shall be used. Rollers shall meet the requirements of Section 4.5.19 and shall be a ten ton (9.10 tonne) vibratory operated static or a ten ton (9.10 tonne) static steel wheeled roller for asphalt pavement finishing.

Paving operations should be planned such that all passes will be brought even “transversely” at the end of each working day. Joints between old and new pavements, or between successive days works shall ensure continuous bond between adjoining work. Construct joints to have the same texture, density, and smoothness as other sections of the bituminous pavement course. Clean contact surface and apply tack coat.

Offset longitudinal joints a minimum of 12 inches in succeeding courses and at least 6 feet transversely to avoid vertical joints through more than one course. In the top course restrict longitudinal joint to 1 foot either side of the lane line. Prevent traffic, including construction traffic, from crossing vertical joint edges.

Excessive rolling shall not be allowed. Wearing course compaction shall be completed prior to the mix temperature drop below 180°F (82°C). When using polymer-modified asphalt, compaction shall be completed prior to the mix temperature dropping below 200°F (93°C).

Asphalt slicks shall be raked immediately. Slick spots that cannot be removed by raking, shall be replaced. All humps or depressions exceeding tolerances shall be corrected. Correction methods shall be approved by the City’s Representative.

All traffic shall be prevented from traveling on the completed wearing course until it has hardened sufficiently and the surface temperature has dropped below 160°F (71°C). The thickness of the compacted wearing course shall not vary more than one-quarter inch (6.35 mm) from the specified thickness. Testing and acceptance shall conform to Section 4.5.24.

4.5.24 ACCEPTANCE TESTING REQUIREMENTS AND TOLERANCES.

The following subsections list the requirements for testing and acceptance for subbase, roadbase, RAM, dense-graded asphalt, open graded asphalt and asphalt pavement surfaces. Testing documentation shall fully address the requirements of these standards.

4.5.24.1 SUBBASE. The following will be required for testing and acceptance of subbase:

- A. One moisture/density test per seven thousand square feet of roadway, or fraction thereof.
- B. One thickness test hole per five thousand square feet.
- C. One gradation test per fifteen thousand square feet of roadway, or fraction thereof. The allowable deviations from the approved subbase targets are as follows:

SIEVE SIZE AMERICAN (METRIC)	ALLOWABLE DEVIATION
2" (50.80 mm) to 6" (152.4 mm)	± 12.1%
1/2" (12.5 mm) to 1" (25.0 mm)	± 10.8%
3/8" (9.5 mm)	± 9.8%
No. 4 (4.75 mm)	± 8.8%
No. 16 (1.18 mm)	± 6.9%
No. 200 (.075 mm)	± 2.9%

C.1 One sand equivalent (SE) value for every gradation outside the allowable deviation. A CBR or R-value shall be performed on twenty five percent of all sand equivalent

test results with a minimum of one test required. Where multiple SE tests are run, the CBR or R-value shall be determined on those SE tests that exhibit the lowest values.

The Following Are the Minimum Values for Roadway Subbases.

- The minimum acceptable SE value shall be eighteen.
- The minimum acceptable R-value shall be sixty.⁽¹⁾
- The minimum acceptable CBR value shall be 8.8.⁽²⁾

Note 1: R-value test: AASHTO T-190 or ASTM-D 2844 (300 psi exudation pressure)

Note 2: CBR Value Test: AASHTO T-193, (3 point)

4.5.24.2 ROADBASE AND RECYCLED AGGREGATE MATERIALS (RAM).

- A. One moisture/density test per seven thousand square feet of roadway, or fraction thereof.
- B. One thickness test hole per five thousand square feet.
- C. One gradation test per fifteen thousand square feet of roadway, or fraction thereof. The allowable deviation from the approved roadbase and RAM targets are as follows:

SIEVE SIZE AMERICAN (METRIC)	ALLOWABLE DEVIATION
1/2" (12.5 mm) to 1" (25.0 mm)	± 10.8%
3/8" (9.5 mm)	± 9.8%
No. 4 (4.75 mm)	± 8.8%
No. 16 (1.18 mm)	± 6.9%
No. 200 (.075 mm)	± 2.9%

C.1 One sand equivalent (SE) value for every gradation outside the allowable deviation. A CBR or R-value shall be performed on twenty five percent of all sand equivalent test results with a minimum of one test required. Where multiple SE tests are run, the CBR or R-value shall be

determined on those SE tests that exhibit the lowest values.

The Following Are the Minimum Values for Roadbase and RAM.

- The minimum acceptable SE value shall be twenty-two.
- The minimum acceptable R-value shall be seventy-six.⁽¹⁾
- The minimum acceptable CBR value shall be 14.5.⁽²⁾

Note 1: R-value test: AASHTO T-190 or ASTM-D 2884 (300 psi exudation pressure)

Note 2: CBR Value Test: AASHTO T-193, (3 point)

4.5.24.3 DENSE-GRADED ASPHALT PAVEMENTS.

A. One density test per seven thousand square feet of surface area, or fraction thereof.

B. One core sample per nine thousand square feet, or fraction thereof, unless sufficient inspection has been made by the City's Representative to verify required thickness.

C. One extraction and gradation test per days work, or one for every five hundred tons or fraction thereof, whichever is greater.

In the event that the asphalt pavement fails to meet the allowable deviation for extraction or gradation tests, or shows a tendency under traffic loading to rut, tear, or distort, or in the opinion of the City's Representative is "tender" or deficient in appearance, the asphalt pavement shall be cored and tested in accordance with AASHTO T-283-89 or ASTM D 4867-92 including Note 5.

The asphalt pavement must possess seventy percent of the tensile strength ratio based on the approved Marshall mix design. Asphalt pavement not meeting this requirement shall be removed.

The maximum allowable deviations from the approved Marshall mix design are:

Asphalt content	+/- 0.46%
1/2" (12.5 mm) and larger	+/- 6.3%
3/8" (9.5 mm)	+/- 5.9%
No. 4 (4.75 mm)	+/- 5.7%
No. 8 (2.36 mm)	+/- 4.8%
No. 16 (1.18 mm)	+/- 4.6%
No. 50 (.300 mm)	+/- 3.8%
No. 200 (.075 mm)	+/- 2.0%

4.5.24.4 COMPACTION OF DENSE-GRADED ASPHALT PAVEMENT.

A. Acceptance of dense graded asphalt pavement shall be as follows:

- When the average of all density tests is not less than ninety six (96) percent of the maximum laboratory density (Marshall) and when no single test is lower than ninety two (92) percent of the Marshall.
- When the average of all density testing falls between ninety three (93) percent to 95.9% of the Marshall with no test lower than ninety two (92) percent of the Marshall, the asphalt pavement shall be tested to determine the percent of air voids. If the percent of air voids are between three to five (3-5) percent, the asphalt pavement will be considered acceptable. If the percent of air voids are between five to seven (5-7) percent, the asphalt pavement will require a slurry seal per these specifications.
- When the average of all density testing falls between ninety one (91) percent of the Marshall and 92.9% of the Marshall with no single test below ninety (90) percent of the Marshall, the asphalt pavement shall be overlaid with a minimum of one inch thick asphalt pavement. Prior to the overlay, the existing asphalt next to the curb, gutter, cross gutter, etc. shall be milled one inch below the top edge of the concrete to provide a finished asphalt surface that is flush with or not more than .02 foot above the concrete gutter.
- Asphalt pavements with an average density less than ninety one percent of the Marshall, or with any single test less than ninety percent of the Marshall, shall be removed and replaced.

4.5.24.5 OPEN-GRADED ASPHALT WEARING COURSE.

In the event that the extraction or gradation fails to meet the allowable deviation, the remaining sample material shall be remolded and tested in accordance with AASHTO T 283-89 or ASTM D 4867-92 including Note 5. The open-graded asphalt pavement must possess seventy percent of the tensile strength ratio based on the approved mix design. Open-graded asphalt not meeting this requirement shall be removed and replaced.

The allowable maximum deviations from the approved Marshall mix design shall be as follows:

Asphalt content	+/- 0.46%
1/2" (12.5 mm)	+/- 6.3%
3/8" (9.5 mm)	+/- 5.9%
No. 4 (4.75 mm)	+/- 5.7%
No. 8 (2.36 mm)	+/- 4.8%
No. 200 (.075 mm)	+/- 2.0%

4.5.24.6 ASPHALT PAVEMENT SURFACES.

The completed surfacing shall be thoroughly compacted, smooth and free from ruts, humps, depressions, rock pockets or slick spots. Any ridges, indentations or other objectionable marks left in the pavement's finished surface shall be corrected prior to acceptance.

The paving contractor shall provide adequate quality control during spreading and finishing procedures to meet or exceed the following longitudinal and transverse profiles:

- Longitudinal deviations shall not exceed ± 0.025 foot in 25 feet when checked by a taut string line.
- Transverse deviations shall not exceed ± 0.01 foot in 10 feet when checked with a ten foot straight edge.
- Longitudinal construction joint deviations shall not exceed ± 0.01 foot when checked with a ten foot straight edge.
- The completed pavement surfaces shall be constructed to the required grades and cross sections. When pavement surfaces contact concrete structures such as drainage structures, curbs & gutters, utility vaults, or manholes, the pavement surfaces shall be flush with or above the concrete structures by not more than 0.02 foot.

All deviations exceeding the specified profile tolerances shall be corrected prior to final rolling.

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4.6 BITUMINOUS SEAL COAT (CHIP SEAL). Bituminous surface treatments (chip seals) shall be applied to the road surface only when required, or approved by the City Engineer. The bituminous surface treatment shall consist of an application of bitumen covered with mineral aggregate and rolled to a smooth surface presenting an even texture. The materials used in the application of the bituminous surface treatment shall be bituminous mineral, and mineral aggregate, as specified below.

4.6.1 MATERIAL SPECIFICATIONS.

4.6.1.1 BITUMINOUS MATERIAL. The bituminous material shall be cationic emulsified asphalt with a natural latex rubber material (type LMCRS-2H) and shall conform to the following requirements:

TEST	SPECIFICATION	PARAMETERS
Viscosity @ 122° F.	AASHTO T-59	100-300 sec.
Sieve	AASHTO T-59	0.3% max.
Settlement, 5 days	AASHTO T-59	5% max.
Demulsibility	AASHTO T-59	40% min.
Storage Stability (1 day test)	AASHTO T-59	1% max.
Ash Content	ASTM D3723	0.2% max.
Tests on Residue by Drying:		
Percent Residue	NV 756	65% min.
Penetration @ 77° F., (100 g., 5 sec.)	AASHTO T-49	40-150 mm.
Ductility @ 77° F., (5 cm./min.)	AASHTO T-51	40 cm. min.
Torsional Recovery	NV 756	18% min.
Particle Charge	AASHTO T-59	POSITIVE

4.6.1.2 AGGREGATE (CHIPS). Mineral aggregate shall consist of crushed stone or crushed gravel, free from adherent films of clay or dust, and shall be of such nature that a thorough coating of the bituminous material used in the work will not strip off upon contact with water.

The gravel or rock shall have a percent of wear not greater than thirty when tested by the Los Angeles Abrasion Test (AASHTO T-9 ASTM C 131).

Chips shall be cubical or pyramidal in shape with at least ninety-five (95) percent fractured faces. The crushed aggregate shall have a weighted percent of loss not exceeding ten percent by weight when subjected to five cycles of sodium sulfate and tested in accordance with AASHTO Designation T-104.

Stripping tests of the mineral aggregate which the Contractor proposes to use shall be furnished to the City's Representative before crushing operations begin. During aggregate crushing, additional stripping tests shall be furnished to the City's Representative upon request. No stripping test shall show a percent stripping greater than ten for LMCRS-2H asphalt. The chip shall be electrically compatible to the asphalt emulsion used.

The crushed aggregate shall conform to the gradation requirements shown in following table.

**TABLE 4.11
GRADATION OF AGGREGATE FOR CHIP SEAL COATS**

SIEVE SIZE	PERCENT BY WEIGHT PASSING (Ideal)	IDEAL GRADATION TOLERANCE (Percent)
1/2 Inch	100	0
3/8 Inch	95	+/- 5
No. 4	10	+/- 5
No. 8	2	+/- 2
No. 200	0.5	+/- 0.5

The initial mineral aggregate used for the production of chips shall be retained on a one-inch sieve prior to being crushed to the gradation specified.

4.6.2 AGGREGATE QUALITY CONTROL. Prior to delivery to the project site the designated wear test, striping test, sodium sulfate test, fracture face count, and gradation tests shall be performed on the crushed aggregate. Each time a source changes said tests will be repeated.

All aggregate (chips) shall be tested for compliance with the gradation and fracture face count during the production of the chips. There shall be no less

than one test performed for every five hundred tons of material produced or one day's production, whichever is less. One gradation test and fracture face count test shall be defined as the average results of tests taken on three different samples taken at one particular time.

All material produced shall be stockpiled in designated stockpile site(s).

When chips are delivered to the project stockpile site there shall be one gradation test conducted for every five hundred tons of material. If the gradation test requirements are not met, the City's Representative may require that the failed material be removed from the stockpile. Chips shall be considered to be out of specification if one test (as defined herein above) fails.

The City's Representative will not accept any chips which do not meet all the designated specifications. No reduction in pay or other remedial terms will be allowed or negotiated.

In addition to the random acceptance samples taken at the stockpile, the City's Representative may sample the aggregate from any portion of stockpile which exhibits a non-uniform appearance.

The Contractor shall take immediate steps to bring the aggregate into specifications when test results show any deviation from the established maximum or minimum values for any sieve as shown in Table 4.11 of these specifications.

At designated stockpile site(s), the Contractor may be required to "push up" the unloaded aggregate into piles suitable for loading into the delivery dump trucks.

Extreme care shall be taken so as not to mix any of the crushed aggregate with the underlying material at the stockpile or the crushing site. In the event that there is contamination of the chip seal aggregate with foreign material, as determined by the City's Representative, or by tests conducted, the contaminated section of material shall be immediately removed from the stockpile or crushing area and properly disposed of. All contaminated material removed from the stockpile, or crushing area, shall be replaced with aggregate which meets the requirements of these specifications.

All testing required by the City's Representative, or by the plans and specifications, shall be performed by an independent testing laboratory. The Contractor shall do everything in his power to ensure that the City's Representative has full access to the testing procedure and shall deliver to the

City's Representative any and all results of tests run. The Contractor shall not proceed with subsequent construction until certified copies of appropriate tests are delivered to the City's Representative. Any materials not properly tested shall be subject to rejection and removal.

4.6.3 EQUIPMENT. All tools, equipment and machines used in the performance of the work shall be subject to the approval of the City's Representative, and shall be maintained in satisfactory working conditions at all times.

4.6.3.1 ASPHALT DISTRIBUTOR. The asphalt distributor shall be equipped with a calibrated dipstick marked in gallons per inch of length, and an accurate thermometer and speedometer. The distributor shall also be capable of maintaining proper pump pressure to ensure a uniform distribution of liquid asphalt emulsion at all times. The pump shall be able to maintain the correct pump speed, or pressure, without either atomizing the asphalt or distorting the spray fan. However, the pump shall be able to maintain a pressure which shall be sufficient to prevent streaking from a non-uniform discharge of material from the individual nozzles.

The distributor shall be equipped with a rear-mounted spray bar capable of covering widths of six to fifteen feet in a single pass. The distributor tank shall be well insulated and be equipped with one or more heaters capable of bringing the asphalt emulsion to spray application temperature. The tank shall have a full circulating system which shall include the spray bar unit. The truck shall also be equipped with a hand-spray for applying the asphalt emulsion to areas that cannot be reached with the spray bar.

The distributor shall be equipped with a computer which will automatically determine the discharge based on the nozzle size, the truck speeds for various application rates, and the corrections for temperature-viscosity variations.

4.6.3.2 AGGREGATE SPREADER. The spreader shall be a self-propelled Flarity chip spreader, or equal, capable of uniformly spreading aggregate at varying application rates as required. The spreader shall be equipped with a tachometer and/or a speedometer to ensure the maintenance of a uniform spreader speed. The aggregate spreader shall also be equipped with a device and so operated that the coarse particles of the screening shall be deposited on the bituminous binder before the finer particles.

4.6.3.3 ROLLERS. The Contractor shall provide at least two self propelled, smooth-tread, pneumatic tired rollers on the job during the chipping operations. Each roller shall weigh at least ten-tons and have staggered (offset) front and rear tires to obtain a uniformly rolled pass. Tire pressure in all tires shall be uniform and inflated to eighty psi. No steel wheel rollers shall be used to roll the chip seal surface treatments. Rolling speed shall not exceed ten miles per hour.

4.6.3.4 DUMP TRUCKS. The Contractor shall provide sufficient ten-wheel dump trucks during the chip sealing operations to ensure that the project can proceed without interruption. FREQUENT STOPS AND STARTS DURING THE CHIP SEAL OPERATION WILL NOT BE PERMITTED.

4.6.3.5 FRONT END LOADERS. The Contractor shall have on hand at least one front end loader to load the aggregate into the dump trucks from the aggregate stockpile(s). The loaders shall have at least a two-and-one-half yard capacity bucket.

4.6.3.6 POWER BROOMS. The Contractor shall provide at least one self-propelled rotary power broom or sweeper at the job site, and shall use said sweeper (supplemented with hand brooms as necessary) as required, to sweep the excess aggregate on the edge of each pass which will be in contact with the next pass so that there will be no build up of aggregate at the seams or joints between passes. The broomed aggregate shall be swept onto the freshly laid course.

4.6.4 BITUMINOUS CHIP SEAL CONSTRUCTION METHODS. The methods employed in installing bituminous chip seal(s) shall include, but are not limited to, the following:

4.6.4.1 SURFACE PREPARATION. All dust, dirt, tracked on clay and foreign material shall be removed from the surfaces to be sealed by sweeping the surface with power brooms, hand brooms, power blowers, or by flushing it with water or a combination of the above. All patching, crack filling and drainage improvements required by the City's Representative shall be completed prior to the commencement of the surface treatment application. After the cleaning operation has been completed, and prior to the application of the surface treatment, the area to be treated will be inspected by the City's Representative to determine its fitness for receiving the surface treatment.

All sewer manhole lids, water valve covers and survey monument covers

shall be protected from the application of the seal coat by placing building paper over the lids (cut to the exact dimensions of the lids) prior to the application of the seal coat. At the completion of the sealing operations, all protective coverings shall be removed from said survey monument covers, manhole lids and valve covers.

At the edges of all passes which will form longitudinal joints in the surface treatment (chip seal) the edge of the pass shall be swept clean of all chips for a distance of from four to six-inches back from the edge prior to the application of the adjacent pass to allow for overlap without chip buildup (humps) in the previous pass. Building paper shall be laid on all cross gutters (concrete waterways) to prevent the chip seal from being applied to said gutters. The Contractor shall place building paper at the beginning of all chip passes. Immediately after the chip application, the building paper shall be removed and destroyed.

4.6.4.2 ASPHALT APPLICATION. Application of the bituminous material shall not be permitted until the loaded aggregate trucks, rollers, and chip-spreader are in place and ready to apply, and roll, the cover aggregate. No surface will be chip sealed until authorization to do so has been obtained from the City's Representative. The asphalt material shall be applied at 0.32 to 0.40 gallons per square yard or as determined by the City's Representative and at a temperature between 125 degrees to 185 degrees Fahrenheit. The exact temperature used to apply the bituminous material shall be determined by the City's Representative.

The bituminous material shall be applied by an asphalt distributor, as described above, so that uniform distribution in the quantities specified is obtained over all points of the surface to be treated. All lightly-coated areas and spots missed by the distributor shall be properly treated with bituminous material applied by hand. No more asphalt shall be applied than can be covered with aggregate in sixty seconds or less. Distances between the distributor and chip-spreader shall be as close as possible, but in no case shall the chip-spreader be greater than fifty feet behind the distributor during the chipping operations.

4.6.4.3 AGGREGATE SPREADING. Immediately following the application of the bituminous material, the aggregate shall be evenly spread over the surface at a uniform quantity of twenty-five to thirty (25-30) pounds per square yard of surface area. Upon commencement of the work, and during its progress, the individual quantities of bitumen and aggregate may be varied to meet specific field conditions,

as directed by the City's Representative. An adequate supply of aggregate shall be available on the job site to permit continual spreading operations. Aggregate shall be damp (not wet) prior to being spread on the surface. The aggregate shall be spread by using a self-propelled spreader machine (Flarity or equal). The aggregate shall be spread evenly by hand on all areas missed by the aggregate spreader. Back-spotting or sprinkling of additional aggregate over the areas having insufficient cover shall be done by hand and shall be continued during the operations whenever necessary.

As the distributor moves forward to spray the asphalt, the aggregate spreader shall start right behind it, spreading the damp chips uniformly and at the specified rate. The asphalt distributor shall travel at the same rate of speed as the chip spreader and in no case shall the two machines be separated by more than fifty feet during the sealing process. Operating the chip spreader at speeds which cause the chips to roll over after striking the bituminous-covered surface will not be permitted.

Excess aggregate deposited in localized areas shall be immediately removed with square-end shovels, and in areas where application is insufficient, additional aggregate shall be added by hand prior to the time the asphalt "breaks".

4.6.4.4 AGGREGATE COMPACTION. The treated surface shall be rolled with rubber-tired rollers immediately after the distribution of the cover aggregate, and rolling shall continue until the aggregate is properly seated in the binder. Rollers shall proceed in the longitudinal direction, working across the treated surface until the entire width and length of the treated surface has been rolled at least four times. All rolling shall be completed within one hour after the application of the cover aggregate. Rollers and gravel trucks shall not be operated at speeds great enough to kick up chips, and in no case shall rollers be operated above ten miles per hour. In all places not accessible to the rollers, the aggregate shall be adequately compacted with pneumatic type hand tampers. Any aggregate that becomes coated, or mixed with dirt or any other foreign material shall be removed, replaced with clean aggregate over a newly-sprayed surface, and then re-rolled as directed by the City's Representative.

Bituminous material and chips shall not be spread more than one hundred feet ahead of completion of initial rolling operations.

No aggregate will be allowed to be swept into the gutters, onto the

sidewalks, or thrown onto private property. The Contractor shall be responsible for the clean up of any and all aggregate swept into these areas.

Prior to placing the second chip seal course on streets designated for double chip seals, the first course shall be thoroughly rolled to set the chips, then no less than 24 hours later the excess chips shall be removed. Upon removal of the excess chips, the second course may be applied.

4.6.4.5. LOOSE AGGREGATE REMOVAL. Upon completion of rolling, traffic will be allowed to use the streets at a speed not to exceed fifteen miles per hour for a period of not less than twenty four hours. After the chips are set in the bituminous binder, but not earlier than the following day, or as directed by City's Representative, loose chips on the surface of the road shall be broomed and removed in such a manner that the aggregate set in the binder will not be displaced. Excessive brooming will not be permitted. At the end of seven days, any excess chips shall be removed in such a manner that the aggregate set in the binder will not be displaced. Excessive rolling or brooming will not be permitted.

4.6.4.6. SANDING. After the surface has been opened to traffic, any excess bituminous material that comes to the surface (bleeds) shall be immediately covered with CLEAN SAND. The Contractor shall be required to have sufficient CLEAN sand (NOT DIRT) on hand or available to immediately sand any bleeding spots when requested by the City's Representative. Sanding shall be accomplished by evenly spreading the sand over the affected area and then hand brooming the sand to a smooth even surface with no bumps, ruts, depressions or irregularities visible.

4.6.4.7. APPEARANCE. The completed chip sealed surface shall present a uniform appearance and shall be thoroughly rolled and compacted and free from ruts, humps, depressions or irregularities due to an uneven distribution of bituminous binder or aggregate. In the event the surface presents an unacceptable appearance, as determined by the City's Representative, the Contractor shall repair unacceptable areas in accordance with the City Representative's directions.

4.6.4.8. WEATHER LIMITATIONS. Chip seal treatments shall be placed only when the air temperature in the shade is above 75 degrees Fahrenheit. The chip seal shall not be placed when the temperature of

the road surface is below 70 degrees Fahrenheit, above 120 degrees Fahrenheit, during rainy weather, when the surface is wet or during other unfavorable weather conditions as determined by the City's Representative.

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4.7 ASPHALT EMULSION SEAL COAT (SLURRY SEAL). This sub-section covers the requirements for the application of slurry seal coats on existing road surfaces. The slurry seal surface treatment shall consist of a mixture of emulsified asphalt, mineral aggregate, mineral filler, set control additive, and water. The slurry shall be properly proportioned, mixed, and spread evenly on a prepared surface in accordance with these specifications, or as directed by the City's Representative. When cured, the slurry shall have a homogeneous appearance, fill all cracks, adhere firmly to the road surface, and have a skid resistant texture.

4.7.1 MATERIAL SPECIFICATIONS.

4.7.1.1. ASPHALT EMULSION. The asphalt emulsion shall conform to the specifications outlined in Tables 4.12, 4.13 and 4.14. Either cationic or anionic emulsion may be used, whichever is best suited to the aggregate and job conditions to be encountered, as determined by compatibility tests and procedures as specified in the latest edition of the ISSA Technical Bulletin #115.

4.7.1.2. AGGREGATE. The mineral aggregate shall consist of angular sand, or crushed stone, that is free from dirt, organic matter, clay balls, adherent films of clay, dust or other objectionable matter. When tested according to AASHTO T-176, the aggregate shall have a sand equivalent of not less than forty five **(45)**, and the aggregate shall be non-plastic. When tested according to AASHTO T-104, the aggregate shall show a loss of not more than fifteen **(15)** percent, and when tested according to AASHTO T-96, the aggregate shall show a loss of not more than thirty five **(35)** percent.

The combined mineral aggregate shall conform to the requirements of type **II** or type III slurry as outlined in Table 4.15.

4.7.1.3. FILLER. The mineral filler shall conform to the requirements of AASHTO M-16 and shall be used to improve the gradation of the aggregate, to provide improved stability and workability of the slurry, and to increase the durability of the cured slurry.

4.7.1.4. SET CONTROL ADDITIVE. To control the setting time of the slurry mixture, an additive shall be added which will retard the set when a cationic emulsion is used, or accelerate the set when an anionic emulsion is used. The set control additive shall be aluminum sulfate or Portland Cement Type I/II, and shall be added to the slurry mix by an approved method that will assure uniform distribution and proper control. The exact amount shall be determined by conditions in the field and as directed by City's Representative.

**TABLE 4.12
SLURRY SEAL TEST SPECIFICATIONS
TESTS OF EMULSIONS**

TESTS	TEST METHOD	TYPE OF EMULSION	
		ANIONIC	CATIONIC
	ASTM	ANIONIC	CATIONIC
		Quick Setting	Quick Setting
		QS-1H	CQS-1H CQS-1H-LM
Particle Charge Test	D244	Negative	Positive
Viscosity, 60 ml., @ 77 ^o F., 5 seconds	D244	15 min. to 100 max.	
Residue by distillation	D244	60 percent by weight, minimum	
Settlement After Five Days (%)	D244	5 percent maximum	
Sieve Test Wt., (%)	D244	0.10 maximum	
Cement Mixing Test	D244, 32-36	2 % Maximum	Not Applicable

**TABLE 4.13
SLURRY SEAL TEST SPECIFICATIONS
TESTS OF RESIDUE**

TESTS	TEST METHOD	TYPE OF EMULSION	
		ANIONIC	CATIONIC
	ASTM	ANIONIC	CATIONIC
		Quick Setting	Quick Setting
		QS-1H	CQS-1H CQS-1H-LM
Penetration 100 gm. @ 77 ^o F for 5 seconds	D244	40 to 90 mm	40 to 90 mm
Solubility in Trichloroethylene	D2042 4d	97.5 percent, minimum	
Ductility, 5 cm/mm @	D244	40 cm., minimum	

**TABLE 4.14
SLURRY SEAL TEST SPECIFICATIONS
TESTS ON SLURRY SEAL JOB MIXTURE**

TESTS	TEST METHOD		TYPE OF EMULSION	
	AASHTO	ASTM	ANIONIC	CATIONIC
			Quick Setting	Quick Setting
			QS-1H	CQS-1H CQS-1H-LM
Mixing Time @ 77 ⁰ F (ISSA TB #102)	---	---	120 seconds minimum	120 seconds minimum
Set Time Tests (30 minutes) Blotter Test (ISSA TB #102)	---	---	No Brown Stain	No Brown Stain
Displacement Test	---	---	No Displacement	No Displacement
Water Resistance Test @ 30 Min. (ISSA TB #102)	---	---	No Discoloration	No Discoloration
Wet Stripping Test, Coating (ISSA TB #114)	---	---	90 percent, minimum	
System Compatability	---	---	Compatible	

**TABLE 4.15
SLURRY MIXTURE GRADATION**

Type of Slurry	II	III
General Usage	General seal, medium textured surfaces; second course slurry	First and/or second application of two-course slurry; highly textured surfaces
Sieve Size (USA Standard Series)	P E R C E N T P A S S I N G	
3/8 inch	100	100
No. 4	90-100	70-90
No. 8	65-90	45-70
No. 16	45-70	28-50
No. 30	30-50	19-34
No. 50	18-30	12-25
No. 100	10-21	7-18
No. 200	5-15	5-15

4.7.1.5. WATER. Water for the slurry mixture shall be potable and free from harmful soluble salts.

4.7.2 MATERIAL QUALITY CONTROL.

4.7.2.1. SAMPLING AND TESTING. Prior to the commencement of sealing operations, sources of all materials shall be selected and tested in accordance with the appropriate test requirements. Additional samples of materials shall be furnished as directed by the City's Representative during the progress of the work. The Contractor's proposed job mix design shall be approved by the City's Representative prior to the commencement of construction.

4.7.2.2. JOB MIX DESIGN. No slurry mixture shall be placed until a mix design submitted by the Contractor has been approved by the City's Representative. The exact proportions of asphalt emulsion, aggregate, mineral filler, and water to be used in the preparation of the slurry seal shall be determined by an approved testing laboratory experienced in slurry mix design procedures.

The residual asphalt content of the mix shall be from 7.5 to 13.5 percent of the dry aggregate for type II slurry seal or 6.5 to 12 percent of the dry aggregate for type III slurry seal.

The slurry shall be a homogeneous mixture, sufficiently stable during the entire mixing-spreading period so that the emulsion will not "break". There shall be no segregation of the fines from the coarser aggregate, and the liquid portion of the mix shall not float to the surface. If it is established that a satisfactory mixture meeting the requirements specified herein cannot be produced from the materials furnished, the materials shall be rejected and the Contractor shall submit new samples.

The wet track abrasion test shall not exceed a maximum wear loss of seventy five grams per square foot.

4.7.3 EQUIPMENT. The equipment, tools, and machines required for the performance of the work shall be subject to the approval of the City's Representative and shall be maintained in a satisfactory working condition at all times.

4.7.3.1. SLURRY MIXING MACHINE. The slurry mixing machine shall be a continuous flow mixing unit, capable of delivering accurately predetermined proportions of aggregate, water and asphalt emulsion to

a revolving spiraled multi-blade mixer tank, and of discharging the thoroughly-mixed product on a continuous basis. The aggregate shall be pre-wetted immediately prior to mixing with the emulsion. The mixing unit shall be capable of thoroughly blending all ingredients together without violent action. The mixing machine shall be equipped with an approved fines feeder with an accurate metering device or method of introducing a predetermined proportion of mineral filler into the mixer as the aggregate is fed into the mixer. The fines feeder shall be used when mineral filler is part of the aggregate blend. The mixing machine shall be equipped with a water pressure system and fog-type spray-bar adequate for completely fogging the surface to be sealed with up to 0.05 gallons of water per square yard, immediately ahead of the spreading equipment. The machine shall be capable of mixing materials at pre-set proportions regardless of the speed of the machine and without changing machine settings.

4.7.3.2. SLURRY SPREADER. Attached to the mixing machine shall be a mechanical-type squeegee distributor, having a rubber-like material in contact with the surface to be sealed to prevent unwanted egress of slurry. An appropriate mechanical device for lateral distribution of the slurry shall be operated within the spreader box. There shall also be a steering device and a flexible strike-off. The spreader box shall be adjustable to various widths from eight (8) to twelve (12) feet. The box shall be kept clean with no extensive build-up of asphalt and aggregate on the box. A burlap drag of at least one foot in width shall be attached to the back of the spreader box to smooth out irregularities in the slurry surface.

4.7.3.3. SURFACE CLEANING EQUIPMENT. Power brooms, power blowers, vacuums, air compressors, water flushing equipment, and hand brooms suitable for cleaning the road surface and cracks therein may be used for surface cleaning.

4.7.3.4. AUXILIARY EQUIPMENT. Hand squeegees, burlap mops, shovels and other equipment shall be provided as necessary to perform the work.

4.7.4 ASPHALT EMULSION SLURRY CONSTRUCTION METHODS.

4.7.4.1. RESIDENT NOTIFICATION. The Contractor shall be responsible for notifying all affected residents of pending cleaning and/or sealing operations on streets abutting their properties. Notification shall be no more than forty eight hours, nor less than twenty four hours, in advance

of said cleaning/sealing operations. If there should be any change in scheduling for a particular days production, the Contractor shall be required to notify all of the residents affected by the schedule change no later than one hour after the schedule change has been determined.

4.7.4.2. VEHICLE REMOVAL. The Contractor shall be responsible for the removal of all vehicles from the streets to be cleaned, and shall endeavor to notify the owners of the vehicles to move them prior to his cleaning operations. In the event owners of said vehicles cannot be located, the Contractor shall have them towed from the construction zone prior to cleaning and shall be responsible for all costs incurred for said towing.

4.7.4.3. PREPARATION OF SURFACE. In the event that patching or surface smoothing is required to prepare the street surface for the slurry seal, the Contractor shall patch the street surface with hot mix asphalt prior to the application of the slurry sealing. Prior to the application of the slurry seal, the City's Representative shall give approval that the surfaces have been properly prepared. No slurry seal material will be laid without the City Representative's approval.

4.7.4.4. CLEANING STREETS. Prior to the commencement of Slurry Seal operations, the Contractor shall thoroughly clean and remove all silt mud spots and loose or objectionable material from the existing pavement surface. Any standard cleaning method will be acceptable, except that water flushing will not be permitted in areas where poor drainage conditions on the road or at the sides of the road are present, as determined by the City's Representative.

Traffic paint on the surface to be treated that is not tightly bonded to the surface shall be removed.

Areas impregnated with grease, oil, or fuel shall be scrubbed with industrial-type detergent and flushed thoroughly to remove all traces of detergent and oil.

After the cleaning operations have been completed, and prior to the application of the surface treatment, the area to be treated will be inspected by the City's Representative to determine it's fitness for receiving the surface treatment. No surface shall be slurry sealed until authorization to do so has been obtained from the City's Representative.

4.7.4.5. SEWER MANHOLE LIDS AND WATER VALVE COVERS. Prior

to the application of the seal coat, all sewer manhole lids, survey monument lids, storm drain manhole lids and water valve covers shall be protected from the application of the slurry seal coat by placing building paper over the lids (cut to the exact dimensions of the frames so as to prevent the slurry seal from entering into the seam between the frame and lid). At the completion of the sealing operations, the Contractor shall remove all building paper protectors placed on said lids and covers.

4.7.4.6. TEST SECTION. Prior to full production, the Contractor shall place a test section of at least sixty square yards in an area designated by the City's Representative. The test section shall be placed using the same equipment, methods, and mix as will be used on the job.

If the test section should prove to be unsatisfactory, necessary adjustments to the mix design, equipment, and/or placement methods shall be made. Additional test sections, as required, shall be placed and evaluated for compliance with the specifications. If the test section does not conform to the specification requirements, the defective slurry seal shall be removed. Full production shall not begin without approval of the City's representative.

4.7.4.7. WATER FOG. Immediately prior to application of the slurry seal, the surface of the pavement shall be moistened with a fog spray of water, applied at the rate of 0.02 to 0.05 gallon per square yard from the spray bar attached to the slurry seal machine. No free water shall pond on the surface of the pavement following the fog spray. The rate of application of the fog spray shall be adjusted during the day to suit pavement temperatures, surface texture, humidity, and dryness of the pavement surface.

4.7.4.8. PREPARATION OF SLURRY. The slurry seal shall be mixed and applied with a slurry machine as outlined below. The amount and type of asphalt emulsion to be blended with aggregate shall be determined by the laboratory mix design. A minimum amount of water, added as specified by the City's Representative, shall be used as necessary, to obtain a workable and homogeneous mixture. The slurry mixture shall be of proper consistency with no segregation when deposited on the surface of the pavement and no additional elements shall be added. The slurry mixture shall show no signs of uncoated aggregate, or premature breaking of emulsion, when applied to the pavement surface. Total time of mixing shall not exceed four minutes.

4.7.4.9. APPLICATION OF SLURRY. Sufficient quantities of the slurry seal mixture shall be fed into the spreader box such that a uniform and complete coverage of the pavement is obtained. The slurry seal machine shall be operated at such a speed that the amount of slurry in the spreader box shall remain essentially constant. The slurry seal shall be placed at a rate within the following general limits: Type II slurry - 10-15 #/yd.²; Type II slurry - 15-20 #/yd.². The finished slurry thickness shall not be less than 3/8 of an inch. No build-up of the cured slurry seal mix shall be allowed to collect in the spreader box. No streaks caused by oversized aggregate particles, or build-up of slurry mix on squeegees, shall be left on the finished surface.

If a uniform thickness cannot be met with one application due to irregularities in the pavement surface, multiple applications shall be made. Where multiple applications are required, as determined by the City's Representative, each application shall be thoroughly cured prior to the application of the subsequent courses.

4.7.4.10. HANDWORK. Approved squeegees and mops shall be used to spread slurry in areas not accessible to the slurry spreader box. Care shall be exercised in leaving no unsightly appearance from handwork. When doing handwork in small areas, especially fill-in behind the slurry machine, the material shall be spread and mopped in the direction of the machine pass.

4.7.4.11. JOINTS. The longitudinal joints between adjacent lanes shall have no visible lap, pinholes, or uncovered areas. Thick spots caused by overlapping shall be smoothed immediately with hand squeegees before the emulsion breaks. Overlaps which occur at transverse joints shall also be smoothed before the emulsion breaks, so that a uniform surface is obtained which contains no breaks or discontinuities.

4.7.4.12. CURING. Treated areas shall be allowed to cure until the treated pavement will not be damaged by traffic. The Contractor shall protect this area for the full curing period with suitable barricades or markers. Areas which are damaged before being opened to traffic shall be repaired by the Contractor.

4.7.4.13. WEATHER LIMITATIONS. The slurry seal shall not be applied when either atmospheric or pavement temperature is below 55 degrees, or above 100 degrees Fahrenheit, when raining or during periods of abnormally high relative humidity, or as determined by the City's Representative.

4.8 CONCRETE WORK. This section defines the materials to be used and the requirements for mixing, placing, finishing and curing all Portland cement concrete work.

4.8.1. MATERIALS. Concrete materials shall conform to the following requirements.

4.8.1.1 PORTLAND CEMENT CONCRETE MATERIAL. Concrete shall be composed of coarse aggregate, fine aggregate, Portland Cement and water, air entrainment and add mixtures and shall conform to the requirements of this section. A concrete mix design shall be prepared by the supplier, certified by an independent testing lab and submitted to the City for review and approval prior to concrete being used in City projects.

A. **PORTLAND CEMENT.** ANSI/ASTM C 150, Type V, shall be used unless otherwise indicated, or approved by the City Engineer. Only one brand of cement shall be used throughout a project, unless otherwise approved by City's Representative. Certified copies of the mill test for the cement shall be furnished upon request of the City's Representative.

B. **AGGREGATE.** Except as otherwise specified herein, concrete aggregate shall conform to all applicable provisions of the latest revision of ASTM Standard Specification C 33.

B.1 Fine Aggregate. Fine aggregate shall consist of natural sand having clean, hard, durable, uncoated grains and shall conform to the requirements of these standards. Other inert materials with similar characteristics shall not be used unless approved by the City Engineer. The amount of deleterious substances shall not exceed the following limits.

**DELETERIOUS MATERIALS
MAXIMUMS**

MATERIAL	PERCENT (by weight)
Clay Lumps	1.00
Coal and lignite	0.50
Material passing No. 200 sieve	3.00
Other deleterious substances such as shale, alkali, mica, coated grains, soft and flaky particles, etc.	3.00
Gypsum	1.00

The combined sum of the percentage of all deleterious substances in fine aggregate listed above shall not exceed three percent by weight.

Fine aggregate shall be well graded and shall range in size from fine to coarse within the following percentages by weight:

FINE AGGREGATE GRADATION REQUIREMENTS

SIEVE SIZE	PERCENT PASSING (by weight)
3/8 inch	100
No. 4	95-100
No. 8	80-90
No. 16	50-75
No. 30	30-50
No. 50	10-20
No. 100	2-5

B.2 Coarse Aggregate. Coarse aggregate shall consist of crushed or natural stone, gravel, slag or other approved inert material with similar characteristics or combination thereof, having clean, hard, durable, uncoated particles free from deleterious matter. Deleterious substances shall not be present in the aggregate in excess of the following limits:

**COARSE AGGREGATE DELETERIOUS MATERIAL
MAXIMUMS**

MATERIAL	PERCENT (by weight)
Soft fragments	2.00
Coal and lignite	0.30
Clay Lumps	0.25
Material passing No. 200 sieve	1.00
Other deleterious substances such as shale, alkali, mica, coated grains, soft and flaky particles, etc.	3.00
Gypsum	1.00

The combined sum of the percentages of deleterious substances (in both coarse and fine aggregate), shall not exceed five percent, by weight.

Coarse aggregate shall be rejected if it fails to meet the following test requirements:

- a. Los Angeles Abrasion Test. If the percent of loss by weight exceeds ten percent at one hundred revolutions, or forty percent at five hundred revolutions.

- b. Sodium Sulfate Test for Soundness. If the weighted average loss after five cycles is more than twelve percent by weight.

c. Gradation. Coarse aggregate shall be graded by weights as follows:

**COURSE AGGREGATE GRADATION
REQUIREMENTS**

SIEVE SIZE	PERCENT PASSING (by weight)
1 inch	100
3/4 inch	90-100
3/8 inch	20-55
No. 4	0-10
No. 8	0-5

d. Aggregate Size. The maximum size of the aggregate shall be not be larger than one-fifth of the narrowest dimension between forms within which the concrete is to be encased, and in no case larger than three-fourths of the minimum clear spacing between reinforcing bars or between reinforcing bars and forms. For non-reinforced concrete slabs, the maximum size of aggregates shall not be larger than one-fourth the slab thickness.

C. WATER. Sufficient potable water shall be added to the mix to produce concrete with the minimum practical slump, the slump shall not be greater than four inches. However, a higher slump may be allowed with plasticizers, providing there is no loss of strength or durability and prior approval for use is obtained from the City's Representative.

The maximum permissible water-cement ratio (including free moisture in the aggregate) shall be five gallons per bag of cement (0.44) for Class A and five and three-quarter gallons per bag of cement (0.51) for Class C concrete.

D. ENTRAINING AGENT. An air-entraining agent shall be used in all concrete exposed to the weather. The agent shall conform to ASTM

designation C 260. Air content for air-entrained concrete shall be five percent by volume (plus or minus one percent). The air-entraining agent shall be added as a liquid to the mixing water by means of mechanical equipment capable of accurate measurement and control.

E. ADMIXTURES

- E.1. **Pozzolan.** When authorized by the City Engineer, pozzolan conforming to the requirements of ASTM C 618 Class F may be added to the concrete mix as outlined below:
1. Pozzolan may be used as a replacement to the required Portland Cement content provided no other supplemental specification prevents its use. The maximum percentage of Portland Cement replacement on a weight basis is **15 percent**.
 - b. Pozzolan/cement replacement ratio is 1.25 to 1 (pozzolan/cement).
 - c. Water/cement ratio is established before Portland Cement is replaced with pozzolan.
 - d. Loss of ignition of pozzolan is less than 1 percent.
 - e. Trial batches for each aggregate source and concrete class have been run for each mix design.
 - f. All other requirements and references to testing procedures and specifications of Section 4.8 "Concrete Work" shall apply.

Pozzolan shall be sampled and tested as prescribed in ASTM C 618 and ASTM C 311. The Concrete Supplier shall obtain and deliver to the City's Representative a certification of compliance signed by the pozzolan supplier identifying the pozzolan and stating that the pozzolan delivered to the batching site complies with applicable specifications.

Pozzolan material shall be handled and stored in the same manner as Portland Cement. When facilities for handling bulk pozzolan are not available, the pozzolan shall be delivered in original unopened sacks bearing the name and brand of supplier, the type and source of the pozzolan, and the weight contained in each sack plainly marked thereon.

Different brands or types of pozzolan shall not be mixed together unless written permission has first been obtained from the Owner's Representative. All pozzolan used in the manufacture of concrete for any individual structure shall be of the same type, and from the same source unless otherwise approved by the City's Representative.

COMPLIANCE ANALYSIS. During the course of concrete testing, the City may require, at random, additional concrete cylinders for the purpose of performing a "Petrographic Examination" in accordance with ASTM C 856.

The "Petrographic Examination" may be initiated when compressive strength tests show inconsistencies, when batch tickets show indications that material is batched which is not in accordance with approved mix designs, or when there are other indicators that the concrete may not meet Standards.

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The "Petrographic Examination" will be performed by a Certified Testing Laboratory

qualified to perform such testing. In the event that the sampled concrete is not in compliance with these standards, the supplier of the concrete will be required to pay for the "Petrographic Examination" and will no longer be allowed to supply concrete for use in any improvements for which City Standards apply until acceptable adjustments are made. If the sampled concrete is found to be in compliance with these standards, the City will pay the cost for the "Petrographic Examination". Additional testing may be required by the City Engineer, at the suppliers expense, to determine the extent of the non-compliant concrete. All work on a project, affected by the non-compliant concrete, will be suspended until the non-compliant concrete work is brought into compliance.

The "Petrographic Examination" will determine the quantity of cementitious matrix including mineral admixture (pozzolan/fly ash) in the mix, proportions of the mix, and other properties of the sampled concrete to verify compliance with the approved mix design. The acceptability of the concrete represented by the examination shall be established by comparing the proportions determined by the examination with those indicated on the batch tickets. When this comparison shows that the pozzolan proportions are within 2% +/- of the approved mix design the admixture proportions will be considered to be in compliance. When comparisons of other proportions of the mix indicate that the concrete is not within acceptable allowable deviation limits the concrete may be rejected even though the pozzolan proportion is acceptable.

The City may use the results of the "Petrographic Examination", inspection records, observation of batch plant operation, compressive strength test results, or any other pertinent information to determine compliance. If any portion of a project is found to be in non-compliance, additional testing shall be required to verify full compliance of all concrete within the project. If the City Engineer has reasonable cause, he may require removal and replacement of any concrete which has been found to be in non-compliance. (For the purpose of demonstrating the acceptability of this admixture specification, compressive strength alone shall not be considered as justification for acceptance).

Repeated violations of these admixture standards may subject the offending concrete supplier to be prohibited from providing concrete that is used in public or private infrastructure improvements within the City of St. George.

E.2. **Calcium Chloride.** Calcium Chloride shall not be added to any concrete mix. Non-chloride accelerators may be used upon approval of the City Engineer or his Representative.

F. CONCRETE MIX. For the purpose of practical identification, concrete has been divided into classes. The basic requirements of class A and class C concrete and the use for each is defined in Table 4.16 of the City Standard Specifications.

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F.1. **Submittals.** The following information must be included with all concrete mix

designs submitted for review and approval by the City as per subsection 4.8.1.1 "Portland Cement Concrete Material".

1. Test results on coarse and fine aggregates to verify compliance with applicable specifications.
2. Trial batch test results and past history test information on proposed mix designs, which support compliance with the requirements for compressive strength, durability, etc. Performance curves used to verify 28 day, 56 day, and 90-day strengths must be submitted with trial batch tests or history information.
3. Certification of compliance from the cement supplier, the pozzolan supplier, and the air-entraining agent supplier, stating that the materials being delivered are in compliance with applicable specifications.
4. All mix designs shall be certified by a Certified Testing Laboratory.

G. BATCH PLANT TICKET. All concrete produced and delivered to a job site within St. George City, will be accompanied by a batch plant ticket. The ticket will state the time manufactured or batched and accurately show all components used for that particular load or batch. Sufficient copies shall be provided for testing personnel and St. George City representatives, if requested.

**TABLE 4.16
CONCRETE MIX SPECIFICATIONS**

Class	Minimum Cement Content		Maximum Water Content** (gal./bag of cement)	Maximum Slump	Minimum 28-day Comp. Strength (psi)	Primary Use
	(Bags/ C.Y.)	(pounds/ C.Y.)				
A	6	564	5	4" 1 1/2"	4000	Reinforced structural concrete; sidewalks; curbs & gutters; cross gutters; pavements; unreinforced footings
C	5	470	5.75	4"	3000	Minor non-structural items such as thrust blocks; anchors, mass concrete, etc.

* For machine placement only.

** Including free moisture in aggregate.

NOTE: Unless otherwise specifically designated by the City Engineer all concrete placed shall be Class "A", six-bag mix, with a minimum allowable compressive strength of 4000 p.s.i at the age of twenty eight days. r, r.1 02/03

4.8.1.2 CONCRETE REINFORCING MATERIALS. Concrete reinforcing materials shall conform to the following requirements.

A. **STEEL BARS.** All bar material used for reinforcement of concrete shall be hard grade deformed round steel conforming to the requirements of ASTM Designation A 615. All reinforcing steel shall be minimum grade sixty (60) unless approved otherwise by the City Engineer. All bars shall be deformed, round and have a net section equivalent to that of plain bar of equal nominal size. Only hard grades will be used. Twisted bars will not be accepted.

All rebar shall be clearly marked with identifying markings in accordance with industry standards.

All reinforcing steel, at the time concrete is placed, shall be free from flaws, cracks, rust, oil, dirt, paint, or other coatings that will destroy or reduce the bond.

B. **WIRE OR WIRE FABRIC REINFORCEMENT.** Welded wire fabric for concrete reinforcement shall conform to the requirements of ASTM A 185. Wire for concrete reinforcement shall conform to the requirements of the "Standard Specification for Cold Drawn Steel Wire for Concrete Reinforcement" ASTM A-82. All wire reinforcement, wire fabric, or expanded metal shall be of the type designated unless an alternate type is approved by the City Engineer.

C. **STEEL FIBER REINFORCEMENT.** Deformed steel fiber for concrete reinforcement shall conform to the requirements of ASTM A-820, type I, deformed fiber, except that the average tensile strength shall be not less than 150,000 psi.

D. **SYNTHETIC REINFORCING FIBERS.** Engineered synthetic reinforcing fibers shall be 100% polypropylene collated, fibrillated fibers. Fiber length, and amount per manufacturer's recommendations shall correspond with the concrete mixture (generally 1.5 pounds per cubic yard of concrete).

Physical property of the fibers shall be as follows:

Specific Gravity	0.91
Modulus of elasticity	500,000 to 700,000 psi
Tensile strength	70,000 to 110,000 psi
Length	0.25 to 2.50 inches

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The fiber manufacturer shall certify that all polypropylene fibers meet the physical properties, and are specifically manufactured for use in concrete from virgin polypropylene, containing no reprocessed olefin materials. If the fiber manufacturer is other than the brand name listed on the literature and packaging, the certification must be from the original manufacturer of the fibers.

Fiber-mesh shall be added only at the concrete batch plant to assure uniform and complete dispersion of the collated-fibrillated fiber bundles into single mono-filaments within the concrete.

4.8.1.3 CURB, GUTTER, SIDEWALK AND BASE MATERIALS. Concrete and base materials shall conform to the following requirements.

A. **GENERAL.** This subsection defines materials, practices and designs to be used in the construction of all public curb, gutter and sidewalk.

All curb, gutter and sidewalk shall consist of air-entrained Type V Portland Cement Concrete and shall be constructed on a prepared subgrade in accordance with these specifications. All work shall conform to the lines and grades, thickness, and typical cross sections shown on the approved plans or established by the City's Representative.

B. **SUBGRADE.** The subgrade shall be excavated and filled with suitable material, as specified in Section 4.3.2.3 of these standards. All soft, yielding and otherwise unsuitable material shall be removed and replaced with suitable materials as outlined above. Filled sections shall be compacted and extend to a minimum of one (1) foot outside the form lines according to Section 4.3.2.3 of these standards.

C. **GRAVEL BASE COURSE.** A gravel base course consisting of crushed road base gravel shall be placed under all curbs, gutters, driveways, waterways, sidewalks and other miscellaneous flatwork. The gravel base material shall conform to the requirements contained in Section 4.5.7 of these specifications. Where the foundation material is found to be unstable, the Contractor shall furnish and place sufficient additional gravel or other suitable material as directed by the City's Representative to provide an adequate foundation upon which the concrete will be placed.

4.8.2. CONSTRUCTION METHODS AND EQUIPMENT. The methods employed in performing the work, all equipment, tools and machinery, and other appliances used in handling the materials and executing the work shall be the responsibility of the Contractor. The Contractor shall make such changes in the methods employed and in the equipment used as are necessary whenever the concrete being installed does not meet the specifications herein established. These methods shall include, but are not limited to the following:

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4.8.2.1 GENERAL CONCRETE PLACEMENT. Generally, concrete shall be placed as follows.

A. **FORMS.** Forms shall be properly built and adequately braced to withstand the liquid weight of concrete being placed in the forms. All linings, studding, whaling and bracing shall be such as to prevent bulging, spreading, loss of true alignment or displacement while placing and during setting of concrete.

B. **PREPARATIONS.** Prior to batching and placing concrete, all equipment for mixing and transporting the concrete shall be cleaned. All debris and ice shall be removed from the areas to be occupied by the concrete. All forms shall be oiled with a form-release agent. Masonry support or filler units that will be in contact with concrete shall be well drenched with water (except in freezing weather). Reinforcement shall be thoroughly cleaned of ice or other coatings. Water shall be removed from areas to receive concrete.

Reinforcement that has become too hot, due to sun exposure, in the opinion of the City Representative, will be cooled with water prior to concrete being placed.

When placing concrete on earth surfaces, the surfaces shall be free from frost, ice, mud, water and other deleterious materials. When the subgrade is dry or pervious, it shall be sprayed with water prior to the placing of concrete or shall be covered with water-proof sheathing paper or a plastic membrane. No concrete shall be placed until the preparatory work (i.e. forms, reinforcement, etc) has been inspected and approved by the City's Representative.

C. **CONCRETE MIXING.** The concrete shall be mixed until there is a uniform distribution of the materials. Sufficient water shall be used in concrete in which reinforcement is to be imbedded, to produce a mixture which will flow sluggishly when worked and can be conveyed from the mixer to the forms without separation of the coarse aggregate from the mortar. In no case shall the quantity of water used be sufficient to cause the collection of a surplus in the forms.

Ready-mixed concrete shall be mixed and delivered in accordance with the requirements set forth in Specifications for Ready-Mixed Concrete (ASTM C-94). Concrete shall be delivered and deposited in its final position within sixty (60) minutes after the cement and water have been added to the mixture.

D. **DEPOSITING.** Concrete shall be deposited as nearly as practical in its final position to avoid segregation due to rehandling or flowing. Concrete

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placement shall be carried on at such a rate that the concrete is at all times plastic and flows readily into the corners of forms and around reinforcing bars. Concrete that has partially hardened or is contaminated by foreign material shall not be deposited in the work. Re-tempered concrete shall not be used.

Temperature of the mixed concrete shall be maintained between 60°F and 90°F at time of placement.

All concrete in structures shall be compacted by means of high-frequency internal vibrators of approved type and design during the operation of placing, and shall be thoroughly worked around reinforcement and embedded fixtures and into the corners of the forms. Care must be taken not to over use vibrators causing separation of cement and aggregates.

E. FINISHING. After the concrete for slabs has been brought to the established grade and screeded, it shall be worked with a magnesium float and then given a light "broom" finish. In no case shall dry cement or a mixture of dry cement and sand be sprinkled on the surface to absorb moisture or hasten hardening. Surface edges of all slabs shall be rounded to a radius of one quarter to one half (1/2) inch with standard concrete finishing tools. Additional water shall not be sprinkled on the surface to aid finishing.

F. CURING AND PROTECTION. As soon as the concrete has hardened sufficiently, it shall be protected and cured in accordance with ACI Standards.

The finished surface shall be kept moist for a minimum of seven days, or a chemical curing agent used to prevent the concrete from premature drying.

The freshly finished surface shall be protected from hot sun and drying winds until it can be sprinkled or covered as above specified. The concrete surface shall not be damaged or pitted by rain. The Contractor shall provide and use, when necessary, sufficient tarpaulins to completely cover all sections that have been placed within the preceding twelve (12) hours. The Contractor shall erect and maintain suitable barriers to protect the finished surface. Any section damaged from traffic, weather, people or other causes occurring prior to its final acceptance, shall be repaired or replaced by the Contractor in a manner satisfactory to the City's Representative.

G. WEATHER LIMITATIONS. Concrete shall not be poured where the air temperature is lower than thirty five (35⁰)degrees F. unless approved by the City's Representative. When there is likelihood of freezing during the curing period, the concrete shall be protected by means of an insulating covering to prevent freezing of the concrete for a period of not less than seven

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days after placing. Equipment for protecting the concrete from freezing shall be available at the job site prior to placing concrete. Particular care shall be exercised to protect edges and exposed corners from freezing. Cold weather placement shall generally follow the requirements of ACI 306.1

Hot weather placement shall generally conform to the requirements of ACI 305.

4.8.2.2 CONCRETE REINFORCEMENT INSTALLATION. Concrete reinforcement shall be installed in accordance with ACI (American Concrete Institute) standard requirements for reinforced concrete and generally as follows.

A. **BENDING.** Reinforcing bars shall be accurately formed to the dimensions indicated on the plans. Bends for stirrups and ties shall be made around a pin having a diameter not less than two (2) times the minimum thickness of the bar. Bends for other bars shall be made around a pin having a diameter not less than six (6) times the minimum thickness of the bar, except that for bars larger than one (1) inch, the pin shall be not less than eight (8) times the minimum thickness of the bar.

B. **SPLICING.** Splicing of bars at points other than where shown on the plans will be permitted only by approval of the City's Representative. Splices of reinforcement at points of maximum stress shall be avoided wherever possible, and when used shall be staggered and in accordance with ACI Standards. The minimum overlap for a lapped splice shall be twenty four (24) bar diameters, but not less than twelve (12) inches and properly tied together.

C. **PLACING.** All reinforcing bars shall be placed accurately in the position shown on the plans, and shall be securely held in position by annealed iron wire ties of not less than sixteen (16) gauge or suitable clips at intersections. All reinforcing bars shall be supported by metal supports, spacers or hangers, in such a manner that there will not be any displacement while placing concrete.

D. **EMBEDMENT AND PROTECTION.** All reinforcing steel shall be protected by concrete embedment and protective cover as shown in Table 4.17, such cover in each case being the shortest distance between the face of the form or concrete surface, and the nearest edge or face of the reinforcement.

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**TABLE 4.17
REINFORCING BAR CLEARANCE**

LOCATION OF REINFORCEMENT	COVER
Bottom bars - where concrete is deposited against ground without use of forms.	Not less than 3"
Main bars - where concrete is exposed to the weather, or exposed to the ground but placed in forms.	Not less than 2"
Bars in slabs and walls not exposed to the ground or weather.	Not less than 1"

4.8.2.3 CURB, GUTTER AND SIDEWALK CONCRETE PLACEMENT. The concrete shall be placed either by an approved slipform/extrusion machine, by the formed method, or by a combination of both methods. Curb and gutter shall be placed as follows:

A. **MACHINE PLACEMENT.** The slipform/extrusion machine shall place, spread, consolidate, screed, and finish the concrete in one complete pass to provide a dense and homogeneous concrete section. A minimum amount of hand finishing should be necessary. The machine shall shape, vibrate, and/or extrude the concrete for the full width and depth of the concrete section being placed. It shall be operated with as nearly a continuous forward movement as possible. All operations of mixing, delivery, and spreading concrete shall provide for uniform progress, with stopping and starting of the machine held to a minimum.

B. **FORMED METHOD.** The forms shall be of wood, metal, or other suitable material straight and free from warp, having sufficient strength to resist the pressure of the concrete without displacement and sufficient tightness to prevent the leakage of mortar. Flexible or rigid forms of proper curvature shall be used for curves having a radius of one hundred feet, or less.

Forms shall be cleaned and coated with an approved form-release agent before concrete is placed against them.

The concrete shall be deposited into the forms without segregation and then tamped and spaded or mechanically vibrated for thorough consolidation. Front and back forms shall be removed without damage to the concrete after it has set.

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C. **FINISHING.** The concrete shall be finished smooth, by a wood or magnesium float and then given a final surface texture using a light broom or burlap drag unless otherwise specified or directed. Concrete that is adjacent to forms and formed joints shall be edged with a standard jointer or edging tool as shown in the standard drawings. The top, face, and flow-line of the curb, and the top of driveway apron, shall be finished true to line and grade without any noticeable surface irregularities.

The Contractor shall be responsible for neatly stamping an "S" in the curb face at all sewer lateral locations and a "W" in the curb face at all water lateral locations along the curb.

The gutter shall not pond water. The surface of the curb and gutter shall not exceed more than one fourth (1/4) of an inch in ten (10) feet. No part of the exposed surface shall present a wavy appearance.

D. JOINTING.

D.1 Contraction Joints. Transverse weakened-plane contraction joints shall be constructed at right angles to the curb line at intervals not exceeding the values in accordance with standard drawings. Where the sidewalk abuts the curb and gutter, joints should align unless otherwise approved by the City's Representative. Joint depth shall at least be one quarter (1/4) of the cross section depth of the concrete. Generally, surface areas shall not exceed fifty square feet without contraction joints unless otherwise approved by the City's Representative.

Contraction joints may be sawed, hand-formed, or made by placing division plates in the form-work. Sawing shall be done within twenty four hours after the concrete has set to prevent the formation of uncontrolled cracking. The joints may be hand-formed either by using an appropriate jointing tool, or a thin metal blade to impress a plane of weakness into the plastic concrete, or by inserting one eighth (1/8) inch thick steel strips into the plastic concrete temporarily. Steel strips shall be withdrawn before final finishing of the concrete. Where division plates are used to make contraction joints, the plates shall be removed after the concrete has set while the forms are still in place.

D.2 Expansion Joints. Expansion joints for curb and gutter shall be constructed at right angles to the curb line at no greater than one hundred fifty (150) foot intervals, at immovable structures and at points of curvature for short-radius curves. Spacing for sidewalk expansion joint shall not exceed twenty (20) feet. Filler material for expansion joints shall conform to requirements of ASTM D-994, D-

1751, or D-1752 and shall be furnished in a single one half inch thick piece for the full depth and width of the joint.

Expansion joints in a slipformed curb and gutter shall be constructed with an appropriate hand tool by raking or sawing through partially set concrete for the full depth and width of the section. The cut shall be only wide enough to permit a snug fit for the joint filler. After the filler is placed, open areas adjacent to the filler shall be filled with concrete and then troweled and edged. Contaminated concrete shall be discarded.

Alternately, an expansion joint may be installed by removing a short section of freshly extruded curb and gutter, immediately installing temporary holding forms, placing the expansion joint filler, and replacing and reconsolidating the concrete that was removed. Contaminated concrete shall be discarded.

D.3 Other Jointing. Construction joints may be either butt or expansion-type joints. Curbs and gutters constructed adjacent to existing concrete shall have the same type of joints as in the existing concrete with similar spacing, however, contraction joint spacing shall not exceed ten feet.

A silicone joint sealer as defined in ASTM C 962 shall be applied to all form-plate expansion joints. The silicone joint sealer shall be applied under pressure to a depth of not less than two inches from the outside surface of the curb and gutter.

E. **PROTECTION.** At all times during the construction of the project, the Contractor shall have materials available at the site to protect the surface of the plastic concrete against rain or other detrimental elements. These materials shall consist of waterproof paper, plastic sheeting or other approved material. For slip-form construction, materials to protect the edges shall also be required.

When concrete is being placed in cold weather and the temperature is expected to drop below 35 degrees F., suitable protection shall be provided to keep the concrete from freezing until it is at least seven (7) days old. Concrete damaged by frost action shall be removed and replaced.

F. **CURING.** Concrete shall be cured for at least three days after placement to protect against loss of moisture, rapid temperature change, and mechanical damage. Liquid membrane curing compound, or other approved methods, or a combination thereof may

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be used as the curing material. Membrane curing shall not be permitted in frost-affected areas when the concrete will be exposed to de-icing chemicals within thirty days after completion of the curing period.

G. BACKFILLING. At least three days after placement and after form removal, the concrete shall be backfilled to the lines and elevations as shown on the drawings or as required by the City's Representative. The length of time may be shortened if it can be demonstrated that the concrete has reached design strength. Any concrete damaged during backfill or other operations, shall be removed and replaced as directed by the City's Representative.

H. CONCRETE REPAIR. In lieu of removing and replacing concrete containing minor cracks, the City's Representative may direct the Contractor to repair the affected sections by sawing, routing, cleaning and sealing the cracks. All cracks repaired shall be sealed with a polyurethane TTS-230 type II crack filler or an approved silicone base joint sealer. Where modifications are to be made to existing concrete, the edges to be poured against shall be sawcut in neat, straight lines and the new concrete shall be edged with a standard edging tool.

I. WEATHER LIMITATIONS. Concrete shall not be poured when there is likelihood of freezing. During the curing period, the concrete shall be protected by means of insulating covers to prevent freezing of the concrete for a period of not less than seven days after placing. Equipment for protecting the concrete from freezing shall be available at the job site prior to placing concrete. Particular care shall be exercised to protect edges and exposed corners from freezing.

Hot weather concreting shall be in accordance with the latest ACI 305 Standards for "Hot Weather Concreting".

4.8.2.4 CONCRETE BASE MATERIALS PLACEMENT. The placement of concrete base materials under curb, gutter and sidewalk shall conform to Section 4.5.7 of these standards.

4.8.3. QUALITY CONTROL. All concrete and base materials shall be placed in accordance with these standards and tested as follows. These are minimum requirements and additional testing may be required by the City's Representative or the Project Geotechnical Engineer.

Testing documentation provided to the City's Representative shall fully address the requirements of these standards.

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4.8.3.1 CONCRETE TESTING. Minimum testing of the concrete shall be as follows:

Mix Design

Certification: One per job. Testing shall be according to the latest ASTM standards.

Compressive

Strength Tests: One set of four cylinders for each fifty cubic yards of concrete placed or portion thereof. Tests shall be according to ASTM C-31.

Air Entrainment: Tested at beginning of placement until two consecutive loads pass. Others tests shall be taken as required. Tests shall be according to ASTM C-231.

Slump Tests: Tested at beginning of placement until two consecutive loads pass. Others tests shall be taken as required. Tests shall be according to ASTM C-143.

4.8.3.2 CONCRETE BASE MATERIAL TESTING. Minimum testing of the curb, gutter and sidewalk base materials shall be as follows:

Gradation Tests: One test per five hundred (500) lineal feet of curb & gutter or fraction thereof. One test per one thousand three hundred fifty (1,350) square feet of a combination of sidewalk and driveway, or fraction thereof.

The sieve analysis shall be according to ASTM C-136, C-117.

Proctor: One determination for each source of base course as necessary to provide required compaction testing. Test shall be according to ASTM D-1557, Method A or D (modified proctor).

Moisture

Density Tests: One test per three hundred (300) lineal feet of curb & gutter and one test per three hundred (300) lineal feet of a combination of sidewalk and driveway or fraction thereof. Moisture content shall be at plus or minus two percent of optimum. Proper moisture shall be maintained until the concrete is poured. Tests shall be according to ASTM D-1556 or D-2922 and D-3017.

Thickness: One random boring or test hole per two hundred (200) lineal feet of curb & gutter and one random boring or

test hole per two hundred (200) lineal feet of a combination of sidewalk and driveway or fraction thereof. If sufficient observation has been made by the City's Representative to verify required thickness, the City's Representative may waive thickness testing. Said waiver must be in writing.

No single measured thickness shall be less than the required thickness.

4.8.3.3 ACCEPTANCE. A total of four (4) concrete test cylinders shall be taken at time of pouring from loads passing the requirements of section 4.8.3.1. One cylinder, shall be broken at seven (7) days and shall be used as an indication of future strength. Two (2) cylinders shall be broken at twenty eight (28) days. If the average of the twenty-eight day breaks is below minimum compressive strength, the concrete may be rejected unless retests prove otherwise. At the Contractor's option, the fourth cylinder (the "hold" cylinder) may be broken at twenty eight (28) days, and included with the average, or it can be held for future testing if additional tests are needed.

Concrete with an average compressive strength below the required strength shall be reviewed by the City's Representative. The "hold" cylinder, if available, may be broken or other specialized tests (such as a spectrum analysis) may be required. If additional tests are required to determine if strength tests are representative they shall be performed by coring in accordance with ASTM C-42 method or other acceptable non-destructive methods. The re-tested strength shall be the average of three cores (or other acceptable method). The City's Representative may accept the concrete as a result of these additional tests, or may require the work to be removed and replaced. The City's Representative shall make the final decision. All costs incurred in resampling and retesting are not the responsibility of the City.

All curb, gutter or sidewalk base material not in compliance with these standards shall be removed and replaced. Any costs for testing the re-work are not the responsibility of the City.

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4.9 RESTORATION OF EXISTING SURFACE IMPROVEMENTS.

4.9.1 INTRODUCTION. The Contractor shall be responsible for the protection and restoration, or replacement, of all existing improvements on public or private property and all improvements placed during the progress of the work. Existing improvements shall include, but not be limited to, asphalt, curbs, gutters, ditches, driveways, culverts, fences, signs, sidewalks, utilities, landscaping and walls, etc. All existing improvements damaged during construction shall be reconstructed to equal or better condition than that which existed. However, as a minimum, the requirements contained in these specifications shall be adhered to.

All traveled surfaces shall be maintained flush with the existing surfaces at all times until permanent repairs are completed.

Prior to the beginning of any work activity involving tunneling under, or making any excavation in any street, alley or other public place, the Contractor shall comply with all requirements for permits and bonding. The Contractor shall also comply, during the work activity, with all of the requirements contained within Section 2.5, BARRICADES AND WARNING SIGNS - WORK AREA PROTECTION, of these specifications.

4.9.2 GRAVEL SURFACES. Where existing gravel surfaces are damaged due to trenching or other works the surfaced areas (such as roads and driveways) shall be restored and maintained as follows.

4.9.2.1 The gravel shall be placed deep enough to provide a minimum of six inches thickness , or to match the thickness of existing material, or to these specifications, whichever is greater.

4.9.2.2 The gravel shall be placed and compacted in the trench (or other work) at the time it is backfilled. The surface shall be maintained by blading, sprinkling, rolling or adding gravel in order to maintain a safe uniform surface satisfactory to the City's Representative. Excess material shall be removed from the premises immediately.

4.9.2.3 Material for use on gravel surfaces shall conform to the requirements contained within these specifications.

4.9.3 BITUMINOUS SURFACES. Where existing bituminous surface is damaged due to trenches or other works, the bituminous surfaced roads, driveways, parking areas, etc., shall be restored within five (5) days as follows:

4.9.3.1 Mud or other soft or spongy material shall be removed from the trench and the space filled with granular backfill to within twelve (12) inches of finished grade. The granular backfill shall be rolled and compacted to a

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minimum of ninety-five (95) percent of maximum dry density in layers not exceeding six (6) inches in compacted thickness. Base gravel shall then be placed to a depth equal to the original gravel base or the requirements of these specifications, but not less than six (6) inches thick and compacted to a minimum of ninety five (95) percent of maximum dry density.

4.9.3.2 Prior to permanent resurfacing, the Contractor shall saw-cut the existing paving to provide vertical, clean, straight lines as nearly parallel to the centerline of the trench as practical. The existing bituminous paving shall be cut back beyond the limits of any excavation so that the edges of the new paving will rest on at least six (6) inches of undisturbed base material.

4.9.3.3 Pavement restoration shall include tacking of pavement edges with type SS-1H bituminous material, and placing and compacting plant mix asphalt in accordance with these specifications to the level of the adjacent pavement surfaces.

4.9.3.4 The bituminous surface shall be restored by standard paving practices to a thickness equal to the original pavement or the requirements of these specifications, but in no case less than two inches. The finished repaired surface shall not deviate more than one quarter (1/4) inch (vertically) from the existing road surface. Any deviations greater than that specified shall be immediately removed and replaced to the proper standards.

4.9.4 CONCRETE SURFACES. All concrete curbs, gutter, sidewalks, and driveways shall be removed and replaced to the next joint or score line beyond the actually damaged or broken sections; or saw-cut to neat, plane faces. All new concrete shall match, as nearly as possible, the appearance and texture of adjacent concrete improvements unless adjacent improvements do not meet these specifications.

All damaged base material shall be restored and compacted in accordance with these specifications.