

**UNIFORM STANDARD SPECIFICATIONS  
CLARK COUNTY AREA**

**SPECIFICATION - YEAR 2004 REVISIONS**

<b>Section</b>	<b>Title</b>	<b>Nature of Change</b>	<b>Page Number</b>	<b>Effective Date</b>
203	Excavation and Embankment	Revision to clarify the responsibilities of engineer.	202-4 - 203-13	04/01/04
401	Plantmix Bituminous Pavements - General	Revised to specify compaction requirements for miscellaneous pavement areas.	401-21 - 402-1	6/1/2004
610	Slope and Channel Protection	Slope and Channel Protection	609-3 - 611-1	04/01/04
623	Traffic Signals And Street Lighting	Revision to Subsection 623 G.03.06 "Foundations" to change concrete cap requirements for foundations.	623-9 - 623-26	08/01/04
706	Aggregates for Portland Cement Products	Revision to add riprap grout criteria.	706-7 - 707-1	04/01/04

REMOVAL OF STRUCTURES AND OBSTRUCTIONS

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Payment will be made under:

PAY ITEM	PAY UNIT
Removal of Structures and Obstructions .....	Lump Sum
Removal of .....	Each, Linear Feet (Meters), Stations (30 Meters), Miles (Kilometers), Square Yards (Square Meters)

**SECTION 203****EXCAVATION AND EMBANKMENT****DESCRIPTION**

**203.01.01 GENERAL:** This work shall consist of grading and excavating the roadway, excavating borrow pits, removing slide material, and excavating ditches and stream channels and satisfactorily disposing of all excavated material and all work necessary for the construction and completion of cuts, embankments, slopes, ditches, dikes, stream channels, approaches, parking areas, intersecting driveways and highways, and subsidiary work. Exceptions are slope rounding, structure excavation, or other separately designated pay items of work which are made a part of the contract. All work shall be in conformity with the alignment, grades, and cross sections shown on the plans or established by the Engineer. Testing requirements for this section are contained in Subsection 203.06.01, "Testing."

**203.01.02 GRADE TOLERANCE:** Immediately prior to placing subsequent layers of material thereon, the grading plane shall conform to one of the following:

- (1) The subgrade shall not vary more than 0.10 foot (30 millimeters) above or below the grade established by the Engineer or Contractor.
- (2) The final subgrade layer prior to application of the structural base shall not vary more than 0.05 foot (15 millimeters) above or below the grade.

**MATERIALS**

**203.02.01 ROADWAY EXCAVATION:** Roadway excavation shall consist of all excavation involved in grading and constructing the roadway and appurtenances, irrespective of the nature or type of material encountered; except excavation designated as structure excavation, drainage excavation, channel, and borrow excavation when these items are provided as items of work under the contract. Dividing the project into construction stages shall not be construed as separate material classifications.

**203.02.02 DRAINAGE EXCAVATION:** Drainage excavation shall include all excavation in the construction of open ditches less than twelve (12) feet (3.7 meters) in bottom width, excepting ditches that are part of the roadway prism as shown in the plans. The nature or type of material encountered shall have no bearing on the classification of material.

**203.02.03 CHANNEL EXCAVATION:** Channel excavation shall include all excavation in the construction of open ditches or stream channels with a bottom width of twelve (12) feet (3.7 meters) or more with the exception of ditches that are part of the roadway prism as shown in the plans. The nature or type of material encountered shall have no bearing on the classification of material.

**203.02.04 BORROW:** Borrow shall consist of approved material excavated and used in the construction of fills, or for other construction purposes. Borrow shall be material which is excavated from sources specified

in the Special Provisions or designated by the Engineer. The source of material to be excavated shall be approved in advance by the Engineer. Borrow shall be excavated to the lines and grades established by the Engineer.

The Contractor shall notify the Engineer sufficiently in advance of opening any borrow site so that adequate time will be allowed for testing the material and establishing cross section elevations and measurements of the ground surface. The widening of roadway cuts shall be considered as roadway excavation and not as borrow, unless otherwise specified. Borrow excavation will not be classified according to type or character of material encountered in the borrow area unless otherwise required in the Special Provisions.

**203.02.05 SELECTED BORROW:** Selected borrow shall consist of approved material required for the construction of embankments within the required limits shown on the plans or directed by the Engineer, and shall be obtained from approved sources.

Selected borrow shall conform to the requirements set forth in the Special Provisions.

## CONSTRUCTION

**203.03.01 ROADWAY:** All excavation shall be made true to lines and grades staked by parties under the supervision of a Nevada licensed professional land surveyor working for the Engineer or Contractor and shall be so conducted as to avoid removing or loosening any material outside the required slopes. If any material is so disturbed, it shall be replaced and thoroughly compacted to the required cross section, unless such replacement is impractical as determined by the Engineer.

The work done under this section shall begin at some definite point or points on the project subject to the approval of the Engineer, and the work shall progress toward completion in an orderly manner. The roadway shall be graded to full cross section width before placing base or surfacing of any type, unless otherwise specified.

Intersecting roads, service highways, ramps, approaches, and driveways shall be graded as shown on the plans or established by the Engineer.

All suitable material removed from the excavation shall be used as far as practicable in the formation of embankments, subgrade, shoulders, slopes, dikes, and backfill for structures, unless otherwise indicated on the plans or disposed of in a manner satisfactory to the Engineer. Excavated material shall not be wasted without permission.

**203.03.02 UNSUITABLE MATERIAL:** Unsuitable material shall be defined as soil or organic matter not suitable for foundation material regardless of moisture content. Material that is unsuitable for planned use, including material below the natural ground surface in embankment areas, shall be excavated and disposed of in a manner approved by the Engineer or as specified in the contract documents.

When unsuitable material is removed and disposed of, the resulting space shall be filled with material suitable for the planned use. Such suitable material shall be placed and compacted in layers as hereinafter specified under embankment.

Disposal of material outside the right-of-way shall be in accordance with Subsection 107.14, "Disposal of Material Outside Project Right-of-Way."

Rev. March 11, 2004

**203.03.03 BLASTING:** Any material outside the authorized cross section on the backslopes which may be shattered or loosened because of blasting shall be removed by the Contractor at his expense. Shattered or loosened material below the bottom limits of required excavation shall be uniformly distributed and compacted or otherwise disposed of in a manner satisfactory to the Engineer. The Contractor shall discontinue any method of blasting which leads to overshooting or is dangerous to the public or destructive to property or to natural features.

The use of coyote holes in blasting is prohibited. Attention is directed to Subsection 107.10, "Explosives."

**203.03.04 ROCK CUTS:** In excavating side hill rock cuts and rock cliffs, the Contractor shall exercise care and use precautionary methods so as not to break down, loosen, or otherwise damage supporting rock below the bottom limits of required excavation. In general, such cuts shall be worked from the top of lifts of such height that will not damage the bench of rock below the bottom limits of required excavation. The Contractor shall be responsible for the methods used, and for any damage to the roadbed resulting from his operations.

The slope of all rock cuts shall be scaled and dressed to a safe, stable condition by removing all loose spalls and rock not firmly keyed to the rock slope. Overhanging rock shall be removed when, in the opinion of the Engineer, it may be a hazard to public use of the roadway.

In solid rock excavation, slopes shall be constructed to the approximate neat lines staked by the Engineer. No rock shall project or overhang more than twelve (12) inches (300 millimeters) from the true slope.

**203.03.05 OVERBREAK:** Overbreak is that portion of material excavated, displaced or loosened outside and beyond the slopes or grade as staked or re-established, regardless of whether any such overbreak is due to blasting, the inherent character of any formation encountered, or to any other cause. Slides and slipouts as defined in Subsection 203.03.10, "Slides and Slipouts," and that portion of rock subgrade as hereinafter set forth, shall not be considered overbreak. All side slope overbreak as so defined shall be removed by the Contractor and shall be disposed of in the same manner as provided for the surplus under the heading of "Surplus Material," but at his own expense and without any allowance for overhaul.

Rock removed to a maximum depth of six (6) inches (150 millimeters) below subgrade will be measured for payment as described in Subsection 203.04.01(b), "Overbreak."

**203.03.06 SLOPES:** All excavation and embankment slopes, except in solid rock, shall be trimmed to the lines staked by the Engineer. The degree of smoothness shall be that normally obtained by hand shovel operations, or blade grader operations.

**203.03.07 WIDENING CUTS:** If the Engineer directs the Contractor to excavate beyond the limits of the typical cross section originally proposed and within the limits of the right-of-way, the Contractor shall do so and compensation therefore will be as set forth in Subsection 203.04.01(c), "Widening Cuts."

**203.03.08 SURPLUS MATERIAL:** Unless otherwise specified in the contract documents, surplus excavated material shall be used to widen embankments uniformly, or to flatten slopes, or at other locations, all in a manner satisfactory to the Engineer. No surplus material shall be disposed of above the grade of the adjacent roadbed nor shall the Contractor waste any material unless approved in writing by the Engineer.

If the quantity of surplus material is specified in the contract documents, such quantity shall be

considered approximate only. The Contractor shall satisfy himself that there is sufficient material available for the completion of the embankments within the areas involved before disposing of any indicated surplus material inside or outside the right-of-way. Any shortage of material caused by premature disposal of the indicated surplus material by the Contractor shall be replaced by him and no compensation will be allowed the Contractor for such replacement.

**203.03.09 SELECTED MATERIAL:** When specified in the contract documents, or when selected by the Engineer, suitable selected material encountered in excavating or widening the roadway prism or any other excavation within the highway right-of-way, or in the excavation or borrow, shall be used for finishing the top portion of the subgrade.

Selected material shall be defined as material which is excavated from one or more of the above sources and which is used for selective purposes.

When practicable, selected material shall be hauled directly from excavation to its final position on the roadbed and compacted in place, and such work shall be paid for at the contract unit price for the excavation item involved. Attention is directed to Subsection 104.05, "Rights in and Use of Materials Found on the Work."

When the transporting of selected material directly from excavation to its final position on the roadway is impractical, the selected material shall be left in place until it can be placed in final position and no additional compensation will be made because of the delayed excavation. If, however, the conditions are such that the undisturbed selected material will hamper ordinary grading operations or cause unnecessary movements of equipment, the Engineer may order in writing the removal of sufficient selected materials and the stockpiling thereof to enable practical hauling operations. If the excavation and stockpiling of selected material is specified in the contract documents or is ordered by the Engineer, the excavation shall be from, and the stockpiling at, locations designated by the Engineer. The selected material shall be removed from the stockpile and placed in final position on the roadbed when approved by the Engineer.

Measurement for payment of selected material stockpiled as above provided will be in accordance with Subsection 203.04.01(d), "Selected Material."

**203.03.10 SLIDES AND SLIPOUTS:** Material outside the planned roadway or ditch slopes which is unstable and constitutes potential slides in the opinion of the Engineer, material from slides which has come into the roadway or ditch, and material which has slipped out of new or old embankments shall be excavated and removed. The material shall be excavated to designated lines or slopes either by benching or in such manner as approved by the Engineer. Such material shall be used in the construction of the embankments or disposed of as approved by the Engineer.

The above provisions shall not be so construed as to relieve the Contractor from the duty of maintaining all slopes true and smooth. Erosion, regardless of amount or extent, caused by the action of the elements which results in damage to work or materials, shall in no case be considered a slide or slipout. Measurement for payment will be in accordance with Subsection 203.04.01(f), "Slides and Slipouts."

**203.03.11 DRAINAGE:** During construction of the roadway, the roadbed shall be maintained in such condition that it will be well drained at all times.

V-type ditches shall be formed to the cross section and dimensions on the plans by means of suitable equipment which will deposit all loose material on the downhill side so that the bottom of the finished ditches shall not be less than two (2) feet six (6) inches (2.5 meters) below the crest of the loose material piled on the downhill side.

In going from cut to fill, the roadway ditches shall be so cut as to avoid damage to embankments by erosion.

The flat-bottom ditches indicated on the plans, or staked by the Engineer, shall be excavated to the required cross section and grade. Materials so obtained shall be used to construct roadway embankments or dikes or both, to form a continuous diversion channel as staked by the Engineer.

**203.03.12 CHANNELS:** To avoid destruction of natural growth during construction of ditches, channels, or dikes, travel of equipment shall be confined to the construction limits. Where ditches, channels or dikes are nearly parallel to the roadway, turn-arounds shall not be located closer than two hundred (200) feet (60 meters) apart. Attention is directed to Subsection 107.12, "Protection and Restoration of Property and Landscape."

Fine grading of channel bottoms will not be required unless paving is specified.

**203.03.13 BORROW:** A possible source of borrow material may be indicated in the contract documents. If the Contractor desires to use borrow materials from sources other than those described in the contract documents, he shall, at his own expense, acquire the necessary right to take materials and pay all costs involved. All costs of exploring such alternate sources shall be borne by the Contractor. Use of material from these sources will not be permitted until approved in writing by the Engineer.

The successful bidder shall, at the time of execution of the contract, execute an "Agreement" for all borrow deposits obtained under an "Option and Agreement for Sale of Materials" when said "Option" is contained in the Special Provisions. This agreement shall be executed whether the material is to be used or not.

In case designated borrow deposits fail to contain the necessary quantity of acceptable material, the Contractor shall immediately notify the Engineer in writing. The Engineer shall thereupon investigate, and if his investigation shows that there is not sufficient quantity of acceptable material, he shall designate an alternate deposit in which to obtain the deficit.

In all borrow pits having undesirable material, including overburden, refuse, organic and deleterious substances, the material shall be removed and wasted or redistributed, in a manner satisfactory to the Engineer. All costs incurred therefor shall be considered as incidental and subsidiary to the borrow.

Borrow shall not be obtained until all other excavation items are complete to the extent necessary to determine the need for borrow.

The Contractor shall notify the Engineer sufficiently in advance of opening any borrow areas so that cross section elevations and measurements of the ground surface after stripping may be taken, and the borrow materials can be tested before being used. Sufficient time for testing the borrow shall be allowed.

Borrow deposits shall be excavated to regular lines as staked to permit accurate measurement. The dimensions of the borrow deposit will be designated and the Contractor shall not excavate below the depth or outside limits given, except with prior approval. The depth of excavation throughout the area of the borrow pits shall be as uniform as practicable and the side slopes shall conform to the requirements of Section 626, "Final Clean Up." Unless otherwise permitted, borrow pits shall be excavated so that they will drain to the nearest natural outlet.

All materials which are not satisfactory for use for the purposes intended shall be rejected at the pit and disposed of in a manner satisfactory to the Engineer.

If the Contractor excavates more material than is required, the excess will not be measured for payment.

All work and materials required to build and maintain borrow haul roads and obliteration of haul roads in accordance with Section 626, "Final Clean Up" shall be considered subsidiary to the "borrow" item and no further compensation will be allowed therefor.

**203.03.14 FOUNDATION:** When embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when embankment is to be built one half width at a time, the slopes that are steeper than four to one (4:1), when measured at right angles to the roadway, shall be continuously benched as the work is brought up in layers. Benching shall be of sufficient width to permit operations of placing and compacting equipment. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. Material thus cut out shall be recompacted along with the new embankment material at the Contractor's expense, unless the width of excavation required by the Engineer exceeds six (6) feet (1.8 meters), in which case the excavated material excess of six (6) feet (1.8 meters) will be measured and paid for as roadway excavation.

All foundations for embankment shall be cleared and grubbed in accordance with Section 201, "Clearing and Grubbing."

In designated areas, unsuitable material shall be removed and disposed of as prescribed in Subsection 203.03.02, "Unsuitable Material."

Where twelve (12) inches (300 millimeters) or less of embankment is placed over existing bituminous surface, such surface shall be removed and incorporated in the embankment or otherwise disposed of as approved by the Engineer. Where more than twelve (12) inches (300 millimeters) of embankment is placed over existing bituminous surface, such surface shall be left undisturbed. Measurement for removal of existing bituminous material will be as prescribed in Subsection 203.04.01, "Measurement," and paid for as roadway excavation unless the contract documents specifically called for payment under Section 202, "Removal of Structures and Obstructions."

**203.03.15 EMBANKMENT MATERIALS:** Embankments shall be constructed with suitable materials, excavated as prescribed and with any excess materials from other operations which are acceptable and suitable for use.

All materials used in embankment shall be free from objectionable material such as leaves, grass, roots, logs, stumps, brush, or other perishable material.

When there is a choice of material, the excavation shall be made so the best material will be placed on top of the embankment for at least one (1) foot (300 millimeters) in depth. This paragraph shall not be interpreted as to require the Contractor to stockpile and subsequently rehandle embankment materials except as provided in Subsection 203.03.09, "Selected Material."

Material shall not be placed in the embankment when either the material, foundation or the embankment on which it would be placed is frozen.

Where embankments are to be made of material from rock cuts or other material which is unsuitable for finishing the roadbed, the upper six (6) inches (150 millimeters) of the roadbed shall be formed of approved material.

**203.03.16 PLACING EMBANKMENT:** For embankment or backfill deposited against structures, attention is directed to Subsection 207.03.02, "Placing and Compacting at Abutments, Piers, Wingwalls, and Retaining Walls."

Where structure abutments are placed on embankment, the embankment shall be constructed to subgrade



elevation prior to excavating for the construction of the abutment. Where the abutment is supported on piles, the embankment shall be constructed to the elevation of the bottom of the footing.

Where a structure is to be covered by a rockfill, it shall be covered with not less than two (2) feet (0.6 meters) of satisfactory soil or granular materials before the rock embankment is placed over the structure.

Embankments shall, except as hereinafter specified, be constructed in layers. The construction of an embankment shall begin at the lowest point of the fill below the grade or the bottom of ravines. Individual layers shall be spread evenly to uniform thickness throughout and parallel with the finished grade for the full width of the embankment, unless otherwise permitted. The thickness of the layer shall be as necessary to secure the required compaction with an twelve (12) inch (300 millimeters) maximum thickness after compaction. Excepted provisions are hereinafter outlined for placing in marsh and placement of rock. Hauling equipment shall be routed to obtain uniform compaction and channelization of haul routes and rutting of the fill shall be avoided.

When embankments are constructed across wet or swampy ground which will not support the weight of heavy hauling and spreading equipment, the Contractor will be expected to choose such methods of embankment construction and to use such hauling and spreading equipment as will least disturb the soft foundation. When soft foundations are encountered, and when approved by the Engineer, the lower part of the fill may be constructed by dumping and spreading successive vehicle loads in a uniformly distributed layer of a thickness not greater than that necessary to support the vehicle while placing subsequent layers, after which the remainder of the embankment shall be constructed in layers and compacted as specified.

It is not the policy of the Contracting Agency to allow an increase in the planned depth of embankment material over soft, wet, or swampy ground for the sole purpose of providing support for heavy hauling and spreading equipment, unless the Contractor proves to the satisfaction of the Engineer that the planned depth is inadequate to support light hauling vehicles. If it proves necessary for the Contractor to use smaller hauling vehicles or different methods of embankment construction than he had originally contemplated in order to comply with the foregoing, such shall not be the basis for a claim for extra compensation against the Contracting Agency. The unit contract price for the various pay items involved shall be full compensation for all labor, materials and equipment necessary to perform the work as outlined herein.

Embankment which, in the opinion of the Engineer, contains enough rock larger than four (4) inches (10 centimeters) to make it impractical to place and compact in twelve (12) inch (300 millimeter) lifts shall be considered as "Rock Embankment." The materials shall be spread in a uniform horizontal layer over the full width of the embankment. The layer thickness shall not exceed one and one-third (1-1/3) times the vertical dimension of maximum size material larger than eight (8) inches (200 millimeters). The largest size rock allowed in the embankment will be three (3) feet (1 meter) measured in vertical direction and rocks larger than this shall be broken up before being placed in the embankment. Rock to be wasted may exceed three (3) feet (1 meter) and be disposed of in an inconspicuous manner approved by the Engineer.

In rock fills where end dumping is employed, direct end dumping upon the previously constructed layer of embankment will not be permitted. Rock shall be dumped on the layer of embankment being constructed and dozed ahead into place. Care shall be exercised to work the fines and smaller rock into the spaces between the larger rock. Compaction will be required as provided in Subsection 203.03.18, "Compaction, Rock Embankment."

To the extent of project requirements for embankments, all rock from excavation shall be used for embankment. The Contractor shall plan his grading operation to use rock which may be encountered in excavation in accordance with the following provisions:

Rock, in general, shall be placed so as to form the base of embankment for the full width of the cross

section; on the side slope or slopes of a new embankment being placed; on the side slope or slopes of an embankment already in place requiring widening or where excess rock may be wasted; or on the side slopes and top of rolled embankment made of embankment materials other than rock.

The Contractor shall not place large rock in embankments where piles will be driven. The Contractor shall be responsible for penetrating the embankment with specified piles.

When rock and other embankment materials are excavated at approximately the same time, the rock shall be distributed throughout the fill and not nested in one location.

When there is insufficient material other than rock in the excavation to permit properly compacted layers, the rock shall be placed for the full cross section width with the larger rocks well distributed and the void spaces filled with the smaller rocks and fragments.

When shown on the plans or considered necessary by the Engineer, embankments shall be built to such elevation above required grade to allow for settlement, or sufficient surcharge shall be placed above the required elevation of earth grade over deposits of unstable material to secure displacement or settlement. Surcharge shall be removed only after the fill has reached stability or the required settlement time has been reached.

**203.03.17 COMPACTION, DIRT EMBANKMENT:** Optimum moisture content of the various soils will be determined or approved by the Engineer. At the time of compaction, the moisture content of the various soils shall be within the following ranges:

Optimum Moisture Content	Tolerances
0% - 20%	+2% to -4%
20% - 30%	+2% to -5%
31% or more	+3% to -6%

When necessary, each layer before being compacted, shall be processed as required in order to bring its moisture content within the prescribed limits. The material shall be wetted by the application of water or dried as necessary and either process may be carried out either on the embankment or at the source of the material or otherwise as approved by the Engineer. Full compensation of any work involved in wetting or drying embankment material to obtain the required moisture content shall be considered as included in the contract unit price bid for excavating or furnishing the material and no additional compensation will be allowed therefor.

Hauling and leveling equipment shall be routed and distributed full width over each layer of the fill in such a manner as to uniformly distribute the compaction afforded thereby. In addition to hauling and leveling equipment, the Contractor shall provide compaction equipment that is specifically designed and manufactured for the purpose of compacting dirt embankments. Said compaction equipment shall work continuously with the grading equipment.

The top 8 inches (200 millimeters) of the base of cuts and natural ground having less than five (5) feet (1.5 meters) of embankment, measured from the subgrade, and all embankment material, shall be compacted to not less than ninety (90) percent relative compaction. When natural ground material is encountered that cannot be compacted to the required density, compaction requirements shall be determined by the Engineer.

All selected borrow and structure backfill placed within the limits of embankment shown on the plans for approaches to bridges shall be compacted to not less than ninety-five (95) percent relative compaction.

It is to be expected that a loss of density in the upper portion of earth subgrade may occur due to the

elements, or for lapse of time, or for other reasons. Recomposition to the specified density will be required prior to placement of any subsequent course and no additional compensation will be allowed therefore.

**203.03.18 COMPACTION, ROCK EMBANKMENT:** Field density tests will not be required on rock embankments. In lieu thereof, the required compaction shall be tested by proof rolling. In this case, compaction shall be attained and tested by using construction methods and equipment as follows:

- (a) **Methods.** The material for the embankment shall be deposited, spread and leveled the full width of the embankment, and the layer of thickness may be one and one-third (1-1/3) times the vertical dimension of maximum size material. The maximum size rock shall not exceed three (3) feet (1 meter).

Hauling and leveling equipment shall be routed and distributed over each layer of the fill in such a manner as to make use of the compaction afforded thereby. Rollers, vibrators, or compactors shall compact the embankment full width with a minimum of three (3) complete passes for each layer of embankment. The compacting equipment shall not exceed a speed of five (5) miles (8 kilometers) per hour and shall work continuously with the grading equipment.

Rolling shall be done in a longitudinal direction along the embankment and shall generally begin at the outer edges and progress toward the center. The travel paths of traffic and construction equipment shall be kept dispersed over the entire width of the embankment so as to aid in obtaining uniform compaction. Weights of equipment used in making embankments over soil having an excessive moisture content may be limited, if, in the judgment of the Engineer, such limitations are necessary in order to maintain the fill in a satisfactory condition.

Water shall be applied to the embankment in the amount necessary to obtain the required compaction.

- (b) **Equipment.** Compaction equipment shall be adequately designed to obtain compaction requirements without adverse shoving, rutting, displacement, or loosening and shall meet the requirements hereinafter specified. Rollers shall have displayed thereon in permanent legible characters, the manufacturer's guaranteed net operating weights as distributed on each axle.

The proof roller shall be a pneumatic-tired roller or pneumatic-tired compactor weighing not less than fifty (50) tons (45 metric tons), and capable of applying to the ground loads of not less than twenty-five thousand (25,000) pounds (11,300 kilograms) per wheel. All tires shall be of equal size and diameter and shall be capable of operating at an air pressure of at least ninety (90) pounds per square inch (620 KPa). They shall be kept uniformly inflated so that the difference in pressure in any two tires shall never exceed five (5) pounds per square inch (0.35 kilograms per square centimeter) and means shall be provided by the Contractor for checking the tire pressure on the job at any time.

- (c) **Tests.** Subsequent layers shall not be placed until the previous layer of the embankment is compacted to the degree that no further appreciable deflection is evidenced under the action of proof rolling equipment, as determined by the Engineer.

Rolling and proof rolling may be deleted on any layer or portion thereof when, in the judgment of the Engineer, accomplishment is physically impractical.

Payment for rolling and proof rolling or for the correction of any subgrade weakness or deficiencies disclosed by the proof rolling operation shall be considered subsidiary to the price bid for the "Excavation" item.

**203.03.19 MAINTENANCE:** Embankment material which may be lost or displaced as a result of natural settlement of the ground or foundation upon which the embankment is constructed shall be replaced by the Contractor with acceptable material from excavation or borrow, etc. The quantity of material required will be paid for at the regular contract price for the type of material used, also overhaul, if applicable, and no additional compensation will be allowed therefore.

The Contractor shall, at his expense, remove and replace with acceptable material any embankment or portion thereof which has been constructed with unapproved material as well as remove and replace portions of the embankment which may become unstable or displaced as the result of carelessness or negligence on his part.

**203.03.20 SUBGRADE TOLERANCE:** Subgrade upon which pavement, sidewalk, curb and gutter, driveways, or other structures are to be directly placed shall not vary more than 1/4 inch (6 millimeters) below or above the specified grade and cross section. Subgrade upon which sub-base or base material is to be placed shall meet the tolerances as specified in Subsection 203.01.02, "Grade Tolerance." Variations within the above specified tolerances shall be compensating so that the average grade and cross section specified are met.

#### METHOD OF MEASUREMENT

**203.04.01 MEASUREMENT:** Unless otherwise specified, excavation will be measured on a volume basis by cross sectioning the area to be excavated and computing neat lines for an end area. The average end area method will be used with no allowance made for curvature. If for any reason it is impossible or impractical to measure quantities by average end areas, the Engineer will compute the quantities by a method which, in his opinion, is best suited to obtain an accurate determination.

The quantity of excavation to be measured for payment will be the number of cubic yards (cubic meters) excavated and placed as required. The estimated quantities shown on the plans, plus or minus authorized changes will be the quantity used for payment. The Contracting Agency or the Contractor may, however, request a final measurement in which case final cross sections will be taken. When final cross sections are taken the determination of quantities derived therefrom will be the quantities used for payment. Furthermore, when the Contractor requests final measurement and the quantities thus determined are less than the planned quantities plus authorized changes, the Contractor shall reimburse the Contracting Agency for the Agency's expenses incurred by such final measurement and calculation.

When changes are made during construction such as widening cuts, changing grades, disposing of unsuitable material, stockpiling selected material, and other changes resulting in increases or decreases in quantities, then additional measurements for payment will be made by the Engineer as hereinafter outlined:

- (a) **Unsuitable Material.** When the removal and disposal of unsuitable material is shown in the contract documents, such material will be measured for payment as excavation for the related item.

Removal and disposal of unsuitable material, not shown on the plans, will be measured and paid for as "Roadway Excavation." However, if removal and disposal of unsuitable material not shown on the plans required special equipment or unusual operations, it may be paid for as extra work according to the provisions of Subsection 104.03, "Extra Work."

No measurement will be made of suitable material temporarily removed and replaced to facilitate compaction of material.

- (b) **Overbreak.** All sideslope overbreak as defined in Subsection 203.03.05, "Overbreak," shall not be paid for.

Rock removed to a maximum depth of six (6) inches (150 millimeters) below subgrade will be measured for payment provided the rock has been removed sufficiently to permit accurate cross sectioning. Replacement to this depth shall be with material designated on the plans approved by the Engineer and will be measured and paid for at the contract unit price for the material used.

Rock loosened or removed in excess of six (6) inches (150 millimeters) below subgrade will not be measured nor paid for. When ordered by the Engineer, the loosened material will be removed and the resultant space refilled with approved material at the expense of the Contractor.

- (c) **Widening Cuts.** If the Engineer directs the Contractor to excavate beyond the limits of the typical cross section and before the excavation is substantially completed, the material shall be classified as "Roadway Excavation" and shall be paid for at the contract bid price. However, if widening cuts requires special equipment, or unusual and extra expense, it may be paid for as extra work according to the provisions of Subsection 104.03, "Extra Work."
- (d) **Selected Material.** Selected material stockpiled as provided in Subsection 203.03.09, "Selected Material" will be measured for payment as roadway excavation both in its original position and also from the stockpile. Measurement of the material taken from stockpile will be made of the volume actually removed.
- (e) **Surplus Material.** Surplus excavated material will be measured for payment as roadway excavation and no further compensation will be allowed by virtue of the method of disposing, placing, or widening embankments caused from such surplus material.
- (f) **Slides and Slipouts.** In the event of slides and slipouts, the Engineer and Contractor shall negotiate in each case and decide the relative difficulty of performing the work, and payment will be made either as "Roadway Excavation" or as "Extra Work" as provided in Subsection 104.03, "Extra Work."

Where slopes have been previously completed by the Contractor, the cost of resloping required in areas

where unstable material is removed will be paid for as extra work as provided in Subsection 104.03, "Extra Work."

The cost of pioneering work necessary to make slide or slipout areas accessible to normal excavation equipment and the cost of necessary clearing and grubbing will be paid for as extra work as provided in Subsection 104.03, "Extra Work."

Only those quantities of slide or slipout material which are authorized and actually removed will be measured for payment.

Excavation in excess of the staked or authorized cross section will not be measured for payment, except as outlined above.

Material used for surcharge, whether shown on the plans or called for by the Engineer, will be measured for payment as roadway excavation both in its original position and when removed from the surcharge position.

Earthwork quantities within the limits of "Slope Rounding" will not be measured for payment.

V-type ditches will be measured parallel to the ground and each one hundred (100) linear feet (30 meters) shall constitute a unit of measure. The volume of excavation for such ditches will not be measured for payment.

The quantity of Selected Borrow or Selected Borrow Excavation to be measured for payment will be the number of cubic yards or tons (cubic meters or metric tons) measured as set forth in the Special Provisions.

All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantities."

#### BASIS OF PAYMENT

**203.05.01 PAYMENT:** The accepted quantities of excavation measured as specified in Subsection 203.04.01, "Measurement," will be paid for at the contract unit price bid for each of the pay items listed in the bid schedule. Such price shall include excavating, loading, hauling, depositing, spreading, compacting, and maintaining the material complete and in place.

The accepted quantities of selected borrow or selected borrow excavation will be paid for at the contract unit price bid per cubic yard or ton (cubic meter or metric ton) for "Selected Borrow" or "Selected Borrow Excavation" which price shall be full compensation for furnishing all materials, loading, hauling, depositing, spreading, watering, compacting and maintaining the material complete and in place.

The contract unit price bid per cubic yard for roadway excavation, borrow excavation and channel excavation shall be considered as including payment for all haul.

All payments will be made in accordance with Subsection 109.02, "Scope of Payment."

Payment will be made under:

#### PAY ITEM

#### PAY UNIT

Roadway Excavation .....	Cubic Yard (Cubic Meter)
Drainage Excavation .....	Cubic Yard (Cubic Meter)
Channel Excavation .....	Cubic Yard (Cubic Meter)
Borrow Excavation .....	Cubic Yard (Cubic Meter)
V-type Ditches .....	Stations (30 Meters)
Selected Borrow .....	Cubic Yard or Ton (Cubic Meter-Metric Ton)
Selected Borrow Excavation .....	Cubic Yard or Ton (Cubic Meter-Metric Ton)

TESTING

203.06.01 TESTING:

Spec. Section	Description	Test	Reference Specification And/Or Test Procedure	Recommended Frequency
203.02.01	Roadway Excavation (Subgrade)	Field Density	AASHTO T310	1/5000 SF
203.02.02	Drainage Excavation (Subgrade)	Field Density	AASHTO T310	1/5000 SF
203.02.03	Channel Excavation (Subgrade)	Field Density	AASHTO T310	1/5000 SF
203.02.04	Borrow	Sieve Analysis	AASHTO T11 & T27 (RTC 301 & Special Provisions)	1/Type
203.02.05	Selected Borrow	Plasticity Index	AASHTO T89 & T90 (RTC 301 & Special Provisions)	1/Type
		R-Value	AASHTO T190	1/Type
203.03.01	Roadway (Subgrade)	Field Density	AASHTO T310	1/5000 SF
203.03.09	Selected Material	Sieve Analysis	AASHTO T11 & T27 (RTC 301 & Special Provisions)	1/5000 SF
		Plasticity Index	AASHTO T89 & T90 (RTC 301 & Special Provisions)	1/5000 SF
		R-Value	AASHTO T190	1/Type
		Field Density	AASHTO T310	1/5000 SF
203.03.14	Foundation (Subgrade)	Field Density	AASHTO T310	1/5000 SF/Lift
203.03.17	Embankment	Field Density Fill	AASHTO T310	1/5000 SF/Lift
		Field Density Subgrade	AASHTO T310	1/5000 SF/Lift
		Field Density Structures	AASHTO T310	If Riding Equipment Used: 1/5000 SF/Lift Per Structure If Walk Behind Equipment Used: 1/1000 SF/Lift Per Structure/Per Day
203.03.18	Rock Embankment	Visual	Issue Inspection Report	Full Time

NOTE: A maximum testable lift is defined as a twelve (12) inch (30 centimeter) layer of compacted material.

**401.03.16 SURFACING MISCELLANEOUS AREAS:** Surfacing of road approaches and connections, street intersection areas, frontage roads, island areas, sidewalks, dikes, curbs, gutters, gutter flares, ditches, downdrains, spillways, aprons at the ends of drainage structures, and other designated areas outside the travelled way shall conform to the provisions specified in these specifications.

The combined aggregate grading for bituminous mixtures placed on miscellaneous areas shall conform to that specified for the bituminous mixture placed on the travelled way, except the aggregates used in the construction of island areas and dikes shall be constructed of aggregate conforming to the requirements of Plantmix Surface Aggregate, Type 3. The amount of bituminous material used in the bituminous mixture placed in dikes, gutters, gutter flares, downdrains, spillways, aprons at the end of drainage structures, and other designated areas outside the travelled ways shall be increased not less than one (1) percent by weight of the aggregate over the amount of bituminous material used in the bituminous mixture placed on the travelled way. Submittal of a revised job-mix formula will not be necessary.

The bituminous mixture placed in island areas, sidewalks, dikes, gutters, gutter flares, ditches, downdrains, spillways, aprons at the end of drainage structures, and other designated areas outside the travelled way may be spread in one layer. The material shall be compacted to the required lines, grades, cross section, and density requirements for Category II pavements in accordance with Subsection 401.03.12, "Acceptance Sampling and Testing of Bituminous Material."

Dikes shall be shaped and compacted with an extrusion machine or other equipment capable of shaping and compacting the material to the required correct grade and cross section.

#### METHOD OF MEASUREMENT

**401.04.01 MEASUREMENT:** The quantity of bituminous plantmix to be measured for payment shall be the number of tons used in the accepted work, and will be determined by weighing the completed mixture of aggregate, mineral filler if required, and bituminous material.

The quantity of shoulder dikes constructed of bituminous plantmix to be measured for payment shall be the number of linear feet (meters) and will be determined from measurement taken along the top of the completed dikes to the nearest one (1) foot (meter) length.

All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantity." Batch weights will not be permitted as a method of measurement unless the alternate provisions of Subsection 401.03.01(b)1, "Plant Scales," are met, in which case the cumulative weight of all the acceptable batches will be used for payment.

Due to possible variations in the specific gravity and voids of the payment, the tonnage used may vary from the proposal quantities and no adjustment in contract unit price will be made because of such variation.

#### BASIS OF PAYMENT

**401.05.01 PAYMENT:** All accepted work and materials measured as prescribed above will be paid for as provided in the representative sections for each type specified.

Full compensation for furnishing and applying bituminous material or asphaltic emulsion as provided for in Subsection 401.03.06, "Preparation of Existing Surface" including "Tack Coat" and 401.03.14, "Joints" shall be considered as included in the contract price paid for the principal items involved and no further compensation will be allowed.



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When bituminous plantmix, Type III, is used in the construction of island areas, or dikes, and there is no separate payment for said mixture, this bituminous plantmix shall be included in the payment for plantmix bituminous surface of the major type shown in the list of bid items and the proposal.

**SECTION 402****PLANTMIX BITUMINOUS SURFACE****DESCRIPTION**

**402.01.01 GENERAL:** This work shall consist of constructing one or more courses of bituminous pavement on a prepared base in accordance with these specifications, and in conformity with the lines, grades, thickness, and typical cross sections shown on the plans or established by the Engineer. The prepared base shall be prime coated or tack coated as specified in Section 405 and 406 prior to the placement of any plantmix bituminous surface. The cured prime coat shall have no raw asphalt exposed and shall be cleaned of all loose material.

The requirements of Section 401, "Plantmix Bituminous Pavements - General" shall be applicable to this work, except as hereinafter specified.

**MATERIAL**

**402.02.01 GENERAL:** The material shall conform to the requirements as specified in Subsections 401.02.01 through 401.02.04, inclusive, of Section 401, "Plantmix Bituminous Pavements - General."

**CONSTRUCTION**

**402.03.01 GENERAL:** The construction requirements shall conform to the requirements as specified in Subsections 401.03.01 through 401.03.15, inclusive, of Section 401, "Plantmix Bituminous Pavements - General," with the exception contained in the following two subsections.

**402.03.02 SPREADING AND FINISHING:** Unless otherwise specified, bituminous plantmix surface shall be placed in courses not exceeding four (4) inches (100 millimeters) in compacted thickness. When more than one course is placed, the courses shall be of approximately equal thickness.

Bituminous plantmix surface to be placed on shoulders and other areas of the travelled way having a width of eight (8) feet (2.4 meters) or more, shall be spread as specified in Subsection 401.03.10, "Spreading and Finishing." When the areas are less than eight (8) feet (2.4 meters) in width the material may be deposited and spread in one or more layers by other mechanical means that will provide a uniform smoothness and texture. Stockpiling bituminous mixture on contiguous pavement that might be stained thereby will not be permitted.

**402.03.03 SURFACE TOLERANCES:**

**402.03.03.01:** The completed surfacing shall be thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities. When a straightedge ten (10) feet (3 meters) long is laid on the finished surface and parallel with the centerline of the highway, the surface shall not vary more than one quarter inch (6 millimeters) from the lower edge of the straightedge.

The transverse slope of the finished surface shall be uniform to a degree such that no depressions greater than one quarter inch (6 millimeters) are present when tested with a straightedge ten (10) feet (3 meters) long laid in a

Portland cement concrete used in new structures of catch basins and inlets will be paid for as specified in Section 502, "Concrete Structures."

Reinforcing steel in catch basins and inlets will be paid for as specified in Section 505, "Reinforcing Steel."

The accepted quantity of precast manholes measured as provided in Subsection 609.04.01, "Measurement" will be paid for at the contract unit price bid per each for types and sizes specified. This price shall be full compensation for furnishing all materials including structure excavation and structure backfill, Portland cement concrete, steel, castings, and incidentals necessary to complete the work.

Structure excavation and structure backfill for catch basins and inlets will be paid for as specified in Section 206, "Structure Excavation" and 207, "Backfill."

All payments will be made in accordance with Subsection 109.02, "Scope of Payment."

Payment will be made under:

PAY ITEM	PAY UNIT
Castings .....	Pound (Kilogram)
Structural Steel Grates .....	Pound (Kilogram)
(Size) Precast Reinforced Concrete Manhole (type) .....	Each
Adjusting Covers .....	Each

## SECTION 610

### SLOPE AND CHANNEL PROTECTION

#### DESCRIPTION

**610.01.01 GENERAL:** This work shall consist of constructing slope and channel protection structures to the lines and grades established by the Engineer using riprap or wire mesh gabions in accordance with the design shown on the plans and these specifications.

Riprap construction shall consist of furnishing and placing riprap (with or without grout), or sacked Portland cement concrete riprap, as the case may be.

Wire mesh gabion construction shall consist of furnishing, assembling, tying, and filling open mesh wire baskets with stone.

#### MATERIALS

**610.02.01 GENERAL:** All materials shall conform to the requirements specified in the following sections:

Water .....	Section 722
Stone for Masonry and Riprap .....	Subsection 706.03.05
Portland Cement .....	Section 701
Grout and Mortar Sand .....	Subsection 706.03.04

When so provided and with prior approval of the engineer, crushed concrete may be substituted for the above designated stone. In such a case, the concrete shall be sound and meet all requirements as specified for stone.

**610.02.02 GROUT:** Grout shall be composed of one part by volume of Portland cement and three parts by volume of sand and shall be of such consistency that it will fill all voids in the riprap.

**610.02.03 SACKED CONCRETE:** Sacked concrete shall be composed of sacks filled with Portland cement concrete. The mixed concrete shall contain a minimum of three hundred seventy-six (376) pounds (170 kilograms) (four sacks) of Portland cement per cubic yard. The amount of water added at the time of mixing shall be such as will produce a mixture with a slump of from three (3) inches (75 millimeters) to five (5) inches.

Unless otherwise provided in the special provisions, aggregate for use in sacked concrete riprap shall consist of river run material of a sandy, gravelly nature, clean and free from roots, vegetable matter, and other deleterious substances. When tested on laboratory sieves, river run material shall conform to the following grading requirements.

Passing a 2-inch (50 millimeters) Sieve .....	80 to 100 Percent
Passing a No. 200 Sieve .....	0 to 4 Percent

Sacks for concrete riprap shall be made of at least 10 ounce (285 gram) burlap, and shall be approximately 19 1/2 x 36 inches (495 x 915 millimeters) measured inside the seams when the sack is laid flat. The capacity of each sack shall be approximately 1.25 cubic feet (35 liters). Sound reclaimed sacks may be used.

**610.02.04 STONES FOR RIPRAP:** Stones used for riprap shall be hard, durable, angular in shape, resistant to weathering and erosion, and free from spoils, cracks and organic matter. The stone for non-grouted riprap shall have a minimum of 2 fractured faces with neither width nor thickness of a single stone less than one-third its length. The specific gravity of the riprap shall not be less than 2.45. The nominal stone size shall be as follows:

**Riprap**

D15 shall be a minimum of 6 inches.

D50 shall be a minimum of 12 inches.

D85 shall be a minimum of 18 inches.

**Heavy Riprap**

D15 shall be a minimum of 9 inches.

D50 shall be a minimum of 18 inches.

D85 shall be a minimum of 24 inches.

This stone shall conform to the following requirements:

Source Requirements	Test Method	Requirements
Percent of Wear . . . . .	ASTM C 535	45% Maximum
Bulk Specific Gravity . . . . .	ASTM C 127	2.5 Minimum

Control of gradation will be by visual inspection. Upon request by the Engineer the Contractor shall provide a sample of stone of at least 5 tons (4.54 metric tons) meeting the gradation for each location riprap is indicated. Each sample shall be located at the construction site near the location where the riprap is to be placed. The sample shall be used as a frequent reference for judging the gradation of the riprap supplied. The sample riprap shall be in place and acceptable to the Engineer before riprap placing work begins. The Contractor shall maintain the placed riprap until the project is completed and any material displaced by any cause shall be repaired to the lines and grades indicated on the plans.

Caliche stone or cementitious materials meeting the requirements of this section may be used as riprap with prior approval of the Engineer. The riprap shall be fully cemented material. Only materials designated as hard (scratches leave only dust, requires many hammer blows to break) or very hard (difficult to scratch or break), shall be utilized. Moderately hard (crumbles with several hammer blows) or partially cemented materials are not acceptable.

The Contractor may be required to provide riprap test results from an approved testing laboratory and a Certificate of Compliance in accordance with Subsection 106.05, "Certificate of Compliance".

**610.02.05 STONES FOR GABIONS:** Stones for filling the gabions shall be well graded, hard stones, conforming to the requirements specified in Subsection 706.03.05, "Stone for Masonry and Riprap".

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Size and gradation shall be such that the predominant size is between 4 to 8 inches (100 to 200 millimeters), eighty-five percent by weight. Minimum stone dimensions shall be 3 inches (75 millimeters) and maximum stone dimension shall be 8 inches (200 millimeters). For gabion baskets less than 1 foot (0.3 meters) in height, the maximum stone dimension shall be 6 inches (150 millimeters).

**610.02.06 FILTER MATERIAL:** When filter material is specified or shown on the plans, it shall consist of mineral aggregate that is clean, hard, durable, and free of any deleterious matter or harmful adherent coatings. Gradation of the filter material shall conform to the requirements specified by the Engineer, or as shown in the special provisions.

**610.02.07 FILTER FABRIC:** When filter fabric is specified or shown on the plans, it shall consist of a geotextile that is made from synthetic fibers. The filter fabric shall be in accordance with the requirements of AASHTO M288, Section A4 and shall conform to the requirements specified by the Engineer.

**610.02.08 WIRE MESH GABIONS AND GABION MATTRESSES:** Wire mesh gabions and gabion mattresses shall be fabricated from either twisted wire mesh or welded wire mesh. All wires shall be galvanized prior to fabricating the mesh and in compliance with ASTM A90. Only one type of wire mesh may be used in any one structure.

Gabion and gabion mattress dimensions of width, height, and length shall be as shown on the plans. Each gabion unit shall not vary more than five percent from the dimensions shown on the plans. Gabions come 1 foot (0.3 meter) or greater in height, 3 foot in width, and they are compartmentalized into cells not larger than 3 foot (0.9 meter) X 3 foot (0.9 meter) by attaching to the base single diaphragm panels made of the same type and size mesh as the gabion panels. Gabion mattresses come 9 inches (0.23 meter) or less in height, 6 foot in width, and they are compartmentalized into cells not larger than 6 foot (1.83 meter) X 3 foot (0.9 meter) by attaching to the base single diaphragm panels made of the same type and size mesh as the gabion mattress panels.

The baskets shall be assembled with the necessary panels and diaphragms secured to the base in accordance with ASTM A975-97 Table 2 requirements. Pleating the base panel to obtain the diaphragms is prohibited.

Fabrication of the wire mesh gabions and gabion mattresses shall be as follows:

**(a) Twisted Wire Mesh Gabions and Gabion Mattresses**

Gabion panels for the twisted mesh style shall be manufactured from galvanized steel wire, Class 3, soft temper, conforming to ASTM A641, or from aluminized steel wire, soft temper, conforming to ASTM A809. The wire shall have a minimum tensile strength of 60,000 psi (415 MPa) when tested in accordance with ASTM A370. Twisted wire mesh gabions and gabion mattresses shall comply with ASTM A975-97 standards.

The mesh shall be formed with non-raveling double twists by twisting each pair of wires through two 360 degrees turns. The mesh openings shall be hexagonal in shape and uniform in size and shall comply with the mesh dimensions and requirements shown on Table 1 and Table 2 below.

All perimeter edges of the mesh panels forming the gabion basket shall be securely tied to a selvedge wire so that the selvedge to mesh connection has at least the same strength as the body of the mesh. Selvedge wire shall be the same kind and type of material used for the mesh, except that their diameters shall be as shown on the tables below.

When specified by the Engineer, the galvanized or aluminized wire shall be coated with a polyvinyl chloride (PVC) material. The coating shall be accomplished by using either extruded or extruded and bonded PVC material, and shall be applied before twisting the wire into mesh panels.

All wire used for twisted mesh gabions and gabion mattresses shall meet the following nominal requirements:

**Table 1 Nominal Requirements for Twisted Wire Mesh Gabions**

Type of Basket	Mesh Size	Mesh Wire	Selvedge Wire
Baskets 1 foot (0.3 meter) or greater in height	3.25 inch X 4.5 inch (82.5 mm X 114 mm)	0.120 inch (3.05 mm)	0.148 inch (3.76 mm)
Baskets 1 foot (0.3 meter) or greater in height with PVC coating	3.25 inch X 4.5 inch (82.5 mm X 114 mm)	0.106 inch (2.69 mm), plus the PVC coating	0.134 inch (3.40 mm), plus the PVC coating

**Table 2 Nominal Requirements for Twisted Wire Mesh Gabion Mattresses**

Type of Basket	Mesh Size	Mesh Wire	Selvedge Wire
Baskets 9 inches (0.23 meter) or less in height	2.5 inch X 3.25 inch (63.5 mm X 82.5 mm)	0.087 inch (2.21 mm)	0.106 inch (2.69 mm)
Baskets 9 inches (0.23 meter) or less in height with PVC coating	2.5 inch X 3.25 inch (63.5 mm X 82.5 mm)	0.087 inch (2.21 mm), plus the PVC coating	0.106 inch (2.69 mm), plus the PVC coating

**(b) Welded Wire Mesh Gabions and Gabion Mattresses**

Gabion panels for the welded mesh style shall be manufactured from welded wire fabric conforming to ASTM A185 and ASTM A974-97, Type 1.

Galvanized wire shall have a Class 3 coating as indicated in ASTM A641. Aluminized wire shall have a minimum coating as indicated in ASTM A809. The wire shall be soft tempered with a minimum tensile strength of 60,000 psi (415 MPa) when tested in accordance with ASTM

A370. Welded wire mesh gabions and gabion mattresses shall comply with ASTM A974-97 standards.

The mesh shall form a square or rectangular grid pattern with the maximum diagonal dimension of any grid opening not to exceed 4.5 inches (114 millimeters).

The welded wire mesh shall be galvanized or aluminized prior to welding into mesh and shall comply with the dimensions and requirements shown on Table 3 and Table 4 below.

When specified by the Engineer, the welded wire mesh shall be coated with a polyvinyl chloride (PVC) material. The PVC coating shall be fusion bonded to the galvanized or aluminized wire after fabrication of the gabion mesh panels.

All wire used for welded mesh gabions and gabion mattresses shall meet the following nominal requirements:

**Table 3 Nominal Requirements for Welded Wire Mesh Gabions**

Type of Basket	Mesh Size	Mesh Wire
Baskets 1 foot (0.3 meter) or greater in height	3 inch X 3 inch (76 mm X 76 mm)	0.120 inch (3.05 mm)
Baskets 1 foot (0.3 meter) or greater in height with PVC coating	3 inch X 3 inch (76 mm X 76 mm), plus the PVC coating	0.106 inch (2.69 mm), plus the PVC coating

**Table 4 Nominal Requirements for Welded Wire Mesh Gabion Mattresses**

Type of Basket	Mesh Size	Mesh Wire
Baskets 9 inches (0.23 meter) or less in height	1.5 inch X 3 inch (38 mm X 76 mm)	0.087 inch (2.21 mm)
Baskets 9 inches (0.23 meter) or less in height with PVC coating	1.5 inch X 3 inch (38 mm X 76 mm), plus the PVC coating	0.087 inch (2.21 mm), plus the PVC coating

For polyvinyl chloride (PVC) coated either twisted or welded mesh gabions and gabion mattresses, the PVC coating shall have a nominal thickness of 0.020 inches (0.51 mm) and a minimum thickness of 0.015 inches (0.38 mm). The coating shall be grey, silvery, green, or black, and conform to the following:

- (a) Specific Gravity: In the range of 1.20 to 1.40, ASTM D 792.
- (b) Abrasion Resistance: The percentage of weight loss shall be less than 12%, when tested according to ASTM D 1242, Method B at 200 cycles, CSI-A Abrader Tape, 80 Grit.
- (c) Brittleness Temperature: Not higher than 15 F, ASTM D 746
- (d) Tensile Strength: Extruded Coating - Not less than 2,980 psi., ASTM D 412. Fusion Bonded Coating - Not less than 2,275 psi., ASTM D 638.



- (e) Modulus of Elasticity: Extruded Coating - Not less than 2,700 psi., at 100 percent strain, ASTM D 412. Fusion Bonded Coating - Not less than 1,980 psi. at 100 percent strain, ASTM D 638.
- (f) Ultraviolet Light Exposure: A test period of not less than 3000 hours, using apparatus type E at 63 C, ASTM G23
- (g) Salt Spray Test: A test period of not less than 3000 hours, ASTM B 117

**610.02.09 INTERNAL CONNECTING WIRES:** Internal connecting wires to reinforce the side panels of individual gabion baskets shall meet the same specifications as the wire used in the gabion body, except its nominal diameter shall be 0.087 inches (2.21 millimeters) or larger. Alternate preformed stiffeners acceptable to the gabion Manufacturer and the Engineer may also be used.

**610.02.10 LACING WIRE:** Lacing wire to assemble, interconnect and close the gabion baskets shall meet the same specifications as the wire used in the gabion body except its nominal diameter shall be 0.087 inches (2.21 millimeters).

**610.02.11 WIRE FASTENERS:** Machine formed spiral wire binders with a 3-inch (76 mm) pitch and 2.5 inch (64 mm) I.D. maximum are the standard fastener for welded wire mesh gabions and gabion mattresses, and shall be formed from wire meeting the same quality and coating thickness requirements as specified above for the gabions and gabion mattresses. As an alternative to lacing wire and spiral binders, wire fasteners including interim fasteners, interlocking ring fasteners, overlapping (hog) ring fasteners and twist ties may be used, subject to the approval of the Engineer. The Contractor shall demonstrate that:

- (a) The proposed fastener can consistently resist an opposed tension force of at least 600 pounds (2.7 kilonewtons) without pulling apart;
- (b) The proposed fastener system can consistently produce a joint with strength of at least 1,400 pounds per lineal foot (20.4 kilonewtons per lineal meter) while encompassing the number of wires as intended for its use. When PVC coated wire is used, the joint strength shall be at least 1,200 pounds per lineal foot (17.5 kilonewtons per lineal meter);
- (c) The proposed fastener system does not cause damage to the protective coating on the wire;
- (d) The Contractor has the proper equipment and trained employees to correctly install the fasteners;
- (e) Proper installation can be readily verified by visual inspection.

The Contractor shall provide a complete description of the fastener system, including the number of fasteners required the number and size of wires that the fastener is capable of properly joining, and a description of a properly installed fastener, including drawings or photographs, if necessary. Properly formed fasteners shall meet the following requirements:

- (a) Each interlocking fastener shall be locked and closed.
- (b) Each overlapping ring fastener shall be closed and the free ends shall overlap a minimum of one (1) inch (25 millimeters).
- (c) Spiral binders shall be crimped to secure the spiral in place.
- (d) Twist ties shall have a minimum of two (2) complete revolutions.

If gages or other aids are needed to verify the proper installation of the fasteners, the Contractor shall furnish the Engineer such gages or aids, in such numbers as may reasonably be required. If more than one wire fastener is proposed, e.g. different gage or length of wire, for different joints, the fasteners shall be readily distinguishable. Wire fasteners shall not be used to join more wires, or larger wires, than for which

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they were tested and approved. As a minimum, a fastener shall be installed at intervals of 4 to 6 inches (100 to 150 millimeters) at the location where mesh wire meets seldedge or edge wire.

Galvanized wire fasteners shall be used with galvanized gabions. Aluminized wire fasteners shall be used with aluminized gabions. Stainless steel overlapping rings or interlocking rings shall be used for stainless steel gabions. PVC coated wire spiral binders shall be used for PVC coated gabions.

Galvanized wire fasteners, shall conform to ASTM A764 with Type III coating. Aluminized wire fasteners shall conform to ASTM A809 for wire diameter and coating, with tensile strength equal to ASTM A764, Table 2. Stainless steel wire fasteners shall conform to ASTM A313, Grade 302. Spiral binder fasteners shall be formed with wire having at least the same thickness and coating as the basket mesh wire. Twist tie fasteners shall meet the requirements of lacing wire, as specified in Subsection 610.02.10.

## CONSTRUCTION

**610.03.01 EARTHWORK:** The areas where riprap or wire mesh gabions are to be placed shall be graded to the required lines and grades as shown on the plans or as directed by the Engineer. Any excavations or backfill required to achieve such grade shall conform to the provisions of Section 206, "Structure Excavation", and Section 201, "Structure Backfill".

**610.03.02 FILTER PLACEMENT:** Filter material shall be spread uniformly on the prepared foundation surface in a manner satisfactory to the Engineer, and to the slopes, lines, and grades as shown on the plans, or as specified by the Engineer. Placing of a filter material by methods, which will tend to segregate particle sizes, will not be permitted. Any damage to the foundation surface during filter placement shall be repaired before proceeding with the work. The filter materials shall be placed and placement shall be repaired before proceeding with the work. The filter materials shall be placed and finished to present a reasonable even surface free from mounds or windrows. Compaction of the filter materials shall conform to the requirements shown on the plans or as outlined in the special provisions.

Filter fabric shall be installed in accordance with the manufacturer's recommendations, and in manner that will not tear, puncture, or shift the fabric. Joining edges of the filter fabric shall be overlapped a minimum of 18 inches (450 millimeters). Filter fabric placed behind and/or beneath gabion or gabion mattress structures shall have a minimum permeability of 0.15 inch/sec (0.38 cm/sec) and shall be designed to retain the fine particles of the subsoil, while releasing any hydrostatic pressure buildup.

**610.03.03 RIPRAP:** Stone for riprap shall be placed in a manner which will produce a well-graded mass of stone with a minimum percentage of voids. The entire mass of stone shall be placed in conformance with the lines, grades, and thicknesses shown on the plans. Riprap shall be placed to its course thickness in one operation and in such a manner as to avoid displacing underlying material. When filter fabric is used under the riprap, the height from which the stone is dropped shall be minimized to avoid fabric damage. Placement of stones shall begin at the bottom of the slope and proceed upward to the top.

The large stones shall be well distributed and the entire mass of stone shall conform to the gradation specified. All material placed as riprap protection shall be so placed and distributed that there would be no large accumulation of either the larger or smaller sizes of stone. Placing of riprap in layers, or by dumping into chutes, or by similar methods likely to cause segregation will not be permitted.

**610.03.04 GROUTED RIPRAP:** When grouted riprap is specified, the stone shall be laid as set forth above for riprap. The spaces between the stones shall then be filled with grout as designed in accordance with Section 706, "Aggregates for Portland Cement Products." Sufficient grout shall be used to completely

fill all voids, except that the face surface of the stone shall be left exposed. After grouting is completed, the surface shall be cured as specified in Section 502, "Concrete Structures" for a period of at least three (3) days.

**610.03.05 SACKED CONCRETE RIPRAP:** The sacks shall be filled with concrete, loosely placed so as to leave room for folding at the top, the fold to be just enough to retain the concrete at the time of placing. Not more than one (1) cubic foot (28 liters) of concrete shall be placed in each sack. Immediately after being filled with concrete, the sacks shall be placed and lightly trampled to cause them to conform with the earth face and to adjacent sacks in place.

The slopes on which the sacked concrete riprap is to be placed shall be finished true to line and grade. The first course shall consist of a double row of stretchers laid in a neatly trimmed trench, and the second course shall consist of a single row of headers. The third and remaining courses shall consist of stretchers. They shall be placed in such a manner that joints in succeeding courses are staggered. All dirt and debris shall be removed from the top of the sacks before the next course is laid thereon. Stretchers shall be placed so that the folded ends will not be adjacent. Headers shall be placed with the folds toward the earth face. Not more than four vertical courses of sacks shall be placed in any tier until initial set has taken place in the first course of any such tier.

When, in the opinion of the Engineer, there will not be proper bearing or bond for the concrete due to delays for any cause, a small trench shall be excavated back of the row of sacks already in place. The trench shall be filled with fresh concrete before the next layer of sacks is laid.

Sacked concrete riprap shall be cured per Section 702, "Concrete Curing Materials and Admixtures."

**610.03.06 WIRE MESH GABIONS AND GABION MATTRESSES:** Prior to the assembly and placement of the wire mesh gabions, a representative of the gabion manufacturer shall be present at the construction site for one day of placement or construction to demonstrate the method of assembling, interconnecting, stone filling and closing the gabion, unless otherwise specified in the special provisions. Construction of the gabion structure shall not proceed until the Engineer approves the Contractor's assembly and placement methods.

Gabion baskets shall first be assembled as empty units. The panels and diaphragms shall be connected to the base panel, rotated into position and joined along the edges with lacing wire, spiral binders or approved wire fasteners. When joined with lacing wire, the lacing wire shall be tightly looped at intervals of not more than 6 inches (150 millimeters) along the seams in such a manner that single and double loops are alternated. When joined with preformed spiral binders, thread the spirals along the panels' edges through every mesh and crimp the spirals ends to secure them in place. When joined with alternate fasteners, they shall be properly installed as specified in Subsection 610.02.11, "Wire Fasteners". For either method, there shall not be any opening greater than 2 inches (50 millimeters) (maximum line dimension) along the joined edges or at the corner of the gabion basket.

Empty gabion baskets shall be placed into position, over the filter fabric when required, on the prepared foundation. Empty gabion baskets shall be joined successively to the next empty gabion basket before filling with stone. Each row, tier, or layer of baskets shall be reasonably straight and shall conform to the line and grade shown on the plans or established by the Engineer. The empty gabion baskets shall be fastened to the adjacent baskets along the top and vertical edges. Each layer shall be fastened to the underlying layer along the front, back, and ends. Unless otherwise shown on the plans, the vertical joints between basket units of adjacent tiers or layers shall be staggered by at least one cell along the length of the structure.

All fastening of adjacent baskets shall be done with lacing wire, spiral binders or approved wire fasteners in order to obtain a monolithic structure. The method of fastening shall meet the same requirements as that

specified for assembling individual gabion baskets.

Fastening shall be made through selvedge-to-selvedge or selvedge-to-edge wire connection. Mesh-to-mesh or selvedge-to-mesh wire connection is allowed along vertical edges or in the case where baskets are offset or stacked, and selvedge-to-mesh or mesh-to-mesh wire connection would be necessary.

Before filling each gabion basket with stone, tension may be applied to the empty baskets to achieve a uniform alignment and shall be accomplished in such a manner as to prevent any possible unraveling. Welded wire mesh gabions do not require stretching. The finished gabion structure shall have no gaps along the perimeter of the contact surfaces between adjoining gabion basket units.

The gabion cells shall be carefully filled with stone placed by hand and/or machine in such a manner that the alignment of the structure will be maintained so as to avoid bulges and to minimize voids. All exposed stone surfaces shall have a reasonable smooth and neat appearance. No sharp stone edges shall project through the wire mesh.

The gabion baskets stone-fill may be either cobbles or crushed stone. The stone shall be clean, hard, durable and of suitable quality to ensure suitable performance in the gabions or gabion mattresses. The stone shall be free from cracks, seams and other defects that would tend to increase its deterioration in the gabion baskets. The inclusion of dirt, sand, clay, debris and rock fines will not be permitted. Stone-fill used in the gabions and gabion mattresses shall be a well-graded mixture with sizes ranging between 4 inches (0.10 meter) and 8 inches (0.20 meter) in diameter for gabions 1 foot (0.3 meter) or greater in height, and between 3 inches (76 mm) and 6 inches (152 mm) in diameter for gabion mattresses 9 inches (230 mm) or less in height.

The gabion cells in any row or layer shall be filled in stages so that local deformations may be avoided. At no time shall any cell be filled to a depth exceeding 12 inches (0.3 meter) more than any adjacent cell. The maximum height from which the stone may be dropped into the basket units shall be 3 feet (0.9 meter).

During filling operations, internal connecting wires shall be placed in all exposed front and side gabion units in the following manner:

- (a) For gabion cells with a 36 inch (0.9 meter) height, stone shall be placed to a depth of one third, 12 inches (0.3 meter), after which a minimum of two equally spaced internal connecting wires shall be placed in each cell, connecting the front and back faces of the compartment. For corner units, internal connecting wires shall be placed in both directions. The connecting wires shall be looped around two twisted wire mesh openings, or a welded wire joint, at each basket face, and the wire terminals shall be securely wrapped to prevent their loosening. This operation shall be repeated when the cell is two thirds full. In welded mesh gabions these cross-ties or stiffeners are made from lacing wire, placed across the corners of the gabion cells at 12 inches from the corners, thus providing a diagonal bracing. Lacing wire or preformed hooked wire stiffeners may be used.
- (b) For thinner gabion cells, internal connecting wires are not required except when 18-inch (450 millimeter) baskets are used to build exposed vertical surfaces. In this case, the procedures under (a) above shall be followed, except that the internal connecting wires shall be placed at 9 inches (230 millimeters) from the base.

#### METHOD OF MEASUREMENT

**610.04.01 MEASUREMENT:** The quantity of riprap, grouted riprap, and wire mesh gabions measured for payment will be the number of cubic yards (cubic meters) or square yards (square meters) complete and in place.

The quantity of sacked concrete riprap to be measured for payment will be the number of cubic yards

(cubic meters) at the mixer or the number of square yards (square meters) of sacked riprap in the completed work. Only work placed within the dimensions shown on the plans or ordered by the Engineer, will be measured for payment. All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

**610.05.01 PAYMENT:** The accepted quantities of riprap, grouted riprap, sacked concrete riprap, and wire mesh gabions measured as provided in Subsection 610.04.01, "Measurement" will be paid for at the contract unit price bid per cubic yard (per cubic meter) or square yard (square meter) for the type specified which payment shall be full compensation for furnishing and placing stone, grout, concrete, wire mesh gabions, filter material, filter fabric, and all other miscellaneous items that are appurtenant to the construction of riprap or gabion structures, including the cost incurred for a manufacturer's representative at the construction site. The above prices shall also include all excavation, grading, and backfill necessary to complete the work.

All payments will be made in accordance with Subsection 109.02, "Scope of Payment."  
Payment will be made under:

PAY ITEM	PAY UNIT
Riprap .....	Cubic Yard or Square Yard (Cubic Meter or Square Meter)
Heavy Riprap .....	Cubic Yard or Square Yard (Cubic Meter or Square Meter)
Grouted Riprap .....	Cubic Yard or Square Yard (Cubic Meter or Square Meter)
Sacked Riprap .....	Cubic Yard or Square Yard (Cubic Meter or Square Meter)
Wire Mesh Gabions .....	Cubic Yard or Square Yard (Cubic Meter or Square Meter)

**SECTION 611**  
**CONCRETE SLOPE PAVING**

**DESCRIPTION**

**611.01.01 GENERAL:** This work shall consist of constructing concrete slope paving and concrete mortar slope paving including aprons and cutoff walls in connection therewith, to the lines and grades established by the Engineer in accordance with the design shown on the plans.

**MATERIALS**

**611.02.01 GENERAL:** Materials shall conform to the requirements specified in the following sections:

Portland Cement Concrete .....	Section 501
Reinforcing Steel .....	Section 505

Concrete mortar slope paving shall consist of a mixture of one (1) part Portland cement to four parts sand, thoroughly mixed in a dry state prior to mixing with water. Measurement may be either by volume or weight. Before placing all lumps three-eighths (3/8) inch (1 centimeter) or over shall be removed by screening. Sand shall conform to the requirements of Subsection 706.03.03, "Fine Aggregate." An Air-Entraining Admixture shall be added to the Concrete Mortar at a rate of four to seven (4-7) percent.

Mesh reinforcing for ditch lining and slope paving reinforcement shall be of the sizes shown on the plans, fabricated of cold drawn steel wire and need not be galvanized. Mesh reinforcing shall conform to the requirements of ASTM A 185.

Header boards consisting of 2" x 4" (5 x 10 centimeters) redwood lumber furnished and placed in the concrete or mortar slope paving shall be as shown on the plans. Lumber used in the construction of header boards shall be commercial grade heart redwood, S4S.

Nails used in construction of header boards shall be commercial quality galvanized nails.

**CONSTRUCTION**

**611.03.01 EARTHWORK:** The subgrade for paved ditches and slope paving shall be formed by excavating to the required depth below the prepared finish surface grade in accordance with dimensions and design indicated on the plans or as directed by the Engineer.

The subgrade shall be thoroughly compacted. Any soft, spongy or other unsuitable material shall be removed to such depth as directed by the Engineer and backfilled with suitable material and thoroughly compacted. Water shall be sprinkled on the subgrade during compaction and the subgrade shall be sufficiently moist prior to placing concrete or mortar to prevent absorption.

**623 G.03.03 SAFETY PRECAUTIONS:** Before starting work on existing series street lighting circuits, the Contractor shall obtain daily a safety circuit clearance from the responsible local agency. By-pass shall be switched to the "off" position, fuses shall be removed, and signs posted at the switch box before any work is done.

**623 G.03.04 EXCAVATING AND BACKFILLING:** Excavations required for the installation of conduit, foundations and other facilities, shall be performed in such a manner as to cause the least possible damage to the streets, sidewalks, and other improvements. Excavations shall not be larger than necessary for the proper installation of conduit, electrical facilities and foundations. Excavating shall not be performed until immediately before installation of conduit, facilities, and foundations.

The material from the excavation shall be placed in a position where the least disruption and obstruction to vehicular and pedestrian traffic will be realized and the least interference with surface drainage will occur.

Surplus excavated material shall be removed and disposed of by the Contractor outside of the right-of-way.

At the end of each day's work, and at other times when construction operations are suspended, equipment and other obstructions shall be removed from the right-of-way.

Structural excavation and backfill shall conform to the requirements of Section 206, "Structure Excavation" and 207, "Structure Backfill."

Trench excavations shall be backfilled in conformance with the requirements of Section 208, "Trench Excavation and Backfill."

Backfilled excavations shall be kept well filled and maintained in a smooth and well-drained condition, until permanent resurfacing is completed as specified in Subsection 208.03.05, "Cutting and Restoring Street Surfacing."

Unless otherwise specified in the Special Provisions, excavation in the street and highway shall be performed in such a manner that not more than one lane of traffic is restricted in either direction at any time, unless otherwise approved by the Engineer.

All streets upon or within which any work is being done shall be kept open to all traffic by the Contractor, as specified in Subsection 104.04, "Maintenance of Traffic," unless otherwise provided in the Special Provisions, or as approved by the Engineer.

Barricading shall conform to the latest editions of the Traffic Control Plans for Highway Work Zones for the Clark County Area and the Manual On Uniform Traffic Control Devices.

**623 G.03.05 REMOVING AND REPLACING IMPROVEMENTS:** Improvements, such as sidewalks, curbs, gutters, Portland cement concrete and asphalt concrete pavement, bituminous surfacing, base material and other improvements removed, broken or damaged by the Contractor, shall be replaced or reconstructed in compliance with the applicable sections of these specifications.

Whenever a part of a square or slab of existing concrete sidewalk or driveway is broken or damaged, it shall be repaired in accordance with Subsection 202.03.02, "Removal of Structures and Obstructions."

The outline of all areas to be removed in Portland cement concrete sidewalks and in pavements shall be cut to a minimum depth of 1-1/2 inches (38 millimeters) with an abrasive type saw prior to removing the sidewalk and pavement material. Cut for the remainder of the required depth may be made by any method satisfactory to the Engineer. Cuts shall be neat and true with no shatter outside the removal area.

**623 G.03.06 FOUNDATIONS:** Foundations for posts, standards, and pedestals shall be concrete conforming to the applicable requirements of Section 501, "Portland Cement Concrete."



For posts, standards, and pedestals, a four (4) inches (100 millimeters) minimum [REDACTED] shall be poured after the post, standard, or pedestal is in proper position. [REDACTED] Arms shall be considered live load and may be mounted only after complying with Subsection 502.03.19. The exposed portions shall be formed to present a neat appearance. The bottom of concrete foundations shall rest on firm undisturbed ground. In addition, for traffic signal installations, the bottom two-thirds (2/3) minimum of the concrete foundation shall be poured against undisturbed soil. If signal foundation is to be placed in area which has been filled, fill shall meet compaction requirements as specified in the Standard Specifications or special provisions and bottom two thirds (2/3) minimum of the foundation shall be poured in drilled compacted fill and/or undisturbed soil.

Forms shall be true to line and grade. Tops of footings for posts and standards, except special foundations, shall be finished one (1) inch (25 millimeters) above grade of curb or sidewalk or as ordered by the Engineer.

Forms shall be rigid and securely braced in place. Conduit ends and anchor bolts shall be held in place by means of a template until the concrete sets. Both forms and ground which will be in contact with the concrete shall be thoroughly moistened before placing concrete. Forms shall not be removed until the concrete has thoroughly set.

Ordinary surface finish shall be applied to exposed surfaces of concrete. Where the edge of a concrete foundation extends within eighteen (18) inches (450 millimeters) of any existing concrete improvement, a slab with a minimum thickness of four (4) inches (100 millimeters) shall be extended to meet said existing improvement.

Concrete for Type XX poles and/or XX-A poles shall set for a minimum of ten (10) days unless otherwise approved by the Engineer. Concrete for smaller bases shall set for a minimum time of seventy-two (72) hours.

**623 G.03.07 WIRING:** Wiring shall conform to appropriate articles of the National Electrical Code. Wiring within cabinets, junction boxes, etc., shall be neatly arranged and laced. Powdered soapstone, talc, or other approved lubricant shall be used when installing conductors in conduit.

Each conductor shall have eighteen (18) inches (450 millimeters) of slack coiled within each standard and at least two feet (600 millimeters) of slack coiled in each pull box.

Series lighting cable shall be installed without splices from luminaire to luminaire and from service to luminaire unless otherwise specified. Multiple lighting conductors may be spliced in the base of standards or in pull boxes adjacent thereto. Signal cable shall run from terminal to terminal without splices unless otherwise indicated on the plans.

Conductors shall be joined by the use of a connector approved by the Engineer.

Conductor insulation shall be well penciled, trimmed to conical shape, and roughened before applying splice insulation. Splice insulation shall be designated by the Engineer.

When conductors and cables are pulled into the conduit, all ends of the conductors and cables shall be taped to exclude moisture. Ends of spare conductors shall be taped. When new conduit is installed for future use, it shall have a #8 green (stranded) pull which is secured at both ends.

The ends of all conduits shall be well reamed to remove burrs and rough edges. Field conduit cuts shall be made square and true so that the ends will butt or come together for the full circumference in the couplings or adapters. Slip joints or running threads shall not be permitted for coupling metal conduit.

When a standard coupling can not be used, an approved union coupling shall be used.

Couplings for steel conduit shall be tightened until the ends of the conduits are brought together, so that a good electrical connection will be made throughout the entire length of the conduit run.



Conduit ends shall be threaded and capped with standard pipe caps until wiring is started. When caps are removed, the threaded ends shall be provided with approved conduit bushings.

Manual or power-operated equipment normally used for cutting rigid steel conduit is acceptable for use in cutting P.V.C. coated rigid steel conduit. P.V.C. shall not be peeled back before cutting and all cuts shall be reamed. Threading shall be the same as for non-coated rigid conduit. All scarred and grip marked areas shall be touched up with approved heavy consistency coating compound.

For P.V.C. coated rigid steel, all couplings and threaded fittings shall be hand tightened before using a wrench. Use strap wrench for the final two turns only. All wrench marks and scores shall be recoated and joints must be sealed with heavy consistency P.V.C. compound. Ensure that the final installation does not have any exposed metal areas.

Conduits shall be bent, without crimping or flattening, and no single run shall include more than two 45 degree bends and two 90 degree bends without prior approval of the Engineer.

P.V.C. coated rigid steel conduit, 2 inches (51 millimeters) in diameter or larger, shall be used for all bends, except for 90 degree bends at street light pole foundations. Standard field bending techniques shall be used which typically uses a shoe one size larger to accommodate the larger pipe diameter. The minimum radius of the bend shall be 36 inches (914 millimeters) for P.V.C. coated rigid steel conduit.

Conduit shall be placed to a depth of not less than 24 inches (600 millimeters) below the finished grade in all areas with the following exceptions. Conduit may be laid on top of and secured to the existing pavement where such pavement is covered by a raised dividing strip having concrete curb. Conduit under railroad tracks shall be installed to railroad specifications. Conduit shall be placed under existing pavement by approved jacking or drilling method. Pavement shall not be disturbed without the approval of the Engineer, and then only in the event obstructions are encountered; however, upon approval of, or as required by the Engineer, small test holes may be cut into the pavement. Jacking or drilling pits shall be kept two (2) feet (600 millimeters) from the edge of any type of pavement whenever possible. Use of water which might undermine pavement, or soften subgrade, will not be permitted.

Conduit terminating in pedestals shall be a minimum of two (2) inches (50 millimeters) and a maximum of four (4) inches (100 millimeters) above the foundation and should be sloped toward the handhole opening.

Conduit shall enter concrete pull boxes from the bottom and shall terminate two (2) inches (50 millimeters) inside the box wall and not less than two (2) inches (50 millimeters) nor more than four (4) inches (100 millimeters) above the bottom, and shall be sloped to facilitate pulling of conductors. Conduit entering the bottom of a pull box shall be located near the end walls to leave the major portion of the box clear. At all outlets, conduit shall enter from the direction of the run.

Existing underground conduit to be incorporated into a new system shall be cleaned by blowing out with compressed air, or by other methods required by the Engineer.

Conduit runs shown on the plans are for bidding purposes only and may be changed with the approval of the Engineer to avoid underground obstructions.

**623 G.03.08 SERVICE:** Service points when required by the Contracting Agency for street lighting, traffic signals, etc. shall be as indicated on the drawings.

Since service points indicated by those other than the Contracting Agency may be subject to change (subdivision street lighting) the Contractor shall obtain the points of attachment from the serving utility company and shall be as close to the center of the circuit as possible.

Padmount service, when called for, shall conform to Uniform Standard Drawings, Clark County Area as applicable.

The Contractor shall furnish and install conduit and conductors to the service point as shown on the plans or as required to complete the installation.

No service point will be considered acceptable unless approved in writing by the serving utility company and the Contracting Agency Engineer or his designee.

## TRAFFIC SECTION

### MATERIAL

**623 T.02.01 CABINETS ENCLOSURE:** The type of cabinet to be furnished shall be a "TYPE VIII" cabinet, and shall conform to Drawing No. 404.307, sheet 1 of 1, in Volume II of the Uniform Standard Drawings, Clark County Area, Nevada. This is commonly referred to as an "R" cabinet. All external seams exposed to the outside shall be 100% welded (no gaps). The cabinet shall be painted with two coats white enamel both inside and outside, or polished aluminum, depending upon contract provisions. There shall be a minimum of 4 shelves provided with each cabinet.

All cabinets shall be provided as a complete unit to include all shelves, foundations, anchor bolts with template, a standard #2 lock, two (2) door stops, etc., and to be completely painted white inside and outside if required by the contract plans. The police panel shall be keyed with a standard police key lock.

All cabinets shall be weatherproof, properly ventilated, and have at least two (2), 110 CFM ventilation fans, with each fan having an independent thermostat. All cabinets shall have the door mounted with hinges welded to door and jamb. There shall be a standard multi-point door stop, along with a supplemental, single-arm door stop. The location of these will be at the top and bottom of the cabinet door, and they shall be fully retractable as not to interfere with the door's closing and opening operation.

Each cabinet must fit the anchor bolt locations and foundations as specified in Standard Drawing 404.213. This shall be accomplished without modification to the cabinet or foundation.

Cabinets shall have two (2) fluorescent fixtures and lights mounted in the cabinet interior. One mounted over the door, at a location least likely to be damaged. The length shall be determined by the cabinet width. The second, an 8 to 15 watt lamp, shall be attached to the bottom of the lowest shelf above the field terminals, yet it still must illuminate the back panel connection terminals. Both fixtures shall have an on-off switch which automatically illuminates the lights when the door is opened, and de-energizes them when the door is closed. The "Back Panel" in each cabinet shall be wired to the NEMA TS2 TYPE 2 standard inputs and outputs. There shall be standard NEMA "A," "B," & "C" connectors with all pins provided a termination point onto the back panel, including spares or unassigned pins. The terminals shall be clearly marked as to their associated function, with silk-screen or other approved method of marking.

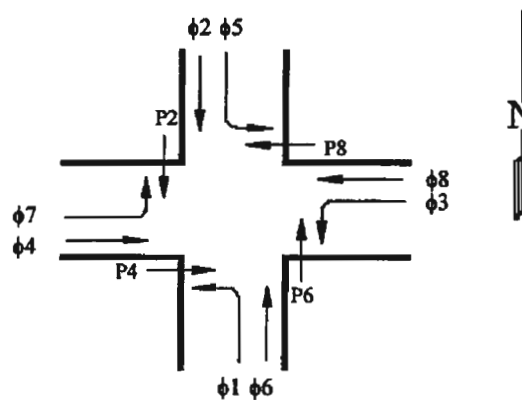
Only cabinets that are designed to use rails with infinite adjustability ('uni-strut' design) on the side of the cabinet that the shelves and panels are connected to will be accepted. These utilize "spring nuts" in the rail channel to tighten the bolts that are used. Cabinets that use carriage bolt assemblies are not acceptable.

When specified a rear access door shall be provided. Permanently affixed lifting eyes shall be provided.

- (a) All cabinet harnesses and wiring shall be neatly and firmly laced or bound together (with ty-rop or approved equivalent).

- (b) Every terminal shall be numbered and identified in accordance with the cabinet wiring diagrams and prints.
- (c) The cabinet shall contain a plastic envelope that can be sealed, which is attached to the cabinet door. This will be used to house wiring diagrams. The cabinet wiring diagrams shall show and identify the connectors for all equipment, switches, terminal blocks, relays, flashers and signal control bases. There shall be included three (3) complete sets of wiring diagrams on "D" size paper, along with a complete copy of the cabinet wiring diagram on a 3 1/2 " floppy disk drawn in Autocad LT95, Autocad Rev. 12, program or approved equivalent.

The cabinet wiring diagram shall have an intersection sketch with signal heads and push-buttons identified as related to phasing. A generic phasing layout similar to the following would be acceptable. The cabinet "controller" phasing shall be referenced as follows:



- (d) All mechanical relays shall have clear dust covers.
- (e) The following equipment shall be furnished and wired in all cabinets:
  - (1) Three (3), single-pole, surface-mount circuit breakers: One (1), 20-amp circuit breaker to operate all the electronic equipment, (e.g. controller, conflict monitor, detection equipment, and preemption equipment) and the upper utility plug.  
 One (1) 15-amp circuit breaker for the fan, light, and lower utility plug.  
 One (1) 60-amp circuit breaker to operate the other cabinet equipment, and to illuminate all the indications at the intersection external from the cabinet.

The circuit breakers must accommodate a #2 AWG stranded conductor which comes from the utility company's service meter. If not, the cabinet must have a supplemental terminal block that can accept this wiring requirement. This terminal block must be a Buss 16204-3, or approved equivalent.

- (2) There shall be a specific terminal, unfused, able to accept # 2 wire for the neutral wire of the power

- supply line. This terminal point shall be in the Buss 16204-3 terminal block, or approved equivalent.
- (3) There shall be a specific terminal, unfused, able to accept # 2 wire for the chassis ground wire of the power supply line. This terminal point shall be in the Buss 16204-3 terminal block, or approved equivalent.
  - (4) The terminal blocks for connecting the pedestrian and vehicle field wires which illuminate the independent signal heads shall be Thomas and Betts #35301, or approved equivalent. The mounting height to the bottom of these terminal blocks must be 14" from the bottom of the cabinet base.
  - (5) Terminal blocks Cinch 12-142 with Thomas and Betts chair lugs, or approved equivalent will be used for connection of pedestrian push button "field" conductors.
  - (6) Terminal blocks for all pins on the wiring harnesses on all connectors of the controller, conflict monitor, detection systems, and preemption systems must be provided separately. All connector pins shall be wired and terminated.
  - (7) A minimum of two (2), sixteen terminal, "Compression type" Copper Ground Strips, with one mounted and grounded to each side of the cabinet wall, for connection of all common conductors must be provided in the cabinet. These terminal strips will be connected to the terminal block that accepts the # 2 stranded wire for the neutral ground wire. These shall be mounted from 2" to 4" up from the bottom of the cabinet.
  - (8) Two compression-type mechanical ground strips shall be mounted on and grounded to the cabinet wall for connection of all mechanical grounds. One shall be mounted on the left and one on the right side of the cabinet 2" to 4" above the cabinet base, and they must be tied to the ground wire from the service point through the terminal block that is used to accept the #2 stranded wire.
  - (9) Two, dual-circuit, solid state NEMA jack-mounted flashers having a flash rate of 50 to 60 flashes per minute (see Section 8, SOLID STATE FLASHERS, of the 1983 TS1 NEMA specifications) will be installed.

Channel "A" on the first flasher is to be wired to flash phases 1 and 4, while channel "B" is wired to flash phases 5 and 8. Channel "A" on the second flasher shall be wired to flash phases 6 and 7, while channel "B" shall be wired to flash phases 2 and 3.

Overlaps driven flash is:

1A does phase 1, 4, & OLA  
1B does phase 5, 8, & OLB  
2B does phase 2, 3 & OLC  
2A does phase 7, 6 & OLD

The red transfer relays will be wired in such a manner that the field wire outputs shall be flashing

when the relays are de-energized. These transfer relays must be energized to operate the traffic signal with colors.

- (10) A single, duplex, "U" ground type of convenience outlet shall be furnished for tools and lighting. It shall have an integral ground fault protection device. This will be located on the door, or within the lower half of the cabinet. The power source for this outlet shall be the 15-amp circuit breaker.

A second, single, duplex, "U" ground type of convenience outlet shall be furnished for video equipment and other electronic test equipment. It shall not have an integral ground fault protection device. This will be located no more than a foot from the roof of the cabinet, on the right or left hand side. The power source for this outlet shall be the 20-amp circuit breaker.

- (11) Police Panel Switch: There shall be a double-pole, double-throw switch behind the police auxiliary door. This shall be identified "Auto/Flash." With the switch placed in the "Flash" position the switch shall be wired to:
- (a) de-energize signal light power and place the intersection to red flashing operation through the conflict monitor (see "d" below). The controller power, however, must remain energized.
  - (b) activate the "stop time" function within the controller. This will be accomplished through the Conflict Monitor (see "d" below).
  - (c) provide logic ground to inform the 2070N controller that the Police Flash Switch has been turned on to put on the traffic signal on flash, on pin "AA", Controller Plug "A".
  - (d) de-energize +24v II to the Conflict Monitor to cause it to fail, which, in turn, causes the Conflict Monitor to provide a logic ground to Controller Plug "A," Pin "n," and Stop Time to controller. This circuit must be diode-isolated.

When the police switch is placed back into the "Auto" position the intersection shall be transferred from red flashing operation to normal operation.

- (12) The following switches shall be installed on the interior of the cabinet. They must act in the specified manner:
- (a) "Controller Power" switch (identified "On-Off") wired to de-energize only the controller power when switched to the "off" position.
  - (b) "Tech Flash" switch (identified "Auto-Flash") shall be wired to de-energize signal light power feeding the load switches and transfer relays when the switch is placed in the "Flash" position. This switch shall cause the intersection signals to flash red, but must keep controller (and all other equipment) energized. Additionally, the controller shall NOT be activated to stop-time, while providing logic ground to inform the 2070N controller that the Tech Flash Switch has been put on flash (Controller Plug "A," Pin "AA"). When the Tech Flash switch is placed back into the "Auto" position the intersection shall be removed from Flash and return to normal operation.

- (c) "Stop Timing" switch (identified "On-Off") shall be wired to "stop time" ring 1 and ring 2 on the controller when switched to the "On" position.
- (d) "Interval Advance" switch, which must be a 'Momentary ON' switch, (identified "Interval Advance") shall be enabled by the "MCE" switch and wired to manually step the controller through intervals. The Interval Advance switch shall have a guard to keep from accidentally advancing the controller.
- (e) "Manual Control Enable" switch" (identified "MCE") shall be wired to enable "MCE" in the controller, while allowing the Interval Advance switch to operate.
- (f) "Pedestrian And Vehicle Test" switches (identified "On/Off/Test") shall be provided in each cabinet. These should be installed on a vehicle and pedestrian detector test panel located on the inside of the cabinet door. They shall be equipped according to contract provisions as follows:
  - (1) With toggle switches (on-off-momentary on) wired for permitting the introduction of manual calls into the controller for every possible vehicle and pedestrian detector input. Each toggle switch, in the up position, shall permit calls into the controller from the vehicle and pedestrian detection source. Each toggle switch, in the center position, shall disconnect the vehicle and pedestrian detection source and permit calls into the controller only via manual push down actuation. All possible vehicle and pedestrian detector circuits shall have a separate toggle switch. Toggle switches shall be provided for 8 vehicle and 8 pedestrian phases and wired independently to the terminal blocks.
  - (2) With toggle switches (on-off) wired for permitting the introduction of manual calls via a separate normally open push button switch into the controller for every possible vehicle and pedestrian detector input. Each toggle switch, in the up position, shall permit calls into the controller from the vehicle and pedestrian detection source, and permit calls into the controller via manually depressing the associated push button for the related phase. Each toggle switch, in the lower position, shall disconnect the vehicle and pedestrian detection source and the related push button. All possible vehicle and pedestrian detector circuits shall have a separate toggle and push button switch. These switches shall be for all 8 vehicle and all 8 pedestrian phases and wired independently to the terminal blocks.
  - (3) All switches and the "lower" convenience outlet may be combined on a single panel and mounted on the inside cabinet door behind the police auxiliary panel, if desired by the supplier.
- (g) Surge suppressors for electrical power shall be Model #HS-P-SP-120A-60A-RJ, and for telecommunications line protection shall be Model #MDF 6 95V, or MF 25 95V.

**623 T.02.02 CABINET EQUIPMENT:**

- (a) **Solid State Load Switches, Red Transfer Relays, and Sockets:** All necessary cabinet wiring, connecting cables, terminal blocks and sockets shall be provided for complete and proper functionality of a 8 vehicle, 4 pedestrian, and 4 overlap phase operation.  
A total of 16 NEMA load switches shall be provided with each cabinet. There will be two (2) discrete

NEMA flashers accompanying each cabinet. Refer to the 1983 Sections 5 and 8 of the NEMA standard publication for operational and dimensional requirements. It is mandatory that a wide angle, high intensity LED, clearly visible in sunlight shall be provided for each load switch and flasher indication.

A minimum of 6 transfer relays shall be delivered with each cabinet. These shall conform to the 1983 NEMA TS1 specifications. Load bay panels shall not exceed 0.125 inches (3 mm) of flex under 5 pounds pressure .

- (b) **Pedestrian Push Button Circuit Isolation:** To separate the pedestrian detector input circuits to the controller from the pedestrian push button circuits in the field, six solid state isolation circuits shall be provided in the cabinet. For four pedestrian movements; channels one, two , three, and four shall correlate to phase 2, 4, 6, and 8. Therefore, the wiring shall be appropriately terminated within the cabinet. Channels five and six shall be spares and be terminated to allow access from the front side of the detector panel.. The "field" push button circuits shall be energized by a 12 VAC source. The isolation circuits shall be mounted on an edge connector-type P.C. board with all required components; i.e., transformer, chips, etc. and shall display an LED indication showing status of field buttons.

- (c) **Video Detection:** All cabinets must be wired for Video Detection in the following manner. This is a requirement whether or not standard loop detection cables are installed into the cabinet.

Every cabinet shall have installed and wired into it a discrete "Video Detection Interface Panel" (VDIP). Phase 1 through 8, and overlap A, B, C, & D 24 VDC green and red outputs from the controller be must be wired to the VDIP, from the back panel. Also, vehicle and pedestrian phase "calls" 1 through 8 must have a termination point on the VDIP.

This VDIP shall be installed under the assumption that the wiring harnesses that accompany all Video Detection Systems will be connected to these independent termination points at some time.

This VDIP shall be installed at a location within the cabinet where the terminal blocks are easily accessible.

- (d) **Loop Detection:** When specified, the cabinet shall be wired for 24, single-channel loop amplifier wiring harnesses, 6, 4-channel loop amplifier wiring harnesses, or a multi-position "rack-mount" style detection system with the breakdown as follows:

(1) **For Single-Channel Detectors:**

There shall be two (2), single-channel loop amplifier wiring harnesses for each of the phases 1, 3, 5, and 7, for left turn operation. These harnesses and plugs conform to the TS-1 1983 specifications. These will be wired as presence loops, with each conductor independently terminated onto an individual terminal. The "Relay Common" ("B" pin) must terminate, then it must be wired to logic ground.

There shall be three (3), single-channel loop amplifier wiring harnesses for each of the phases 2, 4, 6, and 8, for thru traffic extension loop operation. These harnesses and plugs conform to the TS-1 1983 specifications. These will be wired as presence loops, with each conductor independently terminated onto an individual terminal. The "Relay Common" ("B" pin) must terminate, then it must wired to logic ground.

There shall be one (1), single-channel loop amplifier wiring harnesses for each of the phases 2, 4,

6, and 8, for thru-traffic "call loop" operation. These harnesses and plugs conform to the TS-1 1983 specifications. These will be wired not to output a call during the detected phase green service, with each conductor independently terminated onto an individual terminal. The "Relay Common" ("B" pin) must terminate independently, then it must then be wired to the red and yellow output from the controller (this must be diode isolated).

**(2) For Four-Channel Detectors:**

There shall be 6 complete wiring harnesses to match with the standard four channel detection unit for a total of 24 channels of detection specified in NEMA TS-1 standards, Section 11.2.28.2. These shall be wired to so the channel inputs of all channels are terminated directly to logic ground. The number of detection outputs per phase shall be as below:

4 outputs per each even phase (2, 4, 6, 8)  
2 outputs per each odd phase (1, 3, 5, 7)

**(3) For "Rack-Mounted" Detection:**

There shall be a Card rack installed with enough capacity to accommodate 24 separate detection channels. Contract provisions shall specify whether two-channel or four-channel rack-mounted detectors are to be utilized. The number of detection outputs per phase shall be as below:

4 outputs per each even phase (2, 4, 6, 8)  
2 outputs per each odd phase (1, 3, 5, 7)

All wiring harnesses, and rack positions must be clearly marked as to the appropriate phase to which it belongs.

The wiring harnesses shall be of sufficient length for them to reach the top-most shelf inside the cabinet.

- (e) **Optical Preemption Terminal Strip Panel:** Every cabinet supplied shall be wired with an "Optical Emergency Preemption Panel," and shall be marked accordingly. The panel shall have termination points for four preemption outputs directly wired to the discriminator. The M138 Emergency Preemption cable coming from the Optical Detectors shall be terminated to a terminal strip located on this panel.

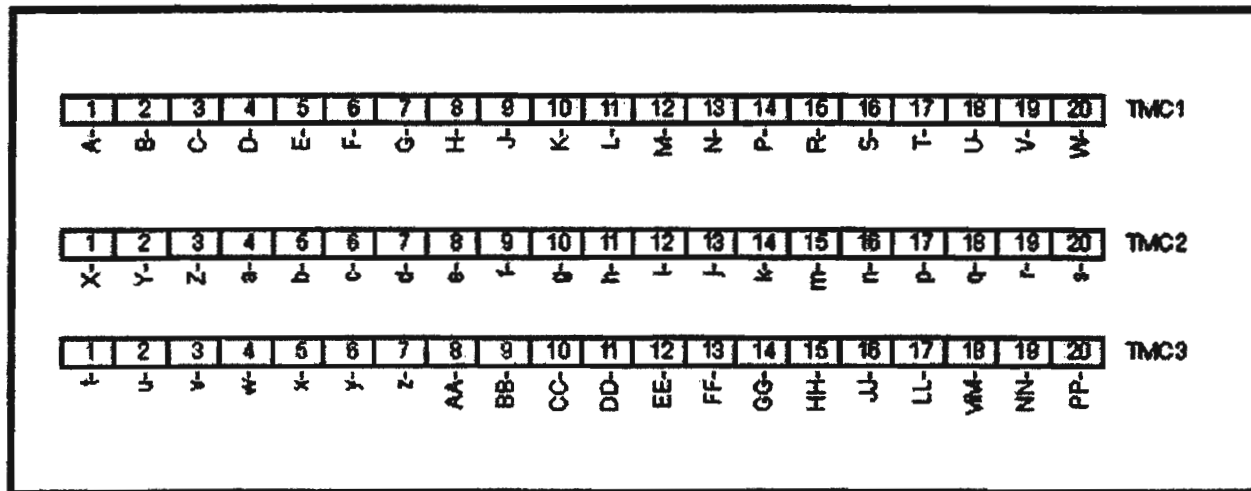
The wiring from this panel to the back panel shall be as follows:

Channel "A" to Controller Plug "A," Pin "q"  
Channel "B" to Controller Plug "A," Pin "y"  
Channel "C" to Controller Plug "B," Pin "W"  
Channel "D" to Controller Plug "B," Pin "X"

- (f) **Supplemental 2070N "D" Plug Interface Panel** (for additional information, see 623 T.02.03)  
Every cabinet shall have a "D" panel wired to which the wiring harness for the "D" plug for the controller will terminate. The plug used for the "D" plug on the 2070N controller shall be an MS3116-24-61S. The wiring from this plug's harness shall have independent termination points as shown on the



panel below. All wiring on this panel, except for the "D" plug connector wiring harness itself shall be performed by the Agency's staff after delivery and acceptance of the controller cabinet.



- (g) **Conflict Monitor Units:** The wiring harness that the conflict monitor plugs use shall have independent termination points. Each and every conductor shall be terminated independently onto a single terminal. There will be no conductors bound, hanging loose, or not terminated.

All conflict monitors shall be NEMA standard, meeting all requirements of section 6 of the 1983 TS1 specifications. In addition, all monitors shall be equipped with the features defined below:

All cabinets shall be equipped with a conflict monitor harness completely wired in the cabinet to a separate panel as shown above for twelve (12) channels of operation. Conflict monitors shall be provided in all cabinets supplied.

Minimum vehicle clearance time monitoring with a time value of 3.0 to 4.0 seconds (able to be selected on a per channel basis).

Separate indicators for activity on each of the red, amber, green and walk inputs of each monitor channel.

Front panel indicators showing active channel(s), date, time and description of the current status, while showing a log of six or more of the most recent failures. All such data shall be stored in a non-volatile memory.

Liquid crystal front panel displays shall be provided.

Failure status indicators for CVM, 24-1, 24-2, conflict, red failure, clearance failure, minimum green failure, dual indication, and program card insertion.

The monitor shall provide a front panel display of the approximate time and date of the occurrence of any power failure in excess of 500 milliseconds duration and the date and time of power restoration. The monitor program shall have computed and logged this data in non-volatile memory by the end of the power restart flash interval.

Front panel connectors "A" and "B" mounted directly to printed circuits will not be accepted.

For every integrated circuit custom-programmed device, or any sole source component, within the unit

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which is of such special design that replacement units would not be available from any local wholesale electronics distributors, one fully programmed duplicate of each IC/device contained therein shall be furnished directly for each conflict monitor delivered.

All conflict monitors shall have RS-232 capability. The vendor shall supply a software program which when run on an IBM compatible computer will communicate with the monitor unit for the downloading of failure event information and any other programmable event including timing, etc.

### 623 T.02.03 TRAFFIC SIGNAL CONTROLLERS:

#### (a) General

- (1) **Controller Assemblies.** A controller assembly shall consist of a complete mechanism for controlling the operation of a traffic control signal, including the controller unit and all necessary auxiliary equipment, mounted in a cabinet. All equipment required to provide the operation shown on the plans and specifications, shall be provided.
- (2) **Flashing Operations.** All controllers shall be equipped for flashing operation of signal lights. Flashing operations, when required by railroad preemption, flashing emergency traffic control, or other causes, shall be set for flashing red on all approaches unless otherwise specified.
- (3) **Wiring Diagrams.** A schematic diagram of the controllers and auxiliary equipment furnished under the contract shall be submitted at the time the controllers are delivered or, on demand of by the Engineer, prior to purchase. This diagram shall give in detail all circuits and parts, and such parts shown thereon shall be identified by name or number and in such manner as to be readily interpreted.
- (4) **Operating Voltage.** All equipment including interconnection facilities and excepting pedestrian push buttons and pressure detectors, shall be designed to operate on 120 volts, 60 Hz. AC. Operation shall be satisfactory at voltages from 105 to 130. The voltage for pedestrian push buttons shall not exceed 24 volts.
- (5) **Tests.** Prior to completion of the work, the Contractor shall cause the following tests to be made on all electrical circuits, in the presence of the Engineer:
  - (1) Test for continuity of each circuit
  - (2) Test for grounds in each circuit
  - (3) A megohmmeter test on each circuit between the circuit conductor and ground. The insulation resistance shall not be less than 150 megohms at 500 volts.
  - (4) A functional test in which it is demonstrated that each and every part of the system functions as specified or intended herein.

Any fault in any material or in any part of the installation revealed by these tests shall be replaced or repaired by the Contractor in a manner approved by the Engineer, and the same test shall be repeated until no fault appears. After testing of each traffic signal system, the system shall be activated and required to function without failure for a period of 14 calendar days. Any fault or failure to the system during this period shall be corrected by the Contractor at his own expense and the system will then be required to function for a period of 14 calendar days without failure. This procedure will continue until the system successfully operates continuously without failure for 14 calendar days.

- (6) **System Turn-On:** The Contractor must have approval of the date for turn-on, at least five (5)

working days prior, from the Traffic Engineer. Systems shall be permitted to be made operational at Agency's direction. Controller manuals shall be available to the Signal Maintenance Division at time of turn-on. The controller manufacturer shall provide a technical representative at the intersection during the turn-on and testing period to provide technical assistance.

The supplier shall provide a manufacturer's representative, with a minimum of an IMSA Level II, Traffic Signal Technician Certification at time of installation for on-street service of all equipment provided.

**(b) NEMA Controller Construction Specification.**

When a NEMA controller is supplied, it shall meet all requirements of the NEMA standards publication, TS2, Type 2 or later version as well as the following requirements:

- (1) Phase reversal shall be activated by applying a logic ground to controller connector "B."
  - Pin B shall reverse phase 1 & 2
  - Pin W shall reverse phase 3 & 4
  - Pin X shall reverse phase 5 & 6
  - Pin y shall reverse phase 7 & 8
- (2) Each controller unit shall be provided complete with all of the following components and timing features:
  - Four keyboard programmable overlaps
  - Three NEMA connectors "A", "B", "C"
  - Two DB25-RS232C ports on the front of each controller. One port shall be for communications and the second port shall be used for occasional connection to a portable computer having priority over port one.

Each controller will be menu driven, with keyboard programming for listing program, status, utilities, and special options. Being able to move between programs, menus, and/or sub-menus and having the ability to copy timing data from one phase to another. The controller shall be able to dim phase outputs by phase or individual phase color. Readout on the display to be visible in bright sunlight or in the dark with back lighting.

The equipment housing shall be a completely enclosed painted metal fabrication that is easily removed and replaced. The design shall include vent holes. The unit shall consist of a frame and mother board, with separate printed circuit modules (CPU, Memory, I/O, etc.) which will facilitate simple and rapid maintenance. The connectors for interfacing with the controller shall be part of the input/output module and are to be located on the front of the unit for ease of access.

The circuit components shall be standard production types that are readily available from any industrial electronics supply house. All components mounted to the circuit boards shall have their circuit reference symbol clearly marked on the board and be identifiable by referencing to the pictorial assembly drawings.

The power supply shall be self contained in a separate and removable module.

The circuit component design life under continuous duty operation shall not be less than 10 years.

All programmed timing and operational parameters shall be retained within electrically erasable and programmable read only memories (EEPROM'S) or equivalent. No batteries for any such backup systems will be acceptable, except as necessary to maintain TOD clock time-keeping during power

failure.

- (3) A complete operations and repair manual shall be supplied with each controller unit. Each manual shall completely describe all features, keystroke sequences, etc. as necessary to activate all functions provided in the controller. Complete schematic diagrams by circuit function, and separate diagrams by module. Complete block diagrams of equipment circuits, and complete parts listing. Detailed circuit-by-circuit description of the operation that follows component-by-component with the schematic diagram or block by block with the logic diagram. This requirement may be waived at the discretion of the purchasing Agency.
- (4) It shall be possible to perform a series of diagnostic tests of the system, which shall include the following:
  - Wrap around Input/output check of connectors A, B and C.
  - Wrap around Input/output check of communications and printer ports.
  - RAM memory check.
  - EEPROM check.

Where special test connectors are required, 2 complete sets of connectors shall be provided per bid order.

- (5) The vendor shall supply a software program to the Agency which when run on an IBM compatible PC connected to the controller will demonstrate to the Agency the controller's communications with respect to baud rates, uploads, downloads, monitoring and activity logging.
- (6) All requisite hardware and software shall be provided fully installed and complete in order to provide the uploading, downloading, monitoring and logging functions required.
- (7) **Double Clearance Overlaps:** The four NEMA required overlap outputs ("A", "B", "C" and "D") shall provide timed double clearance operation. The settings for this type of operation shall include the ability to select which phases and other overlaps may start timing, or commence the display of their green indications, respectively, during the double clearance timer intervals after the terminating parent phase has completed its all red. It shall also be possible to program which phases "on's" and which phases "next's" concurrent output shall cause the double clearance green (lag green interval) to be skipped. It shall be possible to specifically program for each overlap:
  - Compatible phases
  - Conflicting phase

This will allow the overlap to go red during the timing of a phase conflicting with the overlap in one ring even though the overlap movement is compatible with a phase timing concurrently in the other ring.

Independent amber and all red clearance timers shall be provided for each overlap of which shall always operate during an overlap clearance. Output suppression of all drivers during the green (only), or green and amber displays of designated phases for use with "Illinois type" right turn overlap or "Florida style" left turn signal indications, respectively. When such operation is selected, the otherwise unused red of the odd phase load switch drivers shall output a "not red" indication for use in red monitor failure prevention.

Each controller shall also internally provide the option to program each of all load switch driver outputs other than overlaps A through D as an overlap of any or all of the timing phases. This shall be true of the red, yellow, and green outputs of phases 1 - 8, outputs and any or all of the eight unused walk, steady ped clear, and flashing ped clear outputs.

- (8) **Power Up Phase and Interval Sequence:** The controller start up point shall be programmable to

be either the start of green or the start of amber of any legal phase combination.

- (9) **Scheduled Flash:** The scheduled flash shall be generated internal to the controller, and blink the load switch driver inputs independently of the cabinet (conflict monitor) flash circuitry. It shall be possible to program the following parameters:

Last phases before scheduled flash begins, along with the first phases after scheduled flash ends.

The monitor's red enable function shall be active whenever the signal bus is energized, including periods of controller load switch flash. During a scheduled flash all pedestrian outputs shall remain dark as stated in MUTCD. Scheduled flash may be provided as a form of internal controller preemption, callable for the internal time base coordination schedule, as well as by activation of NEMA test input "A". It shall be possible to specify in every other internal preempt program provided whether or not a call for that preempt overrides scheduled flash operation.

- (10) **Primary Phase Assignments:** It shall be possible to program each detector input for phase assignment and as to whether the input places:
- (a) no call
  - (b) call only
  - (c) extension only
  - (d) both call and extension for each phase
  - (e) Upon bulk initialization detector inputs 1 - 8 shall default to the conventional NEMA one to one detector input number to phase number correspondence, placing both call and extensions on those phases. The inputs shall be routed according to these phase assignments provided that the conditions for detector switching are not true.
- (11) **Alternate Phase Assignments:** It shall be possible to program each detector input for phase assignment and as to whether the input places:
- (a) no call
  - (b) call only
  - (c) extension only
  - (d) both call and extension for each phase
  - (e) Upon bulk initialization, detector inputs 1 - 8 shall default to the conventional NEMA one to one detector input number to phase number correspondence, placing both call and extensions on those phases. The inputs shall be routed according to these phase assignments provided that the conditions for detector switching are not true.
- (12) **Detector Switching:** It shall be possible to program the conditions under which each detector input shall switch to the alternate phases assignments. The conditions for each input shall be defined by the condition of phases 1-8 as to whether each phases, (0) not applicable, (1) has a call, (2) is "on".
- (13) **Recall Mode:** Each phase shall be programmable as to (code definitions shall be displayed with each entry screen) the type of recall mode required as listed below:
- (a) Memory off
  - (b) Memory on
  - (c) Minimum recall
  - (d) Maximum recall
  - (e) Minimum and pedestrian recall
  - (f) Maximum and pedestrian recall
  - (g) Non-Actuated

- (h) Omit
- (i) Soft recall or No rest w/detector memory off
- (j) Soft recall or No rest w/detector memory on
- (14) **Max Mode:** Each phase shall be programmable as to (code definitions shall be displayed with each entry screen) the maximum green value required as listed below:
  - (a) Max inhibit (code only assignable for background cycle operation)
  - (b) Max I
  - (c) Max II
- (15) **"No Skip" Phases:** Note that it shall be possible to condition this function to be specific to only those other phases specifically selected (i.e., "Phases always preceded by this one", and "phases always followed by this one").
- (16) Red rest.
- (17) Conditional re-service/service phases, and phases to be either omitted or serviced twice-per-cycle during timing plans called up at certain times of day.
- (18) **Actuated Rest In Walk Operation Phases:** When active, such phase shall rest at the end of its "WALK" interval in the absence of any serviceable opposing call, and shall proceed to time the pedestrian clearance interval as soon as any such opposing call is received and becomes serviceable. The phase shall revert to the beginning of, and proceed to retime the "WALK" interval immediately whenever all opposing calls are lost, so long as the phase remains green and is not under pedestrian omit, whether or not the pedestrian clearance has completed timing.
- (19) **Last Car Passage Phases:** The last car passage and subsequent rest intervals shall not be reset or extended by additional vehicle actuations except in dual ring applications where simultaneous gap is also active and the other ring has not yet reached last car passage or rest.
- (20) Inhibit gap reset after timeout phases (non-simultaneous gap termination).
- (21) **Preemption:** The software shall provide a minimum of handling six unique preempt sequences, and shall operate similarly and provide for transitional timing and signal display to a programmed preempt condition and exit transition timing and display to a programmed return to normal condition. Preempt input priority and the lower four inputs served on a first come first-served basis.
- (22) **Coordination:** The software shall provide a minimum of : Four cycle lengths, Three offsets per cycle, Four splits per cycle, Manual control, Free control and standard interconnect operation.
- (23) **Features Associated With The Internal Time Clock Setting Time/Date:** The internal clock shall be accurately programmable to the second. At the time the clock is updated by the user, all internal commands, coordination patterns and offsets shall also be automatically updated.

**MANUAL COMMAND** - It shall be possible to manually activate the pattern, offset, the system command type.

**DAYLIGHT SAVINGS CORRECTION** - Provisions shall be made for automatic clock correction for the start and end of daylight savings time (DST), including the ability to revise the month and week of month (1-last) of which DST starts and ends from the keyboard Sync Pulse Reference Time (Hour/Minute) - This sync pulse shall be calculated from this point in time. The internal time base clock shall contain at least 50 event command entries which shall be displayed in chronological order but need not be entered in that order.

**DAY SCHEDULE** - The programming of the internal time base coordination event clock shall be of the type in which any event instruction may be directly associated with one or more days of the week or holiday, and not of the type in which day program schedules must be first programmed, and then associated with the calendar days to which they apply. It shall be possible to program any or all of days 0 through 9 for each TOD command with the following association of each number as defined below:

- (1) 0 = Special day program
- (2) 1 = Sunday
- (3) 2 = Monday
- (4) 3 = Tuesday
- (5) 4 = Wednesday
- (6) 5 = Thursday
- (7) 6 = Friday
- (8) 7 = Saturday
- (9) 8 = Special day program
- (10) 9 = Special day program

**(c) 2070N Controller Construction Specification.**

When a 2070N controller is supplied, the following requirements are mandated:

- (1) The 2070N controllers supplied shall conform to the latest published revision of the California Department of Transportation (CALTRANS), Transportation Electrical Equipment Specifications (TEES) requirements, published at time of bid. The following configuration will apply to any controller supplied:
- (2) A 2070-7 "ASYNC SERIAL COMM MODULE" shall be supplied and installed in each controller. The communications interface connection cable incorporated with the 2070-8 shall be supplied with connector DB-9S to mate with the 2070-7 module.
- (3) A communications modem shall be supplied per LVACTS system requirements. The modem shall be delivered complete with the power cord and a five (5) foot DB25 to DB25 RS232 cable for connection of the EX2 connector on the 2070-8 to the DTE connector on the modem.
- (4) The controller that is provided shall be configured with a short power outage tolerance of at least 400 milliseconds without causing a CPU reset, and a minimum of 4 MB of DRAM memory, 4 MB of FLASH memory, and 512 KB of SRAM.
- (5) Except when waived by the purchasing agency, the proposed supplier or apparent low bidder shall furnish a complete and fully operational 2070-N, along with the associated communications equipment, within 2 weeks of bid opening, but prior to contract award. This unit will be returned to the supplier/bidder following the demonstration test and functional assessment. Contract awards shall be contingent upon obtaining agency approval on all proposed equipment submitted for evaluation, including any proposed "approved equivalents" of supplied equipment.
- (6) The "A," "B," "C," and "D" plugs shall be installed on the front of the controller with the identification letters for the Cannon plugs right-side up. The master key shall be located at the top of the plug, not the bottom.
- (7) The evaluation by the potential purchasing agency will include, but not be limited to:

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- (a) proper implementation of all TEES, and the above, specifications.
  - (b) monitoring the operation in a test cabinet environment.
  - (c) confirming that the LCD display and the display cover shall be environmentally sealed to keep dust and other particles from entering between them.
  - (d) verifying operation with short power outages, and momentary surges.
  - (e) verifying operation with the following provisions of software operation and compatibility.
- (8) All 2070N controller units must be compatible and function properly with the latest revision of the Next Phase Intersection Management Software developed by Gardner Transportation Systems.
- (9) All 2070N controller units must be compatible and function properly with the ICONS communication package developed by Gardner Transportation System for the LVACTS Traffic Signal System, and shall be complete with all requisite hardware, cables, connectors, and related firmware for connection to, and communication with the ICONS central software.



Tests	Test Method	Requirements
Sieve Analysis .....	AASHTO T 27	Above
Sampling Aggregate .....	ASTM D 75	-----
Soundness (5 Alternations) .....	AASHTO T 104	10% Maximum Loss
(sodium sulphate)		
Clay Lumps .....	AASHTO T 112	1.0% Maximum
Lightweight Pieces In Aggregate ....	AASHTO T 113	1.0% Maximum
(Less than 2.0 sp. gr.)		
Organic Impurities .....	ASTM C 40	Satisfactory (a)
Mortar Making Properties .....	ASTM C 87	95% Minimum (b)

- (a) Aggregates tested and showing color darker than the standard shall be rejected unless they pass the "Mortar Making Properties" test (ASTM D 87).
- (b) Fine aggregate failing in the test for organic impurities (ASTM C 40) may be used provided that when tested for effect of organic impurities on strength of mortar, the relative strength of 7 and 28 days calculated in accordance with (ASTM C 87) is not less than 95%.

**706.03.04 GROUT AND MORTAR SAND:** This aggregate shall conform to the following requirements:

Sand for grout and mortar shall conform to the size requirements of 706.03.03, "Fine Aggregate," except if the Contractor elects, he may screen the sand over a No. 8 screen to produce the following:

Sieve Sizes	Percentage By Weight Passing Sieve
No. 8 .....	100
No. 50 .....	15-40
No. 100 .....	0-10
No. 200 .....	0-5

Tests	Test Method	Requirements
Sieve Analysis .....	AASHTO T 27	Above
Sampling Aggregate .....	ASTM D 75	-----
Organic Impurities .....	ASTM C 40	Satisfactory (a)
Mortar Making Properties ....	ASTM C 87	95% Minimum (b)

- (a) Aggregates tested and showing color darker than the standard shall be rejected unless they pass the mortar making properties test (ASTM D 87).
- (b) Fine aggregate failing in the test for organic impurities (ASTM C 40) may be used provided that when tested for effect of organic impurities on strength of mortar, the relative strength at 7 and 28 days calculated in accordance with (ASTM C 87) is not less than 95%.

**706.03.05 STONE FOR MASONRY AND RIPRAP:** This stone shall conform to the following requirements:

Source Requirements Tests	Test Method	Requirements
Percentage of Wear (500 Rev.) . . . .	ASTM C 131	45% Maximum
Bulk Specific Gravity . . . . .	ASTM C 127	2.50 Minimum

**706.03.06 RIPRAP GROUT:** The mix design for the placing requirements addresses two placement methods: (1) direct discharge from the transit mixer and (2) placement by small diameter line pumping methods.

Two typical mixtures that would meet the aforementioned minimum requirements are as follows:

**Table 1 Proportions for 1.0 Cubic Yard of Grout**

	Pump Method	Transit Mixer Discharge
	Approx. Volume (Cu. Ft.)	Approx. Volume (Cu. Ft.)
Pea Gravel	3.5	7.6
Washed Concrete Sand	10.6	7.6
Water	6.5	5.9
Type V cement	3.5	3.1
Fly Ash class F	1.6	1.4
Balance Air		

Factors which should be considered for a given grout mix are:

- (a) Fine and coarse aggregates,
- (b) Consistency,
- (c) Elapse time between placement and initial set and
- (d) Length of time between batching and placement during which continuous or intermittent mixing is required.

Materials used in the production of riprap grout should meet the minimum following material standards:

Fine and Coarse Aggregate ASTM C33\* (Section 206)  
 Portland Cement ASTM C150. Type V (Section 701)  
 Fly Ash ASTM C618\* (Section 729)  
 Water (Section 722)  
 Air Entraining Admixture ASTM C260\*

A trial batch shall be placed for review by the Engineer for final approval for the project.  
The Engineer shall be provided with a legible ticket with each load of grout delivered to the contract which shall contain the following information:

Name of Vendor  
Name of Contractor  
Number of Cubic Yards in the Load  
Actual Weights of Cement and of each Size of Aggregate  
Amount of Water Added at the Plant  
Amount of Water in the Aggregate  
Brand and Type of Cement  
Brand and Amount of Admixture  
Time and Date of Batching

**SECTION 707****JOINT MATERIAL****SCOPE**

**707.01.01 MATERIAL COVERED:** This specification covers the quality requirements for poured filler, preformed fillers, and resilient and rubber type gaskets used in the construction of bridges, culverts, sidewalks, etc.

**707.02.01 BLANK:**

**PHYSICAL PROPERTIES AND TESTS**

**707.03.01 JOINT FILLERS:** Preformed fillers for joints shall conform to the requirements of AASHTO M 213, or ASTM D 1751, Fiber Type, and shall be punched or drilled to admit the dowels where called for on the plans. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint unless otherwise specified by the Engineer. When the use of more than one piece is authorized for a joint, the abutting ends shall be fastened securely and held in place, by stapling or other positive fastening satisfactory to the Engineer.

**707.03.02 RUBBER GASKETS:** The ring gaskets shall conform to the requirements of AASHTO M 198.

**707.03.03 WATERSTOPS:** Waterstops shall conform to the following requirements:

(a) **Natural Rubber.**

<b>Test</b>	<b>Test Method</b>	<b>Requirements</b>
Tension Testing of Vulcanized Rubber	ASTM D 412	Tensile strength 3,500 lbs. min. psi (24.1 Mpa) - Elongation at breaking of 550 percent. Unit stress (300 percent) 1,100 lbs. psi min. (7.6 MPa). Unit stress (500 percent) 2,800 lbs. psi Min. (19.3 MPa).
Test for Accelerated aging of Vulcanized Rubber by the Oxygen Pressure Method	ASTM D 572	After 7 days in air at 158 degrees (plus or minus 2 degrees) Fahrenheit (70 degrees (plus or minus 1 degree) Celsius) or after 48 hours in oxygen at 158 degrees (plus or minus 2 degrees) Fahrenheit (70 degrees (plus or minus 1 degree) Celsius) and 300 lbs. psi (2.07 MPa), the tensile strength and elongation shall not be less than 65 percent of the original.

