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SECTION 86: SIGNALS, LIGHTING AND ELECTRICAL SYSTEMS

86-1.01 GENERAL

Signals, lighting, electrical systems shall be constructed/installed in accordance with the following standards listed in priority - the approved improvement plans and specifications, these Construction Standards and the City Design Standards, The California Manual on Uniform Traffic Control Devices (CAMUTCD), The State of California Standard Plans, and the latest edition of The State of California Department of Transportation Standard Specifications hereinafter referred to as the CalTrans Standard Specs. Note that the more recent of either the City of Roseville Construction or Design Standards shall govern the older of the two.

Signal phasing shall start with phase 2 northbound and proceed in a clockwise direction unless directed otherwise due to coordinated corridor restrictions.

A copy of the Traffic Signal Inspection Check List is included on TS-22 as a reference of required inspections during construction.

Temporary signals require design submittal from a registered PE or TE.

86-1.04.1 EQUIPMENT LIST AND DRAWINGS

The City shall provide, as discussed in these Standards, the following traffic signal equipment and materials listed below unless otherwise specified in the plans. (For signals being installed as a developer obligation, the City shall supply equipment as outlined in the City Standards at the developer's cost. Full payment is required prior to the release of the equipment. The Contractor shall identify the cost of the City furnished equipment as a bid item):

Upon 10 calendar day notice to the City's Construction Inspector, the equipment and materials to be provided by the City will be available for pick-up by the Contractor at the City's Corporation Yard located at 2005 Hilltop Circle, Roseville. The Contractor shall provide all labor and equipment necessary to load, transport, and install the City-provided equipment and materials.

Traffic signal standards, posts, and mast arms shall be of the types listed in Table 6-1.

Table 86-1: Traffic Signal Standards, Posts and Mast Arms

STANDARD/POST	MAST ARM	LUMINAIRE ARM
Ped. Push Button (2.5")	none	none
7 to 15 foot 1-B	none	none
Type 15	none	6-15 foot
Type 15TS (7.2' foundation)	none	6-15 foot
16-3-100	15-20 foot	none
17-3-100	15-20 foot	6-15 foot
18-4-100	25-30 foot	none
19-4-100	25-30 foot	6-15 foot
23-4-100	35 foot	none
24-4-100	35 foot	6-15 foot
26-4-100	40-45 foot	6-15 foot
27-4-100	40-45 foot	none
28-5-100	50-55 foot	none
29-5-100	50-55 foot	6-15 foot
60-5-100	60-65 foot	none
61-5-100	60-65 foot	6-15 foot

The typical luminaire arm length used is 15 feet. Signal mast arms and luminaire mast arms shall be within 2 degrees of perpendicular to the centerline of the roadway. The Type 15TS pole above shall be used in conjunction with IISNS installations. Manufactured date of signal lighting luminaires shall be within 12 months of beginning traffic signal construction.

1B poles for 4 section and 5 section heads shall be 13 feet and 14 feet tall respectively.

Poles (except 1B's) shall be permanently labeled with the pole size, manufacturer, and serial number below or above the handhole. Signal pole and arm welding shall be performed by individuals certified by the pole manufacturer and shall not limit the original manufacturer warranty.

86-1.06 MAINTAINING EXISTING & TEMPORARY ELECTRICAL SYSTEMS

Roadway closures requiring restrictions of turning movements and/or signal red flash operations shall be in accordance with Section 12 of these Construction Standards.

86-2.03 FOUNDATIONS

Placement (location) of all foundations shall be verified by the Traffic Engineer, Development Services Inspector and Signal Tech prior to installation (TS-22).

There shall be a minimum 6 inch high curb around the signal controller/service pad, excluding the sidewalk/roadway side of the pad. The minimum curb height shall increase as necessary to ensure no steeper than a 2:1 slope of the native material around the pad. Masonry blocks (not gravity type blocks) may be utilized to achieve the required 2:1 slope. The Contractor shall be responsible for acquiring engineering for retaining walls if the wall is greater than 4 feet from base of footing to top of wall. Refer to TS-4 through TS-8 for further details.

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Signal pole anchor bolts shall be aligned to ensure a maximum mast arm offset of 2 degrees from perpendicular to the roadway and shall be verified by the Traffic Engineer, Development Services Inspector and Signal Tech prior to concrete (TS-22).

Unless otherwise directed by the Inspector or Engineer, the Contractor is not required to place Inspection tubes in the foundations per Caltrans Standard Plan ES-7N.

86-2.04 STANDARD, STEEL PEDESTAL AND POST

Any 1B standard having a signal head display, 4 sections or larger, shall be installed under the following criteria:

1. 4 section displays will be side (SV-1-T or SV-2-T) mounted. The 1B standard shall be 13 feet in height. A PVC cap shall be provided as a pole cap. Special mounting instructions as described in these Standards shall apply. (See Section 86-4.06).
2. 5 section display shall be side (SV-1-T or SV-2-T) mounted. The 1B standard shall be 14 feet in height. A PVC cap shall be provided as a pole cap. Special mounting instructions as described in these Standards shall apply. (See Section 86-4.06).
3. Individuals certified by the pole manufacturer shall perform signal standard welding. The contractor shall give 7 days advance notification prior to any welding on existing poles installed in the public right-of-way. The contractor shall certify that any welding of signal standards will not degrade the integrity of the standards. Upon completion of welding on a signal mast arm, the contractor shall replace any existing electrical wires in the arm.
4. All future tenons shall be covered with a plastic cap and a pull wire shall be installed from the tenon to the side vehicle termination.

Internally Illuminated Street Name Sign (IISNS) Mast Arms shall be per TS-11 and TS-12. The loading of the mast arms and the signal pole to which the sign mast arm is attached shall be approved in writing by the manufacturer or a licensed Structural Engineer.

86-2.05A CONDUIT MATERIAL

All conduits shall be gray PVC, minimum Schedule 40. When directional boring has been approved, the use of Schedule 80 HDPE conduit that complies with the UL65IA listing may be used.

86-2.05B CONDUIT USE

All conduits shall be 2 inch to 3 inch in diameter except the run to the pedestrian push button posts shall be 1 inch.

86-2.05C CONDUIT INSTALLATION

All trenches in existing streets shall be constructed per Section 31-2 of these Standards and as required in this section. See TS-13 for trench details.

All new conduit placed in existing roadways shall be buried at a minimum depth of 18 inches below finished grade. All new conduit placed in new roadways shall be installed prior to any paving operations and be buried at a minimum of 18 inches below finished subgrade with the

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exception of conduit between detector handholes and the first pull box which shall be buried a minimum of 18 inches below finished grade. New conduit installed outside of the roadway and sidewalk shall be installed at a minimum depth of 36 inches below finished grade. All new and existing (empty) conduit that is 2" and larger to be cleaned and inspected via mandrel.

Unless otherwise specified, all signal interconnect (SIC) conduit shall be: 2 inch to 3 inch schedule 40 gray PVC conduit with 3 foot radius 90 degree sweeps into each number 6 pull box.

All traffic signal and SIC conduit shall have a DLC taped with a 5 inch green band labeled "LOCATE" in each pull box or approved equivalent pull tape installed along with the conductors/fibers.

End bells shall be installed on the pull box end of each 90 degree sweep conduit into all pull boxes prior to pulling the wire.


After conductors have been installed, the ends of conduits terminating in pull boxes and controller cabinets shall be sealed with a duct seal type of sealing compound.

If delay to motorists will not exceed 10 minutes, conduit may be installed as allowed by "Trenching In Pavement Method" as provided in Section 86-2.05C of the CalTrans Standard Specifications and these requirements:

1. The trench shall be maximum 6 inches wide and 2 inches wider than the outside diameter of the conduit to be installed. There shall be 1 inch minimum clearance between the conduit and the trench wall. The trench shall be crumbed clean prior to placement of conduit.
2. Aggregate material in concrete shall be pea gravel. Concrete shall be thoroughly consolidated around the conduit filling all voids.
3. Rock wheel trenching shall not be allowed in Portland cement concrete roadways. Rock wheel trenching per detail TS-13 and conduit installation in new and existing AC roadways shall be located along the centerline of the bike lane stripe or stop bar/crosswalk striping whenever possible. The trench cut will be hidden by the thermoplastic stripe where applicable. Pre-existing improvements requiring deviation from the centerline of the stripe shall be accomplished within 20 feet from the beginning to the end of deviation. Deviations along bike lane lines shall be to the curb side of the stripe unless directed otherwise by the City. Deviations greater than 20 feet shall require pavement repair per Item 4 below:
4. Rock wheel trenching parallel to the roadway centerline across acceleration, deceleration, or bus turn out openings that cannot be completed per TS-13 upon the same day shall be filled with concrete to the top of the trench and the Contractor shall return to complete per Detail TB-3.
5. Saw cutting in the street other than rock wheel trenching will require pavement repair per TB-1 or TB-3 and/or grinding between lane lines per City Standards (71-2,C).
6. Should the contractor fail to install the conduits in new asphalt concrete roadways prior to the

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bottom lift of asphalt concrete, the City will require the installation of Tensar GlasGrid 8502 or equivalent matt prior to the final lift of pavement.

7. Should the contractor fail to install the conduits in new Portland cement concrete roadways prior to the placement of concrete, the City will require the conduits be installed by horizontal direction drilling or the contractor shall place the conduit per TB-1 or TB-3a. 

The contractor is solely responsible to provide all labor and equipment necessary to locate existing underground facilities beyond the information provided by the U.S.A. markings including, but not limited to, metal detectors, wire locating equipment, and potholing.

86-2.06 PULL BOXES

Pull boxes shall not be placed within the area of an access ramp or driveway unless directed by the Engineer. Pull boxes should be installed a minimum offset of 1 foot from back of walk when within the sidewalk and from any score or deep tool joint. The bottoms of pull boxes shall be bedded in 6 inches of clean crushed rock. Grout in the bottom of pull boxes is not required. The pull box rim and lid shall be flush with surrounding surface. In planter areas, the pull box rim and lid shall be 1 inch above the finish grade. Pull boxes located outside of the sidewalk or planter area behind a sidewalk shall be of the Caltrans traffic rated pull box design.

Conduit termination in the pull box shall be a minimum of 2 inches from the sides of the pull box, 2 inches above the crushed rock, and at least 8 inches below the bottom of the pull box cover. Conduits shall enter and exit pull box quadrants relative to the direction of the run.

All pull boxes and lids shall be Fiberlyte FL36 with penta head bolts unless otherwise directed by the Engineer.

All pull boxes shall be No. 6 except as modified by the plans or the provisions below:

1. Advance loop pull boxes shall be No. 6 and shall have a minimum of 20 feet of detector lead-in cable (DLC) and 20 feet of extra loop cable spooled in the pull box.
2. The “Home Run” and “Communication Home Run” pull boxes (typically adjacent to the controller) shall be No 6, Fiberlyte FL36 24 inch deep vaults (02006110). Detector loop splicing is not allowed in the “Home Run” pull boxes.
3. Fiberlyte FL36 24 inch deep vaults shall be installed at the fiber hub locations as designated by the City and at every fiber optic cable splice point.

All pull boxes to be abandoned shall have conductors removed from the pull boxes and conduits and the pull box shall be removed. The remaining hole shall be backfilled and compacted with similar material as the surrounding material. If within a sidewalk, the entire square of sidewalk shall be removed and replaced.

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86-2.06B COVER MARKING

Pull box covers shall read “TRAFFIC SIGNAL” (02006400), except covers for pull boxes used solely for traffic signal interconnect. Should the signal interconnect pull box or vault contain any communication cable, the cover shall read “TRAFFIC SIGNAL FIBER OPTICS” instead.

86-2.08 CONDUCTORS

Conductor installation in new conduits shall be limited to 26 percent fill of the conduit maximum. Conductors installed in existing conduits shall be limited to 40 percent fill of the conduit maximum.

A DLC taped with a 5 inch green band and labeled with “LOCATE” in each pull box or approved equivalent pull tape shall be installed in all conduits.

Equipment grounding conductors shall be #6 stranded copper with insulation.

At new and remodeled traffic signals, a 3 inch, two cell “MAX CELL” or equivalent product shall be provided in all street crossing traffic signal conduits and from #1 Home run box to controller cabinet and must be installed using swivels.

Three (3) shielded OSP category 6E cables (from the City approved equipment list), or City approved equivalent, and one (1) power cable (IMSA 14-3/20-1-STR 600V, Belden part number 601195) or City approved equivalent to top of designated pole with 10 feet of slack for each cable at the top of the pole and 40 feet of slack in the pull box adjacent to the pole and 60 feet of slack in the pull box adjacent to the pole.

In order to reduce strain on the shielded OSP CAT6E cabling, all cables shall be adequately supported by feeding them through a Kellems grip which is attached to and suspended from the pole cap. The hole drilled for the cabling shall be drilled on the back side of the pole 3 feet from the top in order to minimize the camera view obstructed by the cable and shall be threaded for a straight $\frac{3}{4}$ inch strain relief cord connector. At least 4 feet of cable shall be pulled through and secured by the strain relief cord connector. The cables shall be looped together, adequately secured to the pole to prevent movement, and sealed on the ends to prevent moisture exposure.

The contractor shall install new wire and/or cable in conformance with guidelines below. It is assumed that all existing conductors and cables are undamaged unless inspected, documented, and reported to the Construction Inspector prior to the contractor starting that section of the work. Otherwise, any damage to City facilities shall be repaired by the contractor at the contractor’s cost in conformance with City standards.

New traffic signal and SIC conductors shall be installed per the following guidelines:

- 1.** New wire may be pulled through existing conduits without removing conductors if based on common conditions:
 - a.** There are a maximum number of 4, 90 degree by 24 inch radius bends in 1 conduit run between pull boxes or termination points, and

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cabinet, in every pull box (for individual conductors not within a cable), and at their field termination point(s).

Cat5 cables being installed shall be identified with electrical tape at both ends with orange for video and blue for the wireless access point.

86-2.08B MULTIPLE CIRCUIT CONDUCTORS

All new and replacement traffic signal phase wiring shall be comprised of multiple circuit conductors per Section 86.08D of the Caltrans Standard Specifications. A separate 3-conductor cable shall be provided for pedestrian pushbutton wiring. Multiple circuit conductor cable used for vehicle displays shall not be used for any part, hot or common, of the pedestrian pushbutton circuit. Unique color coding shall be provided for each wire within the cable. The number of wires per cable shall be the next common size up from that required to provide the necessary wires as specified on the plans. Phases shall be labeled as described in Section 86-2.08A.

The handling of multiple circuit conductors shall be to the best industry standard practice and as follows:

1. Razor blade knives shall not be used to strip back the outer jacket of insulation. A round cable stripper (example: Clifford #6-670-114-0 or equivalent) shall be the only means of stripping back the outer cable insulation.
2. The outer insulation jacket shall not protrude past the top of the signal cabinet entrance conduits.

86-2.08E SIGNAL INTERCONNECT CABLE

Traffic signal interconnect shall be provided for new signal installations, and for modification of existing signals which currently do not have interconnect. The interconnect cable shall have its own conduit and shall not share conduit with service conductors, signal conductors, or lead-in cables.

The interconnect shall connect the subject signal with at least 1 existing traffic signal. If the subject signal is between 2 existing signals, the interconnect shall connect all 3 signals.

If a City Parcel is adjacent to a new fiber run, a fiber stub shall be provided.

Signal interconnect cable (SIC) shall be a 9/125um wavelength, 72 to 216 strand, single mode, indoor/outdoor, loose tube, all-dielectric fiber optic cable as specified on the plans.

A Type 1 splice (refer to TS-26) shall be used at traffic signal locations where 2 point to point fiber cables will be spliced along with a tactical cable to service the local cabinet.

A Type 2 splice (refer to TS-27) shall be used at traffic signal locations where 2 point to point fiber cables will be spliced along with a tactical cable to service the local cabinet and a fiber cable from an outside facility (UE, IT, etc.) is also being spliced.

A Type 3 splice (refer to TS-28) shall be used at traffic signal locations where 2 point to point fiber cables forming a network ring path and 1 fiber cable from a non-ring path will be spliced along with 2 tactical cables to service the local cabinet.

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A Type 4 splice (refer to TS-29) shall be used at traffic signal locations where 2 point to point fiber cables forming a network ring path will be spliced along with a tactical cable to service the local cabinet and 2 point to point fiber cables forming a second network ring path will be spliced along with a tactical cable to service the local cabinet.

SIC shall have footage markings every 4 feet. This marking may be on the outside of the cover or on the inside insulation jacket.

The signal interconnect cable shall not be placed in any conduit runs or pull boxes containing live conductors, unless otherwise directed by the Engineer.

Unless specified otherwise on the plans, 6 feet of copper and/or 15 feet of fiber optic cable slack shall be provided in each pull box. 50 feet of copper and/or 100 feet of fiber optic cable slack for each signal interconnect cable run shall be provided in the dedicated communications Home Run pull box in front of each signal controller or the last pull box before the controller if a dedicated communications Home Run pull box is not available.

An industry standard 4 inch orange or yellow label marked "CAUTION FIBER OPTIC CABLE" in black font shall be attached to each fiber optic cable in each pull box.

At the discretion of the City Engineer existing SIC may be disconnected by the City and moved out of the work area by the contractor during construction. However, the SIC must be reinstalled by the contractor within 7 days of its disconnection. Otherwise, all SIC must remain operational.

Existing copper SIC damaged during construction shall be replaced at the contractor's cost from controller cabinet to controller cabinet on either end of the damage. Splicing of copper SIC is not allowed. Damaged copper SIC shall be replaced with fiber optic SIC, conforming to current City standards including cable, conduit, splices, terminations, patch panels, and pull boxes. The contractor shall also be responsible, at the contractor's cost, to make any additional repairs needed to install the new cable from controller to controller.

Existing fiber optic SIC damaged during construction shall be repaired.

Damage

- 1.** Fiber Optic Cable and related facilities damaged during construction shall be replaced/repared to current City standards and as specified below at the contractor's cost. This work shall include fiber optic cable, conduit, pull boxes/vaults, trenches, concrete, asphalt, traffic control, pull tape, splices, splice enclosures, terminations, labor, etc., as required.
- 2.** Damage is described as a breach in the fiber optic cable jacket, a kink, a break of the cable, or any other condition that causes a reduction in the capacity of the cable.
- 3.** Should fiber optic cable facilities be damaged during construction without visible damage to the cable, the cable shall be tested by a certified fiber optic technician provided by the

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contractor at the contractor's cost to ensure that there is no internal damage. Should the test show internal damage, the cable shall be replaced as specified below. Otherwise, the cable shall be protected and the facilities repaired to current City standards.

Repair

- 1.** Fiber optic cable running between and terminating at adjacent traffic signals or devices shall be replaced from:
 - a.** Termination to termination. All new cable and terminations shall be acceptance tested as required elsewhere in the City standards.
 - b.** If the new cable must be pulled through conduits that contain traffic signal phase wiring, then a "MAX CELL" or equivalent sleeve, per City standards, shall be installed in the conduit prior to the installation of the new fiber optic cable.
 - i.** Pull box adjacent to the damage to controller cabinet.
 - a)** No more than 5 feet of slack may be used out of any one pull box.
 - b)** Pull boxes where new splices shall occur will be replaced with Fiberlyte FL36 24 inch deep vaults as specified in these construction standards (86-2.06)(02006110).
 - c)** At least 50 feet of slack must be provided in the new splice vault.
 - d)** The slack shall be provided in even amounts on either side of the splice enclosure.
 - e)** Only fusion splicing meeting City standards by a certified fiber optic technician will be allowed.
 - f)** All new cable, splices, and terminations shall be acceptance tested as required elsewhere in the City standards.
 - g)** The average optical loss of each splice shall not exceed 0.10 dB. The average is determined by measuring the splice loss in both directions with an OTDR, adding the 2 readings, and dividing by 2. Testing should be performed for both the 1310 and 1550 nm wavelengths.
 - h)** Splicing will not be allowed in pull boxes or vaults shared with non-signal interconnect cables.
 - i)** If the new cable must be pulled through conduits that contain traffic signal phase wiring, then a "MAX CELL" or equivalent sleeve, per City standards, shall be installed in the conduit prior to the installation of the new fiber optic cable.

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- 2.** Fiber optic cable running continuously past multiple traffic signal devices may be repaired by splicing at adjacent pull box locations.
 - a.** A single splice location may be appropriate if the damage is close enough to the adjacent pull box that the repair may be accomplished by using some of the slack in the existing cable.
 - i.** No more than 5 feet of slack may be used out of any 1 pull box.
 - ii.** Pull boxes where new splices shall occur will be replaced with Fiberlyte FL36 24 inch deep vaults as specified in these construction standards (86-2.06)(02006110).
 - iii.** At least 50 feet of slack must be provided in the new splice vault.
 - iv.** The slack shall be provided in even amounts on either side of the splice enclosure.
 - v.** Only fusion splicing meeting City standards by a certified fiber optic technician will be allowed.
 - vi.** All new cable, splices, and terminations shall be acceptance tested as required elsewhere in the City standards.
 - vii.** The average optical loss of each splice shall not exceed 0.10 dB. The average is determined by measuring the splice loss in both directions with an OTDR, adding the 2 readings, and dividing by 2. Testing should be performed for both the 1310 and 1550 nm wavelengths.
 - viii.** Splicing will not be allowed in pull boxes or vaults shared with non-signal interconnect cables.
 - b.** 2 splices may be necessary if the damage is not near an existing pull box. In this case, a splice shall be provided on either side of the damage and a new length of cable meeting City standards shall be installed between the splices.
 - i.** Pull boxes where new splices shall occur will be replaced with Fiberlyte FL36 24 inch deep vaults as specified in these construction standards (86-2.06)(02006110).
 - ii.** At least 100 feet of slack must be provided in each vault.
 - iii.** The slack shall be provided in even amounts on either side of the splice enclosure.
 - iv.** Only fusion splicing meeting City standards by a certified fiber optic technician will be allowed.

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- v. All new cable, splices, and terminations shall be acceptance tested as required elsewhere in the City standards.
 - vi. The average optical loss of each splice shall not exceed 0.10 dB. The average is determined by measuring the splice loss in both directions with an OTDR, adding the 2 readings, and dividing by 2. Testing should be performed for both the 1310 and 1550 nm wavelengths.
 - vii. Splicing will not be allowed in pull boxes or vaults shared with non-signal interconnect cables.
 - viii. If the new cable must be pulled through conduits that contain traffic signal phase wiring, then a “MAX CELL” or equivalent sleeve, per City standards, shall be installed in the conduit prior to the installation of the new fiber optic cable.
3. Repair work must **begin within 24 hours** and be **completed within 48 hours** of the damage occurring irrespective of weekends and holidays.
4. Should the contractor be unable to make the repairs within this time frame, the City will complete temporary repairs and bill the contractor for their time and materials at the City’s billable rate. The temporary repair shall be treated with the same restrictions, requirements, and care as the original cable. The contractor will still be required to make the permanent repairs prior to completion of the project.

Temporary copper SIC repairs must be **made within 48 hours** of the damage and provide sufficient bandwidth and reliability for the intended purpose of the copper SIC. Permanent repairs shall be **completed within 30 days** of the damage. The City may make the repairs and bill the contractor for the work should the contractor be unwilling or unable to meet these requirements.

Should the copper SIC installation be required by the City, the contractor shall test all copper SIC prior to installation as follows:

- 1. For continuity of each wire pair. Resistance shall be consistent.
- 2. For high resistance (meggar) testing (250v setting):
 - a. Each wire pair to ground
 - b. Each wire pair to the cable shielding
 - c. Each wire pair to wire pair
- 3. The test may be in the field or shop
- 4. A city technician does not need to be present

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5. The contractor shall be liable for all inspection costs related to the removal and re-installation of new cable should untested cable found to be faulty after installation

Fiber optic cable shall be acceptance tested, every strand, both before and after installation at both 1310 and 1550 nm wavelengths. All testing shall be documented on OTDR Acceptance Test and Splice Loss Record forms. Losses shall not exceed 1.85 dB per mile of cable including patch panels and splices.

86-2.09 WIRING

All wiring shall meet or exceed the current CalTrans Standards and National Electrical Code Standards.

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86-2.09B WIRING INSTALLATION

Ends of spare conductors or conductors terminated in pull boxes shall be taped and water sealed with ScotchKote or approved equivalent.

86-2.09C CONNECTORS AND TERMINALS

Field conductor wiring shall not be doubled up on any single wire connector. For conductor sizes larger than number 10, connections shall be spliced by the use of "C" shaped compression connectors as shown in the CalTrans Standard Plans.

All field wiring connections shall be soldered after crimping the wire connector.

All crimp connectors shall be sized to accommodate the proper wire gauge.

86-2.09D SPLICING

Grounding conductor splicing shall be water sealed with Scotch Kote sealant or an approved equivalent. 2 applications are required.

86-2.09E SPLICE INSULATION

All splices shall be Method B. Heat-shrink tubing may be used with prior approval by the Engineer.

86-2.09F FUSED SPLICE CONNECTORS

Field fuses shall be installed in the hand hole of the standard.

All ungrounded conductors shall be fused.

86-2.10 BONDING AND GROUNDING

Grounding jumper shall be attached by 3/8 inch or larger galvanized bolt in the signal standard or controller pedestal and shall be run to the conduit, ground rod or bonding wire in adjacent pull box. Grounding jumper shall be visible after cap has been placed on foundation. All ground connections shall be water tight.

Grounding electrodes shall be of copper clad steel rod, not less than 5/8 of an inch in diameter x 10 feet in length.

A grounding electrode shall be installed in all electrical services and controller foundations. They shall be spaced a minimum of 20 feet apart. See NEC 2011 Part III 250.53(A)(3).

The grounding electrode rod in the pull box shall be greater than 20 feet from the service and shall be paralleled with the grounding electrode rod in the Service. This connection shall consist of a continuous stranded #6 green insulated copper conductor. The ground connection shall be on the line side of the electrical entrance terminal block.

A continuous stranded #6 green insulated copper conductor shall connect the ground bus in the electrical service, grounding electrode in service, grounding electrode in the pull box. See Detail TS-25.

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The equipment-bonding conductor for all 1B standards shall be visible and accessible after completion of work.

In the event that ground resistance testing failed, the contractor shall install an additional 8 foot ground rod in the signal “Home Run” pull box. This additional ground rod shall be paralleled with the grounding electrode in the controller pad and service pad with a continuous stranded #6 green insulated copper conductor. The ground wire for this additional ground rod shall be permanently fused to the rod using a “CADWELD PLUS ONE SHOT” connection (See Detail TS-25).

86-2.11 SERVICE

The City shall supply an electrical service consisting of Type III AF, low body configuration, or Type 27-22 service with battery backup system.

The Contractor shall provide an address tag for the service as described in the Roseville Electric Department Specifications for Commercial Construction, Section 6, and “Panel Marking Policy”.

The service pedestal shall be installed a minimum of 5 feet from the controller cabinet.

A City of Roseville Encroachment Permit is required for every traffic signal installation and/or modification. The project address for the permit shall be the service pedestal address. This address should be noted on the plans but is obtainable from the City in its absence. Minor modifications by City forces not involving the service pedestal are exempt from the encroachment permit requirement. Should a traffic signal be a part of a larger project, there may be an encroachment permit for the entire larger project and 1 or more permits for each and every signal installation/modification.

There shall be a 1 inch grouted section between the service and the foundation. A ¼ inch weep drain hole shall be installed in this grout section.

86-2.14 TESTING

The contractor shall contact the Construction Inspector at least 5 working days prior to installation of a tested controller assembly and/or electrical service.

86.2.14B (2) GROUND

Before electrical power can be connected, then grounding electrode shall be tested for earth ground resistance. The City Traffic Signal Technician shall perform this ground resistance testing and said test shall be performed after the service and controller pad foundation have cured. The earth ground resistance shall be a maximum of 5 ohms. If the ground resistance testing results are greater than 5 ohms maximum limit, refer to Section 86-2.10 and drawing TS-25 for corrective action requirements.

86-2.14C FUNCTIONAL TESTING

Functional testing shall be performed for 5 working days prior to signal activation. All systems shall be in place before functional testing can begin.

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A shutdown of the electrical system resulting from damage caused by public traffic or from a power interruption shall not constitute discontinuity of the functional test.

During interconnect cable installation, the Contractor shall, in the presence of the City Traffic Signal Technician, perform a high resistance to ground test, DC resistance test and a dB attenuation loss test. The Contractor shall supply factory specifications prior to the test. The Contractor shall notify the Engineer at least 48 hour prior to interconnect cable installation.

86-2.15 SIGNAL ACTIVATION

On the day of signal activation, the contractor shall be required to have in his possession at the job site all tools, equipment and parts necessary to repair a signal malfunction. These items shall include, but not be limited to, a bucket truck, replacement LED's, wire, etc.

Immediately prior to the activation of a **NEW** traffic signal, the contractor shall install 2 orange flags on the "Signal Ahead" signs. Flags shall remain in place for 2 weeks.

Prior to activation of a **NEW** traffic signal, the contractor shall provide a minimum of 2 flaggers per intersection to control traffic. The number of flaggers may be increased at the request of the City's Construction Inspector for large intersections at no additional cost to the City. Each flagger shall wear appropriate safety gear and carry a stop paddle for controlling traffic. The flaggers shall completely stop traffic prior to the signal changing from red flash to full operation.

86-3.01 CONTROLLER CABINET ASSEMBLY

The City shall supply the controller cabinet assembly.

Wire connections and/or termination shall comply with section 86-2.08.

The traffic signal controller cabinet shall have a 1 inch bead of clear silicone sealant applied between the foundation and the controller cabinet bottom immediately before installation. The bead shall be centered 2 inches in from the outer edge of the controller cabinet around the entire perimeter. All excess silicone on the outer edges shall be cleaned off.

The sealant shall be 35 year rated 100% silicone. There shall be no substitution for the silicone sealant.

On 332 cabinets, the field wire entrance section of the controller shall face the intersection or as directed by the Engineer.

No access to the controller shall be permitted without supervision of a City of Roseville Traffic Signal Technician, unless otherwise directed by the Engineer.

86-3.08 EMERGENCY VEHICLE PREEMPTION EQUIPMENT

The City shall supply emergency vehicle preemption equipment, with the exception of the required cabling from the optical detector to the discriminator in the Controller Cabinet Assembly.

Where existing signals are being modified, and said signals are already equipped with emergency vehicle preemption equipment, the Contractor shall perform any necessary remodel and reinstallation of said equipment as required by the plans or as directed by the City Engineer.

Preemption cables shall be labeled in the following manner:

- Phase 2&5 single gray band
- Phase 4&7 double gray band
- Phase 1&6 triple gray band
- Phase 3&8 quadruple gray band

Labels shall consist of banded colored tape visible at the preemption detector, signal standard Handhole, adjacent pull box and the Controller Cabinet. Cables in the Controller Cabinet shall have tie wrap labels with appropriate phasing descriptions.

86-4.01 VEHICLE SIGNAL FACES

All signal faces shall be aluminum. All mountings for shall be bronze metal.

Signal faces shall have 12 inch LED displays, unless otherwise specified.

Vehicle signals and pedestrian signals shall be of the following types:

- MAT (3 section only)
- MAS
- MAS-4B
- SV-1-T
- SV-2-TB
- SV-3-TB
- TV-1-T
- TV-2-T
- TV-3-T
- SP-1-CS

The MAT mounting shall only be used for 3 section vehicle signals for protected left turn movements. All other mast arm mounted vehicle signals shall be MAS mounted. All MAT and MAS mounts shall use six (6) set screws.

All signal sections shall have full circle visors unless directed otherwise on the plans.

The following vehicle signal alignments are typical. Variations may be required on a case by case basis.

1. For single left turn lanes with protected left turn movement, the left turn signal shall line up with the center of the left turn lane as close as possible.

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2. For dual left turn lanes (which shall have a protected movement), the left turn signal shall line up with the line between the 2 left turn lanes as close as possible.
3. Through movement signal indications shall align as follows:
 - 1 travel lane – the center of the lane.
 - 2 travel lanes – the lane line in-between the 2 lanes
 - 3 or more travel lanes – 1 signal indication shall be provided on each lane line between through lanes.
4. For one through lane with permissive left turn, the MAS signal shall line up as close as possible with the center of the through lane. Far left permissive signal indications shall not be used.
5. When a 4 section MAS (MAS-4B) signal is used, it shall line up with:
 - The lane line between the through and the left turn, or
 - The lane line between dual left turn lanes at a “T” intersection, or
 - The center of a single left turn lane at a “T” intersection, or
 - The center of a split phase shared through/left turn lane at a “T” intersection.

Typical indications are as follows:

1. For protected left turn movements: one 3-section all arrow MAT and one 3-section all arrow far left side pole-mounted signal.
2. For through movements (with protected left turns): one 3-section MAS, one 3-section far right side pole-mounted signal, and one 3-section near right side or top pole-mounted signal.
3. For through movements (with permissive left turns): one 3-section MAS, one 3-section far right side pole-mounted signal, and one 3-section near right side pole-mounted signal. Far left permissive signal indications shall not be used.
4. For split phased situations: one 4-section MAS (MAS-4B w/GA), one 3-section far left side pole-mounted signal (all Arrow), one 3-section far right side pole-mounted signal, and one 3-section near right side pole-mounted signal.
5. For right turn arrow overlap situations: same as above except the far right side and near right side pole-mounted signals shall be 5-section with green and yellow arrows. Right turn arrow

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overlaps shall not be provided without prior approval of the City Engineer. Where right turn arrow overlaps are provided, the conflicting U-turn shall be prohibited via signage.

86-4.01B SIGNAL SECTIONS

All signal sections shall be 12 inch mold-cast aluminum.

86-4.02 LIGHT EMITTING DIODE SIGNAL AND PEDESTRIAN MODULE

All vehicle and pedestrian displays shall be supplied with LED countdown signal lamps. Manufacture date of installed LED's must be newer than one (1) year old. Contact the City Traffic Section for an approved list of vendors and model numbers.

86-4.04 BACKPLATES

All vehicle signal sections shall include aluminum backplates with perforated louvers.

86-4.05 PROGRAMMED VISIBILITY VEHICLE SIGNAL FACES (PV DISPLAY)

All programming of the optic display shall be done in accordance with the manufacturer and the City Engineers' specifications. Programmed visibility heads shall not be used without prior approval from the Engineer and shall be LED type.

86-4.05B FRONT SCREEN

The front screen shall be plastic.

86-4.06 PEDESTRIAN SIGNAL FACES

Pedestrian signals shall be aluminum Type "A" with international symbols.

Pedestrian heads shall be mounted on the intersection side of the signal pole unless otherwise directed by the Engineer.

Pedestrian head indications shall be 9 inch LED countdown type. Contact the City for approved vendors and models.

86-4.08 SIGNAL MOUNTING ASSEMBLIES

Terminal compartments (TV & SV), mast arm slip fitters (MAS & MAT), and pedestrian clam shell mounts shall be bronze.

Signal mast arm mounted 4-section displays shall be type MAS-4B.

Extra support shall be incorporated whenever the following conditions arise:

1. The use of a SV-3-TA or SV-3-TB display.
2. If any display on a side mount is larger than a 3-section 12 inch display.

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The extra support method shall consist of a 1 inch standoff w/ 1/4 X 20 threaded hole. The stand-off shall be banded to the signal standard, 3 inch below the bottom of the top slip fitting of the displays' 1 1/2 inch riser. A 1/4 inch hole shall be drilled in the center of the 1 1/2 inch riser to match the position of the thread hole on the stand-off. The riser shall be attached to the standoff with a 1/4 X 20 bolt, which shall include a lock washer and flat washer.

All signal display mounting assembly top members shall be watertight. The watertight sealing method shall be a 1/2 inch thick layer of clear silicone around the top jointing member of all displays. Additional sealant shall be installed in the same manner on all plugs installed in the top of any signal display. Rubber washers used for water-sealing the top assembly shall not be permitted on any display framework or MAT mounting even if supplied by the manufacturer.

All MAT mounted signal displays shall have only 1 serrated washer Installed between the lock nut and the display.

All MAT and MAS mounts shall be sealed with approved clear silicone around the tenon attachment area, including the through bolt and tenon openings.

The sealant shall be 35 year rated. There shall be no substitution for the silicone sealant.

Where no vehicle or pedestrian displays are to be installed on the side of a signal pole, a terminal compartment only shall be installed on the signal pole at the vehicle display position. All signal display wiring from the signal mast arm shall terminate at this location.

Pedestrian head mounts shall be clam shell type with bronze mounting hardware. Mounting shall include 1 Allen head screw for opening and all wiring shall be quick connect type (plug in).

86-5.01A(4) VEHICLE DETECTORS CONSTRUCTION MATERIALS

The first front call loops shall be Type D or a "Quadra Circle". All other vehicle loops shall be type A. Refer to detail's TS-9 and TS-10 for further information. The loops nearest the stop bar shall be placed 1 foot from the stop bar. Where a loop is designated to have counting ability as discussed above, the loop shall not share an input with any other loop. Loop wire shall terminate in the nearest pull box and not the handhole.

Vehicle loop wire shall be Caltrans Type 1 or Type 2.

All loops placed in concrete shall be City approved performed loops (See City approved equipment list).

Bicycle detection loops shall be Type D modified as follows:

- The loop size shall be decreased such that it is 1 foot narrower than the bike lane. A 6 foot bike lane shall have a 5 x 5 foot loop, a 5 foot bike lane shall have a 4 x 4 foot loop, etc.

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- The loop shall be centered in the lane.
- The front of the loop shall be 6 inches back of the stop bar.
- Each bicycle loop shall have its own detector lead-in cable and shall be spliced in the pull box not the handhole.
- Each loop shall consist of 5 turns of 14 AWG with XLLP insulation.

Lead-in cable shall be Caltrans Type B. Lead-in cable shall not be spliced between the termination point (pull box adjacent to the detector loop) and the controller cabinet terminals. A spare DLC shall be pulled to each advance loop pull box with 20 feet of slack. For intersections that have a fourth crossing conduit, an additional spare DLC must be pulled through the long side and terminated in the advanced pull box. All spare DLC's must be un-spliced and marked in each pull box with a 5 inch green band labeled "LOCATE".

At grade detector hand holes shall be G5 w/ lockable lids (unless otherwise noted). Below grade detector hand holes shall use Type B (unless otherwise noted). Hand holes shall be placed so they line up with roadway stripes to minimize the frequency of vehicle tires driving over the handhole covers. A sufficient number of handholes shall be placed so that detector loop saw cuts shall not cross adjacent lanes of travel.

Traffic signal detectors must remain operational at all times unless approved by the City Engineer. Damaged detectors must be **replaced within 24 hours**. The contractor may use temporary detection including temporary loops, tape down loops, video detection, and microwave detection should the signal loop replacement need to be delayed more than 24 hours.

86-5.01A (5) VEHICLE DETECTORS INSTALLATION DETAILS

The Engineer, prior to saw cutting, shall verify all loop locations. The contractor shall give 48 hour notice prior to loop verification. Debris from saw-cutting operations shall be recovered immediately and disposed of properly. At no time can debris from saw-cutting operations enter the storm drain system.

Signal loops installed in new asphalt concrete (AC) shall be placed in the lift of AC immediately below the final lift. The new bottom lift of AC shall be a minimum of 3 inches thick (5 feet back of advance loop) where the traffic signal loops will be installed. New loops that will be buried under AC shall be installed with a saw cut depth as required to maintain a minimum of 1/2" coverage of loop sealant. Loops installed in the top lift will be saw cut to a depth required to maintain 1" of sealant coverage. Loops installed in existing pavement where existing loops are surface cut on that same approach may also be surface cut per the State of California Standard Plans unless otherwise directed by the Engineer. Vehicle loops shall have four (4) turns of wire in the slot. Bicycle loops shall have five (5) turns.

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Signal loops installed in new concrete pavement shall be placed immediately below the concrete per Section 6-2 of the Design Standards.

Signal loops shall be protected from damage before and during pavement placement.

Existing buried loops damaged by construction shall be reinstalled as if in new pavement per the above paragraph. The contractor shall grind a minimum of 1 ½ inches of asphalt concrete from lane line to lane line and at least 1 foot outside the limits of work required to install the entire loop wire. The loops shall then be covered by an asphalt concrete overlay per City Standards. Should the AC thickness be insufficient to install the loops as specified above, the contractor shall complete any additional grinding, excavating, or paving necessary to install the loops. For concrete pavement, the entire panel, from joint line to joint line, shall be removed and replaced as specified elsewhere in the City Design Standards with the loops installed as described above.

New loops installed in existing pavement with a Pavement Quality Index (PQI) of 85 or greater shall be installed as if in new pavement per the above paragraphs unless the roadway was recently resurfaced.

New loops installed in existing pavement with a Pavement Quality Index of 85 or greater and resurfaced within the past three years, shall be surface cut per the State of California Standard Plans. In addition, the pavement shall be resurfaced with the resurfacing material used in the previous resurfacing project or as otherwise approved by the City Engineer.

Loop wires shall be labeled in the following manner:

- lane 1-black
- lane 2-red
- lane 3-blue
- lane 4-white
- lane 5 –yellow
- right turn lane – orange
- bike lane – brown

Labels shall consist of banded colored tape visible in the pull boxes, where the loop wire is spliced to the detector lead-in cable.

Loop detectors shall be clearly marked to reference their location in relation to the limit line and lane. The loop closest to the crosswalk in the left most lane shall be labeled as loop number 1-1. The second loop in the same lane shall be labeled 1-2, and so on. Refer to details TS-9 and TS-10 for further information.

The start and end leads of a loop detector shall be clearly marked by a means of plastic tie wrap labels.

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Loop Home Run slots shall be double cut to accommodate the twisted pair (3-turns/foot), or as directed by the Engineer. Sealant for filling slots shall be Hot Melt Rubberized Asphaltic Sealant or equivalent as approved by the Engineer. All excess sealant shall be squeegeed off after application if under the top lift. If surface cut lift, must be neatly applied (not squeegeed).

During loop installation, the Contractor shall in the presence of Signal Technician, perform a high resistance test and an inductive reactance test. The Contractor shall notify the Engineer at least 48 hour prior to loop installation.

All wires for each detector loop shall terminate in the nearest pull box, not the hand hole.

Lead-in cables shall not be spliced between the termination point (the pull box adjacent to loop detectors) and the controller cabinet terminals.

Where the approved plans call for preformed detector loops, the following shall apply:

1. The conduit shall be sealed to prevent the entrance of water and the movement of wires within the conduit.
2. The loop wires from the preformed loop to the adjacent pull box or hand hole shall be twisted together into a pair (at least three (3) turns per foot) and encased in Schedule 40 or Schedule 80 PVC or polypropylene conduit (3/8 inches minimum diameter). The lead-in conduit shall be sealed to prevent the entrance of water at the pull box and handhole end.
3. The preformed loop and lead-in conduits shall be placed prior to placing final concrete. In new roadways, the top of the conduit shall be placed flush with the top of the base course. For other roadways, the top of the conduit shall be between 2 and 3 inches below top of finished surface. Where the concrete is steel reinforced, the preformed loops may rest on the steel.
4. All detector loop shields shall be left 6" inches in length and wrapped around the DLC and secured.

Typical vehicle detector layout and inputs shall be as follows (see details TS-9 and TS-10):

1. For permissive or protected left turn situations, the left turn lane shall have four loops with the first and second loops spaced 8 feet apart, the second and third loops spaced 9 feet apart, and the third and fourth loops spaced 10 feet apart. The fourth loop shall have counting ability. The other three loops can share one input.
2. Each through lane shall have two call loops spaced 8 feet apart with one count loop spaced 9 feet behind the second call loop and 1 advanced loop placed per the CAMUTCD.
3. Each right turn only lane shall have one loop placed 30 feet behind the stop bar in line with the through lane count loops. The loop shall be used for counting and may be used for detection following a 10 second minimum delay.

4. For the stem of a "tee" intersection, each left turn lane shall have four loops with the first and second loops spaced 8 feet apart, the second and third loops spaced 9 feet apart, and the third and fourth loops spaced 10 feet apart. The fourth loop shall have counting ability. The other three loops can share one input. No intermediate or advanced loops will be required on "tee" stems.
5. For split phase signals with a shared through/left turn lane, the shared lane shall have four loops with the first and second loops spaced 8 feet apart, the second and third loops spaced 9 feet apart, and the third and fourth loops spaced 10 feet apart. The fourth loop shall have counting ability. There shall also be one advanced loop placed per the CMUTCD.
6. All loops shall have 4 wraps.

86-5.01E DETECTOR LOOP CIRCUITRY

All loops shall be wound in a clockwise rotation. Adjacent loops on the same sensor unit channel shall be sliced to the DLC in an alternating pattern so that the electrical loops will alternate in a clockwise, counterclockwise pattern. The loop at the limit line, closest to the center median (lane 1), shall be spliced in a clockwise direction. The next loop back in the same lane shall be spliced in a counterclockwise direction and so on. The loop detector in lane 2 closest to the limit line, shall be spliced in a counterclockwise direction.

86-5.02 PEDESTRIAN PUSH BUTTON ASSEMBLIES

Pedestrian push buttons shall be aluminum Type "B" with metal international symbol signs. Push buttons shall meet all Americans with Disabilities Act guidelines and be placed 36 inches above the grade of the closest edge of sidewalk and meet reach requirements per section 308.3 Side Reach of the 2010 ADA Standards for Accessible Design (https://www.ada.gov/regs2010/2010ADASTandards/2010ADASTandards_prt.pdf). Buttons shall be solid state, 2 tone audible, momentary LED type. Contact the City for approved vendors and models. The Contractor shall provide a City approved wave file.

Pedestrian push buttons shall be within 5 feet from the edge of the access ramp pan (CAMUTCD Figure 4E-2).

86-6.01 HIGH PRESSURE SODIUM LUMINAIRES

All traffic signal luminaires shall be 400 watt equivalent LED unless directed otherwise by the City. See the City's website for a list of approved equipment. 2 separate 120 volt circuits shall be provided to equally split the powerload.

86-6.065 INTERNALLY ILLUMINATED STREET NAME SIGNS

Internally illuminated street name signs shall be slim profile, LED with City logo. Contact the City for approved vendors and models. Sign proofs must be approved by the City prior to ordering equipment.

Internally Illuminated Street Name Signs (IISNS) shall require a City Traffic Engineering accepted stamp for all layout proof matching existing City LED IISNS's prior to ordering. Only

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products with prior approval from the City shall be allowed.

1. Refer to City of Roseville Construction Standards Section 56 “Signs”.
2. Internally Illuminated Street Name Signs (IISNS)
 - a. All proof require a City approved layout matching existing City LED IISNS’s prior to ordering.
 - b. IISNS name panels shall be manufactured as follows:
 - i. Sign panel material shall be clear (not opaque) poly. Thickness of the panel shall be 3.5 mm/6.0 mm maximum.
 - ii. Sign panels background sheeting shall be: 3M DG3 (Diamond Grade) series 4090. Color (White).
 - iii. Etched sheeting (Street name and City of Roseville logo) shall be 3M EC 1177c material. Color (Green).
 - iv. Manufacture shall warranty, no chemical reaction, shall be exhibited between the background sheeting and etched sheeting components.
 - v. The IISNS shall be double sided with street names on both sides.

86-6.07 PHOTOELECTRIC CONTROLS

Photoelectric controls shall be Type II and pole top mounted.

The Contractor shall supply all equipment, supplies, and material required for mounting the photoelectric cell.

86-6.07B (4) WIRING

Wiring from the photoelectric cell assembly to the electrical service shall be # 14. Wire color for the PEU shall be as follows: black for ungrounded conductor, red for ungrounded switch-leg conductor, and white for grounded conductor.

86-7.01 REMOVING ELECTRICAL EQUIPMENT

All existing traffic control devices, lighting devices, signs, and equipment to be removed and not reused in the work shall be salvaged, unless otherwise specified or directed by the City Engineer. Salvageable equipment shall remain the property of the City. Equipment determined to be unsalvageable by the City Engineer shall become the property of the Contractor. The Contractor shall deliver salvaged equipment to the City’s Corporation Yard located at 2005 Hilltop Circle, Roseville, following at least 48 hours advance notice of delivery.

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Damaged conduits deemed to not be reusable shall be removed from existing pull boxes and ends plugged solid with grout. Existing conductors shall be removed from said conduits prior to plugging. Contractor shall dispose of said conductors.

Abandoned conduits deemed reusable shall have the line blown out, existing conductors shall be removed, a number 10 green locate wire shall be installed, and the ends of the conduits shall be sealed.