STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

MANUAL CHANGE TRANSMITTAL

NO. **12-6**

TITLE:	APPROVED BY:	DATE ISSUED:
Department of Transportation *Construction Manual*	Mark Leja, Chief Division of Construction	November 8, 2012
SUBJECT AREA Table of Contents and various sections of the *Construction Manual*	ISSUING UNIT Division of Construction	
SUPERSEDES	DISTRIBUTION All Requested Manual Holders	

This manual change transmittal delivers the revisions of Chapter 4, Sections 4-63, 4-65, 4-68, 4-69, 4-70, 4-82, 4-84, 4-85, and 4-94 of the *Construction Manual*. Updated sections may contain updated language, information, corrections, and references resulting from updates to the 2010 *Standard Specifications*, and from policy and procedural changes. Change bars in the margins of the revised sections indicate text that was changed or added.

Please update your manual according to the table below.

Section(s)	Incorporates	Remove Old Page(s)	Insert New/Revised Page(s)
Table of Contents	None	TOC.1 thru TOC.4	TOC.1 thru TOC.4
Section 4-63, "Reserved	None	4-63.1 thru 4-63.2	4-63.1
Goldenrod, Section 4-65, "Concrete Pipe"	None	4-65.i	4-65.i
Section 4-65, "Concrete Pipe"	None	4-65.1 thru 4.65.5	4-65.1 thru 4.65.5
Goldenrod, Section 4-68, "Subsurface Drains"	None	4-68.i	4-68.i
Section 4-68, "Subsurface Drains"	None	4-68.1 thru 4-68.4	4-68.1 thru 4-68.5
Section 4-69, "Overside Drains"	None	4-69.1 thru 4-69.2	4-69.1 thru 4-69.2
Section 4-70, "Miscellaneous Drainage Facilities"	None	4-70.1	4-70.1
Section 4-82, "Markers and Delineators"	None	4-82.1 thru 4-82.2	4-82.1 thru 4-82.2
Section 4-84, "Traffic Stripes and Pavement Markings"	None	4-84.1 thru 4-84.3	4-84.1 thru 4-84.3

Section(s)	Incorporates	Remove Old Page(s)	Insert New/Revised Page(s)
Section 4-85, "Pavement Markers"	None	4-85.1 thru 4-85.2	4-85.1 thru 4-85.2
Section 4-94, "Asphaltic Emulsions"	None	4-94.1 thru 4-94.3	4-94.1 thru 4-94.3

Section 4-63, "Reserved"

- Former Section 4-63, "Cast-in-Place Concrete Pipe," deleted from the 2010 *Standard Specifications* because of the availability of alternative solutions. This section reserved for a future topic.

Section 4-65, "Concrete Pipe"

- Modifies section title to align with 2010 *Standard Specifications*
- Changes SI units to US customary units.
- References nonreinforced concrete pipe section of *Standard Specifications* (65-3).

Section 4-68, "Subsurface Drains"

- Adds geocomposite drain as fourth type of subsurface drain, which was included in the 2010 *Standard Specifications*.
- Changes SI units to US customary units.
- Updates references to Sections 65 and 68 of the *Standard Specifications*.

Section 4-69, "Overside Drains"

- Updates *Standard Plan* reference sheets to align with 2010 *Standard Plans*.
- Updates references to align with 2010 *Standard Specifications*.
- Updates *Traffic Manual* references.

Section 4-70, "Miscellaneous Drainage Facilities"

- Modifies section title to align with 2010 *Standard Specifications.*
- Modifies description of items covered to accommodate expanded subject material.
- Generalizes payment guidance to align with 2010 *Standard Specifications.*

Section 4-82, "Markers and Delineators"

- Updates the requirement that listed pavement markers must be on the Authorized Materials List for signing and delineation materials.

Section 4-84, "Traffic Stripes and Pavement Markings"

- Updates the requirement that all materials listed must be on the Authorized Materials List for signing and delineation materials.
- Updates section to follow 2010 *Standard Specifications.*

Section 4-85, "Pavement Markers"

- Removes the requirement that only bituminous adhesive is permitted when moving lane closures are used for placement of pavement markers.
- Updates the requirement that listed pavement markers must be on the Authorized Materials List for signing and delineation material.

Section 4-94, "Asphaltic Emulsions"

- Updates references to align with 2010 *Standard Specifications*.
- Adds payment guidance.
- Changes SI units to US customary units.
- Updates certificate of compliance information.
- Notes California Test Methods requirement.

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This manual is being updated to reflect changes from the 2006 to the 2010 *Standard Specifications*.

Section 63 Reserved

Section 63
Reserved

"Cast-in-Place Concrete Pipe" was removed from the 2010 *Standard Specifications*.

If needed, the previous Section 4-63, "Cast-in-Place Concrete Pipe," can be obtained by contacting: construction_publications@dot.ca.gov

Section 65 Concrete Pipe

This manual is being updated to reflect changes from the 2006 to the 2010 *Standard Specifications*. Bracketed section numbers refer to the 2006 *Standard Specifications*.

Section 65 Concrete Pipe

Section 65
Concrete Pipe

4-6501 General

4-6501
General

Concrete pipe is used for culverts, siphons, drains, and conduits. Section 65-2 [*65*], "Concrete Pipe," of the *Standard Specifications*, includes specifications for circular reinforced concrete pipe, oval-shaped reinforced concrete pipe, and reinforced concrete pipe arch. Section 65-3, "Nonreinforced Concrete Pipe," of the *Standard Specifications*, is reserved for specifications for fabricating and constructing nonreinforced concrete pipe. The resident engineer and assistant resident engineers responsible for inspecting reinforced concrete pipe need to be familiar with the specifications and *Standard Plans* that provide for determining the physical characteristics of the pipe. The specifications provide options to the contractor for selecting the class of pipe and earthwork required for installing the pipe. The Office of Materials Engineering and Testing Services (METS) personnel will test and inspect the pipe during manufacturing, but the resident engineer and assistant resident engineers must ensure that the correct combination of class of pipe and earthwork methods are used in each location.

4-6502 Before Work Begins

4-6502
Before Work
Begins

Well before work begins, review the plans and specifications and inspect the sites of all planned installations. Reviewing these items sufficiently in advance helps prevent scheduling conflicts and errors in ordering materials. During the preliminary review and inspections, the resident engineers and assistant resident engineers should also do the following:

- Review the "Materials Information" from METS and ensure that the special provisions cover any special requirements.
- Note any unsolved drainage problems, and make any necessary changes by change order.
- As soon as final locations and lengths are determined, give the contractor a revised pipe list, including those pipes added or altered by change order.
- Verify that Form CEM-3101, "Notice of Materials to Be Used," includes concrete pipe of the type and class specified. Refer to Section 6-202, "Responsibilities and Procedures for Acceptance of Materials," of this manual for additional information. Note that use of direct design method circular reinforced concrete pipe or nonreinforced pipe is permitted under those conditions enumerated in the specifications.

4-6503 During the Course of Work

During work operations, the resident engineer and assistant resident engineers should do the following:

- Once the pipe arrives at the job site, check the identification tags or marks to ensure a METS inspector has inspected the pipe at the source of origin.
- Determine the final acceptability of the pipe using the guidelines in Section 6-2, "Acceptance of Manufactured Material and Sampling Methods," of this manual. Sections of pipe that have met the requirements of the three-edge bearing test may be used in the work. Cracks resulting from the three-edge bearing test are not a reason for rejecting the pipe. Small numbers of hairline cracks and minor chips are not so serious as to require rejecting pipe, either. However, the following problems are not acceptable: pipe with cracks through the wall; exposed reinforcing steel; or damaged bells, spigots, or joint grooves.
- For culverts that have been installed and backfilled, cracks should not exceed 1/100 inch in width in severely corrosive environments (that is, environments consisting of a pH of 5.5 or less, seawater, or water containing vegetal or animal wastes or chloride concentration greater than 500 ppm). Conversely, for culverts installed in a noncorrosive environment (that is, environments consisting of a pH greater than 5.5, water containing animal or vegetal wastes or chlorides concentration less than 500 ppm), cracks of up to 1/8 inch in width in the installed pipe are acceptable if they are not excessive in number. Note the requirements in the specifications for marking pipe. Ensure that pipe of the specified size, type, and class is installed at the proper locations.
- Before structure excavation, require that embankments be constructed as specified. Before installing pipe, determine the acceptability of excavations and any required bedding, as described in the specifications and as shown in the *Standard Plans*. Excavation must occur for each bell to avoid shear cracking.
- Require methods of handling that will not damage the pipe.
- At the contractor's option and expense, the contractor can use extra strong pipe to withstand the pressures of jacking. Ensure any voids resulting from jacking are filled.
- Elliptically reinforced pipe must be placed so the minor axis is vertical. Note the locations of indicators, painted stripes, or lift holes to ensure proper placement. Before the contractor places the backfill, ensure lift holes are plugged.
- Ensure pipes are placed with belled ends upstream. Where possible, pipes should be laid on the upgrade. Progress on the upgrade facilitates tight joints, particularly for pipes on steep grades. However, extending existing pipes downstream will require laying pipe on the downgrade or will require a special connecting structure.
- Joints must have smooth, uniform interior surfaces. Unless otherwise required, joints must be sealed completely with cement mortar, rubber gaskets, or resilient materials. Reject gaskets that have cracks or splits.
- Check the aggregate and the proportioning of cement mortar. The mortar must be used within 30 minutes after the addition of water. Permit the use of admixtures to improve workability, and determine the amounts to be added.

- Ensure rubber gaskets are stored in a cool place away from sunlight. If lubrication is required before installation, require the contractor to follow the manufacturer's instructions.
- Ensure resilient materials are tested before use. During sealing with liquid materials, ensure molds or runners retain the liquid materials. Liquid sealers must be placed continuously and agitated until the joint is completely filled.
- Review backfill details on the contract plans, *Standard Plans*, or both. Determine that the class of reinforced concrete pipe and method of backfill selected by the contractor meet these details. Refer to Section 4-19, "Earthwork," of this manual for additional instructions on excavation and backfill.
- Backfill may be done while the mortar in joints is plastic. However, after the mortar sets, do not permit backfill until 16 hours after sealing. Further, because free water may not contact the pipeline until seals containing portland cement have aged 24 hours, no backfill may be placed during this period if it must be watered in place. Require backfilling in a manner that will not damage seals, whether by direct impact or through displacement of joints. Imported structure backfill should be checked for pH and resistivity levels to verify that the service life of the pipe will not decrease. The limits of concrete backfill, when required, will be shown on the plans. Concrete backfill is paid for as a separate item. The contractor may use slurry cement backfill for backfilling culverts. When either concrete backfill or slurry cement backfill is used, observe carefully and ensure the pipe is not displaced or floated by uneven or too rapid placement. For rapid strength concrete or rapid strength slurry cement backfill, allow only nonchloride admixtures to accelerate the setting time.
- After the backfill of pressure pipes or siphons to 2 feet over the crown, witness the specified hydrostatic tests. Require the repair of all obvious leaks and leak reductions to the maximum permitted. Refer to Section 65-2.01D(2), "Field Testing of Siphon and Pressure Pipe," of the *Standard Specifications*.
- Require that minimum cover for construction loads, as shown in the *Standard Plans*, be placed over reinforced concrete pipe culverts.
- Insist that pipes be protected from damage during continuing operations. Periodically inspect pipes as work progresses. A particularly critical time to inspect comes after the completion of the grading plane and before the start of base and surfacing. During the final phases of the project, make another inspection, primarily to find any pipes that need cleaning.

4-6504 Measurement and Payment

The length of pipe to be paid for is the slope length designated by the engineer. This slope length is the length shown on the plans, plus or minus any changes the engineer makes, or the length as determined from the surveyors' staking notes. If pipe is cut to fit a structure or a slope, the pay length is the length necessary to be placed before cutting, rounded up to the nearest 2-foot increment. If the contractor forms the pipe out from a structure, the formed distance is also part of the length of the pipe necessary before cutting. If the pipe joins a structure at a skew, the length of pipe necessary to be placed before cutting is the longer side of the pipe. Pipe bends, wyes, tees, and other branches must be field measured in accordance with the specifications. The following are examples for measuring culvert pipe when the length to be paid for is the slope length designated by the engineer.

4-6504 Measurement and Payment

4-6504A Case I

PIPE PLACEMENT	CUT OR UNCUT PIPE	PAYMENT METHOD
Pipe between two structures (inside face to inside face of two drop inlets)	Cut	Pay to the nearest 2-foot increment equal to or longer than the pipe necessary before cutting

Example 1:

The length along centerline between the two faces and additional length required due to skew = 62.33 ft

Individual lengths of pipe placed total 60.08 ft, plus additional length made up in joints and by forming out from one structure.

Pipe is cut due to skew at the other structure.

Therefore:

Pay for 64 ft

Example 2:

Centerline length between inside faces not on a skew = 60.75 ft

Lengths of pipe placed total 64.25 ft

Therefore:

Pay for 62 ft

4-6504B Case II

PIPE PLACEMENT	CUT OR UNCUT PIPE	PAYMENT METHOD
Pipe between two structures.	Uncut	Pay the designated length.

Example:

- Slope length along centerline of the pipe between the two inside faces = 145.5 ft
- Individual lengths of pipe placed total 144 ft, plus additional length made up in joints or forming out from one structure, or both.

Therefore:

Pay for 145.5 ft

4-6504C Case III

PIPE PLACEMENT	CUT OR UNCUT PIPE	PAYMENT METHOD
Pipe placed from toe of fill to toe of fill.	Uncut	Pay the slope length the engineer designates.

Example:

- Designated length = 145 ft
- Laid pipe = 146 ft, with the additional length due to the gain in joints.

One end is allowed to extend the additional distance beyond the toe of fill.

Therefore:

Pay for 145 ft

Under the following circumstances, you may use field measurements in lieu of calculations or you may supplement calculations:

1. A pipe runs between two structures. After verifying that the structures are constructed as shown on the plans, you can determine designated length from a field measurement along the centerline of the pipe between the two inside faces. If the pipe is cut, make appropriate adjustments to the field measurement.
2. After verifying that a pipe is properly staked, you may use field measurements between stakes referenced to the ends of the pipe to determine the length designated by the engineer. If you use a field measurement to determine pay lengths, include on the quantity sheet an explanation of how the field measurement relates to the length designated by the engineer.

Section 68 Subsurface Drains

This manual is being updated to reflect changes from the 2006 to the 2010 *Standard Specifications*. Bracketed section numbers refer to the 2006 *Standard Specifications*.

Section 68 Subsurface Drains

Section 68 Subsurface Drains

4-6801 General

4-6801 General

This section covers four types of subsurface drains: underdrains, horizontal drains, edge drains, and geocomposite drain systems.

Subsurface drains remove groundwater from natural soils and formations. The drains are intended to intercept groundwater or lower its level before it adversely impacts the highway.

Be alert for indications of problem groundwater, particularly before clearing and during grading. Swamps, bogs, springs, and areas of lush growth are possible indicators of excess groundwater. Carefully inspect fill foundations before starting embankments. As excavation progresses, personnel may encounter standing water or various aquifers near slopes or at the grade.

If problem groundwater is found, it may be necessary to add subsurface drains.

For anything but minor investigation to determine subsurface conditions, request assistance from the district materials engineer or the district geologist.

4-6801A Underdrains

Underdrains consist of perforated pipe placed in permeable material. Single installations, in which a pipe and filter material are placed in a narrow trench, are used at the following locations: along the toe of a cut slope; along an upstream (with respect to groundwater) toe of fill; and across the roadbed at the lower end of a through cut.

Multiple installations of perforated pipe are used in permeable blankets and stabilization trenches. Permeable blankets are placed over the width of a roadbed and may be considered part of the structural section.

Permeable material is enclosed in filter fabric, which prevents the migration of fine material into the permeable material.

Pipes that act to collect groundwater must be perforated or slotted; however, pipes that discharge collected water should not be perforated or slotted.

When feasible, the contractor should locate underdrain systems below the invert of adjacent storm water systems. When working in the presence of high groundwater tables and highly erodible soils, consider using watertight joints in culverts.

4-6801B Horizontal Drains

Horizontal drains are made from 1-1/2-inch schedule 80 polyvinyl chloride (PVC) pipes. Horizontal drains can be slotted, perforated, or plain. They are placed in holes drilled into aquifers. Normally they are placed in cut slopes or under fills and their purpose is to reduce the possibility of slides or slipouts.

The extent of groundwater may be determined with exploratory, vertical wells. Where the wells may be kept open, such wells serve as gauges to indicate changes in the elevation of the water table. However, in many cases, it is obvious that groundwater requires drainage by horizontal drains because of signs of distress or saturation at the surface. Then, the exploration and installation of drains may occur concurrently. Each newly installed drain adds information needed to solve the problem. For instance, the extent of the aquifer may be discovered or the volume of flow will indicate whether more, or fewer, drains are required.

4-6801C Edge Drains

Edge drains are installed beneath a paved shoulder, just out from the edge of the concrete pavement. Slotted PVC pipe is placed within asphalt-treated or cement-treated permeable material that is partially encapsulated in filter fabric. These drains remove water from the structural section and prevent migration of fine material from the base or subbase to the area beneath the slab.

4-6801D Geocomposite Drain Systems

Geocomposite drain systems are most commonly used as structure approach drainage systems, which consist of geocomposite drain, filter fabric, plastic pipe, treated permeable base, and drainage pads.

4-6802 Before Work Begins

4-6802 Before Work Begins

During this preliminary inspection, take the following steps:

- Ensure the contractor requests staking for control of line and grade.
- Verify that Form CEM-3101, "Notice of Materials to Be Used," includes all fabricated materials. Refer to Section 6-2 "Acceptance of Manufactured Material and Sampling Methods" and Section 6-3 "Field Tests," of this manual for additional information.
- Ensure the contractor has provided a certificate of compliance for each type of subsurface drain. The certificate of compliance must cover the pipe, tubing, fittings, and specified materials to be used. Generally, there will be no Form TL-0624, "Inspection Release Tag," for these materials with the exception of coatings or fasteners used with subsurface drains.
- Ensure that permeable material is of the class required under the contract.
- Double-check to ensure the use of the proper type and size of materials at each location, and verify the planned quantities for solid and perforated pipe.

4-6802A Underdrains

- Review the locations planned for underdrains to ensure that all areas requiring underdrains have been identified.
- Review Sheet D102 of the *Standard Plans* for underdrain details.

4-6802B Horizontal Drains

- Determine the drain locations and sequence of placement based on plans, exploration work, and observations during excavation. Determine the system by which horizontal drains will be designated and marked, and provide the contractor with this information.

- Plan the placement of collectors and outlets so they are positioned for public safety and ease of maintenance operations.
- Verify planned quantities.

4-6802C Edge Drains

- See Section 4-29, “Treated Permeable Bases,” of this manual for guidelines for the production of treated permeable material.
- Verify planned quantities.
- Review sheets D99A, D99B, D99C, and D99D in the *Standard Plans* for edge drain details.

4-6802D Geocomposite Drain Systems

- Obtain a certificate of compliance for geocomposite drain and accompanying flow capability graph with authorized laboratory verification. Geocomposite drain material must conform to Section 88-1.02C, "Geocomposite Wall Drain," of the *Standard Specifications* unless otherwise specified.
- Review project plan sheets for structure approach drainage details with geocomposite drain systems. Project plan sheets may also identify "Weep Hole and Geocomposite Drain" alternatives, which contractors may choose to use.

4-6803 During the Course of Work

4-6803 During the Course of Work

During the work, take the following steps:

- Subsurface drains are hidden from view for the most part, so ensure complete as-built records are created. Pictures, plans, elevations, and complete descriptions will enable efficient and more complete maintenance and repair.
- Ensure the contractor conforms to the water pollution control plan in handling any water discharged from subsurface drains.

4-6803A Underdrains

- Immediately before placing the filter fabric, examine the condition of the trench. Require the contractor to remove any loose material and also any sharp objects that may damage the filter fabric.
- Observe the placement of the filter fabric, and ensure that any tears or punctures are repaired as specified.
- Ensure that permeable material is of the class required under the contract.
- In accordance with frequencies shown in Section 6-1, “Sample Types and Frequencies,” of this manual, test the permeable material for all specified attributes.
- Initially, more frequent testing may be advisable if any indication exists that segregation or contamination is occurring during handling and placing.
- Require the contractor to place pipe in the manner specified in Section 68-2.03 [*68-1.03*], “ Construction,” in the *Standard Specifications*.
- Terminal cleanouts and intermediate risers are vulnerable to damage throughout the contract’s life. Before recommending contract acceptance, ensure they are in good condition.

4-6803B Horizontal Drains

- Require the contractor to determine the elevation of drilled holes at specified intervals. Record these for inclusion in the permanent records.
- Determine the length of nonperforated pipe to be placed at the drain mouths. Use the minimum specified length when the aquifer extends to the surface. Require outlet pipes to be connected to the collector system.
- Require the space between the drilled hole and the pipe to be tightly plugged with earth, as specified.
- Keep a boring log of material types encountered during drilling; also keep a log of production rates.
- Each drain must be identified by a brass plate bearing an assigned number or other label. Collect data about the drain's location, outlet elevation, grade, lengths of drilled hole and casing, plan of system, and flow. Furnish this data, including the identification information, to the Office of Geotechnical Services in the Division of Engineering Services.
- For the most part, horizontal drains are hidden from view, so ensure complete as-built records are created. Pictures, plans, elevations, and complete descriptions will enable efficient and more complete maintenance and repair.

4-6803C Edge Drains

- Inspect trench excavation for proper location, alignment, and cross-sectional dimensions. Require the contractor to remove any loose material and also any sharp objects that may damage the filter fabric during installation.
- Observe the installation of the filter fabric. Require that it be free of wrinkles and that any tears or punctures are repaired as specified.
- Verify that the contractor meets the requirements for atmospheric temperature and mix temperatures for cement-treated and asphalt-treated permeable materials.
- Cement-treated permeable material delivered in truck mixers may have a tendency to segregate at the end of the load. When the material is obviously segregated, do not permit its use. An excess of fines and water can enter and plug the slotted pipe. Moreover, an overly coarse aggregate grading may not bond and will be unstable.
- Require that the curing of cement-treated permeable material meets specifications.
- Require that edge drains, vents, and cleanout pipes be tested, as required by the specifications, for obstructions. Animal guards, if required, should be positioned immediately after the placement of the drains. Pipes may also be damaged by asphalt-treated material that is too hot or may be plugged by excessive free mortar in cement-treated permeable material. Observe all testing, and record that it was done. Require the replacement of any pipe that the flushing nozzle cannot penetrate.
- For the most part, edge drains are hidden from view, so ensure complete as-built records are created. Pictures, plans, elevations, and complete descriptions will enable efficient and more complete maintenance and repair.

4-6803D Geocomposite Drain Systems

- Ensure that the geocomposite drain is installed with the filter fabric side facing the embankment and oriented so that corrugations are placed perpendicular to the drainage collection system.
- Ensure that joints in the geocomposite drain have the required overlaps and positioning is maintained throughout subsequent operations.
- Ensure that exterior edges are wrapped with filter fabric to prevent soil migration from these areas.
- Require any tears or punctures in the fabric of the gecomposite drain be replaced with new fabric or repaired as specified.

4-6804 Measurement and Payment

4-6804 Measurement and Payment

Measurement and payment must conform to the special provisions, *Standard Specifications*, or both.

Underdrains, horizontal drains, edge drains, and geocomposite drains each have different measurement and payment clauses.

For underdrains and edge drains, see Section 4-65, "Concrete Pipe," in this manual for a discussion of slope length designated by the engineer. Note that in sections 68-2 [*68-1*] "Underdrains," and 68-4 [*68-3*], "Edge Drains," of the *Standard Specifications* the actual length designated is to be paid for, and no provision exists for paying for additional length due to cutoff.

As horizontal drain installation progresses, measure the length of drain placed so that a final quantity can be determined.

Payment for geocomposite drains is included in related items of work unless specifically excluded.

This manual is being updated to reflect changes from the 2006 to the 2010 *Standard Specifications*. Bracketed section numbers refer to the 2006 *Standard Specifications*.

Section 69 Overside Drains

4-6901 General

Overside drains consist of various types of pipes, flumes, and lined ditches installed to remove surface water from highways or from benches in cut or fill slopes.

4-6902 Before Work Begins

During this preliminary inspection, take the following steps:

- Review the project with the maintenance superintendent to assess any problem drainage areas.
- Review sheets D87A, D87B, D87C, and D87D in the *Standard Plans* for information on downdrains and overside drains.
- Verify that Form CEM-3101, "Notice of Materials to Be Used," includes all fabricated materials. Refer to Section 6-2, "Acceptance of Manufactured Material and Sampling Methods," and Section 6-3, "Field Tests," of this manual for additional information.
- Ensure the contractor has provided a certificate of compliance for steel, aluminum, and plastic materials used in overside drains. Generally, there will be no Form TL-0624, "Inspection Release Tag," for these materials with the exception of coatings used with overside drains.
- Check the condition of the materials to discover any damage possibly sustained during shipping and handling. Require the repair of minor damage to coatings or galvanizing. (See Section 66-1.02C [*66-1.03*], "Protective Coatings, Linings, and Pavings," and Section 75-1.05, "Galvanizing," of the *Standard Specifications*.) If satisfactory repair cannot be achieved, require unacceptable materials to be removed from the project.
- Inspectors from the Office of Materials Engineering and Testing Services (METS) will inspect and test any coating materials.
- Review any planned installations of metal beam guardrail. If overside drains are in a metal beam guardrail area, consider using long span nested guard rail. (See the *Traffic Manual*, Chapter 7-03.6, "Guardrail Design Considerations" and Figure 7.9, "Long Span Nested Guardrail.")
- Review plans and planned overside drain locations by verifying design with the actual field surveys. Make any necessary changes and give the contractor a revised list of lengths.
- You can determine the exact location of overside drains, in an area where the grade is flat, by having a water truck dump part of its load in the gutter and cutting the dike where the water ponds.

Section 69 Overside Drains

4-6901 General

4-6902 Before Work Begins

4-6903 During the Course of Work

4-6903 During the Course of Work

During work, take the following steps:

- Determine that pipe sections have watertight joints and are properly installed.
- As specified in Section 19 of the *Standard Specifications*, ensure the contractor disposes of the surplus material resulting from excavation and performs the backfill.
- Ensure entrance areas are watertight.
- Require fog sealing of all asphalt concrete spillways and downdrain entrance areas.

4-6904 Measurement and Payment

4-6904 Measurement and Payment

Count entrance tapers, tapered inlets, reducers, slip joints, and anchor assemblies. The length of downdrain pipe and flume to be paid for is the length ordered by the engineer with an adjustment when downdrain pipe is cut to fit a structure or slope. The length ordered by the engineer is the length shown on the plans or any revised lengths the resident engineer deems necessary to meet field conditions. In the lengths of pipe and flume downdrains to be paid for, do not include lengths of tapered inlets and entrance tapers (including tail pipe and slip joints).

For additional information, see the discussion on measuring pipe in Section 4-65, "Concrete Pipe," of this manual.

This manual is being updated to reflect changes from the 2006 to the 2010 *Standard Specifications*. Bracketed section numbers refer to the 2006 *Standard Specifications*.

Section 70 Miscellaneous Drainage Facilities

Section 70 Miscellaneous Drainage Facilities

4-7001 General

4-7001 General

Items covered under this section are related to water drainage facilities, water transmission pipe lines, and casings for bridges.

4-7002 Before Work Begins

4-7002 Before Work Begins

Before work begins, take the following steps:

- Verify that Form CEM-3101, "Notice of Materials to Be Used," includes drainage facilities and appurtenances. Refer to Section 6-202, "Responsibilities and Procedures for Acceptance of Materials," of this manual for additional information.
- Before the contractor places orders, notify the contractor of any changes affecting quantities of miscellaneous drainage facilities.

4-7003 During the Course of Work

4-7003 During the Course of Work

Once work begins, take the following steps:

- Check all items as they are delivered to the job site to ensure that the Office of Materials Engineering and Testing Services has released the materials for shipment. Also, inspect the materials in accordance with Section 6-2, "Acceptance of Manufactured Material and Sampling Methods," of this manual. Pay particular attention to precast concrete facilities and linings and coatings. Throughout the life of the project, continue to observe and inspect these items for any possible damage by the contractor's operations.
- Determine that the various components at each installation are properly matched. Prohibit the combined use of aluminum and steel in the same installation except as the specifications permit.
- Observe and record the results of any pressure tests of welded steel pipes.
- Before constructing pipe manholes or inlets to the final grade, require that new pavement or surfacing be completed immediately adjacent to the structure.

4-7004 Measurement and Payment

4-7004 Measurement and Payment

No adjustment in length is made when pipe is cut to fit a structure.

To properly measure and pay for the various items covered in this section, carefully read the payment clauses in the *Standard Specifications*. Payment for excavation and backfill is included in the payment for the type of miscellaneous drainage facility work involved.

This manual is being updated to reflect changes from the 2006 to the 2010 *Standard Specifications*. Bracketed section numbers refer to the 2006 *Standard Specifications*.

Section 82 Markers and Delineators

Section 82 Markers and Delineators

4-8201 General

4-8201 General

This section describes the work for providing and installing markers and delineators at locations shown on the plans or where the engineer directs. Object markers are used to mark obstructions within or adjacent to the roadbed, including paved shoulders. Delineators are reflective devices installed in a series at the side of the roadway to indicate the roadway alignment.

4-8202 Before Work Begins

4-8201 Before Work Begins

Before work begins, take the following steps:

- Review the marker and delineator lists shown on the plans, and inform the contractor of any changes, preferably before material is ordered or information is stenciled on the markers. The *California Manual of Uniform Traffic Control Devices (California MUTCD)*, Part 3, provides design details for markers and delineators.
- Verify that Form CEM-3101, "Notice of Materials to Be Used," includes markers and delineators. All materials listed on Form CEM-3101 must be on the authorized materials list for signing and delineation materials. Refer to Section 6-202, "Responsibilities and Procedures for Acceptance of Materials," of this manual for additional information.
- Examine markers and delineators to ensure they meet specification. Verify that they match the materials shown on Form CEM-3101 and that a correctly prepared certificate of compliance accompanies the material.
- Provide the contractor with a list of post mile values to be stenciled on highway post markers.
- Order and obtain the Department-furnished material identified in the special provisions.

4-8203 During the Course of Work

4-8203 During the Course of Work

Inspect the materials and method of installation according to the *Standard Specifications* and special provisions. This inspection will include, but is not limited to, the following steps:

- Ensure that the contractor's layout work conforms to the plans.
- Document and approve minor deviations from the plans.
- Before the material is incorporated, inspect material either by collecting the inspection tags or matching the material against information in the certificate of compliance.

- Ensure that the contractor follows the method of placement specified in the *Standard Specifications* and the special provisions.
- During the installations of target plates, check that the contractor has used washers and installed nuts and rivets properly.
- After installation, check for any damage to the installed material; document any rejections.
- Do a night inspection to check and document the reflectivity of the installed material. If you encounter any problems, notify the contractor immediately so the contractor can make corrections.

4-8204 Measurement and Payment

4-8204 Measurement and Payment

Count markers and delineators, and record the counts to support partial and final payments.

This manual is being updated to reflect changes from the 2006 to the 2010 *Standard Specifications*. Bracketed section numbers refer to the 2006 *Standard Specifications*.

Section 84 Traffic Stripes and Pavement Markings

Section 84 Traffic Stripes and Pavement Markings

4-8401 General

4-8401 General

This work consists of applying painted and thermoplastic traffic stripes and pavement markings. The special provisions may also allow the contractor to substitute traffic striping and pavement marking tape. The bid items, special provisions, and the contract plans will indicate when and where the contractor must use paint or thermoplastic.

4-8402 Before Work Begins

4-8402 Before Work Begins

Before work begins, the resident engineer should discuss the operation with the maintenance striping superintendent or supervisor. Ask if there are any particular striping or marking concerns or requests that should be addressed. In addition, the resident engineer should take the following preliminary steps:

- Discuss materials to be used with the contractor. If the contractor plans to use solvent-borne or acetone-based paint, ensure its use conforms to the regulations of the local agency for air pollution control.
- Review striping and marking plans, standard details, and any special requirements.
- Review existing field conditions. Consult with district traffic unit personnel if any changes appear to be necessary.
- Verify that Form CEM-3101, "Notice of Materials to Be Used," includes striping tape, paint, thermoplastic material, and glass beads. All materials listed on Form CEM-3101must be on the authorized materials list for signing and delineation materials. Refer to Section 6-202, "Responsibilities and Procedures for Acceptance of Materials," of this manual for additional information.
- Examine the material as it arrives on the project. Look for identification tags indicating that personnel from the Office of Materials Engineering and Testing Services previously inspected the material.
- Read the manufacturer's instructions for striping tape and thermoplastic materials. When primer is required, determine the type the manufacturer recommends. Also determine the application temperature range for the thermoplastic material.
- Inspect the contractor's equipment for specification compliance either in the contractor's or subcontractor's yard or on another project. Examine the contractor's methods for checking spread rates of paint and glass beads, application temperatures of thermoplastic material, and maximum temperatures of paint.

- Ensure that the contractor's stencils will produce correctly dimensioned pavement markings.

4-8403 During the Course of Work

4-8403 During the Course of Work

During the work, do the following:

- Check the contractor's layout work. Determine that traffic stripes and pavement markings will be correctly located. Where necessary, assist the contractor to match existing striping cycles.
- Require that thermoplastic material be placed within the specified temperature range. Thermoplastic material heated to excessive temperatures can flash and splatter when exposed to air. Check for accuracy the temperature gages mounted on heating equipment. Ensure employees working around thermoplastic material wear suitable personal safety equipment, long-sleeved shirts, and eye protection.
- Before the contractor applies thermoplastic material, check and document the pavement temperature.
- Before the contractor applies paint, check and document the atmospheric temperature and expected weather conditions. Never allow the contractor to apply paint when rain, fog, or condensation could damage the freshly painted surface.
- Require that paint temperatures not be allowed to exceed the specified maximums for solvent-borne or water-borne paints.
- Before the contractor applies striping or markings, check the condition of the pavement. Require the pavement to be dry and clean as specified.
- Check traffic stripes for the correct width and edge definitions, lengths of gaps and individual stripes, alignment, direction of application, and correct superimposition of second coats.
- Require the contractor to remove drips, overspray, improper markings, and material tracked by traffic.
- Check that the applied thermoplastic material complies with thickness requirements.
- Check application rates for glass beads and paint. Inspect the stripes to ensure that glass beads are spread uniformly and properly embedded.
- Check thermoplastic markings for workmanship as the markings are applied. Do not permit bumps resulting from overlaps in extruded materials. Check complete thermoplastic traffic stripe or thermoplastic pavement marking to ensure it is free of runs, bubbles, craters, drag marks, stretch marks, and debris.
- After application, look for any damage to striping or marking and document any rejections.
- Conduct and document an immediate night inspection to ensure the reflectivity of the installed material. If you encounter any problems, notify the contractor immediately for corrections.

4-8404 Measurement and Payment

4-8404
Measurement and
Payment

Measure the striping and markings according to the units and manner specified in the *Standard Specifications* and the special provisions. Record such measurements in the daily reports and the calculation sheets to support partial and final payments.

The *Standard Specifications* require measurements along the line of the traffic stripe. Such measurement would normally be done with a measuring wheel or a vehicle-mounted electronic measuring device.

The areas of the various standard pavement markings are shown in the *Standard Plans*. You may use these areas in calculations to determine pay quantities. Where the areas are variable, such as for limit lines of variable lengths, you will need to make field measurements.

This manual is being updated to reflect changes from the 2006 to the 2010 *Standard Specifications*. Bracketed section numbers refer to the 2006 *Standard Specifications*.

Section 85 Pavement Markers

4-8501 General

This work consists of furnishing and placing retroreflective, nonreflective, and retroreflective-recessed pavement markers. In addition to the information in this section of this manual, see the following:

- For details about placing pavement markers, see the "Pavement Markers and Traffic Lines, Typical Details" sheets of the *Standard Plans*.
- For the specifications for epoxy adhesive, see Section 95, "Epoxy," of the *Standard Specifications*.
- For the specifications for hot-melt bituminous adhesive, see Section 85, "Pavement Markers," of the *Standard Specifications*.

When specified, pavement markers may be placed using a moving lane closure to control traffic. The special provisions and *Standard Plans* provide details for moving lane closures.

In areas subject to snow, the specifications may require the contractor to place pavement markers in recesses in the pavement.

4-8502 Before Work Begins

Before work begins, take the following steps:

- Review plans, the *Standard Specifications*, and the special provisions.
- Review the contractor's proposed method of controlling traffic and ensure that all the specified components of any required traffic control system are in place.
- Verify that Form CEM-3101, "Notice of Materials to Be Used," includes pavement markers and adhesive material. Listed pavement markers must be on the authorized materials list for signing and delineation materials. Refer to Section 6-202, "Responsibilities and Procedures for Acceptance of Materials," of this manual for additional information.
- Examine materials as they arrive on the project to ensure they are the same as the materials shown on Form CEM-3101 and that they arrive with a correctly prepared certificate of compliance.
- Take samples, when necessary, in accordance with the sampling frequency tables in Chapter 6, "Sampling and Testing," of this manual.
- When the contractor is to use bituminous material, check the maximum safe heating temperature recommended by the manufacturer.
- Inspect the contractor's equipment, and determine the method to be used for checking the bituminous adhesive temperature.

Section 85 Pavement Markers

4-8501 General

4-8502 Before Work Begins

- Check the contractor's layout work to ensure correct alignment and spacing.
- Determine the proposed method of removing and disposing of residue from pavement recesses.
- Do not permit pavement removal to begin until the contractor has submitted the required documents.

4-8503 During the Course of Work

During the work, do the following:

- Before the placing of pavement markers, ensure that pavement has cured for the specified time.
- Before the contractor applies adhesives, ensure the pavement is clean and the surface dry.
- Check pavement and air temperatures.
- Verify markers are placed using the correct adhesive.
- When the contractor uses epoxy adhesive which comes in two separate components, check the mixing for specification compliance. Ensure the proportions of the two components match the specifications. During the placing of pavement markers, observe the epoxy adhesive to ensure it is uniformly gray without black or white streaks. Even minor variations in the correct proportions of the two components will weaken the adhesive quality of epoxy.
- Verify that the application temperature of bituminous adhesive is within the specified range.
- Determine that the contractor meets the time requirements between mixing adhesive and placing pavement markers.
- Determine that the patterns and types of pavement markers are placed correctly in accordance with the typical details on the plans.
- After placement, determine that the pavement markers are not on longitudinal or transverse joints and that they are fully supported with adhesive.
- Also after placement, look for any missing or damaged pavement markers and document any rejections. Conduct and document an immediate night inspection to ensure the reflectivity of the installed material. If you encounter any problems, notify the contractor immediately for corrections.

4-8504 Measurement and Payment

Measure the pavement markers according to the units specified in the *Standard Specifications* and the special provisions. Record such measurement in the daily reports and the calculation sheets to support partial and final payments.

When large quantities of pavement markers will be placed, you may count the markers by keeping track of the number of boxes of markers used. Check this number against the theoretical number of markers to be placed.

This manual is being updated to reflect changes from the 2006 to the 2010 *Standard Specifications*. Bracketed section numbers refer to the 2006 *Standard Specifications*.

Section 94 Asphaltic Emulsions

Section 94 Asphaltic Emulsions

4-9401 General

4-9401 General

Asphaltic emulsions are described in Section 94, "Asphaltic Emulsions," of the *Standard Specifications*. They are used for bituminous seals and tack coat. Asphaltic emulsions are also used for other purposes, such as curing seals for lime stabilization and cement-treated base and for coating the surface of cement-treated permeable base to facilitate measuring the thickness of concrete pavement.

In addition to the specifications for asphaltic emulsions in Section 94, of the *Standard Specifications*, refer to the requirements for asphaltic emulsions in other sections of the *Standard Specifications*—Sections 18, 24, 27, 37, 39, 40, 66, 86—covering work in which asphaltic emulsions are used.

Refer to the *Tack Coat Guidelines* for more information at the following address:

http://www.dot.ca.gov/hq/construc/publications/tackcoatguidelines.pdf

4-9402 Before Work Begins

4-9402 Before Work Begins

Before work begins, take the following steps:

- Verify that Form CEM-3101, "Notice of Materials to Be Used," includes asphaltic emulsion. Refer to Section 6-202, "Responsibilities and Procedures for Acceptance of Materials," of this manual for additional information.
- Examine the distributor truck to ensure it meets the specified requirements.
- Ensure the contractor properly equips delivery trucks, storage tanks, and spreading equipment with specified devices for measuring volumes of asphaltic emulsion.
- Verify the receipt of a certificate of compliance.
- If the polymer content of polymer modified asphaltic emulsion is determined under California Test Method 401, verify that the contractor has submitted a sample to the Office of Engineering Materials and Testing Services.

4-9403 During the Course of Work

4-9403 During the Course of Work

During the work, take the following steps:

- If asphaltic emulsion is used before sampling and testing, obtain a certificate of compliance containing the specified information.
- Check the temperature of the asphaltic emulsion to ensure it is within the specified range when applied.
- Before asphaltic emulsion is applied, ensure the surface to be treated is clean and dry.
- Ensure that asphaltic emulsion is not sprayed outside designated areas and that bituminous material does not drip from distribution equipment.

- Check the application rate of asphaltic emulsion to ensure the designated rate. After the first few hundred feet of application, check the initial spread rate. The frequency for checking the spread rate will depend on the accuracy and consistency of the first few checks. Record the spot-check results and the overall daily spread rate in the daily report.
- Sample asphaltic emulsion in accordance with the table in Section 6-1, "Sample Types and Frequencies," and the instructions in Section 6-202E, "Materials Accepted on the Basis of a Certificate of Compliance," of this manual. If water has been added to the asphaltic emulsion, note on Form TL-0101, "Sample Identification Card," the ratio of added water to the total mixture.

4-9404 Measurement and Payment

4-9404 Measurement and Payment

Section 94, "Asphaltic Emulsions," of the *Standard Specifications*, does not contain provisions for payment. Asphaltic emulsion is paid for as part of the item of the work, unless a separate bid item requires payment by ton measured in accordance with Section 93, "Liquid Asphalts," of the *Standard Specifications*. Asphaltic emulsion is subject to adjustment for price index fluctuations in accordance with Section 9-1.07 of the *Standard Specifications*.

Obtain weight tickets for deliveries of asphaltic emulsion.

It is a good practice, before the asphaltic emulsion is discharged, to measure the volume in the distributor and to make this volumetric measurement again whenever a partial load leaves the work. These actions result in a good check against scale weights, and the second measurement may be used if the contractor fails to submit a weight ticket for the unused asphaltic emulsion.

When the specifications provide for additional water to be mixed with asphaltic emulsion, it is necessary to determine the mass of asphaltic emulsion without the mass of the added water. Delivery weight tickets will show the mass of the emulsion before water was added and the total mass of asphaltic emulsion and added water.

When making volumetric measurements, measure the temperature and apply the proper factors for converting volume to mass.

In a partial load using volumetric measurements, the procedure for determining the mass of asphaltic emulsion with added water is as follows:

- Measure the volume and temperature of the mixture in the partial load. Calculate the volume of emulsion in the original load at the temperature of the partial load. Convert tons of added water in the original load to gallons.
- Based on the final temperature reading, calculate the ratio of the volume of asphaltic emulsion to the total volume in the original load.
- Calculate the volume, at 60°F of emulsion in the partial load.
- Determine the mass of emulsion remaining in the partial load.

Example:

Assume the following:

- Weight ticket shows 10.00 tons of emulsion and 5.00 tons of added water. (Total = 15 tons) Temperature at the time of weighing was 131°F.
- 534 gallons of emulsion and added water remain in the partial load. At the time of measuring, the temperature of the mixture is 131°F.

Using these assumptions, calculate as follows:

1. Volume of emulsion at 131°F in the original load:

   10.00 tons x 240 gallons/ton at 60°F ÷ 0.98225 (see the conversion table in Section 94-1.04 [*94-1.07*], "Payment," of the *Standard Specifications*) = 2443 gallons

2. Volume of added water in the original load:

   (5 tons x 2000 lbs.) / 8.33 lb./gallon = 1200 gallons

3. Ratio of volume of emulsion at 131°F to total volume in the original load:

   2443/3643 = 0.671

4. Volume at 60°F of emulsion in the partial load:

   0.671 x 534 x 0.98225 = 352 gallons

5. Mass of emulsion in partial load:

   352 ÷ 240 = 1.46 tons

6. Emulsion used on the project:

   10.00 – 1.46 = 8.54 tons