DEPARTMENT OF TRANSPORTATION
DIVISION OF ENGINEERING SERVICES
OFFICE ENGINEER
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SACRAMENTO, CA 95816-8041
FAX (916) 227-6214
www.dot.ca.gov/hq/esc/oe

Serious Drought.
Help save water!

February 22, 2016

07-Ven-33-40.0/42.0
07-2W9304
Project ID 0715000020

Addendum No. 1

Dear Contractor:

This addendum is being issued to the contract for CONSTRUCTION ON STATE HIGHWAY IN VENTURA COUNTY ABOUT 28 MILES NORTH OF OJAI FROM 1.0 MILE NORTH OF ADOBE CANYON BRIDGE TO 0.7 MILE SOUTH OF PINE MOUNTAIN RIDGE ROAD to revise the *Notice to Bidders and Special Provisions*.

Submit bids for this work with the understanding and full consideration of this addendum. The revisions declared in this addendum are an essential part of the contract.

Bids for this work will be opened on Tuesday, March 1, 2016.

In the Special Provisions, Section 30-6, is replaced as attached.

In the Special Provisions, Section 39-8, is replaced as attached.

To *Bid* book holders:

Inquiries or questions in regard to this addendum must be communicated as a bidder inquiry and must be made as noted in the *Notice to Bidders* section of the *Notice to Bidders and Special Provisions*.

Submit the *Bid* book as described in the *Electronic Bidding Guide* at the Bidders' Exchange website.

http://www.dot.ca.gov/hq/esc/oe/electronic_bidding/electronic_bidding.html

Inform subcontractors and suppliers as necessary.

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Inform subcontractors and suppliers as necessary.

This addendum, EBS addendum file and attachments are available for the Contractors' download on the Web site:

http://www.dot.ca.gov/hq/esc/oe/project_ads_addenda/07/07-2W9304

If you are not a *Bid* book holder, but request a book to bid on this project, you must comply with the requirements of this letter before submitting your bid.

Sincerely,

Shirley Choate

for CARRIE BOWEN
District Director

Attachments

Replace section 30-6 of the RSS with:

30-6.01 PAVEMENT RECYCLING WITH INTELLIGENT COMPACTION

30-6.01A GENERAL

30-6.01A(1) Summary

Section 30-6 includes specifications for compaction of cold in-place recycling (CIR) utilizing intelligent compaction. This is a pilot project for evaluating intelligent compaction and the Department will not consider a VECP that substitutes the processes or equipment specified in this section 30-6. Intelligent compaction does not waive any specifications for CIR.

Intelligent compaction uses vibratory steel drum rollers with intelligent compaction equipment and static pneumatic tire rollers equipped with automated machine guidance system that provide the roller operator with real time information for quality control and produce data for standardized software Veta. For Veta, go to:

www.intelligentcompaction.com

Use Veta to analyze the data for coverage uniformity and intelligent compaction measurement values.

Create project layout files for the intelligent compaction system, automated machine guidance system and Veta from the existing pavement using GPS rover calibrated for the project site.

Project layout files must delineate the CIR construction area of the project.

30-6.01B Definitions

action limit: T*he minimum and maximum values of a quality control measurement that can be interpreted as representing acceptable performance with respect to the parameter being tested. Values less than the minimum or greater than the maximum action limit or level indicate that corrective action must be taken by the contractor.*

all passes data: Compaction data that contain measurements from all passes.

automated machine guidance roller: Rollers equipped with measurement devices installed by the roller manufacturer or a post manufacture retrofit system including GPS, temperature sensor, on-board documentation system, and displays.

bonded layer: Pavement structural section material bonded in a matrix by asphalt, cement, or any other stabilization agent.

California coordinate system of 1983 (CCS83): A set of 6 geographic zones or coordinate systems designed for specific regions of the State of California, the boundaries of which follow county lines. CCS83 is based on NAD83. When a project crosses state plane zone boundaries, a single zone will be used for the entire project.

compaction data: Data collected by intelligent compaction equipment and automated machine guidance compaction equipment.

coordinated universal time (UTC): A time measurement system commonly referred to as Greenwich Mean Time (GMT) based on a 24-hour time scale from the mean solar time at the Earth's prime meridian (zero degrees longitude) located near Greenwich, England

coverage: Roller single pass over a given area.

dynamic cone penetration test: ASTM D6951 is used to assess in situ strength of undisturbed soil and compacted materials or both.

dynamic cone penetration index: The vertical movement of the dynamic cone penetration cone produced by one drop of the hammer, expressed in inch per blow.

final coverage: Compaction data that contain the last pass measurements for a given area.

foot: Unit of measurement equal to U.S. survey foot.

geodetic coordinates: A coordinate system to describe a position in longitude, latitude, and altitude above the imaginary ellipsoid surface based on a specific geodetic datum. The NAD83 datum is required for use with CCS83 State Plane Coordinates.

global positioning system (GPS): A space-based satellite navigation system that provides location and time information in all weather, anywhere on or near the Earth to determine the location in geodetic coordinates. GPS refers to all GPS-related signals including US GPS, and other Global Navigation Satellite Systems (GNSS). GPS satellite signals are subject to interference from canyons, buildings, trees or even fencing. Not all locations are suitable for GPS techniques, and it is your responsibility to determine if the site conditions are practical for GPS, and to notify the Engineer if they are not.

GPS base station: A single ground-based system consisting of a GPS receiver, GPS antenna, and telemetry equipment (typically radio and radio antenna or cellular phone) to provide L1/L2 differential GPS correction signals to other GPS receivers.

GPS correction service subscription: A service that can be subscribed to receive differential GPS correction signals for higher accuracy GPS positioning without the need of a GPS Base Station. Signals are normally received via cellular wireless data services. Examples of GPS correction service subscriptions are: Trimble VRS™, Leica Smart RTK™, Topcon TopNet™ or OmniSTAR™.

GPS rover: A portable L1/L2 GPS antenna, mount, and receiver with telemetry equipment for Real Time in-situ point measurements.

GPS site calibration or localization: A process to establish a relationship between the observed GPS coordinates and the known grid coordinates.

grid: A Cartesian system of XY (or North-East) coordinates utilizing the California State Plane Coordinates, known as the California Coordinate System of 1983 (CCS 83).

intelligent compaction measurement value: A generic term for measurements of resistance to deformation of underlying material based on the responses of the roller drum vibrations in units specific to the roller manufacturer.

intelligent compaction equipment: Measurement devices installed by the roller manufacturer or a post manufacture retrofit system including accelerometer, GPS, temperature sensor, on-board documentation system, and displays.

intelligent compaction roller: Rollers equipped with measurement devices installed by the roller manufacturer or a post manufacture retrofit system including accelerometer, GPS, temperature sensor, on-board documentation system, and displays.

intelligent compaction target value: Compaction target values established at test strip or specified that are used by roller operator to monitor compaction and in data analysis to generate compaction quality control report.

network real time kinematic (Network RTK): A system of multiple bases in real-time to provide high-accuracy GPS positioning within the coverage area that is generally larger than that covered by a single GPS base station.

real time kinematic global positioning system (RTK-GPS): A system based on the use of carrier phase measurements of the available GPS signals where a single GPS base station or RTK network provides the corrections in order to achieve centimeter-level accuracy in real time.

roller pass: The area covered by one width of the roller in a single direction.

universal transverse mercator (UTM) coordinate system: Is a 2-dimentional Cartesian coordinates system that divides the surface of Earth between 80°S and 84°N latitude into 60 zones, each 6° of longitude in width and centered over a meridian of longitude. Zone 1 is bonded by longitude 180° to 174° W and is centered on the 177th West meridian. The UTM system uses projection techniques to transform an ellipsoidal surface to a flat map that can be printed on paper or displayed on a computer screen. Note that UTM is metric-based.

30-6.01C Submittals

30-6.01C(1) General

At least 15 days before mapping the existing pavement, you must register with the Department's secure file sharing system. To obtain information on the registration process, send an e-mail with your contact information to the following electronic mailbox address:

IC@dot.ca.gov

Forms for intelligent compaction submittals are available at:

http://www.dot.ca.gov/hq/construc/ic/

30-6.01C(2) Intelligent Compaction Training

30-6.01C(2)(a) Just-In-Time Training

Submit a list of names participating in the just-in-time training at the time of the mix design submittal. Identify each participant’s name, employer, title, and role in intelligent compaction.

At least 10 days prior to just-in-time training, submit:

1. Just-in-time training presentation and handouts for review.
2. Completed *Intelligent Compaction Field Operations Just-In-Time Training Checklist* form
3. Completed *Geospatial Data and Analysis Just-In-Time Training Checklist* form

30-6.01C(2)(b) Intelligent Compaction Quality Control Technician Training

At least 15 days before performing intelligent compaction, submit the name of your intelligent compaction quality control technician. Effective July 1, 2016, submit documentation that the technicians have completed a Department authorized intelligent compaction quality control training course within the last 12 months.

30-6.01C(2)(c) Data Analysis Technician Training

At least 5 days before CIR production, submit the name of your data analysis technician. Effective July 1, 2016, submit the technician has completed a Department authorized intelligent compaction data analysis and reporting training course within the last 12 months.

30-6.01C(3) GPS Site Calibration or Localization Report and Check Testing

Submit GPS site calibration or localization report and check testing results for compaction rollers within 1 business day of calibration, localization or check testing.

30-6.01C(4) Reports and Information

30-6.01C(4)(a) General

If unable to submit or upload report and information within the specified time, notify the engineer of the actions being taken to submit and upload information timely.

30-6.01C(4)(b) Reports

30-6.01C(4)(b)(i) Mapping Existing Pavement

At least 5 working days before sampling for mix designs for CIR, submit:

1. Hard copy of completed *Intelligent Compaction Cold-In-Place Recycling Mapping Summary Report*
2. Adobe *.pdf file of the mapping report by email to the Engineer using one of the following mapping procedures:
    2.1. Mapping with intelligent compaction roller for the existing pavement determined by mapping the existing pavement under section 30-6.03B(1).
    2.2 Mapping with coring and dynamic cone penetration determined by mapping the existing pavement under section 30-6.03B(2).

30-6.01C(4)(b)(ii) Test Strip

Within 1 business day of test strip submit:

1. Hard copy of *Intelligent Compaction Cold-In-Place Recycling Test Strip Submittals Summary*
2. Adobe *.pdf file of the test strip report by email to the Engineer
3. Adobe *.pdf file of *Intelligent Compaction Cold-In-Place Recycling Quality Control Report Checklist* form by email to the Engineer

30-6.01C(4)(b)(iii) CIR Compaction

Within 1 business day of CIR compaction submit:

1. Hard copy of completed *Intelligent Compaction Cold-In-Place Recycling Compaction Quality Control Report Summary*
2. Adobe *.pdf file of compaction quality control report by email to the Engineer
3. Adobe *.pdf file of *Intelligent Compaction Cold-In-Place Recycling Quality Control Report Checklist* form by email to the Engineer

30-6.01C(4)(c) Information

Within 3 business days of mapping, test strip, or CIR compaction:

1. Submit information on a digital medium to the Engineer.
2. Upload information to the Department's secure file sharing system
3. After uploading the compaction information to the Department’s file sharing system, send an email notification of your electronic submittal to the Engineer and IC@dot.ca.gov with the appropriate completed checklist form as an attachment:
    3.1. *Intelligent Compaction Cold-In-Place Recycling Mapping Information Checklist*
    3.2. *Intelligent Compaction Cold-In-Place Recycling Test Strip Information Checklist*
    3.3 *Intelligent Compaction Cold-In-Place Recycling Quality Control Report Checklist*

30-6.01C(5) Data and Software Analysis Results

30-6.01C(5)(a) General

Not Used

30-6.01C(5)(b) Data

Submit mapping, test strip and compaction data elements in a format that is readable by Veta. You may combine roller data for multiple rollers operating in echelon into a section file.

Name the data file using:

YYYYMMDD_TTCCCRRR_DB_L_B_E_TOR_TC_T_Data

where:
YYYY = year
MM = Month, leading zero
DD = Day of month, leading zero
TT = District, leading zero
CCC = County, 2 or 3 letter abbreviation as shown in section 1-1.08 no leading zero
RRR = Route number, no leading zeros
DB = Traffic direction as NB, SB, WB, EB or PM for mapping
L = Lane number from left to right in direction of travel
B = Beginning station to the nearest foot (i.e., 10+20) or beginning post mile to the nearest hundredth (i.e., 25.06) maximum 6 characters with no leading zero.
E = Ending station to the nearest foot (i.e., 14+20) or ending post mile to the nearest hundredth (i.e., 28.06) maximum 6 characters with no leading zero
TOR = Type of reclamation “CIR” for cold in place recycling or “FDR” for full depth reclamation
TC= Type of compaction “PM” for mapping, “IC” for initial compaction or “SC” for supplemental compaction
T= Type of roller “R” for rubber tire or “SV” for steel drum with vibratory, “SS” for steel drum static, “SS-SV” for single roller combination of steel drum static and vibratory on.

Use the following header information for each compaction data file or section:

Item No.	Description
1	Section Title
2	Machine Manufacture
3	Machine Type
4	Machine Model
5	Drum Width (inch)
6	Drum Diameter (inch)
7	Machine Weight (ton)
8	Name index of intelligent compaction measurement values
9	Unit index for intelligent compaction measurement values
10	Reporting resolution for independent intelligent compaction measurement values – 90 degrees to the roller moving direction (inch)
11	Reporting resolution for independent intelligent compaction measurement values – in the roller moving direction (inch)
12	CCS83 Zone
13	Offset to UTC (hrs)
14	Number of compaction data points

Use the following data field names for each compaction data point:

Item No.	Data Field Name	Example of Data
1	Date Stamp (YYYYMMDD)	20080701
2	Time Stamp (HHMMSS.SS -military format)	090504.00 (9 hr 5 min. 4.00 s.)
3	Longitude (decimal degrees or degrees-minutes-seconds)	94.85920403
4	Latitude (decimal degrees or degrees-minutes-	45.22777335
5	Easting (foot)	6,096,666.000
6	Northing (foot)	1,524,166.650
7	Elevation (foot)	339.9450
8	Roller pass number	2
9	Direction index	1 forward, 2 reverse
10	Roller speed (mph)	2.0
11	Vibration on	1 for yes, 2 for no
12	Frequency (vpm)	3500.0
13	Amplitude (inch)	0.0236
14	Intelligent compaction measurement values	20.0

Note: Provide either items 3 and 4 or items 5 and 6

The GPS coordinate for each compaction data point recorded in data files must be at the center of the drum or center of the roller in front.

The size of the data mesh after post processing must be less than 1.5 feet by 1.5 feet in the X and Y directions.

30-6.01C(5)(c) Software Analysis Results

Analyze the compaction data daily using Veta and include nuclear gage data point tests, target values for passes, and intelligent compaction measurement values. For a sublot report, use sublot length of 528 feet.

For test strips and daily compaction quality control reports you must create and apply a boundary filter for the area of CIR to be analyzed to exclude extraneous intelligent compaction data. The boundary filter may be applied in the preprocessed raw roller data or created and applied in the Veta analyses. Create the boundary in Veta analyses by either importing GPS coordinates measured in the field from the boundary of the area of CIR production or by using the project layout and applying a filter to limit the analysis to the area CIR production.

Name report files and post processed Veta files using:

YYYYMMDD_TTCCCRRR_DB_L_B_E_TOR_TC_T_TYPE

where:
YYYY = year
MM = Month, leading zero
DD = Day of month, leading zero
TT = District, leading zero
CCC = County, 2 or 3 letter abbreviation as shown in section 1-1.08 no leading zero
RRR = Route number, no leading zeroes
DB = Traffic direction as NB, SB, WB, EB, or PM for mapping
L = Lane number from left to right in direction of travel
B = Beginning station to the nearest foot (i.e., 10+20) or beginning post mile to the nearest hundredth (i.e., 25.06) maximum 6 characters with no leading zero
E = Ending station to the nearest foot (i.e., 14+20) or ending post mile to the nearest hundredth (i.e., 28.06) maximum 6 characters with no leading zero
TOR = Type of reclamation "CIR" for cold in place recycling or "FDR" for full depth reclamation
TC = Type of compaction "PM" for mapping, "IC" for initial compaction, "SC" for supplemental compaction
T = Type of roller "R" for rubber tire, "S" for steel drum or "R-S" if data combined.
TYPE = Mapping report use "MAPPING_REPORT" for *.pdf files
Test strip report use "TS_REPORT" for *.pdf files
Compaction quality control report use "QC_REPORT" for *.pdf files
Post processed Veta files use "VETA"

Plots must be scaled to be legible and must be 11 by 17 inches.

30-6.01C(5)(d) Mapping

30-6.01C(5)(d)(i) General

Not Used.

30-6.01C(5)(d)(ii) Mapping With Intelligent Compaction Roller

Analyze the intelligent compaction mapping data using Veta. Use the project layout to create a boundary of the area of mapping.

Report of mapping with intelligent compaction roller must include:

1. Mapping results on *Intelligent Compaction Cold-In-Place Recycling Mapping Report Summary* form
2. Color layout plots of intelligent compaction measurement value for the existing pavement
3. Color layout plots of intelligent compaction measurement value for soft areas with intelligent compaction measurement values equal or less than to 10 percent of the average intelligent compaction measurement value of the existing pavement
4. Final coverage histogram of intelligent compaction measurement value
5. Final coverage histogram of intelligent compaction measurement value for a 528 foot sublot

Mapping information must include:

1. Adobe *.pdf file of mapping report
2. Project layout and/or mapping boundary which can be imported to Veta
3. Electronic data from compaction rollers in file format readable by Veta
4. Post processed Veta file *.vetaproj used for creating the mapping report of the existing pavement
5. *Intelligent Compaction Cold-In-Place Recycling Mapping Information Checklist*

30-6.01C(5)(d)(iii) Mapping with Coring and Dynamic Cone Penetration

Use the results of dynamic cone penetration to identify each layers of structural section.

Report of mapping with coring and dynamic cone penetration must include:

1. Plot of pavement structural section profile based on cores
2. Plot of pavement unbonded layer dynamic cone penetration index profile
3. Locations of unbonded layer zone classified as “B” and “C”

Mapping information must include:

1. Adobe *.pdf file of mapping report.
2. Dynamic cone penetration index and the corresponding GPS coordinates which can be imported into Veta

30-6.01C(5)(e) CIR Test Strip

Test strip report must include:

1. Completed *Intelligent Compaction Cold-In-Place Recycling Test Strip Report Summary* form
2. Nuclear gage density readings and the corresponding GPS coordinates
3. All passes compaction curves from Veta
4. All passes correlation analysis plot from Veta
5. Field compaction curve density versus number of passes
6. Color layout plot of distribution of intelligent compaction measurement value over test strip
7. Color layout plot of distribution of pass count over test strip

Test strip information must include:

1. Adobe *.pdf file of the test strip report from data analysis performed using Veta software
2. Test strip boundary which can be imported to Veta
3. Nuclear gage density readings and the corresponding GPS coordinates which can be imported into Veta
4. Electronic data from compaction rollers in file format readable by Veta
5. Post processed Veta file *.vetaproj used for creating the test strip report
6. Adobe.* pdf file of *Intelligent Compaction Cold-In-Place Recycling Test Strip Information Checklist*

30-6.01C(5)(f) CIR Compaction

For each day of production, prepare a CIR compaction quality control report that includes:

1. Completed *Intelligent Compaction Cold-In-Place Recycling Compaction Quality Control Report Summary* form
2. Veta analysis report results for:
    2.1. Percent compliance with target roller passes
    2.2. Percent compliance with target CIR intelligent compaction measurement value of steel drum roller with vibratory on
3. Final coverage histogram of number of passes for each roller and histogram of intelligent compaction measurement value of steel drum roller with vibratory on.
4. Final coverage histogram of number of passes for each roller and histogram of intelligent compaction measurement value of steel drum roller with vibratory on for a 528 feet sublot.
5. All passes histogram for each roller
6. Color layout plots of:
    6.1. Roller passes for each roller
    6.2. Intelligent compaction measurement value for final coverage of intermediate compaction when required.
7. Quality control density measurements and corresponding GPS coordinate.

Plots must include quality control density testing locations and test results.

Compaction information must include:

1. Adobe *.pdf file of the compaction quality control report from data analysis performed using Veta software
2. Project layout data files which can be imported to Veta
3. Boundary data files which can be imported to Veta
4. Nuclear gage density readings and the corresponding GPS coordinates which can be imported into Veta
5. Electronic data from compaction rollers in file format readable by Veta
6. Post processed Veta data file *.vetaproj used for creating the compaction quality control

30-6.01D Quality Control and Assurance

30-6.01D(1) General

Not Used

30-6.01D(2) Technical Representative

A technical representative from the intelligent compaction equipment manufacturer and automated machine guidance system or post manufacture retrofit system must be on site during the initial setup and verification testing of the compaction rollers and the first 2 days of CIR production. If requested, the technical representative must assist the Engineer with data management using Veta including compaction data input and processing.

30-6.01D(3) Intelligent Compaction Training

30-6.01D(3)(a) Just-In-Time Training

Provide roller operation just-in-time training and intelligent compaction geospatial data and analysis just-in-time training onsite or near the project site for your personnel and Department project personnel. Provide an enclosed facility with electrical power for visual presentations.

The just-in-time-training for intelligent compaction is divided into two sessions:

1. Intelligent compaction field operations
2. Intelligent compaction geospatial data and analysis

30-6.01D(3)(a)(i) Intelligent Compaction Field Operations Just-In-Time Training

At least 2 business days before training, notify the Engineer of the time and place of intelligent compaction field operations just-in-time training. Intelligent compaction field operations just-in-time training must be at least 2 hours in duration and include the following topics:

1. Background information for the specific intelligent compaction system and automated machine guidance system to be used.
2. Setup and checks for compaction systems including:
   - 2.1. GPS receiver
   - 2.2. GPS base station
   - 2.3. GPS rovers
   - 2.4. Rollers
3. Operation of the intelligent compaction system and automated machine guidance systems on the rollers including:
   - 3.1. Setup data collection
   - 3.2. Start/stop of data recording
   - 3.3. On-board display options

The following personnel must attend field operations just in time training:

1. Roller operators
2. Intelligent compaction quality control technician
3. Technical representative
4. CIR foreman

30-6.01D(3)(a)(ii) Intelligent Compaction Geospatial Data and Analysis Just-in-Time Training

Schedule the just-in-time training with the Engineer at a mutually agreed time and place. Provide training materials for 2 Department personnel. Intelligent compaction geospatial data and analysis just-in-time training must be at least 2 hours in duration and include the following topics:

1. Transferring raw compaction data from the rollers using USB connections
2. Operation of vendor's software to open and view raw compaction data files and to export all-passes and proofing data files in Veta-compatible format. If using the vendor's software to create boundary for the CIR daily compaction work, demonstrate the procedure.
3. Operation of Veta software to:
    - 3.1. Import the exported all-passes and proofing data files
    - 3.2. Import project layout
    - 3.3. If using the Veta software to create boundary for the CIR daily compaction work, demonstrate the procedure for creating the boundary.
    - 3.4. Review the compaction maps
    - 3.5. Import compaction point test data
    - 3.6. Perform statistical analysis
    - 3.7. Generate specified reports
4. Method for establishing target values for:
    - 4.1. Number of passes
    - 4.2. Temperature
    - 4.3. Intelligent compaction measurement values
5. Coverage and uniformity requirements
6. Corrective actions to be taken when coverage and uniformity requirements are not met

The following personnel must attend intelligent compaction geospatial data and analysis just in time training:

1. Technical representative
2. Compaction quality control technicians
3. Data analysis technician
4. CIR foreman

30-6.01D(3)(b) Intelligent Compaction Quality Control Technician Training

Effective January 1, 2017, submit documentation that the technician has completed a Department authorized intelligent compaction quality control training course within the last 12 months. A Department authorized intelligent compaction quality control training course must cover:

1. Intelligent compaction specification requirements for quality control technician responsibilities.
2. GPS site calibration or localization
3. GPS check testing for the compaction rollers and rovers
4. Equipment operation verification
   - 4.1. Positioning system
   - 4.2. Temperature sensor
   - 4.3. Accelerometer
5. Establishing project layout
6. Establishing construction boundary for:
   - 6.1. Test strip
   - 6.2. Daily CIR area
7. Test section construction to establish target compaction pass counts, and target values for the stiffness of the CIR using nuclear gauges, and intelligent compaction rollers
8. Establishing action limits for roller passes
9. Monitoring the rollers operation for compliance with target values
10. Quality control testing for compaction.
11. Review daily compaction quality control report results for compliance with the specifications and taking corrective action when necessary for compliance.
12. Data management
    - 12.1. Verify uploading data
    - 12.2. Downloading data from rollers
    - 12.3. Backing up compaction data
13. Daily set-up, take-down, of GPS and compaction roller components.

30-6.01D(3)(c) Data Analysis Technician Training

Effective January 1, 2017, the data analysis technician must have completed a Department authorized training course covering:

1. Intelligent compaction specification requirements for:
   - 1.1. Data analysis using Veta
   - 1.2. Reporting
2. Operation of Veta software to:
   - 2.1. Import the exported all-passes and final coverage files
   - 2.2. Import project layout
   - 2.3. Import points and create boundary
   - 2.4. Create boundary for the area of CIR daily production using project layout and beginning and ending stations
   - 2.5. Import compaction point test data
   - 2.6. Review the compaction maps
   - 2.7. Generate 11 by 17 inches plots
   - 2.8. Perform statistical analysis
   - 2.9. Generate specified reports
3. Using example project data provide hand on Veta analysis training to produce a mock up mapping report.
4. Using example project data provide hand on Veta analysis training to produce a mock up test strip report.
5. Using example project data provide hands-on Veta analysis training to produce a mock up compaction quality control report.
6. Provide training for completing intelligent compaction forms.
7. Cover specification requirements for submittal of reports and information including file naming requirements.

30-6.01D(4) Prepaving Meeting

The Intelligent compaction quality control technician must attend the CIR prepaving meeting.

30-6.01D(5) Quality Control

30-6.01D(5)(a) General

For CIR placed under section 30-4, use intelligent compaction rollers and automated machine guidance rollers for documenting that CIR compaction complies with roller passes target values established at test strip.

The number of roller passes, temperature, and intelligent compaction measurement values are report only and not used for compaction acceptance.

30-6.01D(5)(a)(i) Quality Control Technician

During mapping, test strip, and CIR compaction, provide a full time intelligent compaction quality control technician.

The quality control technician is responsible for oversight of the following:

1. GPS site calibration or localization and upload to GPS receivers
2. GPS check testing for the compaction rollers and rovers
3. Accuracy verification of the temperature sensor by comparing to a NIST traceable standard. The equipment temperature sensor measurement must be within +/- 3 degrees F of NIST traceable standard.
4. During test strip construction, determining the target values for compaction roller passes and target values for intelligent compaction measurement values
5. Construction operation monitoring of the compaction rollers
6. Quality control testing for compaction
7. Backing up compaction data twice per day
8. Downloading data from rollers at the end of the work shift
9. Monitoring daily compaction quality control report results for compliance with the requirements in these specifications and taking corrective action when necessary for compliance.
10. Daily set-up, take-down, of GPS and compaction roller components

30-6.01D(5)(a)(ii) Data Analysis Technician

Provide an intelligent compaction data analysis technician who is responsible for performing the following:

1. Exporting final coverage and all-passes data to Veta compatible form by using vendor specific intelligent compaction software
2. Analyzing the data from the compaction rollers using Veta and producing reports.
3. Submitting and uploading intelligent compaction reports and information.

30-6.01D(6) IC Test Strip

30-6.01D(6)(a) General

A test strip is used to establish CIR intelligent compaction target values for the following:

1. Number of roller passes for initial compaction for each type of roller
2. Number of roller passes for supplemental compaction for each type of roller
3. Intelligent compaction measurement value based on break over point density for CIR

The target number of roller passes is based on your roller pattern established to achieve break over point density.

30-6.01D(6)(a)(i) Establishment Target Value for Intelligent Compaction Measurement Value

On the first day of CIR production and within a 500 foot portion of the CIR test strip specified in section 30-4.01D(4)(b), construct IC test strip. Use handheld rover to establish boundary for the 500 foot section. Use handheld rover to establish 3 randomly selected nuclear gage density test locations.

Establish intelligent compaction target values for initial and supplemental compaction as follow:

1. After each roller pass, use a nuclear gage to measure the density at 3 preselected random locations throughout the covered 500 foot section. Record the roller pass number and density readings.
2. Establish the density of the tests strip for each coverage by averaging the density at the 3 locations
3. Continue roller passes and collecting nuclear gage density readings until the density remains constant, or decreases. The break over density target value is the maximum density on the plot of test strip density versus number of passes for each coverage target value. The target number of roller passes is the number of passes for each roller in reaching the break over density.
4. After reaching break over density, use an intelligent compaction vibratory steel drum roller to make a last coverage of test strip with vibration on set at low amplitude. Use a nuclear gage to measure the density at 10 randomly selected locations throughout the 500 foot section. Record the density readings, and the GPS coordinates for each test location. Average the density readings and compare with break over point target value. Either of the following may apply based on the density test results:
    - 4.1. If the last coverage produces an increase in density above the break over point density, continue rolling with steel drum roller with vibration on until a new break over point density is determined. Use this new break over point density for production. Use pneumatic tire rollers to repair any damage caused by the intelligent compaction vibratory steel drum roller.
    - 4.2. If the last coverage produces a reduction in the compaction below the break point density:
        - 4.2.1. The requirement of maximum density will be waived on the 500 foot portion of the test strip.
        - 4.2.2. Use pneumatic tire rollers to repair any damage caused by the last single pass of the intelligent compaction vibratory steel drum roller.
5. Use Veta to create a compaction curve that relates the roller all passes to the intelligent compaction measurement values. The target value for intelligent compaction measurement value corresponds to last pass of the steel drum vibratory roller with vibration on based on your roller pattern.

30-6.02 MATERIALS

Not Used

30-6.03 CONSTRUCTION

30-6.03A General

Before CIR production, upload the project layout file into the compaction data analysis software and depending on the roller manufacturer, the on-board documentation system.

30-6.03A(1) Equipment

30-6.03A(1)(a) General

Use intelligent compaction rollers and automated machine guidance rollers for initial and supplemental compaction.

30-6.03A(1)(b) Rollers

For mapping existing pavement, the mapping roller must meet the following:

1. Be minimum 3 feet wide single or double-drum vibratory steel rollers with accelerometers mounted in or about the drum to measure the relative stiffness of the pavement.
2. Have GPS radio and receiver units mounted on roller to monitor the steel drum roller locations.
3. Include an integrated on-board documentation system that is capable of displaying real-time color-coded maps, including the stiffness response values, vibration frequencies, roller drum amplitude, roller location, roller speeds and capable of transferring stored data from a USB port.

For CIR, in addition to the requirements in section 30-4, intelligent compaction roller must meet the following:

1. Be double-drum vibratory steel rollers with accelerometers mounted in or about the drum to measure the interaction between the rollers and compacted materials in order to evaluate the applied compactive effort.
2. Be equipped with non-contact temperature sensors for measuring pavement surface temperatures.
3. With vibratory on, produce output that represents the stiffness of the material based on the vibration of the roller drums and the measured response from the underlying materials.
4. Have GPS radio and receiver units mounted on each intelligent compaction roller to monitor the steel drum roller locations and track the number of passes of the rollers.
5. Include an integrated on-board documentation system that is capable of displaying real-time color-coded maps, including the stiffness response values, vibration frequencies, roller drum amplitude, roller location, number of roller passes, roller speeds and capable of transferring data from a USB port.

For CIR, in addition to the requirements in section 30-4, automated machine guidance pneumatic tire rollers must meet the following:

1. Be equipped with non-contact temperature sensors for measuring surface temperatures.
2. Have GPS radio and receiver units mounted on each automated machine guidance roller to monitor the roller locations and track the number of passes of the rollers.
3. Include an integrated on-board documentation system that is capable of displaying real-time color-coded maps of roller location, number of roller passes, roller speeds and capable of transferring data from a USB port.

30-6.03A(2) Global Positioning System

GPS must be real time kinematic using one of the following:

1. GPS base station
2. Network real time kinematic (RTK)
3. Satellite-based augmentation station system capable of providing position accuracy within 0.25 foot.

You may use other high precision positioning systems in lieu of GPS. The positioning system must meet or exceed the precision specified for GPS.

GPS used must provide a minimum 90 percent coverage of project site.

GPS devices for this project must be set to the same consistent datum, coordinate system, CCS83 zone, and site calibration or localization. The CCS83 zone must be set to zone no. 5.

Prior to July 2016, you may use UTM coordinate system if your roller on-board documentation system and display are not compatible with CCS83. Notify the engineer if you will use UTM coordinate system.

30-6.03A(3) Correction Signal Source

Provide either a GPS base station correction signal or a GPS correction service subscription. The GPS correction signal must be received by the GPS receivers on the compaction roller and the rovers during operations with a survey tolerance of not greater than 0.25 foot in both X and Y horizontal directions.

Install GPS repeaters at selected locations to relate the GPS correction signal to resolve GPS shadows.

30-6.03A(4) Survey Control Points

Survey control points are included in Supplemental Project Information.

30-6.03A(5) GPS Site Calibration or Localization and Check Testing

Prior to mapping of the existing pavement, perform a GPS site calibration or localization to the survey control points.

Whenever the GPS base station is moved to a new location, verify GPS base station position by measuring the position of two known points using a rover. Perform a GPS site calibration or localization if the position of known points and measured positions differ by more than 3 centimeters.

At least 2 business days before start of production, perform roller verification testing by conducting roller check testing.

Before the start of daily production and using the same datum, conduct check testing for the proper setup of the GPS, the GPS of the rollers and the GPS rover:

1. On a location nearby or within the project limits, the GPS base station, if required by the GPS, must be established and the compaction roller and the GPS rover tied into the same base station
2. Verify that the roller and rover are working properly and that there is a connection with the base station
3. Verify the roller GPS coordinates by:
    3.1. Stopping the roller at a location
    3.2. Marking the location of both ends of the roller drum or the outside of the front tires on the surface with a tee
    3.3. Recording the GPS measurements from the roller ensuring the distance offsets are applied so that the GPS coordinate is at the center of the front drum or center of front axle.
    3.4. Moving the roller from the marked location
    3.5. Finding the mid-point of the 2 marked ends of the roller and mark this location on the surface. This marked location is the theoretical center of the front drum or the front axle.
    3.6. Using the GPS rover to measure GPS coordinates of the marked location and record the GPS measurements
    3.7. Computing the difference between recorded compaction roller GPS coordinates and GPS rover recorded GPS measured coordinates. The differences of the coordinates in grid must be within 0.50 foot in both the horizontal axes X and Y

30-6.03B Mapping Existing Pavement

Before CIR, map the existing pavement using intelligent compaction roller or coring and dynamic cone penetration testing.

30-6.03B(1) Mapping Existing Pavement with Intelligent Compaction Roller

Map the existing pavement with a single pass over the entire pavement using a mapping roller. Use low vibration amplitude and the same settings, including speed and frequency, throughout the section.

30-6.03B(2) Mapping Existing Pavement with Coring and Dynamic Cone Penetration

Obtain data for mapping the existing pavement structural section and unbonded layer stiffness as follows:

1. For structural section mapping, at 500 feet intervals obtain 6 inch cores of the bonded layers of the existing pavement at following locations:
    1.1. Center of each lane
    1.2. Center of each shoulder
    1.3. If cores show significant differences between consecutive intervals, such as different types of material or a variation of overall pavement thickness by more than 50 percent, the interval will be halved and cores will be taken at the half interval. Additional cores and dynamic cone penetration testing at the half interval will be change order work.
2. Remove and log the core of the pavement structural section
3. Use GPS rover to measure and record coordinates of each core location
4. At each core hole, perform ASTM D6951 using dual mass hammer (8.0 kg) on the unbonded layer for each location

5. Analyze dynamic cone penetration results in terms of the dynamic cone penetration indices as for each location as follow:
   5.1. Calculate dynamic cone penetration index for each 5 blows over the depth of 1.5 feet below the bonded layer or refusal. Refusal is 0.1 inch or less per blow.
   5.2. Calculate average and standard deviation of the dynamic cone penetration of indices at each core hole to identify uniform section and problem areas based on average dynamic cone penetration index shown in table below:

Average dynamic cone penetration Index (inch/blow)	Unbonded layer zone	Unbonded layer stiffness description
<0.7	A	Relatively strong
0.7-1.2	B	Marginal strength
>1.2	C	Weak, potentially wet

Map the existing pavement structural section and unbonded layer stiffness description as follows:

1. For each set of cores taken, plot the accumulative dynamic cone penetration index for over the depth of 1.5 feet below the bonded layers.
2. For each set of cores taken along the longitudinal axis of the area to be cold in place recycled, plot a pavement thickness profile and a lift thickness profile. Profiles will be electronically plotted at a horizontal scale of 1 inch equals 100 feet, and a vertical scale of 1 inch equals 1 foot.
3. For each set of cores taken transverse to the roadway of the area to be cold in place recycled, plot transverse pavement thickness and lift thickness cross sections. Transverse cross sections will be electronically plotted at a horizontal scale of 1 inch equals 5 feet, and a vertical scale of 1 inch equals 1 foot.
4. For unbonded layer stiffness, plot core location coordinates and unbonded layer stiffness description category for each core taken along the roadway longitudinal axis to be cold in place recycled. Mapping must be electronically plotted at a horizontal scale of 1 inch equals 100 feet for longitudinal plot.
5. For unbonded layer stiffness, plot core location coordinates and unbonded layer stiffness description category for each core taken along the roadway transverse axis to be cold in place recycled. Mapping must be electronically plotted at a horizontal scale of 1 inch equals 5 feet.

Backfill core holes with commercial cold mix and compact the material.

30-6.03C CIR Compaction

During compaction, monitor each roller's compaction graphical user interface display for roller passes and intelligent compaction measurement values.

Use GPS rover to measure and record coordinates of each quality control nuclear gage reading.

For each day of CIR production establish the boundaries of each lot of CIR production using the rover.

30-6.03C(1) Roller Coverage

At least 90 percent of the CIR production area must meet or exceed the target number of passes for each roller type determined from the test strip for that area. When the daily compaction quality control report shows the target number of roller passes are not met, take corrective action and notify the Engineer of action taken.

30-6.03C(2) CIR Intelligent Compaction Measurement Value

CIR Intelligent compaction measurement value is report only.

30-6.04 PAYMENT

Not Used

Replace section 39-8 of the RSS with:

39-8 INTELLIGENT COMPACTION FOR HOT MIX ASPHALT

39-8.01 GENERAL

39-8.01A Summary

Section 39-8 includes specifications for compacting HMA using intelligent compaction. This is a pilot project for evaluating intelligent compaction and the Department will not consider a VECP that substitutes the processes or equipment specified for intelligent compaction. Intelligent compaction does not waive any specifications for HMA.

Intelligent compaction uses vibratory steel drum rollers with intelligent compaction equipment and static pneumatic tire rollers equipped with automated machine guidance system that provide roller operator with real time information for quality control and produce data for standardized software Veta. For Veta, go to:

www.intelligentcompaction.com

Use Veta software to analyze the data for coverage uniformity, HMA temperature, and intelligent compaction measurement values.

Use intelligent compaction rollers and automated machine guidance rollers for breakdown, and intermediate compaction.

Create project layout files for the intelligent compaction system, automated machine guidance system and Veta from the existing pavement using GPS rover calibrated for the project site.

Project layout files must delineate the HMA construction area of project.

39-8.01B Definitions

action limit: T*he minimum and maximum values of a quality control measurement that can be interpreted as representing acceptable performance with respect to the parameter being tested. Values less than the minimum or greater than the maximum action limit or level indicate that corrective action must be taken by the contractor.*

all passes data: Compaction data that contain measurements from all passes.

automated machine guidance roller: Rollers equipped with measurement devices installed by the roller manufacturer or a post manufacture retrofit system including GPS, temperature sensor, on-board documentation system, and displays.

California coordinate system of 1983 (CCS83): A set of 6 geographic zones or coordinate systems designed for specific regions of the State of California, the boundaries of which follow county lines. CCS83 is based on NAD83. When a project crosses state plane zone boundaries, a single zone will be used for the entire project.

compaction data: Data collected by intelligent compaction equipment and automated machine guidance compaction equipment.

coordinated universal time (UTC): A time measurement system commonly referred to as Greenwich Mean Time (GMT) based on a 24-hour time scale from the mean solar time at the Earth's prime meridian (zero degrees longitude) located near Greenwich, England.

coverage: Single roller pass over a given area.

final coverage: Compaction data that contain the last pass measurements for a given area.

foot: Unit of measurement equal to U.S. survey foot.

geodetic coordinates: A coordinate system to describe a position in longitude, latitude, and altitude above the imaginary ellipsoid surface based on a specific geodetic datum. The NAD83 datum is required for use with CCS83 State Plane Coordinates.

global positioning system (GPS): A space-based satellite navigation system that provides location and time information in all weather, anywhere on or near the Earth to determine the location in geodetic coordinates. GPS refers to all GPS-related signals including US GPS, and other Global Navigation Satellite Systems (GNSS). GPS satellite signals are subject to interference from canyons, buildings, trees or even fencing. Not all locations are suitable for GPS techniques, and it is your responsibility to determine if the site conditions are practical for GPS, and to notify the Engineer if they are not.

GPS base station: A single ground-based system consisting of a GPS receiver, GPS antenna, and telemetry equipment (typically radio and radio antenna or cellular phone) to provide L1/L2 differential GPS correction signals to other GPS receivers.

GPS correction service subscription: A service that can be subscribed to receive differential GPS correction signals for higher accuracy GPS positioning without the need of a GPS Base Station. Signals are normally received via cellular wireless data services. Examples of GPS correction service subscriptions are: Trimble VRS™, Leica Smart RTK™, STARFIRE™, Topcon TopNet™ or OmniSTAR™.

GPS rover: A portable L1/L2 GPS antenna, mount, and receiver with telemetry equipment for Real Time in-situ point measurements

GPS site calibration or localization: A process to establish a relationship between the observed GPS coordinates and the known grid coordinates.

grid: A Cartesian system of XY (or North-East) coordinates utilizing the California State Plane Coordinates, known as the California Coordinate System of 1983 (CCS 83).

intelligent compaction measurement value: A generic term for all intelligent compaction measurements in units specific to each roller manufacturer.

intelligent compaction equipment: Measurement devices installed by the roller manufacturer or a post manufacture retrofit system including accelerometer, GPS, temperature sensor, on-board documentation system, and displays.

intelligent compaction roller: Rollers equipped with measurement devices installed by the roller manufacturer or a post manufacture retrofit system including accelerometer, GPS, temperature sensor, on-board documentation system, and displays.

intelligent compaction target value: Compaction target values established at test strip or specified that are used by roller operator to monitor compaction and in data analysis to generate compaction quality control report.

network real time kinematic (Network RTK): A system that uses multiple bases in real-time to provide high-accuracy GPS positioning within the coverage area that is generally larger than that covered by a single GPS base station.

real time kinematic global positioning system (RTK-GPS): A system based on the use of carrier phase measurements of the available GPS signals where a single GPS base station or RTK network provides the corrections in order to achieve centimeter-level accuracy in real time.

roller pass: Movement of the roller in either direction.

universal transverse mercator (UTM) coordinate system: Is a 2-dimentional Cartesian coordinates system that divides the surface of Earth between 80°S and 84°N latitude into 60 zones, each 6° of longitude in width and centered over a meridian of longitude. Zone 1 is bounded by longitude 180° to 174° W and is centered on the 177th West meridian. The UTM system uses projection techniques to transform an ellipsoidal surface to a flat map that can be printed on paper or displayed on a computer screen. Note that UTM is metric-based.

39-8.01C Submittals

39-8.01C(1) General

At least 15 days before performing intelligent compaction, you must register with the Department's secure file sharing system. To obtain information on the registration process, send an e-mail with your contact information to the following electronic mailbox address:

IC@dot.ca.gov

Forms for intelligent compaction submittals are available at:

http://www.dot.ca.gov/hq/construc/ic/

39-8.01C(2) Intelligent Compaction Training

39-8.01C(2)(a) Just-In-Time Training

At the time of JMF submittal, submit a list of names participating in the just-in-time training. Identify each participant's name, employer, title, and role in intelligent compaction.

At least 10 days prior to just-in-time training, submit:

1. Just-in-time training presentation and handouts for review
2. Completed *Intelligent Compaction Field Operations Just-In-Time Training Review Checklist form*
3. Completed *Geospatial Data and Analysis Just-In-Time Training Review Checklist form*

39-8.01C(2)(b) Intelligent Compaction Quality Control Technician Training

At least 15 days before performing intelligent compaction, submit the name of your intelligent compaction quality control technician. Effective July 1, 2016, submit the technician has completed a Department authorized intelligent compaction quality control training course within the last 12 months.

39-8.01C(2)(c) Data Analysis Technician Training

At least 5 days before performing intelligent compaction, submit the name of your data analysis technician. Effective July 1, 2016, submit the technician has completed a Department authorized intelligent compaction data analysis training course within the last 12 months.

39-8.01C(3) GPS Site Calibration or Localization Report and Check Testing

Submit GPS site calibration or localization report and check testing results for intelligent compaction rollers and automated machine guidance rollers within 1 business day of calibration or check testing.

39-8.01C(4) Reports and Information

39-8.01C(4)(a) General

If unable to submit or upload report and information within the specified time, notify the engineer of the actions being taken to submit and upload information timely.

39-8.01C(4)(b) Reports

39-8.01C(4)(b)(i) Test Strip

Within 1 business day of test strip submit:

1. Hard copy of completed *Intelligent Compaction Hot Mix Asphalt Construction Test Strip Submittals Summary*
2. Adobe *.pdf file of the test strip report by email to the Engineer
3. Adobe *.pdf file of *Intelligent Compaction Hot Mix Asphalt Quality Control Report Checklist* form by email to the Engineer

39-8.01C(4)(b)(ii) HMA Placement

Within 1 business day of HMA placement submit:

1. Hard copy of completed:
   1.1. *Intelligent Compaction Quality Control Report Summary for Hot Mix Asphalt With Method Compaction*
   1.2. *Intelligent Compaction Quality Control Report Summary for Hot Mix Asphalt with Density Requirement.*
2. Adobe *.pdf file of the compaction quality control report by email to the Engineer
3. Adobe *.pdf file of *Intelligent Compaction Hot Mix Asphalt Quality Control Report Checklist* form by email to the Engineer

39-8.01C(4)(c) Information

Within 3 business days of test strip or HMA placement:

1. Submit information on a digital medium to the Engineer.
2. Upload information to the Department's secure file sharing system.
3. After uploading the compaction information to the Department's file sharing system, send an email notification of your electronic submittal to the Engineer and IC@dot.ca.gov with the appropriate completed checklist form as an attachment:
   3.1. *Intelligent Compaction Hot Mix Asphalt Test Strip Information Checklist*
   3.2. *Intelligent Compaction Hot Mix Asphalt Quality Control Information Checklist*

39-8.01C(5) Data and Software Analysis Results

39-8.01C(5)(a) General

Not Used

39-8.01C(5)(b) Data

Submit compaction data in a format that is readable by Veta. You may combine roller data for multiple rollers operating in echelon into a section file.

Name the data file using:

YYYYMMDD_TTCCCRRR_DB_L_B_E_X_PT_TC_T_Data

where:
YYYY = year
MM = Month, leading zero
DD = Day of month, leading zero
TT = District, leading zero
CCC = County, 2 or 3 letter abbreviation as shown in section 1-1.08
RRR = Route number, no leading zeros
DB = Traffic direction as NB, SB, WB, or EB
L = Lane number from left to right in direction of travel
B = Beginning station to the nearest foot (i.e., 10+20) or beginning post mile to the nearest hundredth (e.g., 25.06) no leading zero
E = Ending station to the nearest foot (i.e., 14+20) or ending post mile to the nearest hundredth (i.e., 28.06) maximum 6 characters with no leading zero
X = HMA layer number, 1, 2 …etc.
PT = Pavement Type (e.g., HMA, RHMA, HMA-O, RHMA-O, RHMA-G, etc.) with maximum 6 characters
TC = Type of compaction “BC” for breakdown compaction, “IC” for intermediate compaction, “FC” for finish compaction. When combined use combination e.g. “BC-IC” for breakdown and intermediate compaction.
T= Type of roller “R” for rubber tire, “SV” for steel drum with vibrator on, “SS” for steel drum static, “SV-SS” for single roller combination of steel drum static and vibratory on.

Use the following header information for each compaction data file or section:

Item No.	Description
1	Section Title
2	Machine Manufacture
3	Machine Type
4	Machine Model
5	Drum Width (inch)
6	Drum Diameter (inch)
7	Machine Weight (ton)
8	Name index of intelligent compaction measurement values
9	Unit index for intelligent compaction measurement values
10	Reporting resolution for independent for intelligent compaction measurement values 90 degrees to the roller moving direction (inch)
11	Reporting resolution for independent intelligent compaction measurement values in the roller moving direction (inch)
12	CCS83 Zone
13	Offset to UTC (hrs)
14	Number of IC data points

Use the following data field names for each compaction data point:

Item No.	Data Field Name	Example of Data
1	Date Stamp (YYYYMMDD)	20080701
2	Time Stamp (HHMMSS.SS -military format)	090504.00 (9 hr 5 min. 4.00 s.)
3	Longitude (decimal degrees or degrees minutes-seconds)	94.85920403
4	Latitude (decimal degrees or degrees-minutes-seconds)	45.22777335
5	Easting (Foot)	6,096,666.000
6	Northing (Foot)	1,524,166.650
7	Elevation (Foot)	339.9450
8	Roller pass number	2
9	Direction index	1 forward, 2 reverse
10	Roller speed (mph)	2.0
11	Vibration on	1 for yes, 2 for no
12	Frequency (vpm)	3500.0
13	Amplitude (inch)	0.0236
14	Surface temperature (ºF)	270
15	Intelligent compaction measurement values	20.0

Note: Provide either items 3 and 4 or items 5 and 6.

The GPS coordinate for each compaction data point recorded in data files must be at the center of the front drum or center of the roller in front.

The size of data mesh after post processing must be less than 1.5 feet by 1.5 feet in the X and Y directions.

39-8.01C(5)(c) Software Analysis Results

Analyze the compaction data daily using Veta and include nuclear gage and temperature data point tests, target values for passes, HMA temperature, and intelligent compaction measurement values. For a sublot report, use sublot length of 528 feet.

For test strips and daily compaction quality control reports you must create and apply a boundary filter for the area of hot mix to be analyzed to exclude extraneous intelligent compaction data. The boundary filter may be applied in the preprocessed raw roller data or created and applied in the Veta analyses. Create the boundary in Veta analyses by either importing GPS coordinates measured in the field from the boundary of the area of hot mix asphalt placed or by using the project layout and applying a filter to limit the analysis to the area of hot mix asphalt placed.

Name report files and post processed Veta files using:

YYYYMMDD_TTCCCRRR_DB_L_B_E_X_PT_TC_T_TYPE

where:
YYYY = year
MM = Month, leading zero
DD = Day of month, leading zero
TT = District, leading zero
CCC = County, 2 or 3 letter abbreviation as shown in section 1-1.08
RRR = Route number, no leading zeros
DB = Traffic direction as NB, SB, WB, or EB
L = Lane number from left to right in direction of travel
B = Beginning station to the nearest foot (i.e., 10+20) or beginning post mile to the nearest hundredth (i.e., 25.06) maximum 6 characters with no leading zero.
E = Ending station to the nearest foot e.g., 14+20) or ending post mile to the nearest hundredth (i.e., 28.06) maximum 6 characters with no leading zero.
X = HMA layer number, 1, 2 …etc.
PT = Pavement Type (e.g., HMA, RHMA, HMA-O, RHMA-O, RHMA-G, etc.) maximum 6 characters.
TC = Type of compaction "BC" for breakdown compaction, "IC" for intermediate compaction or "FC" for finish compaction
T = Type of roller "R" for rubber tire or "S" for steel drum
TYPE = Test strip report use “TS_REPORT” for *.pdf files
Quality control compaction report use “QC_REPORT” fo *.pdf files
Post processed Veta files use “VETA”

Plots must be scaled to be legible and must be 11 by 17 inches.

39-8.01C(5)(c)(i) Test Strip

Test strip report must include:

1. Completed *Intelligent Compaction Hot Mix Asphalt Test Strip Report Summary* form
2. Nuclear gage density per location and corresponding GPS measured coordinates per location
3. All passes compaction curves from Veta
4. All passes correlation analysis plot from Veta
5. Field compaction curve density versus number of passes
6. All passes histogram for each roller
7. Color layout plots of:
    - 7.1. Roller passes for each roller
    - 7.2. HMA temperature for first coverage of breakdown compaction
    - 7.3. HMA temperature for final coverage of intermediate compaction
    - 7.4. Intelligent compaction measurement value for final coverage of steel drum with vibration on
8. Hot mix asphalt mat temperature readings with corresponding GPS coordinates

Test strip information must include:

1. Adobe *.pdf file of the test strip report from data analysis performed using Veta software
2. Project layout data files which can be imported to Veta
3. Test strip boundary data files which can be imported to Veta
4. Nuclear gage density readings and the corresponding coordinates which can be imported into Veta
5. Electronic data from compaction rollers in file format readable by Veta
6. Post processed Veta file *.vetaproj used for creating the test strip report

39-8.01C(5)(c)(ii) HMA Compaction

For each day of production, prepare a HMA compaction quality control report that includes:

1. Summary of HMA compaction quality control results on *Intelligent Compaction Quality Control Report Summary for Hot Mix Asphalt With Method Compaction* form or *Intelligent Compaction Quality Control Report Summary for Hot Mix Asphalt with Density Requirement* form.
2. Veta analysis report results for:
   - 2.1. Percent compliance with target roller passes
   - 2.2. Percent compliance with target HMA temperature for first coverage of breakdown compaction
   - 2.3. Percent compliance with target HMA temperature for final coverage of intermediate compaction
   - 2.4. Percent compliance with target HMA intelligent compaction measurement value when measurement of intelligent compaction measurement value is required
3. Final coverage histogram of number of passes for each roller and histogram of intelligent compaction measurement value of steel drum roller with vibratory on.
4. Final coverage histogram of number of passes for each roller and histogram of intelligent compaction measurement value of steel drum roller with vibratory on for a sublot.
5. All passes histogram for each roller
6. Color layout plots of:
   - 6.1. Roller passes for each roller
   - 6.2. HMA temperature for first coverage of breakdown compaction.
   - 6.3. HMA temperature for final coverage of intermediate compaction.
   - 6.4. Intelligent compaction measurement value for final coverage of intermediate compaction when required.
7. Quality control density measurements and corresponding GPS coordinate.
8. Hot mix asphalt mat temperature readings with corresponding GPS coordinates.

Plots must include quality control density testing and HMA mat temperature locations and test results.

Quality control compaction information must include:

1. Adobe *.pdf file of the compaction quality control report from data analysis performed using Veta software
2. Project layout data files which can be imported to Veta
3. Boundary data files which can be imported to Veta
4. Nuclear gage density readings and the corresponding GPS coordinates which can be imported into Veta
5. HMA mat temperatures and the corresponding GPS coordinates which can be imported into Veta
6. Electronic data from compaction rollers in file format readable by Veta
7. Post processed Veta file *.vetaproj used for creating the test strip

39-8.01D Quality Control

39-8.01D(1) General

For HMA placed under section 39-1.03O(2) method compaction, use intelligent compaction rollers and automated machine guidance rollers for documenting that HMA compaction complies with the method compaction requirements for the followings:

1. Number of roller passes
2. HMA temperature for first coverage of breakdown compaction
3. HMA temperature at the completion of intermediate compaction

Do not collect intelligent compaction measurement values when the compacted HMA layer is less than 0.15 foot.

When HMA thickness is 0.15 foot or greater, intelligent compaction rollers provide additional real time quality control for HMA density based on the intelligent compaction measurement value which is correlated to the specified HMA target density at the test strip.

The number of roller passes, HMA temperature and intelligent compaction measurement values are report only and are not used for compaction acceptance.

39-8.01D(2) Technical Representative

A technical representative from the intelligent compaction equipment manufacturer and automated machine guidance system or post manufacture retrofit system must be on site during the initial setup, verification testing of the compaction rollers and first 2 days of production. If requested, the technical representative must assist the Engineer with data management using Veta including compaction data input and processing.

39-8.01D(2)(a) Quality Control Technician

During HMA compaction provide a full time intelligent compaction quality control technician to be responsible for oversight of the following:

1. GPS site calibration or localization and upload to all GPS receivers
2. GPS check testing for the compaction rollers and rovers
3. Accuracy verification of the temperature sensor by comparing to a NIST traceable standard. The equipment temperature sensor measurement must be within +/- 3 degrees F of NIST traceable standard.
4. Test section construction to establish target compaction pass counts and target values for the stiffness of the HMA using nuclear gauges, pavement cores, and intelligent compaction rollers
5. Construction operation monitoring of the compaction rollers
6. Quality control testing for pavement temperature and compaction.
7. Backing up data compaction data twice per day
8. Downloading data from rollers at the end of the work shift
9. Monitoring daily compaction quality control report results for compliance with the requirements in these specifications and taking corrective action when necessary for compliance.
10. Daily set-up, take-down, of GPS and compaction roller components.

39-8.01D(2)(b) Data Analysis Technician

Provide an intelligent compaction data analysis technician who is responsible for performing the following:

1. Exporting final coverage and all-passes data to Veta compatible form by using vendor specific intelligent compaction software.
2. Analyzing the data from the compaction rollers using Veta and producing reports
3. Submitting and uploading intelligent compaction reports and information

39-8.01D(3) Intelligent Compaction Training

39-8.01D(3)(a) General

Not Used

39-8.01D(3)(b) Just-in-Time Training

Provide just-in-time training onsite or near the project site for your personnel and Department project personnel. Provide an enclosed facility with electrical availability for visual presentations.

The just-in-time-training for intelligent compaction is divided into two sessions:

1. Intelligent compaction field operations
2. Intelligent compaction geospatial data and analysis

39-8.01D(3)(b)(i) Intelligent Compaction Field Operations Just-in-Time Training

At least 2 business days before training, notify the Engineer of the time and place of intelligent compaction field operations just-in-time training. Intelligent compaction field operations just-in-time training must be at least 2 hours in duration and include the following topics:

1. Background information for the specific intelligent compaction system and automated machine guidance system to be used.
2. Setup and checks for compaction systems including:
   - 2.1. GPS receiver
   - 2.2. GPS rovers
   - 2.3. Rollers
3. Operation of the intelligent compaction system and automated machine guidance systems on the rollers including:
   - 3.1. Setup data collection
   - 3.2. Start/stop of data recording
   - 3.3. On-board display options
4. Action limits to be used by the roller operators for:
   - 4.1. HMA Mat Temperature
   - 4.2. Number of passes

The following personnel must attend the intelligent compaction field operations just in time training:

1. Roller operators
2. Intelligent compaction quality control technician
3. Technical representative
4. HMA foreman

39-8.01D(3)(b)(ii) Intelligent Compaction Geospatial Data and Analysis Just-in-Time Training

Schedule the just-in-time training with the Engineer at a mutually agreed time and place. Provide training materials for 2 Department personnel. Intelligent compaction geospatial data and analysis just-in-time training must be at least 2 hours in duration and include the following topics:

1. Transferring raw compaction data from the rollers using USB connections
2. Operation of vendor’s software to open and view raw compaction data files and to export all-passes and proofing data files in Veta-compatible format. If using the vendor’s software to create boundary for the area of hot mix asphalt daily production, demonstrate the procedure.
3. Operation of Veta software to:
   - 3.1. Import the exported all-passes and proofing data files
   - 3.2. Import project layout
   - 3.3. If using the Veta software to create boundary for the area of hot mix asphalt daily production, demonstrate the procedure for creating the boundary.
   - 3.4 Review the compaction maps
   - 3.5. Import compaction point test data
   - 3.6. Perform statistical analysis
   - 3.7. Generate specified reports
4. Method for establishing target values for:
   - 4.1. Number of passes
   - 4.2. Temperature
   - 4.3. Intelligent compaction measurement values
5. Coverage and uniformity requirements
6. Corrective actions to be taken when coverage and uniformity requirements are not met

The following personnel must attend the intelligent compaction geospatial data and analysis just in time training:

1. Technical representative
2. Intelligent compaction quality control technicians
3. Data analysis technician
4. HMA foreman

39-8.01D(3)(c) Intelligent Compaction Quality Control Technician Training

Effective January 1, 2017, submit the technician has completed a Department authorized intelligent compaction quality control training course within the last 12 months. A Department authorized intelligent compaction quality control training course must cover:

1. Intelligent compaction specification requirements for quality control technician responsibilities.
2. GPS site calibration or localization
3. GPS check testing for the compaction rollers and rovers
4. Equipment operation verification of:
   - 4.1. Positioning system
   - 4.2. Temperature sensor
   - 4.3. Accelerometer
5. Establishing project layout
6. Establishing construction boundary for:
   - 6.1. Test strip
   - 6.2. Daily HMA placement
7. Test section construction to establish target compaction pass counts, temperature and target values for the stiffness of the HMA using nuclear gauges, pavement cores, and intelligent compaction rollers
8. Establishing of action limits for:
   - 8.1. Roller passes
   - 8.2. HMA mat temperature
9. Monitoring the rollers operation for compliance with target values.
10. Quality control testing for pavement temperature and compaction.
11. Review of daily compaction quality control report results for compliance with the specifications and taking corrective action when necessary for compliance.
12. Data management
    - 12.1. Verify uploading of data
    - 12.2. Downloading data from rollers
    - 12.3. Backing up compaction data
13. Daily set-up, take-down, of GPS and compaction roller components.

39-8.01D(3)(d) Data Analysis Technician Training

Effective January 1, 2017, submit the technician has completed a Department authorized intelligent compaction data analysis training course within the last 12 months. A Department authorized data analysis training course must cover:

1. Intelligent compaction specification requirements for:
   - 1.1. Data analysis using Veta
   - 1.2. Reporting
2. Operation of Veta software to:
   - 2.1. Import post processed all-passes and final coverage data files
   - 2.2. Import project layout
   - 2.3. Import points and create boundary
   - 2.4. Create boundary for the area of hot mix asphalt daily production using project layout and beginning and ending stations
   - 2.5. Import compaction point test data
   - 2.6. Import HMA mat temperature data
   - 2.7. Review the compaction maps
   - 2.8. Generate 11 by 17 inches plots
   - 2.9. Perform statistical analysis
   - 2.10. Generate specified reports
3. Using example project data provide hand on Veta analysis training to produce a mock up test strip report.
4. Using example project data provide hands-on Veta analysis training to produce a mock up compaction quality control report.
5. Provide training for completing intelligent compaction forms.
6. Cover specification requirements for submittal of reports and information including file naming requirements.

39-8.01D(4) Prepaving Meeting

The intelligent compaction quality control technician must attend the prepaving meeting.

39-8.01D(5) IC Test Strip

39-8.01D(5)(a) General

When HMA thickness is 0.15 foot or greater, a test strip is used to establish intelligent compaction target values. Establish intelligent compaction target values for the following:

1. Number of roller passes for breakdown compaction
2. Minimum temperature in degrees F for roller 1st pass of breakdown compaction
3. Number of roller passes for intermediate compaction
4. Minimum temperature in degrees F for completing intermediate compaction
5. Intelligent compaction measurement value

The target number of roller passes is based on your roller pattern established to achieve specified density.

To establish target minimum hot mix asphalt mat temperatures:

1. Use Veta to analyze the hot mix asphalt mat temperature for 1st pass of breakdown compaction to establish the target minimum temperature in degrees for the 1st pass of breakdown compaction.
2. Use Veta to analyze the hot mix asphalt mat temperature for last pass of intermediate compaction to establish the target minimum temperature in degrees for F for the last pass of intermediate compaction.

39-8.01D(5)(b) Initial Establishment of Target Value for Intelligent Compaction Measurement Value

On the first day of placement of each layer of HMA construct a test strip at least 500 feet long to determine the intelligent compaction target values. The compaction curve must be created by Veta and relate the number of roller passes to intelligent compaction measurement values. Use handheld rover to establish boundary for the 500 foot section. Use handheld rover to establish 3 randomly selected nuclear gage density test locations. Nuclear gages must be correlated with density cores under Part 2 of California Test 375.

To establish the target intelligent compaction measurement value within the test strip:

1. After each coverage, use a nuclear gage to measure the density of the HMA at 3 preselected locations throughout the covered 500 foot section. Record the density readings, and number of roller passes.
2. Establish the density of the tests strip for each coverage by averaging the density at the 3 locations.
3. Continue roller passes and collecting nuclear gage density readings until the density remains constant, decreases, or reaches maximum specified density.
4. When you determine that the density remains constant, decreasing, or reaches maximum specified density, take an additional 7 randomly selected nuclear gage readings. If the average density of the 10 locations determined for the last coverage indicates an increase in density by more than 3%, then continue rolling and testing, except if the average density equals or exceeds the maximum specified density.
5. Use Veta to create compaction curve and relate the number of target value for roller passes to intelligent compaction measurement values.
6. Use the Veta generated correlation analysis report for all passes to establish production target intelligent compaction measurement value based on target density (% theoretical maximum density) that meets the specified in-place compaction requirements.

If the last roller coverage of intermediate compaction is not done with the steel drum roller with vibration on, establish target intelligent compaction measurement value for the final roller pass of the steel drum roller with vibration on based on your test strip roller pattern.

39-8.01D(5)(c) Reestablishment of Target Value for Intelligent Compaction Measurement Value

Reestablish the target intelligent compaction measurement value by recording density readings versus measured intelligent compaction measurement value. During HMA placement within a 500 foot section, for the roller pass used as the basis for the target intelligent compaction measurement value use a nuclear gage to measure the density at three random locations. Record the density readings, roller pass number, and the GPS coordinates for each test location. Use handheld rover to establish boundary for the 500 foot section.

Use the Veta generated correlation analysis report to reestablish production target value for intelligent compaction measurement value based on target density (% theoretical maximum density) that meets the specified in-place compaction requirements. If the last roller coverage of intermediate compaction is not done with the steel drum roller with vibration on, reestablish target intelligent compaction measurement value for the final roller pass of the steel drum roller with vibration on based on your roller pattern.

39-8.02 MATERIALS

Not Used

39-8.03 CONSTRUCTION

39-8.03A General

Before the start of production upload the project layout file into the intelligent compaction data analysis software and depending on the roller manufacture, on-board documentation system of the rollers.

39-8.03B Equipment

39-8.03B(1) General

Not Used

39-8.03B(2) Rollers

In addition to the requirements of section 39-1.03B(3), each intelligent compaction roller must:

1. Be double-drum vibratory rollers equipped with accelerometers mounted in or about the drum to measure the interactions between the rollers and compacted materials in order to evaluate the applied compaction effort
2. Be equipped with non-contact temperature sensors for measuring pavement surface temperatures.
3. With vibratory on, produce output that represents the stiffness of the material based on the vibration of the roller drums and the measured response from the underlying materials
4. Have mounted GPS receiver, antenna, and telemetry equipment to monitor the drum locations and track the number of passes
5. Include an integrated on-board documentation system that is capable of displaying real-time color-coded maps, including the stiffness response values, vibration frequencies, roller drum amplitude, roller location, number of roller passes, roller speeds and capable of transferring data from a USB port

In addition to the requirements in section 39-1.03B(3), automated machine guidance pneumatic tire rollers must meet the following:

1. Be equipped with non-contact temperature sensors for measuring pavement surface temperatures.
2. Have GPS radio and receiver units mounted on each automated machine guidance roller to monitor the roller locations and track the number of passes of the rollers.
3. Include an integrated on-board documentation system that is capable of displaying real-time color-coded maps of roller location, number of roller passes, roller speeds and capable of transferring data from a USB port.

39-8.03B(3) Global Positioning System

39-8.03B(3)(a) General

GPS must be real time kinematic using one of the following:

1. GPS base station
2. Network real time kinematic **(**RTK)
3. Satellite based augmentation station system capable of providing position accuracy within 0.25 foot

You may use other high precision positioning systems in lieu of GPS. The positioning system must meet or exceed the precision specified for GPS.

GPS used must provide a minimum 90 percent coverage of project site.

GPS devices for this project must be set to the same consistent datum, coordinate system, CCS83 zone, and site calibration or localization. The CCS83 zone must be set to zone no 5.

Prior to July 2016, you may use UTM coordinate system if your roller on-board documentation system and display are not compatible with CCS83. Notify the engineer if you will use UTM coordinate system.

39-8.03B(3)(b) Correction Signal Source

Provide either a GPS base station correction signal or a GPS correction service subscription. The GPS correction signal must be received by the GPS receivers on the compaction roller and the rovers during operations with a survey tolerance of not greater than 0.25 foot in both X and Y horizontal directions.

Install GPS repeaters at selected locations to relate the GPS correction signal to resolve GPS shadows.

39-8.03B(4) Survey Control Points

Survey control points are included in Supplemental Project Information.

39-8.03B(5) GPS Site Calibration or Localization and Check Testing

At least 2 business days before start of production, perform a GPS site calibration or localization to the survey control points.

Whenever the GPS base station is moved to a new location, verify GPS base station position by measuring the position of two known points using a rover. Perform a GPS site calibration or localization if the position of known points and measured positions differ by more than 3 centimeters.

At least 2 business days before start of production, perform roller verification testing by conducting roller check testing.

Before the start of daily production and using the same datum, conduct check testing for the proper setup of the GPS, the GPS on the rollers, and the GPS rover:

1. On a location nearby or within the project limits, the GPS base station, if required by the GPS, must be established and the compaction roller and the GPS rover must be tied into the same base station
2. Verify that the roller and rover are working properly and that there is a connection with the base station
3. Verify the roller GPS coordinates by:
    - 3.1. Stopping the roller at a location
    - 3.2. Marking the location of both ends of the roller drum or the outside of the front tires on the surface with a tee
    - 3.3. Recording the GPS measurements from the roller ensuring the distance offsets are applied so that the GPS coordinate is at the center of the front drum
    - 3.4 Moving the roller from the marked location
    - 3.5. Finding the mid-point of the two marked ends of the roller and mark this location on the surface. This marked location is the theoretical center of the front drum or center of front axle.
    - 3.6. Using the GPS rover to measure GPS coordinates of the marked location and record the GPS measurements.
    - 3.7. Computing the difference between recorded compaction roller GPS coordinates and GPS rover recorded GPS measured coordinates. The differences of the coordinates in grid must be within 0.5 foot in both the horizontal axes X and Y.

39-8.03C HMA Compaction

39-8.03C(1) General

Intelligent compaction does not apply to areas of hot mix asphalt placed under Bid Item “Replace Asphalt Concrete Surfacing” or areas shown as digouts.

During HMA compaction, monitor each roller’s compaction graphical user interface display for roller passes, and HMA temperature. When HMA layer thickness is 0.15 foot or greater, monitor each roller’s compaction graphical user interface display for intelligent compaction measurement value.

For every 4 hours of HMA placement, Use a verified NIST traceable temperature measuring device and measure the temperature of the HMA at 3 random locations on first pass of breakdown and last pass of intermediate compaction. The temperature measuring device must be within +/- 3 degrees F of NIST traceable standard. Use GPS rover to measure and record coordinates of each temperature test point reading.

For intermediate compaction of RHMA-G, use an intelligent compaction roller instead of the automated machine guidance pneumatic tire roller.

When HMA thickness is 0.15 foot or greater, use GPS rover to measure and record coordinates of each quality control nuclear gage reading.

For each day of HMA placement establish the boundaries of the area for HMA placed using the rover.

39-8.03C(2) Roller Coverage, HMA Temperature, and Intelligent Compaction Measurement Values

At least 90 percent coverage of the construction area must meet or exceed the target number of passes for each roller type. When the daily HMA compaction quality control report shows the specified or target roller passes are not met, take corrective action and notify the Engineer of action taken.

When the roller HMA temperature sensor indicates compaction temperatures are below target temperatures take immediate corrective action.

At least 95 percent of the construction area must comply with the target temperatures. When the daily HMA compaction quality control report indicates less than 95 percent of the construction area is completed after HMA is below the minimum target temperature, implement corrective action before the next HMA placement day and notify the Engineer.

For HMA 0.15 foot or greater in layer thickness, monitor the intelligent compaction measurement value against the target value established in the test strip. If intelligent compaction measurement value is 10 percent or more below the target value, verify that HMA compaction complies with density specified requirements with a nuclear gage.

If the daily average intelligent compaction measurement value is 20 percent or more below the target measurement value, reestablish the target value for intelligent compaction measurement value.

For HMA 0.15 foot or greater in layer thickness, when density is verified, then the corrective action for number of passes and temperature is not required.

39-8.04 PAYMENT

Not Used