Delaware Department of Transportation

REQUEST FOR PROPOSALS
PROFESSIONAL SERVICES

RFP Number: **1990S**

Road Rating Services

Submission Due Date/Time: **Thursday, November 5, 2020 prior to 2:00 P.M. Local Time**

Three (3) year term with two (2) possible one-year extensions

Agreement Type: Project Specific

One (1) agreement may be awarded from this solicitation

The resulting agreement may be State funded

The anticipated method of payment is cost plus fixed fee

29 Del.C. §6981, §6982(b)

PROJECT INFORMATION

This Request for Proposal (RFP) issued by the Delaware Department of Transportation (DelDOT) is for the purpose of acquiring Proposals from interested firms to collect pavement ratings, biennially, for each segment of state-maintained roadway in Delaware including state-maintained suburban streets. The data collected will be used by the Pavement Management section to prioritize the paving list that is presented for the bond bill and assist in projecting the Department's funding needs for current and future paving projects.

PROJECT DESCRIPTION

The total mileage to be surveyed is approximately 4,459 miles for state-maintained roads and approximately 1,422 miles for suburban streets. State-maintained road mileage includes approximately 70 miles of the National Highway System (NHS) interstate network and approximately 654 miles of the NHS non-interstate network. All miles will be surveyed in one direction only, in the direction given by the begin and ending descriptions in the data file supplied by the Department.

SERVICES REQUIRED

Services may include, but may not be limited to:

1. Collection of automated pavement condition data including distress data in accordance with the Delaware's Pavement Management Distress Dictionary, *Appendix I*; and Data Quality Management Plan (DQMP), *Appendix II*.
2. Collection of the NHS System shall be completed for HPMS on off years.
3. Collection of NHS data yearly.

4. Collection of video log images of all state-maintained road segments and the possible collection and extraction of LIDAR data to include road features such as lights, signs and guardrail along the state network of roads.
5. Initial calibration verification.
6. Data quality management and reporting.
7. Conducting field surveys as directed by the Department's Distress Data Dictionary and DQMP using a profiler and/or an automated 3D Laser Crack Measurement System (LCMS) include all items listed in DelDOT Data Dictionary including:

    - Roughness
    - Rutting
    - Cracking
    - Total Crack Length
    - Patching
    - Raveling
    - Joints
    - Faulting
    - Type of pavement
    - Severity of distress in pavement
    - Extent of distress in pavement

    Data shall be provided in the most up-to-date version of Access, XLS, or Oracle 12c data import file. The data shall be compatible with the department's Pavement Management System. The data collection shall include high resolution, digital images of the pavement right of way taken at increments of 20 feet or less and be in JPG format.

    In addition, the consultant shall provide training for all personnel who perform the field surveys.

8. Location Referencing

    DelDOT will provide the selected firm with a GIS shape file or geodatabase that includes all road segments to be surveyed. All survey data collected will be required to be delivered in tabular data format, with the GIS ID included (so that it can be related back to the GIS information), summarized in 1/10th mile segments, with start and end points located by Latitude and Longitude coordinates which shall be stated in WGS84 coordinate systems. All location attributes are to be captured according to the DelDOT Data Dictionary.

OTHER REQUIREMENTS

Proposers should describe how they meet the requirements of the DQMP for the following:

A. Survey Data

All data shall be collected in through lanes. Exceptions to this should be noted where possible. Proposers should describe in their proposal how exceptions and possible bad data will be flagged. Included in this flagged list shall, at a minimum, be indicators of bridges, railway crossings and construction zones.

Data shall be collected for roadway distress specified in the Data Dictionary. Data collected for distresses shall follow the format specified in the Data Dictionary and according to the methods described in the DQMP. This includes specific protocols required for equipment and methods of collecting the data.

B. Equipment

The selected firm shall use a fully integrated system designed to collect all data in a single pass by synchronizing all data to a single point of reference in the field (with no post processing).

1. Digital Laser Profiler (also applies if collecting roughness using LCMS)
    - Must meet the standards for roughness collection specified in the DQMP.
2. 3D Laser Crack Measurement System (LCMS)
    - Capable of collecting Rutting (full transverse pavement measurement covering a pavement width of 12 ft), 3D surface profile, pavement roughness, automated crack detection classification and categorization, and automated pothole classification. All measurements (including if LCMS used for collection of roughness) shall meet the standards specified in the DQMP.
3. Location Measurement
    - Differential global positioning system (sub meter accuracy) backed up by inertial system in case of loss of GPS. High accuracy Distance Measuring Instrument (DMI).
4. Digital Imaging System
    - All cameras must be calibrated for scale measurement to allow visible assets to be referenced geospatially from the images now or in the future.
    - High-resolution roof-mounted digital cameras for asset extraction.
    - Imagery to be integrated with pavement data using the same geo-location system.
5. Integrated Viewing Software
    - Software access to view and export survey data, including synchronized pavement and ROW imagery through a data viewer application that allows users to navigate through collected data and view the distresses on the road surface, individual images, as well as summarized data and output graphs.
    - The software should allow the user to specify the location to be viewed.
    - Data must be hosted externally with no need to install software.
    - The proposal should include any software license costs for the term of the contract with the option to extend.
6. Post Processing
    - Recorded information must have the necessary resolution and accuracy to allow post processing to extract additional inventory or condition at a later date.

C. Quality Management

Both Quality Assurance (QA) and Quality Control (QC) are important to ensure collected pavement condition data is accurate and repeatable. The selected firm will be responsible for QA/QC of the data and will be required to submit a QA/QC plan to the Department in accordance with the DQMP. The selected firm will be required to provide a copy of their Quality Management Plan.

OPTIONAL ITEMS

The following items are optional items to be collected and delivered as additional attributes with the Data Collection Segment dataset. The selected firm will be required to submit the cost per mile for these items and describe the attributes that will be collected for the indicated cost.

These items are to be captured at a 6 ft segmentation level (i.e. every 6 ft [or 2 m] along the pavement) and should be accompanied by location attribute data to enable tying of the data to an associated 1/10th mile segment, as well as latitude and longitude coordinates for the starting points of the 6 ft segments.

Low Severity Crack Density in R85 Zones 1-5 (TKG_CRKD_Zx_L)	Number (10,2)	Crack density of cracks having widths < 0.25" measured as crack length per unit area in zones 1-5 of data collection segment (Ft/SqYd)
High Severity Crack Density in R85 Zones 1-5 (TKG_CRKD_Zx_H)	Number (10,2)	Crack density of cracks having widths ≥ 0.25" measured as crack length per unit area in zones 1-5 of data collection segment (Ft/SqYd)

QUESTIONS

Questions must be submitted before the due date identified in the Procurement Schedule for this RFP. All inquiries must be submitted in the Q/A section of the project listing in the Bonfire Procurement Portal.

The Department's response to questions will be posted, according to the procurement schedule, under the project listing in Bonfire and to the State of Delaware Bid Solicitation Directory Website: http://www.bids.delaware.gov/.

PROCUREMENT SCHEDULE

Action Item	Date	Time
Deadline for Questions to ensure response:	Thursday, October 22, 2020	2:00 P.M. Local Time
Final Response to Questions posted by:	Thursday, October 29, 2020	2:00 P.M. Local Time
Proposals Due prior to:*	Thursday, November 5, 2020	2:00 P.M. Local Time

NOTE: Only asterisk (*) marked date changes will be communicated (via posted Addendums).

PROPOSAL REQUIREMENTS

Interested firms must submit the material required herein or they may not be considered for the project:

1. Proposals must be received before the Proposal Due Date and Time, as identified in the Procurement Schedule for this RFP. Responses submitted by hard copy, mail, facsimile, or e-mail will not be accepted. Responses received after the Proposal Due Date and Time will not be considered.

2. **Upload your submission at**: https://deldot.bonfirehub.com/portal/

   Important Notes:
   - Logging in and/or uploading the file(s) does not mean the response is submitted. Users must successfully upload all the file(s) and MUST click the submit button before the proposal due date and time.
   - Users will receive an email confirmation receipt with a unique confirmation number once the submission has been finalized. This will confirm that the proposal has been submitted successfully.
   - Each submitted item of Requested Information will only become visible to DelDOT after the proposal due date and time.
   - If the file is mandatory, you will not be able to complete your submission until the requirement is met.
   - Uploading large documents may take significant time depending on the size of the file(s) and your Internet connection speed. The maximum upload file size is 1000 MB.
   - Minimum system requirements: Internet Explorer 11, Microsoft Edge, Google Chrome, or Mozilla Firefox. Java Script must be enabled.

   Need Help? Please contact Bonfire directly at Support@GoBonfire.com or 1(800)654-8010 ext. 2 for technical questions or issues related to your submission. You can also visit their help forum at https://bonfirehub.zendesk.com/hc.

3. **The Prime Consultant must be Registered,** or submit application for registration, with DelDOT at or before the time of submission in order to be considered. For registration information, click here.

4. **Submit one (1) Original and one (1) Redacted copy** of the Proposal. The original must be a .pdf file of the original signed proposal and should be clearly marked "Original" on the first page of the document. The redacted copy must be a .pdf file of the original signed proposal with any proprietary or confidential information redacted, and this copy should be clearly marked as "Redacted" on the first page of the document. The redacted copy is required even if the submission contains no proprietary or confidential information.

   To determine what information may be considered proprietary or confidential and may be redacted from their Proposal, firms should review Delaware's Freedom of Information Regulations here; http://regulations.delaware.gov/AdminCode/title8/1400.shtml#TopOfPage. Under Delaware FOIA law, 29 Del. C, §10002(l)(2), "Trade secrets and commercial or financial information…which is of a privileged or confidential nature" are "records that shall not be deemed public" and are therefore exempt from disclosure under FOIA.

5. **Architect-Engineer Qualifications**; **GSA SF330:**
http://www.gsa.gov/portal/forms/download/116486

Follow instructions for the SF330, and add the following Individual Agency Instructions:

A. Part I Section C 11, Proposed Team;
Indicate if the firm is a DBE and provide the approximate percentage of the contract cost they will perform.

B. Part I Section E, Resumes of Key Personnel Proposed for this Contract;
Resume information is limited to eight (8) individuals regardless of affiliation.

C. Part I Section F, Example Projects;
Example Projects provided are limited to ten (10).

D. Part I Section H 30, Additional Information;
(The Department recommends formatting this section using Times New Roman, 12 pt. font)
1) The Prime consultant must indicate the current workload with the Department by listing the following in a table format:
Agreement No.; Agreement Title; Consultant PM; Prime or Sub; Total Dollars paid to date; current number of Tasks issued; and date of contract expiration.
2) List any DelDOT agreement number your firm has been selected for and not included above.
3) Firms may include a "Rating Criteria Support Information" Section, limited to four (4) pages on two (2) sheets of paper, within Section H, that covers any information that directly relates to the firm's ability to meet the specific rating criteria listed in this RFP.

Note: Letters of Interest should not be included.

6. **Joint venture** submissions will not be considered.

7. DelDOT reserves the right to reject any and all submissions. Submissions become property of the Department and shall be retained electronically for a minimum period of three (3) years from the date of receipt. DelDOT reserves the right to any and all ideas included in this response without incurring any obligations to the responding firms or committing to procurement of the proposed services.

8. **Required Certification Forms.** All firms responding to the RFP must complete and return the submission forms located in 'Appendix A' of this document.

No promotional materials or brochures are to be included as part of the submission.

RATING CRITERIA

#	**Criteria Description**:	**Weight**
1	Firm's resources and capability to accomplish proposed work on schedule	25 %
2	Firm's experience pertaining to roadway distress collection and processing	20 %
3	Technical Approach	20 %
4	Project understanding, approach, services required	20 %
5	Key Staff and Project Team qualifications	15 %
	TOTAL :	**100%**

OVERVIEW OF SELECTION PROCESS

- This is a project specific agreement where the services as described in this RFP will be provided over the life of the project.
- This is a single phase solicitation process with the availability for discussions with up to three (3) of the most highly qualified firms. Based upon the listed criteria and evaluation of each firm's submitted proposal, the Selection Committee may decide if a small sample task and/or discussions will be held with the most highly qualified consultants. If discussions are held, they will serve to clarify the technical approach, qualifications, and capabilities provided in response to the RFP, after which the committee will determine the ranking of the candidate firms.
- Selection Committee members will individually score each firm's submitted proposal which determines individual ranking. The Department's ranking is the combined ranking of all Committee members. Firms, in order of ranking, will have the opportunity to negotiate an agreement with the Department. If the Department cannot reach agreement with the highest ranked firm(s), the Department terminates negotiations and begins negotiations with the next highest ranked firm, and so on until an agreement is reached. The Department notifies via email the awarded firm(s) of the opportunity to enter into an agreement with the Department. This notification also includes information on the next steps for the agreement process.
- After the ranking process has been completed, applicable price information will be requested from the successful candidate firm(s), such as; salary rates for various classifications of personnel; and an indirect cost derivation for the most current accounting period.
- Payroll burden and overhead will be computed on direct salary costs only (not including overtime) at the consultant's audited rate, as per Federal Acquisition Regulations Part 31, and Department policies. Computer and CADD costs are not allowable as a direct cost to this project. Rate determination and applicability is subject to audit by the Department. Additionally, candidates should be prepared for the Department to work with your current accounting firm to provide information and backup documentation. Full and immediate cooperation is required to avoid delays in execution of an agreement. Failure to cooperate may result in breaking off of negotiations and moving to the next ranked firm.
- Selection Committee membership appointments are confidential. The Department's Professional Services Procurement Manual may be viewed here.

INSURANCE REQUIREMENTS

The selected firm(s) must obtain at its own cost and expense and keep in force and effect during the term of the agreement, including all extensions, the minimum coverage limits specified below with a carrier satisfactory to the State.

a. Worker's Compensation and Employer's Liability Insurance in accordance with applicable law.

b. Commercial General Liability - $1,000,000 per occurrence/$3,000,000 per aggregate.

c. Miscellaneous Errors and Omissions - $1,000,000 per occurrence/$3,000,000 per aggregate.

d. Automotive Liability Insurance covering all automotive units used in the work (including all units leased from and/or provided by the State to Vendor pursuant to this Agreement as well as all units used by Vendor, regardless of the identity of the registered owner, used by Vendor for completing the Work required by this Agreement to include but not limited to transporting Delaware clients or staff), providing coverage on a primary non-contributory basis with limits of not less than:

   1. $1,000,000 combined single limit each accident, for bodily injury;
   2. $250,000 for property damage to others;
   3. $25,000 per person per accident Uninsured/Underinsured Motorists coverage;
   4. $25,000 per person, $300,000 per accident PIP benefits if carrying any of our clients or employees; and
   5. Comprehensive coverage for all vehicles leased from the State of Delaware Fleet Services which shall cover the replacement cost of the vehicle in the event of collision, damage or other loss.

Certificate of Insurance and/or copies of the insurance policies will be requested at time of award.

In no event shall the State of Delaware be named as an additional insured on any policy required under this agreement.

MISCELLANEOUS

The Department is not liable for any cost incurred by the consultant in the preparation or presentation of the Proposal.

Any individual, business, organization, corporation, consortium, partnership, joint venture, or any other entity including subconsultants currently debarred or suspended is ineligible to participate as a candidate for this process. Any entity ineligible to conduct business in the State of Delaware for any reason is ineligible to respond to the RFP.

The Department of Transportation will affirmatively insure individuals and businesses will not be discriminated against on the grounds of race, creed, color, sex, or national origin in consideration for an award. Minority business enterprises will be afforded full opportunity to submit bids/proposals in response to this invitation.

Department of Transportation
State of Delaware
By: Jennifer Cohan
Secretary
Dover, DE

Appendix A - REQUIRED FORMS

The following completed forms are required to be returned with each proposal:

- Certification of Eligibility
- Certificate of Non-Collusion

CERTIFICATION OF ELIGIBILITY

Delaware Department of Transportation

Request for Proposal 1990S – Road Rating Services

We have read Request for Proposal number 1990S and fully understand the intent of the RFP as stated, certify that we have adequate personnel and knowledge to fulfill the requirements thereof, and agree to furnish such services in accordance with the contract documents as indicated should we be awarded the contract.

_____ hereby certifies that it is not included on the United States Comptroller General's Consolidated List of Persons or Firms Currently Debarred for Violations of Various Public Contracts Incorporating Labor Standard Provisions.

_____Signature of the Bidder or Offeror's Authorized Official

_____Name and Title of the Bidder or Offeror's Authorized Official

_____Date

Sworn and subscribed before me this _____ day of _____, 20___

_____ My commission expires: _____ / _____ / 20___

Notary Public Month Day Year

CERTIFICATE OF NON-COLLUSION

By submission of this bid, each bidder and each person signing on behalf of any bidder certifies, and in the case of a joint bid, each party thereto certifies as to its own organization, under penalty of perjury, that to the best of knowledge and belief:

1) The prices in this bid have been arrived at independently without collusion, consultation, communication, or agreement for the purpose of restricting to such prices, with any other bidder or with any competitor;

2) Unless otherwise required by law, the prices which have been quoted in this bid have not been knowingly disclosed by the Bidder and will not knowingly be disclosed by the Bidder prior to opening, directly or indirectly, to any other bidder or to any competitor; and

3) No attempt has been made or will be made by the Bidder to induce any other person, partnership or corporation to submit or not to submit a bid for the purpose of restricting competition.

_____Signature of the Bidder or Offeror's Authorized Official

_____Name and Title of the Bidder or Offeror's Authorized Official

_____Date

Sworn and subscribed before me this _____ day of _____, 20___

_____ My commission expires: _____ / _____ / 20___

Notary Public Month Day Year

Appendix I - Data Dictionary

DelDOT Pavement Data Dictionary

Version 2.2

Prepared by: Mandli Communications, Kercher Engineering, and AECOM
Last Updated: November 2017

Background

This pavement data dictionary defines the distress types, severity levels, and methods of measurement for automated road rating data collection for the Delaware Department of Transportation (DelDOT). Pavement condition data is input into DelDOT's pavement management system, which allows for calculation of Overall Pavement Condition (OPC) index values and subsequent treatment selection. OPC assignment to pavement sections allows DelDOT to review current conditions, project future conditions, and plan maintenance and rehabilitation activities across its network.

Pavement distresses are considered for four pavement types, namely asphalt concrete (AC), Portland cement concrete (PCC), composite pavement (AC over PCC, or APC), and surface treated (ST). Table 1 summarizes applicable distresses by pavement type, while Table 2 shows Highway Performance Monitoring System (HPMS) distresses and attributes. With few exceptions, lengths of lane exclusions related to bridges, construction, lane deviations, or railroads will be reported for each route.

Table 1: Distresses by Pavement Type

Distress	AC	APC	PCC	ST
Bleeding				X
Block Cracking	X	X		X
Crown / Cross-Slope				X
Edge Cracking				X
Fatigue Cracking	X	X		X
International Roughness Index (IRI)*	X	X	X	X
Joint Deterioration / Spalling			X	
Joint Reflective Cracking		X		
Joint Seal Damage			X	
Map Cracking / Alkali-Silica Reactivity (ASR)			X	
Non-Wheel Path Longitudinal Cracking	X	X		X
Patch Deterioration / Potholes	X	X	X	X
Raveling	X	X		X
Rutting*	X	X		X
Slab Cracking			X	
Transverse Cracking	X			X

*Distresses not shown in imagery but factor into treatment recommendations.

It is worth noting that while imagery is not included for several distresses in this data dictionary, ride (as measured by the International Roughness Index, or IRI), roughness and crown, and rutting are important pavement characteristics that factor into treatment recommendations.

Table 2: Distresses and Attributes by Pavement Type for HPMS Sections

Distress / Attribute	AC	PCC	Definition	Measure
Crack Length	X		Length of transverse crack per mile	Ft
Crack Percentage	X	X	Fatigue area for AC and crack slabs for PCC	Percent
Curvature	X	X	Central angle	Degrees
Curve Class	X	X	HPMS curve class	A, B, C, D, E, F
Faulting		X	Average fault height, right wheel path	In
Grade	X	X	Slope	Percent Grade
Grade Class	X	X	HPMS grade class	A, B, C, D, E, F
International Roughness Index (IRI)	X	X	Road roughness index, each wheel path	In/Mi
Radius	X	X	Curve Radius	Ft
Rutting	X		Average rut depth, each wheel path	In

The data dictionary presents examples of high-resolution imagery for pavement distresses at each severity level. Data capture relies on use of the automated Laser Crack Measurement System (LCMS). LCMS data capture is augmented by human rating when appropriate. Automated distress capture modules are expected for edge cracking, joint seal damage, and raveling in the future but are not incorporated into collection protocols at this time.

In using the LCMS system to characterize and quantify pavement distress, colored image overlays are shown next to raw imagery. In general, crack width defines severity level, with finer cracks representing lower severity cracks. A legend for the distress overlays produced by the LCMS is shown in Figure 1. The distress overlay features in this image are:

1. AASHTO zone dividers, with zones defined as follows:
   Zone 1: Lane area between the inside wheel path and the lane edge or centerline (variable width).
   Zone 2: Lane area encompassing the inside wheel path (39-inch width)
   Zone 3: Lane area between the left and right wheel paths (variable width).
   Zone 4: Lane are encompassing the outside wheel path (39-inch width.
   Zone 5: Area between the outside wheel path and the lane edge or shoulder (variable width).
2. Hairline cracks
3. Low-severity cracks
4. Medium-severity cracks
5. High-severity cracks
6. Pothole
7. Edge of pavement or drop-off
8. Curb
9. Lane marking

Images shown in Figure 2 to Figure 4 represent other common image overlays seen throughout the data dictionary. Cracks that extend beyond a single AASHTO zone are boxed, as shown in Figure 2. When cracks are sealed, they will appear as shown in Figure 3. Joint detection on PCC pavements is represented as shown in Figure 4.

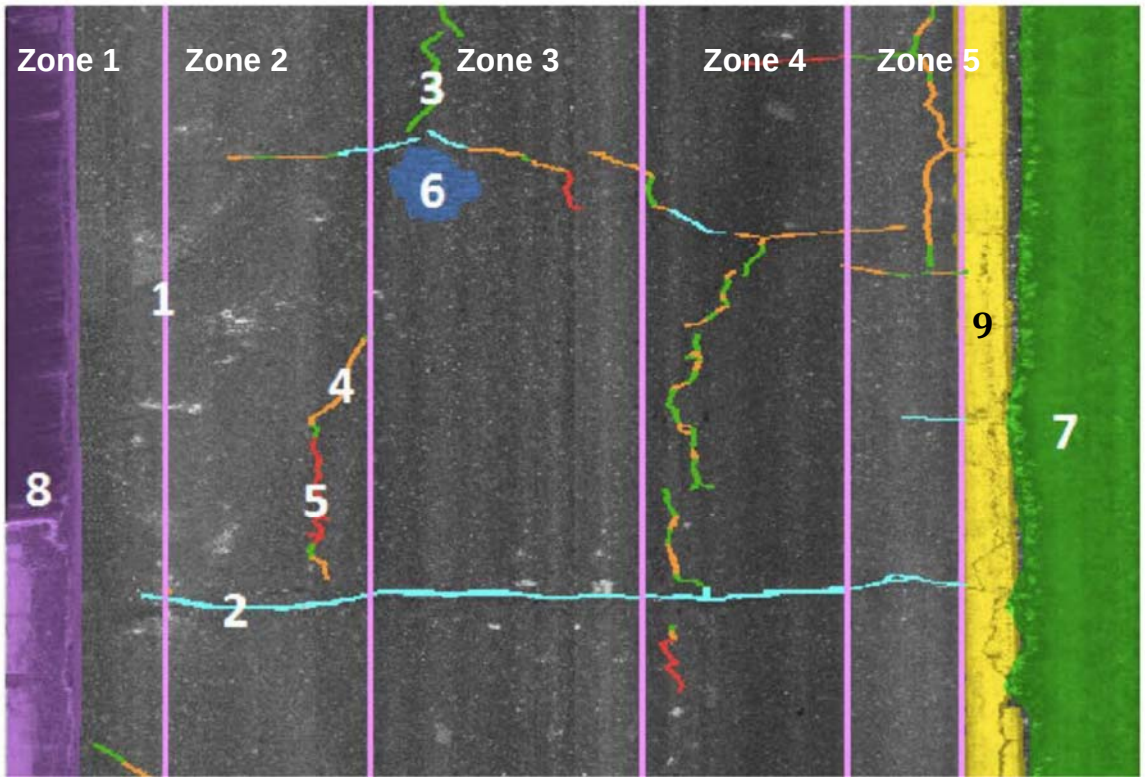


Figure 1: LCMS Distress Overlay on AC Pavement

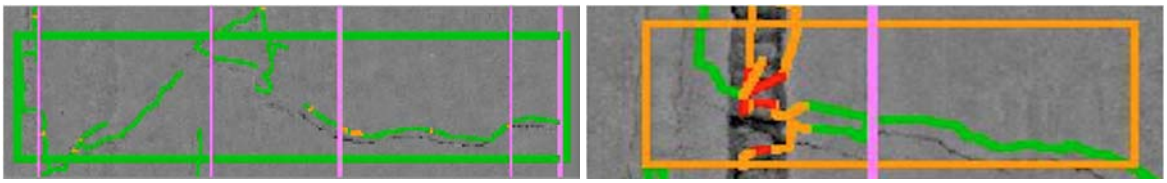


Figure 2: Low Severity (left) and High Severity (right) Transverse Cracking

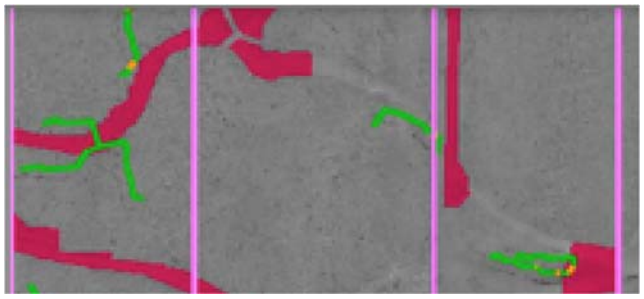


Figure 3: Sealed Cracking Shown in Pink

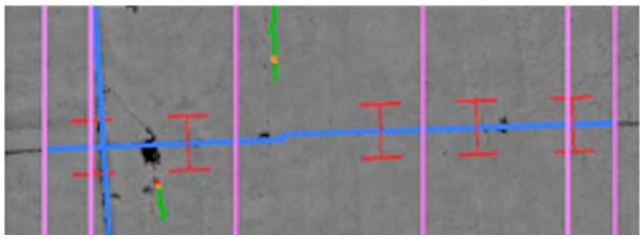


Figure 2: Joint Detection on PCC Pavements

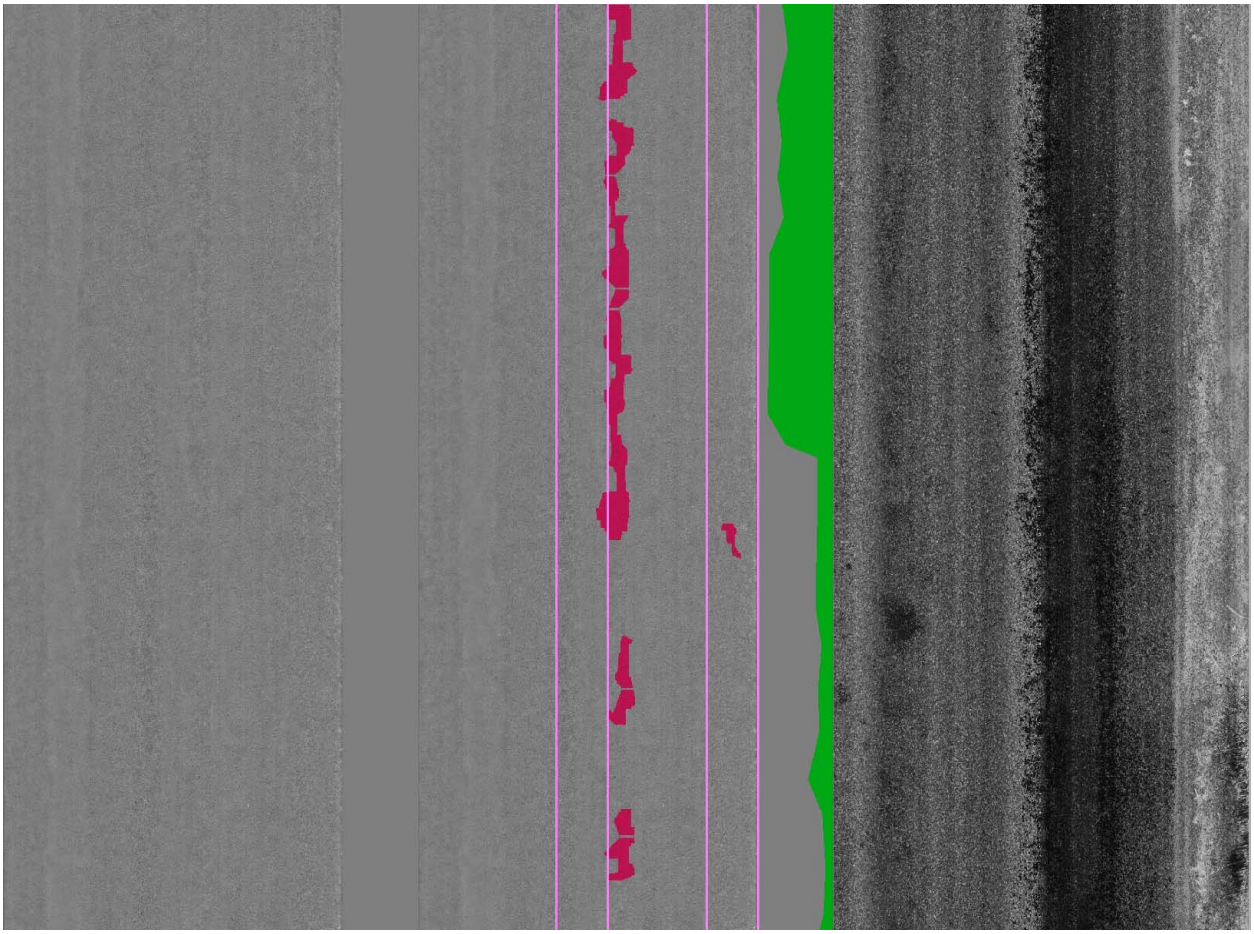
Bleeding

Method of Measurement:	Manual	**Unit of Measure:**	Sq Ft
Pavement Type:	ST	**Severity Levels:**	Yes

Definition: A film of bituminous material on the pavement surface that creates a shiny, glasslike, or reflective surface.

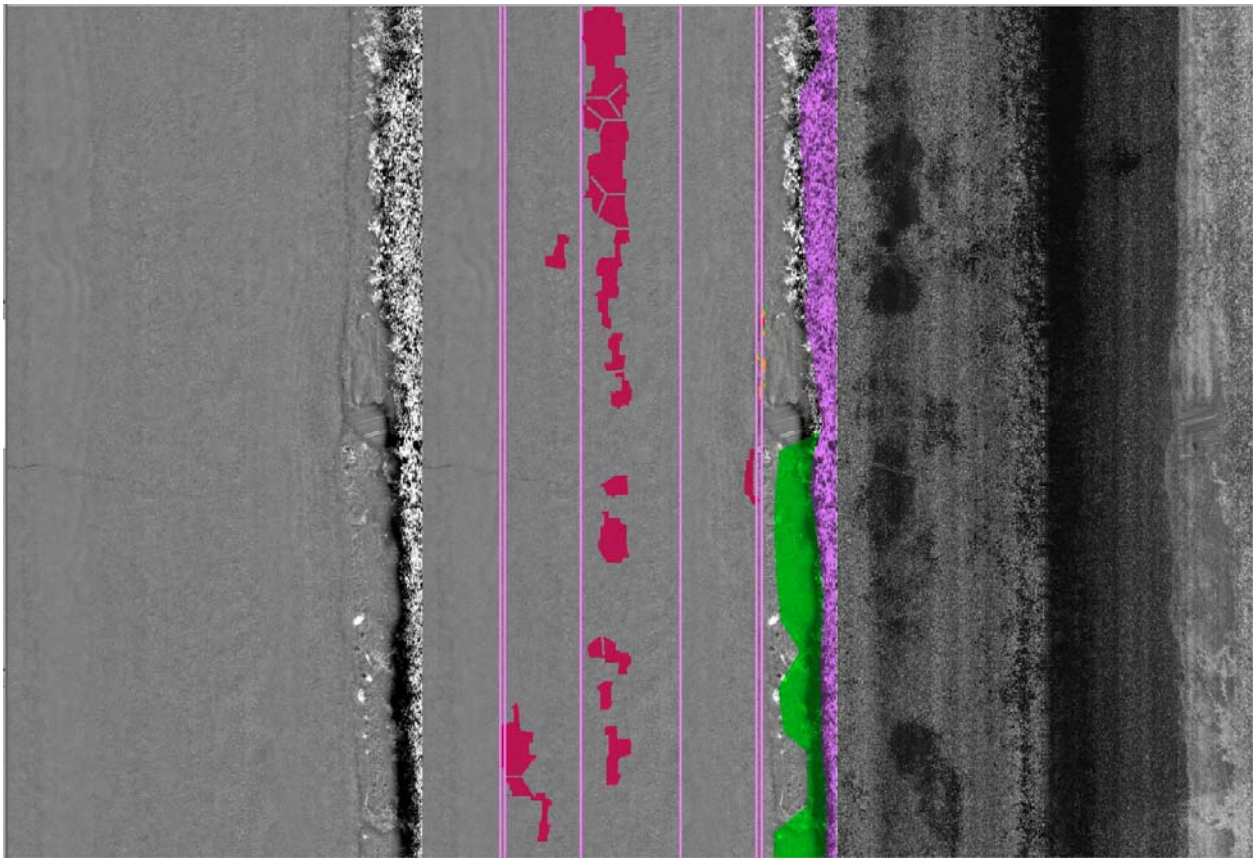
Bleeding (Low Severity)

Pavement area discolored by excess asphalt cement.



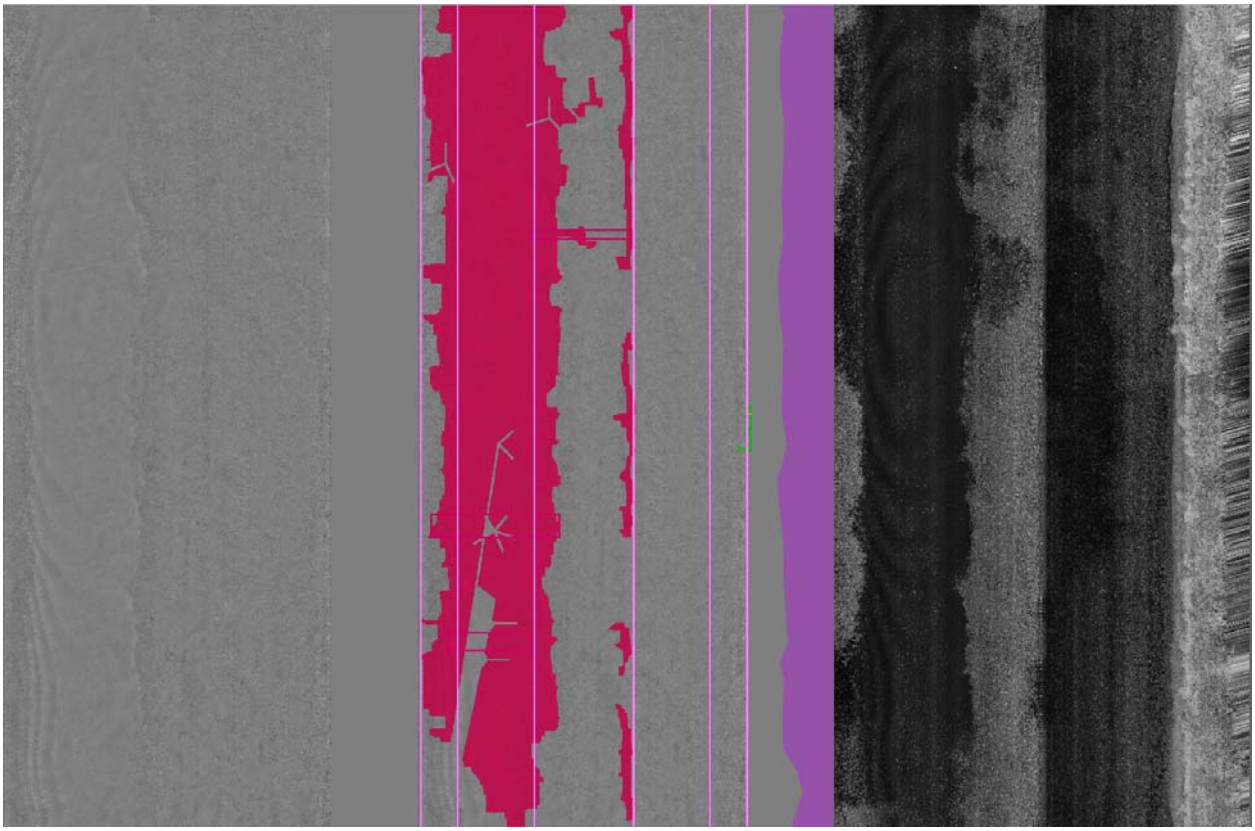
Bleeding (Medium Severity)

Pavement area begins to lose surface texture due to excessive asphalt binder at the surface.



Bleeding (High Severity)

Excessive asphalt cement at the pavement surface conceals aggregates under a shiny surface.



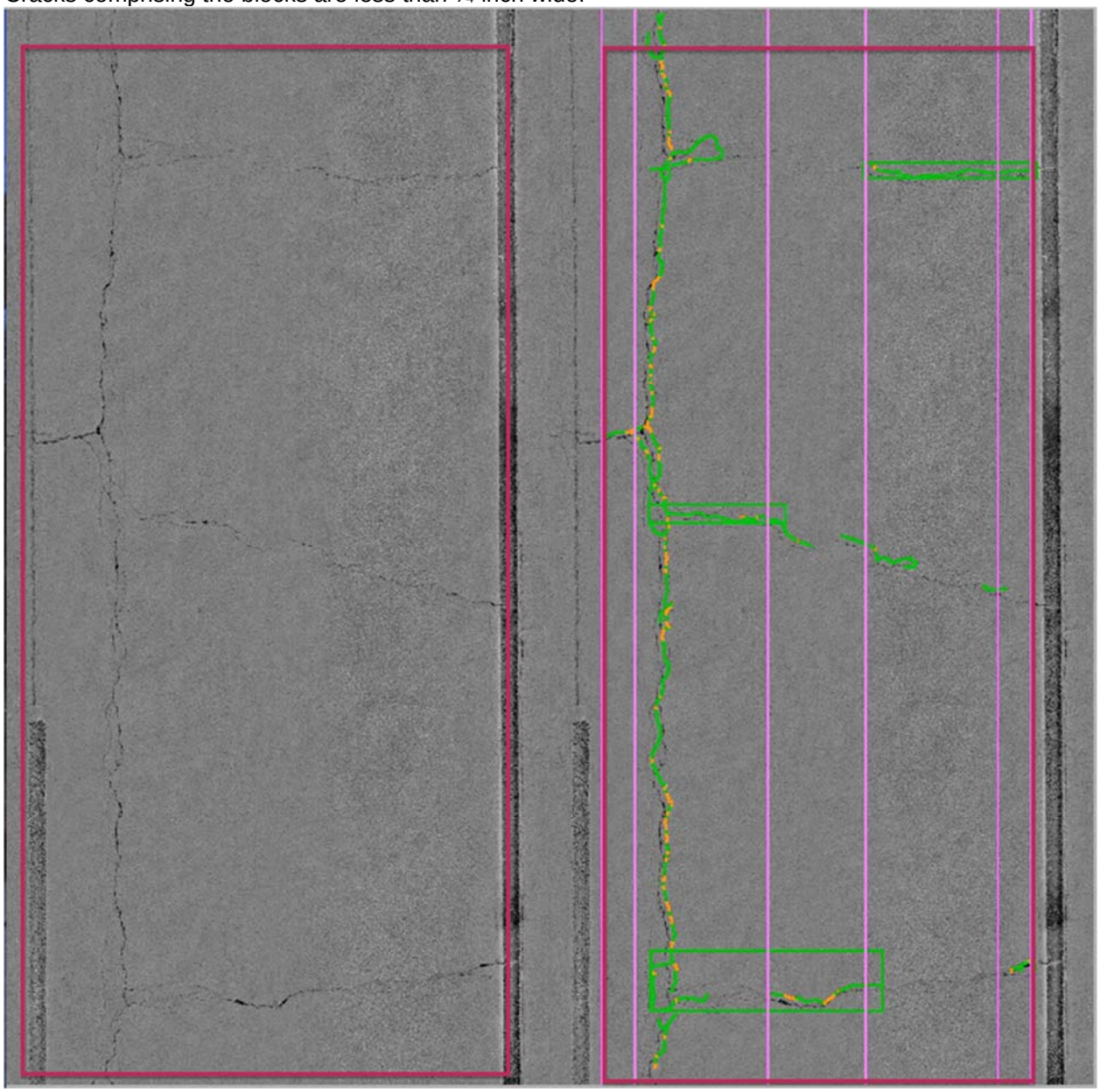
Block Cracking

Method of Measurement:	LCMS	**Unit of Measure:**	Sq Ft
Pavement Type:	AC, APC, ST	**Severity Levels:**	Yes

Definition: Interconnected cracks that divide the pavement into approximately rectangular pieces. Blocks may range in size from approximately 1 sq ft to 100 sq ft. Crack width defines block cracking severity levels. Block cracking is shown in the red boxes in the following images.

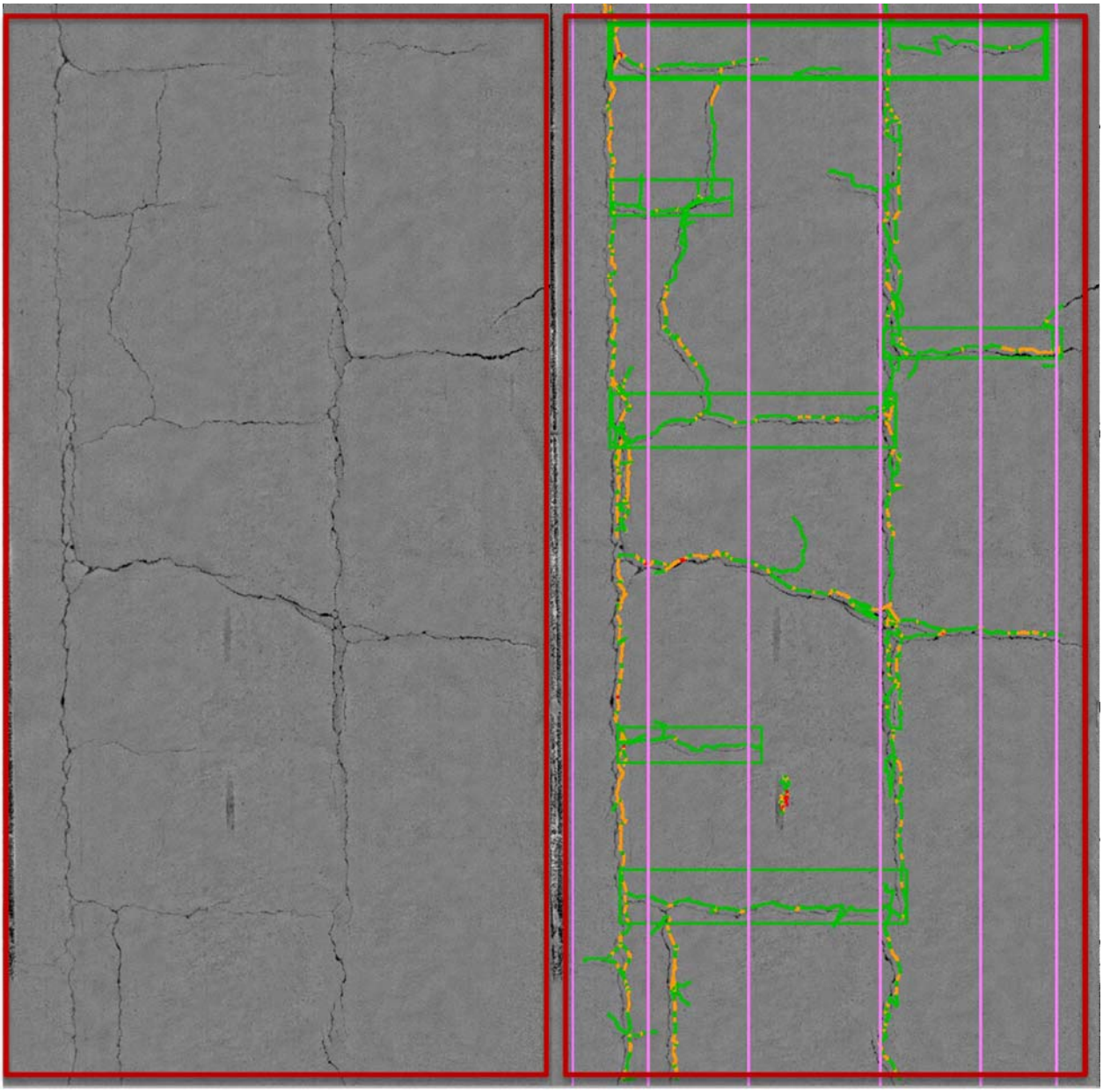
Block Cracking (Low Severity)

Cracks comprising the blocks are less than ¼-inch wide.



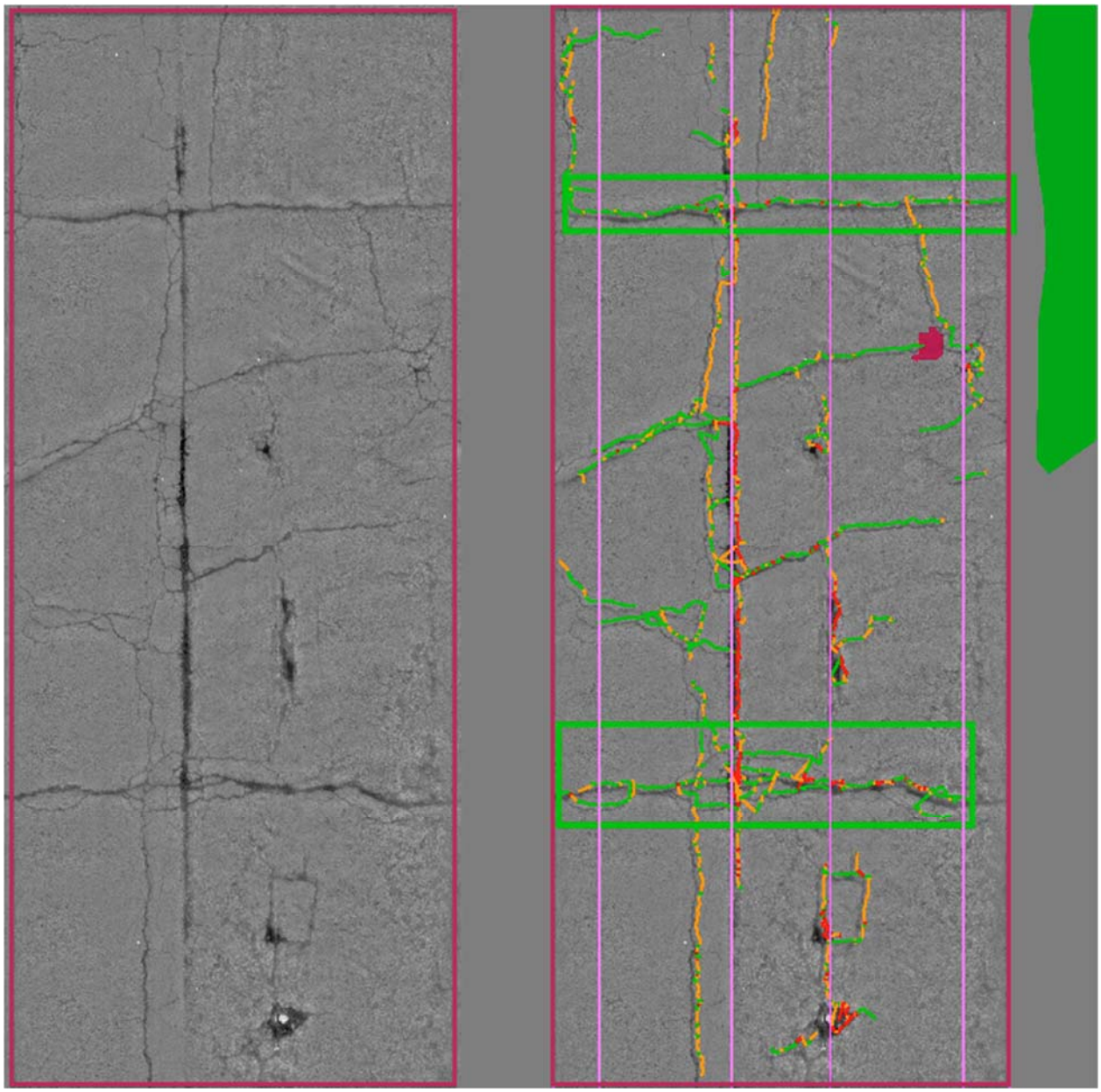
Block Cracking (Medium Severity)

Cracks comprising the blocks are greater than ¼-inch wide and less than ¾-inch wide. Spalling less than 3 inches wide may be present at the medium-severity level.



Block Cracking (High Severity)

Cracks comprising the blocks are greater than ¾-inch wide. Spalling greater than 3 inches wide may be present at the high-severity level, and there may be a significant loss of material.



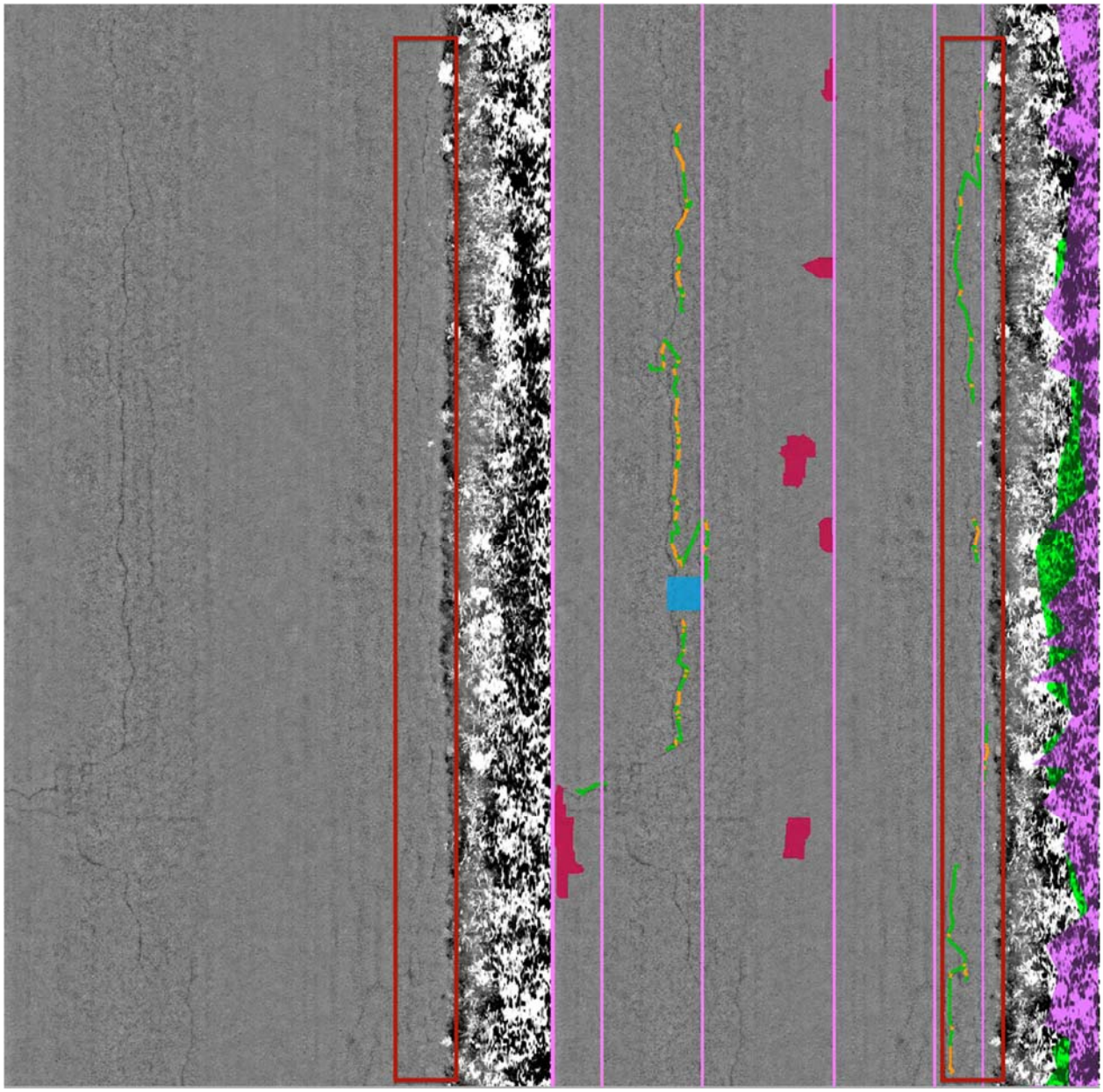
Edge Cracking

Method of Measurement:	Manual	**Unit of Measure:**	Ft
Pavement Type:	ST	**Severity Levels:**	Yes

Definition: Edge cracks are longitudinal cracks that run parallel to the pavement edge and typically appear within 1 to 1.5 feet of the edge. Edge cracking only appears in the absence of a curb or paved shoulder and is only rated when it is captured in the downward image. The red boxes in the following images denote edge cracking.

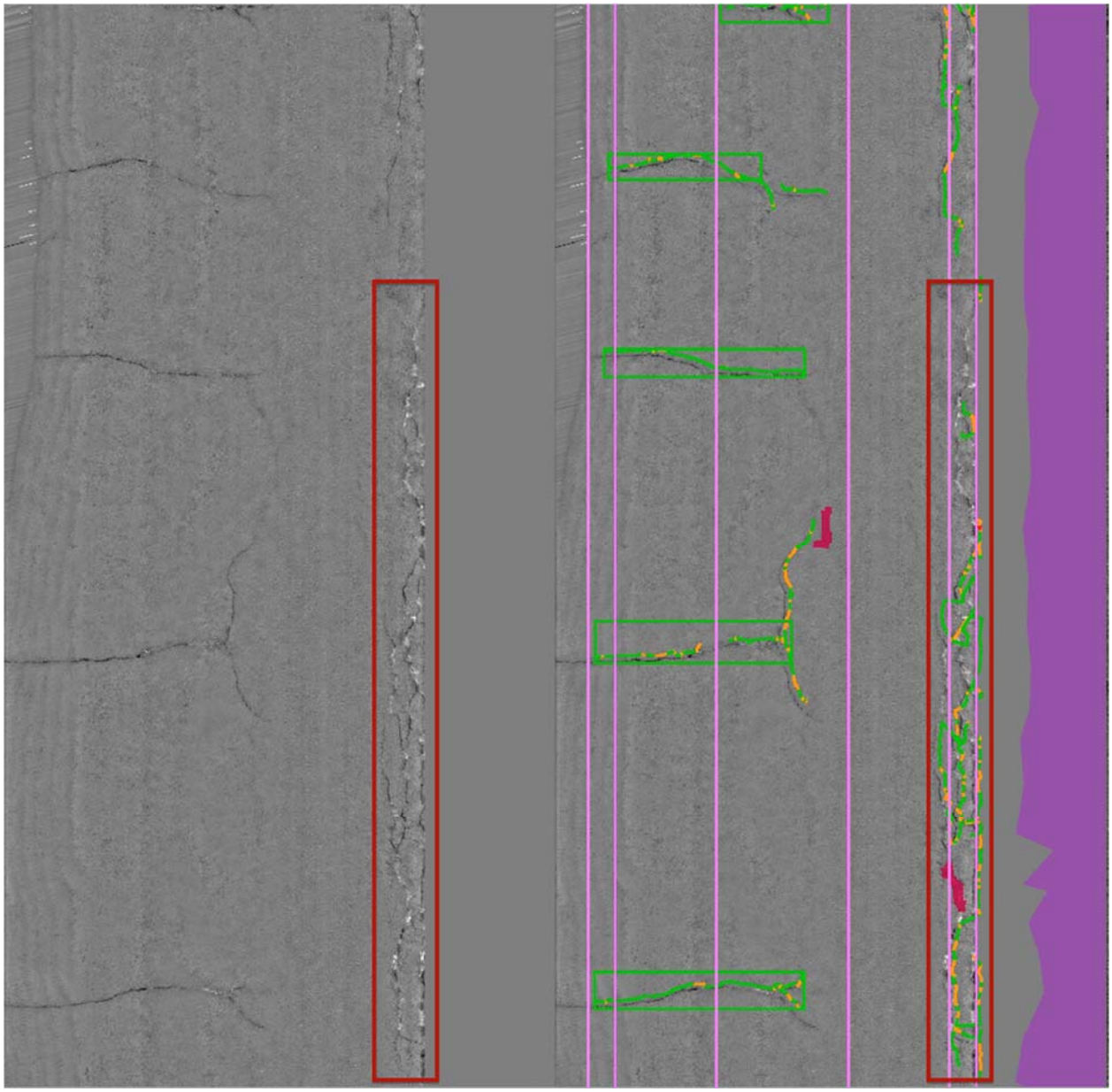
Edge Cracking (Low Severity)

A crack pattern clearly develops with crack widths less than ¼-inch. Some spalling may be present, but the pavement remains relatively intact at the edge of the pavement.



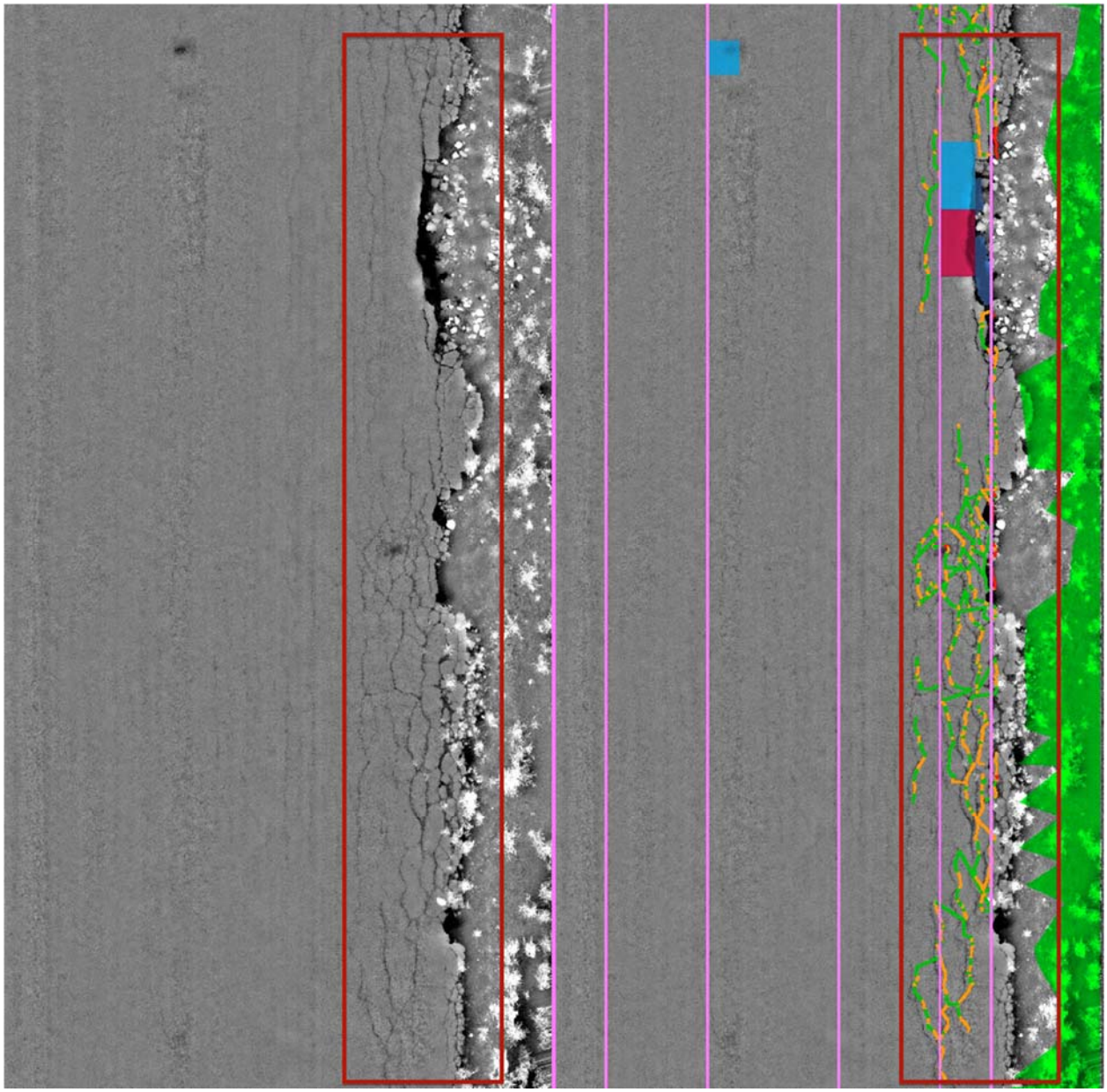
Edge Cracking (Medium Severity)

A crack pattern clearly develops and includes cracks with widths exceeding ¼-inch. Spalling along cracks is possible and pavement pieces may have broken off the edge of the roadway.



Edge Cracking (High Severity)

An interconnected crack pattern with severe spalling is possible at the high-severity level. Crack widths may exceed ¾-inch. Significant material loss is possible.



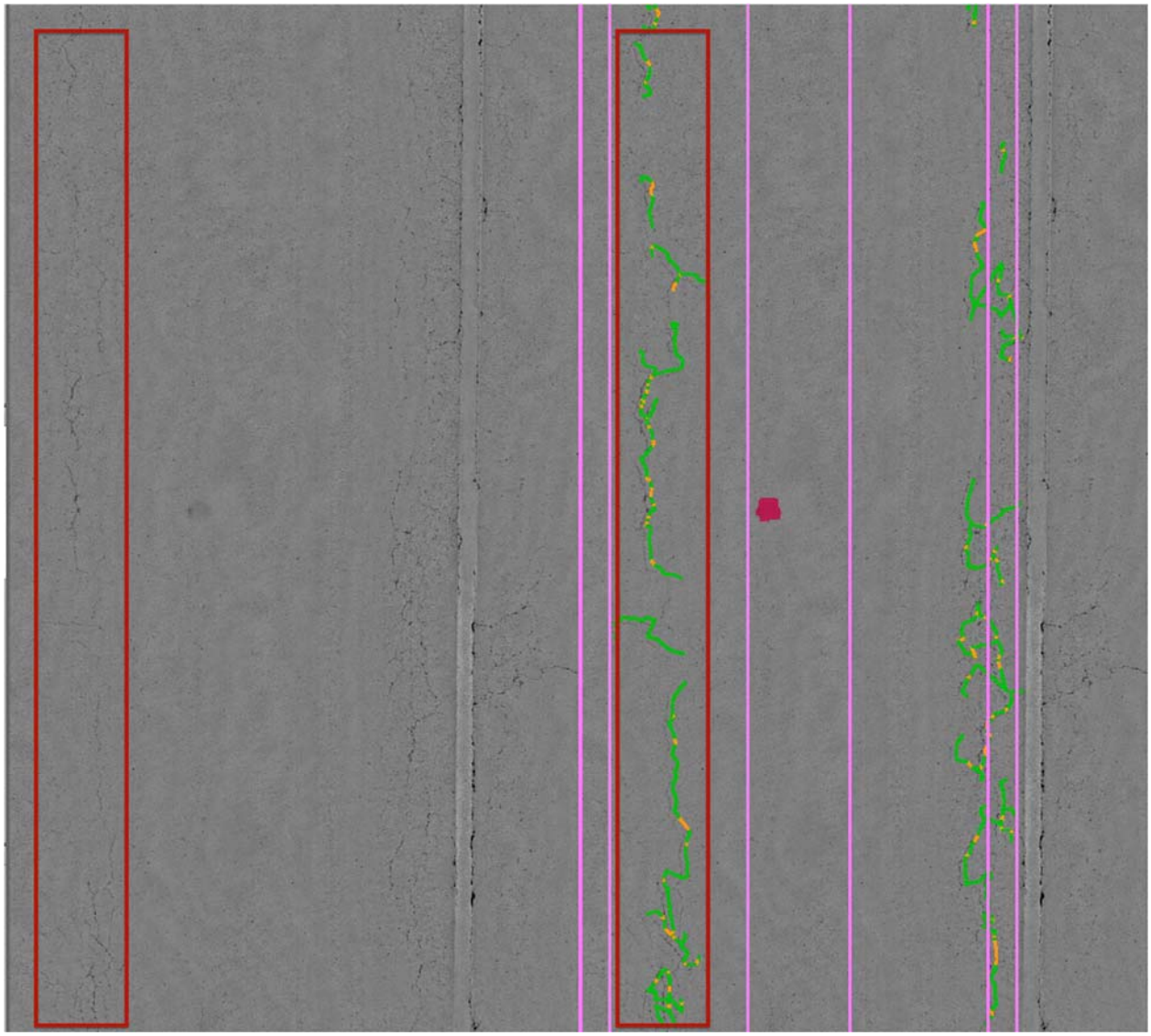
Fatigue (Alligator) Cracking

Method of Measurement:	LCMS	**Unit of Measure:**	Sq Ft
Pavement Type:	AC, APC, ST	**Severity Levels:**	Yes

Definition: A series of interconnecting cracks caused by repeated traffic loading, resulting in many small pieces resembling chicken wire or alligator skin. Cracks originating in the wheel path and migrating beyond the wheel path are considered fatigue cracks. Fatigue cracking is identified in the red boxes in the following images.

Fatigue Cracking (Low Severity)

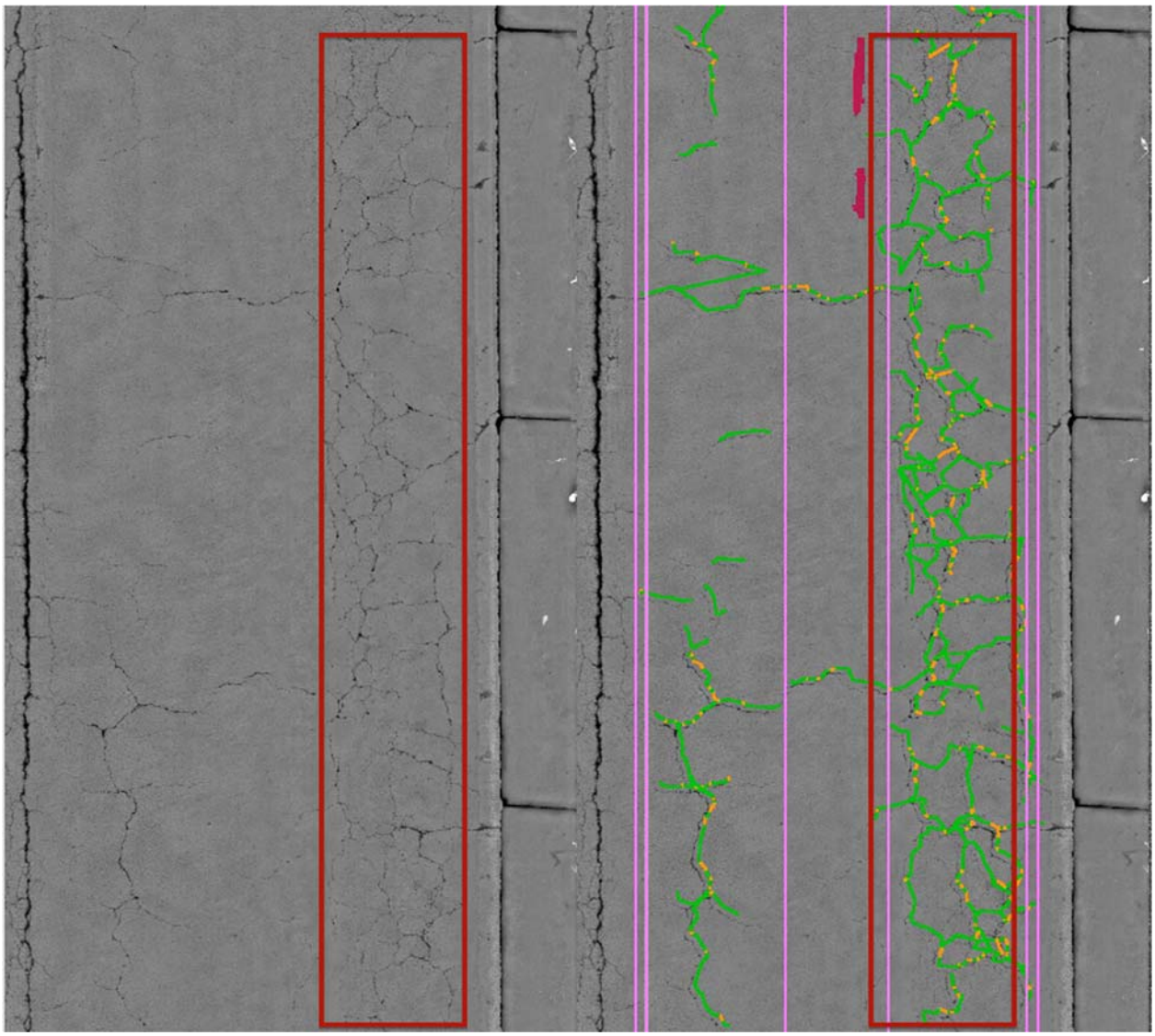
Unsealed fine parallel cracks with no associated cracks or few secondary cracks, including longitudinal cracking within the wheel path.



Fatigue Cracking (Medium Severity)

Definition

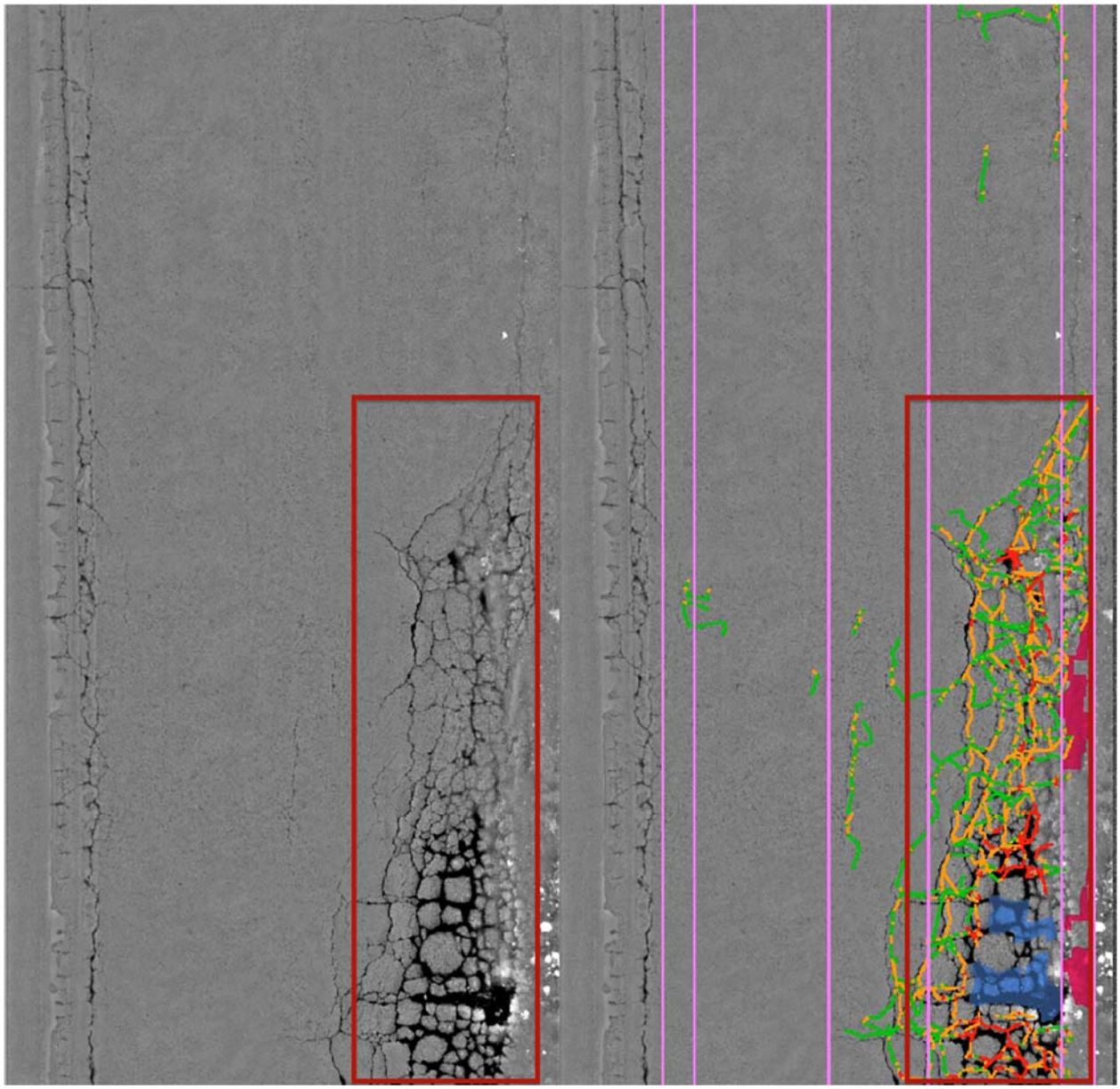
At the medium-severity level, fatigue cracks begin to form a connected pattern, with individual pavement pieces generally having dimensions exceeding 12 inches in length.



Fatigue Cracking (High Severity)

Definition

High-severity fatigue cracking shows a full-developed crack pattern, with dimensions of pieces typically 12 inches or less in length. Significant spalling or distortion may be evident, along with potholes and loss of material.



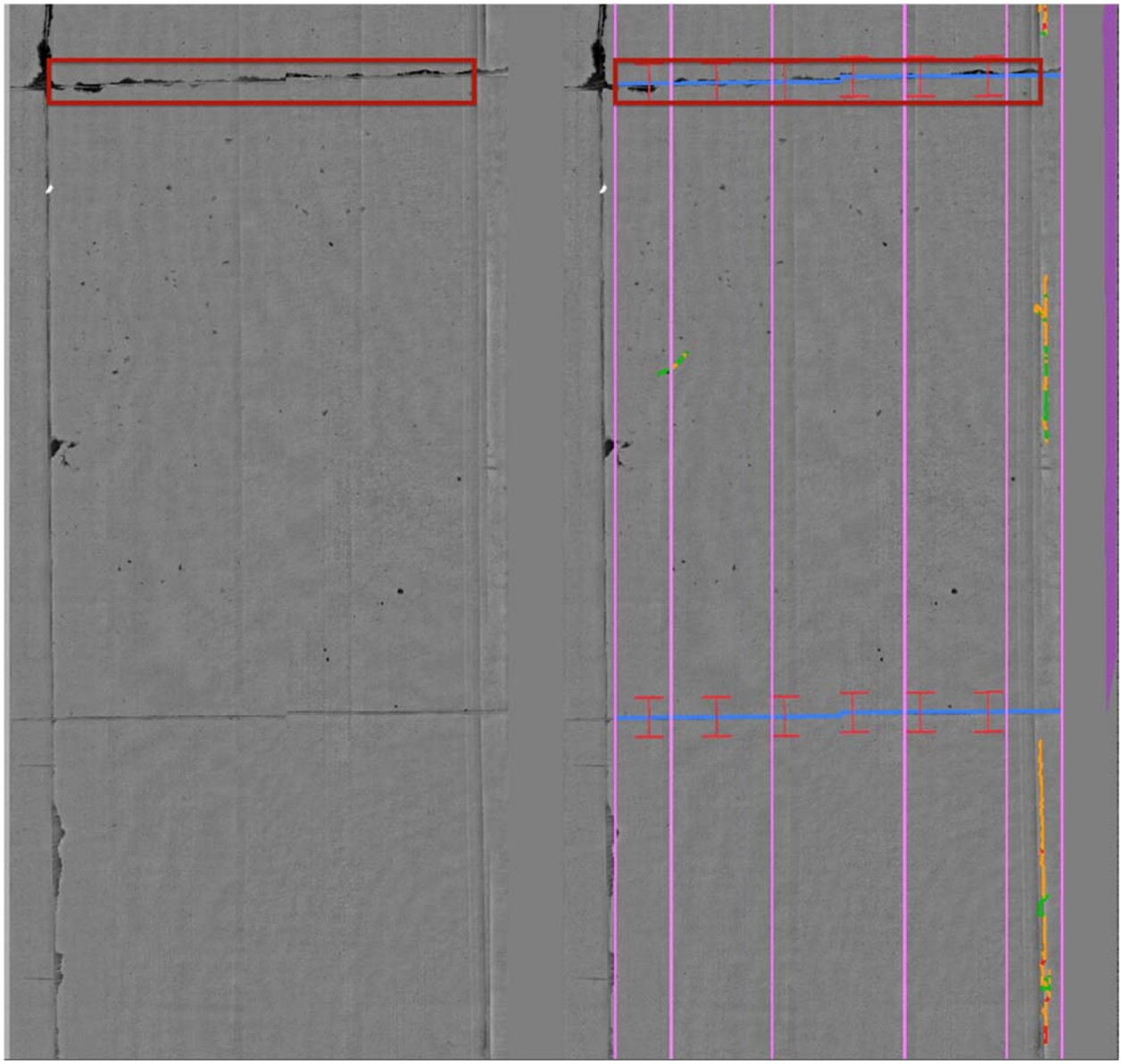
Joint Deterioration (Spalling)

Method of Measurement:	Manual	**Unit of Measure:**	Count
Pavement Type:	PCC	**Severity Levels:**	Yes

Definition: The breakdown of a slab adjacent to the joint edge anywhere along the length of the joint. The spall usually does not extend vertically through the slab, but intersects the joint at an angle.

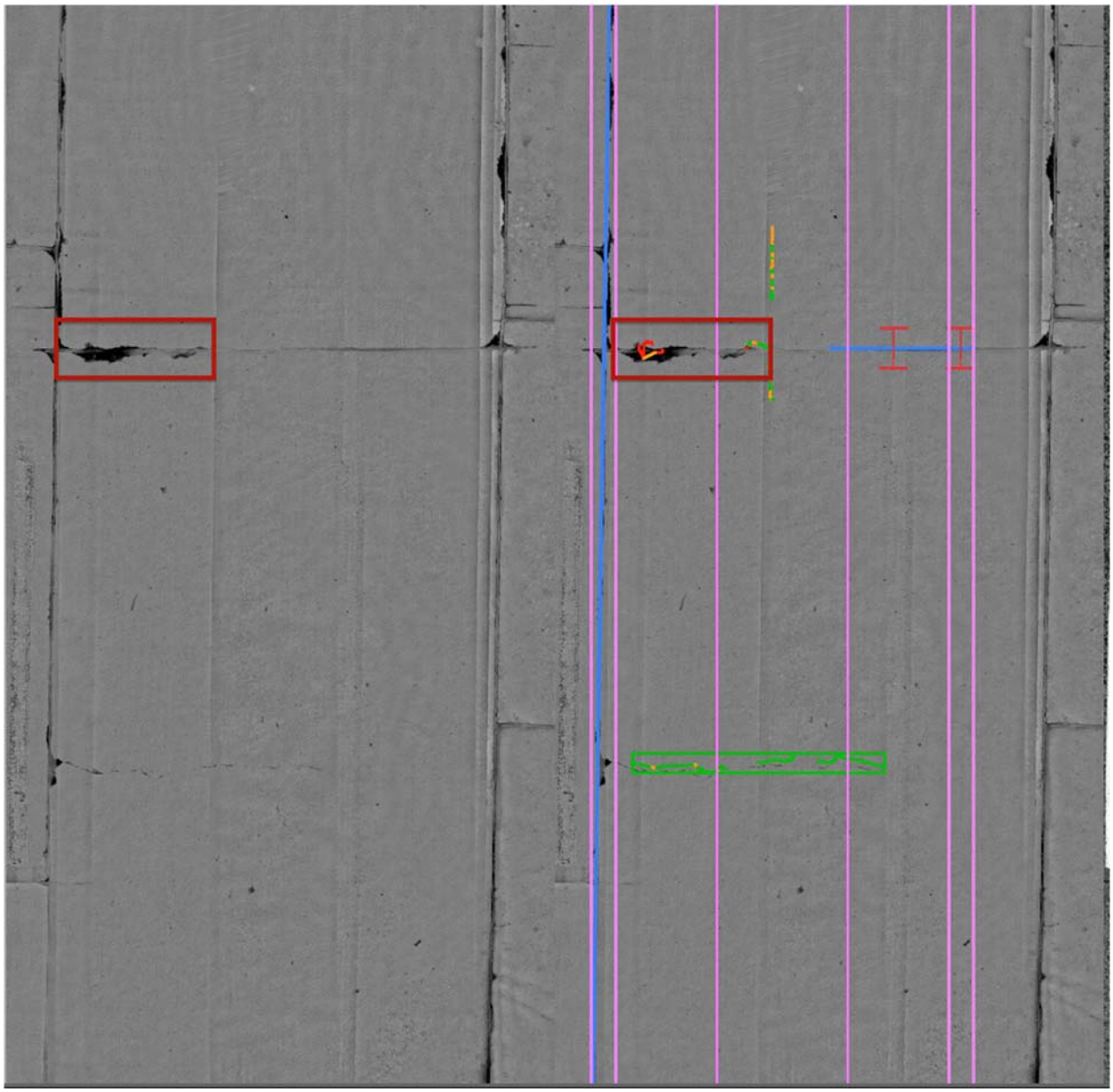
Joint Deterioration (Low Severity)

Low-severity joint deterioration is characterized by spalls less than 3 inches wide with no significant loss of material. Single cracks in the corner of the slab will be counted toward cracking.



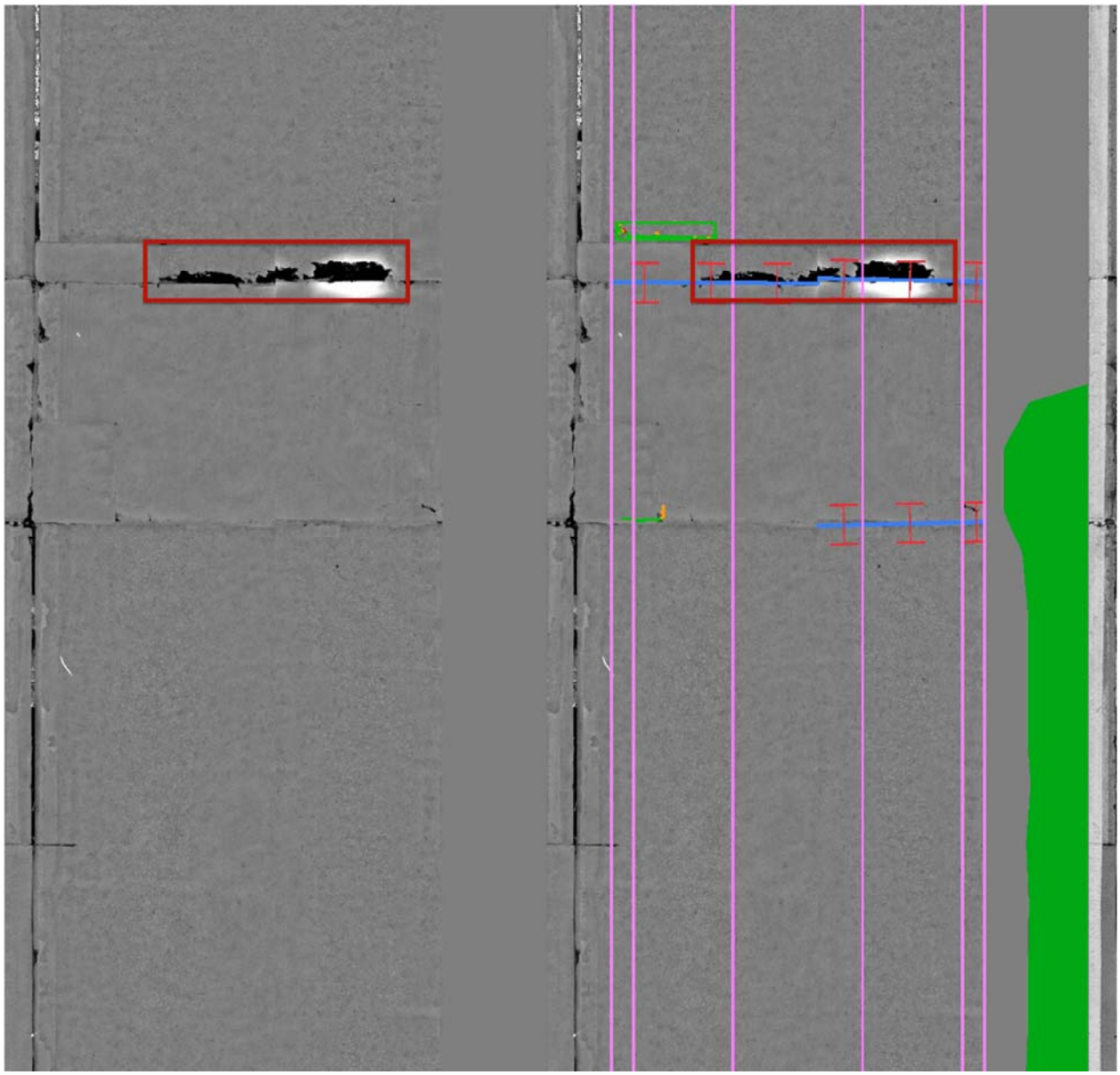
Joint Deterioration (Medium Severity)

Spalls 3 to 6 inches wide with a loss of material are evident in medium-severity joint spalling.



Joint Deterioration (High Severity)

High-severity joint spalls exceed 6 inches wide and show a significant loss of material.



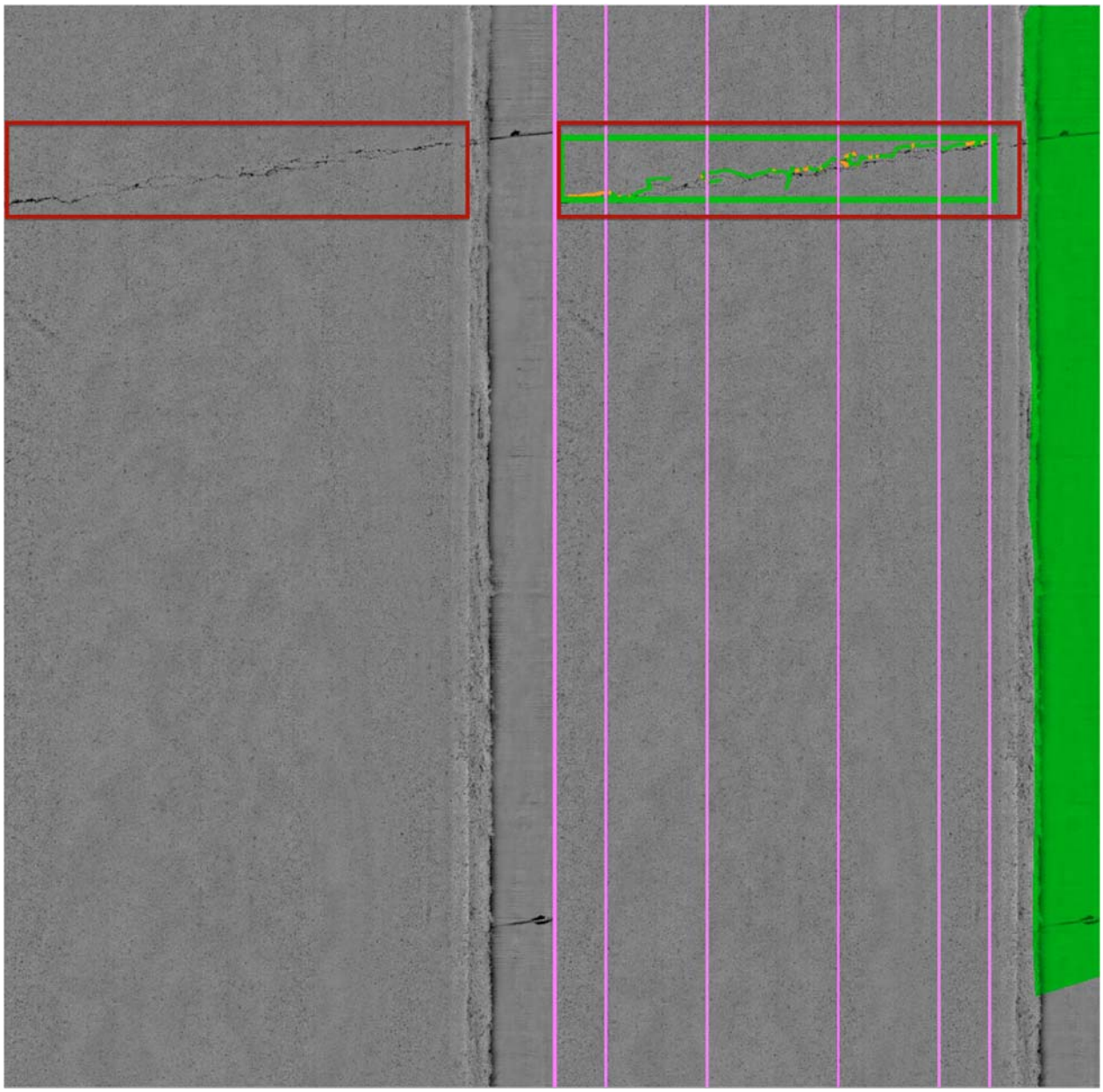
Joint Reflective Cracking

Method of Measurement:	LCMS	**Unit of Measure:**	Ft, Count
Pavement Type:	APC	**Severity Levels:**	Yes

Definition: Joint reflective cracking occurs only on composite pavements. Only cracks at least 3 feet in length are counted.

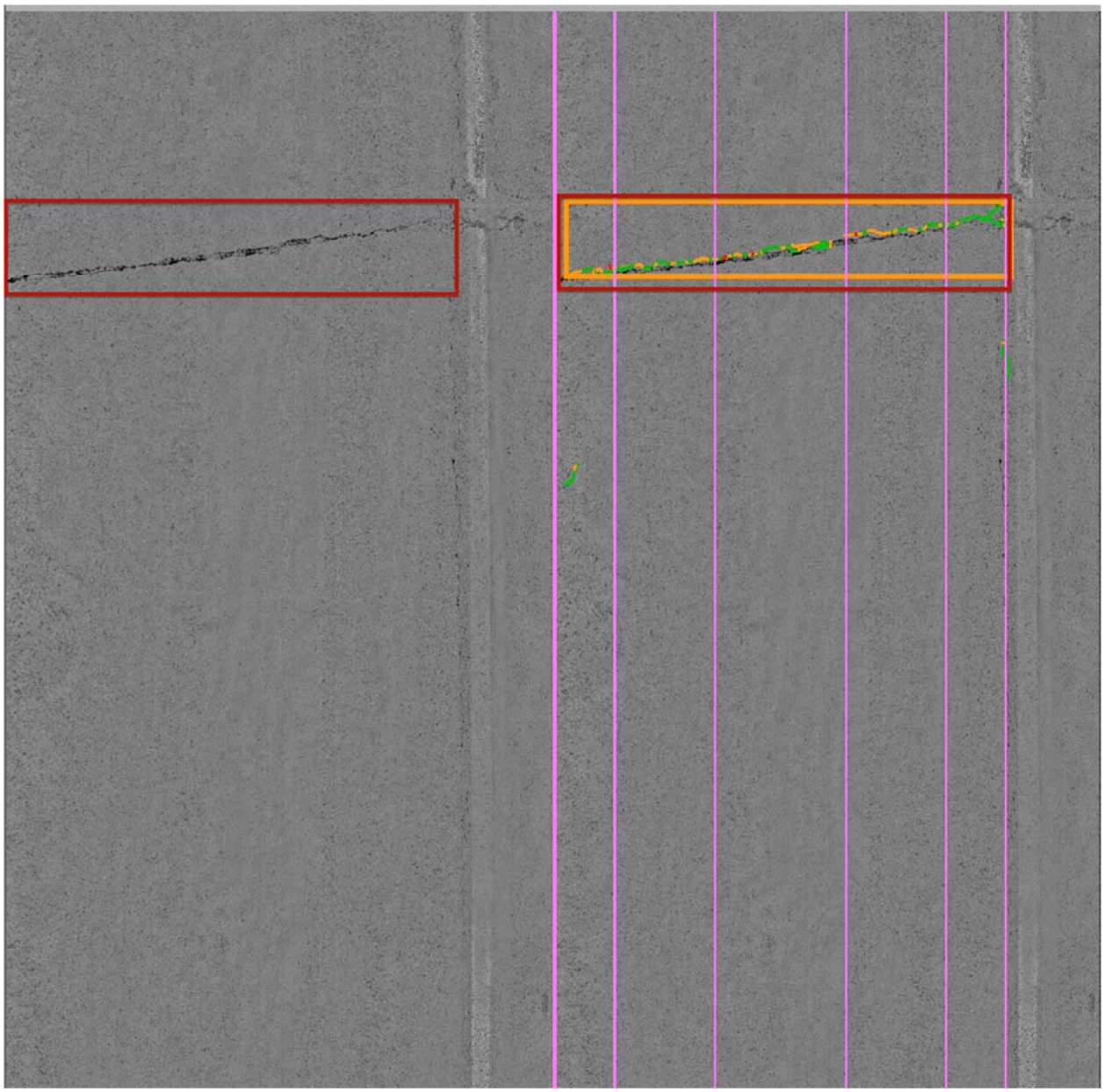
Joint Reflective Cracking (Low Severity)

Cracks with widths less than ¼-inch or sealed cracks in good condition characterize low-severity reflective cracking.



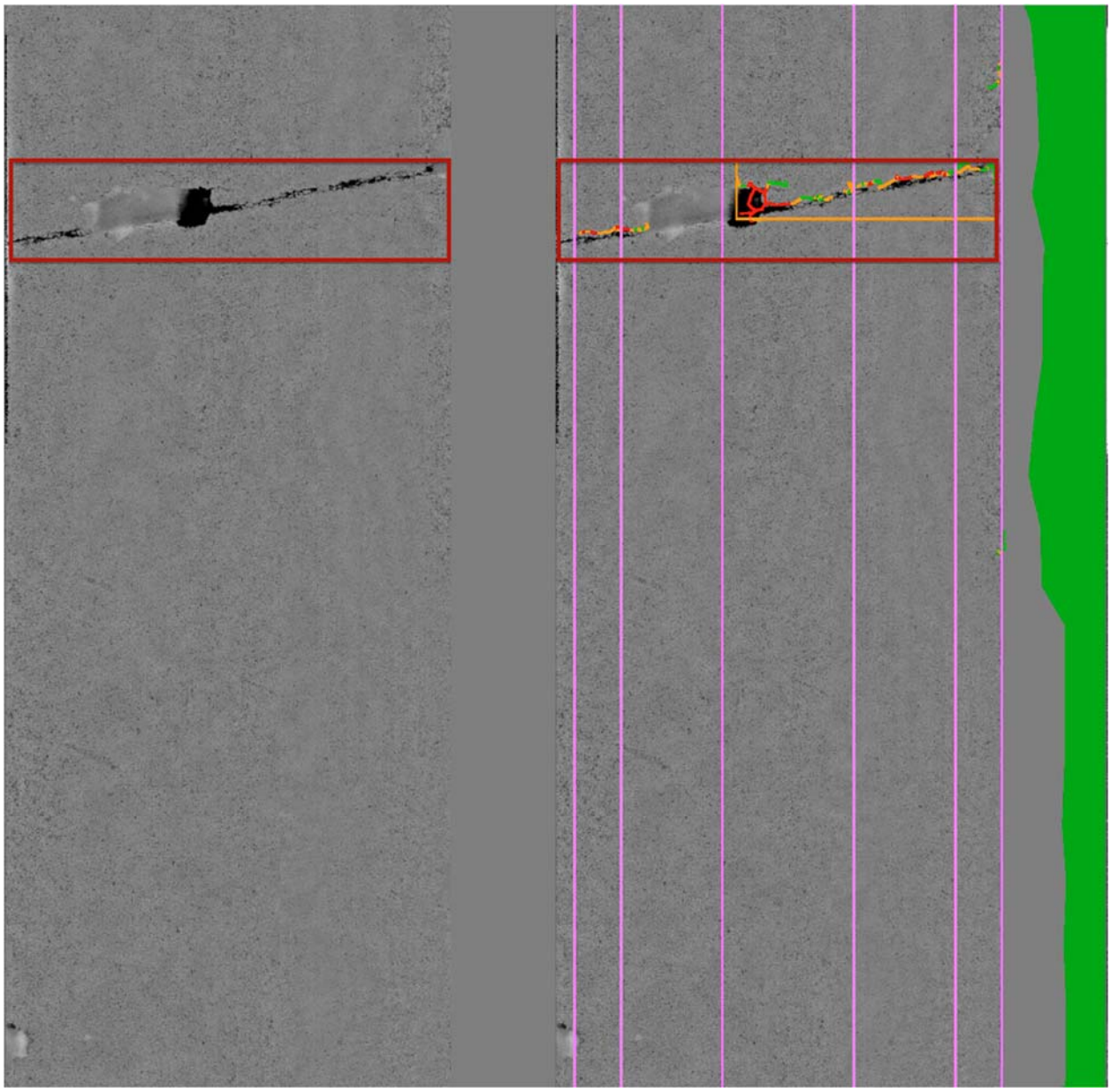
Joint Reflective Cracking (Medium Severity)

Medium-severity reflective cracking is characterized by cracks with widths between ¼-inch and ¾-inch and with spalls 3 inches or less in width.



Joint Reflective Cracking (High Severity)

High-severity reflective cracking is characterized by cracks with widths exceeding ¾-inch or spalls exceeding 3 inches wide with a significant loss of material.



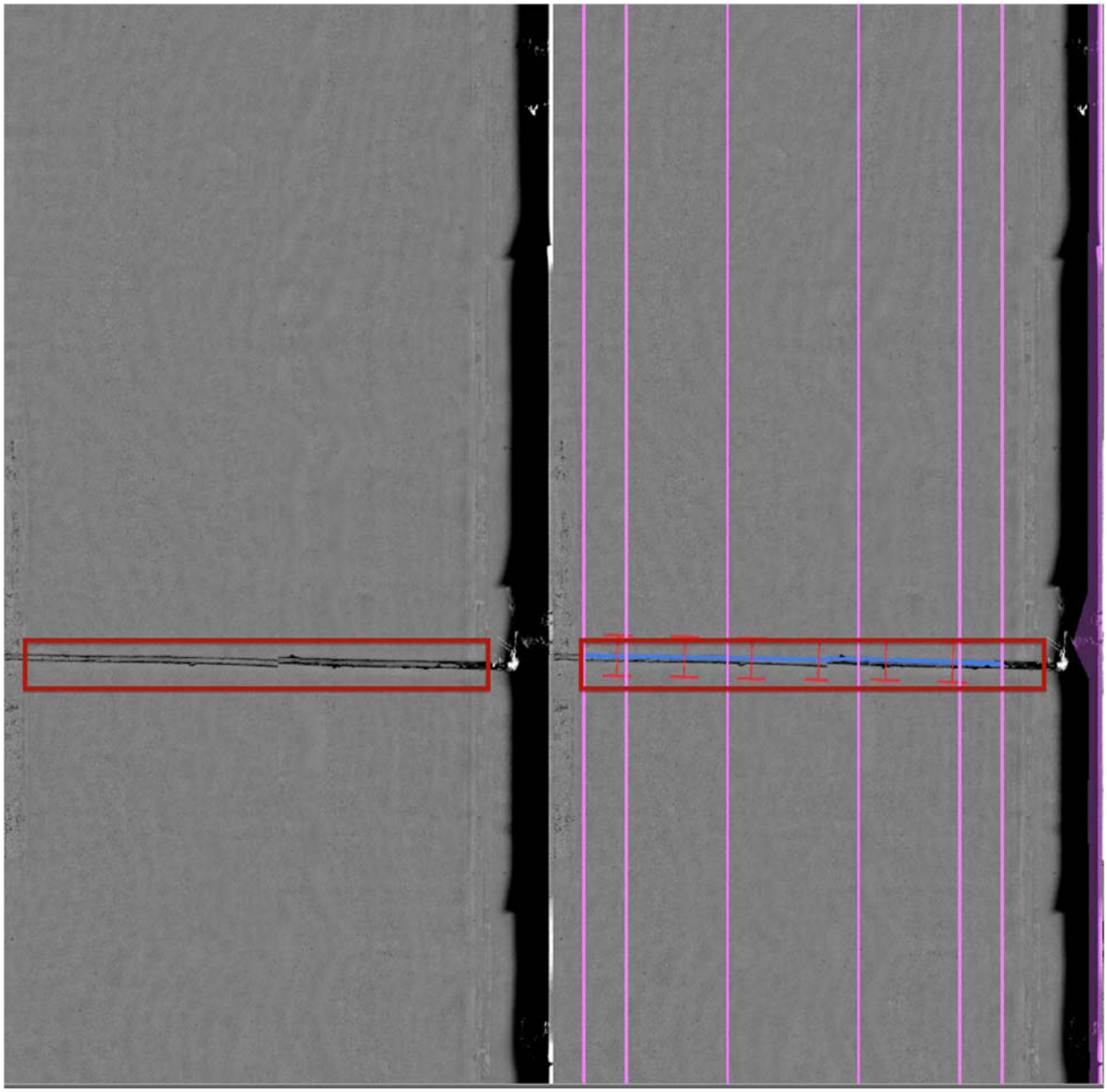
Joint Seal Damage

Method of Measurement:	Manual	**Unit of Measure:**	Joint Count
Pavement Type:	PCC	**Severity Levels:**	Yes

Definition: Conditions that enable incompressible materials to accumulate in joints and allow water infiltration indicate joint seal damage. Joint seal damage types include joint sealant stripping or extrusion; weed growth; hardening of the filler (oxidation); bond loss; and lack or absence of sealant in the joint.

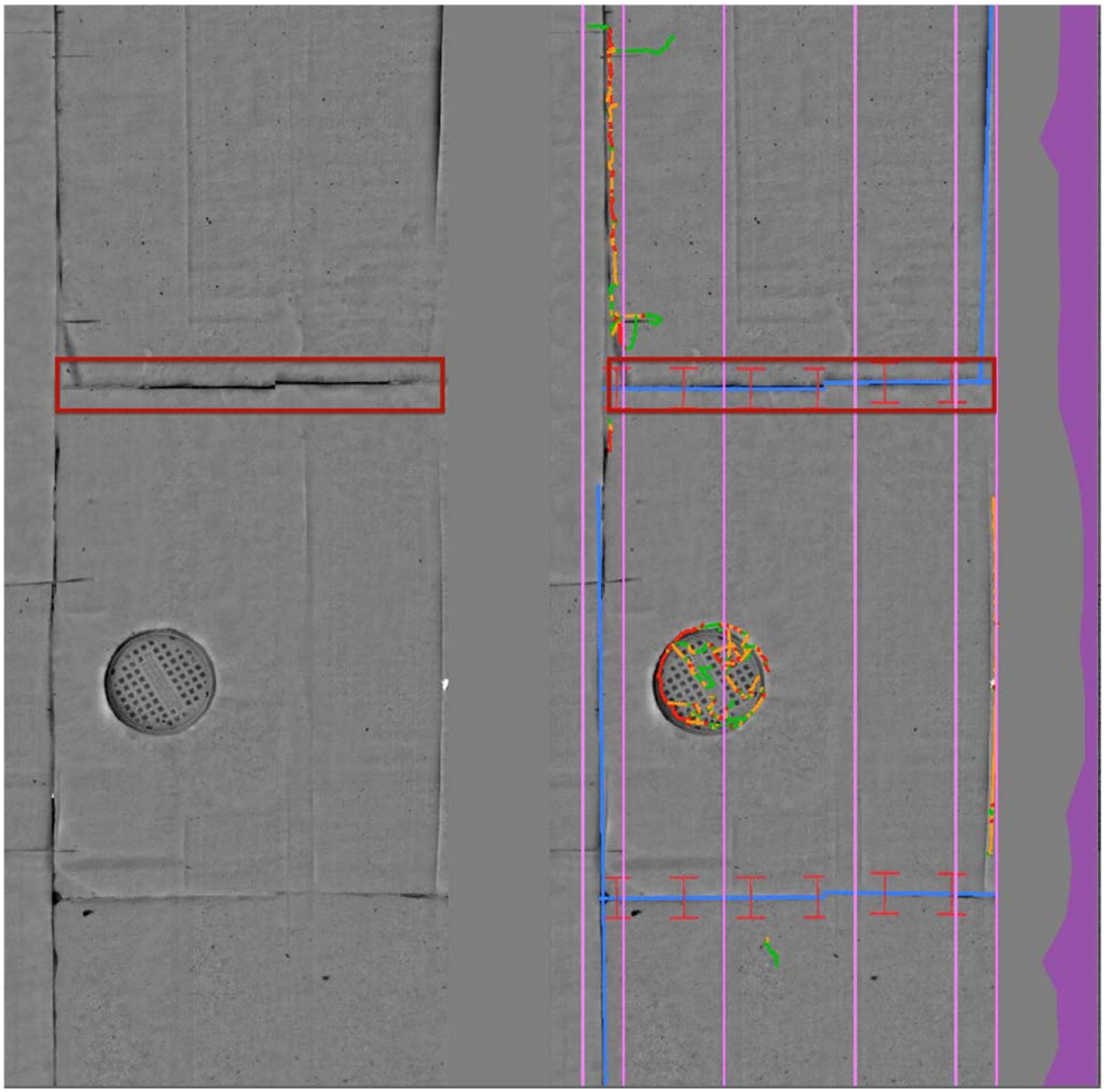
Joint Seal Damage (Low Severity)

Joints exhibiting less than 10% loss of sealant are characterized as low-severity joint seal damage.



Joint Seal Damage (High Severity)

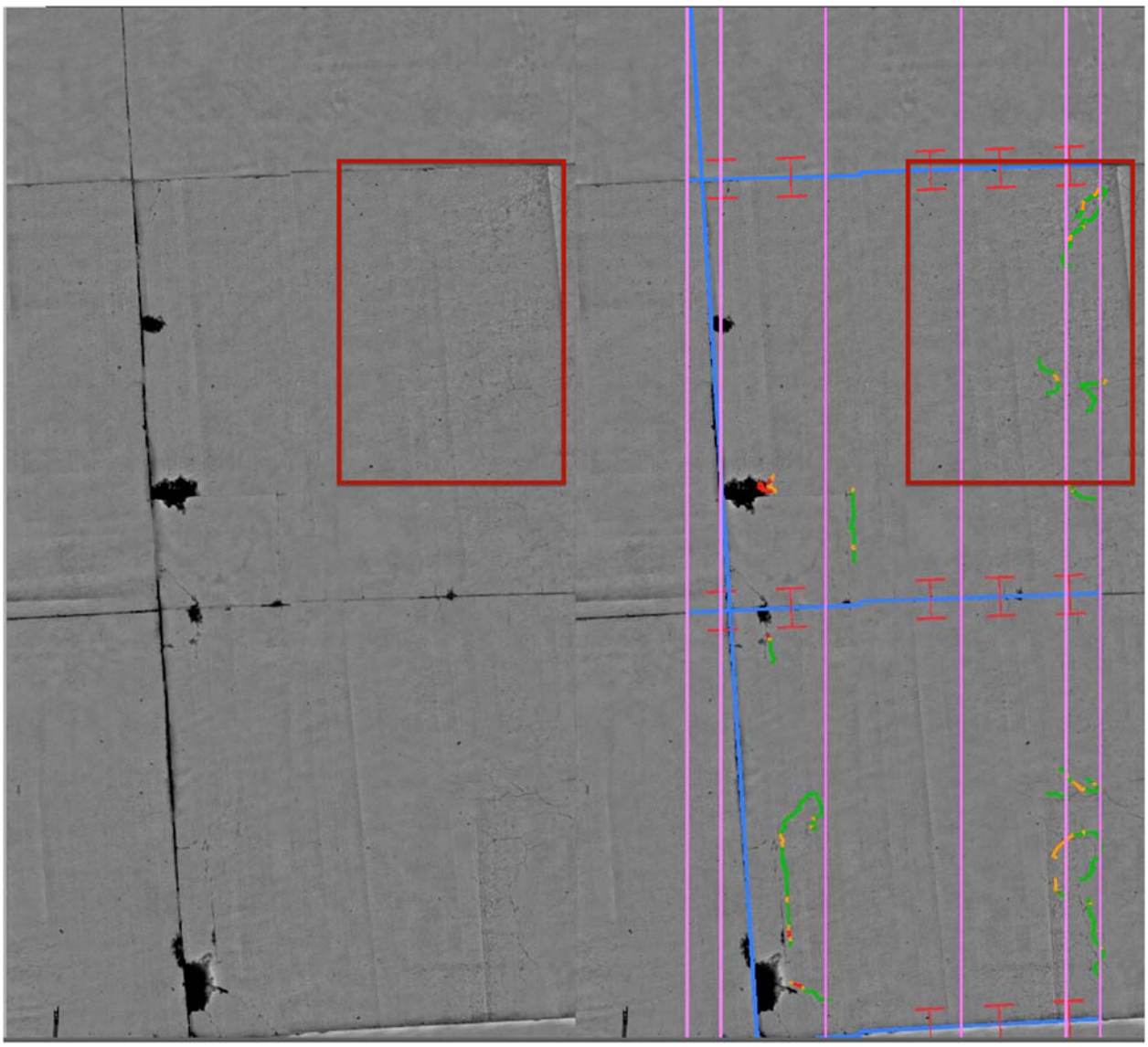
Joints exhibiting more than 10% loss of sealant are characterized as high-severity joint seal damage.



Map Cracking / Alkali-Silica Reactivity (ASR)

Method of Measurement:	Manual	**Unit of Measure:**	Count
Pavement Type:	PCC	**Severity Levels:**	No

Definition: Map cracking refers to a network of shallow, fine, or hairline cracks that extend only through the upper surface of the concrete. Map cracking is caused by concrete over-finishing and may lead to surface scaling, which is the breakdown of the slab surface to a depth of approximately 0.25 to 0.5 inches. Map cracking may also be referred to as Alkali-Silica Reactivity (ASR).



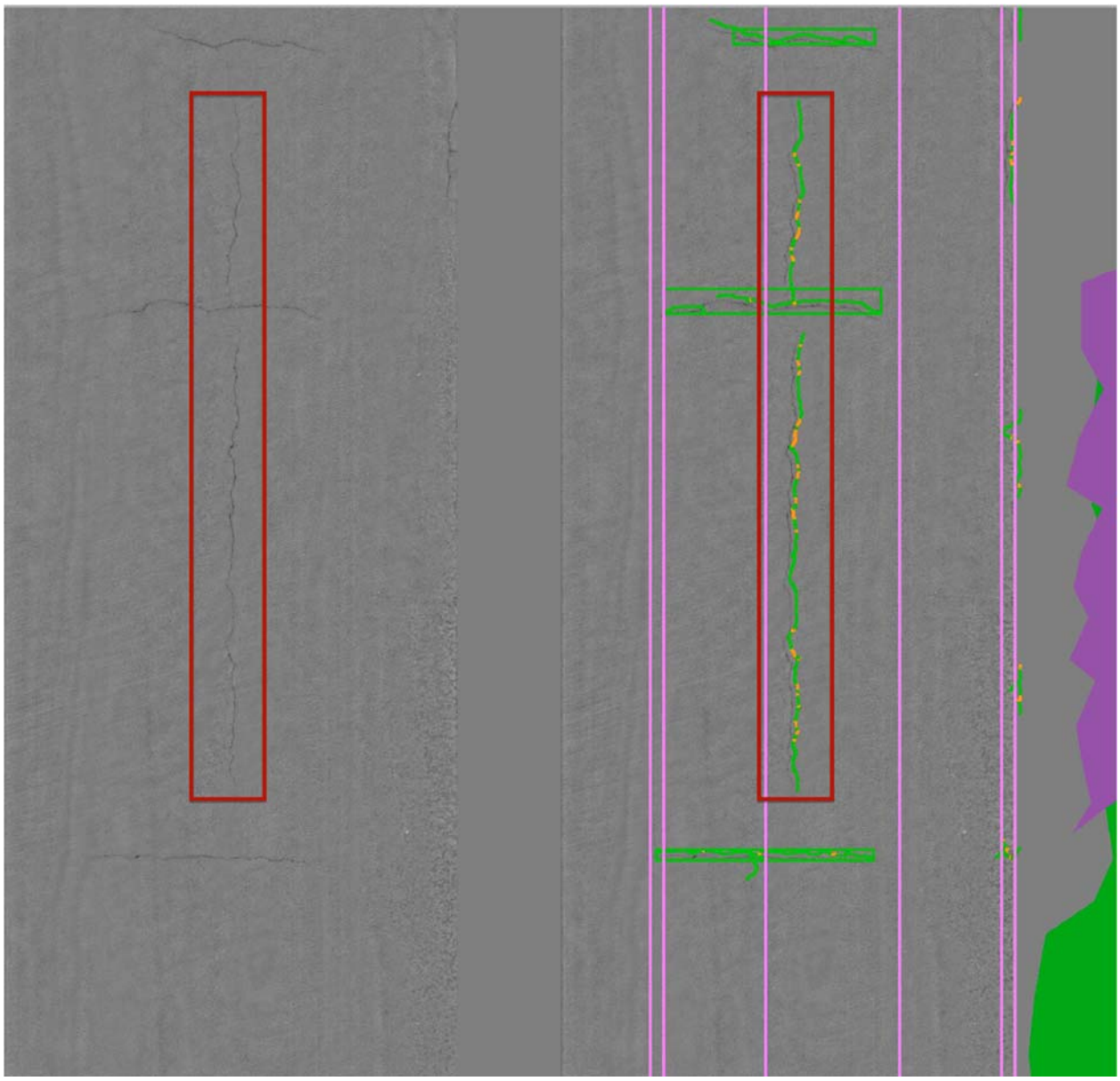
Non-Wheel Path Longitudinal Cracking

Method of Measurement:	LCMS	**Unit of Measure:**	Ft
Pavement Type:	AC, APC, ST	**Severity Levels:**	Yes

Definition: Cracks oriented parallel to the pavement centerline that exist beyond the wheel path.

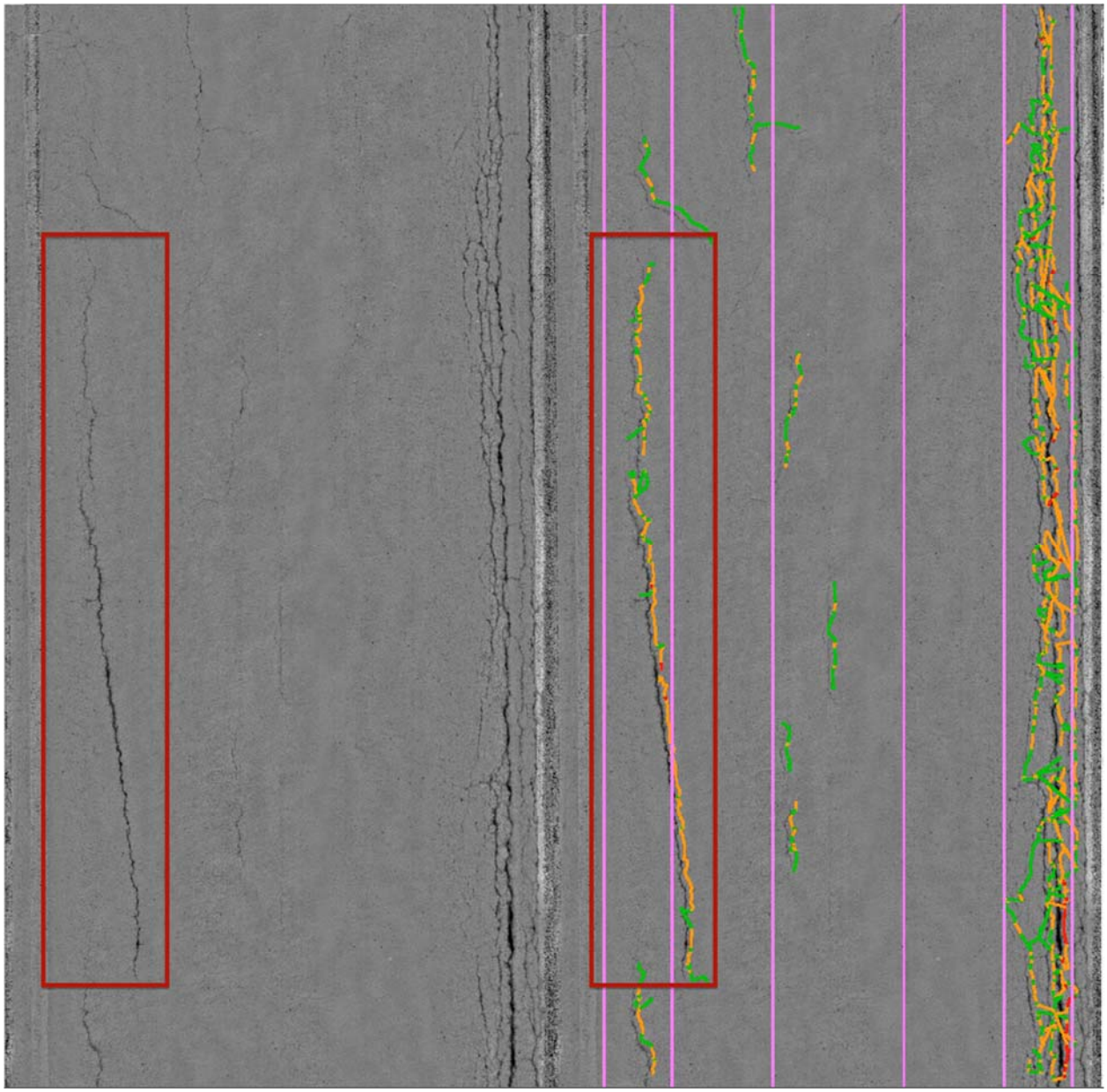
Non-Wheel Path Longitudinal Cracking (Low Severity)

Low-severity non-wheel path longitudinal cracking is characterized by cracks with widths less than ¼-inch or sealed cracks in good condition.



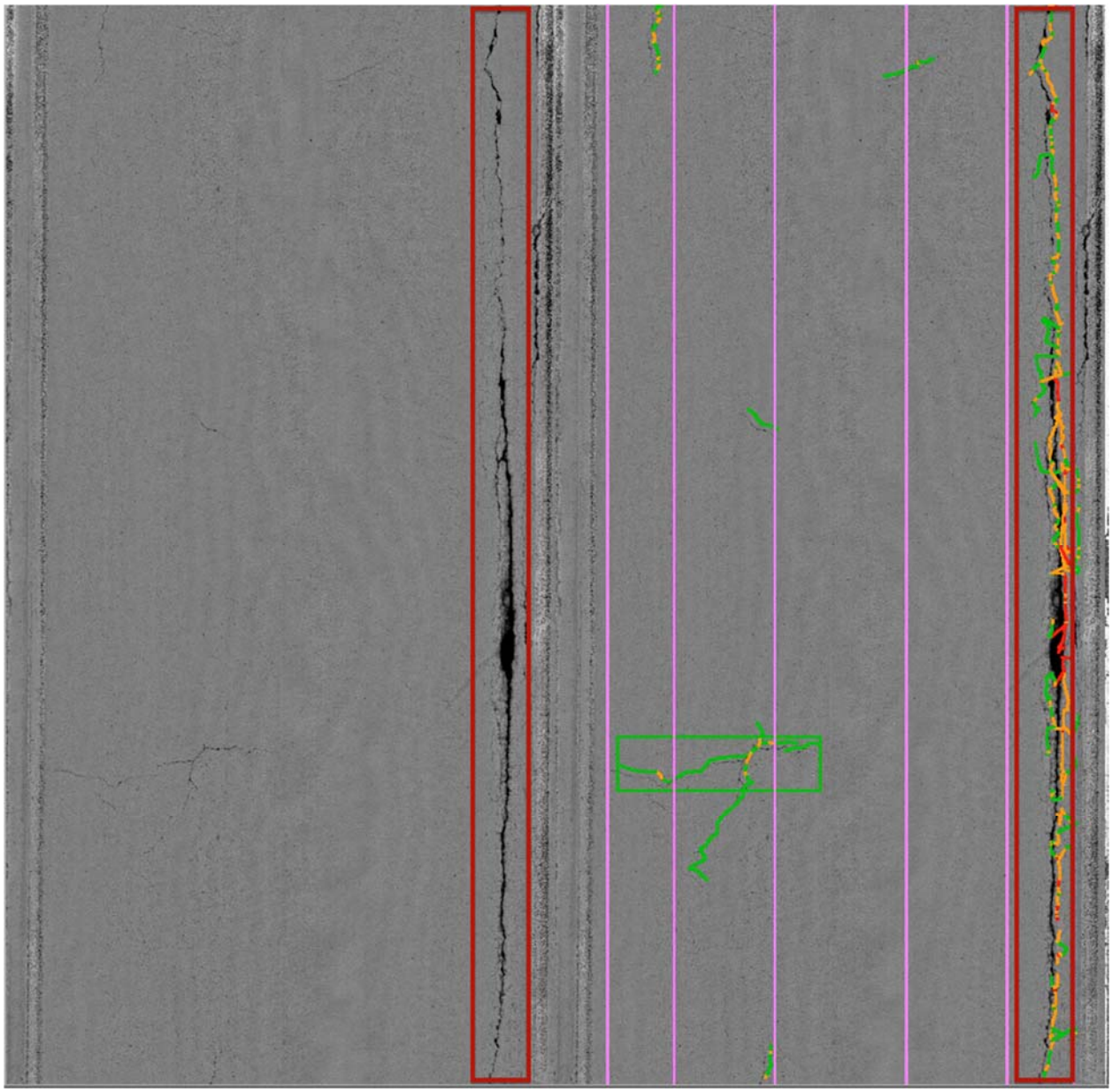
Non-Wheel Path Longitudinal Cracking (Medium Severity)

Medium-severity non-wheel path longitudinal cracking is characterized by cracks with widths between ¼-inch and ¾-inch and with spalls 3 inches or less in width.



Non-Wheel Path Longitudinal Cracking (High Severity)

High-severity non-wheel path longitudinal cracking is characterized by cracks with widths exceeding ¾-inch or spalls exceeding 3 inches wide with a significant loss of material.



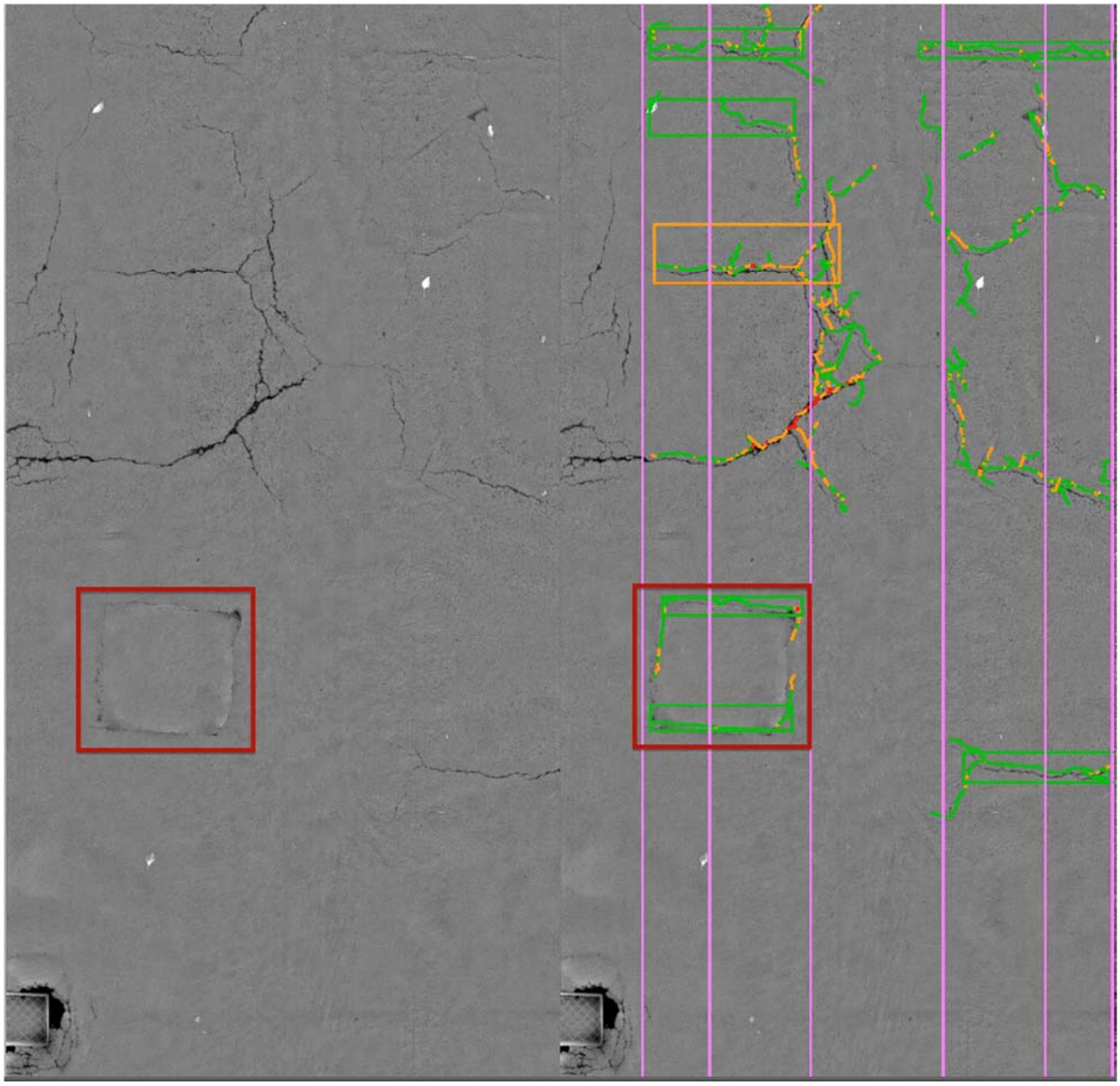
Patch Deterioration / Potholes

Method of Measurement:	Manual	**Unit of Measure:**	Sq Ft
Pavement Type:	AC, APC, PCC, ST	**Severity Levels:**	Yes

Definition: A patch is an area of pavement that has been replaced by a filler material. A patch is considered a defect no matter its condition. All patches are rated at least at a low-severity level. Distresses within the patch are not rated independently. Patches are shown in red boxes in the following images. For PCC pavements, any full-width patch is considered a slab and not a patch.

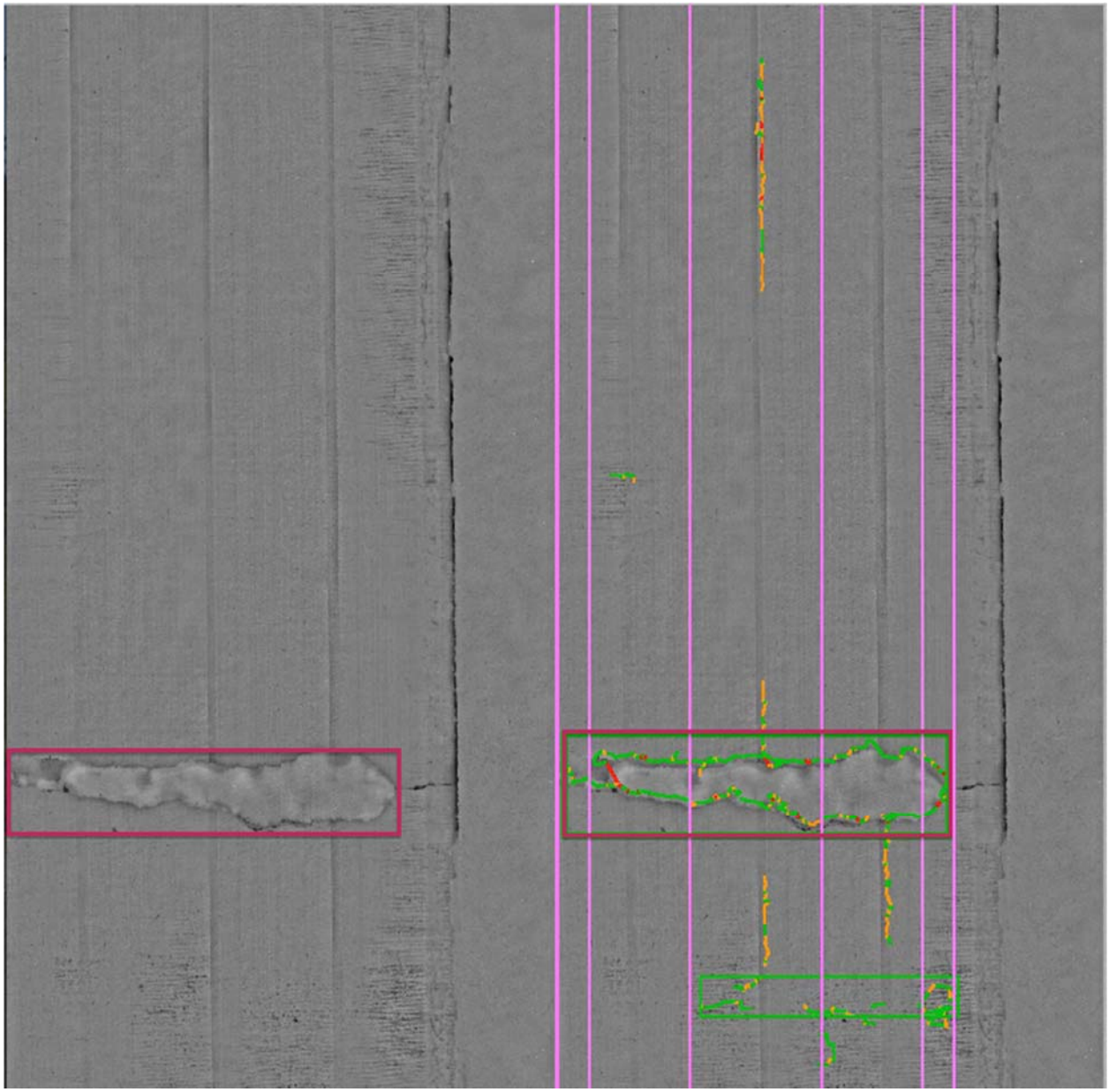
Patch Deterioration / Potholes – AC (Low Severity)

Patches show few defects and are usually smooth and new with uniform boundaries.



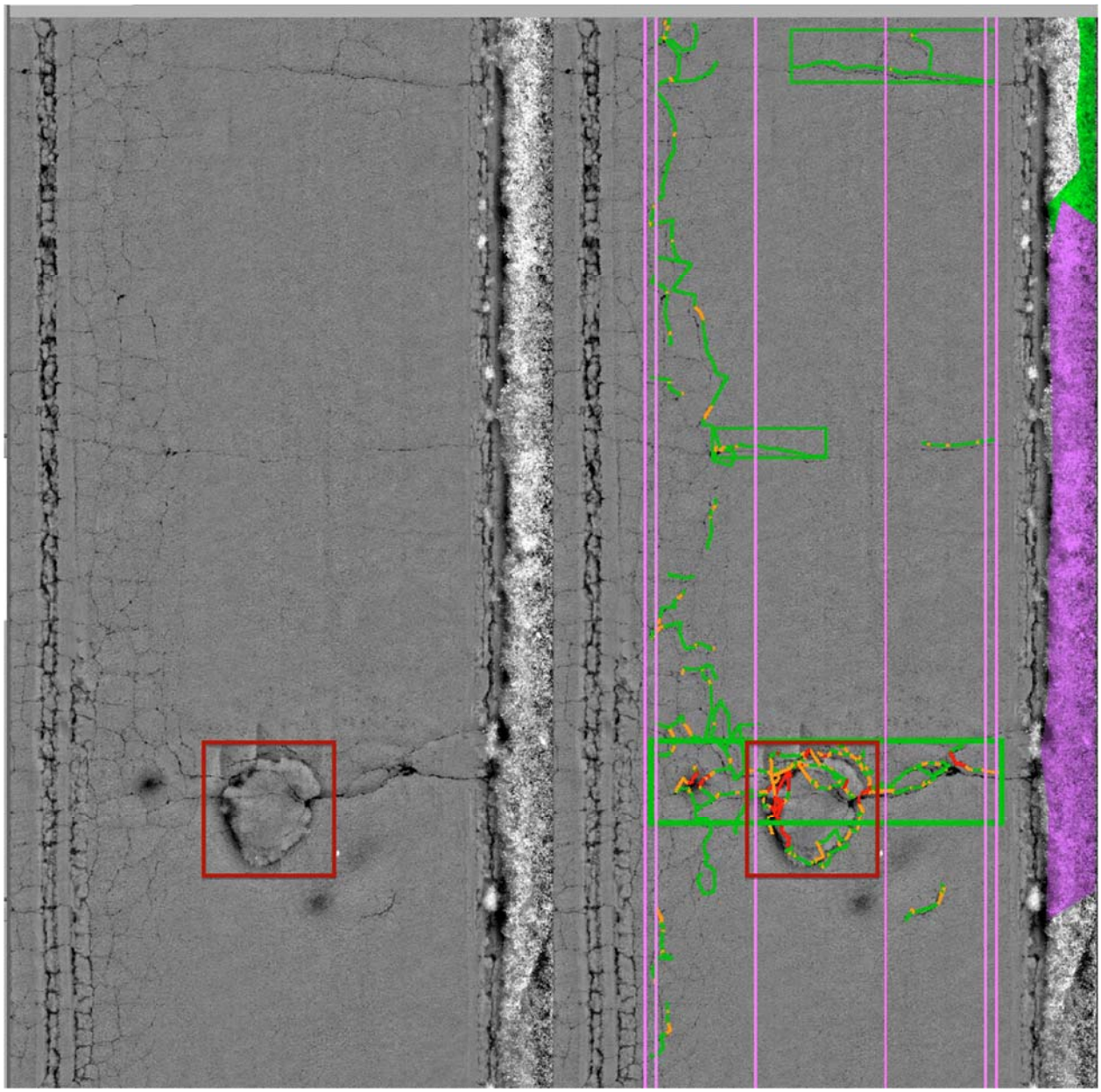
Patch Deterioration / Potholes – PCC (Low Severity)

Patches show few defects and are usually smooth and new with uniform boundaries.



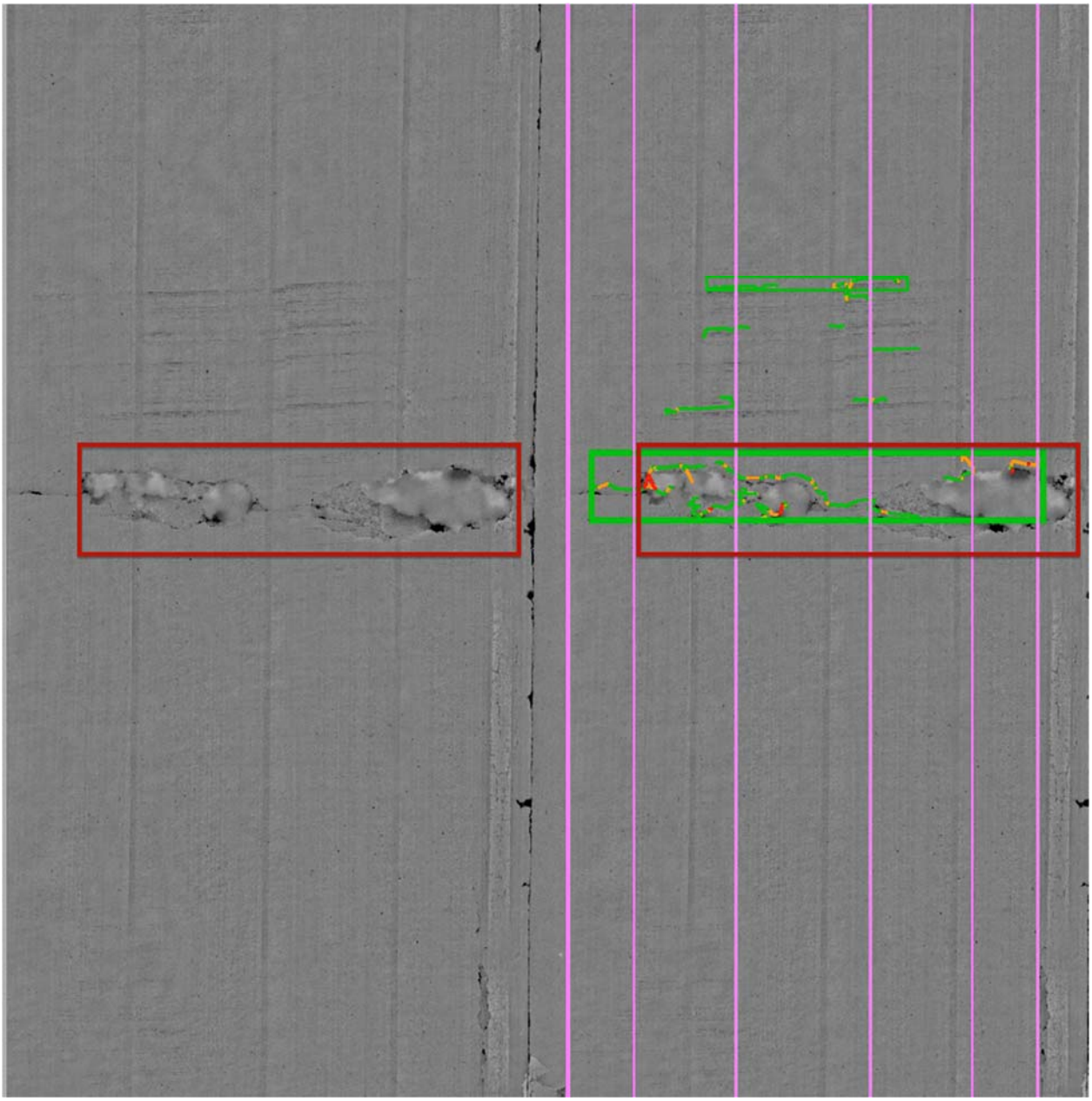
Patch Deterioration / Potholes – AC (Medium Severity)

Patches display medium severity defects and may have jagged edges with some distress or cracks present.



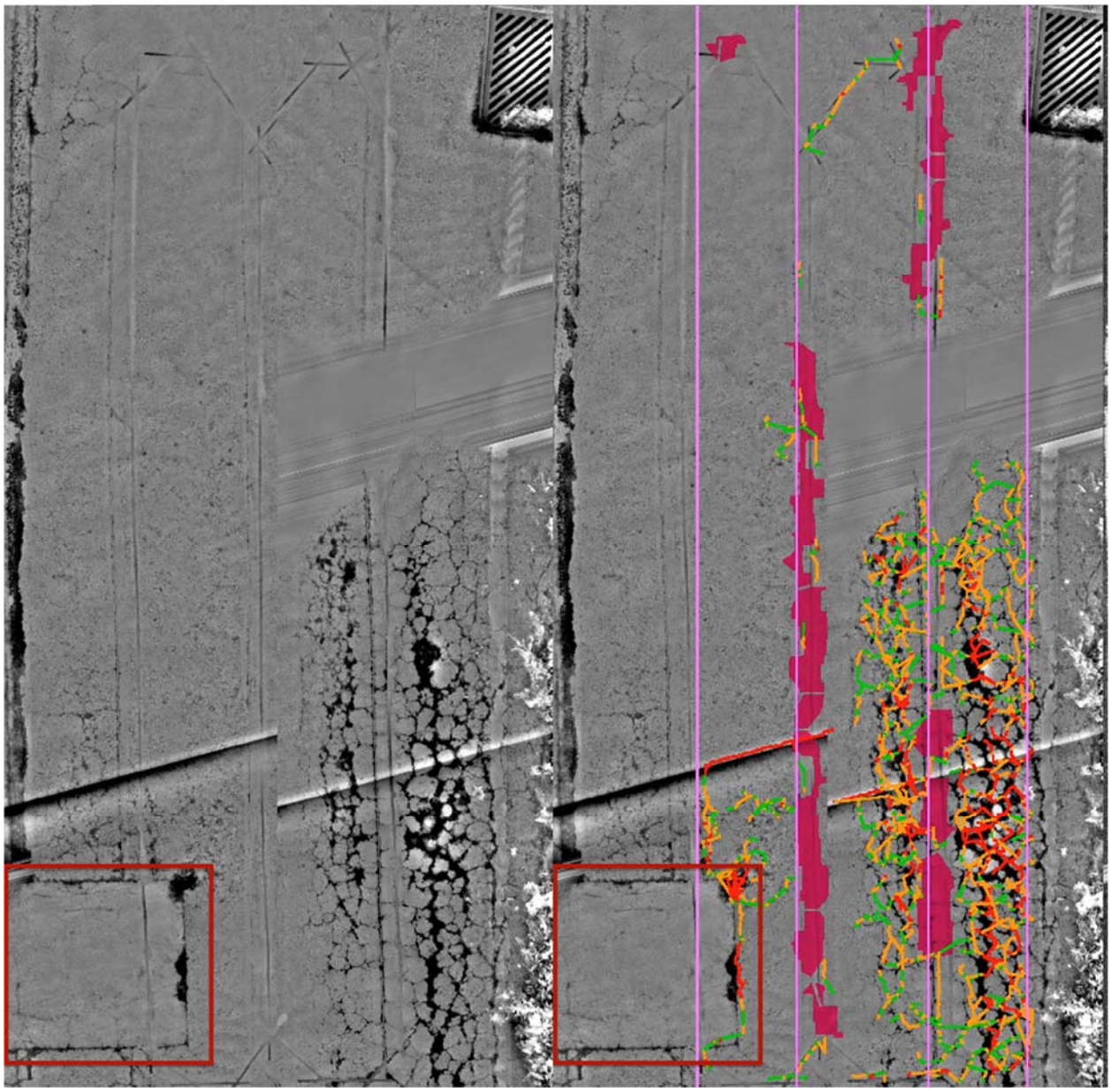
Patch Deterioration / Potholes – PCC (Medium Severity)

Patches display medium severity defects and may have jagged edges with some distress or cracks present. Any AC patch found with no defects or low severity defects will be considered a medium severity PCC patch.



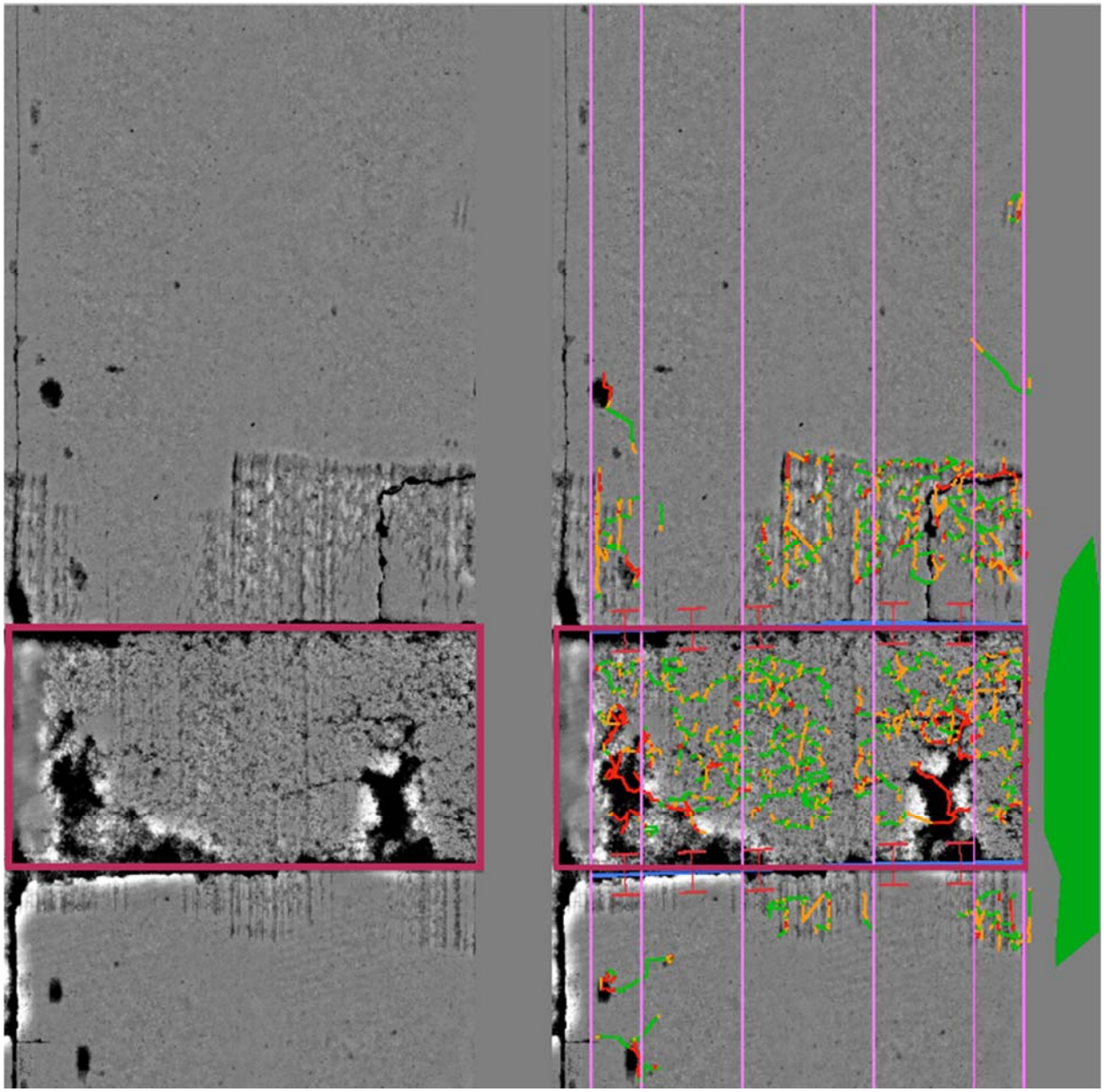
Patch Deterioration / Potholes – AC (High Severity)

Patches show high severity defects with gaps, potholes, broken pieces, or additional patches. Any pothole is considered high severity patch deterioration.



Patch Deterioration / Potholes – PCC (High Severity)

Patches show high severity defects with gaps, potholes, broken pieces, or additional patches. Any AC patch found with medium or high severity distress is considered a high severity PCC patch.



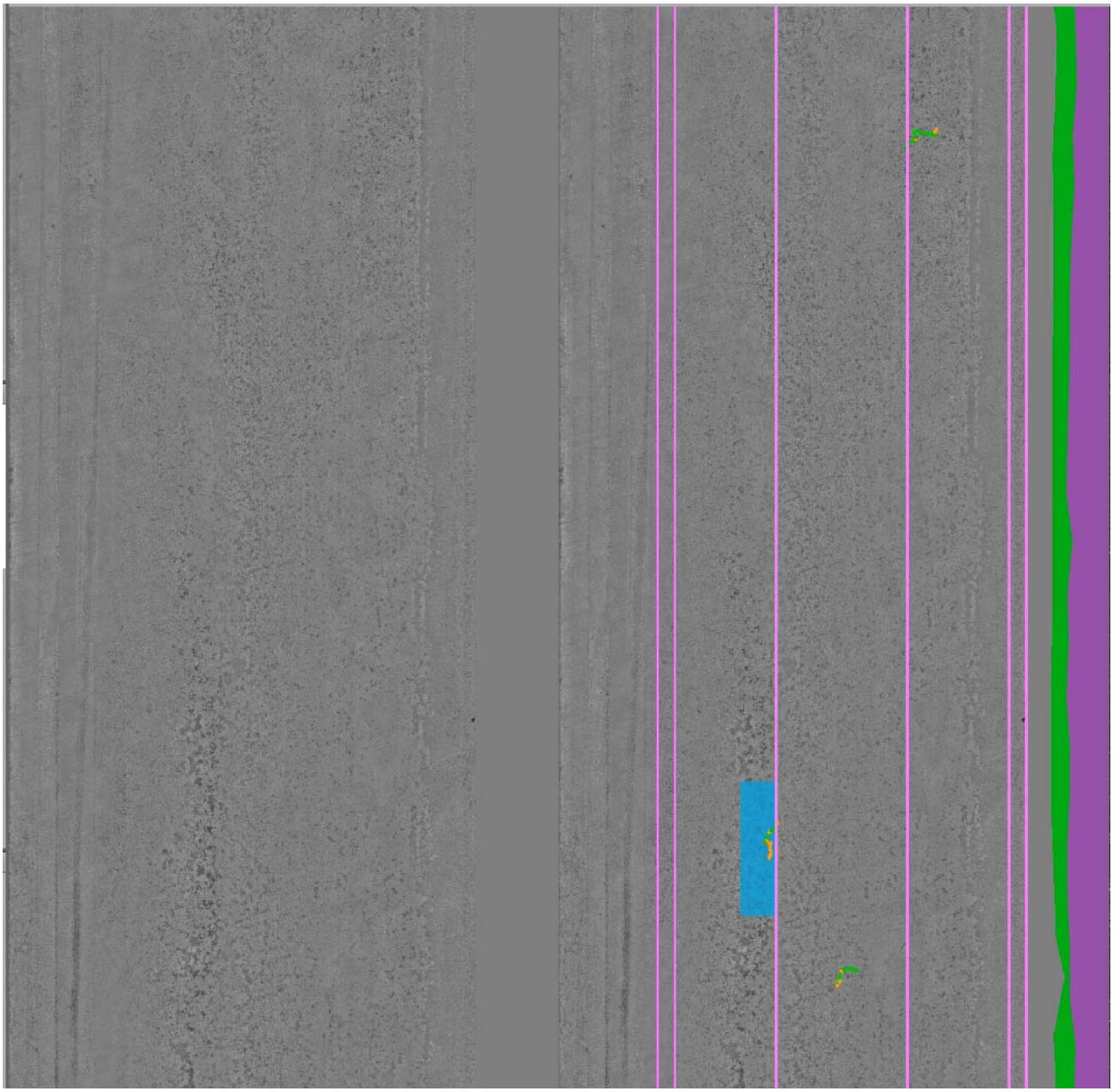
Raveling

Method of Measurement:	Manual	**Unit of Measure:**	Sq Ft
Pavement Type:	AC, APC, ST	**Severity Levels:**	Yes

Definition: Raveling is the dislodging of coarse aggregates from the pavement surface due to a loss of adhesion between the asphalt binder and aggregates.

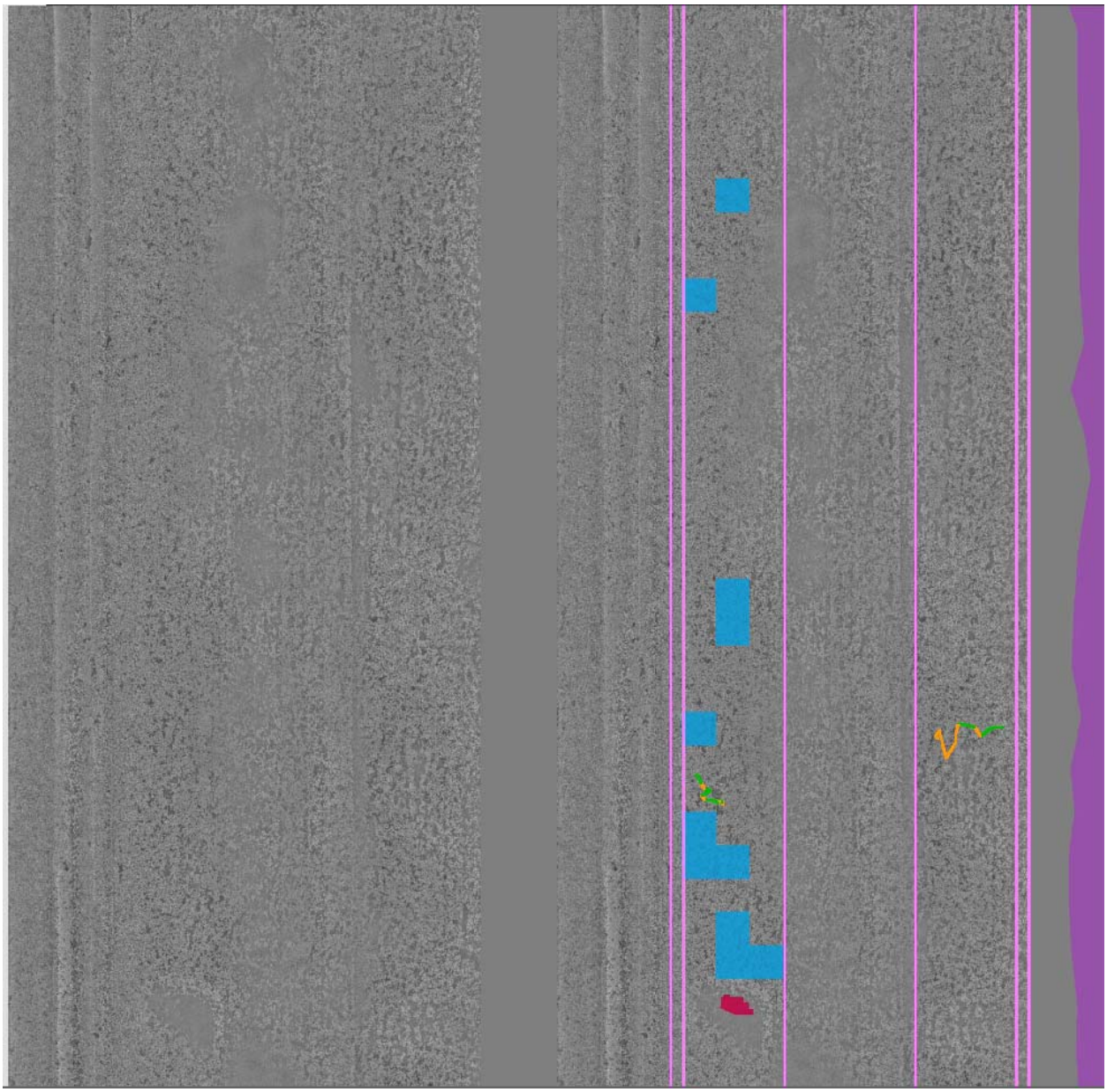
Raveling (Low Severity)

Aggregates begin to wear away on the surface at the low-severity level.



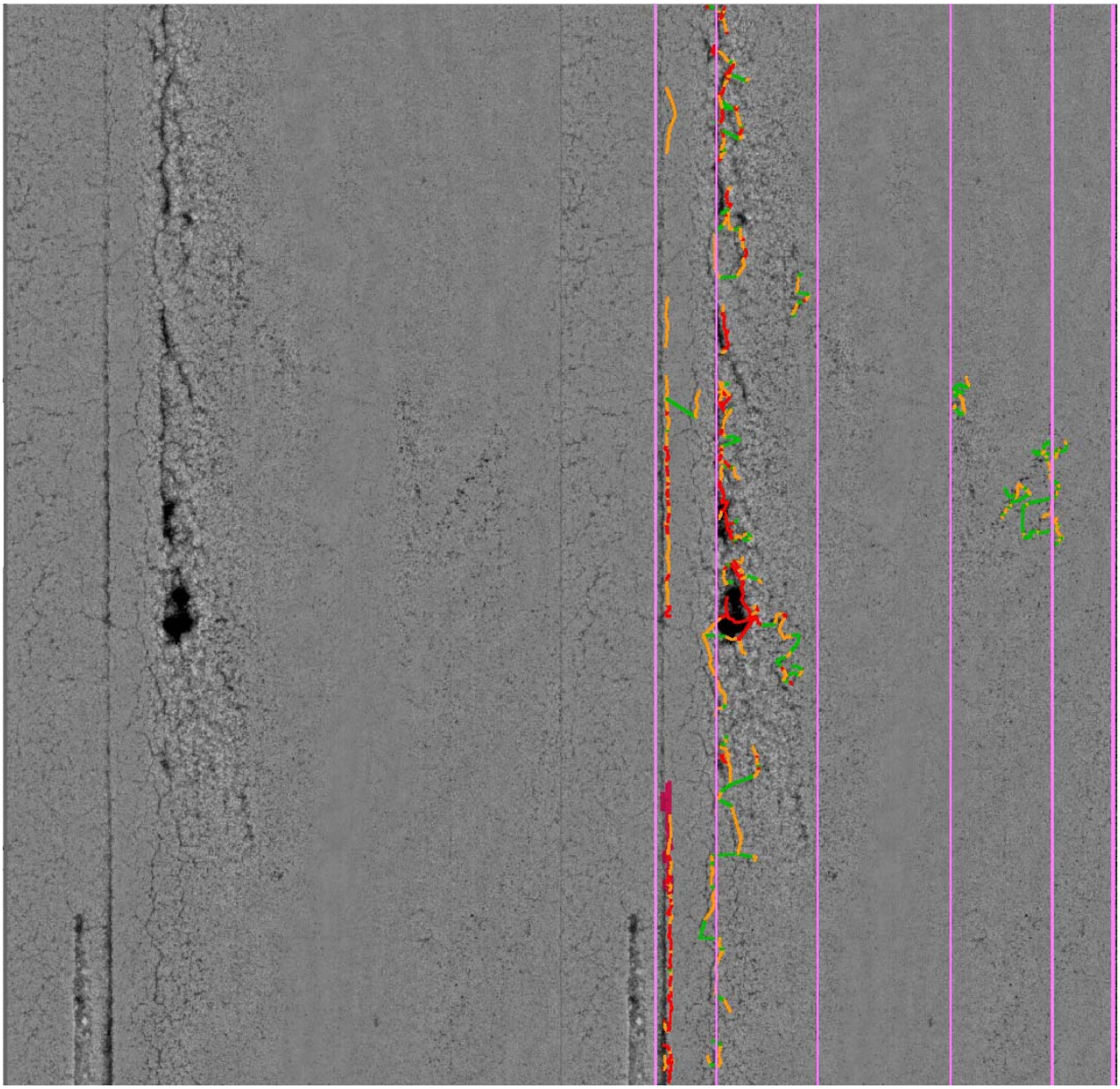
Raveling (Medium Severity)

Loss of aggregates is more pronounced at the medium-severity level.



Raveling (High Severity)

High-severity raveling shows a significant loss of aggregates.



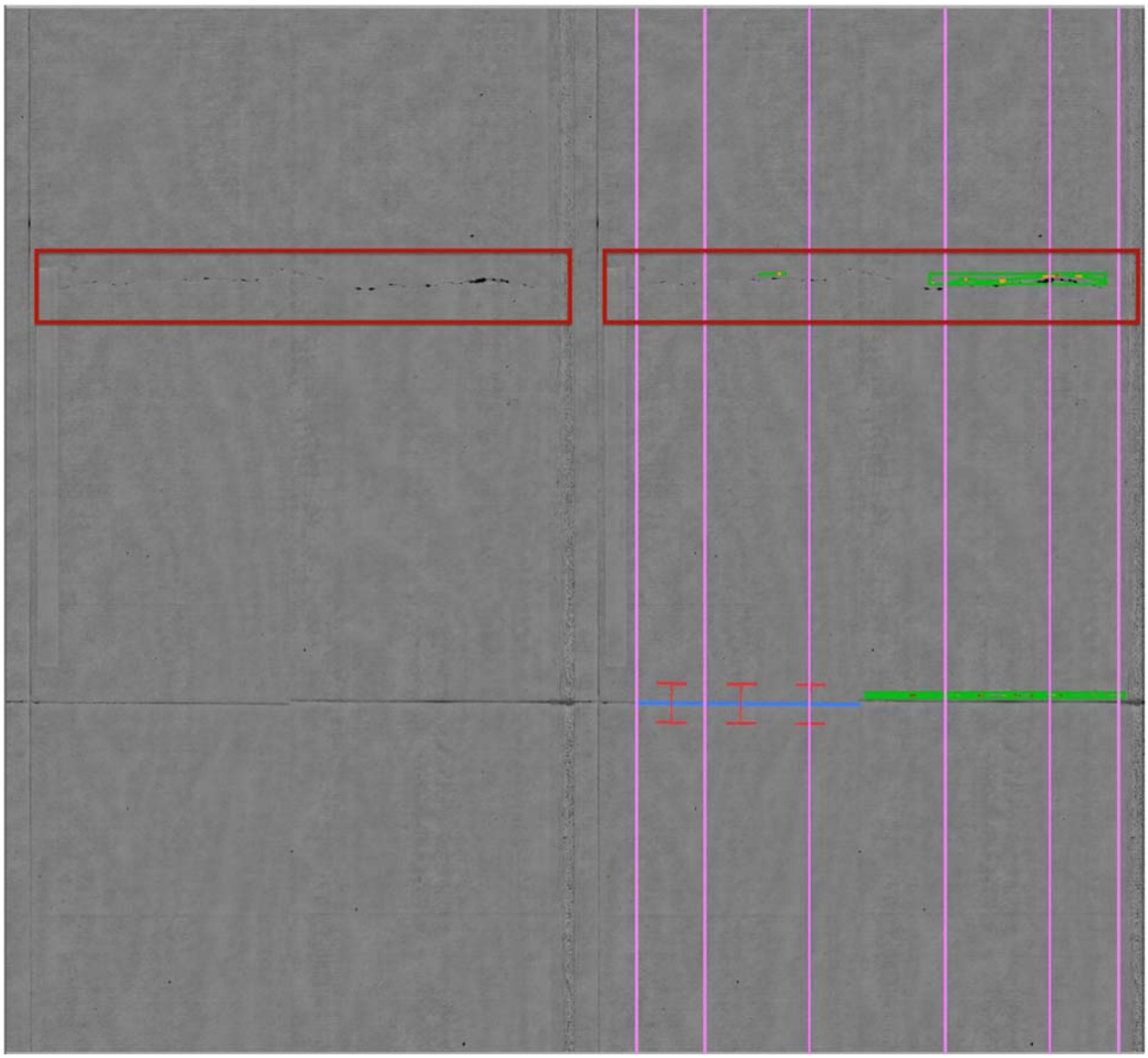
Slab Cracking

Method of Measurement:	Manual	**Unit of Measure:**	Slab Count
Pavement Type:	PCC	**Severity Levels:**	Yes

Definition: Slab cracking encompasses both transverse and longitudinal cracking on PCC slabs. The highest severity crack defines the severity level of the slab. If a slab is broken into three or more pieces, the severity level is increased.

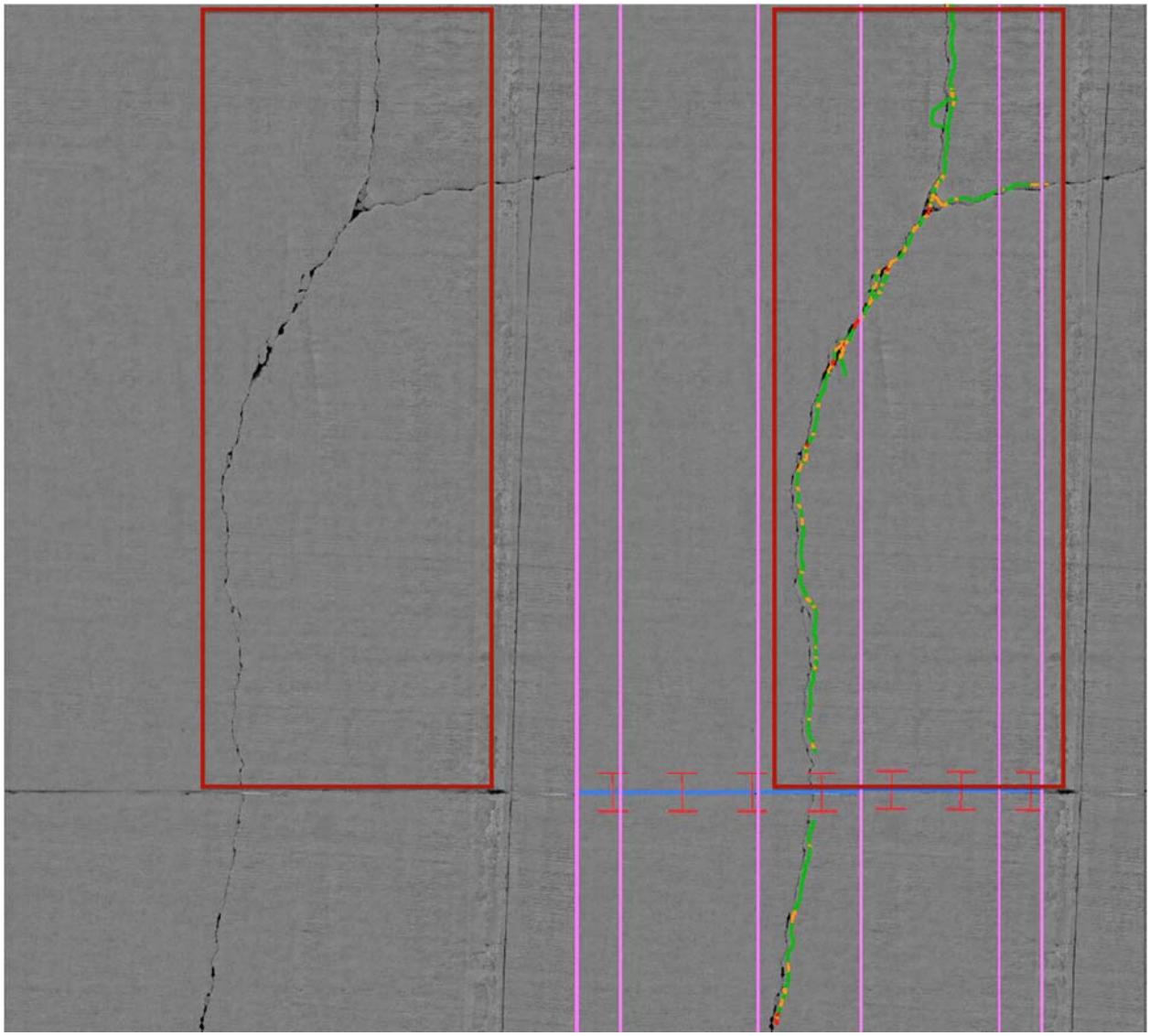
Slab Cracking (Low Severity)

Cracks with widths less than ¼-inch or sealed cracks in good condition characterize low-severity slab cracking. If the cracks create three or more pieces, the severity level is increased by one severity level.



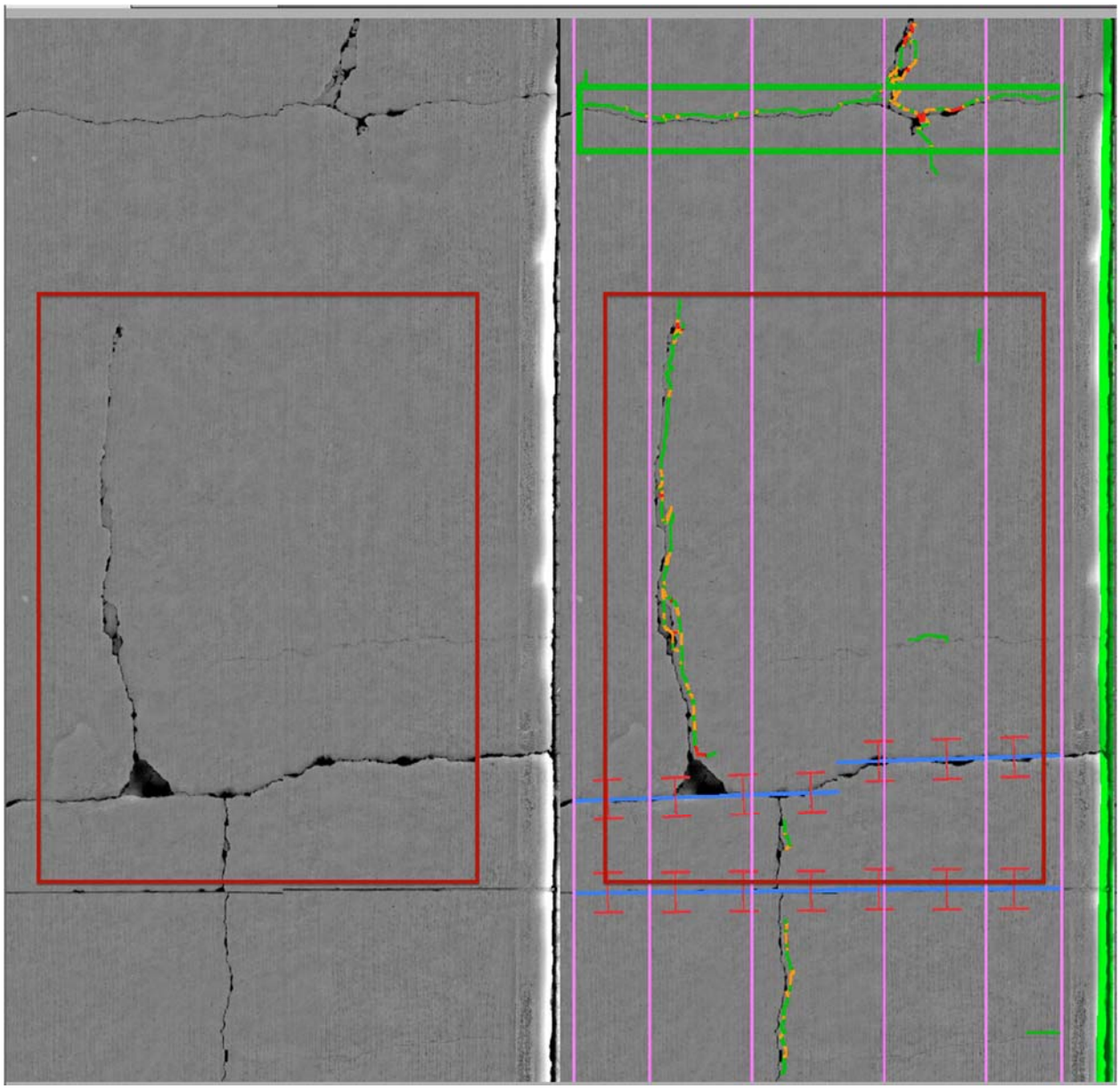
Slab Cracking (Medium Severity)

Cracks with widths between ¼-inch and ¾-inch or spalling less than 3 inches wide characterizes medium-severity slab cracking. If the cracks create three or more pieces, the severity level is increased by one severity level.



Slab Cracking (High Severity)

High-severity slab cracking exhibits cracks with widths exceeding ¾-inch or spalling exceeding 3 inches wide.



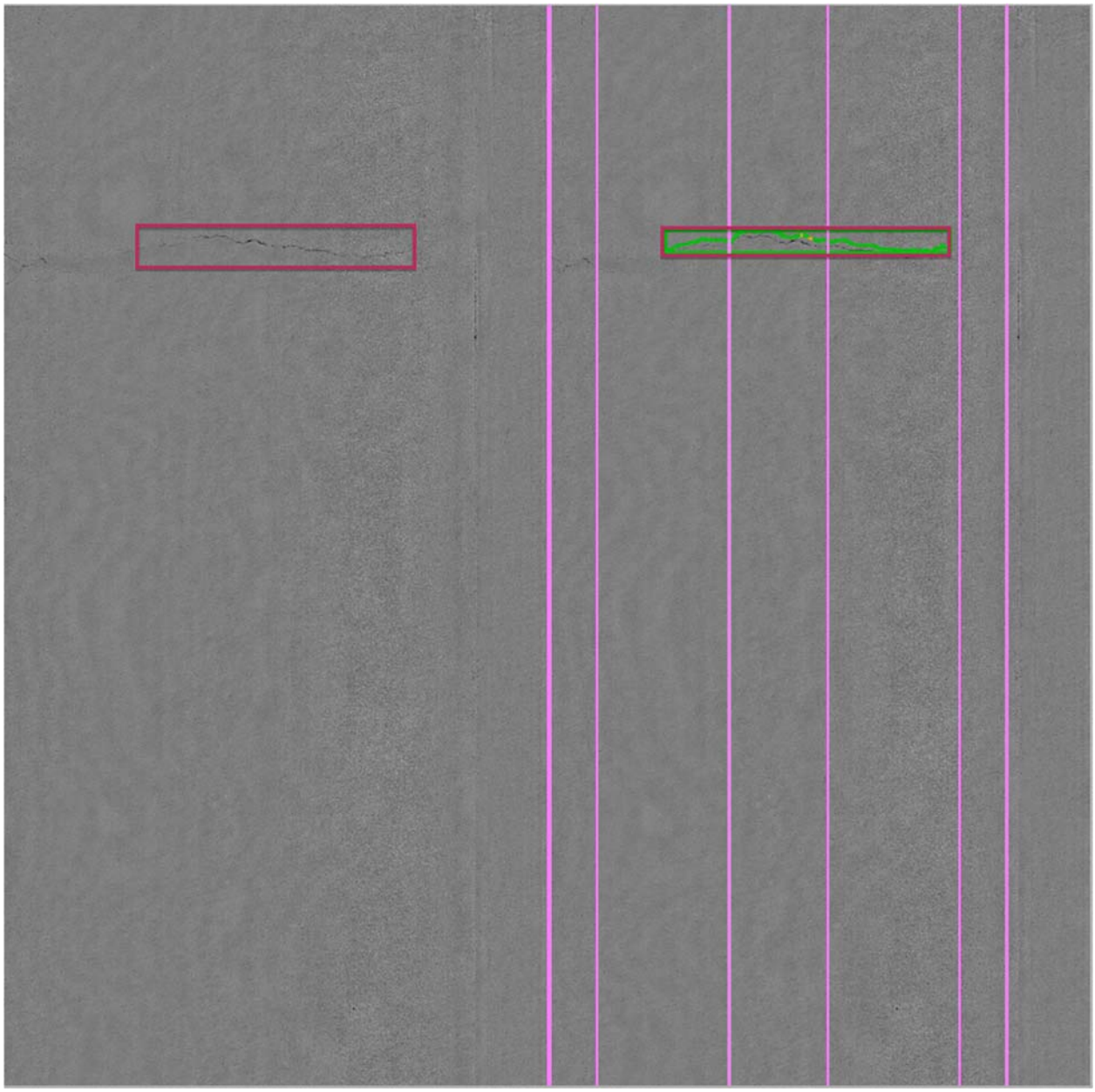
Transverse Cracking

Method of Measurement:	LCMS	**Unit of Measure:**	Ft, Count
Pavement Type:	AC, ST	**Severity Levels:**	Yes

Definition: Cracks oriented perpendicular to the pavement centerline that exist beyond the wheel path. Only cracks at least 3 feet in length are counted. Transverse cracks are shown in the red boxes in the following images.

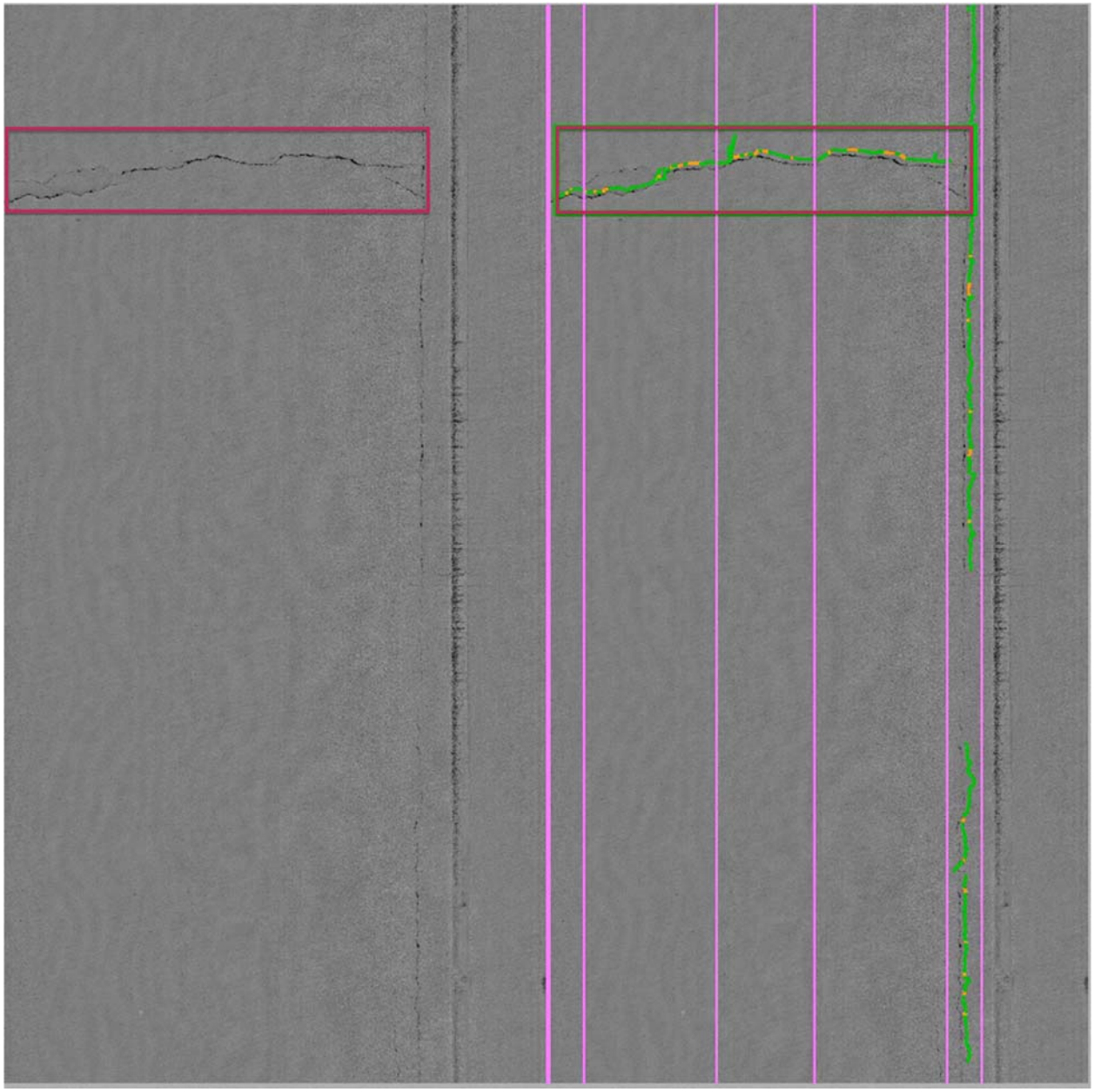
Transverse Cracking (Low Severity)

Low-severity transverse cracking is characterized by cracks with widths less than ¼-inch or sealed cracks in good condition.



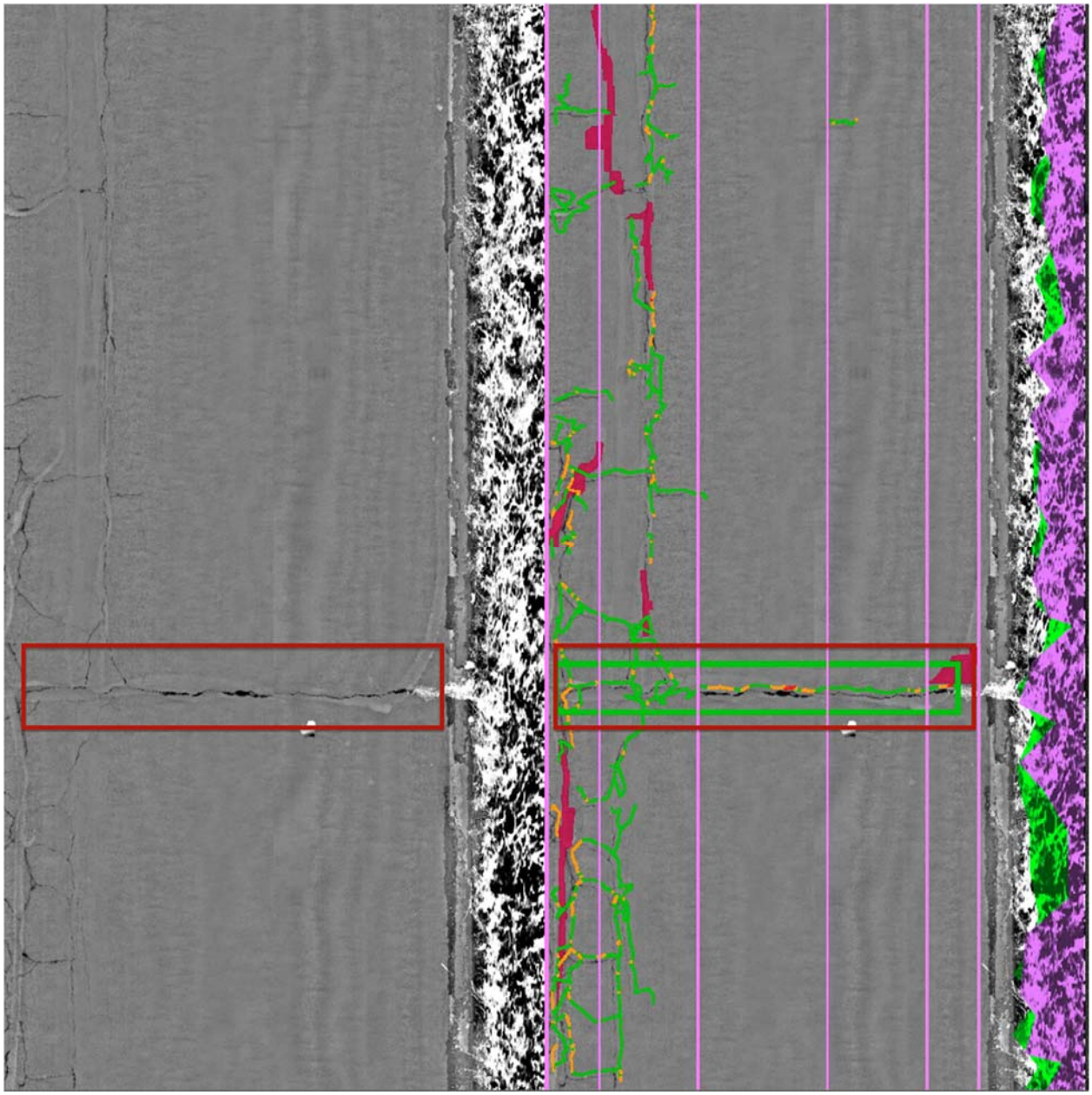
Transverse Cracking (Medium Severity)

Medium-severity transverse cracking is characterized by cracks with widths between ¼-inch and ¾-inch and with spalls 3 inches or less in width.



Transverse Cracking (High Severity)

High-severity transverse cracking is characterized by cracks with widths exceeding ¾-inch or spalls exceeding 3 inches wide with a significant loss of material.



Appendix II - DQMP

Delaware Department of Transportation
Pavement Management Support Services

Pavement Distress Data Quality Management Plan

July 28, 2020

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Revision History

Version	Date	Author	Description
v0.1-0.9x	5/8/18	Kercher Group	Initial Drafts
v1.0	5/8/18	Kercher Group	Initial submittal for FHWA
v1.1	8/27/18	Kercher Group	Updated submittal for FHWA
V1.11		Kercher Group	Repeatability requirements for Crack Length, Faulting, Rutting, and IRI have bene changed. Accuracy requirements for Crack Length are changed.
V1.13	11/04/2019	Kercher Group	Requirement of Slab Cracking Length and Patch Deteriorations/Potholes Count is dropped from Table 1.
V1.2	7/28/2020	Kercher Group	Updated based on QA report

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Introduction

This document defines the Data Quality Management Plan for DelDOT.

Based on §490.319(c) of the Federal Register of January 5, 2015 and the final rule published by the FHWA on January 18, 2017, it is required by the FHWA that "Each State DOT shall develop and utilize a Data Quality Management (QM) Program, approved by the FHWA, that addresses the quality of all data collected, regardless of the method of acquisition, to report the pavement condition metrics, discussed in §490.311, and data elements discussed in §490.309(c)."

These elements are required for target setting according to 23 CFR 490.105 - Establishment of performance targets, 23 CFR 490.307 - National performance management measures for assessing pavement condition, 23 CFR 490.309 - Data requirements, 23 CFR 490.311 - Calculation of pavement metrics, and 23 CFR 490.313 - Calculation of performance management measures. The pavement performance management measures are required on the Interstate System, and the NHS (excluding the Interstate).

Under 23 CFR 490.319(c), the State DOT must develop a DQMP that addresses the following:

A. Data collection equipment calibration and certification;
B. Certification process for persons performing manual data collection;
C. Data quality control measures to be conducted before data collection begins and periodically during the data collection program;
D. Data sampling, review and checking processes; and
E. Error resolution procedures and data acceptance criteria.

These areas are addressed in the following sections with the exception of certification processes for manual data collection since this is not applicable for DelDOT.

In addition to the condition data used for pavement management in the DelDOT pavement management system, this Data Quality Management Plan therefore includes the data elements used to determine pavement condition from the most current HPMS Field Manual[1] specifically identified in 23 CFR 490.311 - Calculation of pavement metrics:

- IRI Rating (IRI)
  - All pavements
- Cracking Percent Value (percent)
  - Asphalt Pavements: fatigue type cracking for all severity levels in the wheelpath in each section
    - Fatigue Cracking (sf)
  - Jointed Concrete Pavements: percentage of slabs within the section that exhibit transverse cracking based on
    - Slab Cracking (lf)
    - Slab Count (count)
  - CRCP: area of the section exhibiting longitudinal cracking, punchouts, and/or patching (sf)

[1] Most current HPMS Field Manual: https://www.fhwa.dot.gov/policyinformation/hpms/fieldmanual/hpms_field_manual_dec2016.pdf

        - N/A for DelDOT at this time
- Rutting value (inches)
    - Asphalt and Composite Pavements only.
- Faulting value (inches)
    - Jointed Concrete Pavements only.

The underlying objective for this document is to create a repeatable process to ensure that data being delivered to support the Pavement Management program and FHWA pavement condition reporting is accurate and repeatable so that:

- Trends based on quality data are available over time for analysis and reporting.
- Inputs to the pavement management system are reliable and as accurate as possible.

As noted in the FHWA *Practical Guide for Quality Management of Pavement Condition Data Collection*, *"An effective pavement management system depends on reliable, accurate, and complete information. Quality pavement condition data is directly linked to the ability of the pavement management system to produce reasonable, timely, and reliable recommendations regarding an agency's pavement network. Increasingly, pavement managers realize that money is wasted and poor decisions are made when data are substandard. Confidence in data is eroded and people within the organization will tend to work around poor-quality data. The savings from using good data comes from more accurate decisions and lower life cycle cost for maintaining the pavements."*

The approach followed in this Data Quality Management Plan is to define and provide detailed descriptions for all parts of the quality management cycle while not being so prescriptive as to require vendors to change their own quality management processes and procedures that would already result in high quality, accurate and repeatable final data and does not unreasonably regulate source and raw data except where existing AASHTO and ASTM standards are applicable.

The following definition of the Data Quality Management Cycle is quoted from the FHWA *Practical Guide for Quality Management of Pavement Condition Data Collection*.

Data Quality Management Cycle

Management of data quality is based on many of the same principles as other QM processes, such as Total Quality Management (TQM) and the Deming cycle of "Plan, Do, Check, and Act" for quality enhancement. Wang (1998) identified four phases that are essential in the QM cycle to ensure high quality data: define, measure, analyze, and improve. Expanding these concepts to pavement condition data collection includes (also shown in figure 7):

• **Define data quality** – Identify the acceptable levels of resolution, accuracy, and repeatability.
• **Plan and implement QC** – Develop and implement a set of procedures to produce, check, and ensure data of acceptable quality.
• **Perform acceptance tests and evaluate results** – Perform tests to compare delivered data to acceptability metrics.
• **Take corrective action** – Take steps to re-collect or reprocess data as needed to achieve data acceptance standards.
• **Report on data quality** – Document the data quality standards, protocols, equipment, personnel, collection and processing methods, QC, acceptance tests, and results.
• **Improve the process** – Use the knowledge and experienced gained to modify processes as needed to improve data quality.

It should be noted that the steps in the QM cycle incorporates a feedback process so that the collection team evaluates data quality continually throughout the collection and makes any needed process modifications as soon as it becomes evident.

To address all parts of the Data Quality Cycle, this document divided into the following sections:

- **Introduction**: This gives the purpose and layout of the document.
- **Data Collection**: This section lists the deliverables, including individual data elements, being collected, and the protocols, resolution, accuracy, and repeatability required for each.

- **Quality Control**: This gives the QC activities for each deliverable, and the frequency at which the QC activity should be performed. The section is further divided into sub-sections for pre-collection activities, activities carried out during collection, and post-collection activities.
- **Acceptance**: This section gives a description of acceptance percentage (%) within limits required for each acceptance test, and the action that will be taken if the acceptance test fails.
- **Team Roles and Responsibilities**: This describes each role, the assigned resource, and the quality management responsibilities for that role.
- **Quality Reporting Plan**: The last section details the reporting that will be performed on the quality management activities, including which role is responsible for generating the reporting.

1. Deliverables, Protocols, and Quality Standards

Data Elements

The distresses and individual data elements listed in Table 1 are required to be collected for use in the DelDOT pavement management program. Pavement distresses are considered for four pavement types, namely Asphalt Concrete (AC), Portland Cement Concrete (PCC), Composite pavement (AC over PCC, or APC), and Surface Treated (ST) pavements. These data elements shall be in accordance with the *DelDOT Pavement Data Dictionary version 2.1* or latest iteration. The QM process assumes that data will be collected using the following methods and frequency:

- Automated survey equipment shall be used for all ratings.
- All state-maintained roadway ratings shall be completed by August 31 of every other calendar year.
- All state-maintained suburban street ratings shall be completed by December 31 of every other calendar year.
- All NHS roadway ratings shall be completed for HPMS by August 31 on off years.

Lengths of lane exclusions related to bridges, construction, lane deviations, or railroads should be reported for each route.

Table 1 – Data Elements collected for pavement management

Data Elements	Pavement Type				Description, Severity Levels and Units	Individual Data Fields
	AC	APC	ST	PCC		
Route, Direction, Lane (From, To – placeholders only)	X	X	X	X	N/A	ROUTE_ID LANE_DIR LANE_ID OFFSET_FROM OFFSET_TO
GIS Route	X	X	X	X	N/A	DE_GIS_ROADWAY
Section Width	X	X	X	X	Width of Lane Rated (Ft)	SEC_WIDTH
From, To	X	X	X	X	From, To milepoints based on measured shape file (Miles)	FROM_POINT TO_POINT
Wearing Course	X	X	X	X	Wearing Course ID (1=AC, 2=PCC, 3=APC, 4=ST)	WC_ID
Date Rated	X	X	X	X	MM/DD/YYYY	DATE_RATED
Bleeding			X		High, Medium, Low (SqFt)	DE_BLEEDING_HI_SF DE_BLEEDING_LOW_SF DE_BLEEDING_MED_SF

Data Elements	Pavement Type				Description, Severity Levels and Units	Individual Data Fields
	AC	APC	ST	PCC		
Block Cracking	X	X	X	X	High, Medium, Low (SqFt)	DE_BLOCK_CRK_HIGH_SF DE_BLOCK_CRK_LOW_SF DE_BLOCK_CRK_MED_SF
Crown / Cross-Slope			X		(Linear Ft)	DE_ROUGH_CROWN_LF
Edge Cracking			X		High, Medium, Low (Linear Ft)	DE_EDGE_CRACK_HI_LF DE_EDGE_CRACK_LOW_LF DE_EDGE_CRACK_MED_LF
Fatigue Cracking	X	X	X		High, Medium, Low (SqFt)	DE_FATIGUE_HI_SF DE_FATIGUE_LOW_SF DE_FATIGUE_MED_SF
Faulting				X	High, Medium, Low (Count), Average fault height Right Wheel Path (Inches)	DE_FAULTING_RWP_IN DE_FAULTING_HI_CT DE_FAULTING_LOW_CT DE_FAULTING_MED_CT
International Roughness Index (IRI)	X	X	X	X	Left Wheel Path, Right Wheel Path (Inches Per Mile)	DE_IRI_LWP_INCH_MILE DE_IRI_RWP_INCH_MILE
Joint Deterioration / Spalling				X	High, Medium, Low (Count)	DE_JOINT_DET_HI_CT DE_JOINT_DET_LOW_CT DE_JOINT_DET_MED_CT
Joint Reflective Cracking		X			High, Medium, Low (Linear Ft, Count)	DE_JNT_REFL_HI_LF DE_JNT_REFL_LOW_LF DE_JNT_REFL_MED_LF DE_JNT_REFL_HI_CT DE_JNT_REFL_LOW_CT DE_JNT_REFL_MED_CT
Joint Seal Damage				X	High, Low (Count)	DE_JOINT_SEAL_HI_CT DE_JOINT_SEAL_LOW_CT
Map Cracking / Alkali-Silica Reactivity				X	Occurrences (Count)	DE_ASR_CNT
Non-Wheel Path Longitudinal Cracking	X	X			High, Medium, Low (Linear Ft)	DE_NWP_CRK_HI_LF DE_NWP_CRK_LOW_LF DE_NWP_CRK_MED_LF
Patch Deterioration / Potholes	X	X	X	X	High, Medium, Low (SqFt)	DE_PATCH_DET_HI_SF DE_PATCH_DET_LOW_SF DE_PATCH_DET_MED_SF
Raveling / Surface Defects	X	X	X		High, Medium, Low (SqFt)	DE_SURF_DFCTS_HI_SF DE_SURF_DFCTS_LOW_SF DE_SURF_DFCTS_MED_SF
Rutting	X	X	X	X	Left Wheel Path, Right Wheel Path; High, Medium, Low	DE_RUT_LWP_AVG_IN DE_RUT_RWP_AVG_IN DE_RUT_LWP_HI_LF DE_RUT_LWP_LOW_LF DE_RUT_LWP_MED_LF

Data Elements	Pavement Type				Description, Severity Levels and Units	Individual Data Fields
	AC	APC	ST	PCC		
					(Linear Ft); Average, Maximum (Inches)	DE_RUT_LWP_MAX_IN DE_RUT_RWP_MAX_IN DE_RUT_RWP_HI_LF DE_RUT_RWP_LOW_LF DE_RUT_RWP_MED_LF
Slab Cracking				X	High, Medium, Low (Count)	DE_SLAB_CRACK_HI_CT DE_SLAB_CRACK_LOW_CT DE_SLAB_CRACK_MED_CT
Transverse Cracking	X		X		High, Medium, Low (Linear Ft, Count)	DE_TRANS_CRACK_HI_LF DE_TRANS_CRACK_LOW_LF DE_TRANS_CRACK_MED_LF DE_TRANS_CRACK_HI_CT DE_TRANS_CRACK_LOW_CT DE_TRANS_CRACK_MED_CT
Slab Count				X	Number (Count)	DE_SLAB_CNT
Joint Spacing				X	Average Spacing (Linear Ft)	DE_JNT_SPACING_LF
Joint Count				X	Number (Count)	DE_JNT_CT
Unclassified Cracking	X	X	X	X	High, Medium, Low (SqFt)	UNCLASS_CRACK_LOW UNCLASS_CRACK_MED UNCLASS_CRACK_HIGH
Length	X	X	X	X	Length (Miles)	LENGTH
GPS Coordinates (Segment Begin, End; Lat, Long Altitude)	X	X	X	X	Latitude, Longitude (Degrees), Altitude (Ft)	BEGIN_LAT BEGIN_LONG BEGIN_ALT END_LAT END_LONG END_ALT
Exclusions	X	X	X	X	Bridges, Construction, Railroads (Count); Total Length Excluded (Miles)	BRIDGE BRIDGE_LENGTH CONSTRUCTION CONSTRUCTION_LENGTH LANE_DEVIATION LANE_DEVIATION_LENGTH RAILROAD RAILROAD_LENGTH

Table 2 – Data Elements for HPMS collected specifically for FHWA pavement condition metrics[2]

Data Elements	Pavement Type		Description, Severity Levels and Units	Individual Data Fields
	AC	PCC		
Crack Percentage	X	X	Fatigue area for AC and cracked slabs for PCC (Percent)	(Derived. See Fatigue Cracking, Slab Cracking and Slab Count in Table 1)

[2] 23 CFR 490.311

Data Elements	Pavement Type		Description, Severity Levels and Units	Individual Data Fields
	AC	PCC		
Faulting		X	Average fault height Right Wheel Path (Inches)	(Captured. See Faulting in Table 1)
International Roughness Index (IRI)	X	X	Average of Left Wheel Path and Right Wheel Path (Inches Per Mile)	(Derived. See IRI in Table 1)
Rutting	X		Average of Left Wheel Path and Right Wheel Path (Inches)	(Derived. See Rutting in Table 1)

Data Collection Scope

The following is required by DelDOT regarding scope of services by the data collection vendor.

- The consultant shall conduct field surveys on all pavement segments (approximately 25,056 segments) of state-maintained roads (approximately 4,459 miles) and suburban streets (approximately 1,422 miles) to identify:
    - Type of pavement
    - Severity of distress in pavement
    - Extent of distress in pavement
- The consultant will provide data in the most up-to-date version of Access, XLS, or Oracle 12c data import file. Images shall be in JPG format. The data shall be compatible with the department's Pavement Management System.
- The consultant shall provide training for all personnel who perform the field surveys.
- All state-maintained roadway ratings shall be completed by August 31 of every other calendar year.
- All state-maintained suburban street ratings shall be completed by December 31 of every other calendar year.
- All NHS roadway ratings shall be completed for HPMS by August 31 on off years.[3]
- The data collection vendor will be required to provide QA/QC to ensure data is reliable. The QA/QC plan should be submitted to DelDOT prior to collection data. This will be the responsibility of the vendor.

[3] Note that the August 31 date is for data collection completion – the resulting HPMS data is due to FHWA on April 15 of the following year for Interstates, and June 15 biennially of the following year for Non-Interstate.

Data Protocol, Resolution, Accuracy and Repeatability

The expected data units and resolution, accuracy and repeatability are identified for each data element in Table 3 - Data Protocols, Resolution, Accuracy and Repeatability below.

Table 3 - Data Protocols, Resolution, Accuracy and Repeatability for Data Elements

Data Elements	Protocol	Resolution	Accuracy (mean over 10 runs compared to reference value)	Repeatability (for 10 replicate runs)
Route, Direction, Lane (From, To – placeholders only)	e.g. 1-00001, R, 1	N/A	Exact	Exact
GIS Route	GIS Route ID based on provided measured shape file. E.g. 10928	N/A	Exact	Exact
Section Width	Total width of 5 AASHTO zones between lane edge or centerline, and lane edge or shoulder.	1 Ft	± 0.5 Ft	± 0.5 Ft
From, To	From, To milepoints based on measured shape file (Miles)	0.1 Miles	± 0.02 Miles	± 0.02 Miles
Wearing Course	Wearing Course ID (1=AC, 2=PCC, 3=APC, 4=ST)	N/A	Exact	Exact
Date Rated	Date Format: (MM/DD/YYYY)	N/A	Exact	Exact
Bleeding	*DelDOT Pavement Data Dictionary version 2.1* or latest iteration. (for Fatigue Cracking, also *HPMS Field Manual*)	1 SqFt (per Severity Level)	Mean within ± 50 SqFt of reference value (10 replicate runs)	Std. dev. < 5% of mean (10 replicate runs) or CV < 10%
Block Cracking		1 SqFt (per Severity Level)	± 250 SqFt	Std. dev. < 5 SqFt or CV < 50%
Crown / Cross-Slope		1 Ft	± 50 Ft	Std. dev. < 5 Ft or CV < 50%

Data Elements	Protocol	Resolution	Accuracy (mean over 10 runs compared to reference value)	Repeatability (for 10 replicate runs)
Edge Cracking		1 Ft (per Severity Level)	± 50 Ft	Std. dev. < 5 Ft or CV < 50%
Fatigue Cracking		1 SqFt (per Severity Level)	± 250 SqFt	Std. dev. < 5 SqFt or CV < 50%
Faulting	AASHTO R36-13[4] (also *HPMS Field Manual*)	1 Count (per Severity Level), 0.01 Inches (for Average fault height Right Wheel Path)	± 50 Count	Std. dev. < 5 Count Std. dev. < 0.10 inches Or CV < 10%
International Roughness Index (IRI)	AASHTO R43-13[5] (also *HPMS Field Manual*)	1 inch per mile (for Left Wheel Path, Right Wheel Path)	± 15 inches per mile	Std. dev. < 5 inches per mile or CV (Std. Dev./Mean) < 5%
Joint Deterioration / Spalling	*DelDOT Pavement Data Dictionary version 2.1* or latest iteration.	1 Count (per Severity Level)	± 5 Count	Std. dev. < 5 Count
Joint Reflective Cracking		1 SqFt (per Severity Level), 1 Count (per Severity Level)	± 5 SqFt ± 5 Count	Std. dev. < 5 SqFt/Count or CV < 50%
Joint Seal Damage		High, Low (Count)	± 5 Count	Std. dev. < 5 Count or CV < 10%
Map Cracking / Alkali-Silica Reactivity		Occurrences (Count)	± 5 Count	Std. dev. < 5 Count or CV < 10%
Non-Wheel Path Longitudinal Cracking		High, Medium, Low (Linear Ft)	± 50 Linear Ft	Std. dev. < 5 Linear Ft or CV < 50%
Patch Deterioration / Potholes		High, Medium, Low (SqFt, Count)	± 50 SqFt	Std. dev. < 5 SqFt or CV < 10%

[4] 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics
[5] 23 CFR 490.311(b)(1)(i) Computation of IRI. Note that additional equipment standards required prior to data collection startup such as AASHTO R56-14 are listed in Table 5 – Equipment and Data Collection Protocols and Standards.

Data Elements	Protocol	Resolution	Accuracy (mean over 10 runs compared to reference value)	Repeatability (for 10 replicate runs)
Raveling / Surface Defects		High, Medium, Low (SqFt)	± 50 SqFt	Std. dev. < 5 SqFt
Rutting	AASHTO R 87 or R 48-10[6] (also *HPMS Field Manual*)	1 ft (for Left Wheel Path, Right Wheel Path; per severity); 0.01 inches (for Average, Maximum)	± 50 Ft ± 0.25 inches	Std. dev. < 20 Ft. or CV < 5% Std. dev. < 0.05 inches for average or CV < 5% Std. dev. < 0.3 inches for max or CV < 5%.
Slab Cracking	*DelDOT Pavement Data Dictionary version 2.1* or latest iteration.	High, Medium, Low (Linear Ft, Count)	± 50 Linear Ft ± 5 Count	Std. dev. < 5 Linear Ft Std. dev. < 5 Count or CV < 10%
Transverse Cracking		High, Medium, Low (Linear Ft, Count)	± 50 Linear Ft ± 5 Count	Std. dev. < 5 Linear Ft Std. dev. < 5 Count or CV < 10%
Slab Count	Number of full slabs in segment	1 Count	± 5 Count	Std. dev. < 5 Count or CV < 10%
Joint Spacing	Average joint spacing in segment	1 Ft	± 5 Ft	Std. dev. < 5 Ft or CV < 10%
Joint Count	Number of joints in segment	1 Count	± 5 Count	Std. dev. < 5 Count or CV < 10%

[6] 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics. Alternatively, for automated rut data capture, the following are applicable:

- Collection of transverse pavement profiles in accordance with AASHTO Standard PP 70-1419 and
- Quantification of Rut Depth values in accordance with AASHTO Standard PP 69-1420, with the modifications specified in the HPMS Field Manual

Data Elements	Protocol	Resolution	Accuracy (mean over 10 runs compared to reference value)	Repeatability (for 10 replicate runs)
Unclassified Cracking	SqFt of cracking not classified into any other distress. Severities as for other cracking distresses.	1 SqFt (per Severity)	Total area < 5 percent of area of segment	Std. dev. < 5% or CV < 50%
Length	Length of surveyed segment.	0.1 Miles	± 0.02 Miles	± 0.1 Miles or CV (Std. Dev./Mean) < 10%
GPS Coordinates (Segment Begin, End; Lat, Long Altitude)	GPS	0.00000001 degrees	± 15 Ft (0.00004 degrees latitude; 0.00005 degrees longitude)	± 15 Ft (0.00004 degrees latitude; 0.00005 degrees longitude)
Exclusions	Bridges, Construction, Railroads (Flag); Total Length Excluded (Miles)	Flag (1,0); Length 0.01 Miles	Exact for Flag; No requirement for length.	Exact for Flag; No requirement for length.
Crack length	Total length of cracking for each severity as measured by the LCMS	1 ft	± 40 Linear Ft or ± 10%	Std. dev. < 50 Linear Ft or CV (Std. Dev./Mean) < 10%

2. Quality Assurance and Quality Control

The data collection vendor is required to submit a quality assurance (QA), quality control (QC) plan to the DelDOT as part of their proposal. DelDOT will review and approve the plan to check it has at a minimum the required elements as defined in this document, as well as approve the results of the QC activities defined below in Table 4 – QC Activities.

Quality assurance focuses on procedures and processes to ensure quality. Quality control focuses on the activities that will be performed to check the quality of the data being collected.

Required QC activities are summarized below in Table 4 – QC Activities. The individual activities are then described in more detail in the subsequent sections. The activities and sections are categorized into:

- Activities required prior to the main data collection effort
- Activities required during collection
- Activities required at the end of the data collection prior to final acceptance

Table 4 – QC Activities

Activity[7]	Quality Expectation	QC Check and Responsibility	Frequency
Certification of DelDOT Personnel	DelDOT Pavement Management Engineer certifies that DelDOT personnel or their designees are certified to perform QC/QA tasks and approve or certify deliverables.	Memorandum confirming certification of personnel.	Pre-collection
Pre-Approval of Equipment and Methods	Vendor warrants that equipment and methods meet specifications identified in Table 5 and that data elements are collected in accordance with protocols in Table 3.	Review and approval by DelDOT[8] of Vendor Start-up Report	Pre-collection (as part of vendor Startup Report)
Pre-approval of Quality Management Plan	Vendor submits a Quality Management Plan that addresses items including list in section below discussing the Vendor Quality Management Plan	Review and approval by DelDOT of Vendor Quality Management Plan	Pre-collection

[7] QC activities are summarized here and described in detail in the remainder of this section. The acceptance criteria and corrective actions are described in the following section relating to Acceptance below.
[8] Review and approval by DelDOT denotes review by pavement management staff (as noted in section 4. Team Roles and Responsibilities) and approval by the pavement management engineer. This applies for all QC Activities relating to the Startup Report.

Activity[7]	Quality Expectation	QC Check and Responsibility	Frequency
Initial Calibration	Data meets acceptance requirements from Table 8 for the designated number of runs for each calibration test site.	Review and approval by DelDOT of Start-up Report	Pre-collection (as part of vendor Startup Report)
Calibration Verification	Data meets acceptance requirements from Table 8 for the designated number of runs for each calibration test site.	Approval by DelDOT of Monthly Data Submission Deliverable	Monthly (typically, as part of monthly vendor data submission)
Ongoing Discrepancy Monitoring	Discrepancies and invalid data should be flagged (manually and automatically) and reported by the vendor in a Discrepancy Report according to the Vendor's Quality Management Plan.	Certification by DelDOT that Discrepancies are within Acceptance limits and defined in the vendor QMP.	Monthly (as a separate vendor Discrepancy Report)
Independent Bounds and Format Checking	Inspect 100% of uploaded data samples to ensure within normal bounds and in the required format. Minimum data checks: IRI • 30 < IRI ≤ 500 inch/mile • Left and right IRI values differ ≤ 150 inch/mile Rutting • Values ≤ 1.0 inch • Left and right rutting values differ ≤ 0.25 inch Cracking • Percentages for SqFt and LnFt ≤ 100 based on calculated values Faulting • Values ≤ 1.0 inch • Values > 0 when joints are present Use database checks to compare with previous year and flag results > 10% different.	Independent data check by DelDOT to confirm Vendor's discrepancy report findings	Monthly (as part of Independent Quality Report)

Activity[7]	Quality Expectation	QC Check and Responsibility	Frequency
Independent Image Sample Checking	Inspect a random sample of 10 images against associated uploaded data to ensure distress data derived from LCMS or video data is accurate.	Independent data check by DelDOT to confirm Vendor's distress ratings.	Monthly (as part of Independent Quality Report)
Independent Distance and Location Verification	Inspect a random sample of 10 sections of location data by plotting on a GIS map using provided GPS data and comparing accuracy to underlying base map alignments, and LRS routes, from and to points.	Independent location data check by DelDOT to confirm Vendor's location data.	Monthly (as part of Independent Quality Report)
Final data review	Scope • Data coverage (excluding identified occurrences e.g. construction, railroads, etc.) > 99% Within bounds • Data within bounds specified in the bounds checks > 98%	Approval by DelDOT of Final Data Submission Deliverable	Prior to Final Acceptance (as part of final Independent Quality Report)

Certification of DelDOT Personnel or Representatives

Personnel from DelDOT (or their representatives) who perform QC/QA processes shall be certified at the start of each data collection cycle. This certification will ensure that personnel are competent to perform the process (or part of the process) for which they are responsible. The certification process will involve the Pavement Management Engineer or, at the discretion of the Pavement Management Engineer, a person who is currently certified or was certified for the previous data collection cycle, assessing the person's competency to perform each task.

Roles and responsibilities for QA/QC personnel are documented in section 4. Team Roles and Responsibilities below.

The following processes or tasks from Table 4 – QC Activities that are performed by personnel other than the Pavement Management Engineer require certification:

- Certification of Vendor Start-up Report
    - Initial Calibration
        - Determination of reference values for use in initial calibration by the vendor
        - Verification that vendor's calculations pertaining to calibration are correct

- Approval of Monthly Data Submission Deliverable
    - Calibration Verification
        - Verification that vendor's calculations pertaining to calibration are correct based on previously defined initial calibration reference values
    - Ongoing Discrepancy Monitoring
    - Independent Bounds and Format Checking
    - Independent Image Sample Checking
    - Independent Distance and Location Verification
- Final data review

The certification shall identify each of the above processes or tasks and the person or persons certified to undertake these.

Pre-Production Activities

A vital part of quality management is to ensure that any vendor awarded a contract has equipment matching the required standards and protocols, as well as sound standard operating procedures and training for their equipment operators.

The data collection vendor must undertake a pavement data collection start-up process annually. The startup process must be finished (including DelDOT review) before production data may be collected.

The results of these pre-collection activities shall be reported by the vendor in a Startup Report.

The start-up process must include the following:

1. The data collection vendor shall provide all pavement data collection start-up work, reported at one time in a Start-up Report.
2. An initial pavement data collection/processing validation, verification and calibration exercise shall be carried out on calibration roadway sections selected by DelDOT based on the number of sections and repetitions defined in Table 6.
3. During this exercise, the contractor will submit data to DelDOT or their representative who will conduct accuracy and precision tests for all data items based on the accuracies and precisions defined in Table 3.
4. In addition, calibration procedures, camera angles and coverage, data calculation methods and standard operating procedures will be verified according to the vendor's quality management plan.
5. The DelDOT Project Manager must approve the Start-up Report and its findings in writing before future work is undertaken.

Vendor Quality Management Plan

It is important that Vendor's maintain a Quality Management Plan but it is understood that these may cover somewhat different aspects of quality management and be formatted according to the vendor's preferences. Nonetheless, vendors' Quality Management Plans should address, at a minimum, QC areas including but not limited to:

- Image capture methods and QC,
- Automated Crack detection image processing and QC,
- Pavement profile data processing and QC (including block test and bounce test frequency),
- Distance and location measurement QC and exception handling (bridges, construction zones, etc.),
- Handling of multiple vehicles,
- Handling of equipment adjustment and repairs,
- Handling of adverse weather conditions,
- Automated and manual flagging, handling, monitoring and reporting of invalid data,
- Personnel training and certification,
- Vendor quality management roles and responsibilities.

Pre-Approval of Data Collection Vendors using Automated Equipment

For equipment used to collect condition measurements, the data collection vendor shall certify that the protocols for initial certification and ongoing data collection specified in Table 5 are met. Where applicable, these standards and protocols are also specified in Table 3 for ongoing data collection.

For collection of IRI, the vendor shall undertake the certification detailed in AASHTO R56-14 as noted in Table 5 below. While not repeating the full R56 specification here, the vendor shall ensure the test is conducted at an established test site (not necessarily within the state) that meets the criteria as designated in 8.2.1 of the standard and is acceptable to DelDOT. A reference profile shall be collected as defined in 8.2.2 of the standard, and 5 test runs shall be made at a minimum of two speeds as defined in 8.2.3 of the standard. Test data shall be analyzed by the vendor using the ProVAL software and shall result in cross-correlation agreement scores of at least 0.92 and 0.90 for repeatability and accuracy respectively. The full results of the certification with at least the information designated in 8.5 of the standard (including location of the test site, DMI results, and cross-correlation tables for repeatability and accuracy) shall be submitted by the vendor as part of the Startup Report for approval by the DelDOT.

Table 5 – Equipment and Data Collection Protocols and Standards

Pavement Condition Metric	Protocol
IRI[9]	• IRI collection device in accordance with AASHTO Standards M328-14. • Collection of IRI data in accordance with AASHTO Standard R57-14.

[9] Incorporated in Federal Regulation by reference in 23 CFR 490.111, and 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics

Pavement Condition Metric	Protocol
	• Quantification of IRI data in accordance with AASHTO Standard R43-13. • Certification of IRI data in accordance with AASHTO Standard R56-14.
Cracking percent [10]	• For asphalt, collection of pavement surface images in accordance with AASHTO Standard PP 68-1413, with the modifications specified in the HPMS Field Manual. • Quantification of cracking from asphalt pavement surface images in accordance with AASHTO Standard PP 67-14. • Quantification of cracking in asphalt pavement surfaces, both in wheelpath and non-wheelpath areas with AASHTO Standard R 55-10. • Quantification of cracking from jointed and continuously reinforced concrete pavements in accordance with HPMS Field Manual. • Computation of Cracking Percent for each pavement type in accordance with the HPMS Field Manual.
Rutting for asphalt pavements [11]	• Collection of Rut Depth values conforming to AASHTO Standard R48-10, with the modifications specified in the HPMS Field Manual. OR: • Collection of transverse pavement profiles in accordance with AASHTO Standard PP 70-1419 and • Quantification of Rut Depth values in accordance with AASHTO Standard PP 69-1420, with the modifications specified in the HPMS Field Manual.
Faulting for jointed concrete pavements [12]	• Faulting computed based on AASHTO Standard R36-1322, with the parameters specified in the HPMS Field Manual.

Initial Calibration of Automated Equipment

Calibration Sites and Number of Repetitions per Site

Prior to the start of every data collection effort, a set of initial calibration sites shall be chosen to adequately represent the current pavement types. The number of initial calibration sites shall be at least as many as the number given in Table 6 – Calibration Sites below.

[10] Incorporated in Federal Regulation by reference in 23 CFR 490.111, and 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics

[11] Incorporated in Federal Regulation by reference in 23 CFR 490.111, and 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics

[12] Incorporated in Federal Regulation by reference in 23 CFR 490.111, and 23 CFR 490.309(b)(3) Data collection methods for each of the condition metrics

Table 6 – Calibration Sites and Number of Repetitions per Site

Pavement Type	Approximate CL Length	Number of Sites	Number of Repetitions per Site
Asphalt	0.1 miles	9	10
Composite	0.1 miles	7	10
Surface Treated	0.1 miles	8	10
PCC	0.1 miles	6	10

Sites should be chosen according to the criteria given in Table 7 – Criteria for Selecting Calibration Sites.

Table 7 – Criteria for Selecting Calibration Sites

Criteria for selecting Calibration Sites
Try to minimize drive time between sections.
Sites can be contiguous, but avoid more than 3 at a route location.
No Interstates.
Avoid section lengths less than 0.05 miles long.
Avoid bridges and approaches.
Avoid sections with Lane Deviations if possible.
No recent construction.
Preferably sections with OPC ranging between 40-80, with representative cross-section within the range.
Targeted Distresses - Sections that include combinations of Low Severity Fatigue, Any Severity NWP Longitudinal, Any Severity Transverse/Joint Reflective, and/or Any Severity Block Cracking are preferable. Past experience is that combinations of these distresses are most problematic.
Suburban - Avoid Routes with cul-de-sacs or abrupt ending.
Suburban - Avoid parked vehicles if possible. Requires review of imagery.
Suburban - Vendor to provide imagery/photos of vehicle location on each site to provide lateral location for field measurement team.
Suburban - Consider providing curb and/or drop-off location with location information.
Suburban - Field Measurement team will need to have imagery to know the direction of travel.

Calibration Reference Value Data Collection and Review

The following equipment should be taken to the calibration site:

- Measuring wheel with electronic readout and measuring precision to the 1/10th of a foot. This will be used:

  - To confirm the length of the data section by measuring along the centerline from Begin Milepoint to End Milepoint.
  - To identify the average data capture width and length measured by the data collection van. In cases where striping is present, the width between outer lane lines may be used. For locations without striping, use the measurement from the visible edge of pavement towards the centerline may be used.
  - To measure length and width of each area of distress on the pavement and classify each into appropriate severity definition based on visual inspection.
- Measuring tape as a backup to the measuring wheel.
- Spray paint for marking of 100 ft segments and identified distress extents.
- Smart Level with % cross-slope readout to the 1/10th percent. This is used to measure transverse cross-slope at 100' intervals along the length of surface treated pavements.
- Digital photos may be taken at 100' intervals along the length of the calibration sites to compare against imagery taken from data collection van. Digital photos may also be taken of spot locations of interest.

For crack length measurements, the calibration shall be checked as follows:

- Prior to visiting each site to check crack length detection calibration, the data collection vehicles should have already completed the required repeat runs. The images from a randomly selected run (from the 10) should then be made available, with the overlayed LCMS crack detection and distress identification, to the DelDOT QC/QA designated person checking calibration.
- Using the LCMS images, the actual cracking on the ground will be checked against the cracks measured by the LCMS.
- The beginning of the calibration section covered by the LCMS imagery should be found on the road (e.g. using GPS coordinates).
- For each crack location, where there is a discrepancy between the observed cracking on the ground and the cracking marked up in the images, a discrepancy should be recorded with the length of the discrepancy noted. Note that discrepancies where a crack is missed by the LCMS, and also where cracks are wrongly identified by the LCMS, should both be recorded. Crack lengths less than a foot long will not be evaluated. Only discrepancies totaling more than 1 linear foot of cracking should be recorded. Only cracks with width greater than or equal to the resolution of the LCMS should be considered.
- For fatigue or block cracking, to determine discrepancy values, the reference crack length in a specific area will be estimated as follows:
  - Crack length = 2 * [Area] / [Ave. block width]
  - Where :
    - Crack length = linear feet of cracking
    - Area = the area of fatigue or block cracking measured in square feet.
    - Ave. block width = width of the average block measured in linear feet.

- The total absolute length of the discrepancies defines the reference discrepancy value. This reference discrepancy value should be checked against the accuracy requirement from Table 3.
- Repeatability of crack length measurement should be checked against the requirements from Table 3. All calibration sites should be checked for repeatability which is not dependent on manual measurement and is purely a function of the automated runs.

For distress data elements, the calibration shall be checked as follows:

- Prior to visiting each site to check crack length detection calibration, the data collection vehicles should have already completed the required repeat runs. The images from a randomly selected run (from the 10) should then be made available, with the overlayed LCMS crack detection and distress identification, to the person checking calibration.
- Using the LCMS images, the actual distress on the ground will be checked against the distress measured by the LCMS.
- The beginning of the calibration section covered by the LCMS imagery should be found on the road (e.g. using GPS coordinates).
- Any distress that is outside of the limit of length and van measured width should not be considered in the physical measurements to the extent reasonably possible.
- For each distress element in the output data set (i.e. each severity of each distress type):
    - For each distress location, where there is a discrepancy between the observed distress on the pavement and the distress identified in the images, the discrepancy should be recorded with the amount of the discrepancy noted. Note that discrepancies where distress is missed by the LCMS, and also where distresses are wrongly identified by the LCMS, should both be recorded. A discrepancy shall be recorded as follows. For each distress:
        - For each distress location identified on the pavement, a discrepancy shall be recorded if the LCMS identified distress does not match the distress identified on the pavement within a tolerance of 10 ft along the pavement.
        - The value of the discrepancy in this case shall be determined based on the unit of measure of the distress. The value shall be noted as the amount of the pavement distress minus the amount of the distress identified by the LCMS and shall thus be logged as positive where there is more pavement distress and negative where there is more LCMS distress.
        - For each gap between distress locations identified on the pavement, a discrepancy shall be recorded if there is LCMS identified distress identified within the gap within a tolerance of 10 ft along the pavement.
        - The value of the discrepancy in this case shall be determined based on the unit of measure of the distress. The value shall be noted as zero minus the amount of the distress identified by the LCMS and shall thus be logged as negative.
        - A note describing the discrepancy shall be recorded for each entry for reference purposes.

        - The approximate location of each discrepancy to within 100 ft within the calibration section shall be recorded for reference.
    - For each calibration site, for each distress element, the total value of the discrepancies shall be added to the quantity obtained for the randomly selected van run to define the reference value. The reference discrepancy shall be obtained by subtracting the average of the multiple van runs from this reference value. This reference discrepancy value should be checked against the accuracy requirement from Table 3.
    - Repeatability of distress measurements should be checked against the requirements from Table 3. All calibration sites should be checked for repeatability which is not dependent on manual measurement and is purely a function of the automated runs.
- Regular intervals should be marked on the road surface with surveying paint for location reference.

In the case of IRI, Rutting and Faulting measurements, because it shall be certified that the data collection vehicles have been calibrated for these measurements, the reference value will be assumed to be the average of the repeat runs.

The reference values obtained should be compared to the previous calibration reference values to check they are within the acceptable limits defined in Table 3 - Data Protocols, Resolution, Accuracy and Repeatability .

Figure 1: Field Measurement Tools

Iterative Calibration Process

Multiple data collection runs should be made on each calibration section as defined in Table 6 – Calibration Sites. The average and standard deviation of the data collection runs compared to the reference values, as well as whether these meet the accuracy and repeatability requirements defined in Table 3 - Data Protocols, Resolution, Accuracy and Repeatability , should be reported in the Startup Report.

The measurement of cracking distress is a two-stage process: first the LCMS initially measures crack length and width, and then this 'raw' information is translated into distresses. Because the initial step of capturing crack width is independent of the second step, the processing of the crack data into distresses, if the initial cracks are detected properly, it is not necessary to redo this step if there is a problem only with the second step. As a result, once the crack length calibration has verified, it is possible to allow the Vendor to begin data collection, under the assumption that the processing step can be repeated multiple times independently to ensure distress processing calibration. However, data acceptance and payment will be dependent on distress calibration also being approved and not just crack length detection being approved.

Production Activities

Calibration Verification at Calibration Sites

Calibration Verification Site Selection

Calibration verification will take place on all initial calibration sites defined for initial calibration.

Calibration Site Monitoring Process

The data collection vendor will undertake a calibration verification process according to the frequency defined in Table 4 – QC Activities.

It will be required to make 5 repeat runs on each calibration site for calibration verification. The reference values obtained in the initial calibration for each distress on each calibration site will be used for evaluation of accuracy.

The vendor will deliver the results of this calibration verification as part of the monthly data submission. The vendor may continue to collect data prior to approval of the monthly data submission but will do so at risk. If the monthly data submission is not approved, the vendor will be required to follow the acceptance process defined in Table 8 – QC Acceptance Requirements.

Ongoing Monitoring

Vendor Discrepancy Monitoring

The vendor will deliver a Discrepancy Report according to the frequency defined in Table 4 – QC Activities and based on the format defined in section 5 Quality Reporting Plan. This report will list all discrepancies identified in the data for the previous reporting time interval. The discrepancies will contain bounds checks according to the vendor's quality management plan, and at a minimum, identify any data collected outside the bounds defined in Table 4 – QC Activities for independent bound checking.

In addition to bounds checking, the vendor will list all deviations noted in the field where supplied information (such as sections and section limits to be measured) was identified as possibly inaccurate.

Independent Bounds Checking

DelDOT or its designated representative, will use a database or spreadsheet checking method to check data being delivered based on the bounds and frequency defined in Table 4 – QC Activities for independent bound checking.

Independent Image Sample Checking

DelDOT, or its designated representative, will use a manual method to spot check that data being delivered based on LCMS data remains accurate and that there are no major discrepancies.

Independent Distance and Location Verification

DelDOT or its designated representative, will use a manual method to spot check that the location information of data being delivered is accurate by spot checking GPS and LRS data by plotting on a GIS map with appropriately accurate layers.

Post-Production Activities

Prior to final acceptance of the data, checks for completeness of overall scope and that all data is within bounds will be conducted by either DelDOT or their designated representative in accordance with the specifications defined in Table 4 – QC Activities.

3. Acceptance

The focus of acceptance is to validate that deliverables meet the established quality standards. Following is a description of acceptance testing, the frequency to be performed, and corrective actions for items that fail to meet criteria.

Table 8 – QC Acceptance Requirements

QC Activity [13]	Acceptance (percent within limits) [14]	Acceptance Testing and Frequency	Action if Criteria not Met
Pre-approval of Quality Management Plan	N/A	Vendor Quality Management Plan is checked to ensure that, at a minimum, it addresses items required. Certification of Vendor Quality Management Plan.	Deliverable returned with comments for correction.
Pre-Approval of Equipment and Methods	N/A	Vendor warrants that equipment and methods meet specifications identified in Table 5 and that data elements are collected in accordance with protocols in Table 3. Part of Certification of Vendor Start-up Report.	Data collection cannot commence until Acceptance criteria are met.
Initial Calibration	≥90% of calibration sections within all limits as defined in Table 3. No more than 5% failing > 4 acceptance criteria.	Data meets acceptance requirements from Table 3 for the designated number of runs for each calibration test site. Part of Certification of Start-up Report.	Vendor will rerun calibration for any sections that fail. Data collection cannot commence until Acceptance criteria are met. **Exception**: If it is determined that the crack detection in the images is not a problem and that the only problems are due to accuracy

[13] Repeated from *Table 4 – QC Activities* above.
[14] Based on values from *Table 4 – QC Activities* above.

QC Activity [13]	Acceptance (percent within limits) [14]	Acceptance Testing and Frequency	Action if Criteria not Met
			limits based on processing of the cracking data, the vendor shall be allowed to proceed but must work with DelDOT or their representative to ensure crack processing parameters are determined that result in distress measurements that meet acceptance limits. No data will be accepted for which the full pre- and post-calibration verification has not been approved.
Calibration Verification	≥90% of calibration sections within all limits as defined in Table 3. No more than 5% failing > 4 acceptance criteria.	Data meets acceptance requirements from Table 2 for the designated number of runs for each calibration test site. Part of Approval of Monthly Data Submission Deliverable.	Vendor will rerun calibration for any sections that fail. All data since last approved calibration check to be re-submitted within acceptable limits.
Ongoing Discrepancy Monitoring	≥90% of sections within all bounds as defined in Table 4. No more than 5% failing > 4 bounds criteria.	Discrepancies and invalid data should be flagged (manually and automatically) and reported in a Discrepancy Report according to the Vendor's Quality Management Plan. Part of Approval of Monthly Data Submission Deliverable.	All data since last approved check to be re-submitted within acceptable limits

QC Activity [13]	Acceptance (percent within limits) [14]	Acceptance Testing and Frequency	Action if Criteria not Met
Independent Bounds and Format Checking	≥90% of sections within all bounds as defined in Table 3. No more than 5% of sections failing > 4 bounds criteria.	Inspect 100% of uploaded data samples to ensure within normal bounds and in the required format. Part of Approval of Monthly Data Submission Deliverable.	All data since last approved check to be re-submitted within acceptable limits.
Independent Image Sample Checking	100% of samples free of major problems.	Inspect a random sample of 10 images against associated uploaded data to ensure distress data derived from LCMS or video data is accurate. Part of Approval of Monthly Data Submission Deliverable.	Problems are discussed with vendor and dealt with on a case by case basis. If problems cannot be resolved, DelDOT reserves the right to withhold payment.
Independent Distance and Location Verification	≥90% of sections within all limits relating to distance and location as defined in Table 3. No more than 5% failing > 4 acceptance criteria.	Inspect a random sample of 10 sections of location data by plotting on a GIS map using provided GPS data and comparing accuracy to underlying base map alignments, and LRS routes, from and to points. Part of Approval of Monthly Data Submission Deliverable.	Problems are discussed with vendor and dealt with on a case by case basis. If problems cannot be resolved, DelDOT reserves the right to withhold payment.
Final data review	Scope • Data coverage (excluding identified occurrences e.g. construction, railroads, etc.) > 99% Within bounds • Data within bounds specified in the bounds checks > 98%	Approval of Final Data Submission Deliverable Part of Final Acceptance.	Vendor to continue work to meet acceptance criteria. Payment withheld until acceptance criteria are met.

4. Team Roles and Responsibilities

The following identifies the quality-related responsibilities of the DelDOT data management team and lists specific quality responsibilities.

Table 9 – Roles and Responsibilities

Team Role	Quality Management Responsibilities
DelDOT Pavement Management Engineer	• Set quality standards, acceptance criteria, and corrective actions. • Assess effectiveness of QM procedures. • Recommend improvements to quality processes. • Certification of resources in other roles.
DelDOT Project Manager	• Manage the contract with the vendor. • Approve each deliverable per quality standards. • Approve resolution of quality issues. • Check vendor Discrepancy Reports.
DelDOT Quality Representative	• Work with the DelDOT Project Manager to identify calibration sites. • Provide calibration reference values for distresses. • Work with vendor to ensure vendor obtained calibration values are within required limits. Iterate with vendor to adjust calibration post processing on LCMS data to properly define cracking and other distress types from images. • Evaluate and make approval recommendations to project manager regarding Vendor deliverables (e.g. Startup Report, Quality Management Plan, Data submissions, etc.). • Recommend improvements to quality processes and acceptance limits. • Certification of new resources in this role.
DelDOT Data Expert	• Perform independent checks (e.g. bounds, format, image, location etc.) as called for in Table 4. • Make approval recommendations to project manager based on outcome of checks. • Be available for consultation with other quality roles and the vendor when deliverables fall outside quality limits.
Data Collection Vendor representative	• Submit deliverables as defined in the contract. • Be responsible for ensuring Vendor quality processes and procedures are followed based on approved quality management plan. • Work with DelDOT project manager regarding scheduling and payment issues.

5. Quality Reporting Plan

The following Quality deliverables are defined. Frequency of submission and quality management content should be as defined in Table 3 and the section of this document describing Quality Assurance and Quality Control.

- **Vendor Quality Management Plan** – This should be submitted by the vendor and contain all quality assurance and quality control processes and procedures that the vendor warrants will be undertaken during the project.
- **Vendor Startup Report** – This should be submitted by the vendor and contain a description of the startup process and quality information as defined in Table 4 and the section of this document describing Quality Assurance and Quality Control.
- **Interim Data Submissions** – The vendor will submit interim data at regular intervals, and include quality information as defined in Table 4 and the section of this document describing Quality Assurance and Quality Control.
- **Discrepancy Reports** – The vendor will submit reports listing all data discrepancies identified by the vendor (whether by automated or manual checking) at regular intervals as defined in Table 4 and the section of this document describing Quality Assurance and Quality Control.
- **Independent Quality Report** – These reports will be submitted to the DelDOT project manager by a party independent of the vendor (either by DelDOT internally, or by a DelDOT appointed representative). These reports should be submitted at regular intervals, and include quality information as defined in Table 4 and the section of this document describing Quality Assurance and Quality Control.