NEW CAR ASSESSMENT PROGRAM
LANE DEPARTURE WARNING CONFIRMATION TEST
NCAP-DRI-LDW-21-09

2021 Kia Seltos SX Turbo AWD

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4 March 2021

Draft Report

Prepared Under Contract No. DTNH22-14-D-00333

U.S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
New Car Assessment Program
1200 New Jersey Avenue, SE
West Building, 4th Floor (NRM-110)
Washington, DC 20590

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16. Abstract These tests were conducted on the subject 2021 Kia Seltos SX Turbo AWD in accordance with the specifications of the New Car Assessment Program's (NCAP) most current Test Procedure in docket NHTSA-2006-26555-0135 to confirm the performance of a Lane Departure Warning system. The vehicle passed the requirements of the test for all three lane marking types and for both directions.			
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Section I

INTRODUCTION

The purpose of the testing reported herein was to confirm the performance of a Lane Departure Warning (LDW) system installed on a 2021 Kia Seltos SX Turbo AWD. The LDW system for this vehicle provides both visual and audible alerts. The vehicle passed the requirements of the test for all three lane marking types and for both directions.

The test procedure is described in detail in the National Highway Traffic Safety Administration (NHTSA) document "LANE DEPARTURE WARNING SYSTEM CONFIRMATION TEST" dated February of 2013 (Docket No. NHTSA-2006-26555-0135). Its purpose is to confirm the performance of LDW systems installed on light vehicles with gross vehicle weight ratings (GVWR) of up to 10,000 lbs. Current LDW technology relies on sensors to recognize a lane delimiting edge line. As such, the test procedures described in the document rely on painted lines, taped lines, or Botts Dots being present on the test course to emulate those found on public roadways. Although it is impossible to predict what technologies could be used by future LDW systems (e.g., magnetic markers, RADAR reflective striping, ultra violet paint, infrared, etc.), it is believed that minor modifications to these procedures, when deemed appropriate, could be used to accommodate the evaluation of alternative or more advanced LDW systems.

Section II

DATA SHEETS

LANE DEPARTURE WARNING

DATA SHEET 1: TEST RESULTS SUMMARY

(Page 1 of 1)

2021 Kia Seltos SX Turbo AWD

VIN: *KNDETCA29M718xxxx*

Test Date: *2/17/2021*

Lane Departure Warning setting: *Lane Departure Warning - On;*
Warning Timing - Normal

Test 1 – Continuous White Line	Left: *Pass*	Right: *Pass*
Test 2 – Dashed Yellow Line	Left: *Pass*	Right: *Pass*
Test 3 – Botts Dots	Left: *Pass*	Right: *Pass*

Overall: *Pass*

Notes:

LANE DEPARTURE WARNING

DATA SHEET 2: VEHICLE DATA

(Page 1 of 1)

2021 Kia Seltos SX Turbo AWD

TEST VEHICLE INFORMATION

VIN: *KNDETCA29M718xxxx*

Body Style: *SUV* Color: *Cherry Black*

Date Received: *2/8/2021* Odometer Reading: *11 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *KIA MOTORS CORPORATION*

Date of manufacture: *12/20*

Vehicle Type: *MPV*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard: Front: *235/45R18*

Rear: *235/45R18*

Recommended cold tire pressure: Front: *230 kPa (33 psi)*

Rear: *230 kPa (33 psi)*

TIRES

Tire manufacturer and model: *Kumho Majesty 9 Solus TA91*

Front tire size: *235/45R18 94V*

Rear tire size: *235/45R18 94V*

Front tire DOT prefix: *1Y0 KRYAJ9*

Rear tire DOT prefix: *1Y0 KRYAJ9*

LANE DEPARTURE WARNING

DATA SHEET 3: TEST CONDITIONS

(Page 1 of 2)

2021 Kia Seltos SX Turbo AWD

GENERAL INFORMATION

Test date: *2/17/2021*

AMBIENT CONDITIONS

Air temperature: *15 C (59 F)*

Wind speed: *1.5 m/s (3.5 mph)*

X Wind speed ≤10 m/s (22 mph)

X Tests were not performed during periods of inclement weather. This includes, but is not limited to, rain, snow, hail, fog, smoke, or ash.

X Tests were conducted during daylight hours with good atmospheric visibility (defined as an absence of fog and the ability to see clearly for more than 5000 meters). The tests were not conducted with the vehicle oriented into the sun during very low sun angle conditions, where the sun is oriented 15 degrees or less from horizontal, and camera “washout” or system inoperability results.

VEHICLE PREPARATION

Verify the following:

All non-consumable fluids at 100% capacity: **X**

Fuel tank is full: **X**

Tire pressures are set to manufacturer's recommended cold tire pressure: **X**

Front: *230 kPa (33 psi)*

Rear: *230 kPa (33 psi)*

LANE DEPARTURE WARNING

DATA SHEET 3: TEST CONDITIONS

(Page 2 of 2)

2021 Kia Seltos SX Turbo AWD

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*481.3 kg (1061 lb)*	Right Front:	*460.8 kg (1016 lb)*
Left Rear:	*347.5 kg (766 lb)*	Right Rear:	*324.3 kg (715 lb)*
		Total:	*1613.9 kg (3558 lb)*

LANE DEPARTURE WARNING

DATA SHEET 4: LANE DEPARTURE WARNING SYSTEM OPERATION

(Page 1 of 3)

2021 Kia Seltos SX Turbo AWD

Name of the LDW option, option package, etc.:

Lane Departure Warning (LDW) (Standard equipment)

Type and location of sensor(s) used:

Camera, located near the rearview mirror

Lane Departure Warning Setting used in test:

Lane Departure Warning- On; Warning Timing - Normal

How is the Lane Departure Warning presented to the driver?

(Check all that apply)

- **X** Warning light
- **X** Buzzer or audible alarm
- _____ Vibration
- _____ Other _____

Describe the method by which the driver is alerted. For example, if the warning is a light, where is it located, its color, size, words or symbol, does it flash on and off, etc. If it is a sound, describe if it is a constant beep or a repeated beep. If it is a vibration, describe where it is felt (e.g., pedals, steering wheel), the dominant frequency, (and possibly magnitude), the type of warning (light, audible, vibration, or combination), etc.

When the LDW system is turned on, a small indicator in the center of the instrument cluster appears in white. At 45 mph and above, when lane markings are detected, the symbol changes to green. When lane departure is detected, the green indicator flashes on and off. See Appendix A, Figure A12.

The Auditory warning is a pulsed tone.

LANE DEPARTURE WARNING

DATA SHEET 4: LANE DEPARTURE WARNING SYSTEM OPERATION

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2021 Kia Seltos SX Turbo AWD

Is the vehicle equipped with a switch whose purpose is to render LDW inoperable? **X** Yes / ____ No

If yes, please provide a full description including the switch location and method of operation, any associated instrument panel indicator, etc.

The system can be disabled in two ways. A switch to the left of the steering column can be used to turn the system on or off. See Appendix A, Figure A13.

The system can also be disabled using the system menus, accessed by a setup button located at the bottom of the center display. See Appendix A, Figure A11. The menu hierarchy is:

Setup

Vehicle Settings

Driver Assistance

Lane Safety

Select Off

See Appendix A, Figures A9 and A10.

Is the vehicle equipped with a control whose purpose is to adjust the range setting or otherwise influence the operation of LDW? **X** Yes / ____ No

If yes, please provide a full description.

The timing can be adjusted using the system menus, accessed by a setup button located at the bottom of the center display. See Appendix A, Figure A11. The menu hierarchy is:

Setup

Vehicle Settings

Driver Assistance

Warning Timing

Select Normal or Late

See Appendix A, Figures A9 and A10.

LANE DEPARTURE WARNING

DATA SHEET 4: LANE DEPARTURE WARNING SYSTEM OPERATION

(Page 3 of 3)

2021 Kia Seltos SX Turbo AWD

Are there other driving modes or conditions that render LDW inoperable or reduce its effectiveness? **X** Yes ____ No

If yes, please provide a full description.

Limitations of the system are described on pages 5-131 through 5-134 of the Owner's Manual, shown in Appendix B pages B-9 through B-12.

Notes:

Section III

TEST PROCEDURES

A. Test Procedure Overview

Each LDW test involved one of three lane marking types: solid white lines, dashed yellow lines, or Botts Dots. Lane departures were done both to the left and to the right, and each test condition was repeated five times, as shown in Table 1.

Table 1. LDW Test Matrix

Lane Geometry	Line Type	Departure Direction	Number of Trials
Straight	Solid	L	5
		R	5
	Dashed	L	5
		R	5
	Botts Dots	L	5
		R	5

Prior to the start of a test series involving a given lane marking type and departure direction combination, the accuracy of the distance to lane marking measurement was verified. This was accomplished by driving the vehicle to the approximate location at which the lane departure would occur and placing the tire at the lane marking edge of interest (i.e., distance to lane marking = 0). The real-time display of distance to the lane marking was then observed to verify that the measured distance was within the tolerance (5 cm). If the measured distance was found to be greater than the tolerance, the instrumentation setup was checked and corrected, if necessary. If the measured distance was found to be within the tolerance, the instrumentation setup was considered appropriate and the test series was begun.

To begin the maneuver, the vehicle was accelerated from rest to a test speed of 72.4 km/h (45 mph), while being driven in a straight line parallel to the lane marking of interest, with the centerline of the vehicle approximately 1.83 m (6.0 ft) from the lane edge (i.e., such that the vehicle would pass through the center of the start gate). The test speed was achieved at least 60 m (200 ft) before the start gate was reached. Striking any start gate cones was not permitted, and any run in which a cone was struck was considered to be invalid. Also, during the initialization and test phases, the test driver avoided using turn signals and avoided applying any sudden acceleration, sudden steering, or sudden braking, and any use of the turn signals, sudden acceleration, sudden steering, or sudden braking invalidated the test trial.

Data collection began with the vehicle at least 60 m (200 ft) from the start gate, which was configured using a pair of non-reflective, low-contrast color traffic cones. A second set of cones, placed 6 m (20 ft) longitudinally before the start gate, was used to guide the driver into the start gate. The lateral width between the cone pairs was 20 cm (8 in) greater than the width of the vehicle, and the centerline of each pair was laterally offset from the lane marking by 1.8 m (6 ft).

Once the driver passed the gate, the driver manually input sufficient steering to achieve a lane departure with a target lateral velocity of 0.5 m/s with respect to the lane line. As shown in Figure 1, two additional non-reflective cones were used to guide the driver in making this steering maneuver. Throughout the maneuver, the driver modulated the throttle or used cruise control, as appropriate, such that vehicle speed remained at constant speed. The test was considered complete when the vehicle crossed at least 1 m (3.3 ft) over the lane edge boundary.

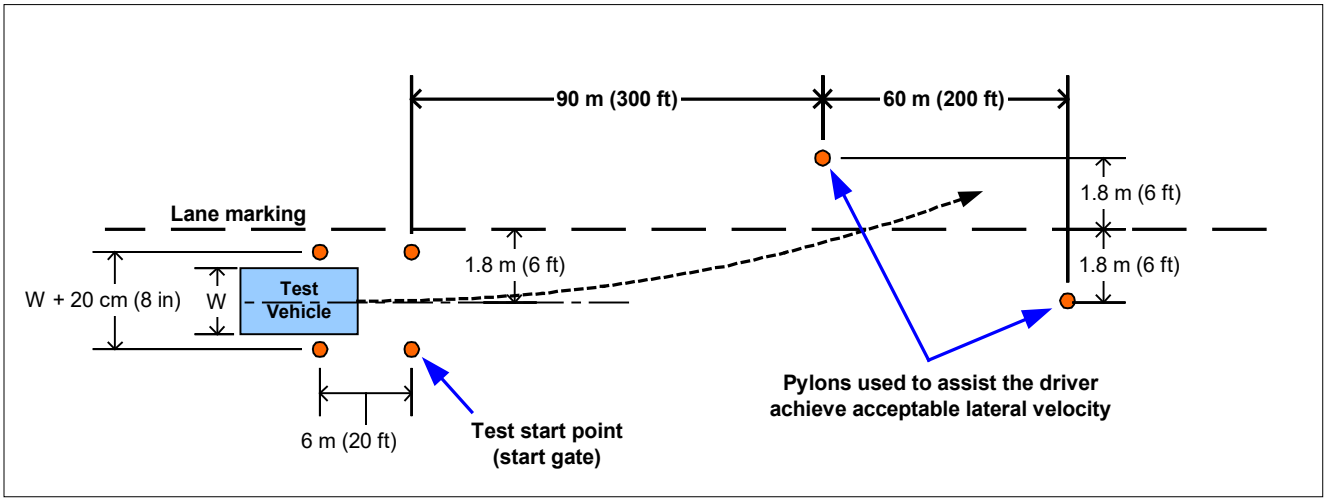

Figure 1. Position of Cones Used to Assist Driver

Data collected included vehicle speed, position, and yaw rate. In addition to cone strikes, vehicle speed and yaw rate data were used to identify invalid runs as described in Section C below. Data from trials where speed or yaw rate were outside of the performance specification were not considered valid.

B. Lane Delineation Markings

The New Car Assessment Program's Test Procedure for the confirmation of a Lane Departure Warning system contains a requirement that all lane markings meet United States Department of Transportation (USDOT) specifications as described in the Manual on Uniform Traffic Control Devices (MUTCD) and be considered in "very good condition".

1. Lane Marker Width

The width of the edge line marker was 10 to 15 cm (4 to 6 in). This is considered to be a normal width for longitudinal pavement markings under Section 3A.05 of the MUTCD.

2. Line Marking Color and Reflectivity

Lane marker color and reflectivity met all applicable standards. These standards include those from the International Commission of Illumination (CIE) for color and the American Society for Testing and Materials (ASTM) on lane marker reflectance.

3. Line Styles

The tests described in this document required the use of three lane line configurations: continuous solid white, discontinuous dashed yellow, and discontinuous with raised pavement markers.

- Continuous White Line

  A continuous white line is defined as a white line that runs for the entire length of the test course.

- Dashed Yellow Line

  As stated in the MUTCD, and as shown in Figure 2, a discontinuous dashed yellow line is defined as by a series of 3 m (10 ft) broken (dashed) yellow line segments, spaced 9.1 m (30 ft) apart.

- Raised Pavement Marker Line (Botts Dots)

  California Standard Plans indicates raised pavement markers are commonly used in lieu of painted strips for marking roads in California. Other states, mainly in the southern part of the United States, rely on them as well. These markers may be white or yellow, depending on the specific application, following the same basic colors of their analogous white and yellow painted lines. Following the California 2006 Standard Plans, three types of raised pavement markings are used to form roadway lines. It is believed that these types of roadway markings are the hardest for an LDW sensor system to process. Type A and Type AY are non-reflective circular domes that are approximately 10 cm (4 in) in diameter and approximately 1.8 cm (0.7 in) high. Type C and D are square markings that are retro reflective in two directions measuring approximately 10 x 10 x 5 cm (4 x 4 x 0.5 in), and Type G and H that are the same as C and D only retro reflective in a single direction.

For the tests described in this document, raised pavement markers were set up following California Standard Plan A20A, Detail 4, as shown in Figure 3. Note that in this figure, the squares are Type D yellow reflectors and the circles are yellow Type AY discs.

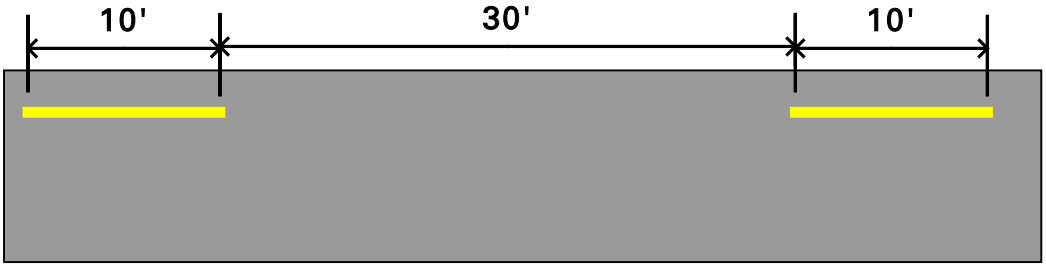

Figure 2. MUTCD Discontinuous Dashed Line Specifications

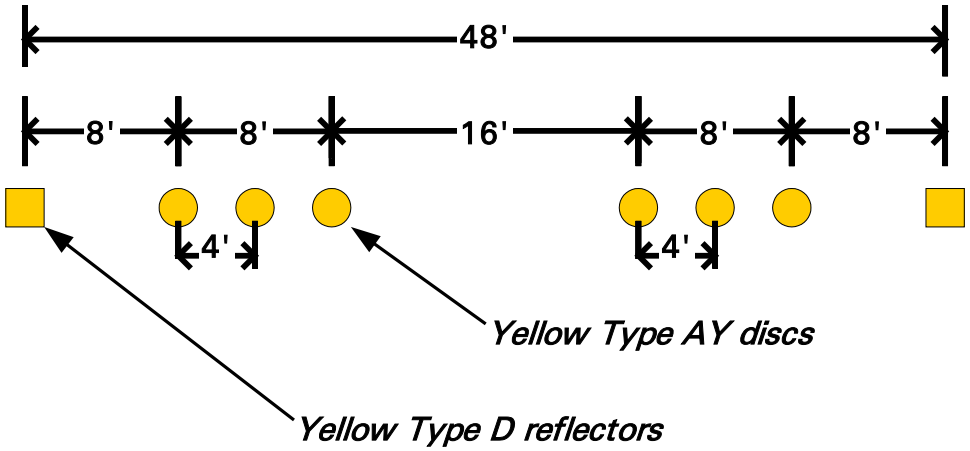

Figure 3. California Standard Plan A20A, Detail 4

C. Test Validity

1. Speed

All LDW tests were conducted at 72.4 km/h (45 mph). Test speed was monitored and a test was considered valid if the test speed remained within ± 2 km/h (± 1.2 mph) of the 72.4 km/h (45 mph) target speed. It was required that the speed must remain within this window from the start of the test until any part of the vehicle crossed a lane line by 1 m (3.3 ft) or more.

2. Lateral Velocity

All tests were conducted with a lateral velocity of 0.1 to 0.6 m/s (0.3 to 2.0 ft/s), measured with respect to the lane line at the time of the alert. To assist the test driver in being able to efficiently establish the target lateral velocity, cones were positioned in the manner shown in Figure 1.

3. Yaw Rate

It was required that the magnitude of the vehicle's yaw rate could not exceed 1.0 deg/sec at any time during lane departure maneuver, from the time the vehicle passes through the start gate to the instant the vehicle has crossed a lane line by 1 m (3.3 ft).

D. Pass/Fail Criteria

The measured test data were used to determine the pass/fail outcome for each trial. The outcome was based on whether the LDW produced an appropriate alert during the maneuver. In the context of this test procedure, a lane departure is said to occur when any part of the two-dimensional polygon used to represent the test vehicle breaches the inboard lane line edge (i.e., the edge of the line close to the vehicle before the departure occurs). In the case of tests performed in this procedure, the front corner of the polygon, defined as the intersection of the center of the front wheels (longitudinally) with the outboard edge of the front tire (laterally), crossed the line edge first. So, for example, if the vehicle departed its lane to the left, the left front corner of the polygon would first breach the lane line edge.

For an individual trial to be considered a "pass":

- Test speed, lateral velocity, and yaw rate validity conditions must be satisfied.
- The LDW alert must not occur when the lateral position of the vehicle is greater than 0.75 m (2.5 ft) from the lane line edge (i.e., prior to the lane departure).
- The LDW alert must occur before the lane departure exceeds 0.3 m (1.0 ft).

For an overall, "Pass" the LDW system must satisfy the pass criteria for 3 of 5 individual trials for each combination of departure direction and lane line type (60%), and pass 20 of the 30 trials overall (66%).

E. Instrumentation

Table 2 lists the sensors, signal conditioning, and data acquisition equipment used for these tests.

Table 2. Test Instrumentation and Equipment

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Tire Pressure Gauge	Vehicle Tire Pressure	0-100 psi 0-690 kPa	0.5 psi 3.45 kPa	Ashcroft, D1005PS	18111410000	By: DRI Date: 5/4/2020 Due: 5/4/2021
Platform Scales	Vehicle Total, Wheel, and Axle Load	8000 lb 35.6 kN	±1.0% of applied load	Intercomp, SWII	0410MN20001	By: DRI Date: 4/20/2020 Due: 4/20/2021
Differential Global Positioning System	Position, Velocity	Latitude: ±90 deg Longitude: ±180 deg Altitude: 0-18 km Velocity: 0-1000 knots	Horizontal Position: ±1 cm Vertical Position: ±2 cm Velocity: 0.05 km/h	Trimble GPS Receiver, 5700 (base station and in-vehicle)	00440100989	N/A
Multi-Axis Inertial Sensing System	Position: Longitudinal, Lateral, and Vertical Accels: Lateral, Longitudinal and Vertical Velocities: Roll, Pitch, Yaw Rates: Roll, Pitch, Yaw Angles	Latitude: ±90 deg Longitude: ±180 deg Altitude: 0-18 km Velocity: 0-1000 knots Accel: ±100 m/s^2 Angular Rate: ±100 deg/s Angular Disp: ±180 deg	Position: ±2 cm Velocity: 0.05 km/h Accel: ≤ 0.01% of full range Angular Rate: ≤ 0.01% of full range Roll/Pitch Angle: ±0.03 deg Heading Angle: ±0.1 deg	Oxford Technical Solutions (OXTS), Inertial+	2258	By: Oxford Technical Solutions[1] Date: 5/3/2019 Due: 5/3/2021
Real-Time Calculation of Position and Velocity Relative to Lane Markings	Distance and velocity to lane markings	Lateral Lane Dist: ±30 m Lateral Lane Velocity: ±20 m/sec	Lateral Distance to Lane Marking: ±2 cm Lateral Velocity to Lane Marking: ±0.02m/sec	Oxford Technical Solutions (OXTS), RT-Range	97	N/A

[1] Oxford Technical Solutions recommends calibration every two years.

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Microphone	Sound (to measure time at alert)	Frequency Response: 80 Hz – 20 kHz	Signal-to-noise: 64 dB, 1 kHz at 1 Pa	Audio-Technica AT899	N/A	N/A
Light Sensor	Light intensity (to measure time at alert)	Spectral Bandwidth: 440-800 nm	Rise time < 10 msec	DRI designed and developed Light Sensor	N/A	N/A
Coordinate Measurement Machine	Inertial Sensing System Coordinates	0-8 ft 0-2.4 m	±.0020 in. ±.051 mm (Single point articulation accuracy)	Faro Arm, Fusion	UO8-05-08-06636	By: DRI Date: 1/6/2021 Due: 1/6/2022

Type	Description	Mfr, Model	Serial Number
Data Acquisition System	Data acquisition is achieved using a dSPACE MicroAutoBox II Data from the Oxford IMU, including Longitudinal, Lateral, and Vertical Acceleration, Roll, Yaw, and Pitch Rate, Forward and Lateral Velocity, Roll and Pitch Angle are sent over Ethernet to the MicroAutoBox. The Oxford IMUs are calibrated per the manufacturer's recommended schedule (listed above).	D-Space Micro-Autobox II 1401/1513	
		Base Board	549068
		I/O Board	588523

For systems that implement audible or haptic alerts, part of the pre-test instrumentation verification process is to determine the tonal frequency of the audible warning or the vibration frequency of the tactile warning through use of the PSD (Power Spectral Density) function in Matlab. This is accomplished in order to identify the center frequency around which a band-pass filter is applied to subsequent audible or tactile warning data so that the beginning of such warnings can be programmatically determined. The band-pass filter used for these warning signal types is a phaseless, forward-reverse pass, elliptical (Cauer) digital filter, with filter parameters as listed in Table 3.

Table 3. Audible and Tactile Warning Filter Parameters

Warning Type	Filter Order	Peak-to-Peak Ripple	Minimum Stop Band Attenuation	Passband Frequency Range
Audible	5^{th}	3 dB	60 dB	Identified Center Frequency ± 5%
Tactile	5^{th}	3 dB	60 dB	Identified Center Frequency ± 20%

APPENDIX A

Photographs

LIST OF FIGURES

Figure A1. Front View of Subject Vehicle

Figure A2. Rear View of Subject Vehicle

Figure A3. Window Sticker (Monroney Label)

Figure A4. Vehicle Certification Label

Figure A5. Tire Placard

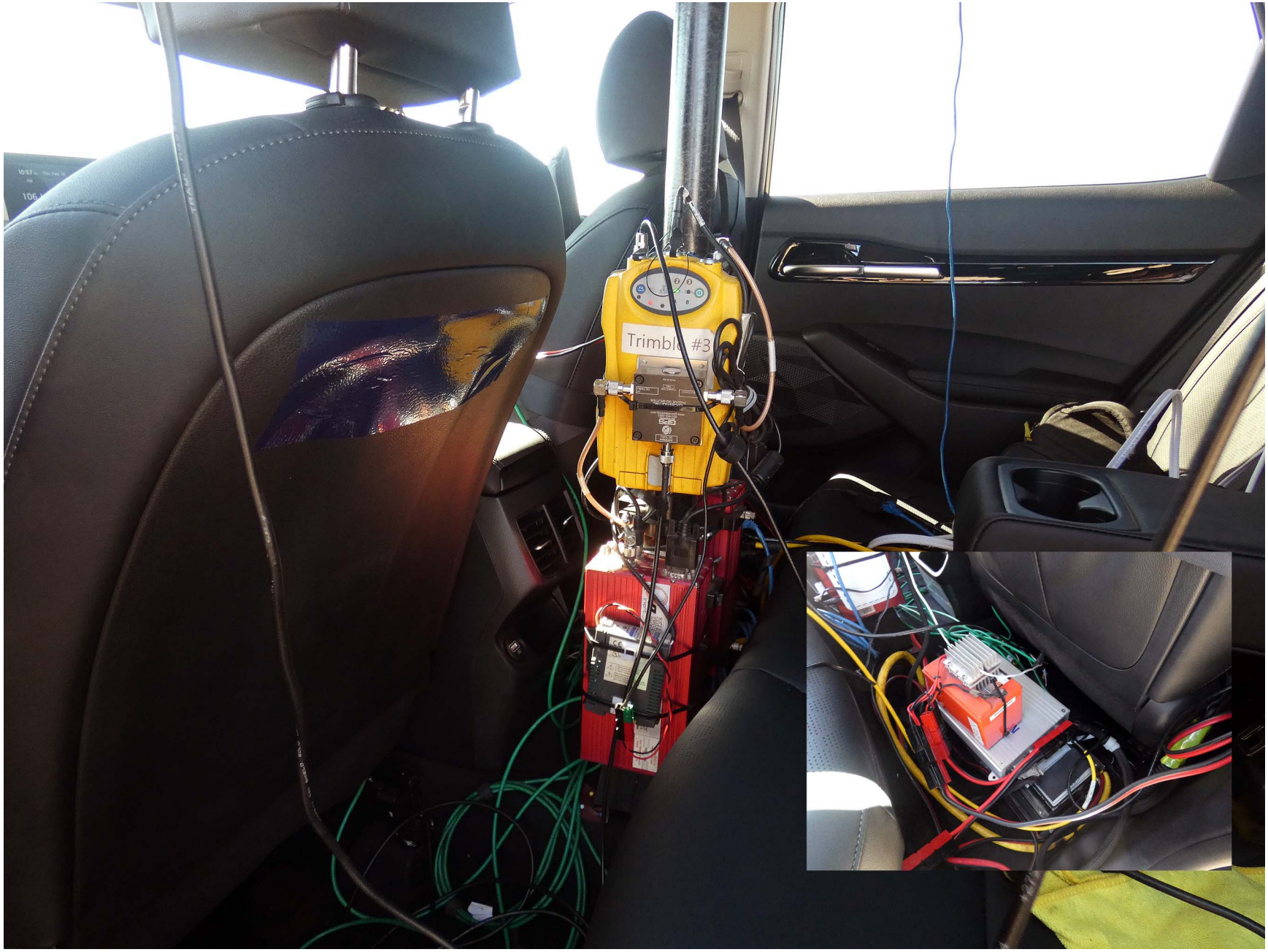

Figure A6. DGPS, Inertial Measurement Unit, and MicroAutoBox Installed in Subject Vehicle

Figure A7. Sensors for Detecting Visual and Auditory Alerts

Figure A8. Computer Installed in Subject Vehicle

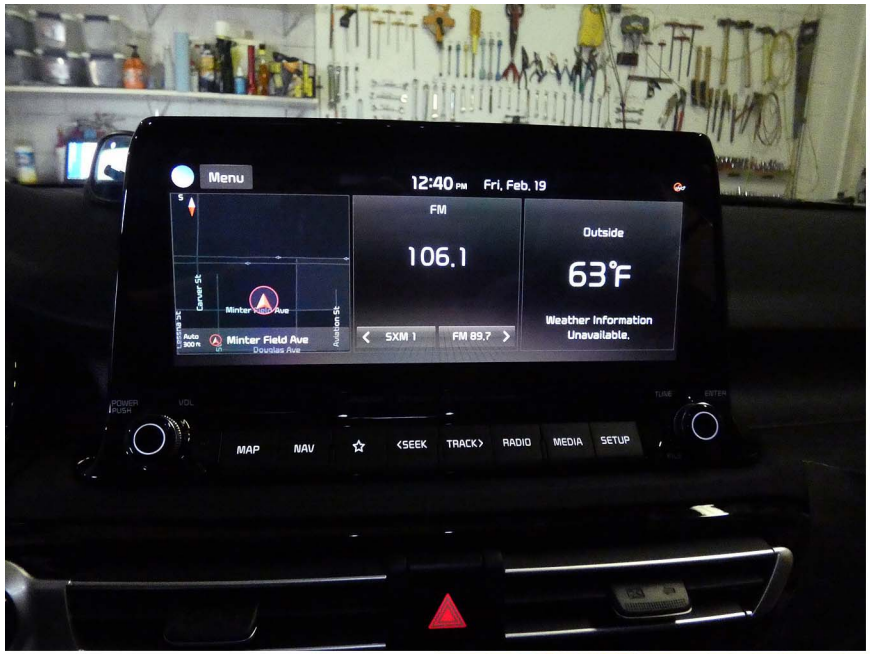

Figure A9. LDW Menus (page 1 of 2)

Figure A10. LDW Menus (page 2 of 2)

Figure A11. Button for Accessing System Menus

Figure A12. LDW Status Indicator/Visual Alert

Figure A13. LDW on/off Switch

APPENDIX B

Excerpts from Owner’s Manual

LCD Display Modes

You can switch modes by pressing the Mode button.

	Mode				
	Trip Computer	Turn By Turn (TBT)*	Driving Assist	User Settings	Master warning
Up/Down	Fuel Economy	Route Guidance	SCC*/ Lane Safety	Head-Up Display	The Master Warning mode displays warning messages related to the vehicle when one or more systems is not operating normally.
	Accumulated Info	Destination Info	Driver Attention Warning*	Driver Assistance	
	Drive Info		AWD*	Door	
				Lights	
	Transmission Temperature		TPMS	Convenience	
				Service Interval	
				Other features	
				Language	
				Reset	

The information provided may differ depending on which functions are applicable to your vehicle.

✻ NOTICE

Keep the engine running when configuring the display settings to prevent the battery from discharging.

Trip Computer mode

OON048111NR

The trip computer mode displays information related to vehicle driving parameters including fuel economy, tripmeter information and vehicle speed.

* For more details, refer to "Trip information (trip computer)" on page 4-68.

Turn By Turn (TBT) mode

OSK3048115NR

This mode displays the state of the navigation.

Driving Assist mode

OSP2049108L

This mode displays the state of:

- SCC (if equipped)
- Lane Safety system (if equipped)
- Driver Attention Warning (if equipped)
- AWD (if equipped)
- Tire pressure

* For more details, refer to each system information in "Driving your vehicle" on page 5-6.

Tire pressure status

* For more details, refer to "Tire Pressure Monitoring System (TPMS) (if equipped)" on page 6-10.

1. Head-Up Display (if equipped)

Items	Explanation
Display Height	Adjust the height (1~20) of the HUD image on the HUD screen.
Rotation	Adjust the degree (-5~+5) of the HUD rotation.
Brightness	Adjust the intensity (1~20) of the HUD brightness.
Speed Size	Small/Medium/Large
Speed Color	White/Orange/Green

2. Driver Assistance (if equipped)

Items	Explanation
Driving Assist	• Highway Driving Assist • Highway Auto Curve Zone Slowdown To select the functions.
Warning Timing	• Normal/Later To select the Warning time
Warning Volume	• High/Medium/Low To select the Warning volume
Driver Attention Warning	• Leading vehicle departure alert • Inattentive Driving Warning To select the function. * For more details, refer to the "Driver Attention Warning (DAW)" on page 5-145.
Forward Safety	To adjust Forward Collision-Avoidance Assist system. • Active Assist / Warning Only / Off To select the functions.
Lane Safety	To adjust Lane Keeping Assist system. • Lane Keeping Assist / Lane Departure Warning / Off To select the functions.
Blind-Spot Safety	To select the functions. • Safe Exit Assist To adjust Blind-Spot Collision-Avoidance Assist system. • Active Assist / Warning Only / Off

The color of the indicator will change depending on the condition of the LKA.

- White: Sensor does not detect the lane marker or vehicle speed is less than 40 mph (64 km/h).
- Green: Sensor detects the lane marker and system is able to control the steering.

LKA system function change

The driver can change LKA to Lane Departure Warning system or change LKA system mode from the LCD display or infotainment system display. Go to the 'User Settings → Driver Assistance → Lane Safety → Lane Keeping Assist/Lane Departure Warning/Off'.

If your vehicle is equipped with an infotainment system, you can learn how to setup on the website via QR code in the infotainment quick reference guide.

Lane Keeping Assist

This mode guides the driver to help keep the vehicle within the lanes. It rarely controls the steering wheel, when the vehicle drives well inside the lanes. However, it starts to control the steering wheel, when the vehicle is about to deviate out of the lane.

Lane Departure Warning

Lane Departure Warning alerts the driver with a visual warning and a warning alarm when the system detects the vehicle departing the lane. The steering wheel will not be controlled.

Off

If you select 'Off', LKA system is deactivated.

Note that the vehicle speed must be at least approximately 40 mph (64 km/h) to ENABLE LKA system. The indicator in the cluster will illuminate green.

The color of indicator will change depending on the condition of LKA system.

- White: Sensor does not detect lane markers or vehicle speed is under 40 mph (64 km/h).
- Green: Sensor detects lane markers and the system is able to control vehicle steering.

✻ NOTICE

If the indicator (white) is activated from the previous ignition cycle, the system will turn ON without any additional control. If you press LKA button again, the indicator on the cluster goes off.

LKA system operation

- To see LKA system screen on the LCD display in the cluster, select Driving Assist mode ( ). For more details, refer to "LCD Display Modes" on page 4-59.
  After LKA is activated, if the lane markers are detected, vehicle speed is over 40 mph (64 km/h) and all the activation conditions are satisfied, a green steering wheel indicator will illuminate and the steering wheel will be controlled.

⚠ WARNING

Lane Keeping Assist system is a system to help prevent the driver from leaving the lane. However, the driver should not solely rely on the system but always check the road conditions and surroundings when driving.

Lane marker undetected

Lane marker detected

- If vehicle speed is over 40 mph (64 km/h) and the system detects lane markers, the color of lanes changes from gray to white.
- Both lane markers must be detected for the system to fully activate.

- If your vehicle departs from the projected lane in front of you, LKA system operates as follows:

OSP2059129L

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1. A visual warning appears on the cluster LCD display. Either the left lane marker or the right lane marker in the cluster LCD display will blink depending on which direction the vehicle is veering. Also, a warning sound will be heard.
2. LKA system will control the vehicle's steering to prevent the vehicle from crossing the lane marker in below conditions.
   - Vehicle speed is over 40 mph (64 km/h)
   - The system detects both lanes
   - When driving, the vehicle is located between both lanes normally.
   - The steering wheel is not turned suddenly.

When both lane markers are detected and all the conditions to activate LKA system are satisfied, a LKA system indicator light will change from white to green. This indicates that LKA system is in the ENABLED state and the steering wheel will be controlled.

Warning light and message

Keep hands on steering wheel

OSP2059131L

If the driver takes their hands off the steering wheel for several seconds while LKA system is activated, the system will warn the driver.

⚠ WARNING

- The warning message may appear late according to road conditions. Therefore, always have your hands on the steering wheel while driving.
- If you hold the steering wheel lightly, the system may generate hands off warning.

⚠ WARNING

- The driver is responsible for accurate steering.
- Even though the steering is assisted by the system, the driver may control the steering wheel.
- Turn off the system and drive the vehicle in below situations.
  - In bad weather
  - In bad road condition
  - When the steering wheel needs to be controlled by the driver frequently.
  - When towing a vehicle or trailer.
- The steering wheel may feel heavier when the steering wheel is assisted by the system than when it is not.

Check Lane Keeping Assist (LKA) system

If there is a problem with the system, a message will appear for a few seconds. If the problem continues LKA system failure indicator will illuminate.

LKA system indicator

LKA system indicator (yellow) will illuminate if LKA system is not working properly. You should have the vehicle inspected by an authorized Kia dealer.

When there is a problem with the system do one of the following:

- Turn the system on after turning the engine off and on again.
- Check if the ignition switch is in the ON position.
- Check if the system is affected by the weather. (e.g. fog, heavy rain, etc.)

- Check if there is foreign matter on the camera lens.

If the problem is not solved, you should have the vehicle inspected by an authorized Kia dealer.

LKA system will not be in the ENABLED state and/or the steering wheel will not be assisted when:

- The turn signal is turned on before changing a lane. If you change lanes without the turn signal on, the steering wheel might be controlled.
- The vehicle is not driven in the middle of the lane when the system is turned on or right after changing a lane.
- ESC (Electronic Stability Control) or VSM (Vehicle Stability Management) is activated.
- The vehicle is driven on a sharp curve.
- The steering will not be assisted when vehicle speed is below 40 mph (64 km/h). Always obey all traffic laws and drive safely.
- The steering will not be assisted when you change lanes quickly.
- The steering will not be assisted when you brake suddenly.
- The steering will not be assisted when the lane is very wide or narrow.
- There are more than two lane markers such as a construction area.
- Radius of a curve is too small.
- When you turn the steering wheel suddenly, the LKA will be disabled temporarily.
- Driving on a steep slope or hill.
- Starting the engine or initializing (or rebooting) the Front View Camera for about 15 seconds

Limitations of the system

LKA system may operate prematurely even if the vehicle does not depart from the intended lane or, LKA system may not assist your steering or warn you if the vehicle leaves the intended lane under the following circumstances:

When the lane and road conditions are poor

- It is difficult to distinguish the lane marker from road when the lane marker is covered with dust or sand.
- It is difficult to distinguish the lane marking from the road surface or the lane marking is faded or not clearly marked.
- It is difficult to distinguish the color of the lane marker from the road.
- There are markings on the road surface that look like a lane marker that is inadvertently being detected by the camera.
- The lane marker is indistinct or damaged.

- The lane marker is merged or divided (e.g. tollgate).
- The lane number increases or decreases or the lane marker are crossing complicatedly.
- There are more than two lane markers on the road in front of you.
- The lane marker is very thick or thin.
- The lane is very wide or narrow.
- The lanes ahead are not visible due to rain, snow, water on the road, damaged or stained road surface, or other factors.
- The shadow is on the lane marker by a median strip, trees, guardrail, noise barriers, etc.
- The lane markers are complicated or a structure substitutes for the lines such as a construction area.
- There are crosswalk signs or other symbols on the road.
- The lane marker in a tunnel is stained with oil, etc.
- The lane suddenly disappears such as at the intersection.

When external condition is intervened

- The brightness outside changes suddenly such as when entering or exiting a tunnel, or when passing under a bridge.
- The brightness outside is too low such as when the headlamps are not on at night or the vehicle is going through a tunnel.
- There is a boundary structure in the roadway such as a concrete barrier, guardrail and reflector post that is inadvertently being detected by the front view camera.
- When light coming from a street light or an oncoming vehicle is reflected on a wet road surface such as a puddle in the road.
- Road surface is not evenness.
- The distance from the vehicle ahead is very short or the vehicle ahead drives hiding the lane line.
- The field of view in front is obstructed by sun glare.
- There is not enough distance between you and the vehicle in front to be able to detect the lane marker or the vehicle ahead is driving on the lane marker.
- Driving on a steep grade, over a hill, or when driving on a curved road.
- The adverse road conditions cause excessive vehicle vibrations while driving.
- The surrounding of the inside rear view mirror temperature is high due to direct sunlight, etc.

When front visibility is poor

- The windshield or the camera lens is covered by strange materials.
- The windshield glass is fogged up; a clear view of the road is obstructed.
- Placing objects on the dashboard, etc.
- The front view camera cannot detect the lane because of fog, heavy rain or snow.

⚠ WARNING

Lane Keeping Assist system is a system designed to help prevent the driver from leaving the lane. However, the driver should not solely rely on the system but always take the necessary actions for safe driving practices.

Lane Following Assist (LFA)

Lane Following Assist system helps detect lane markers on the road with a front view camera at the front windshield, and assists the driver's steering to help keep the vehicle between lanes.


OSP2N059011

⚠ WARNING

- It is the driver's responsibility to operate the steering wheel for safe driving.
- Do not turn the steering wheel hastily if Lane Following Assist system is activated.
- Lane Following Assist system is designed to provide steering inputs so that the vehicle can stay in the center of the detected lane. LFA system does not automatically control the steering wheel at all times, which means the driver must have hands on the wheel at all times while driving.

- When using LFA system, always be aware of your surroundings and road conditions that may interrupt or stop LFA system.

⚠ CAUTION

- Do not attach glass tinting, stickers, accessories to the windshield near the front camera near where the indoor mirror is placed.
- Inspection or modification may be required when replacing parts related to the windshield or front camera. Have the system be inspected by an authorized Kia dealer.
- Depending on your surroundings and road conditions, LFA system could fail to recognize the lane and stop working. As such, extra caution is required while driving with LFA system on.
- Be sure to check the non-operating conditions and cautions for the driver before using LFA system.
- Do not place reflective materials, such as white paper or mirror, on the dashboard. Sunlight reflections can cause LFA system to not function properly.
- Loud audio volumes can prevent the occupants from hearing the alarm sounds from LFA system.
- Keeping your hands off the wheel while driving will trigger the hands-off warning and deactivate the steering-assist system.
- When driving at a high speed, the steering assist force can become weak and the vehicle can drive out of its lane, requiring extra caution. Comply with the speed limit.
- Attaching an object to the steering wheel could deter steering assistance.
- Attaching an object to the steering wheel could deter the hands-off alarming system.

LFA operation

With the ENGINE START/STOP button is in the ON or START position, Lane Following Assist can be activated by pressing the button ( ) on the steering wheel.

OSP2N059003

APPENDIX C

Run Log

Subject Vehicle: **2021 Kia Seltos SX Turbo AWD** Test Date: **2/17/2021**

Driver: **K. Nagao** **Note: For Distance at Warning, positive values indicate inside the lane**

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Audible Alert (ft)	Distance at Visual Alert (ft)	Pass/Fail	Notes
1	Botts	Left	N				Lateral velocity
2			N				SV speed
3			N				SV yaw
4			N				SV yaw
5			N				SV yaw
6			N				SV speed
7			Y	-0.62	-0.75	Pass	
8			Y	-0.82	-0.91	Pass	
9			N				SV yaw
10			Y	-0.63	-0.83	Pass	
11			Y	-0.72	-0.90	Pass	
12			N				Lateral velocity
13			Y	-0.77	-0.84	Pass	
14			N				SV yaw
15			Y	-0.76	-0.90	Pass	
16			Y	-0.82	-0.98	Pass	

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Audible Alert (ft)	Distance at Visual Alert (ft)	Pass/Fail	Notes
17	**Botts**	**Right**	N				Test setup did not conform to NCAP test procedures. See runs 59-67
18			N				
19			N				
20			N				
21			N				
22			N				
23			N				
24			N				
25			N				
26			N				
27	**Dashed**	**Right**	N				Lateral velocity
28			Y	-0.45	-0.63	Pass	
29			N				SV yaw
30			Y	-0.41	-0.56	Pass	
31			Y	-0.39	-0.49	Pass	
32			Y	-0.38	-0.61	Pass	
33			Y	-0.54	-0.70	Pass	
34			N				Lateral velocity
35			Y	-0.44	-0.57	Pass	
36			Y	-0.47	0.72	Pass	
37	**Dashed**	**Left**	Y	-0.63	-0.77	Pass	
38			Y	-0.66	-0.83	Pass	

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Audible Alert (ft)	Distance at Visual Alert (ft)	Pass/Fail	Notes
39	**Dashed**	**Left**	Y	-0.60	-0.71	Pass	
40			Y	-0.67	-0.75	Pass	
41			Y	-0.64	-0.79	Pass	
42			Y	-0.68	-0.79	Pass	
43			Y	-0.59	-0.68	Pass	
44	**Solid**	**Left**	Y	-0.59	-0.67	Pass	
45			Y	-0.52	-0.69	Pass	
46			Y	-0.56	-0.64	Pass	
47			Y	-0.58	-0.67	Pass	
48			Y	-0.59	-0.71	Pass	
49			Y	-0.66	-0.82	Pass	
50			Y	-0.62	-0.80	Pass	
51	**Solid**	**Right**	Y	-0.39	-0.57	Pass	
52			Y	-0.47	-0.58	Pass	
53			Y	-0.56	-0.64	Pass	
54			Y	-0.50	-0.59	Pass	
55			Y	-0.59	-0.78	Pass	
56			Y	-0.50	-0.61	Pass	
57			Y	-0.60	-0.72	Pass	
58			Y	-0.63	-0.74	Pass	Extra run

Run	Lane Marking Type	Departure Direction	Valid Run?	Distance at Audible Alert (ft)	Distance at Visual Alert (ft)	Pass/Fail	Notes
Retest of Botts Right condition 3 May 2021							
59	**Botts**	**Right**	Y	-0.65	-0.76	Pass	(Retest run 1)
60			Y	-0.68	-0.81	Pass	(Retest run 2)
61			N				(Retest run 3) Lateral velocity
62			Y	-0.69	-0.80	Pass	(Retest run 4)
63			Y	-0.70	-0.83	Pass	(Retest run 5)
64			Y	-0.73	-0.83	Pass	(Retest run 6)
65			N				(Retest run 7) Yaw rate
66			Y	-0.70	-0.85	Pass	(Retest run 8)
67			Y	-0.70	-0.81	Pass	(Retest run 9)

APPENDIX D

Time History Plots

LIST OF FIGURES

Description of Time History Plots

A set of time history plots is provided for each valid run in the test series. Each set of plots comprises time varying data from the Subject Vehicle, as well as pass/fail envelopes and thresholds. The following is a description of data types shown in the time history plots, as well as a description of the color code for data envelopes.

Time History Plot Description

Time history figures include the following sub-plots:

- Warning – Indicates timing of warning issued by LDW system. Depending on the type of LDW alert or instrumentation used to measure the alert, this can be any of the following:
    - Filtered and rectified sound signal
    - Filtered and rectified acceleration (e.g., steering wheel vibration)
    - Light sensor signal
    - Discrete on/off value
- Speed (mph) – Speed of the Subject Vehicle
- Yaw Rate (deg/sec) – Yaw rate of the Subject Vehicle
- Distance to Lane Edge (ft) – Lateral distance (in lane coordinates) from the outer front tire bulge to the inside edge of the lane marking of interest for a given test (a positive value indicates the vehicle is completely within the lane while a negative value indicates that the outer front tire bulge has crossed over the inner lane marking edge). The distance to the lane edge at the moment the LDW alert is issued, is displayed to the right of subplot.
- Lateral Lane Velocity (ft/sec) – Lateral velocity (in lane coordinates) of the outer front tire bulge
- Bird’s Eye View – Indicates the position of the Subject Vehicle with respect to the lane marking of interest for a given test. Green rectangles represent the Subject Vehicle’s position at approximately 2 second intervals, while the yellow rectangle indicates the position of the Subject Vehicle at the time of LDW warning issuance.

Envelopes and Thresholds

Each of the time history plot figures can contain either green or yellow envelopes and/or black threshold lines. These envelopes and thresholds are used to programmatically and visually determine the validity of a given test run. Envelope and threshold exceedances are indicated with either red shading or red asterisks, and red text is placed to the right side of the plot indicating the type of exceedance.

Green envelopes indicate that the time-varying data should not exceed the envelope boundaries at any time within the envelope. Exceedances of a green envelope are indicated by red shading in the area between the measured time-varying data and the envelope boundaries.

Yellow envelopes indicate that the time-varying data should not exceed the envelope only at the right end. Exceedances at the right extent of a yellow envelope are indicated by red asterisks. Data within the boundaries at the right extent of a yellow envelope are indicated by green circles.

For the warning plot, a dashed black threshold line indicates the threshold used to determine the onset of the LDW alert. The alert is considered on the first time the alert signal crosses this threshold line.

Color Codes

Color codes have been adopted to easily identify the types of data, envelopes, and thresholds used in the plots.

Color codes can be broken into three categories:

1. Validation envelopes and thresholds
2. Instantaneous samplings
3. Text

1. Validation envelope and threshold color codes:
   - Green envelope = time varying data must be within the envelope at all times in order to be valid
   - Yellow envelope = time varying data must be within limits at right end
   - Black threshold (Solid) = time varying data must not exceed this threshold in order to be valid
   - Black threshold (Dashed) = for reference only – this can include warning level thresholds which are used to determine the timing of the alert

2. Instantaneous sampling color codes:
   - Green circle = passing or valid value at a given moment in time
   - Red asterisk = failing or invalid value at a given moment in time

3. Text color codes:
   - Green = passing or valid value
   - Red = failing or invalid value

Other Notations

- NG – Indicates that the value for that variable was outside of bounds and therefore “No Good”.
- No Wng – No warning was detected.

The minimum (worst) GPS fix type is displayed in the lower right corner of each page. The only valid fix type is RTK fixed (displayed in green). If the fix type during any portion of the test was anything other than RTK fixed, then “RTK Fixed OR LESS!!” is displayed in red.

Examples of time history plots (including passing, failing and invalid runs) are shown in Figure D1 through Figure D3. Actual time history data plots for the vehicle under consideration are provided subsequently.

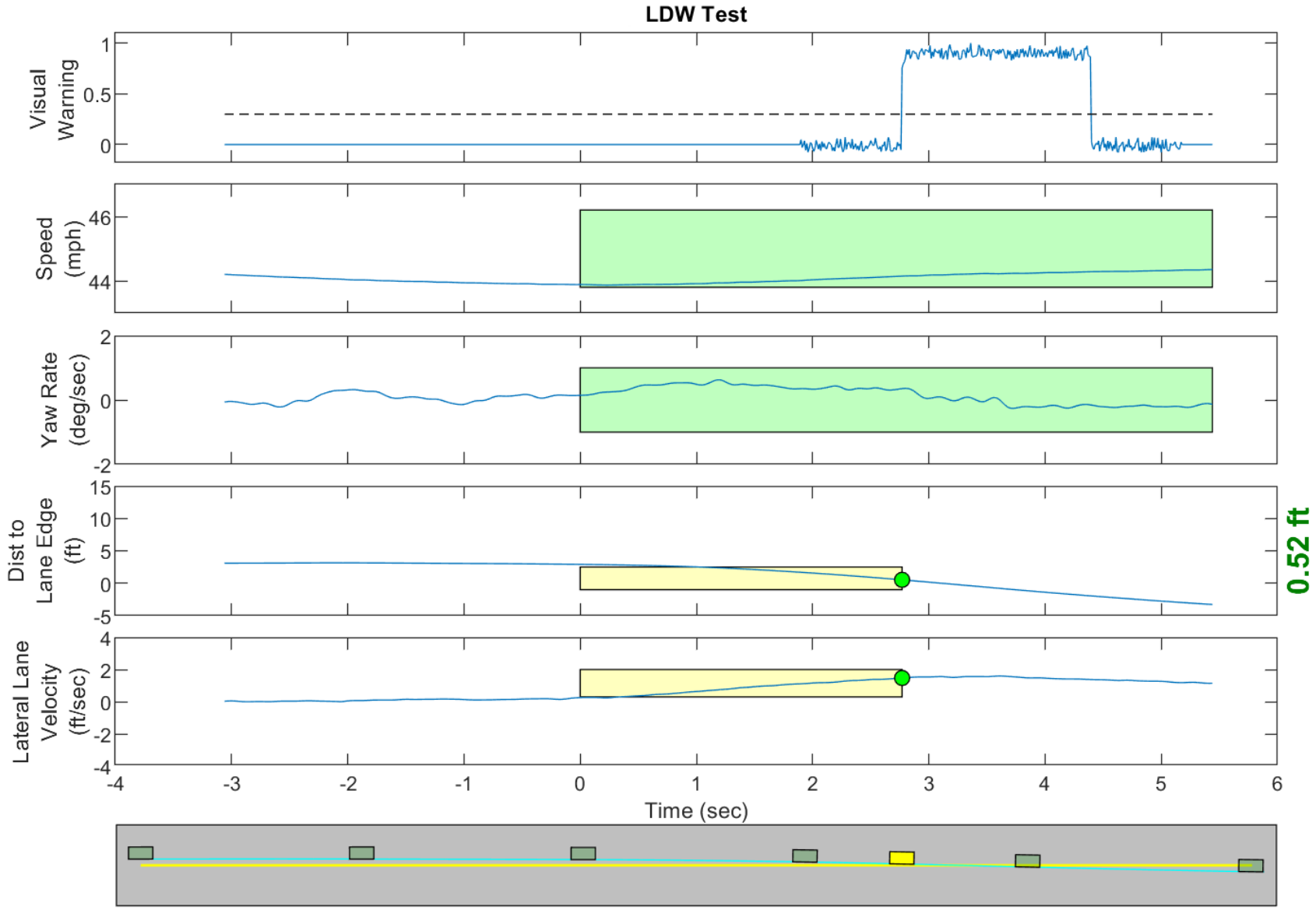

Figure D1. Example Time History for Lane Departure Warning Test, Passing

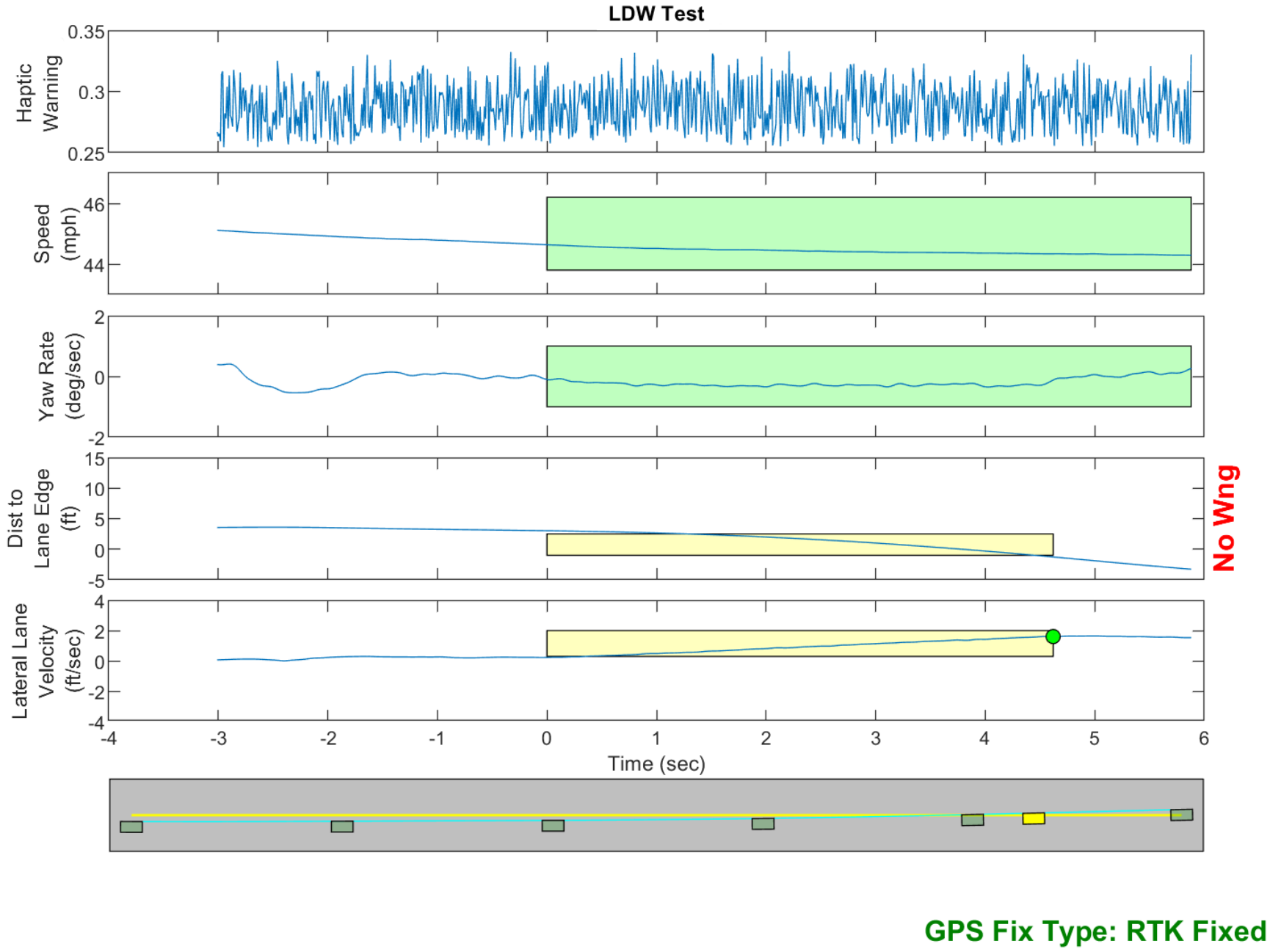

Figure D2. Example Time History for Lane Departure Warning Test, Failing, No Warning Issued

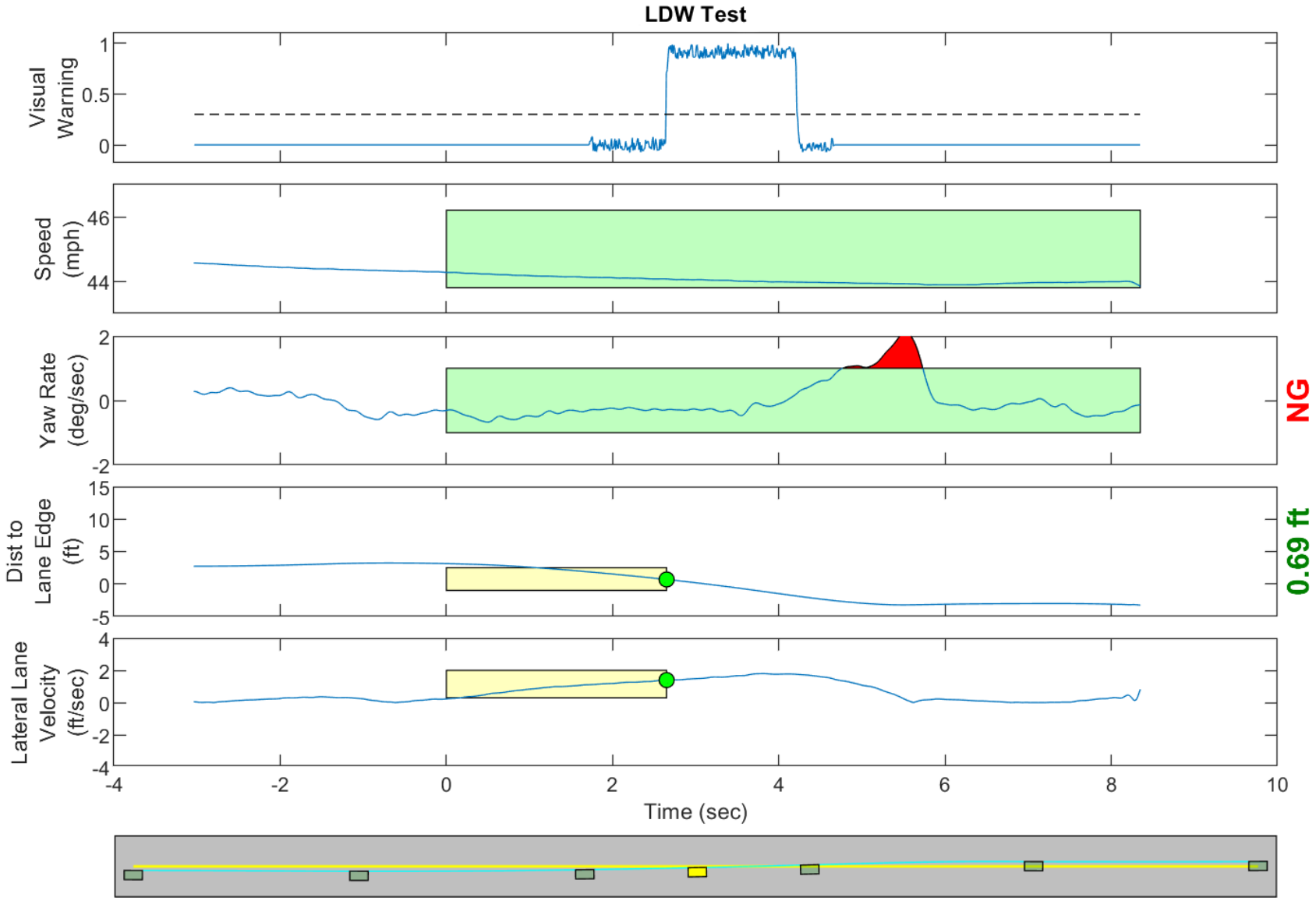

Figure D3. Example Time History for Lane Departure Warning Test, Invalid Run Due to Subject Vehicle Yaw Rate

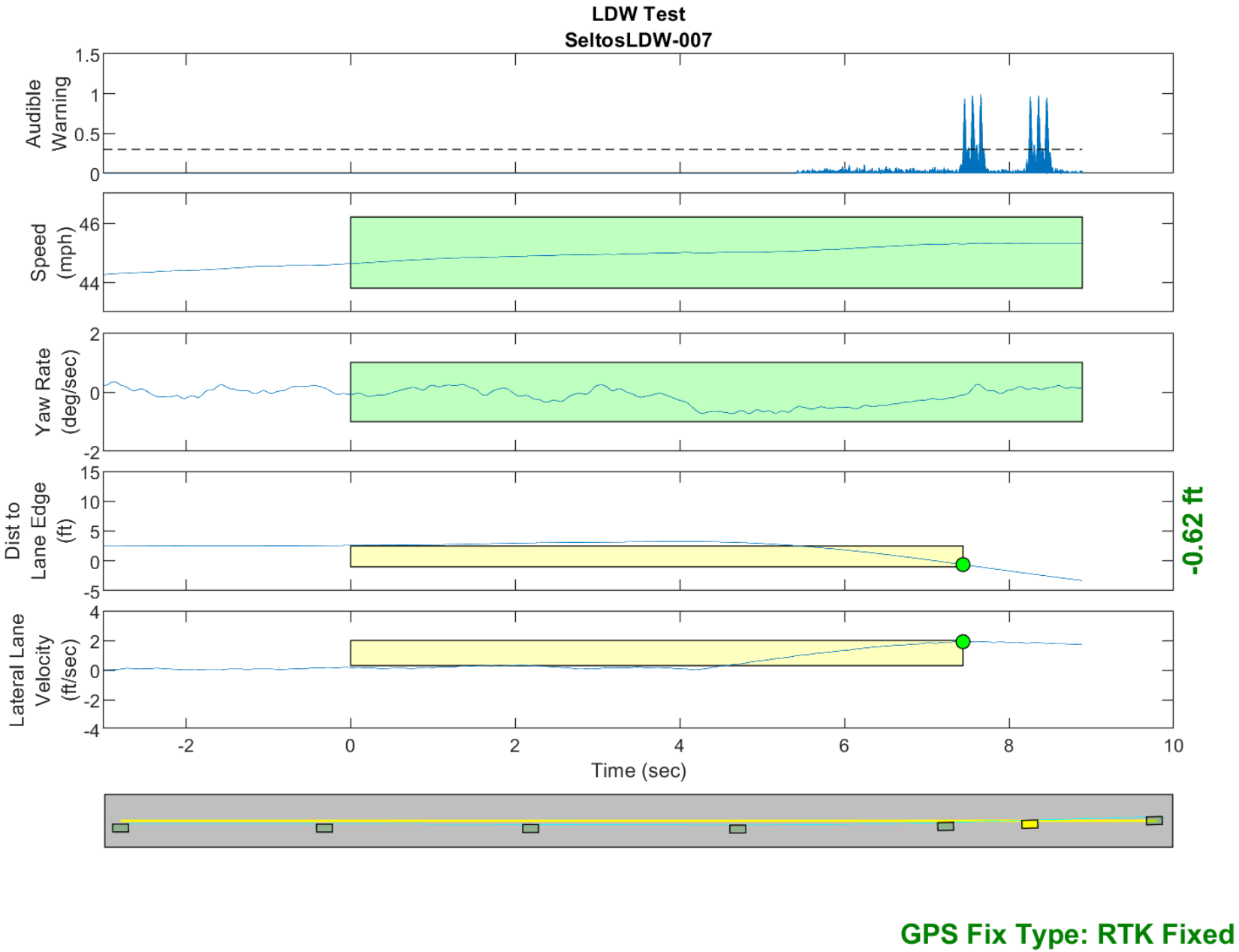

Figure D4. Time History for Run 07, Botts Dots, Left Departure, Auditory Warning

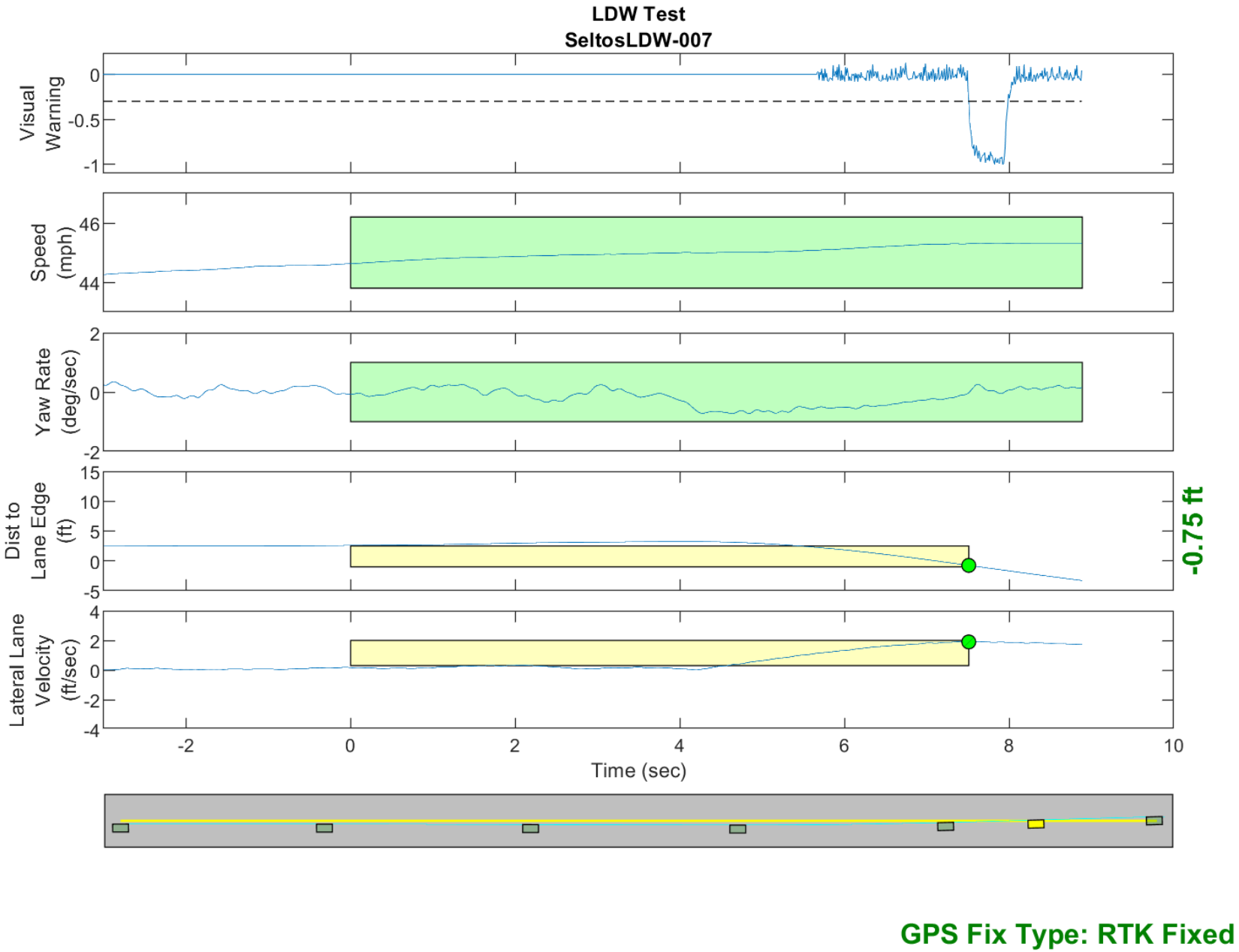

Figure D5. Time History for Run 07, Botts Dots, Left Departure, Visual Warning

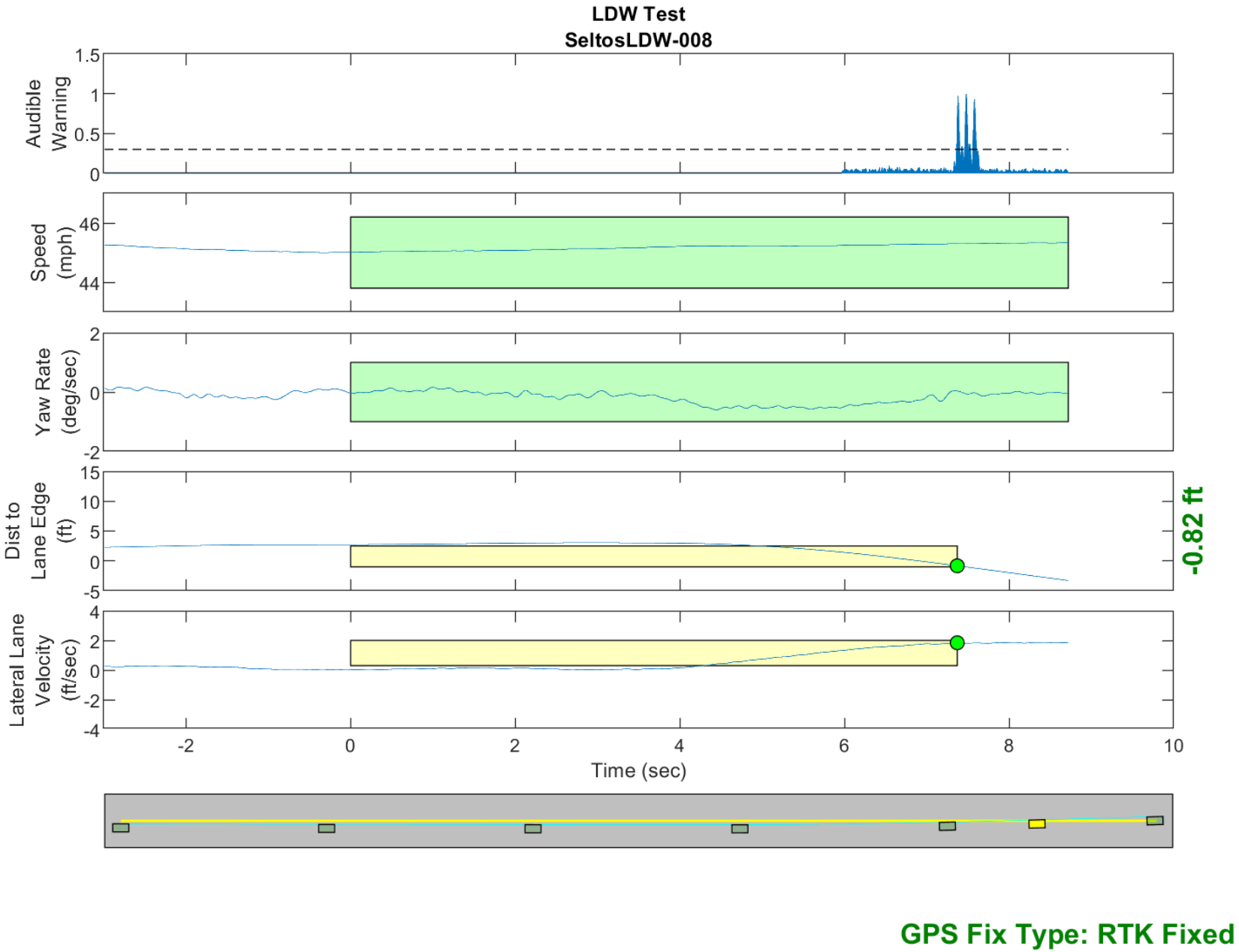

Figure D6. Time History for Run 08, Botts Dots, Left Departure, Auditory Warning

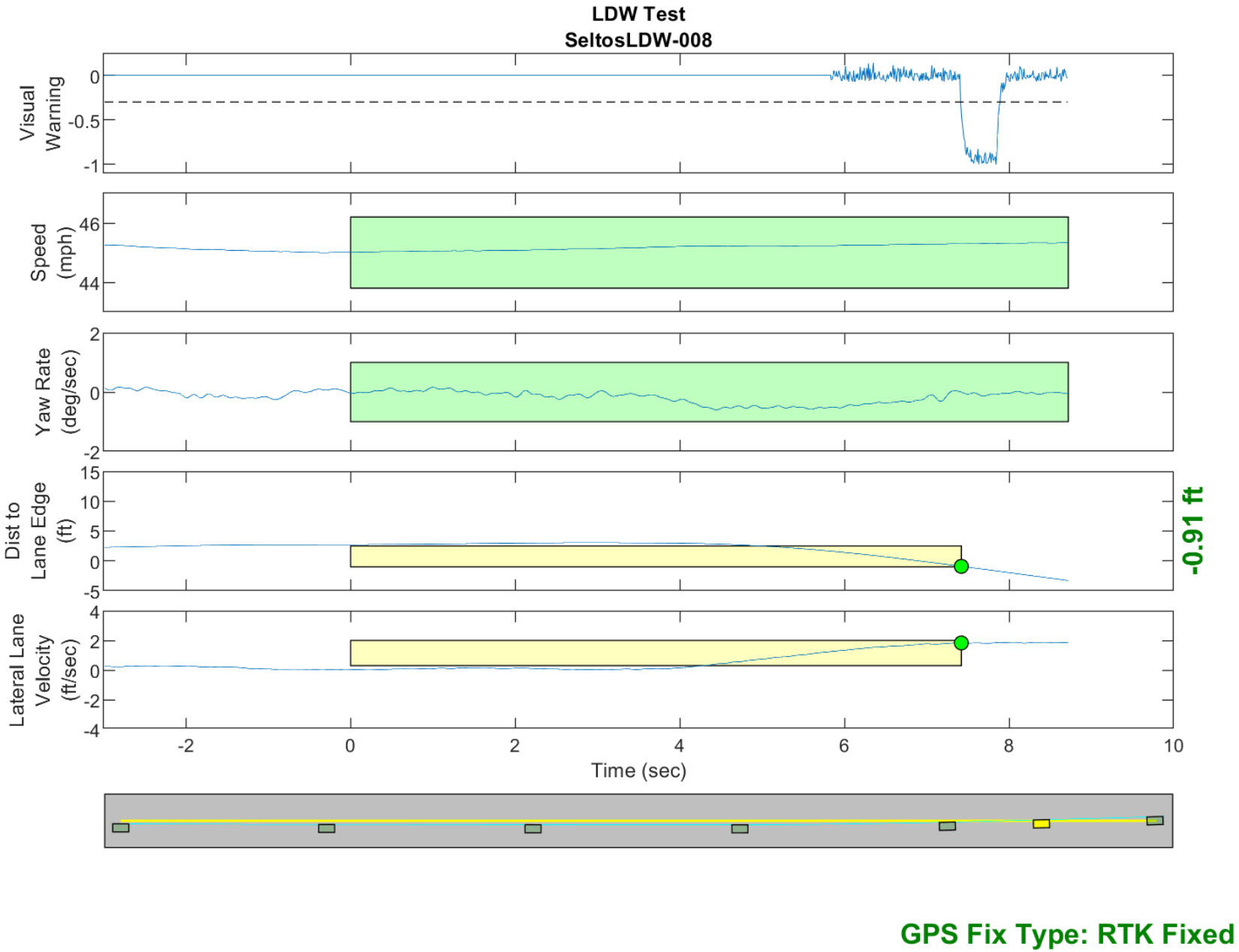

Figure D7. Time History for Run 08, Botts Dots, Left Departure, Visual Warning

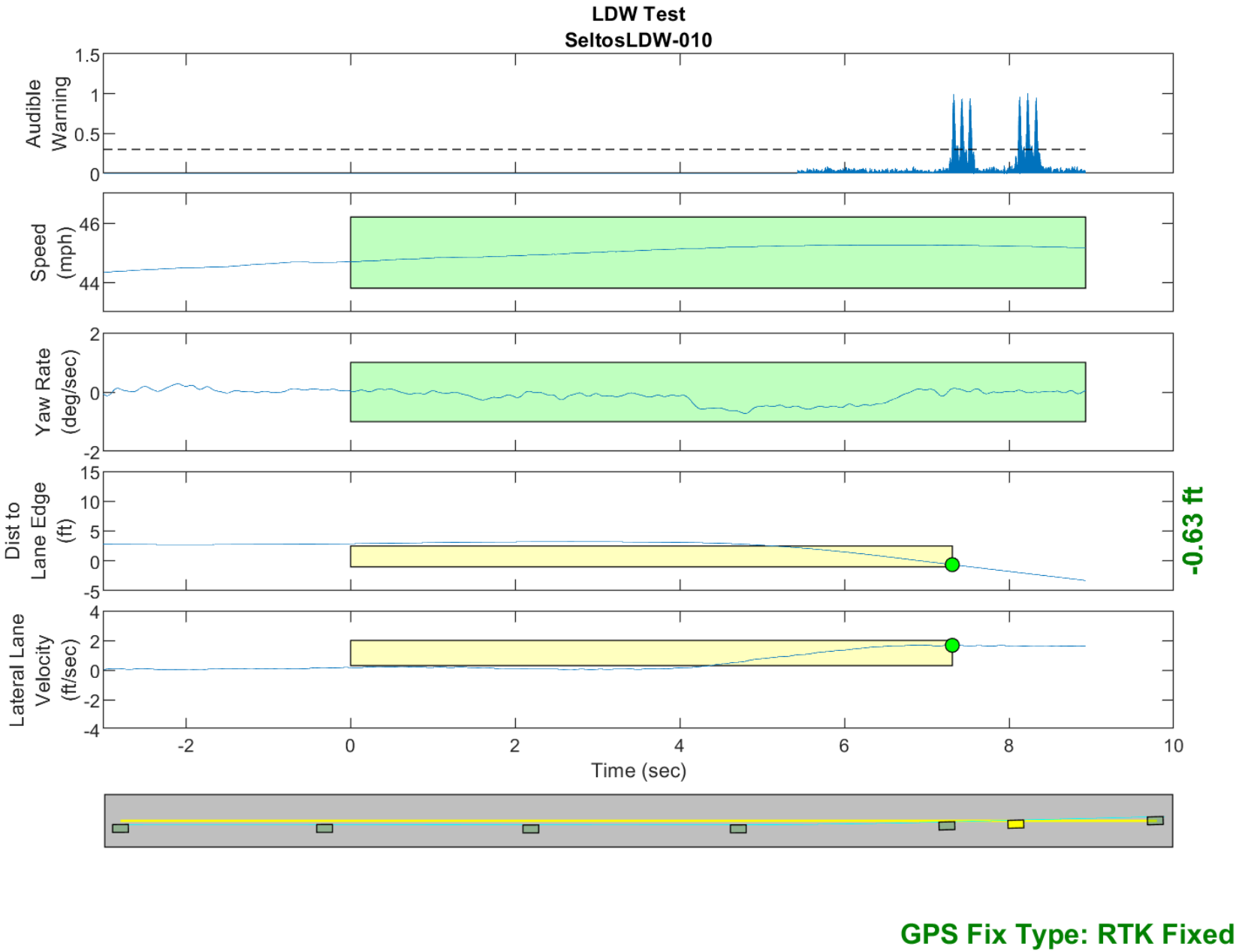

Figure D8. Time History for Run 10, Botts Dots, Left Departure, Auditory Warning

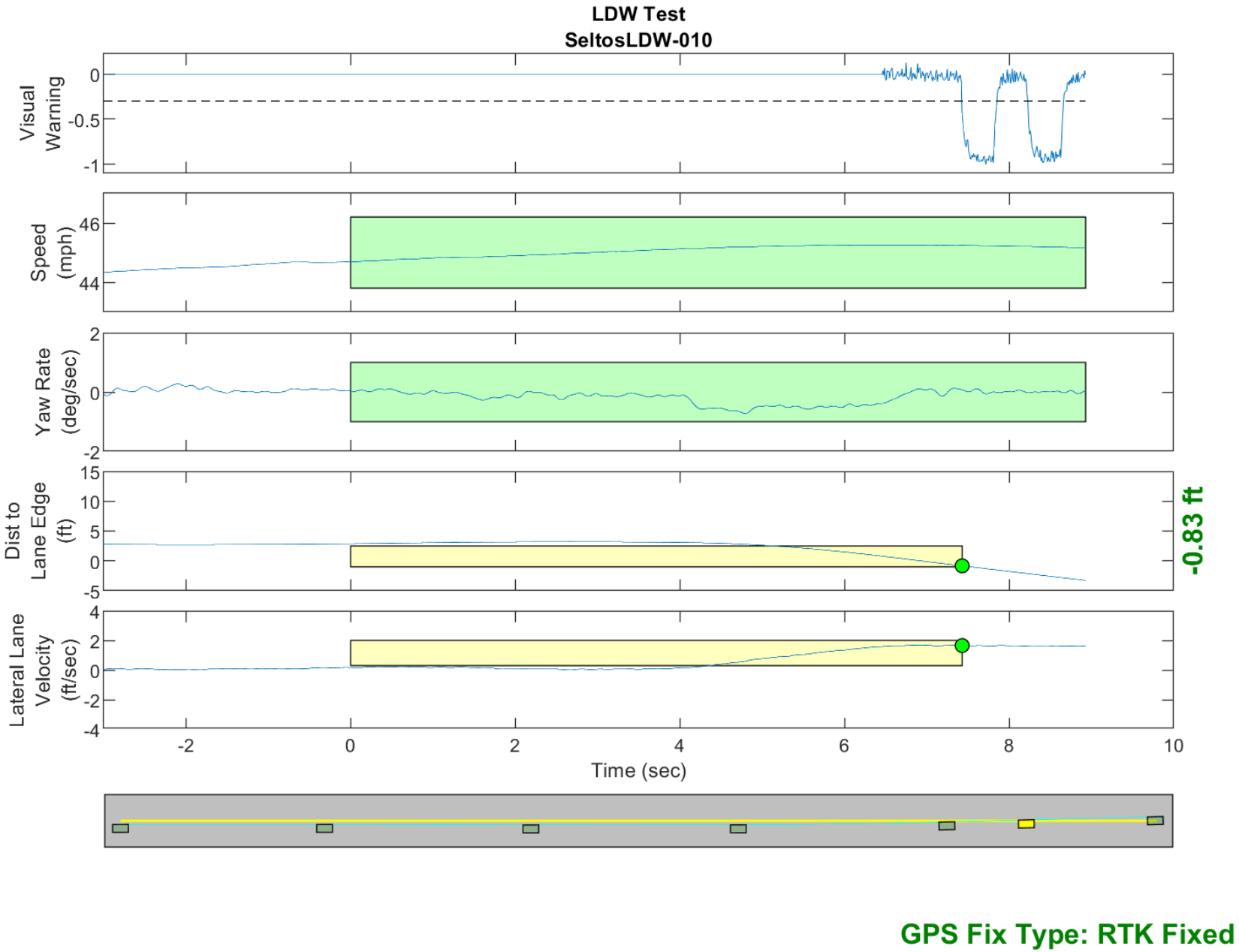

Figure D9. Time History for Run 10, Botts Dots, Left Departure, Visual Warning

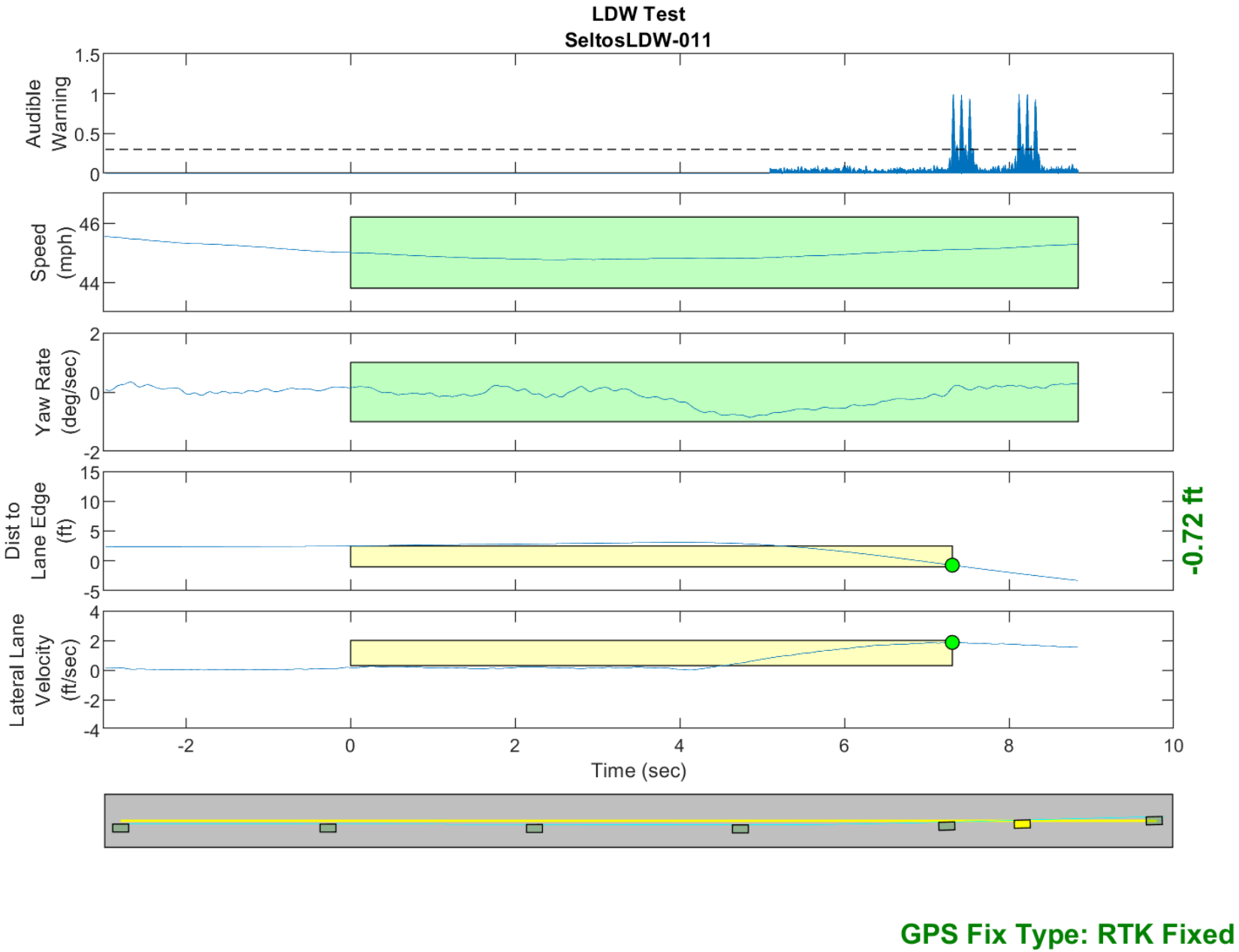

Figure D10. Time History for Run 11, Botts Dots, Left Departure, Auditory Warning

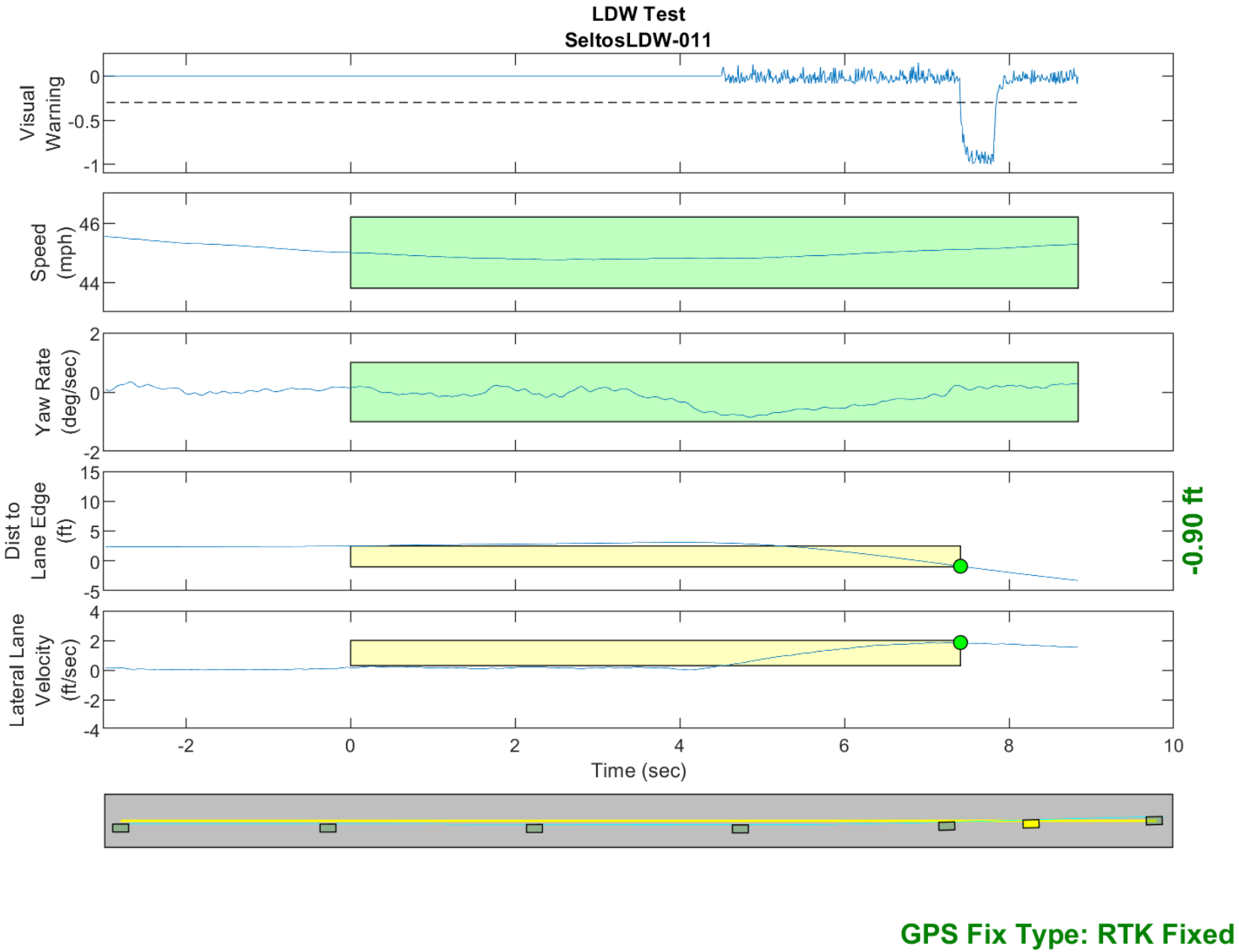

Figure D11. Time History for Run 11, Botts Dots, Left Departure, Visual Warning

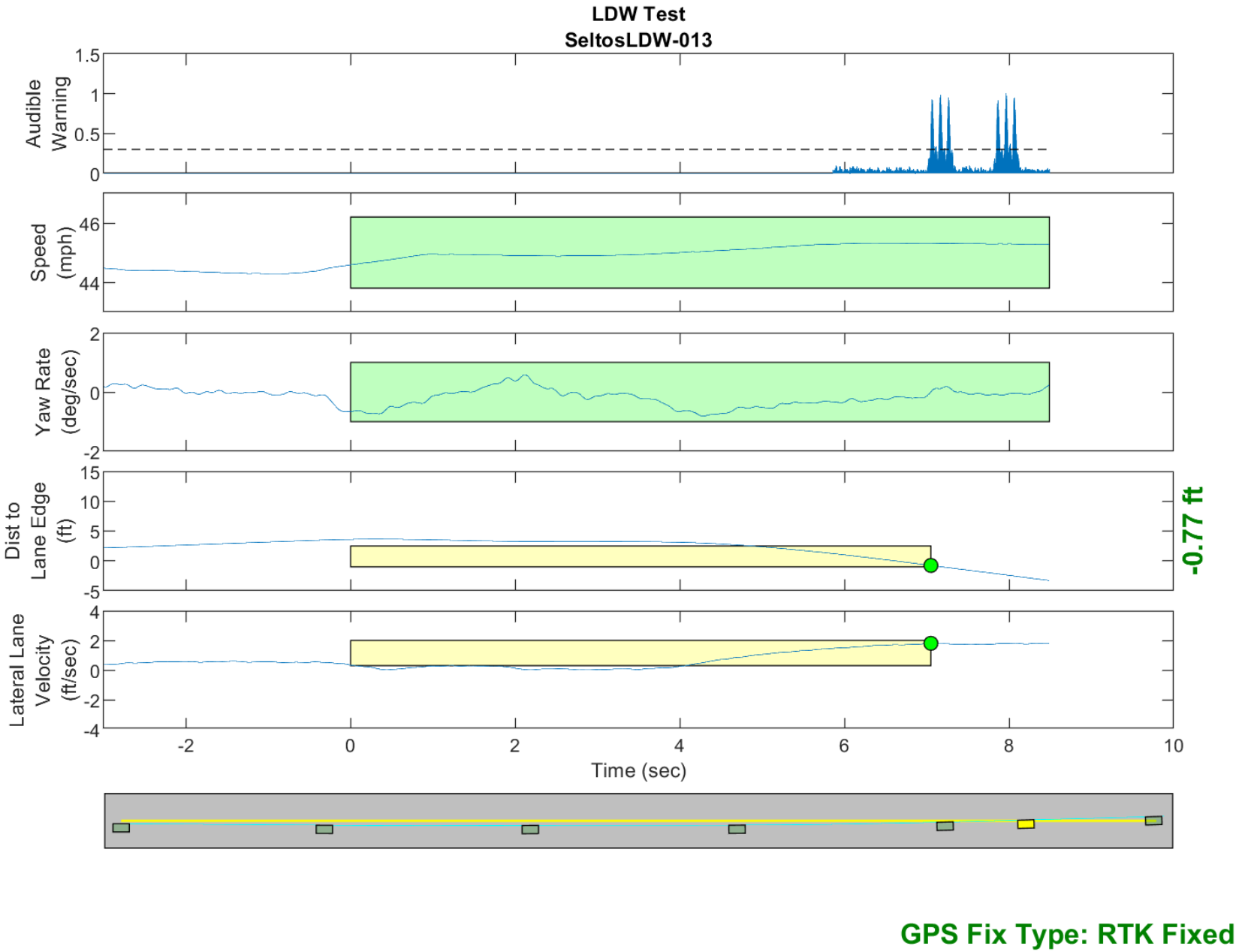

Figure D12. Time History for Run 13, Botts Dots, Left Departure, Auditory Warning

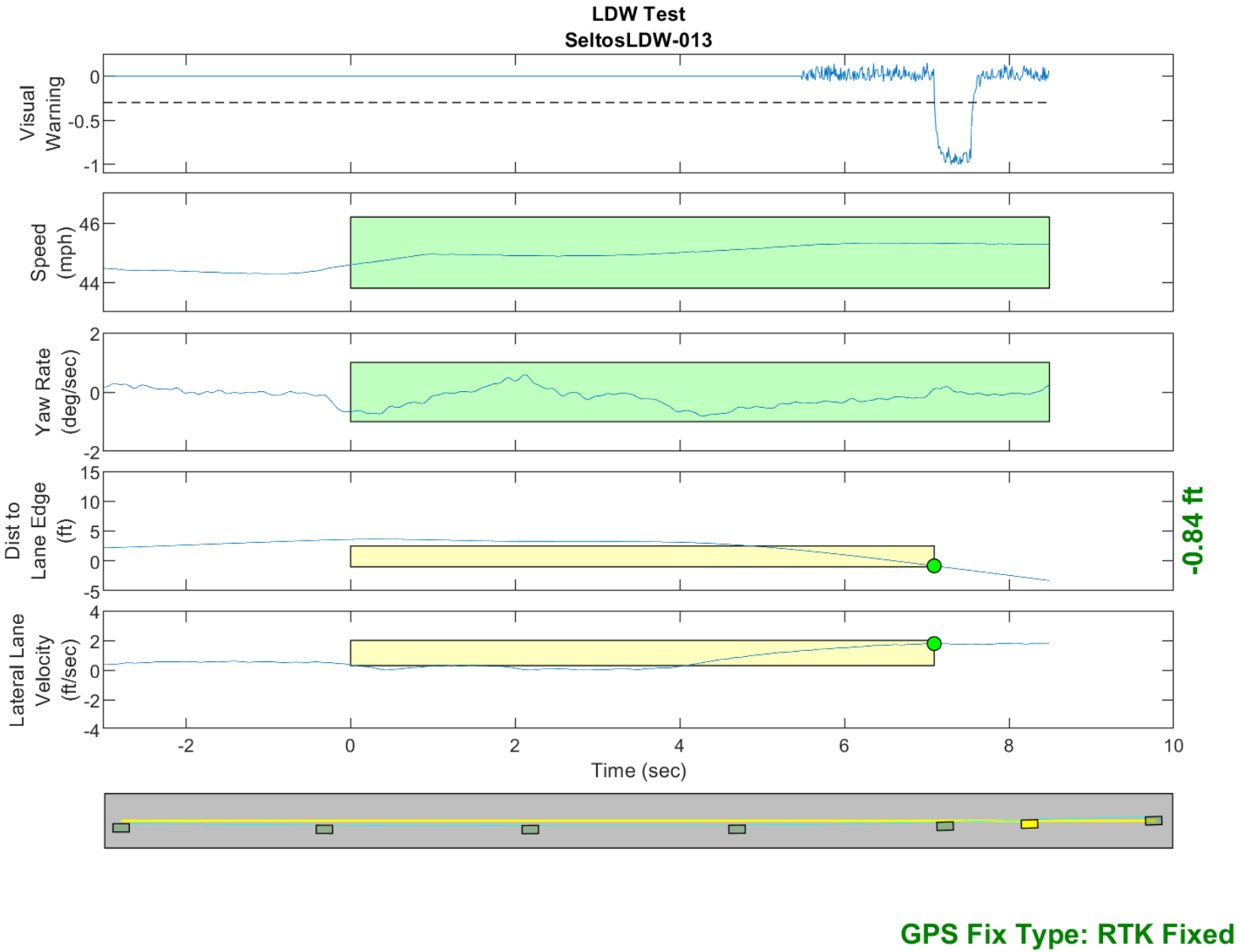

Figure D13. Time History for Run 13, Botts Dots, Left Departure, Visual Warning

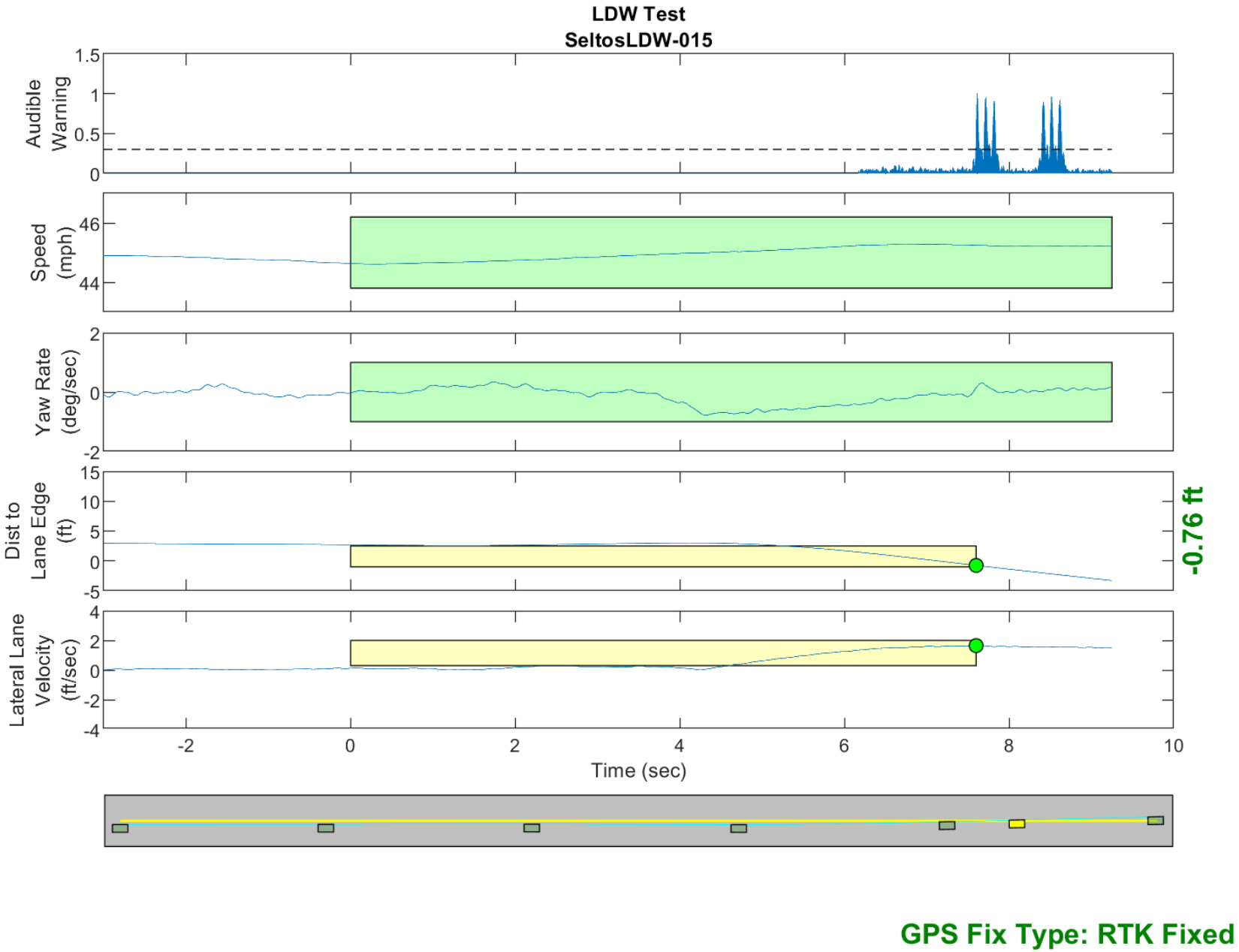

Figure D14. Time History for Run 15, Botts Dots, Left Departure, Auditory Warning

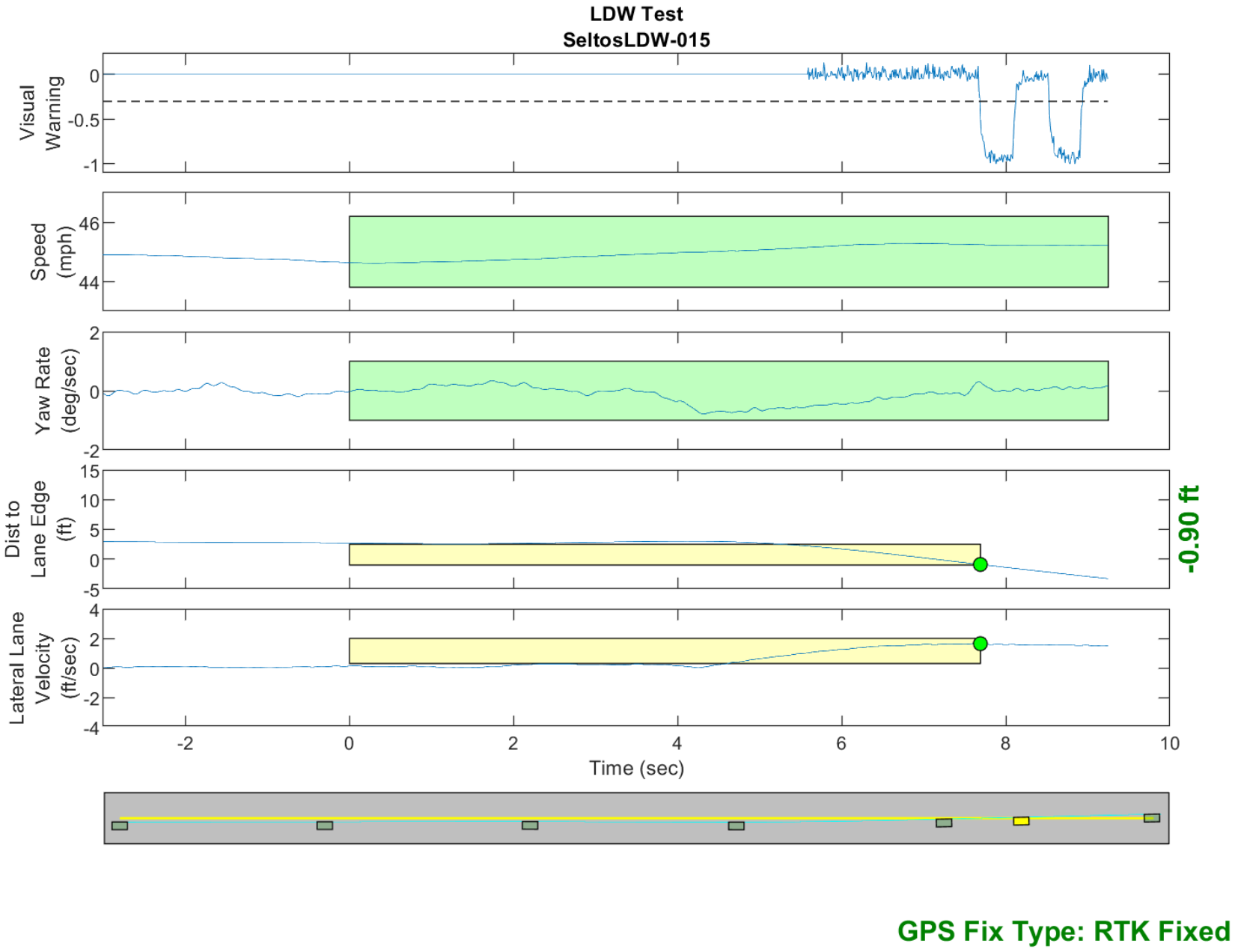

Figure D15. Time History for Run 15, Botts Dots, Left Departure, Visual Warning

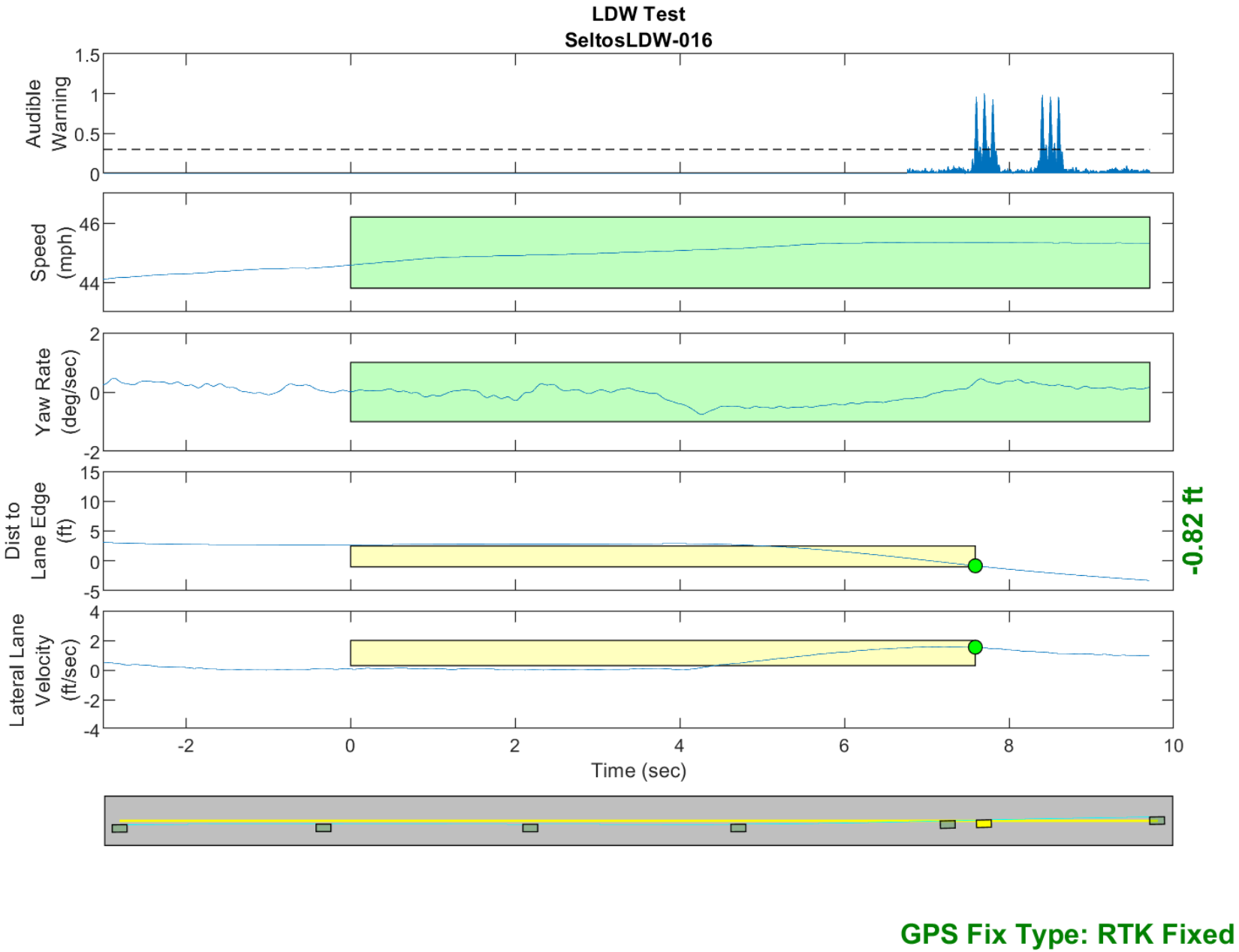

Figure D16. Time History for Run 16, Botts Dots, Left Departure, Auditory Warning

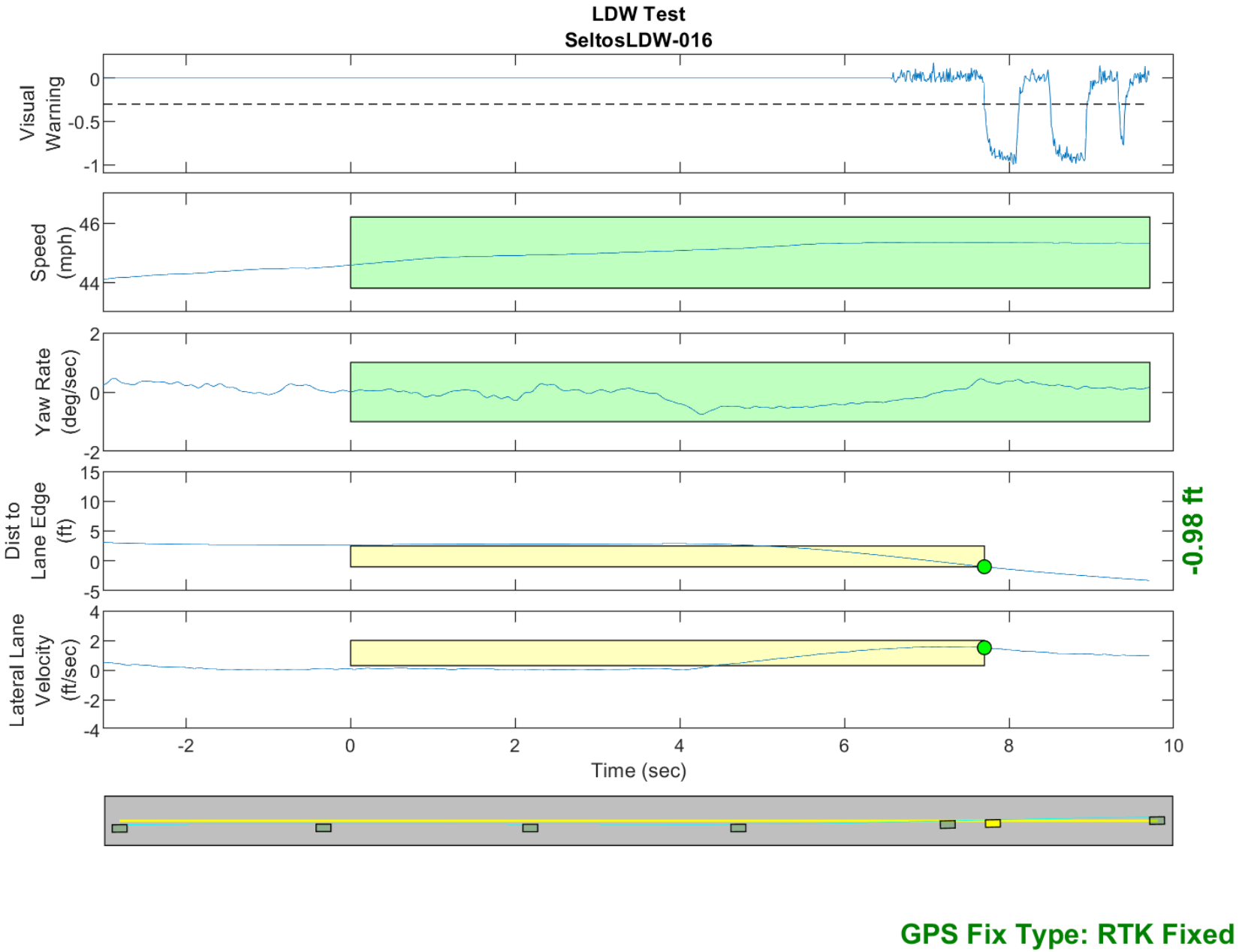

Figure D17. Time History for Run 16, Botts Dots, Left Departure, Visual Warning

Test setup did not conform to NCAP test procedures for runs 17-26. See runs 59-67.

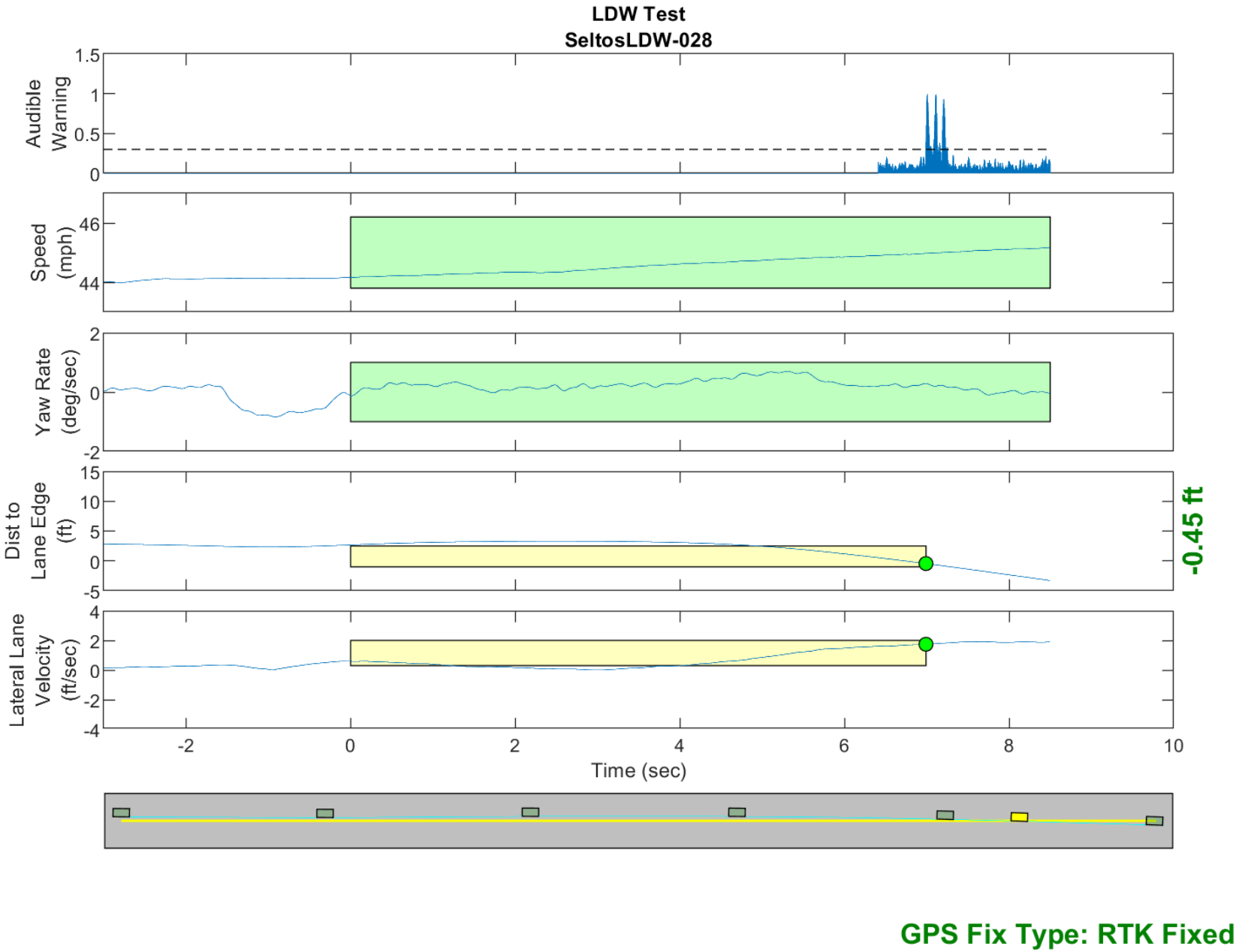

Figure D18. Time History for Run 28, Dashed Line, Right Departure, Auditory Warning

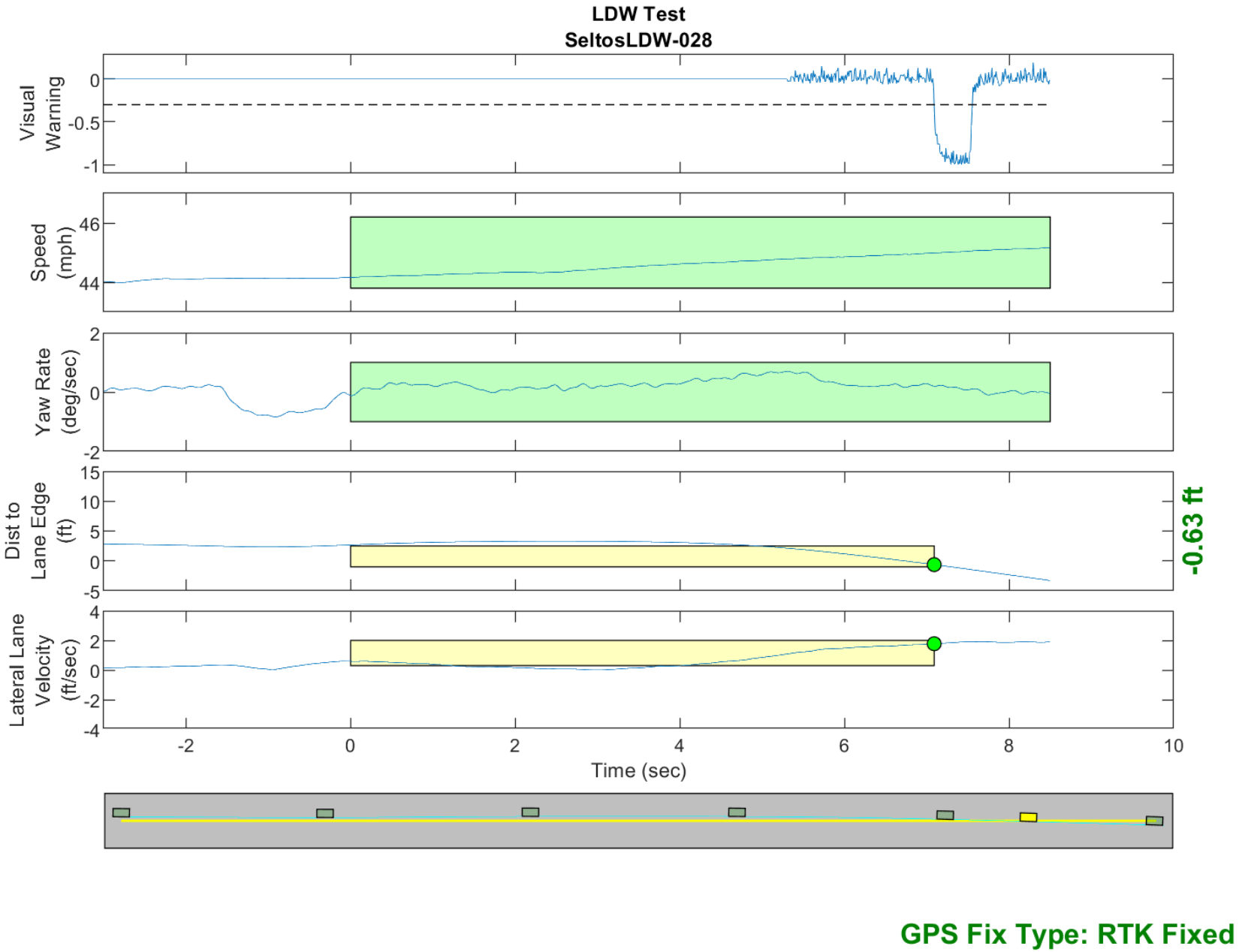

Figure D19. Time History for Run 28, Dashed Line, Right Departure, Visual Warning

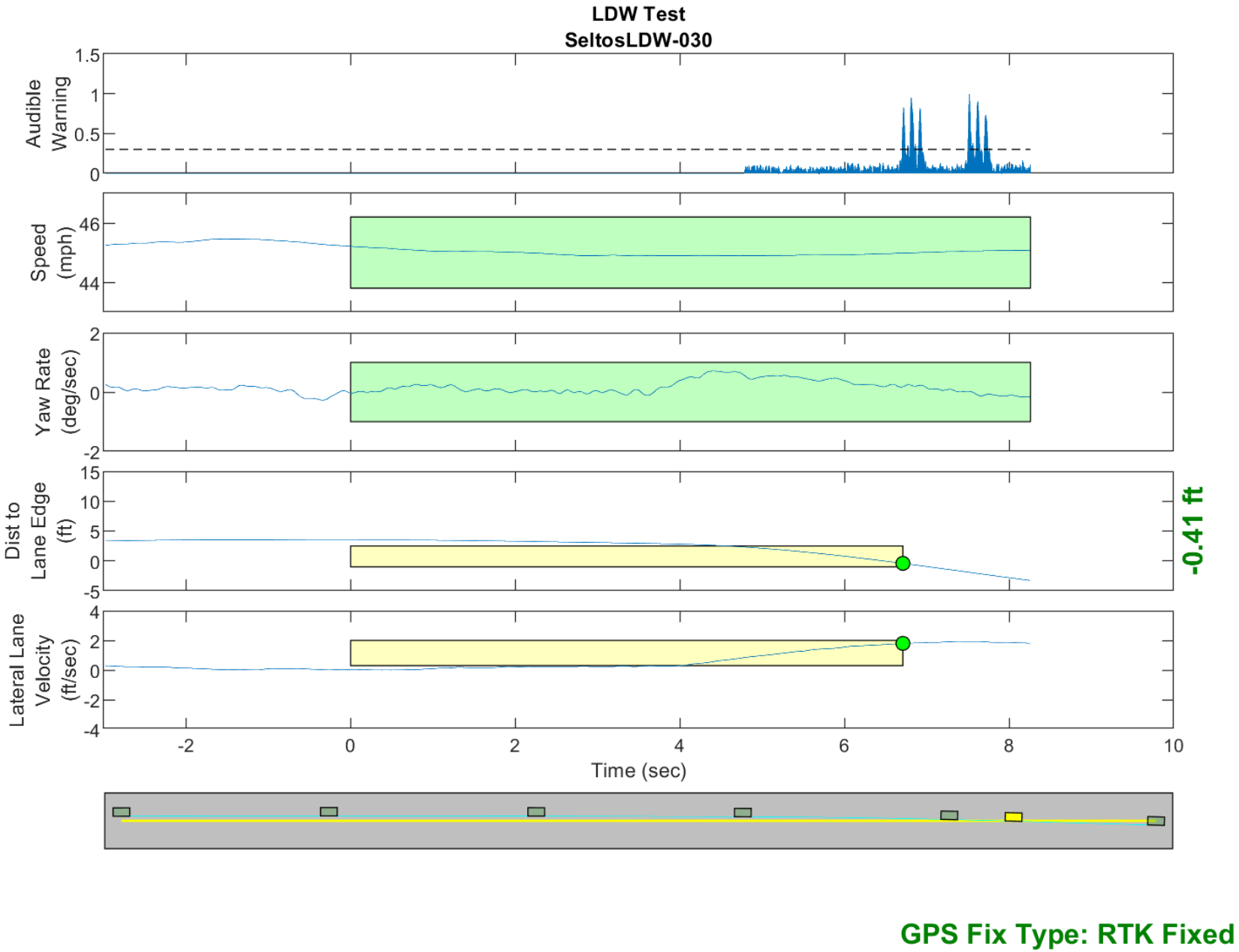

Figure D20. Time History for Run 30, Dashed Line, Right Departure, Auditory Warning

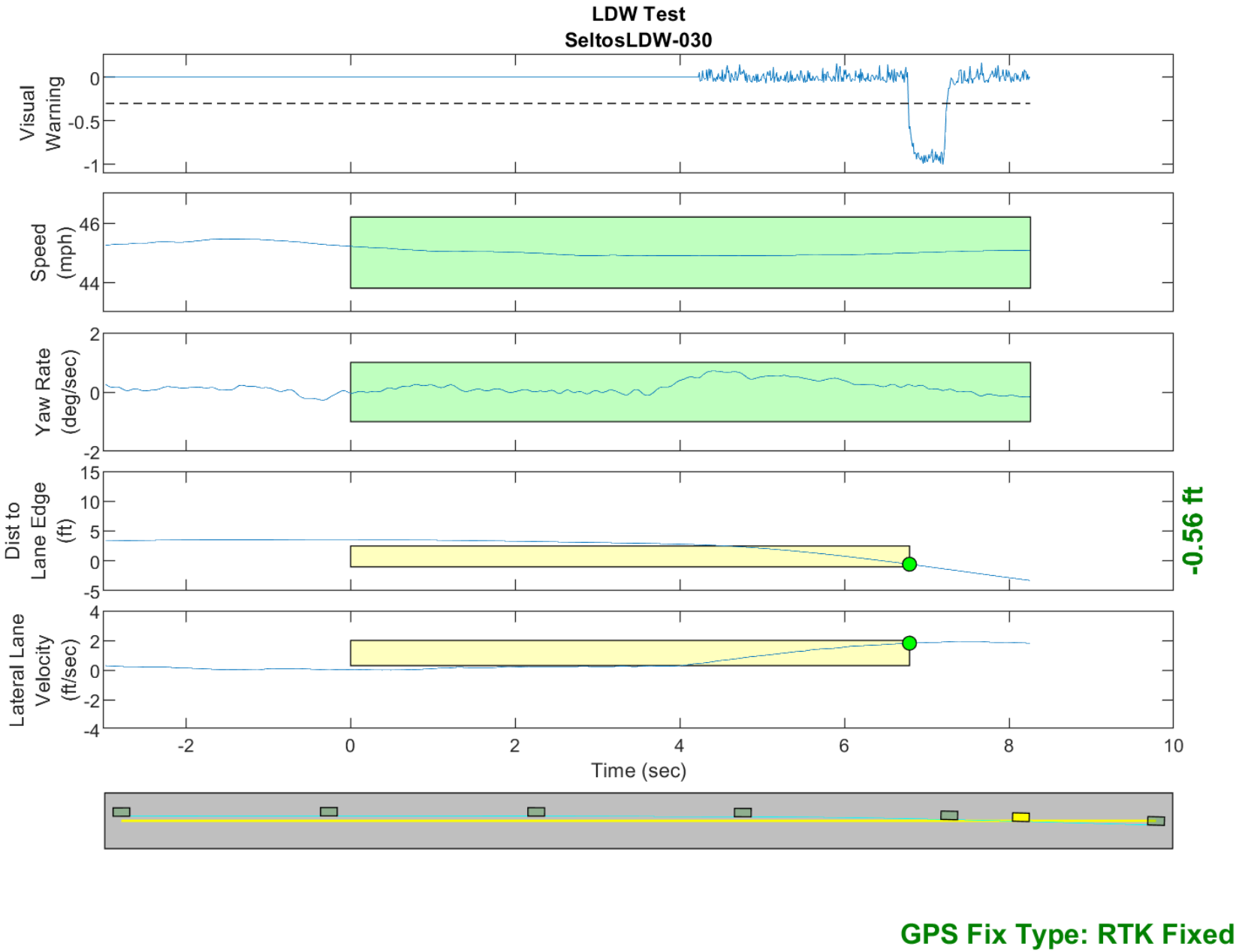

Figure D21. Time History for Run 30, Dashed Line, Right Departure, Visual Warning

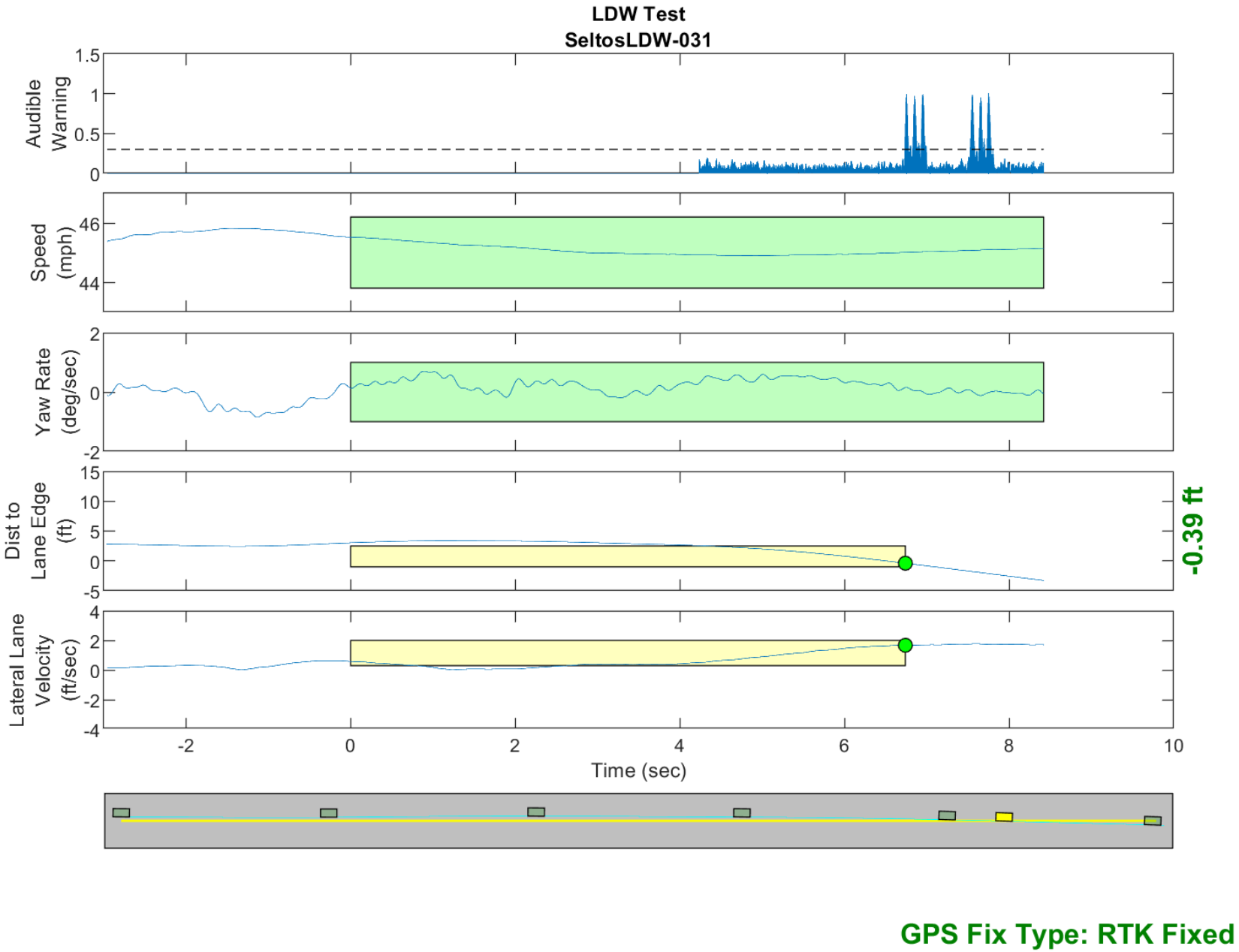

Figure D22. Time History for Run 31, Dashed Line, Right Departure, Auditory Warning

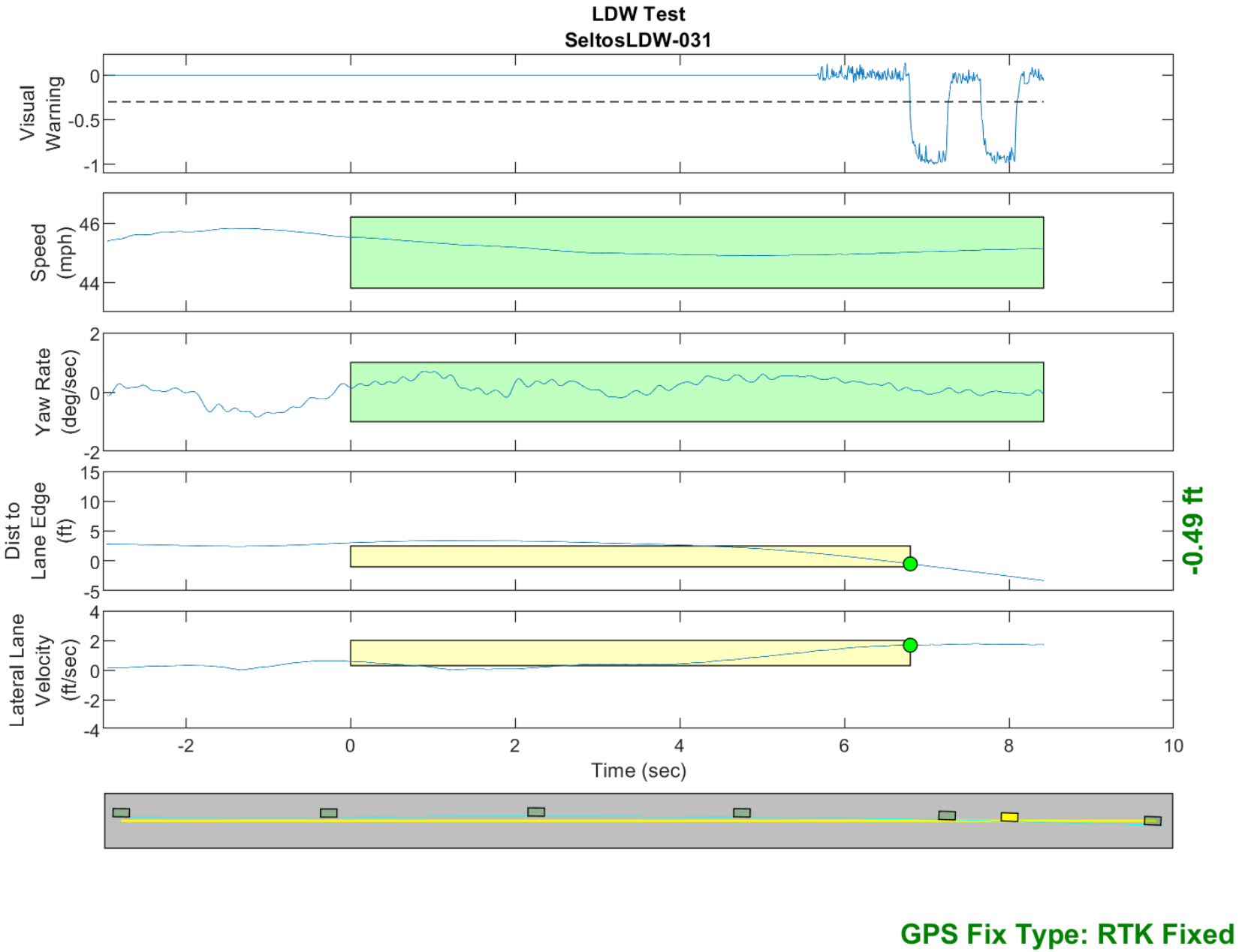

Figure D23. Time History for Run 31, Dashed Line, Right Departure, Visual Warning

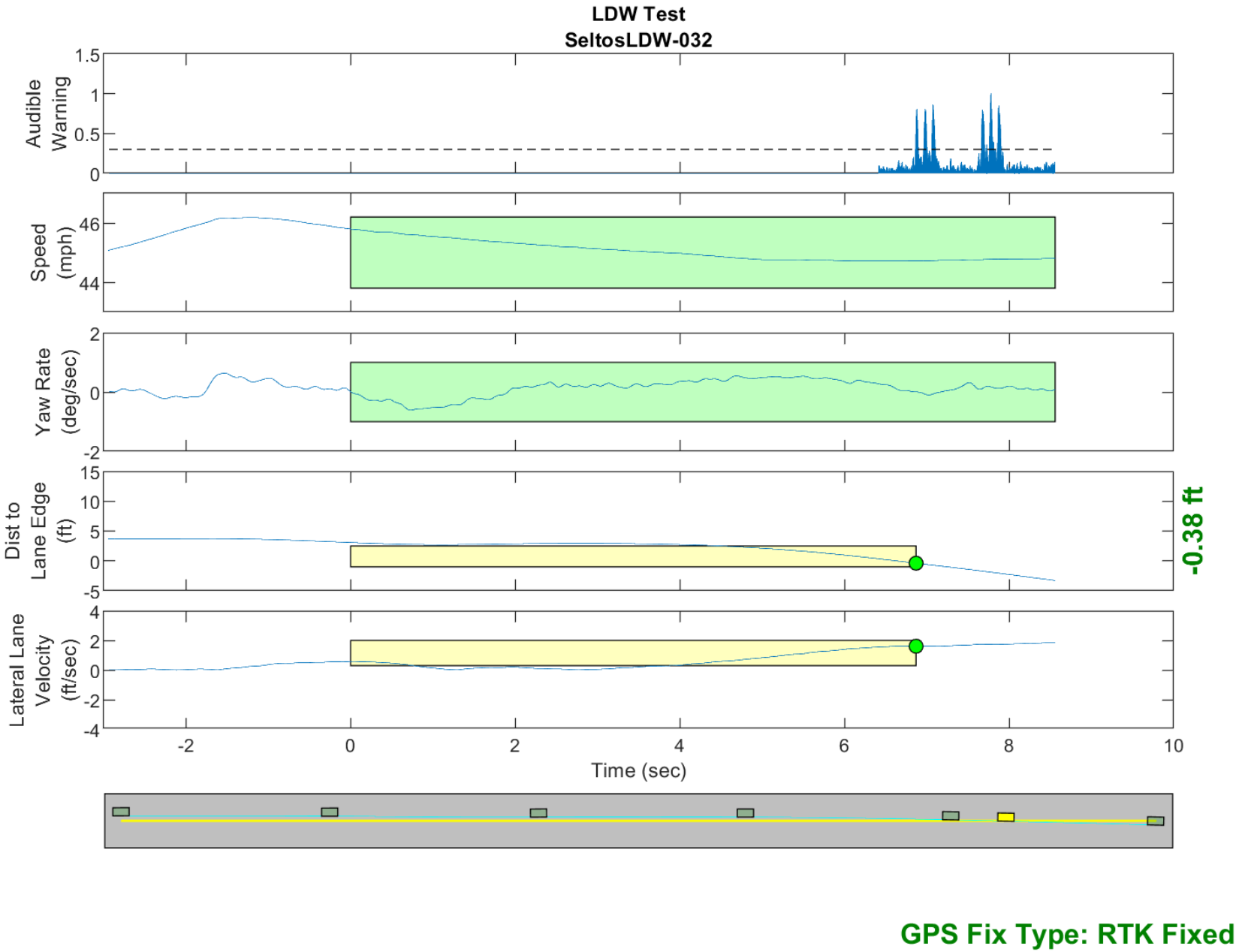

Figure D24. Time History for Run 32, Dashed Line, Right Departure, Auditory Warning

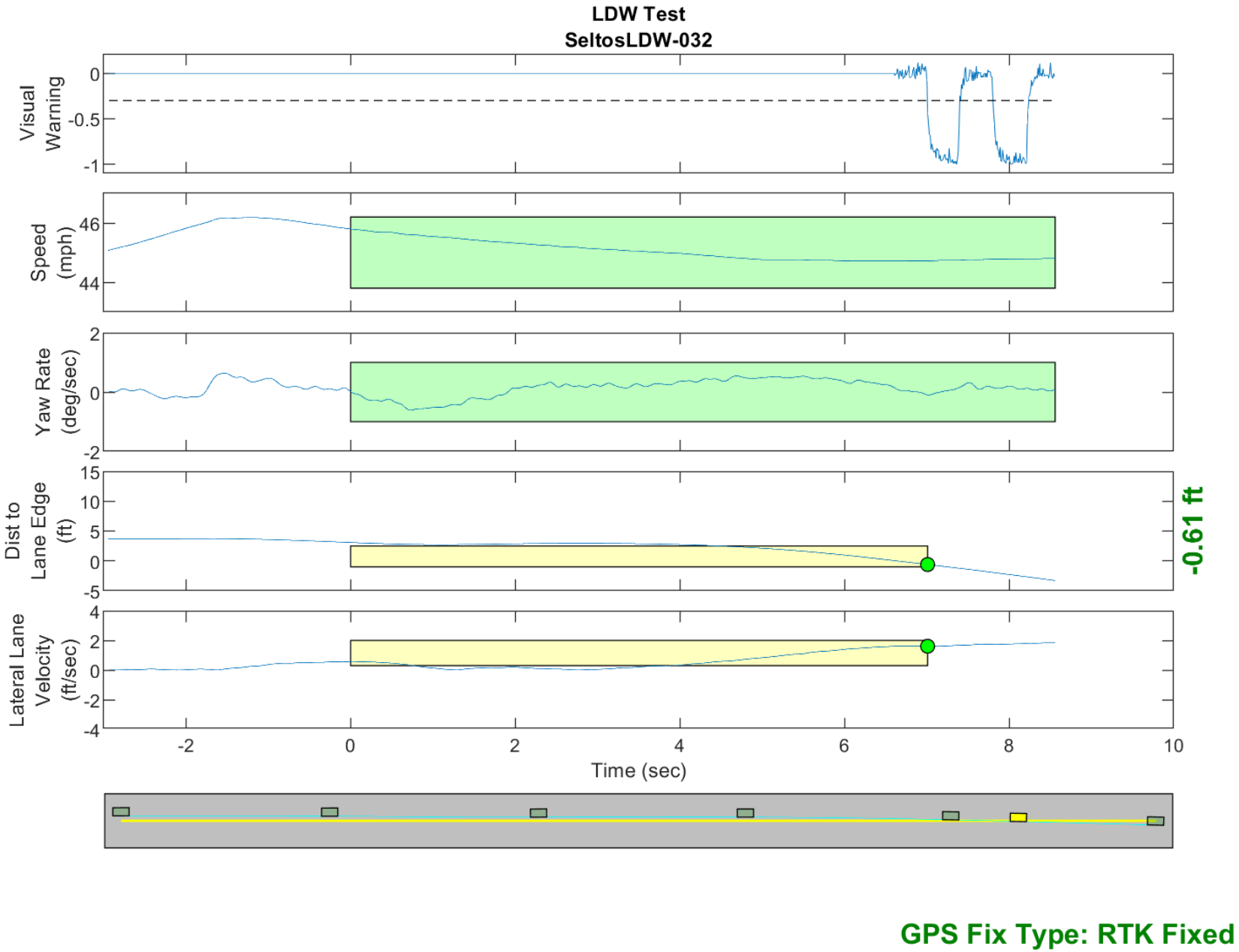

Figure D25. Time History for Run 32, Dashed Line, Right Departure, Visual Warning

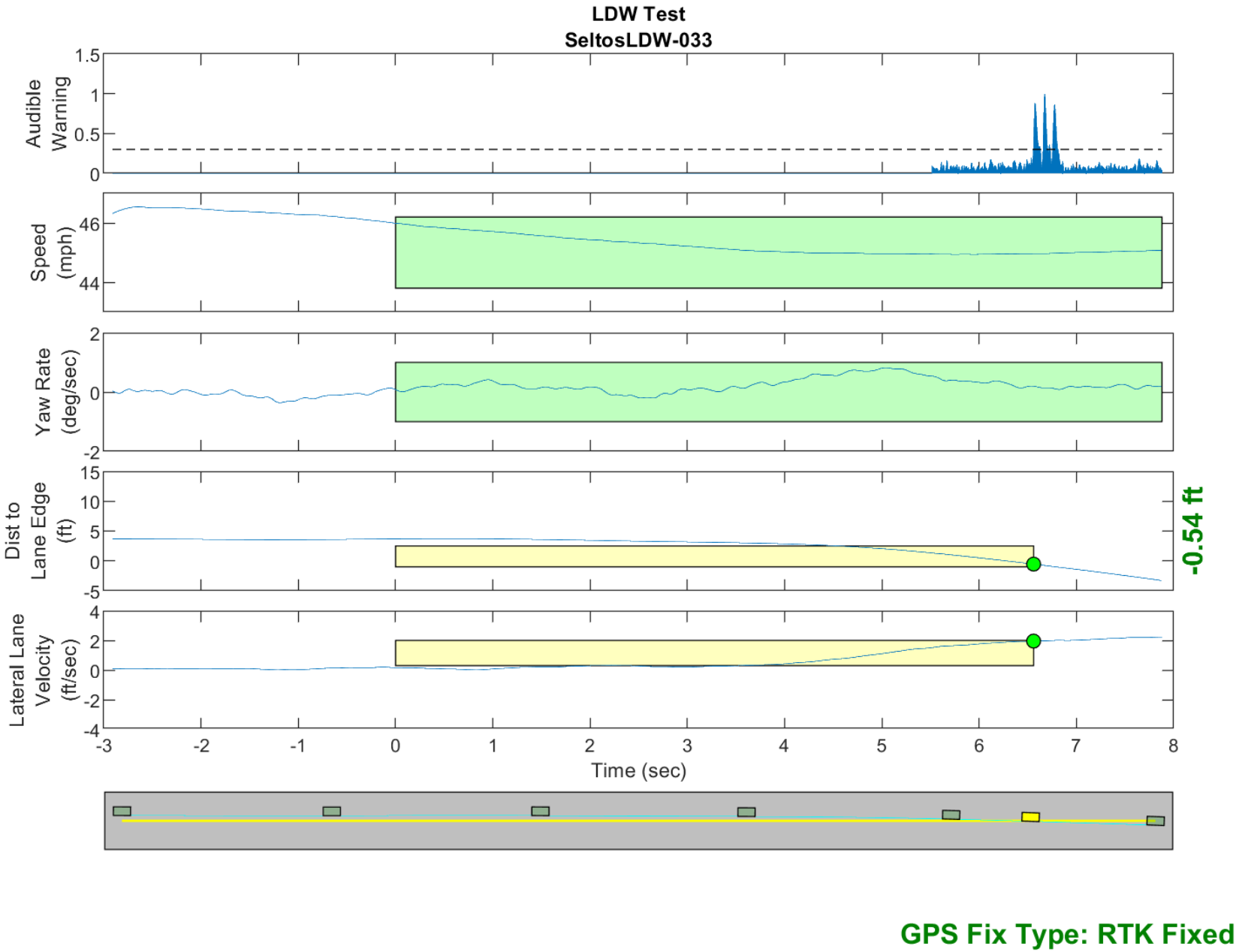

Figure D26. Time History for Run 33, Dashed Line, Right Departure, Auditory Warning

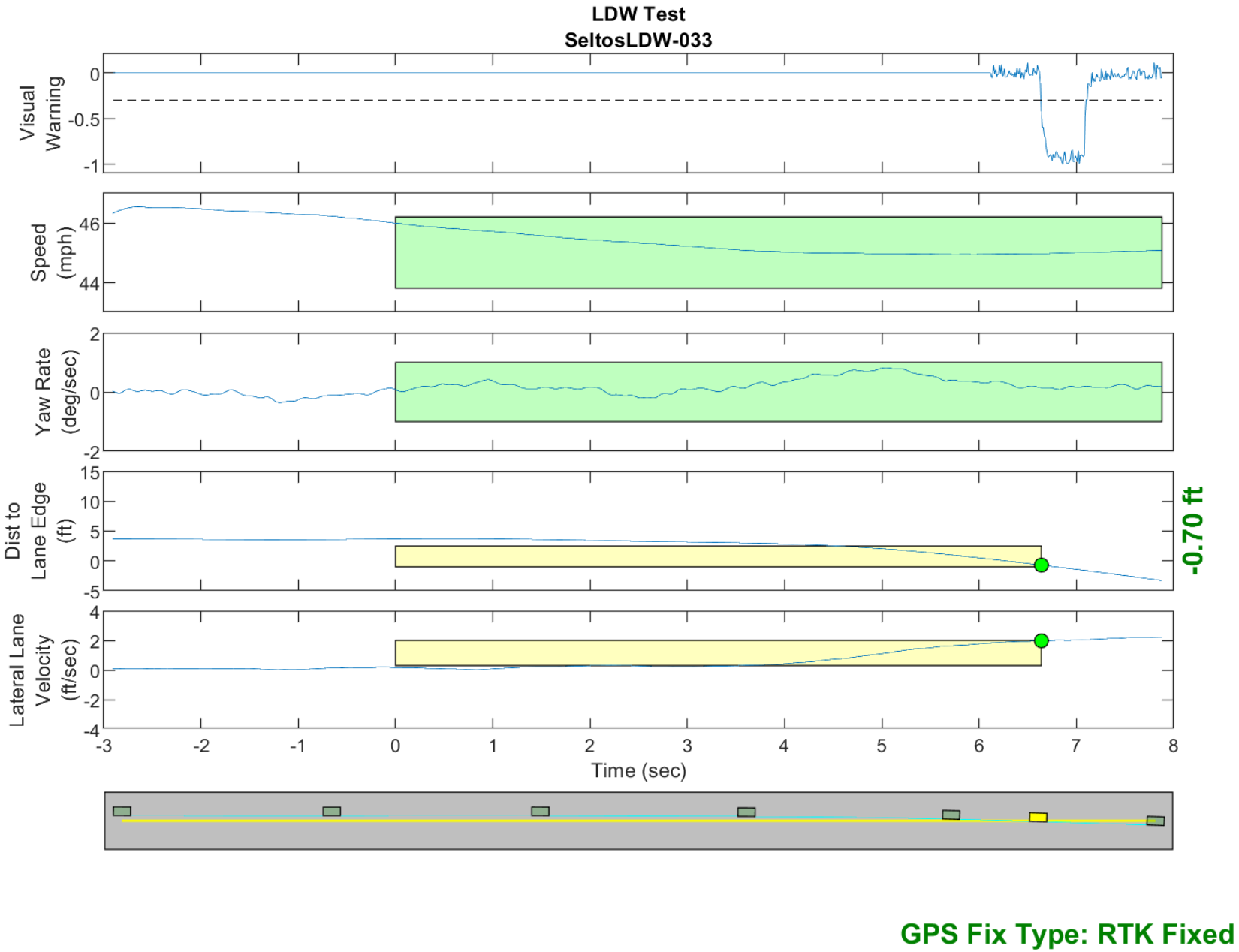

Figure D27. Time History for Run 33, Dashed Line, Right Departure, Visual Warning

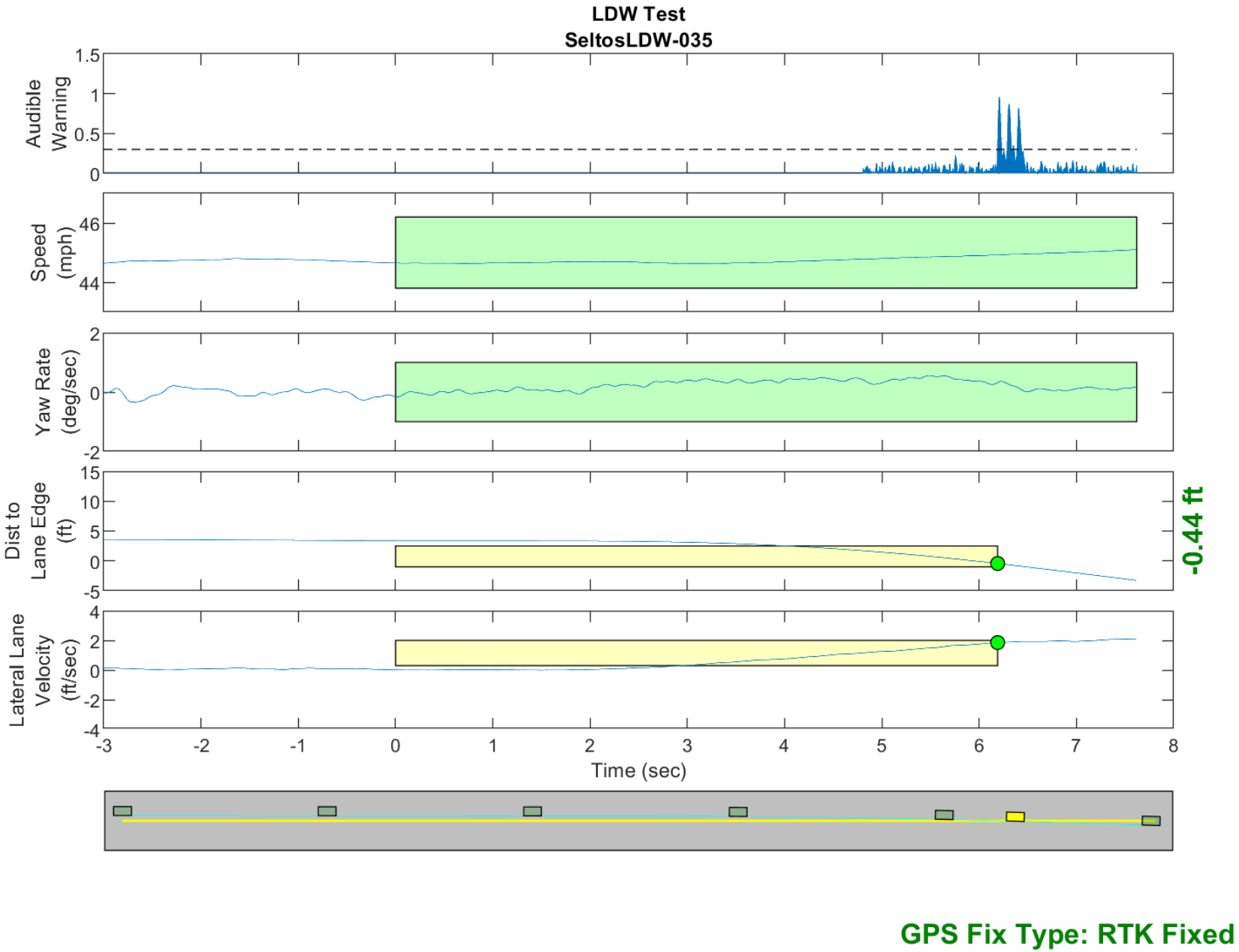

Figure D28. Time History for Run 35, Dashed Line, Right Departure, Auditory Warning

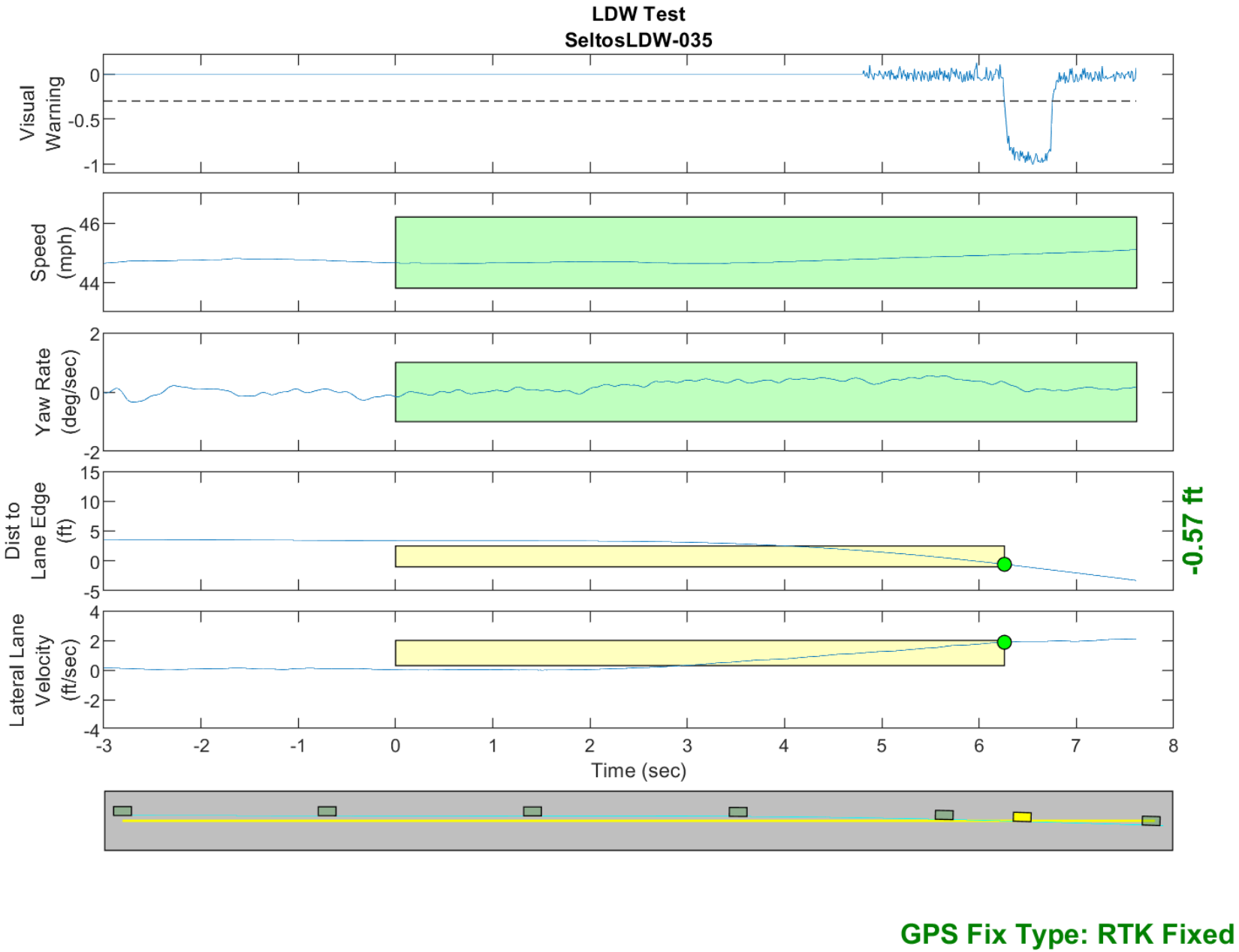

Figure D29. Time History for Run 35, Dashed Line, Right Departure, Visual Warning

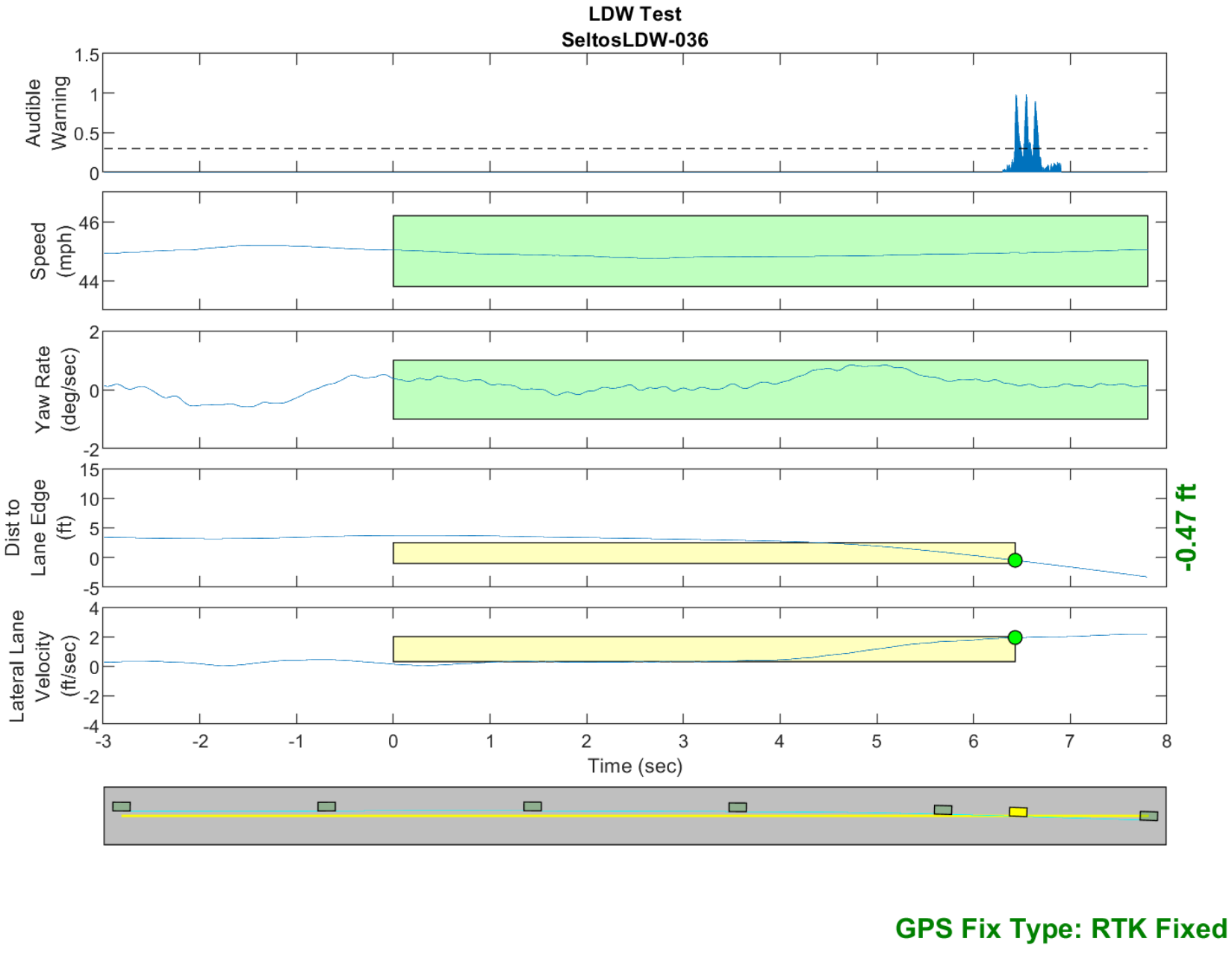

Figure D30. Time History for Run 36, Dashed Line, Right Departure, Auditory Warning

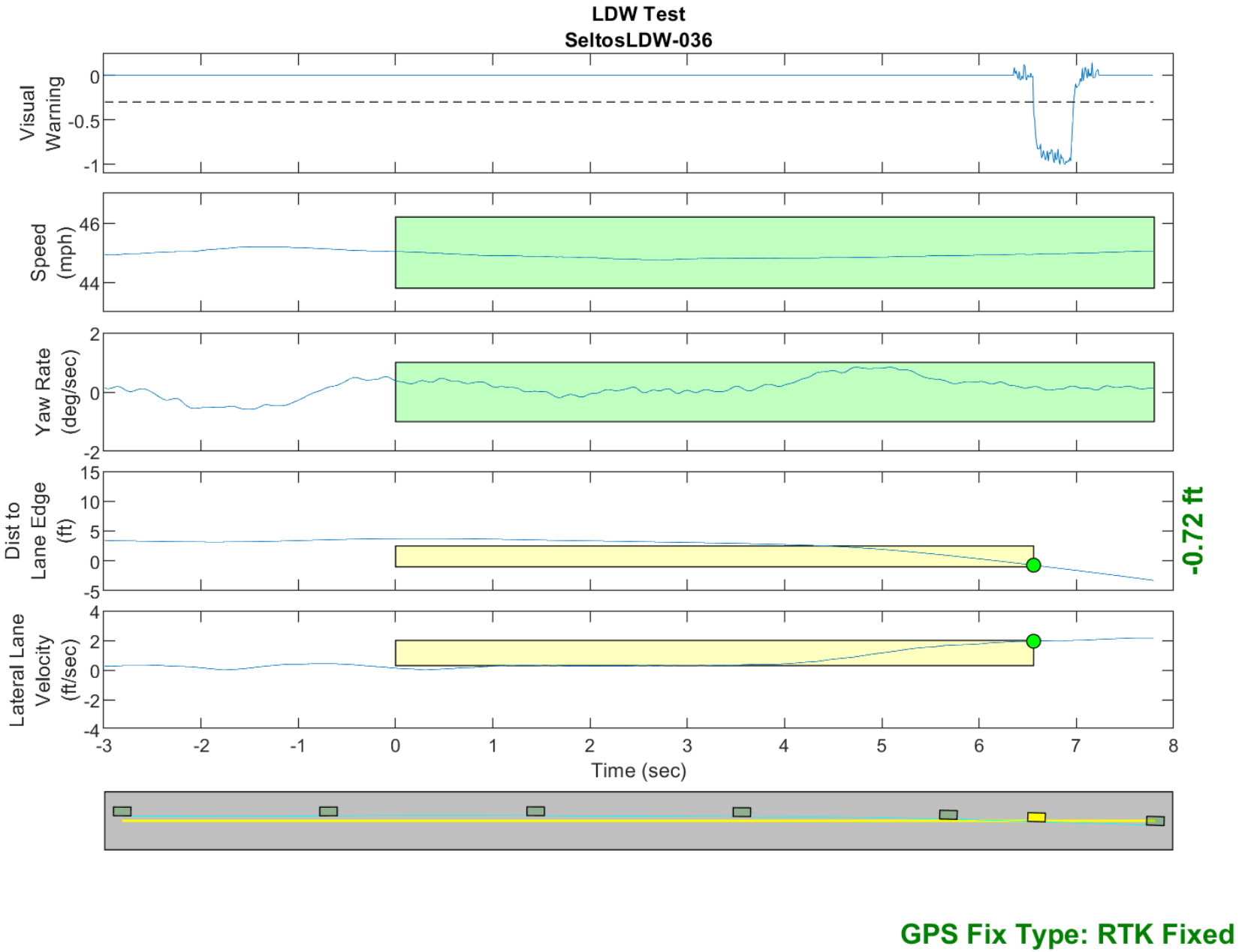

Figure D31. Time History for Run 36, Dashed Line, Right Departure, Visual Warning

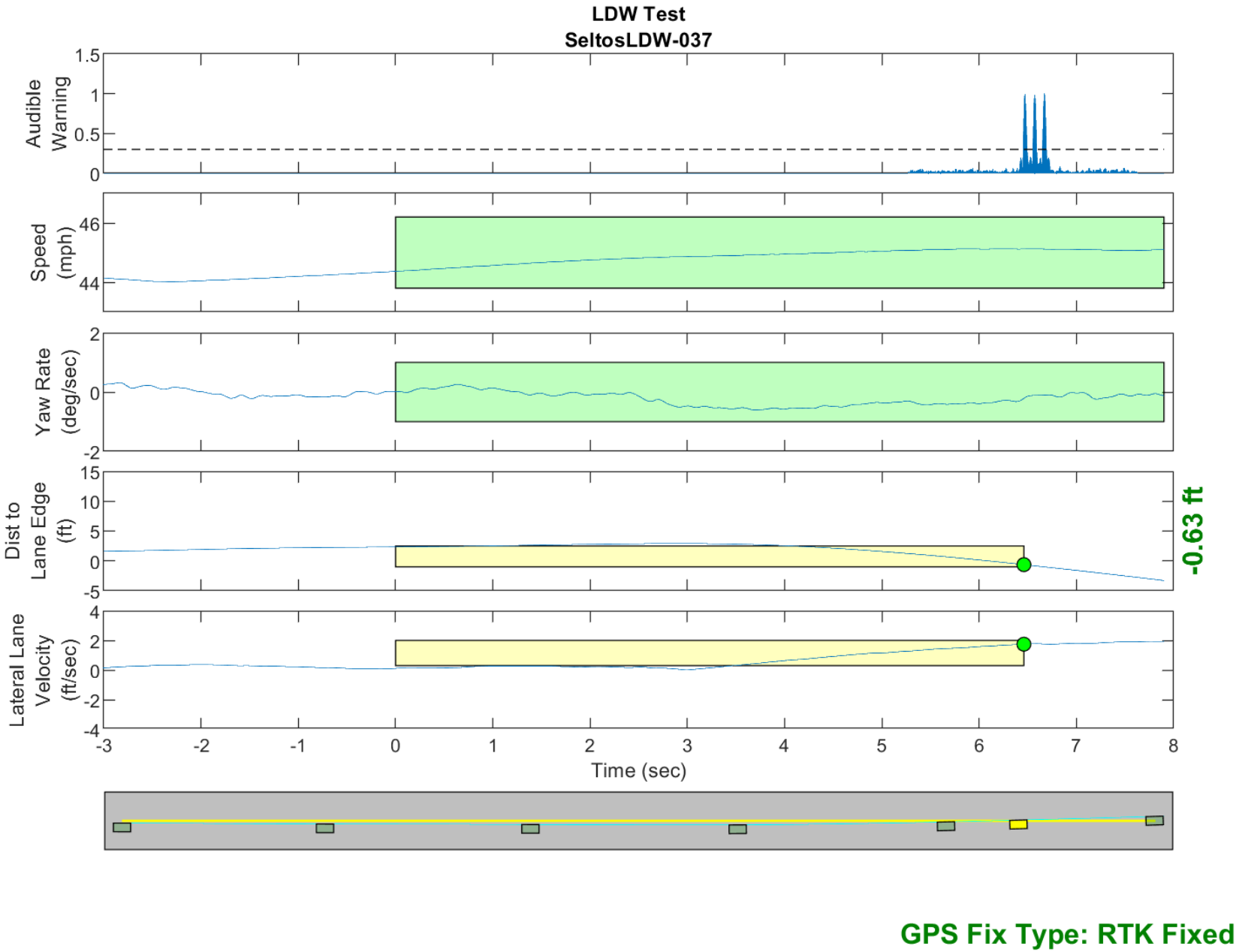

Figure D32. Time History for Run 37, Dashed Line, Left Departure, Auditory Warning

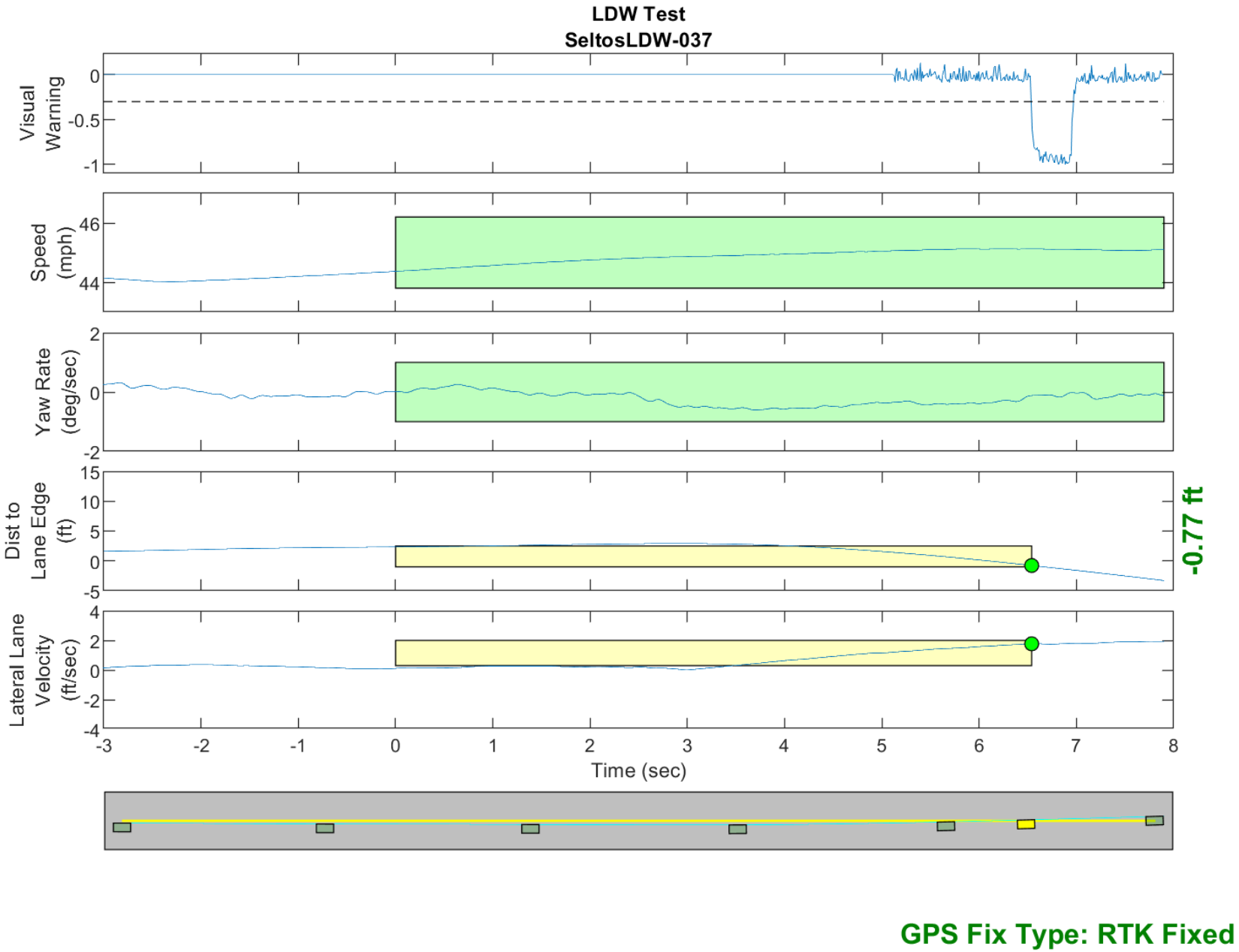

Figure D33. Time History for Run 37, Dashed Line, Left Departure, Visual Warning

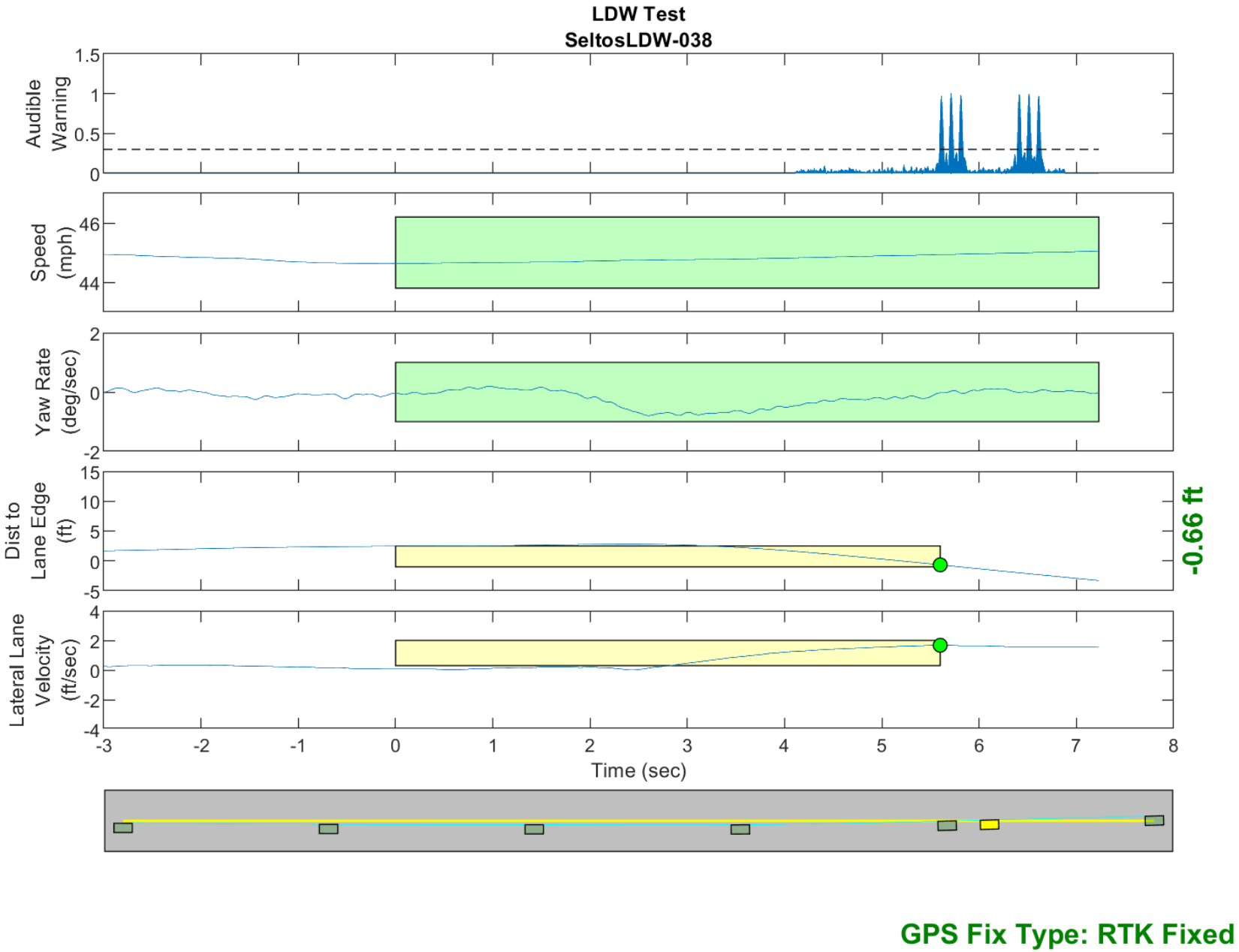

Figure D34. Time History for Run 38, Dashed Line, Left Departure, Auditory Warning

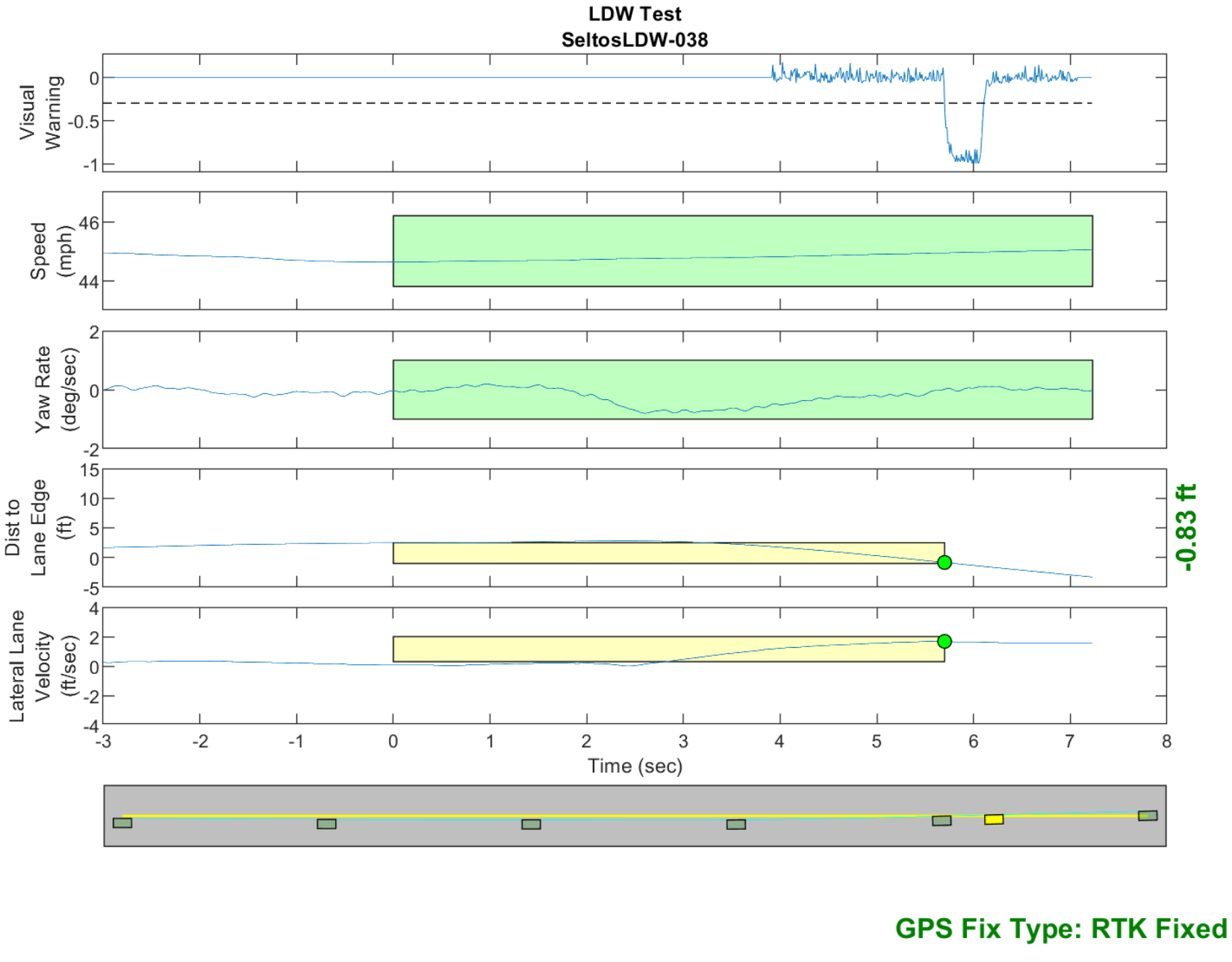

Figure D35. Time History for Run 38, Dashed Line, Left Departure, Visual Warning

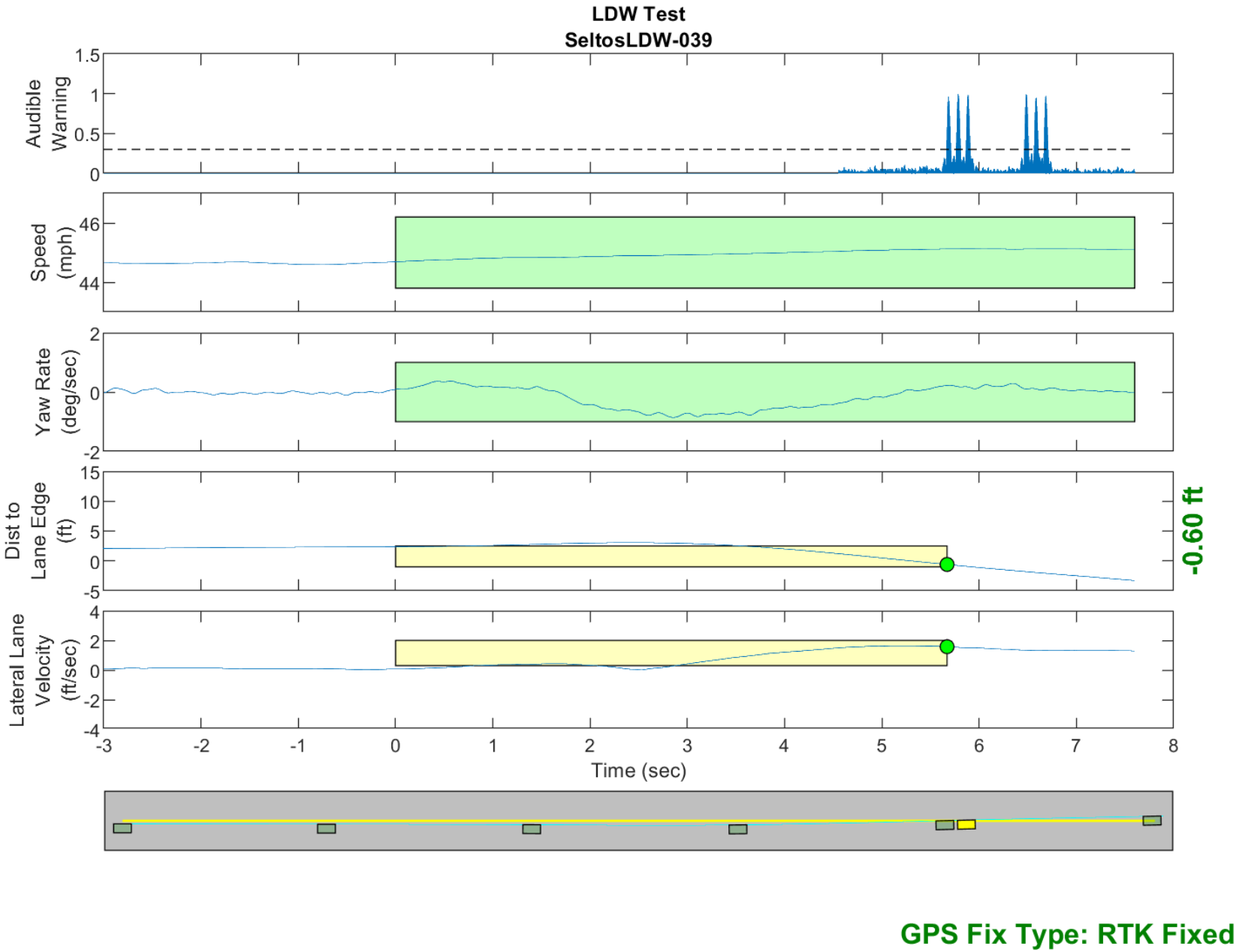

Figure D36. Time History for Run 39, Dashed Line, Left Departure, Auditory Warning

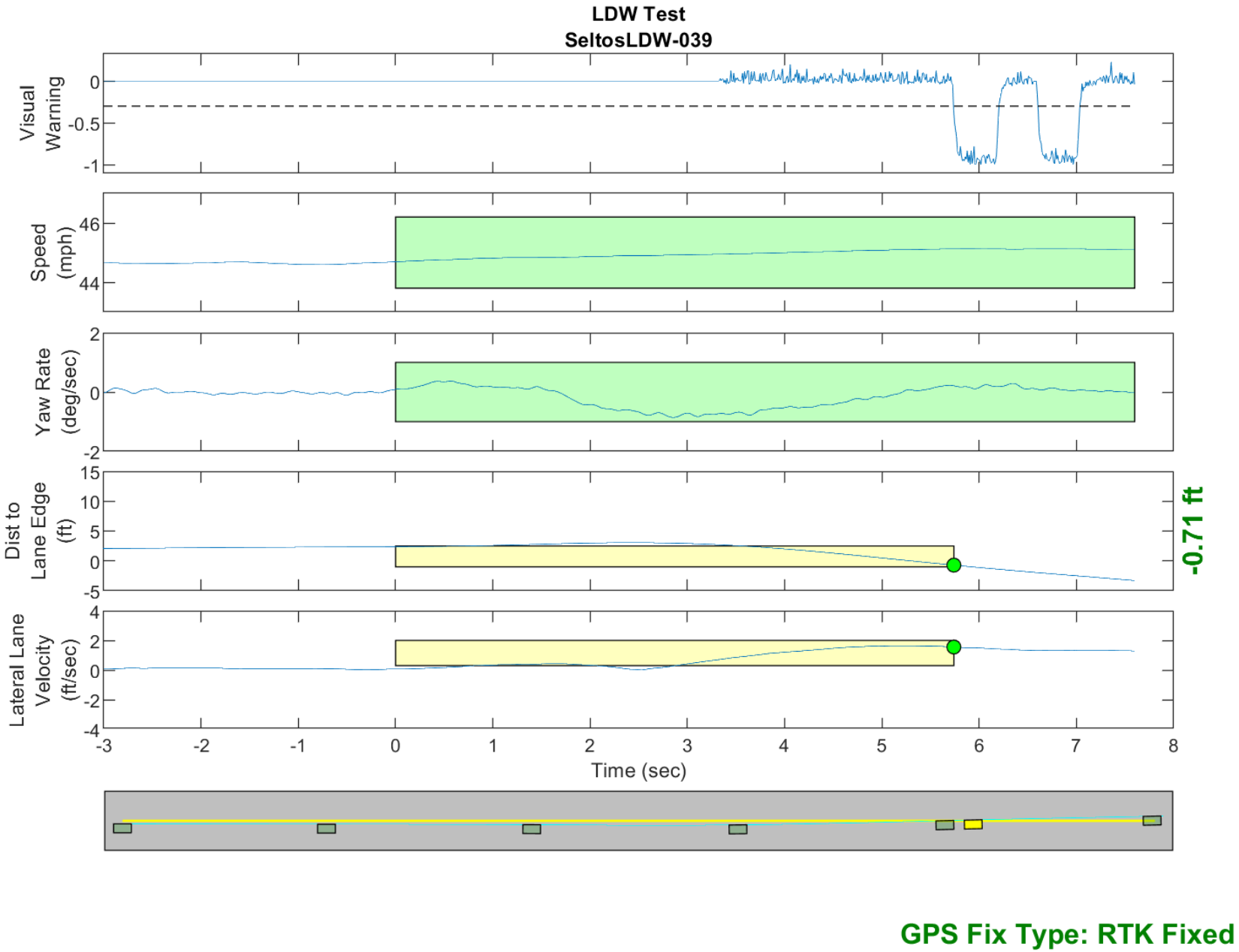

Figure D37. Time History for Run 39, Dashed Line, Left Departure, Visual Warning

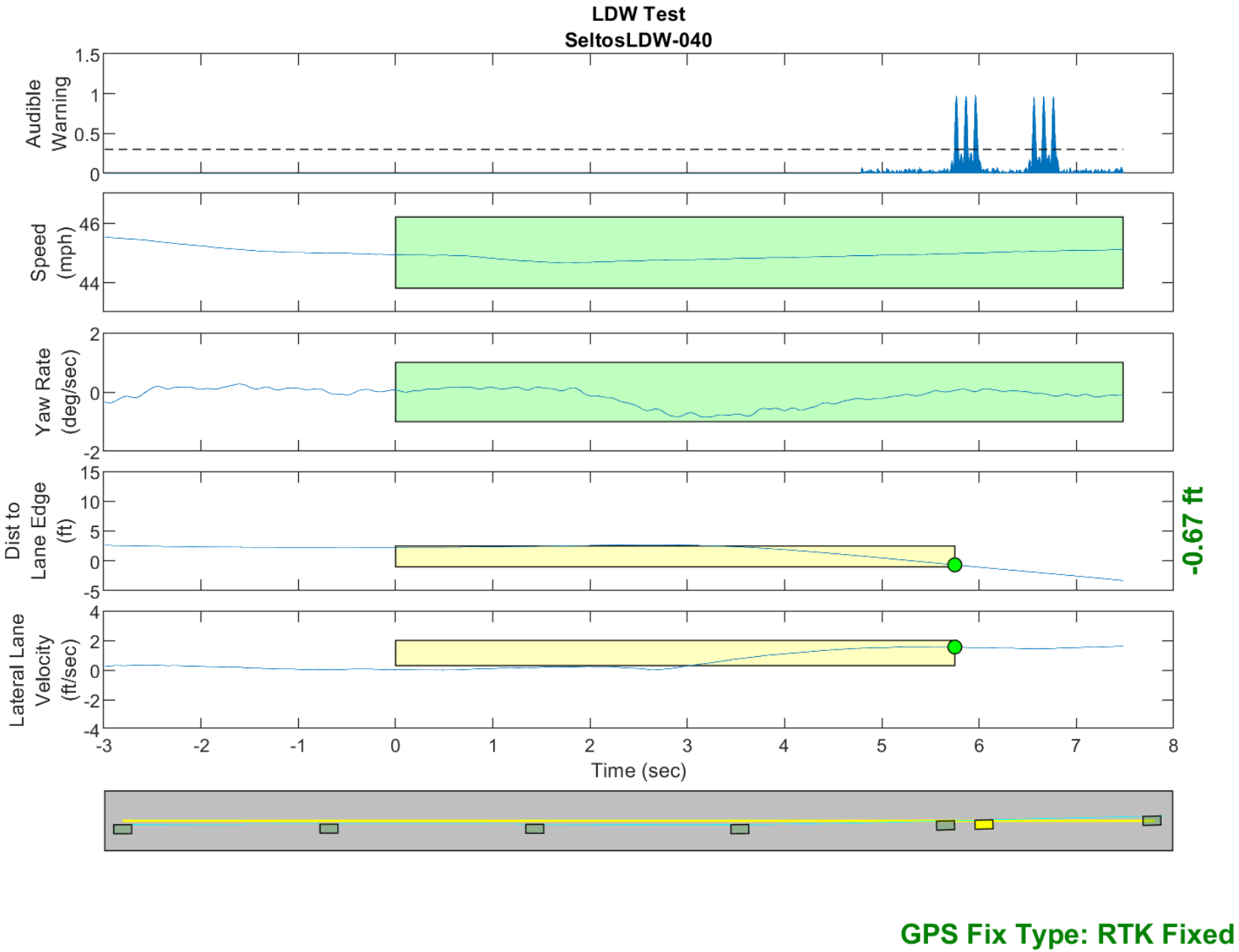

Figure D38. Time History for Run 40, Dashed Line, Left Departure, Auditory Warning

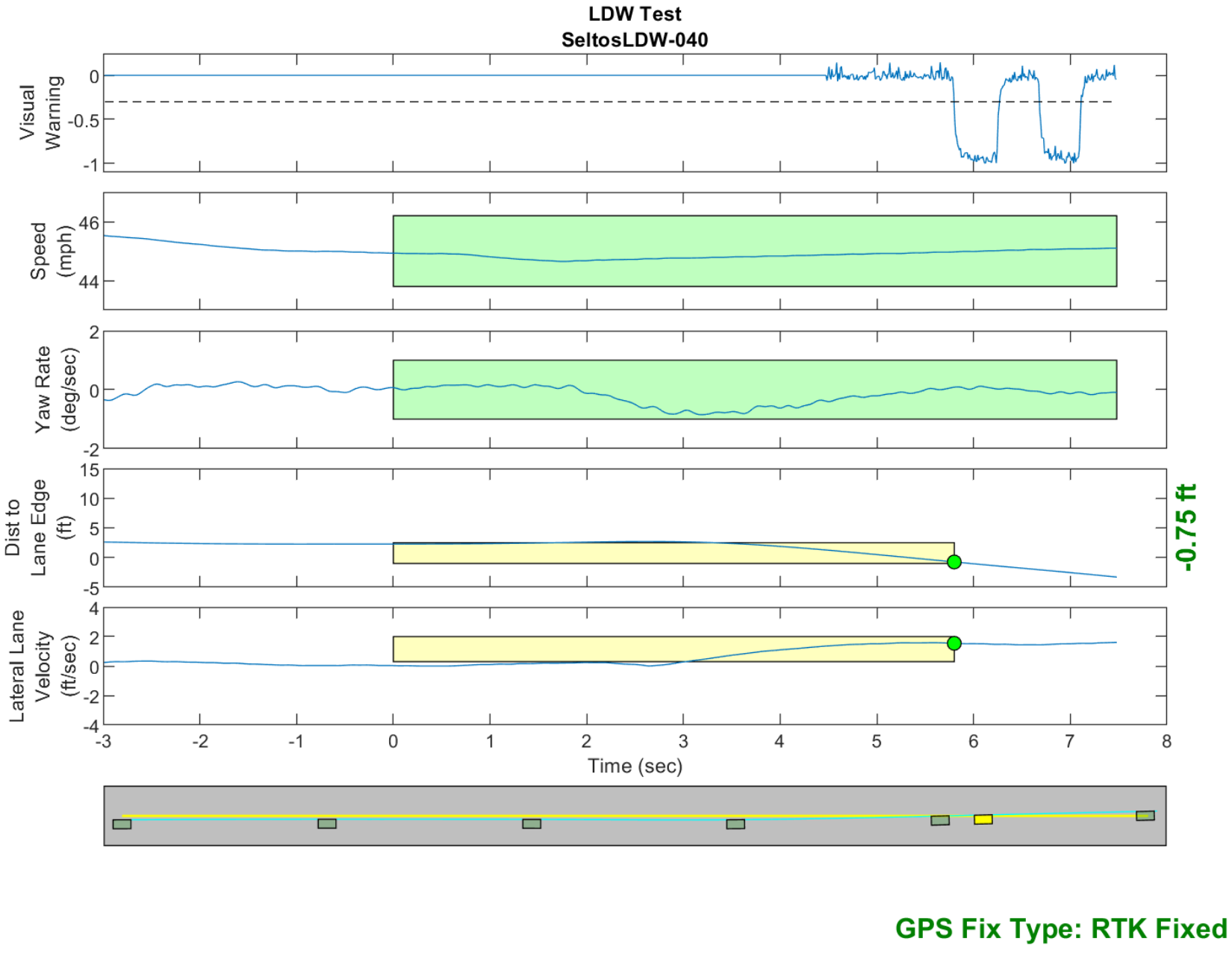

Figure D39. Time History for Run 40, Dashed Line, Left Departure, Visual Warning

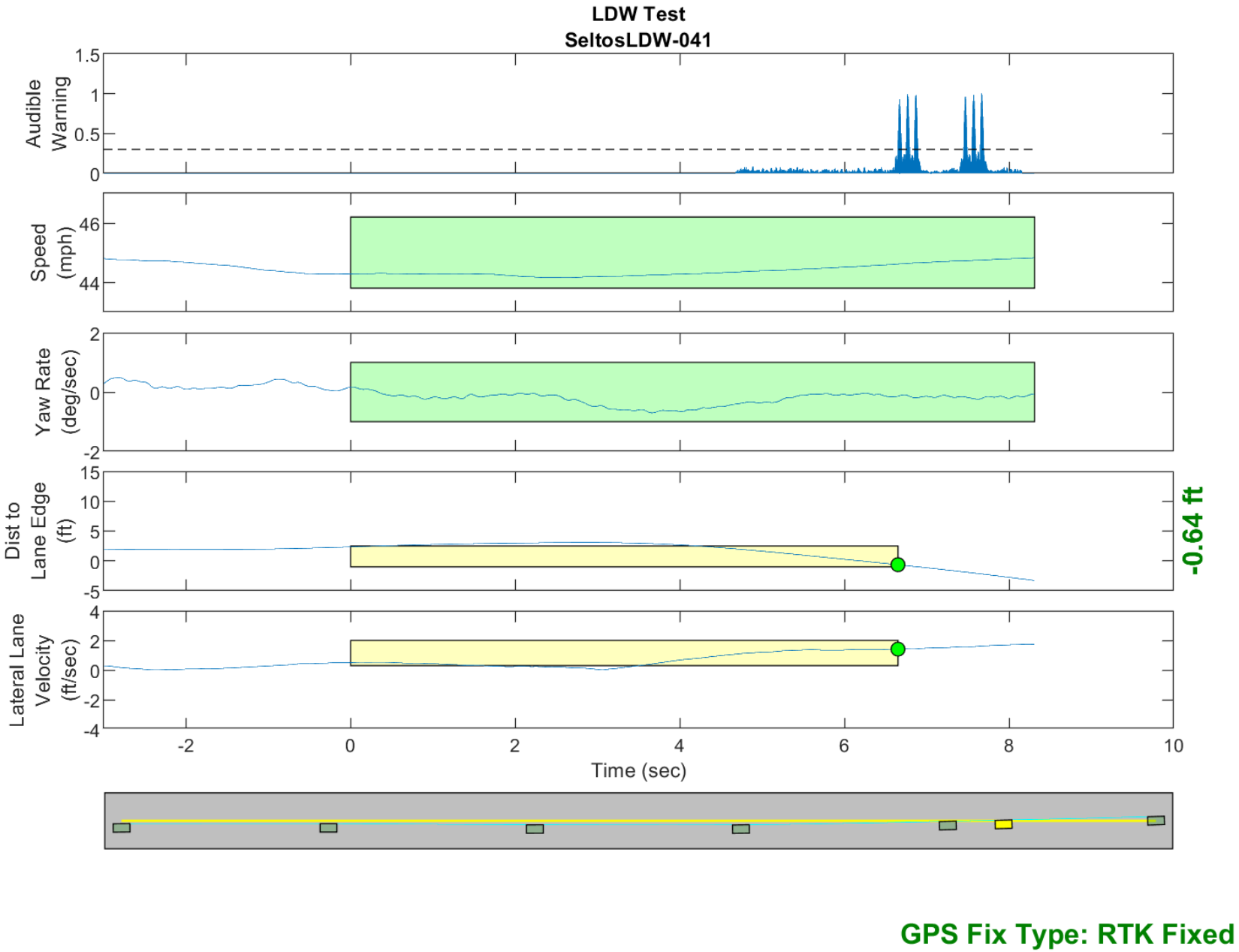

Figure D40. Time History for Run 41, Dashed Line, Left Departure, Auditory Warning

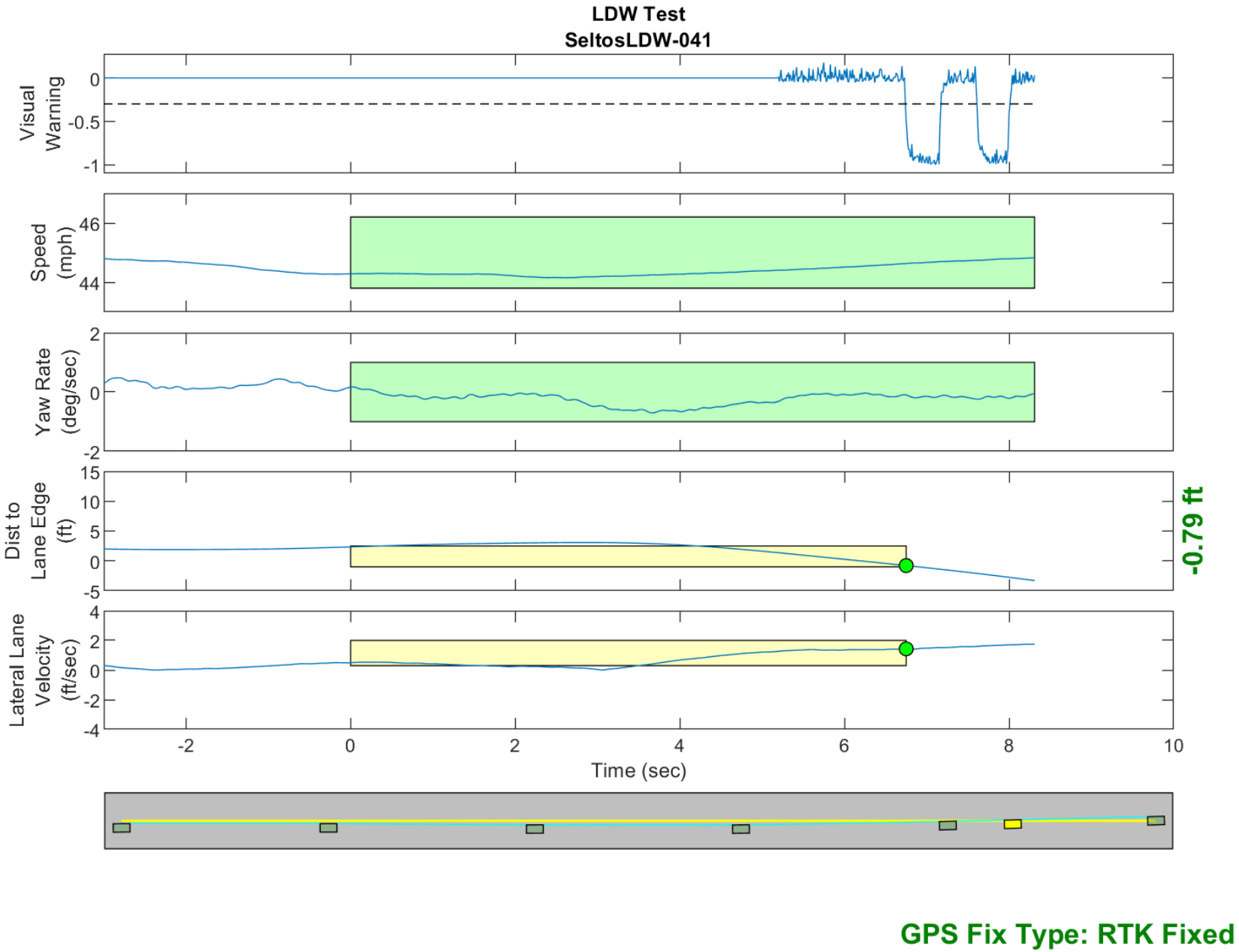

Figure D41. Time History for Run 41, Dashed Line, Left Departure, Visual Warning

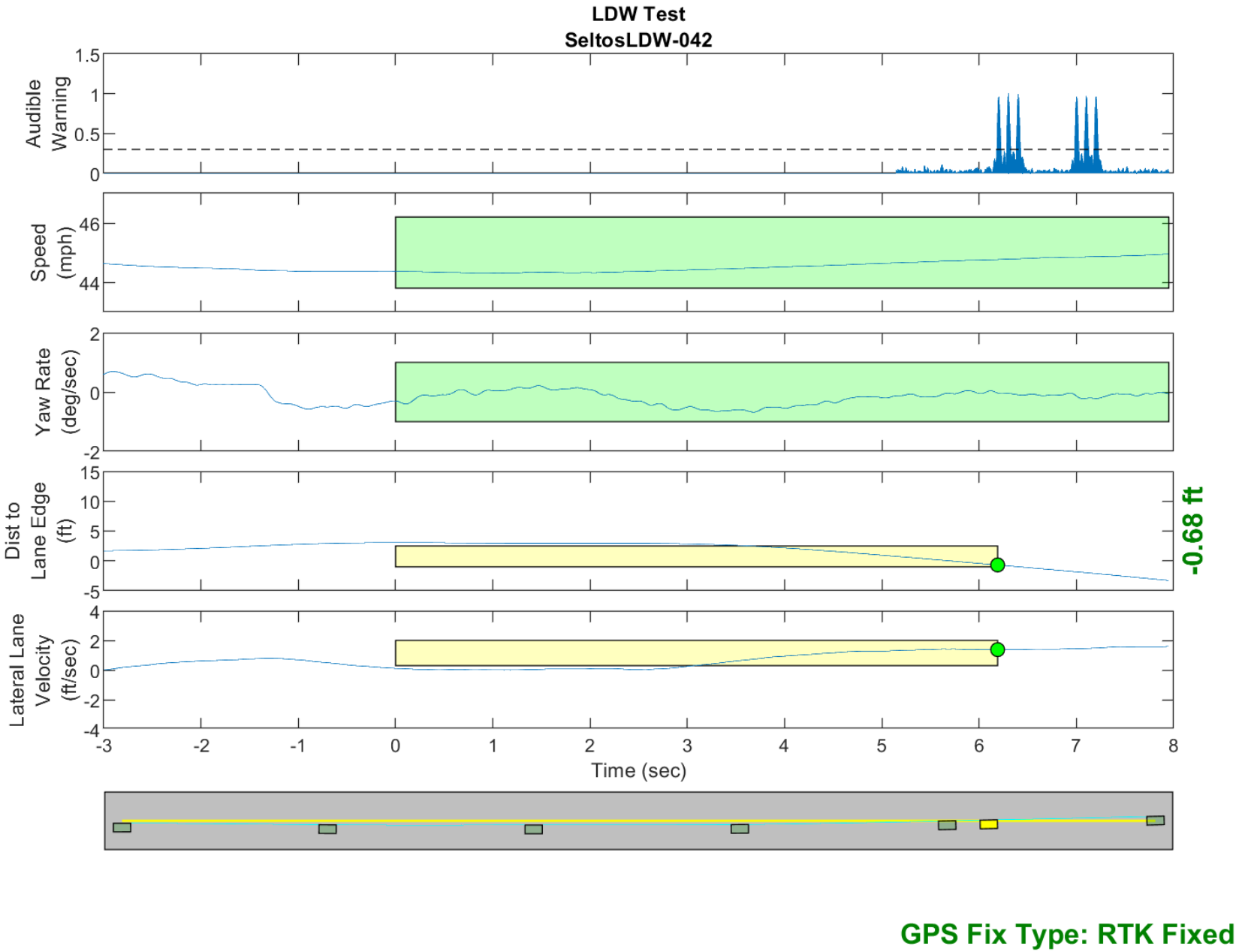

Figure D42. Time History for Run 42, Dashed Line, Left Departure, Auditory Warning

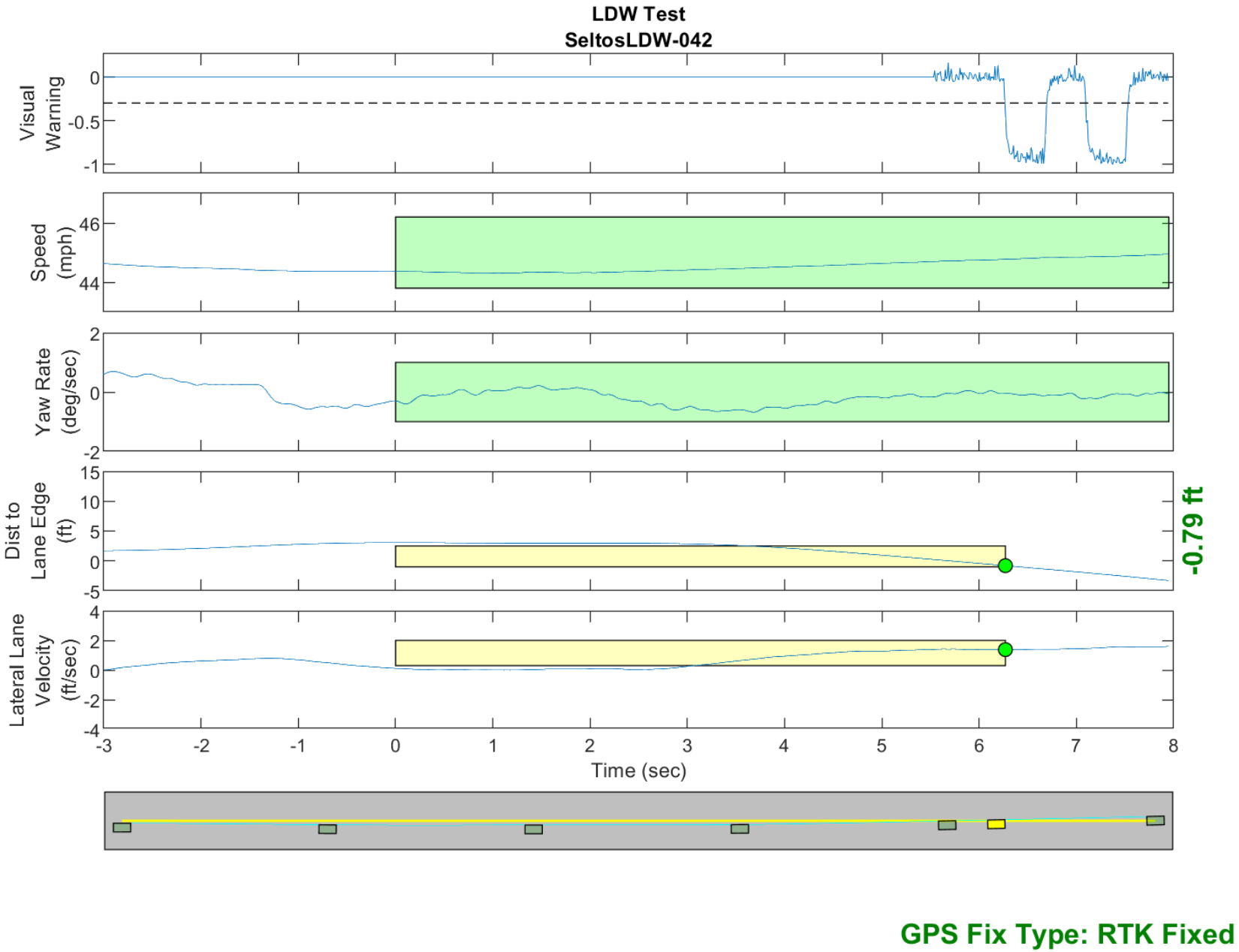

Figure D43. Time History for Run 42, Dashed Line, Left Departure, Visual Warning

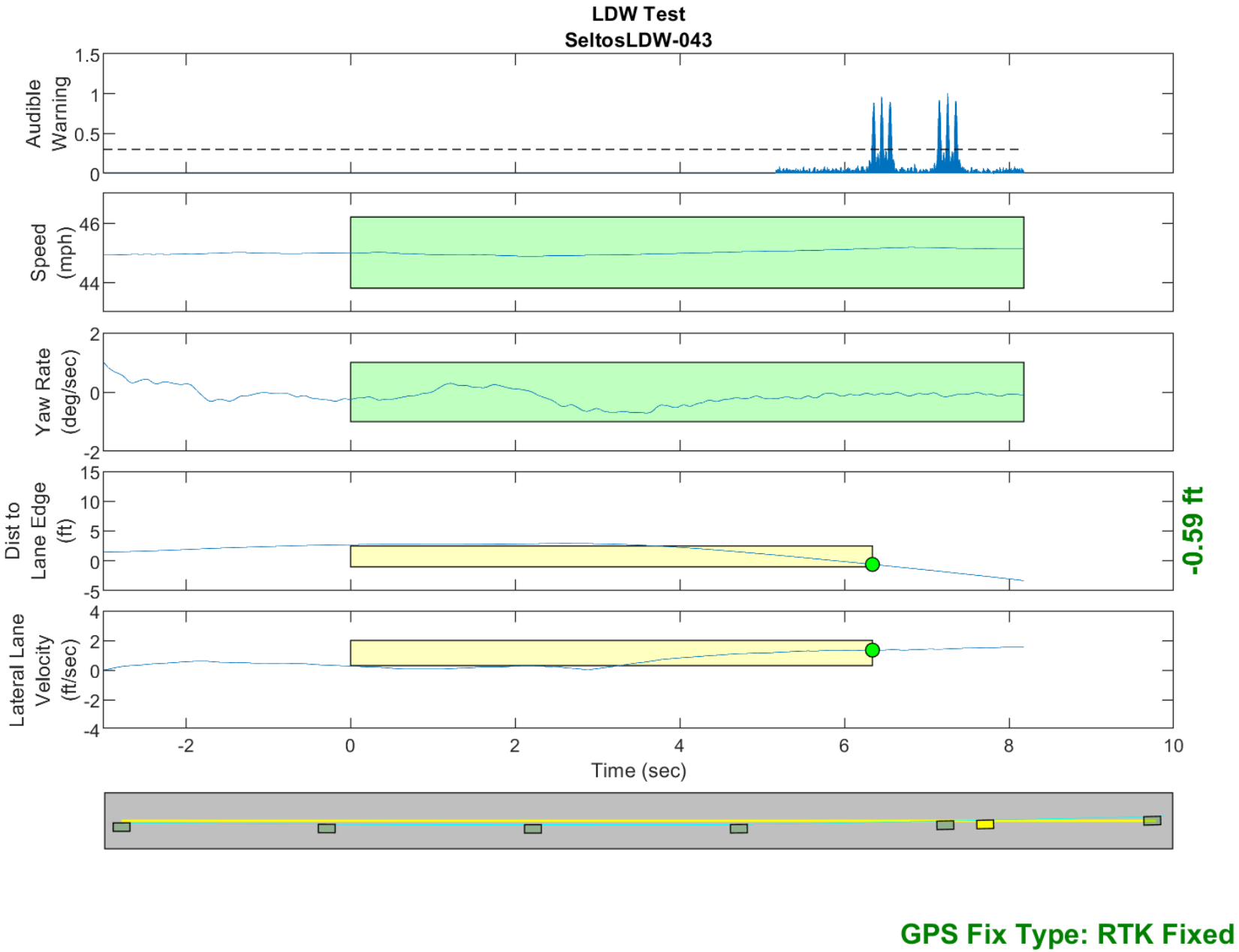

Figure D44. Time History for Run 43, Dashed Line, Left Departure, Auditory Warning

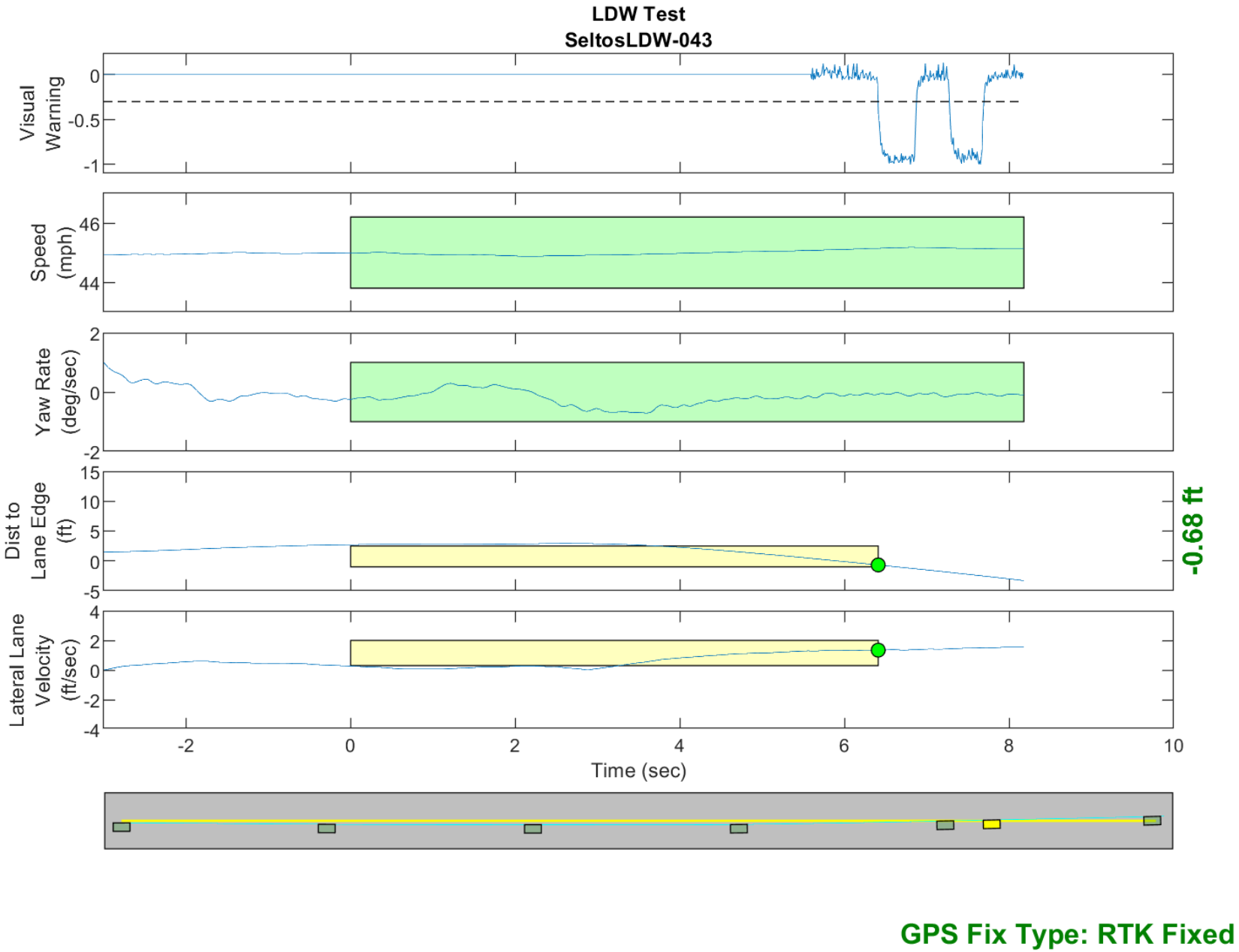

Figure D45. Time History for Run 43, Dashed Line, Left Departure, Visual Warning

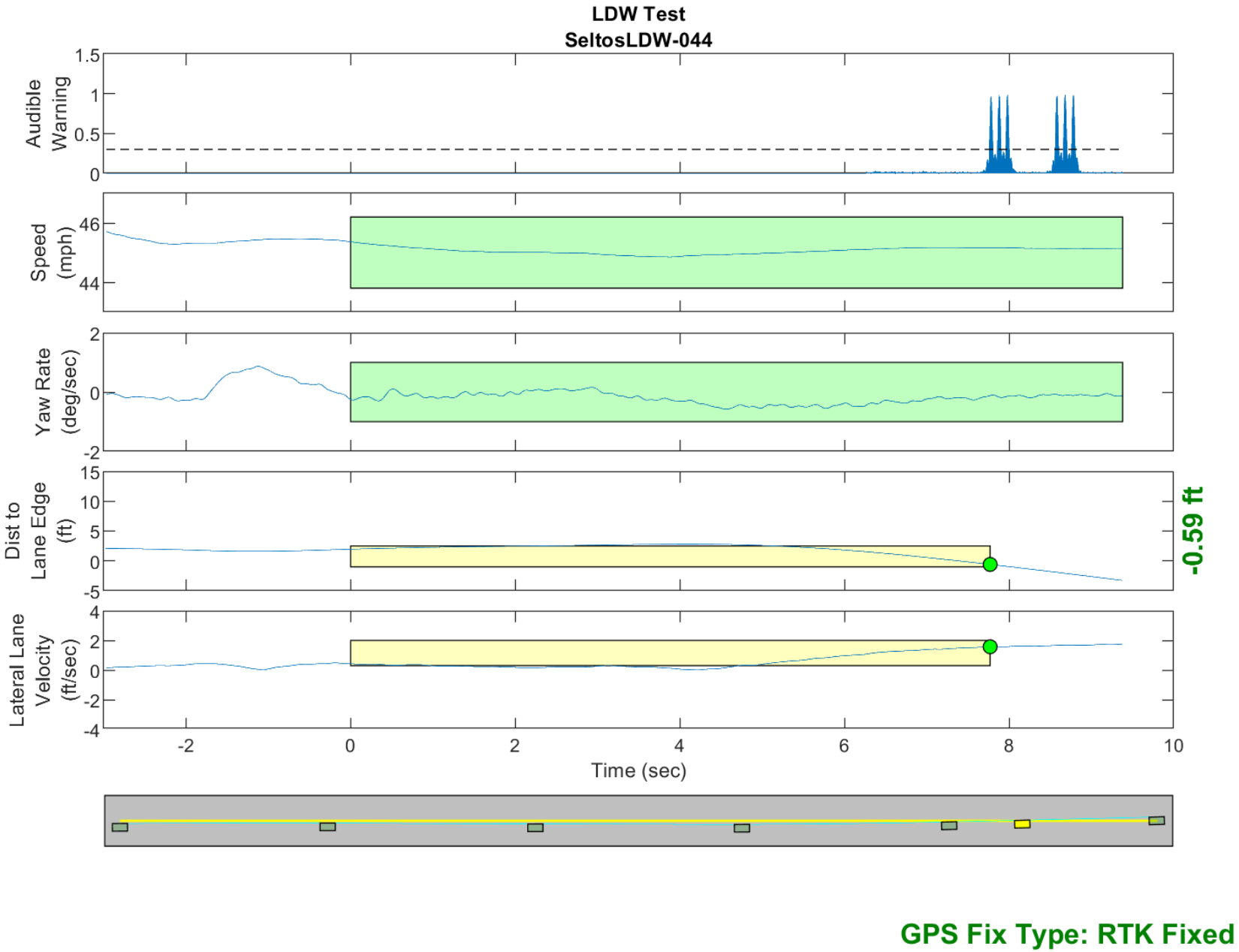

Figure D46. Time History for Run 44, Solid Line, Left Departure, Auditory Warning

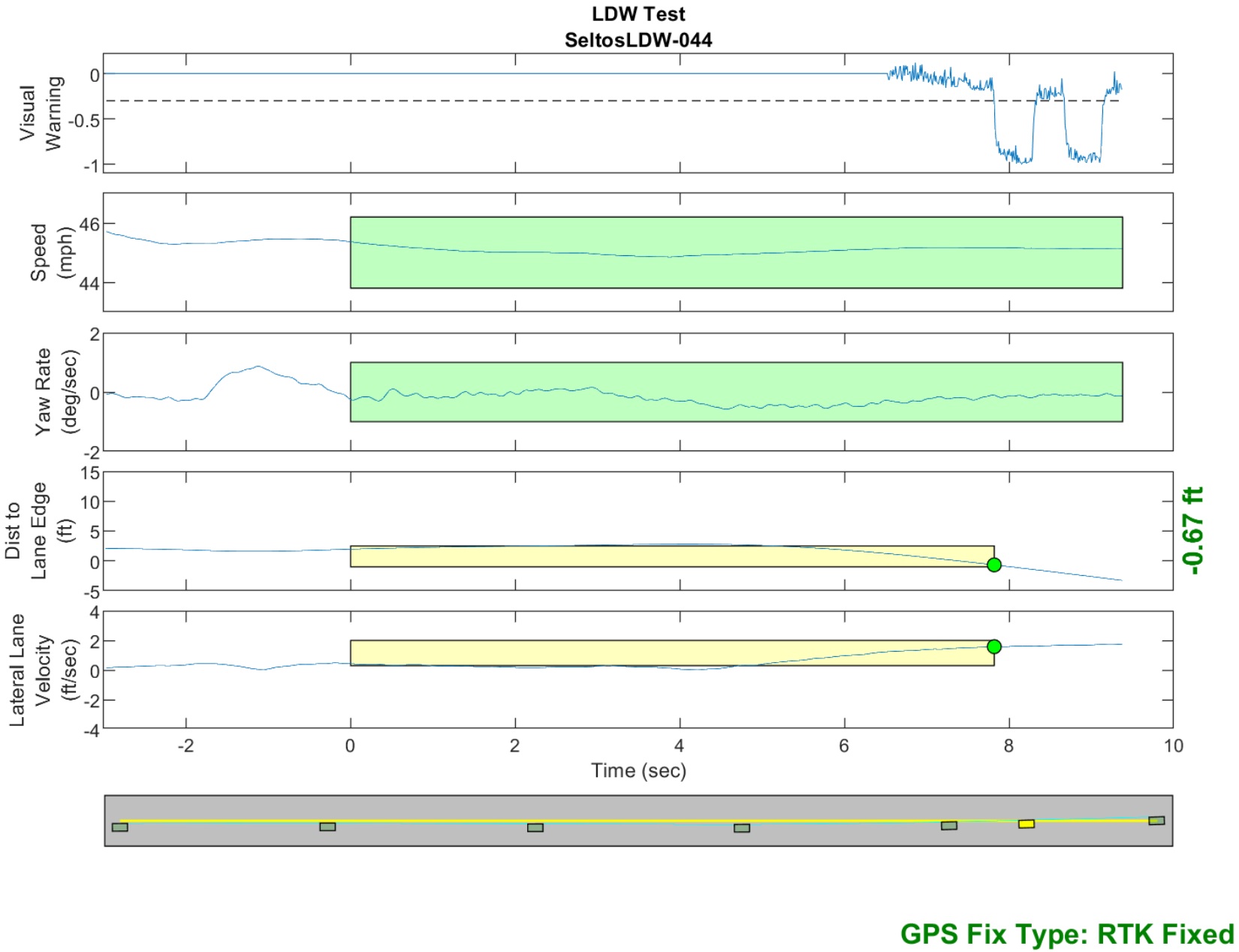

Figure D47. Time History for Run 44, Solid Line, Left Departure, Visual Warning

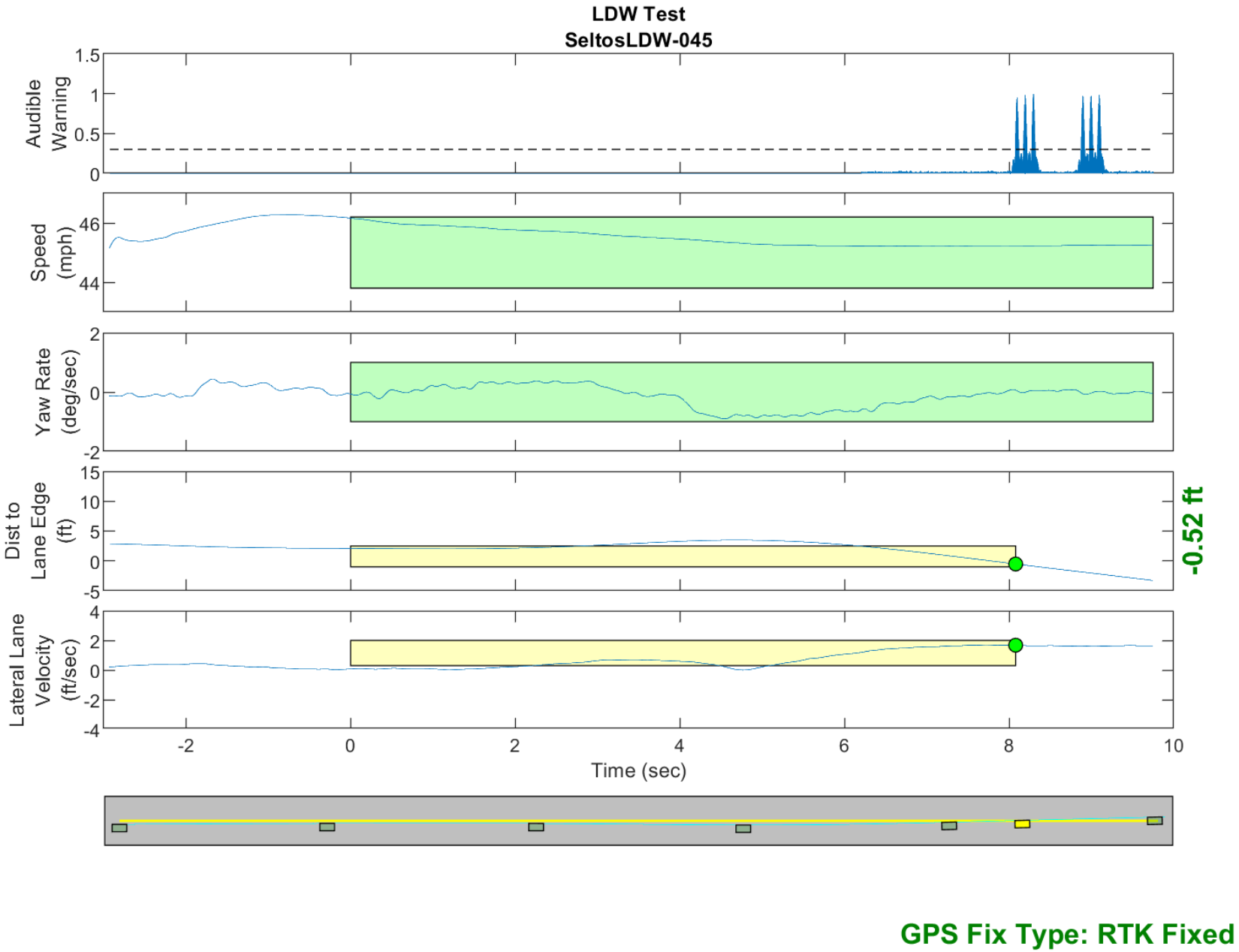

Figure D48. Time History for Run 45, Solid Line, Left Departure, Auditory Warning

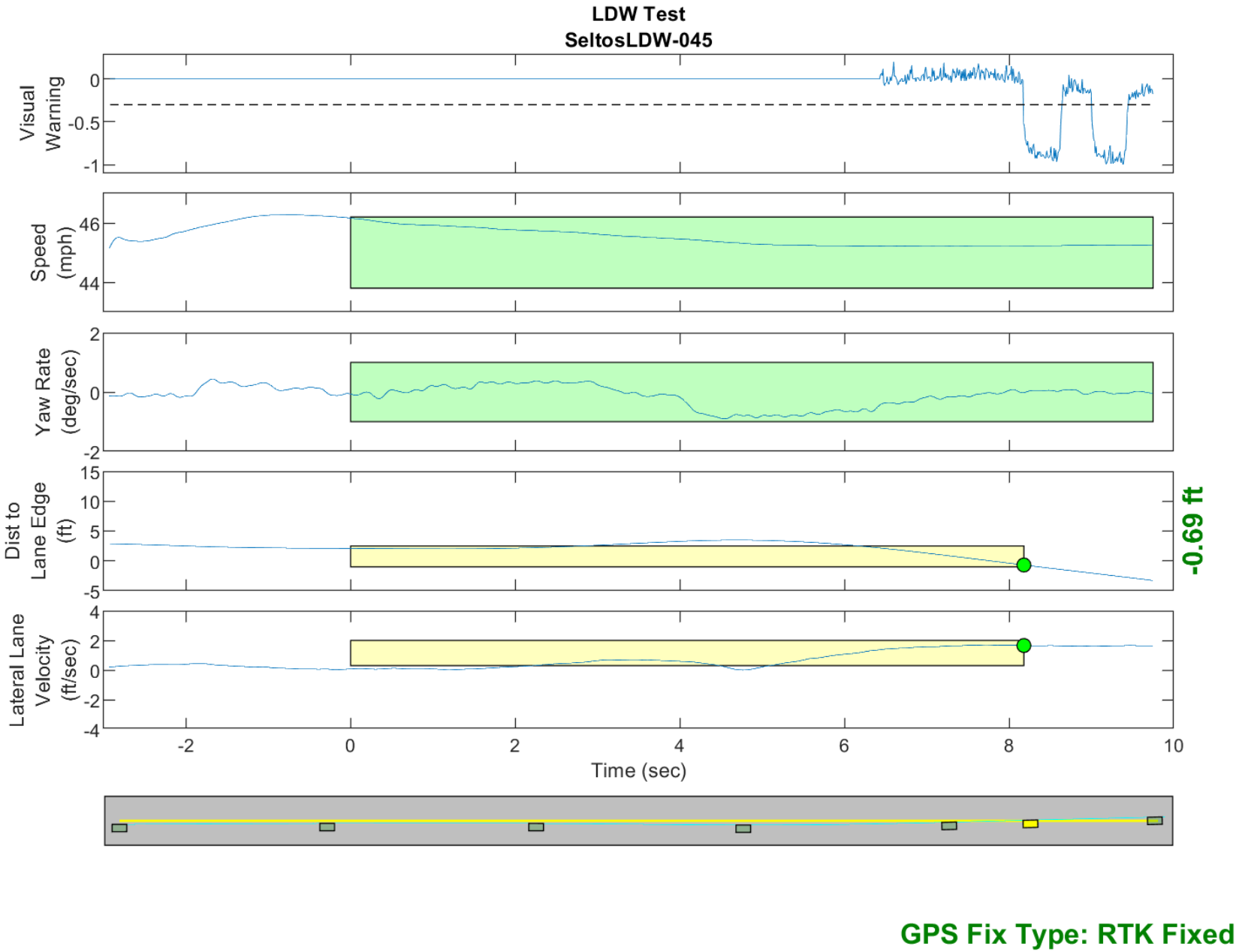

Figure D49. Time History for Run 45, Solid Line, Left Departure, Visual Warning

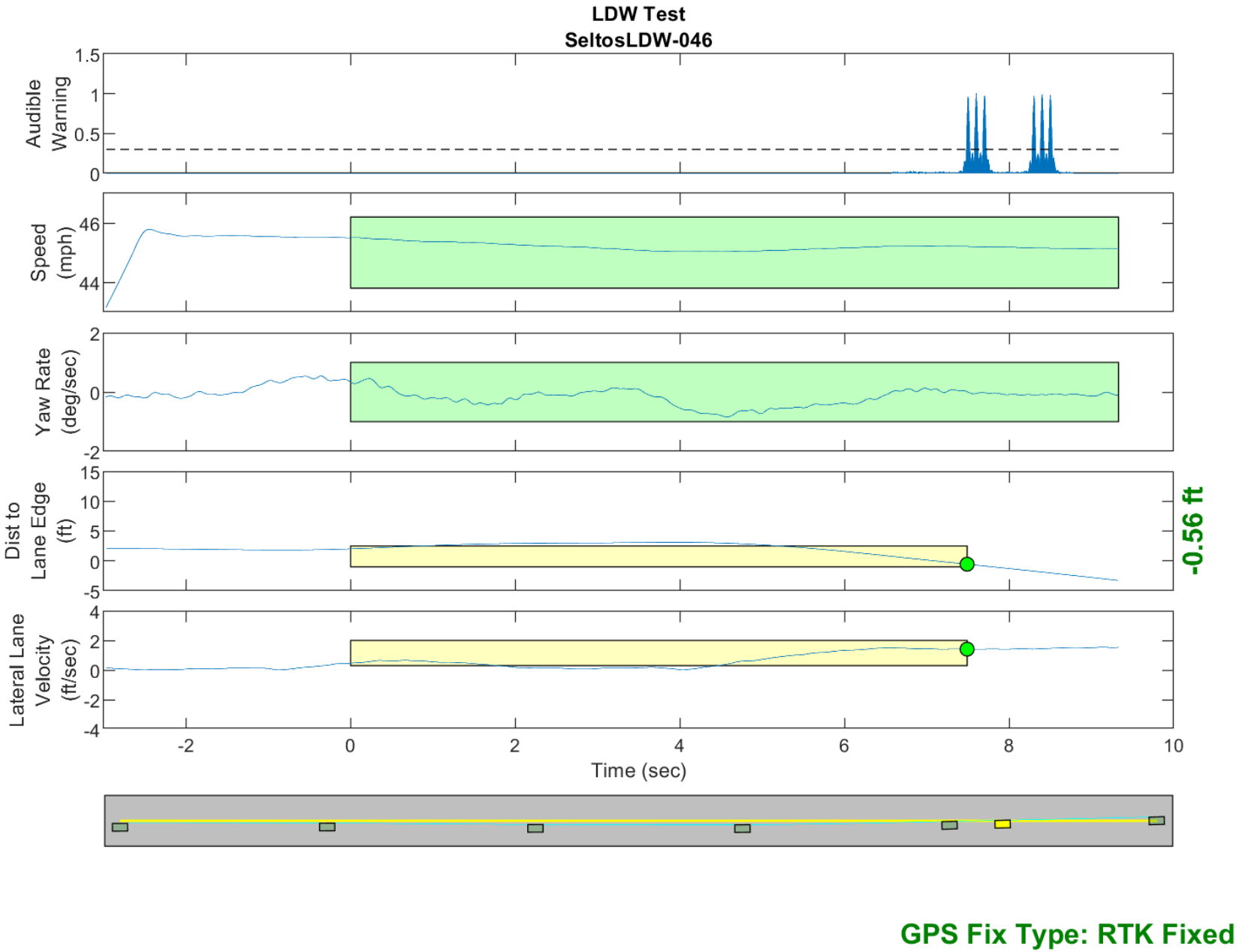

Figure D50. Time History for Run 46, Solid Line, Left Departure, Auditory Warning

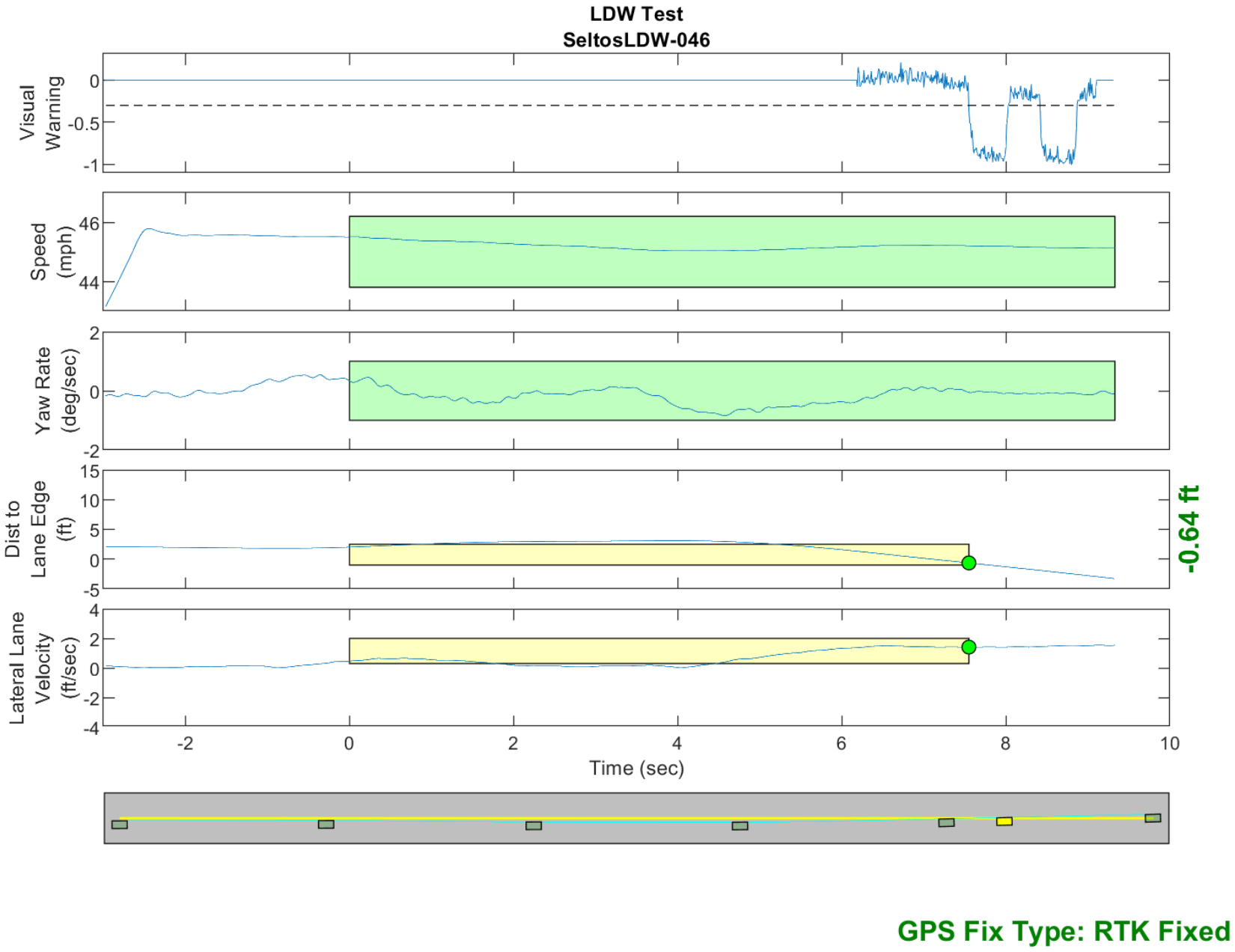

Figure D51. Time History for Run 46, Solid Line, Left Departure, Visual Warning

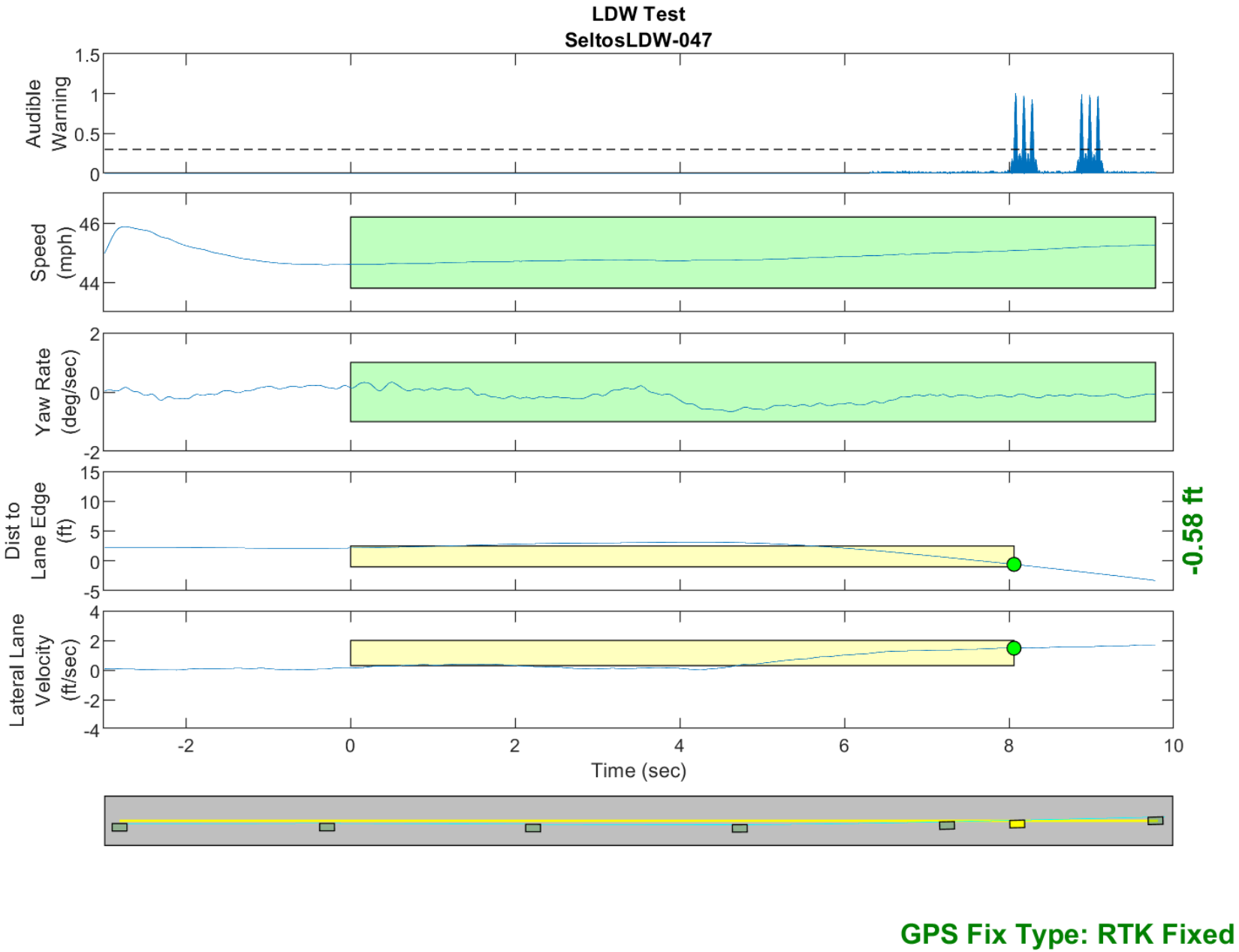

Figure D52. Time History for Run 47, Solid Line, Left Departure, Auditory Warning

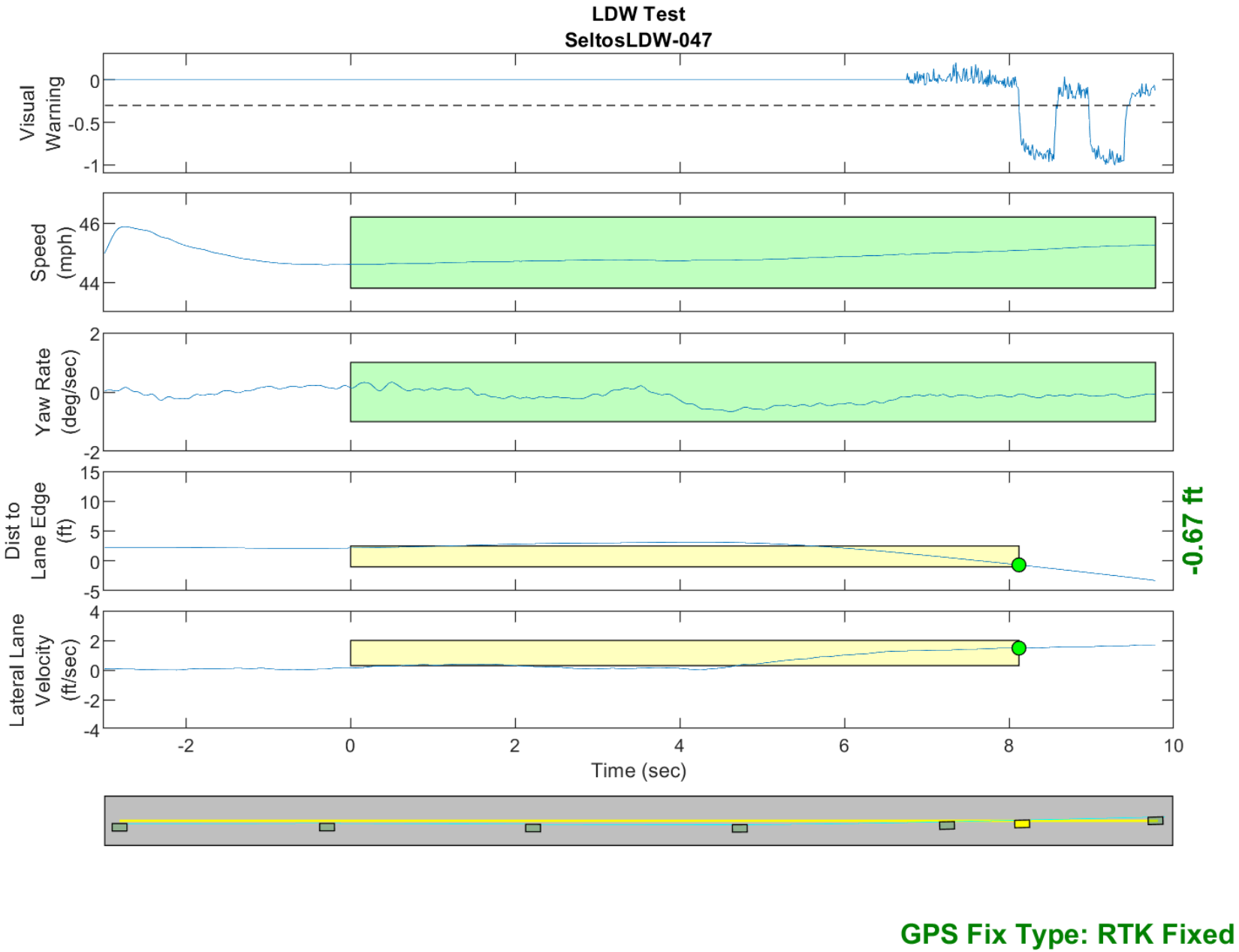

Figure D53. Time History for Run 47, Solid Line, Left Departure, Visual Warning

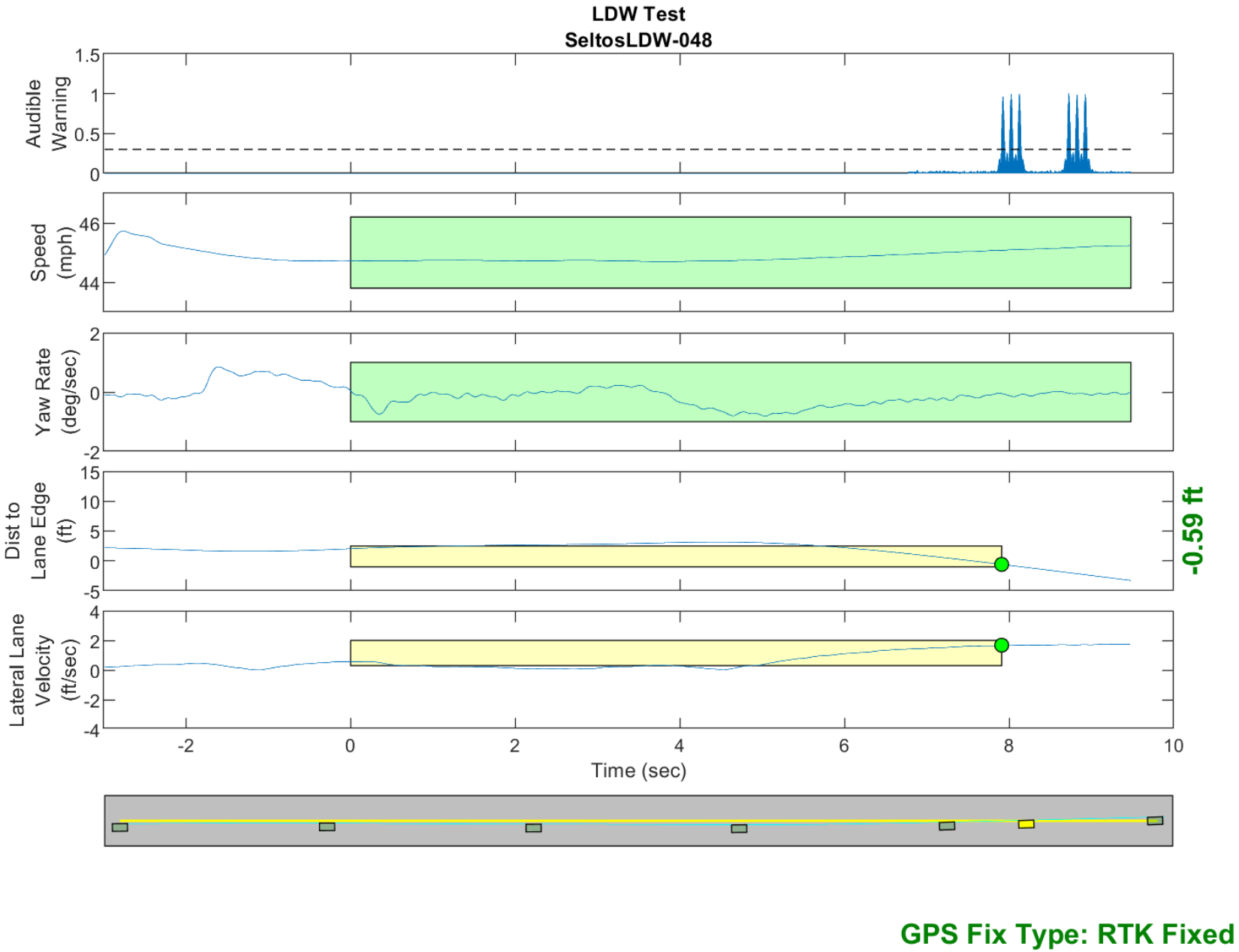

Figure D54. Time History for Run 48, Solid Line, Left Departure, Auditory Warning

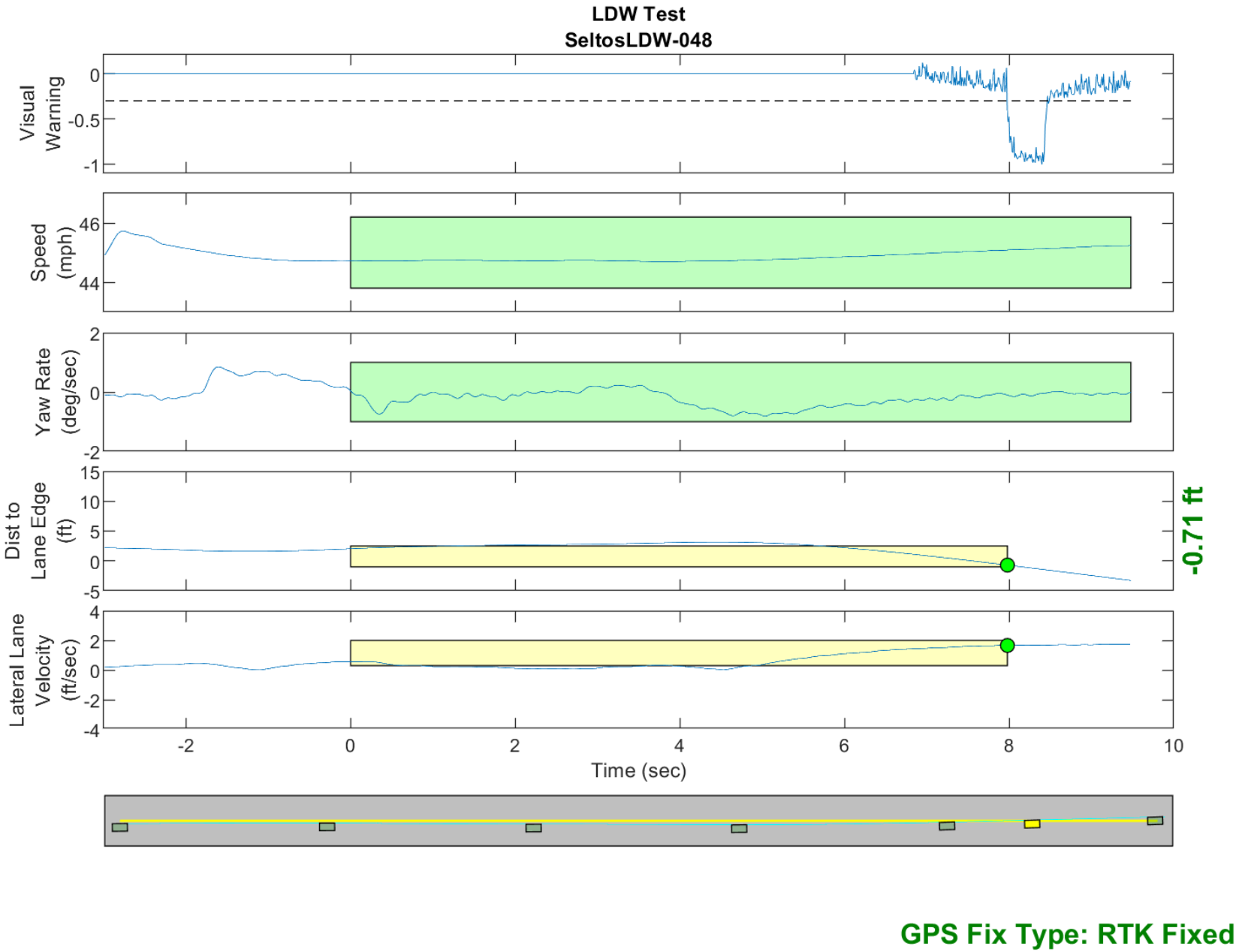

Figure D55. Time History for Run 48, Solid Line, Left Departure, Visual Warning

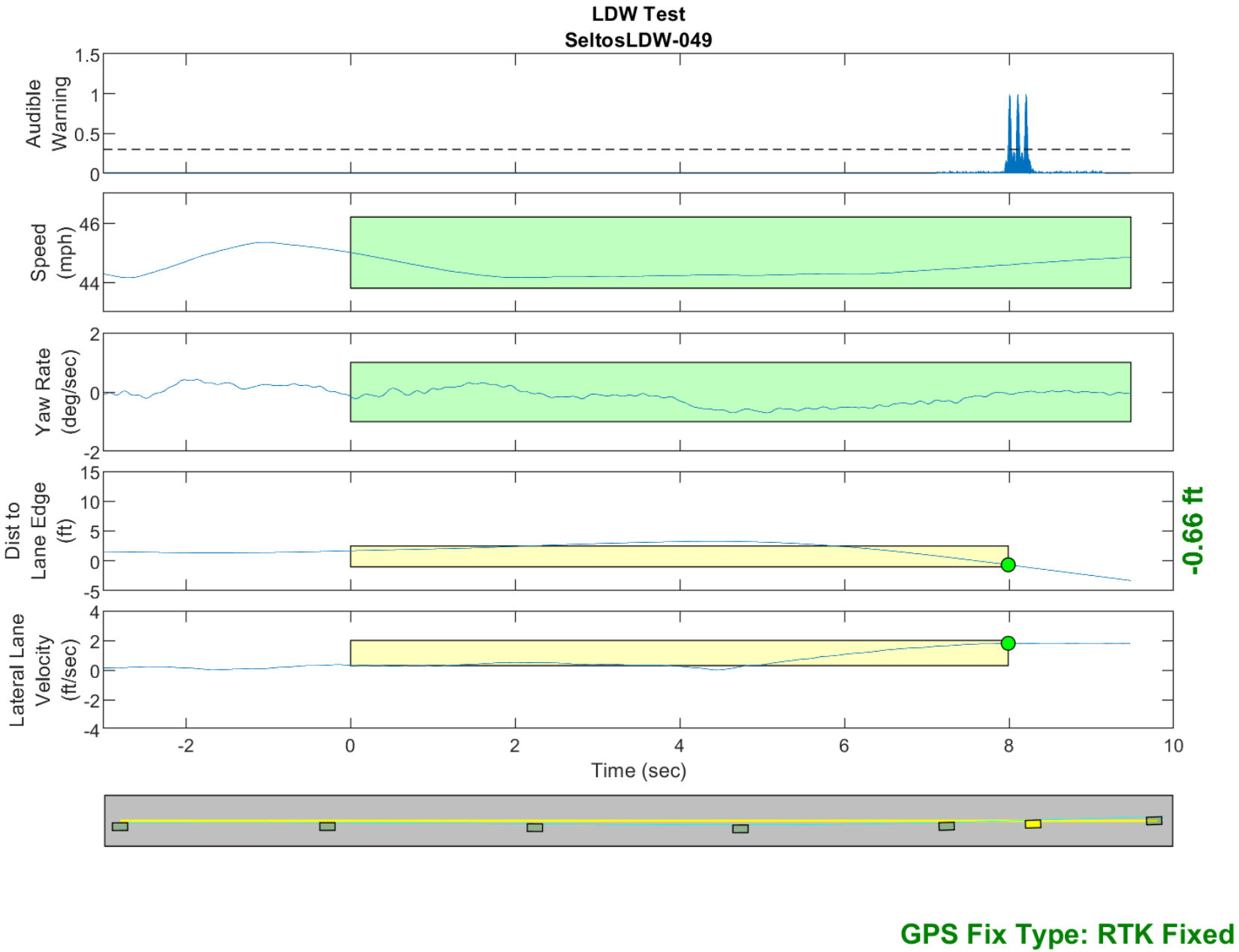

Figure D56. Time History for Run 49, Solid Line, Left Departure, Auditory Warning

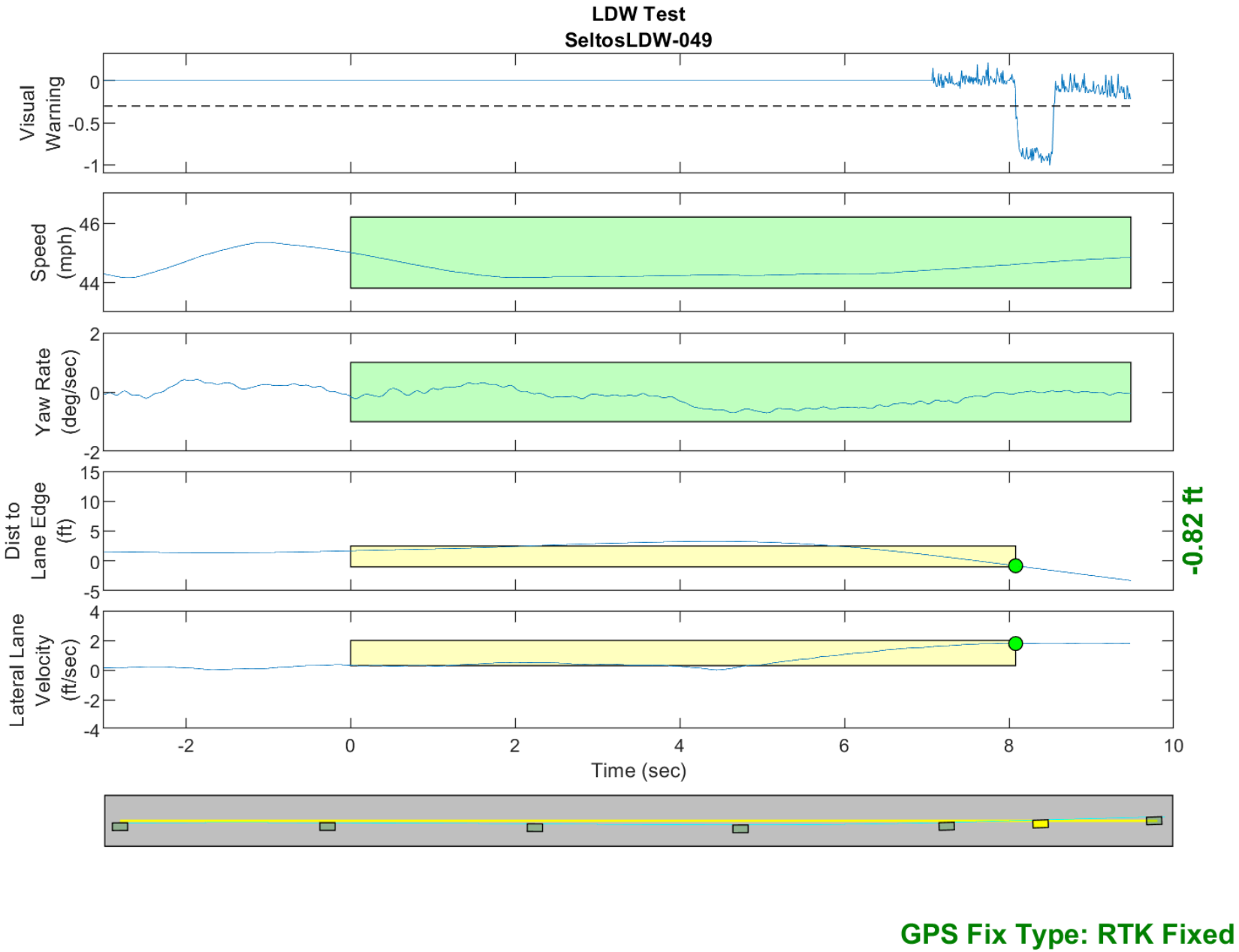

Figure D57. Time History for Run 49, Solid Line, Left Departure, Visual Warning

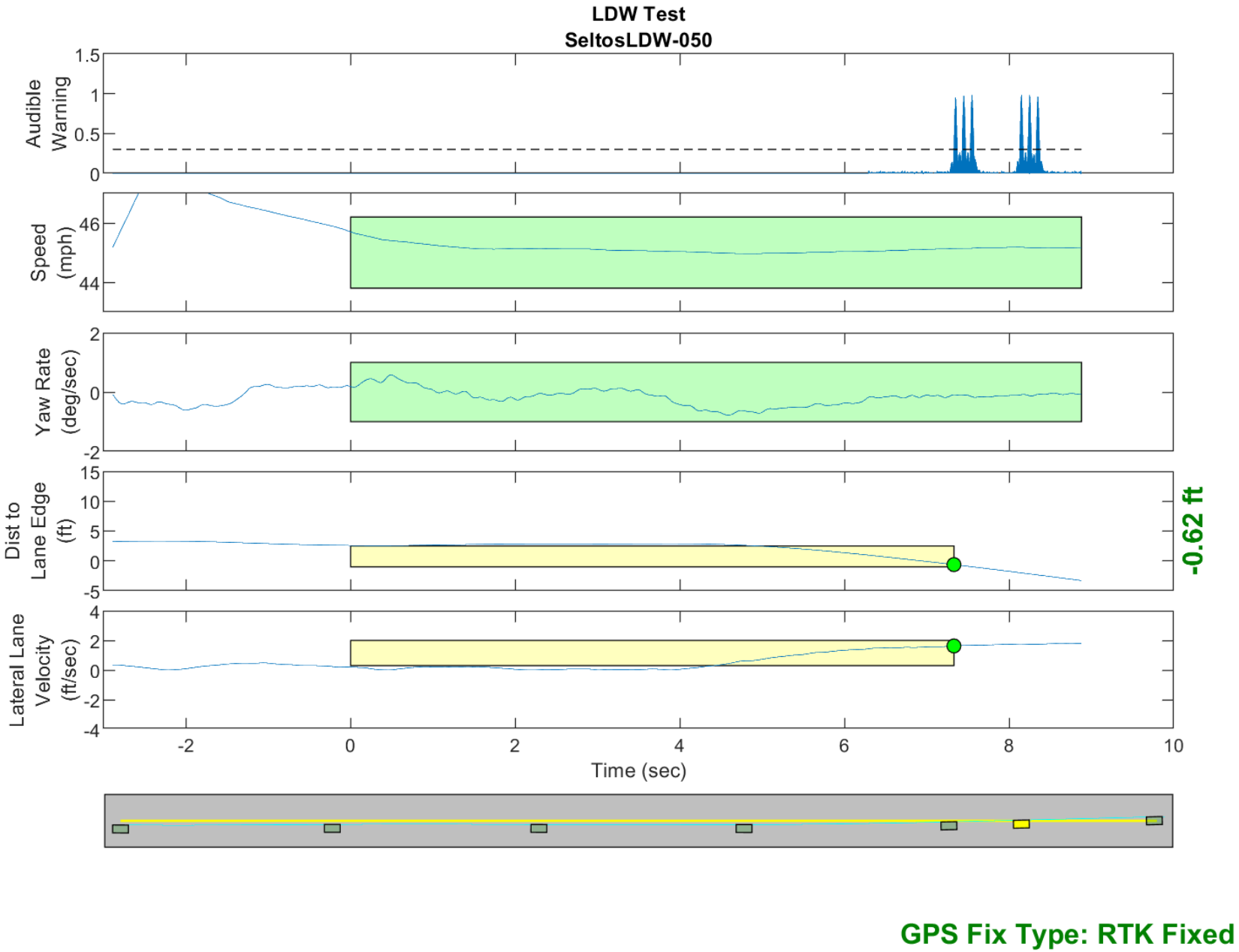

Figure D58. Time History for Run 50, Solid Line, Left Departure, Auditory Warning

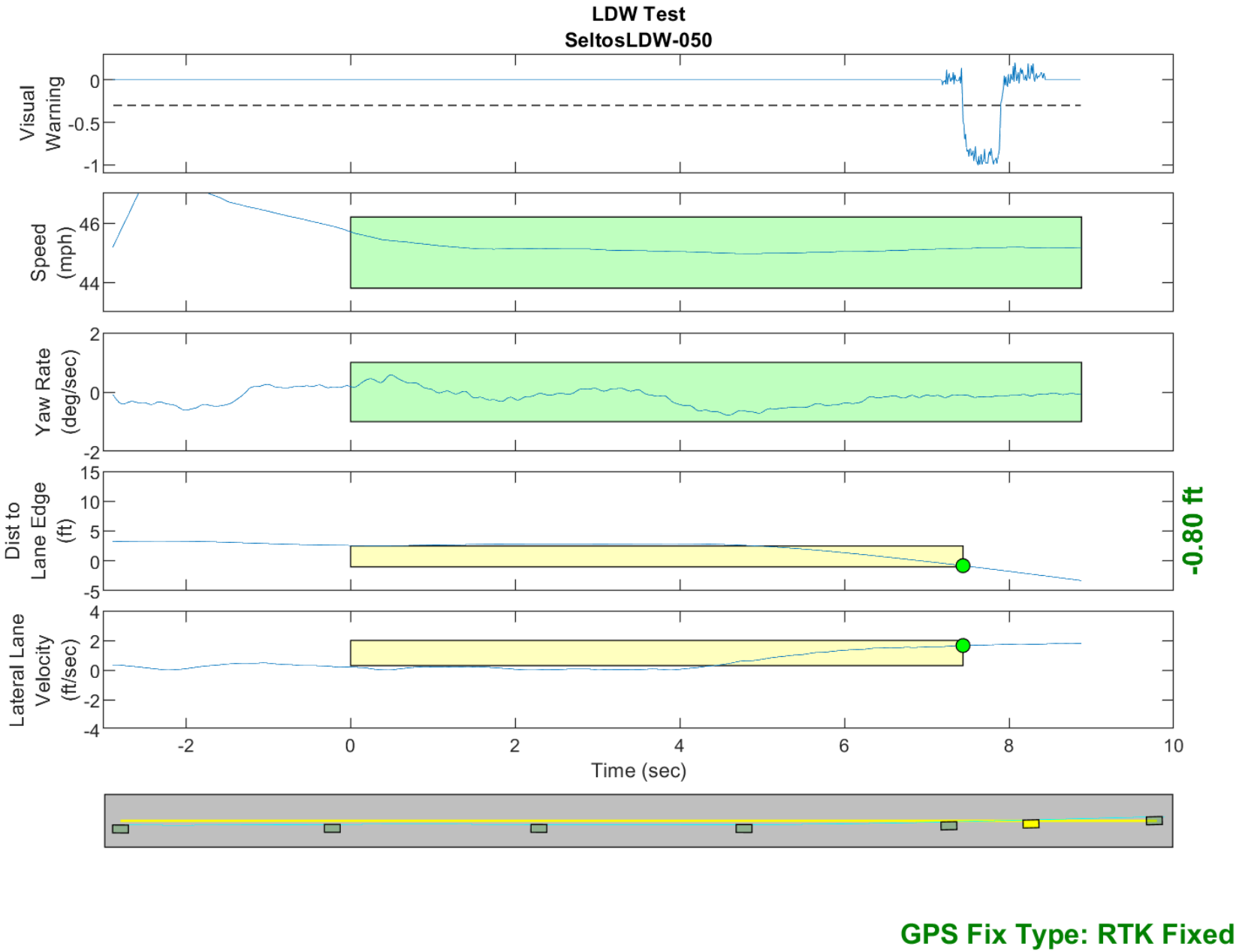

Figure D59. Time History for Run 50, Solid Line, Left Departure, Visual Warning

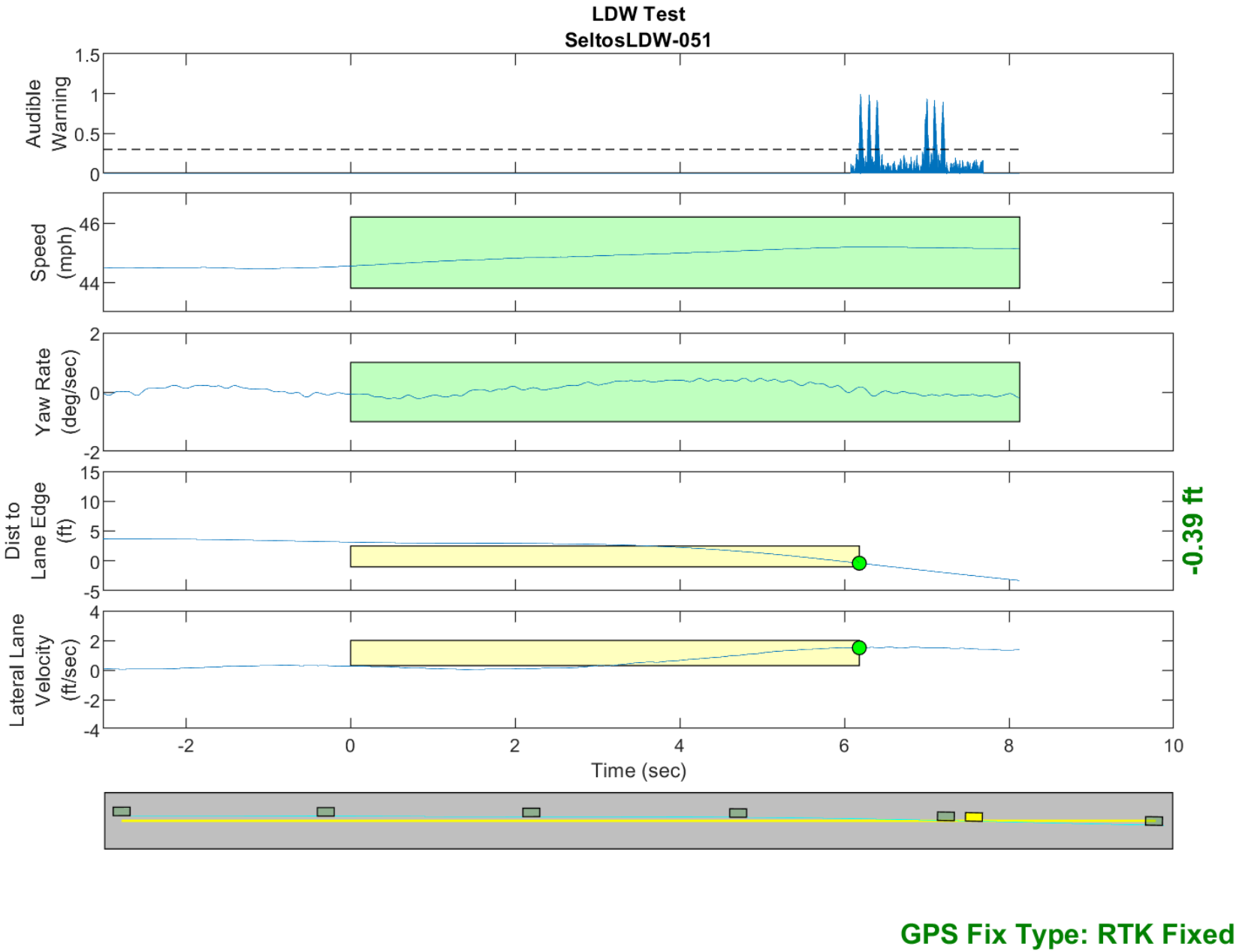

Figure D60. Time History for Run 51, Solid Line, Right Departure, Auditory Warning

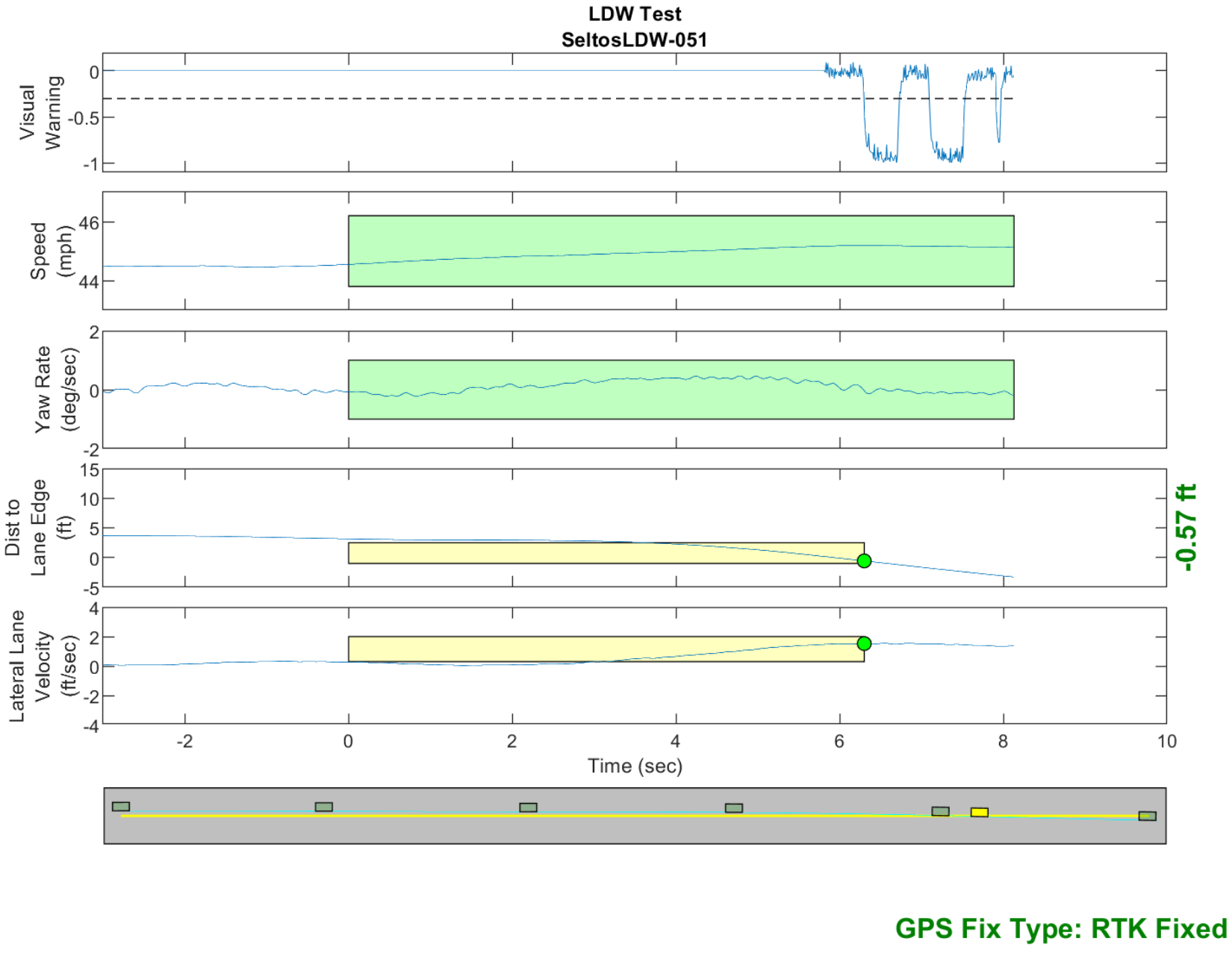

Figure D61. Time History for Run 51, Solid Line, Right Departure, Visual Warning

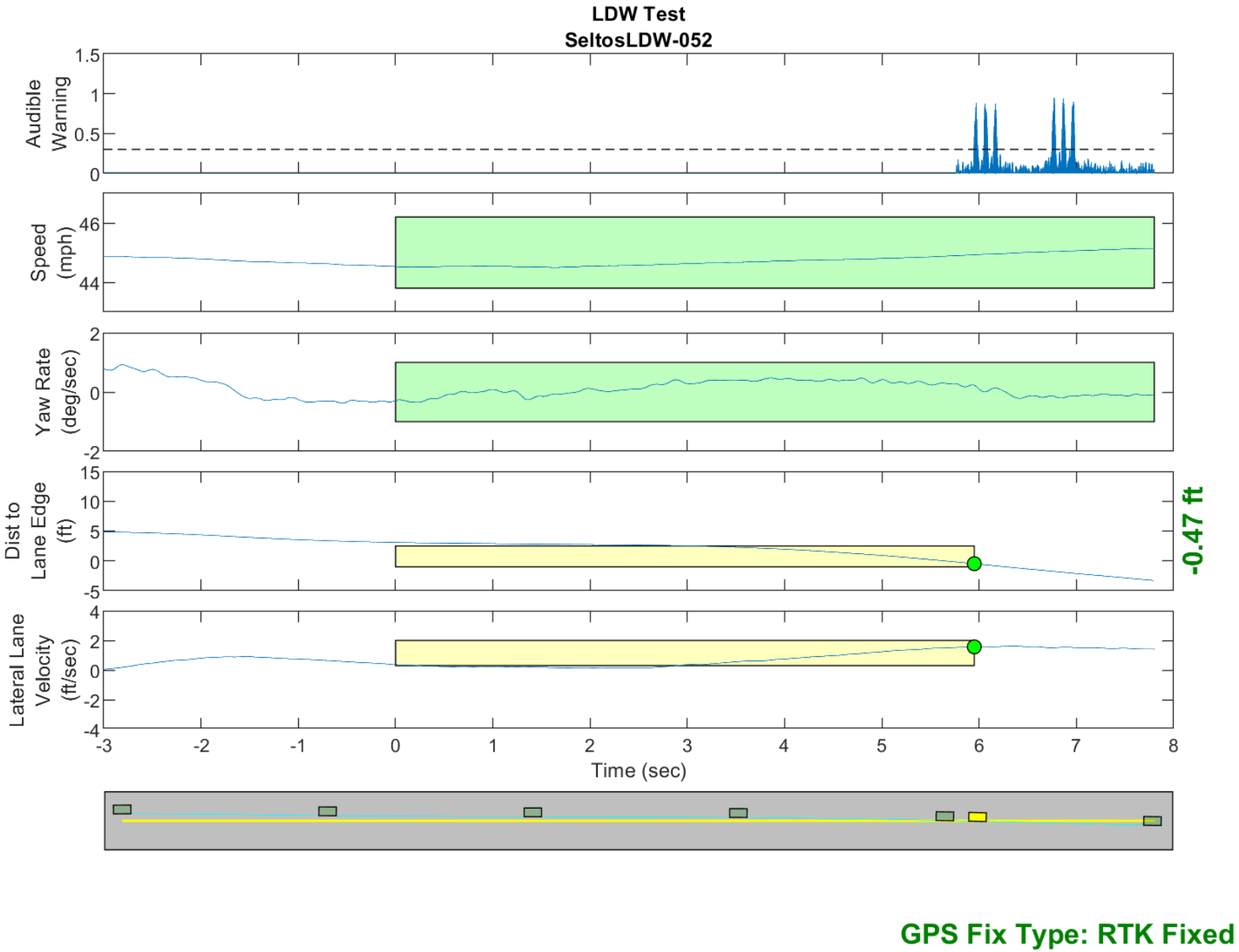

Figure D62. Time History for Run 52, Solid Line, Right Departure, Auditory Warning

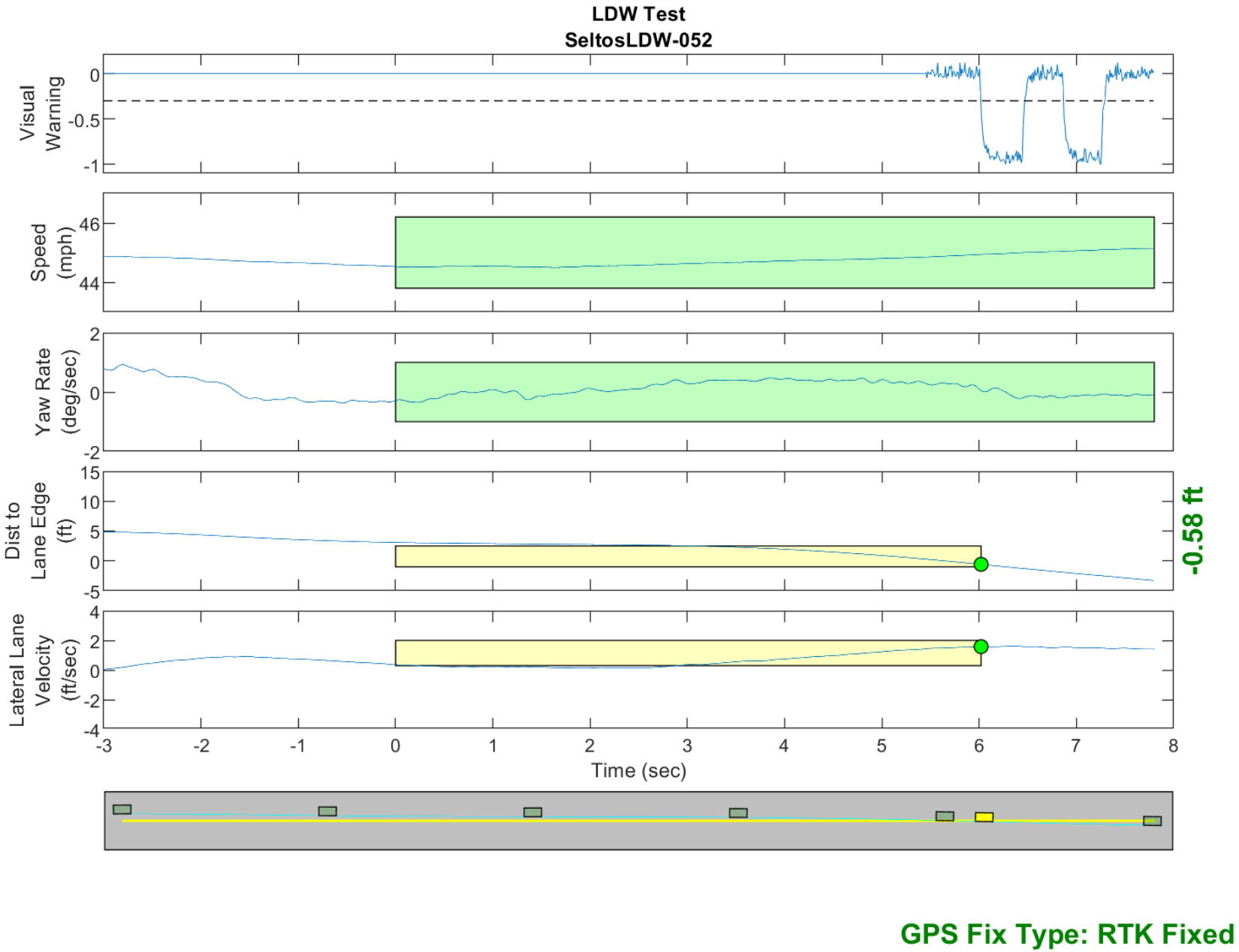

Figure D63. Time History for Run 52, Solid Line, Right Departure, Visual Warning

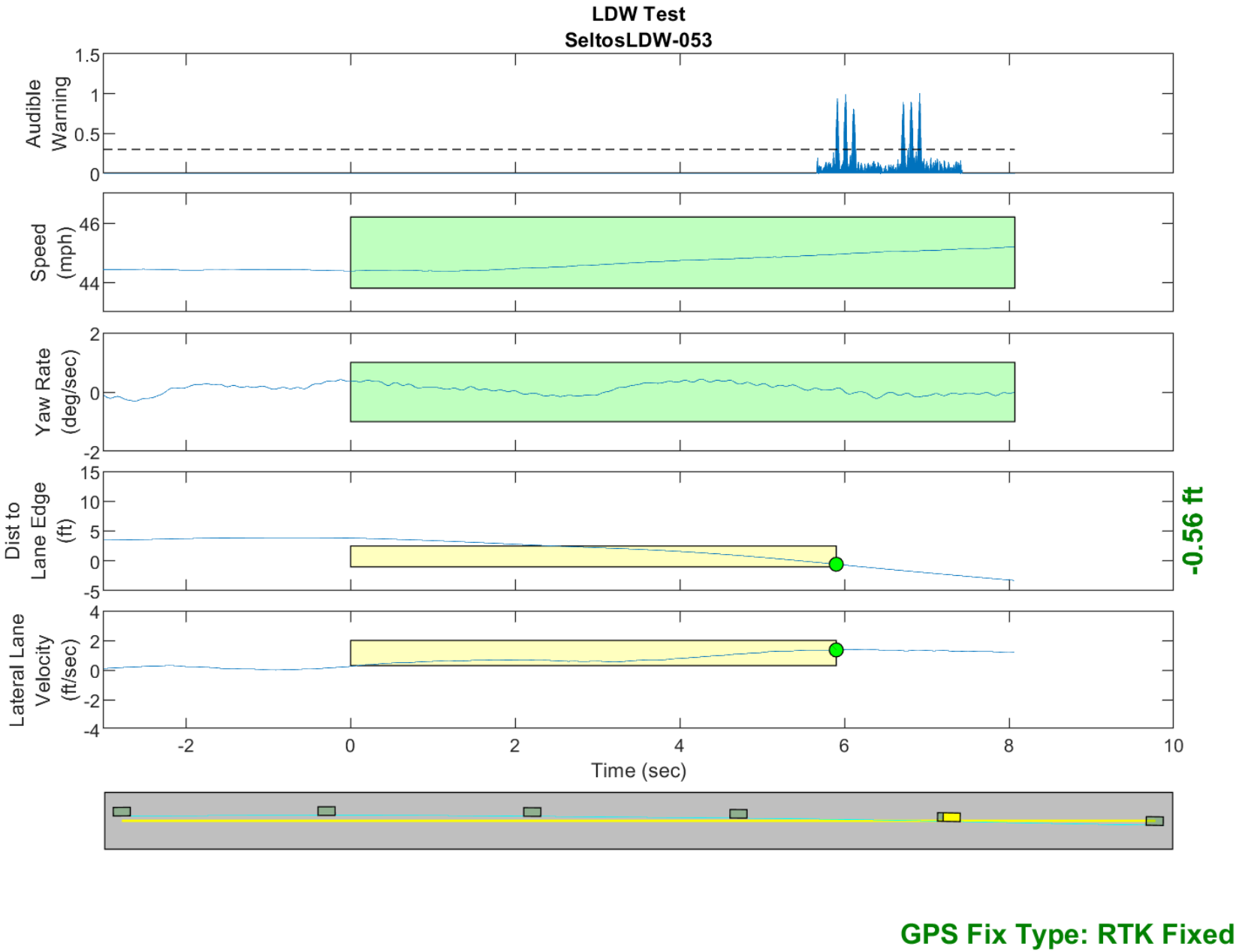

Figure D64. Time History for Run 53, Solid Line, Right Departure, Auditory Warning

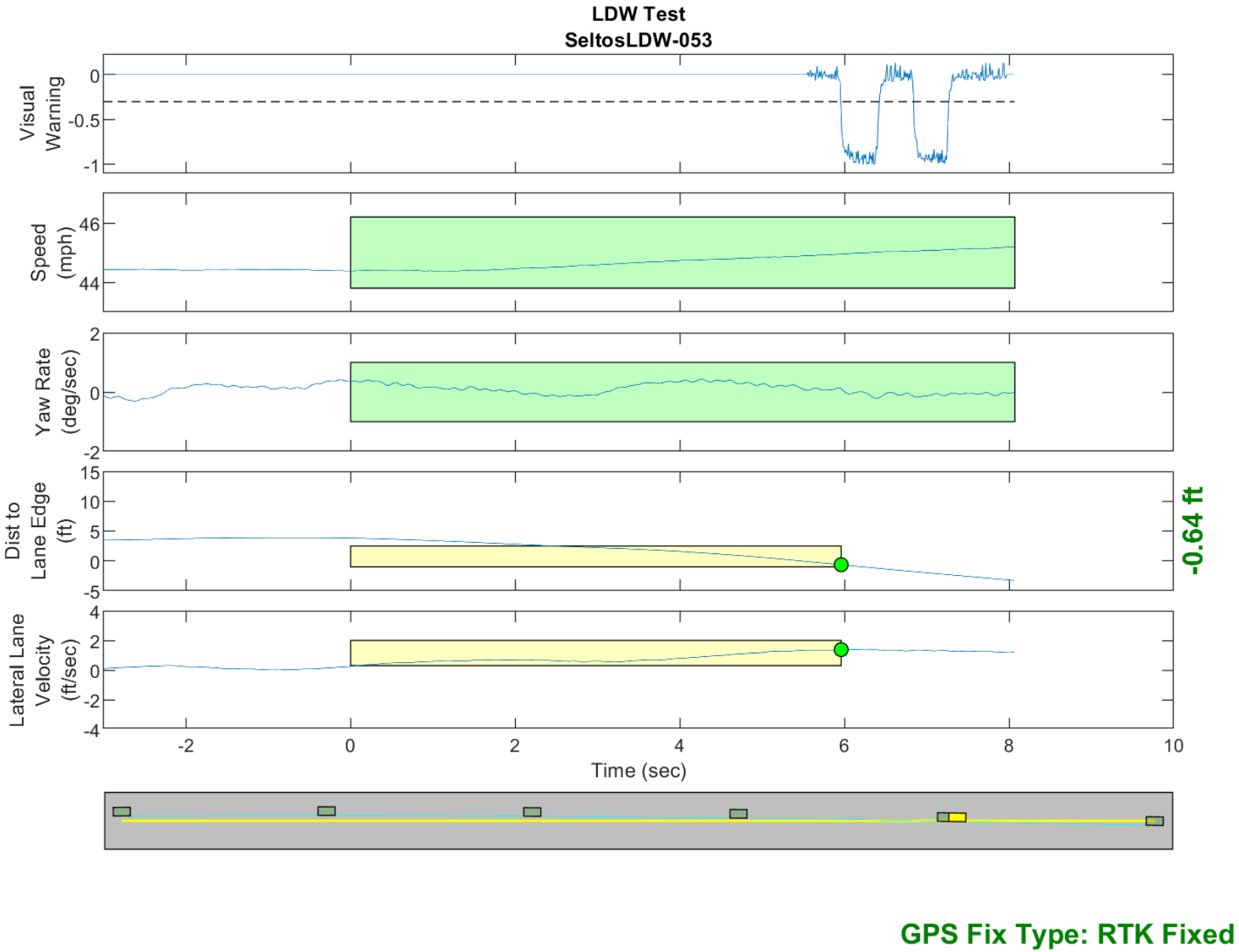

Figure D65. Time History for Run 53, Solid Line, Right Departure, Visual Warning

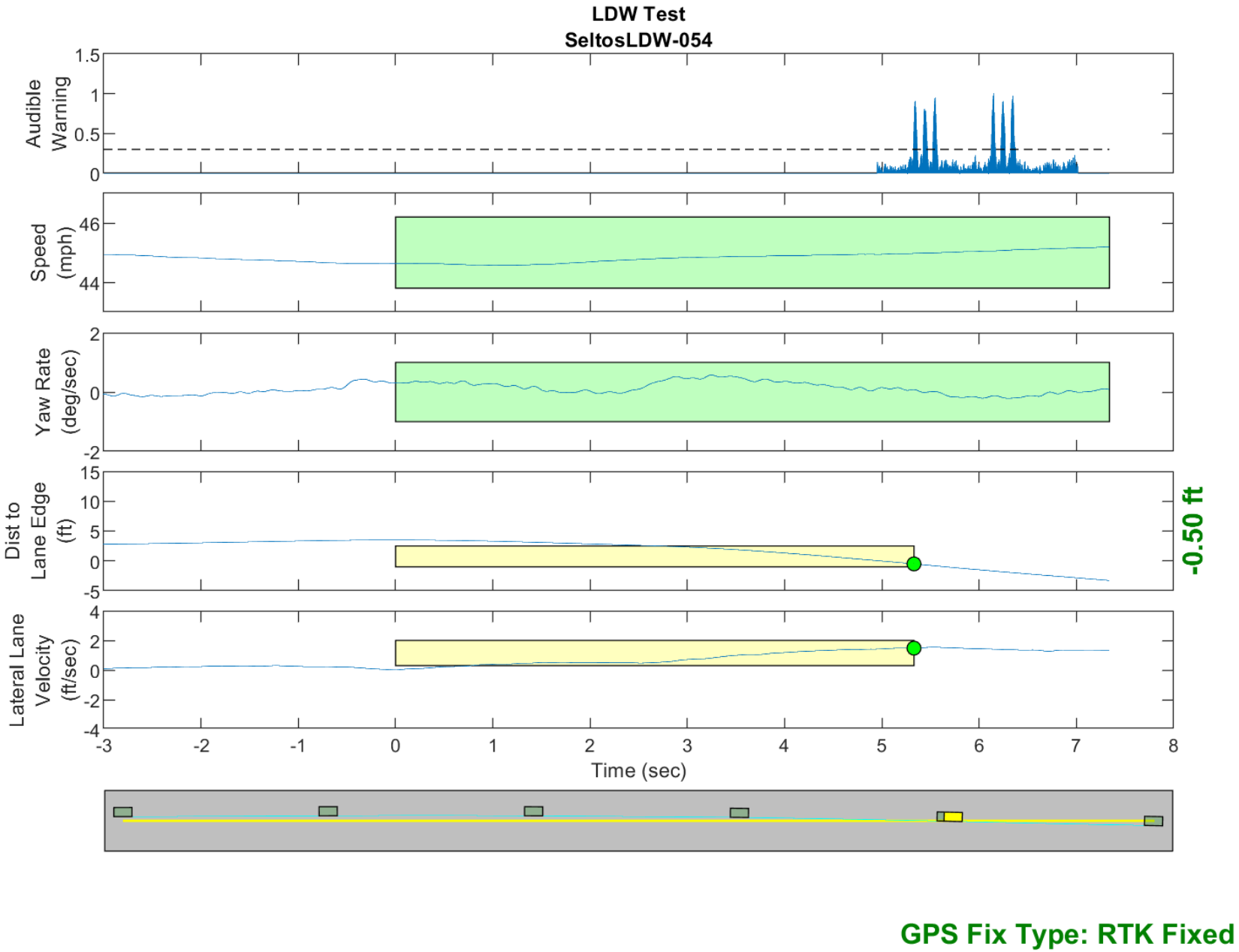

Figure D66. Time History for Run 54, Solid Line, Right Departure, Auditory Warning

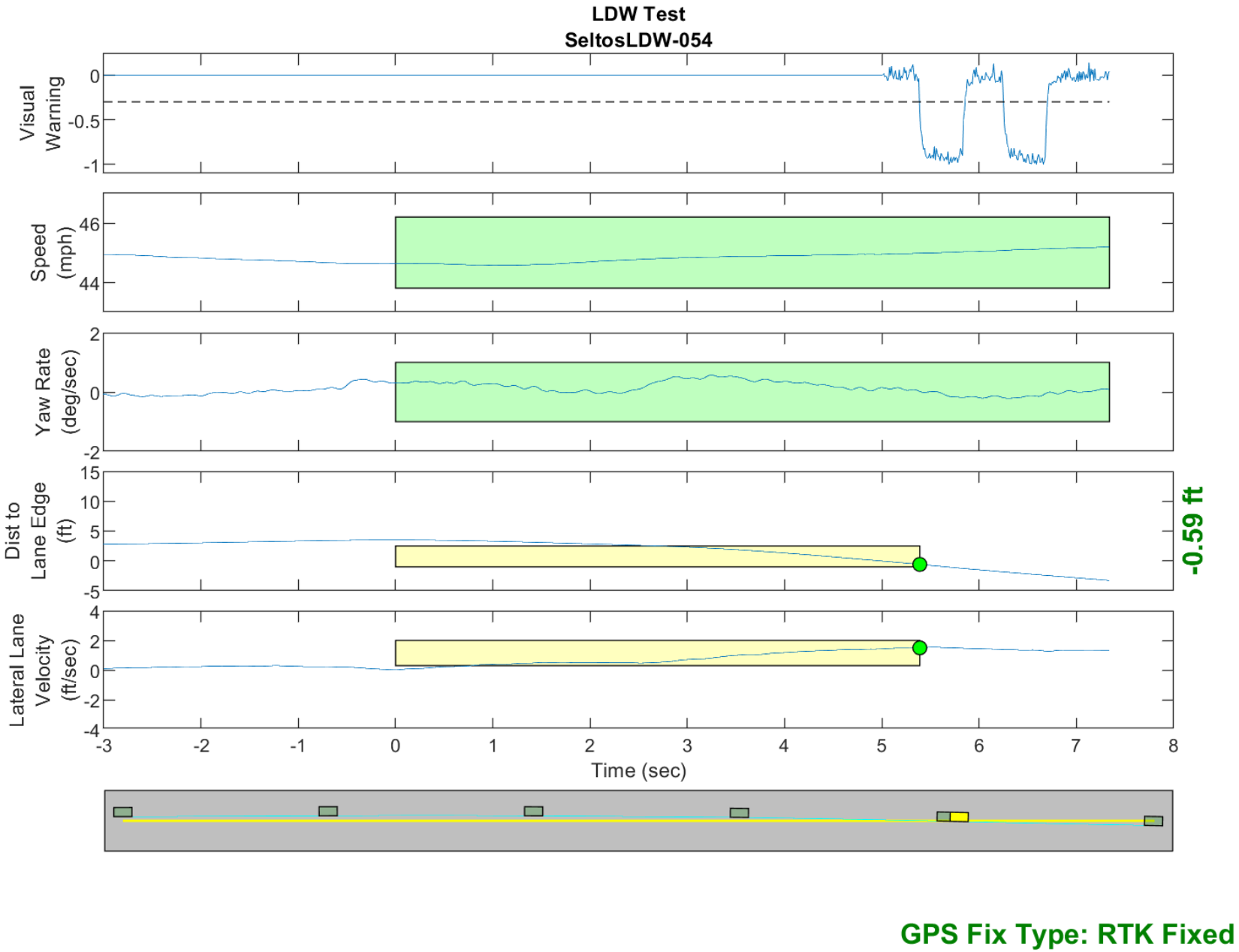

Figure D67. Time History for Run 54, Solid Line, Right Departure, Visual Warning

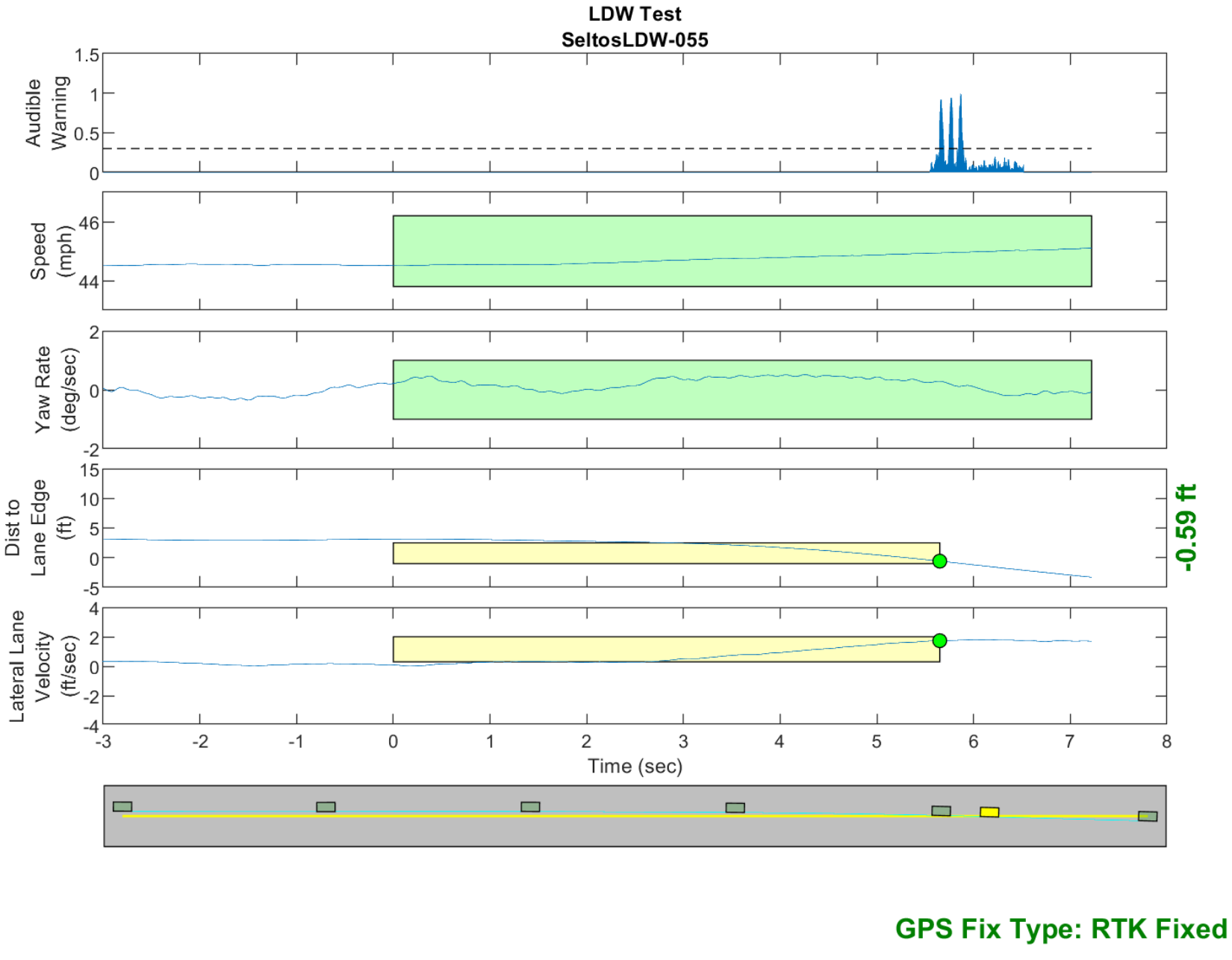

Figure D68. Time History for Run 55, Solid Line, Right Departure, Auditory Warning

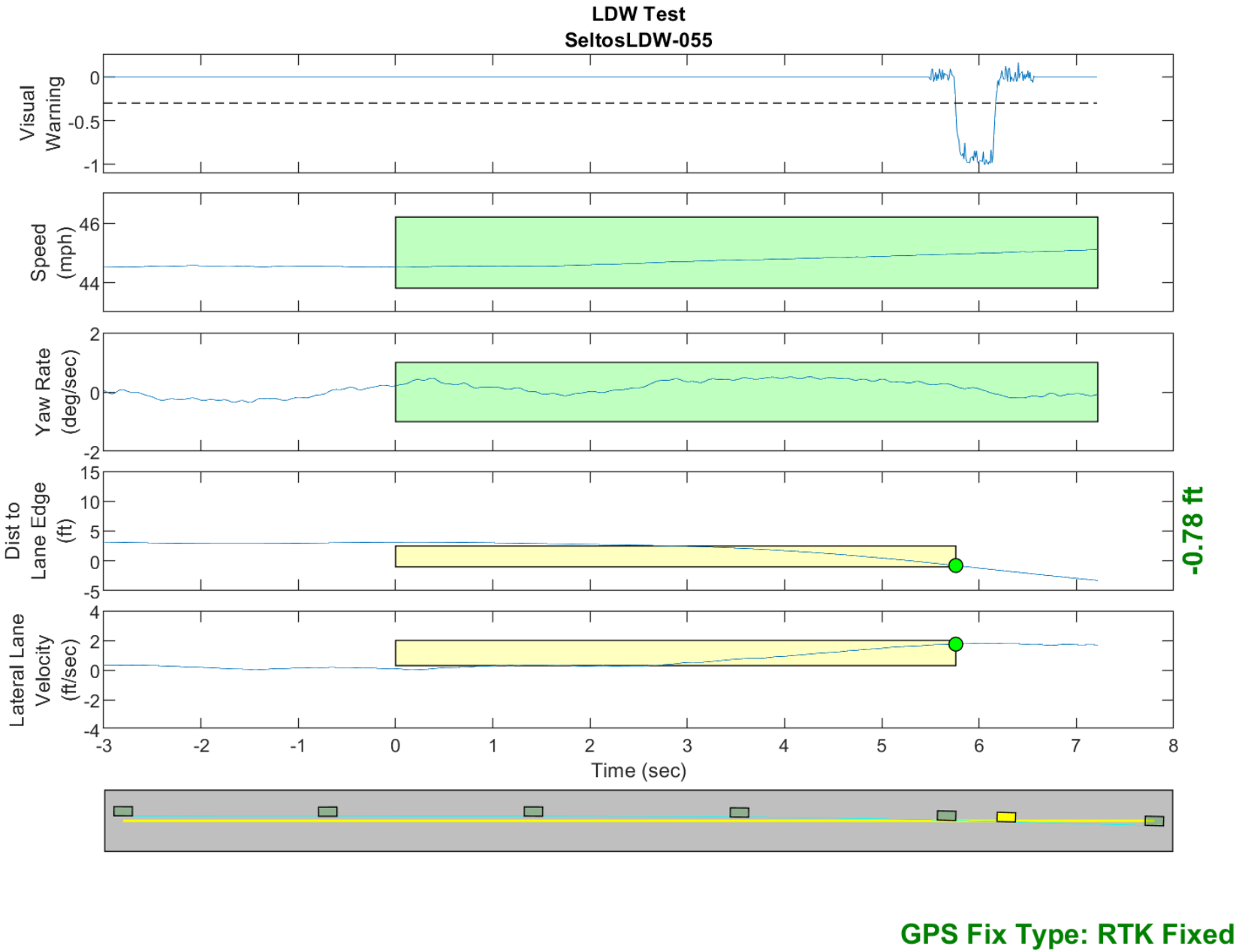

Figure D69. Time History for Run 55, Solid Line, Right Departure, Visual Warning

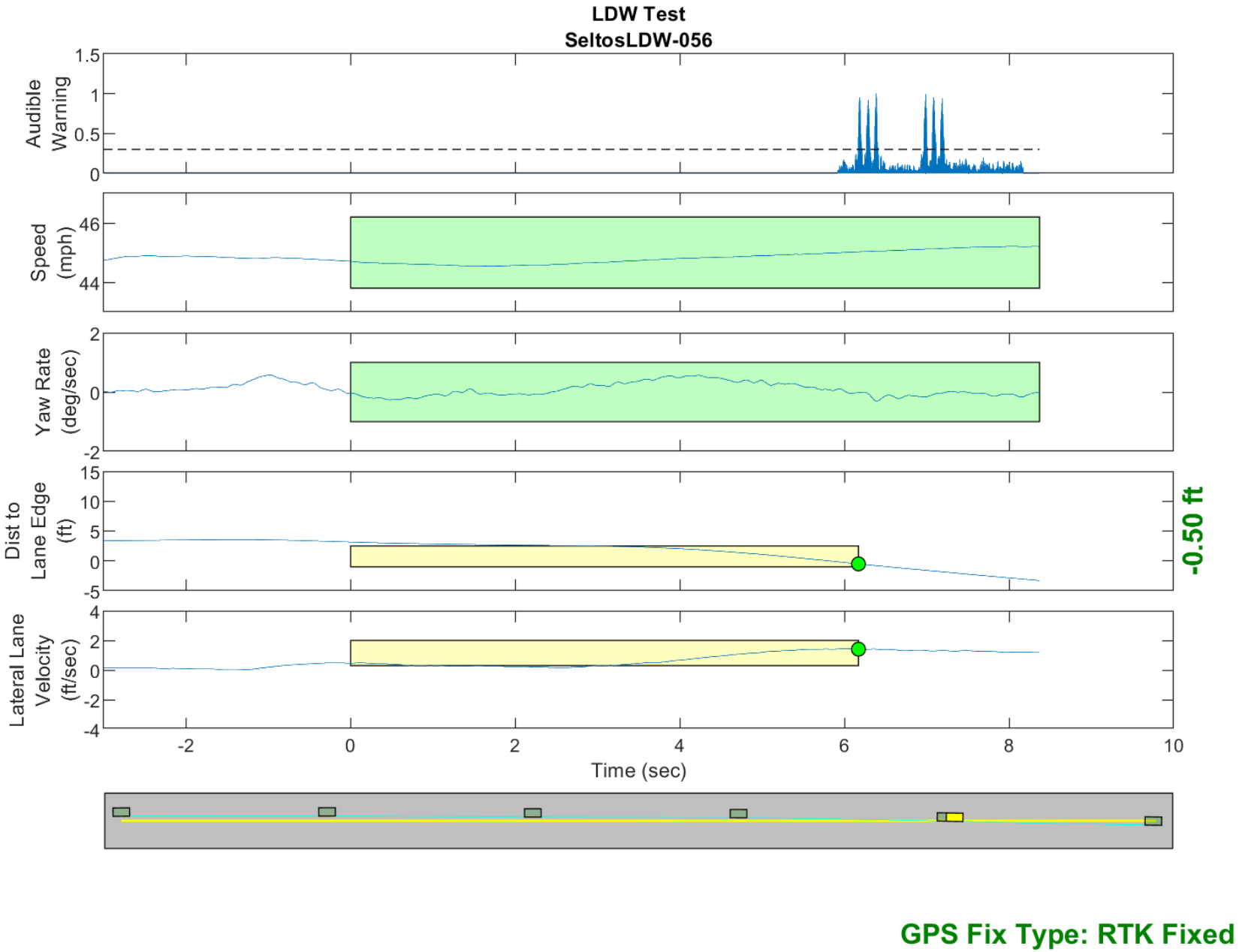

Figure D70. Time History for Run 56, Solid Line, Right Departure, Auditory Warning

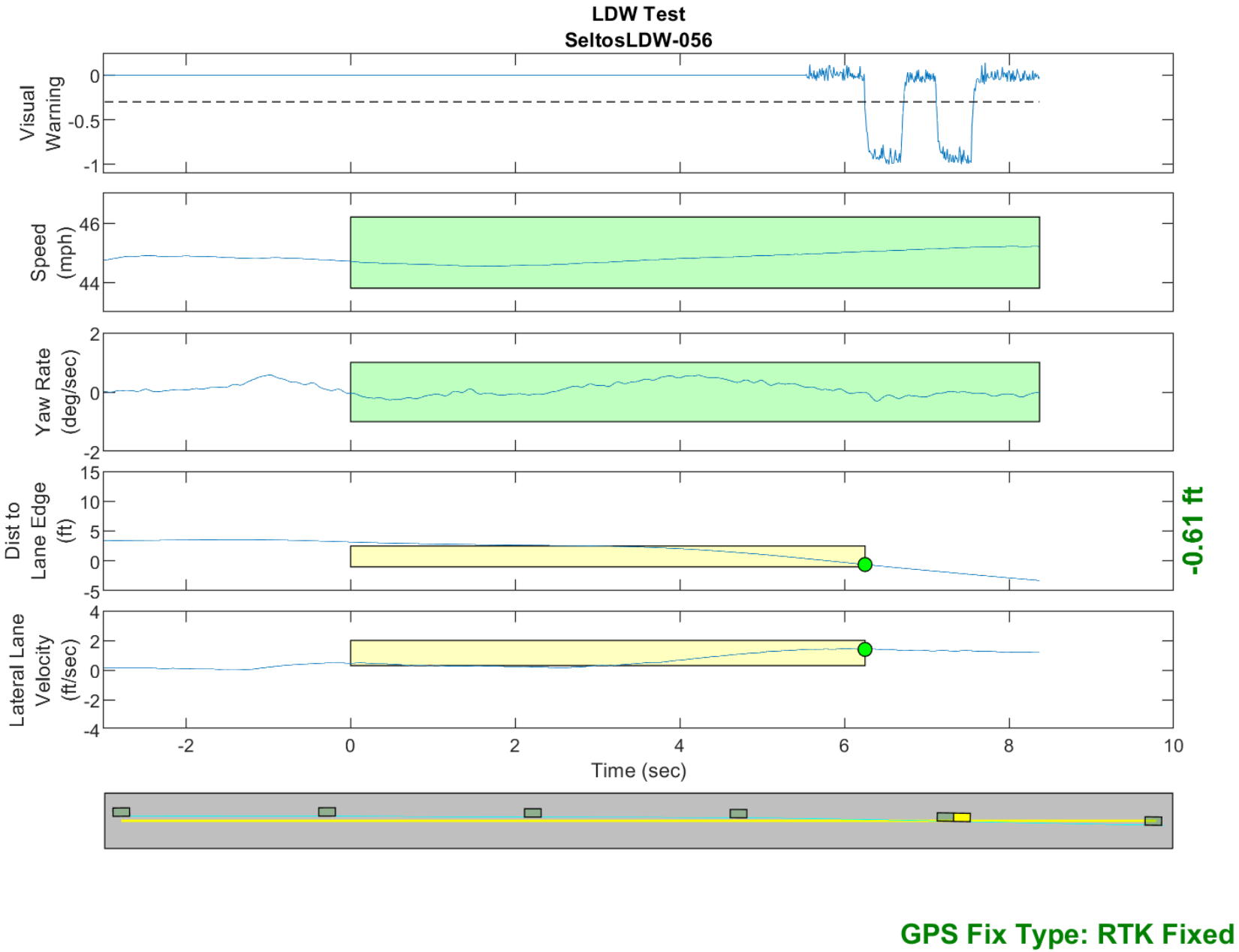

Figure D71. Time History for Run 56, Solid Line, Right Departure, Visual Warning

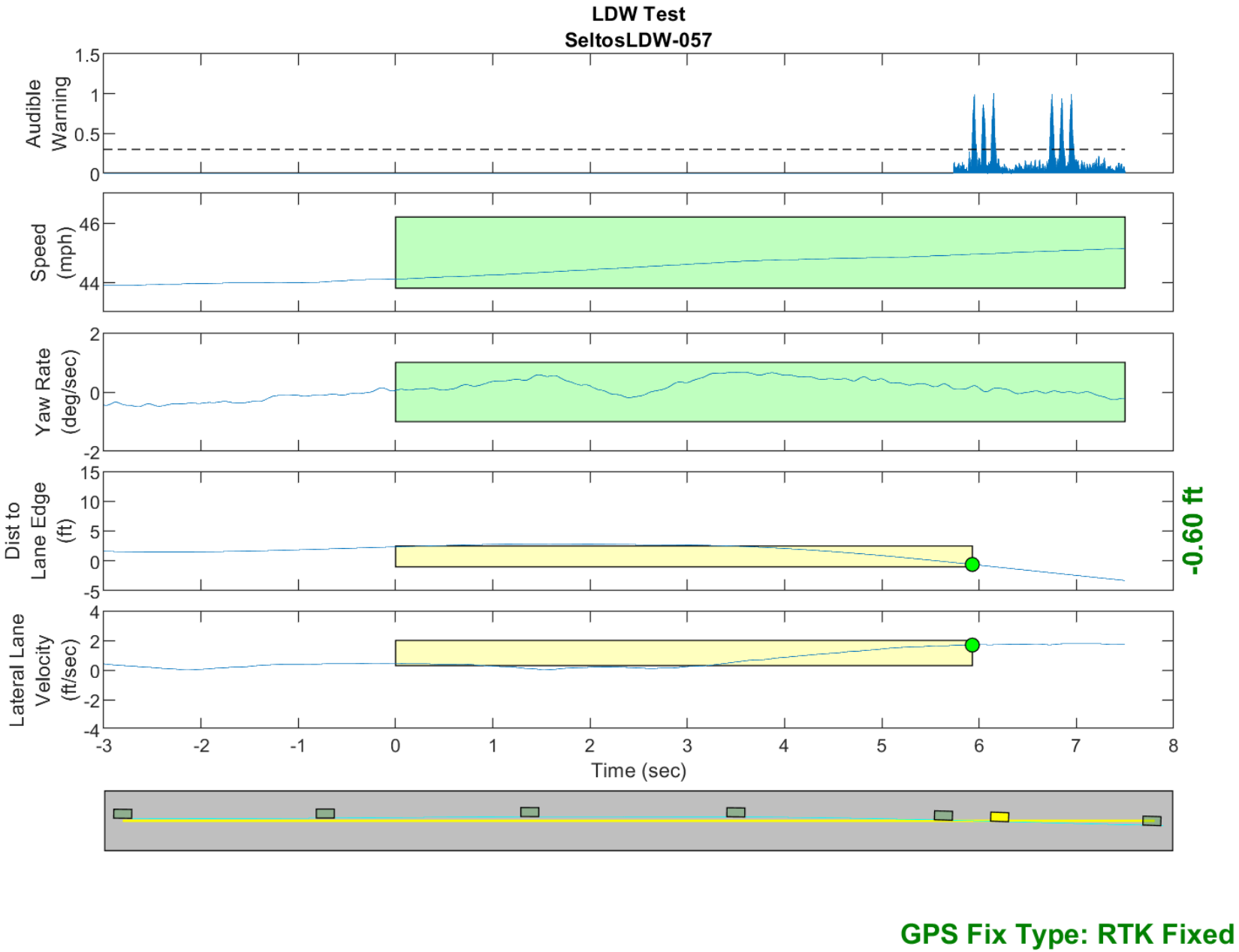

Figure D72. Time History for Run 57, Solid Line, Right Departure, Auditory Warning

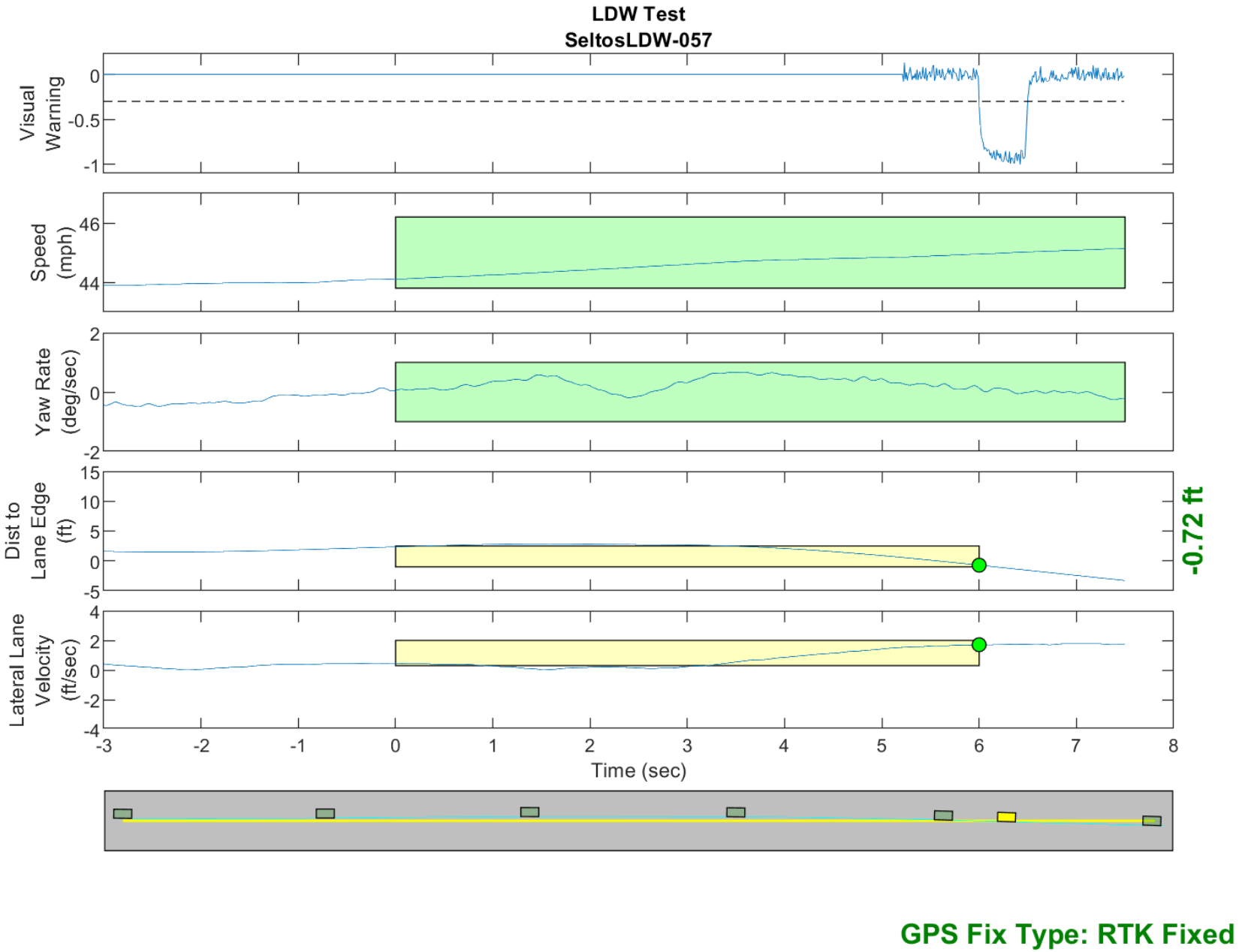

Figure D73. Time History for Run 57, Solid Line, Right Departure, Visual Warning

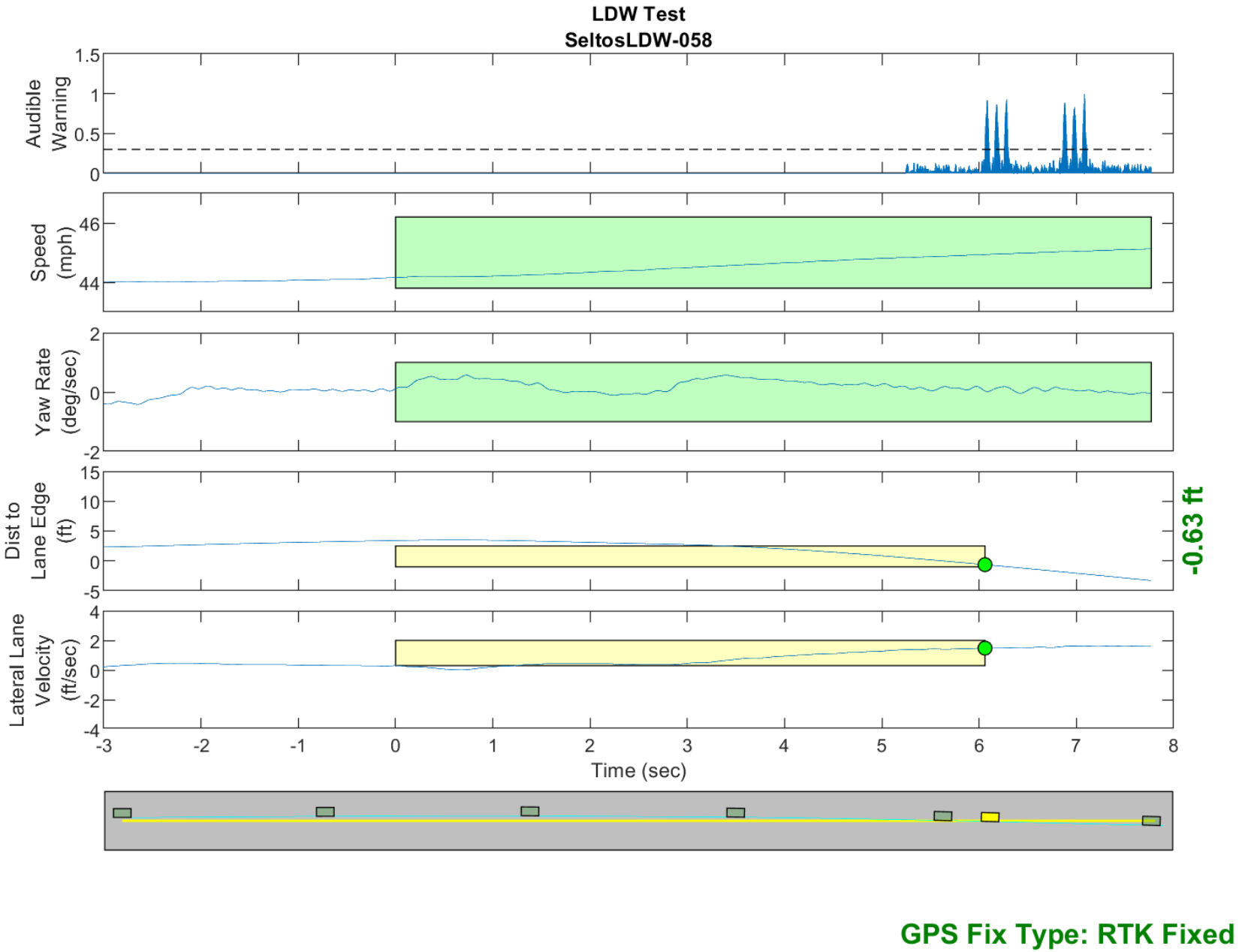

Figure D74. Time History for Run 58, Solid Line, Right Departure, Auditory Warning

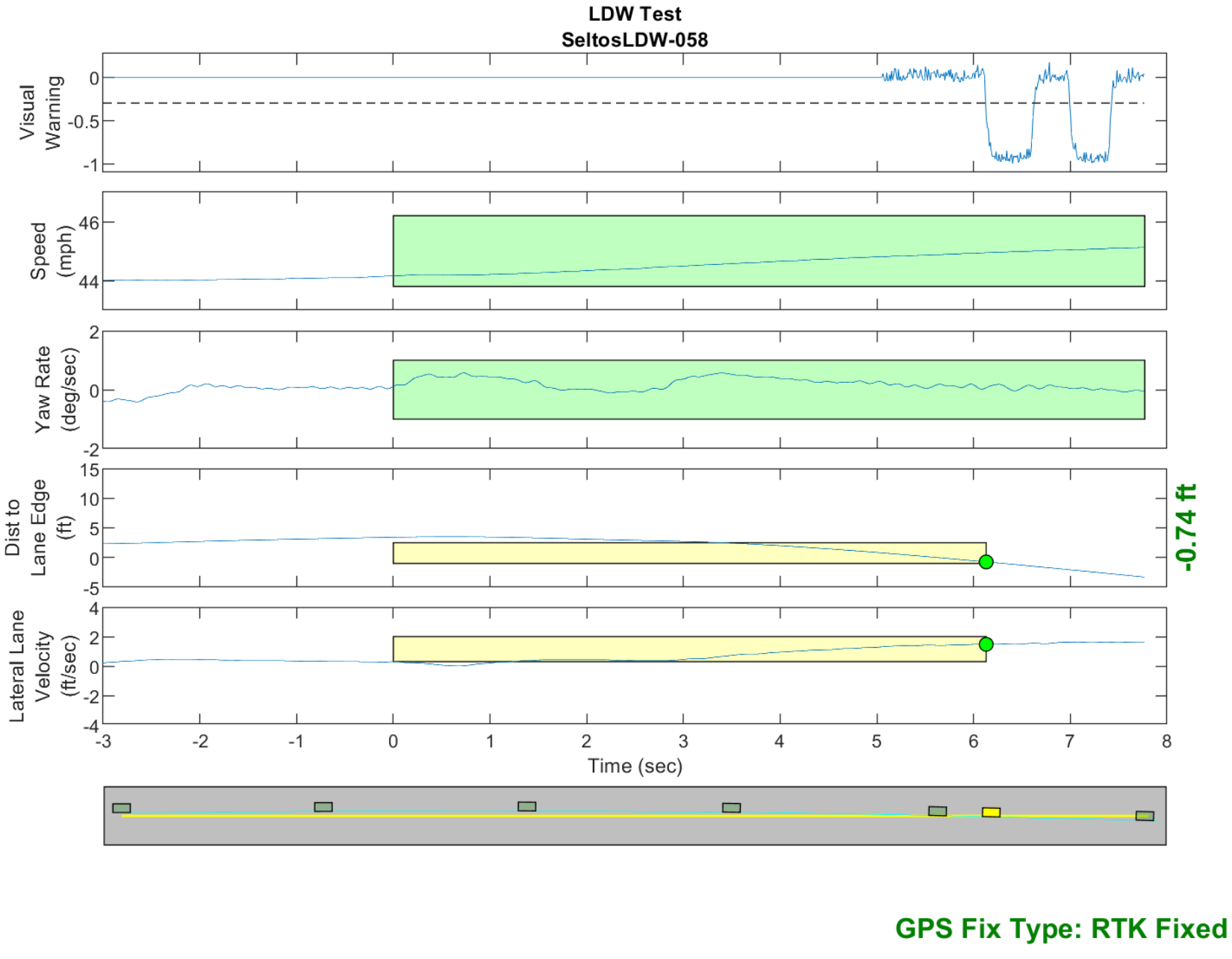

Figure D75. Time History for Run 58, Solid Line, Right Departure, Visual Warning

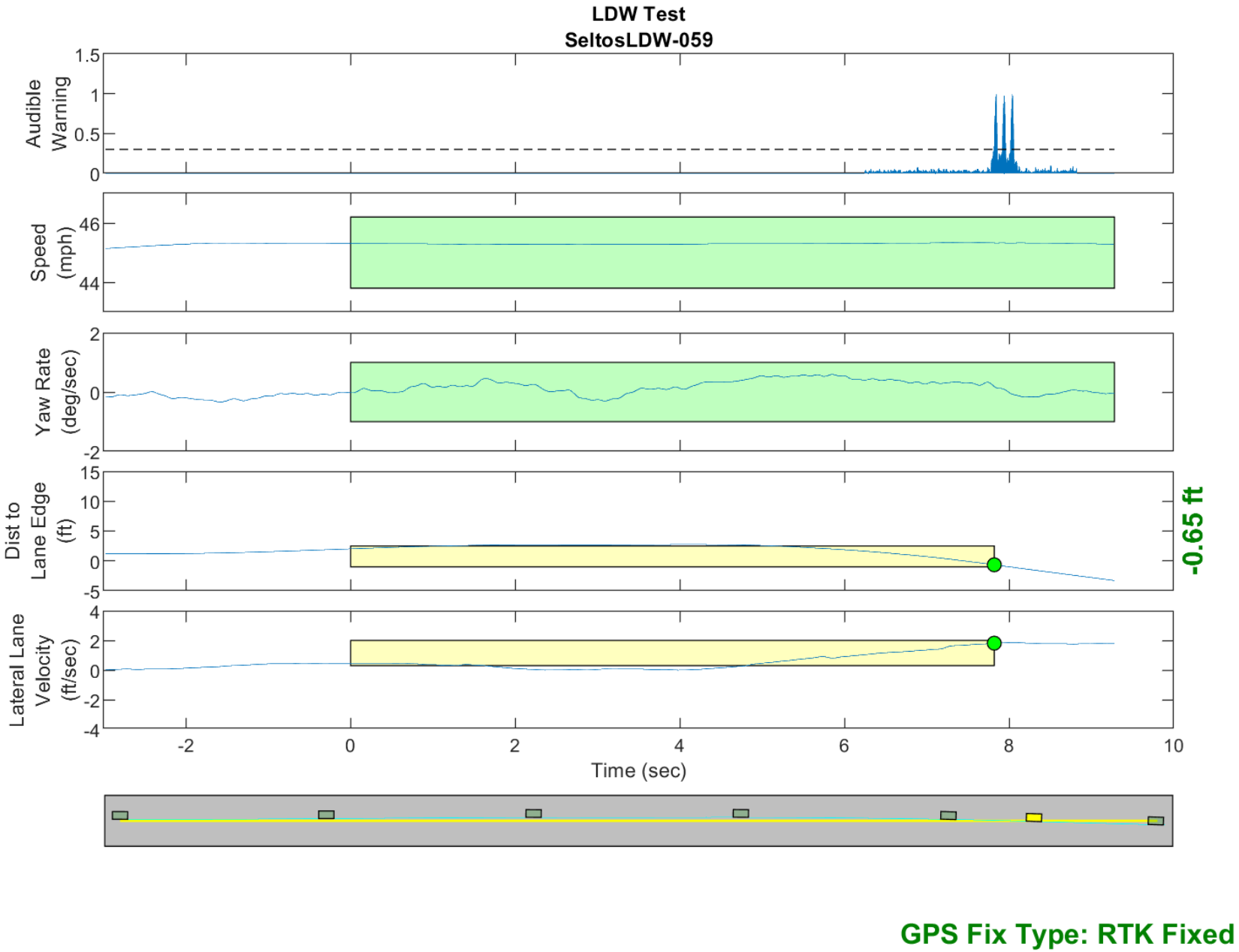

Figure D76. Time History for Run 59, Botts Dots, Right Departure, Auditory Warning

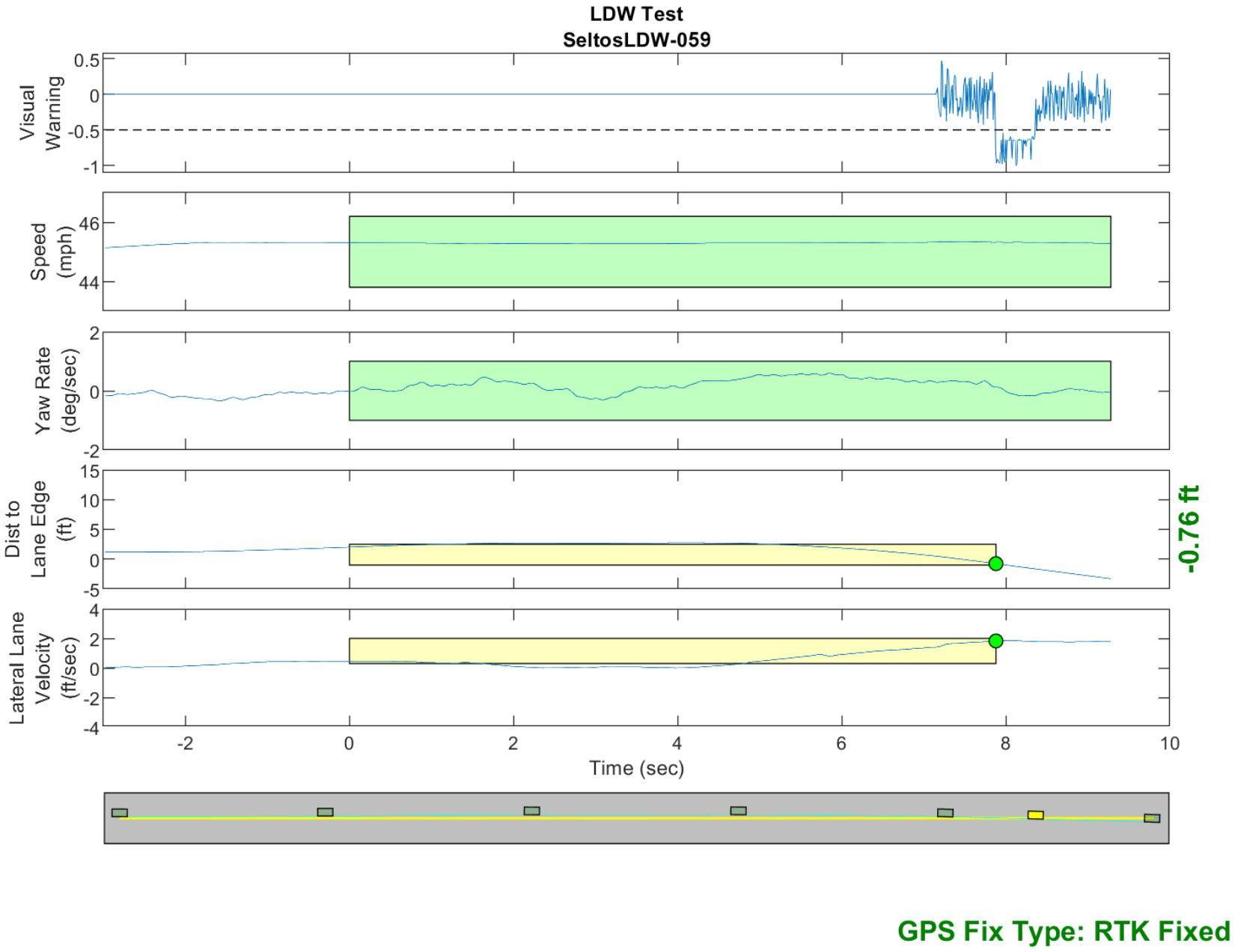

Figure D77. Time History for Run 59, Botts Dots, Right Departure, Visual Warning

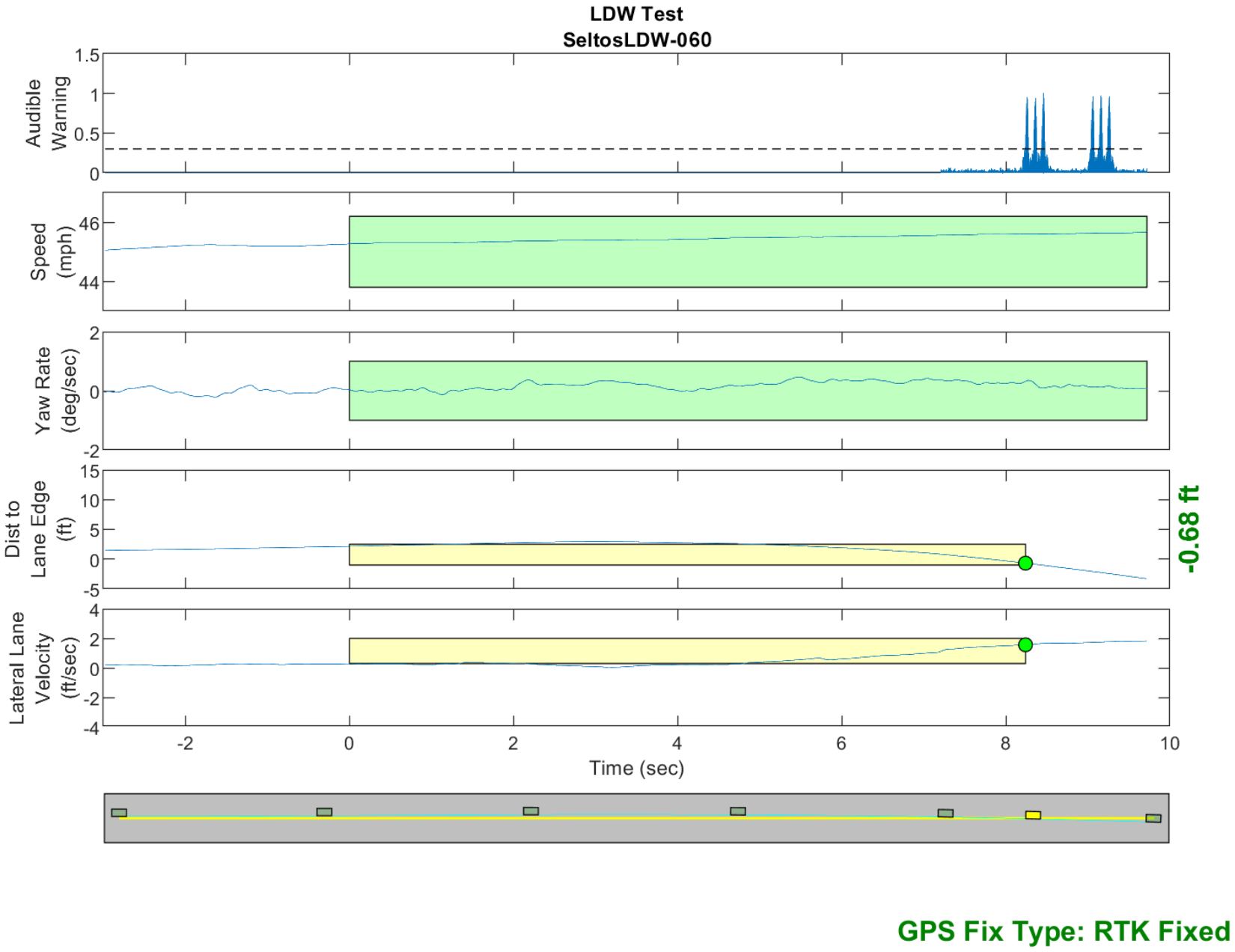

Figure D78. Time History for Run 60, Botts Dots, Right Departure, Auditory Warning

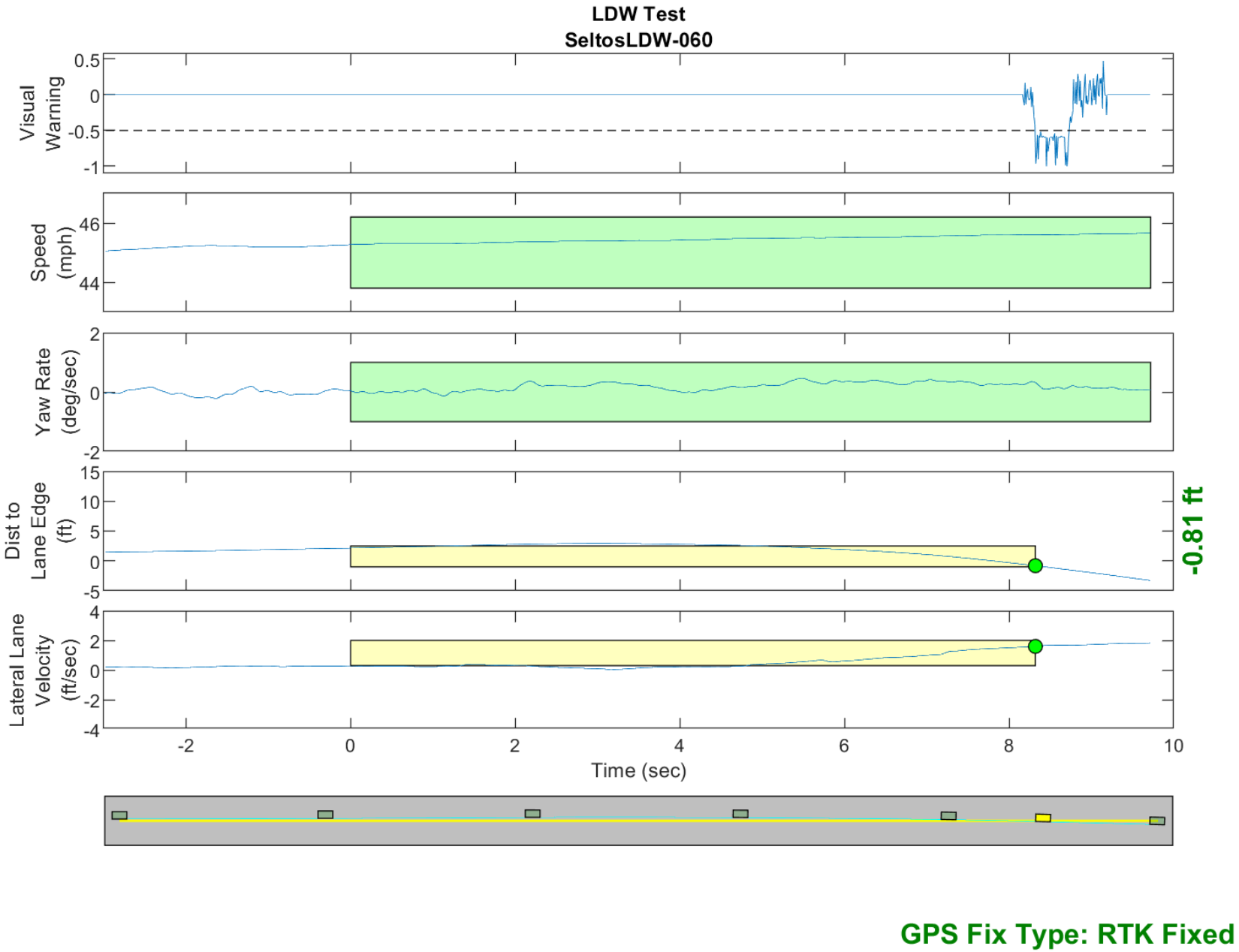

Figure D79. Time History for Run 60, Botts Dots, Right Departure, Visual Warning

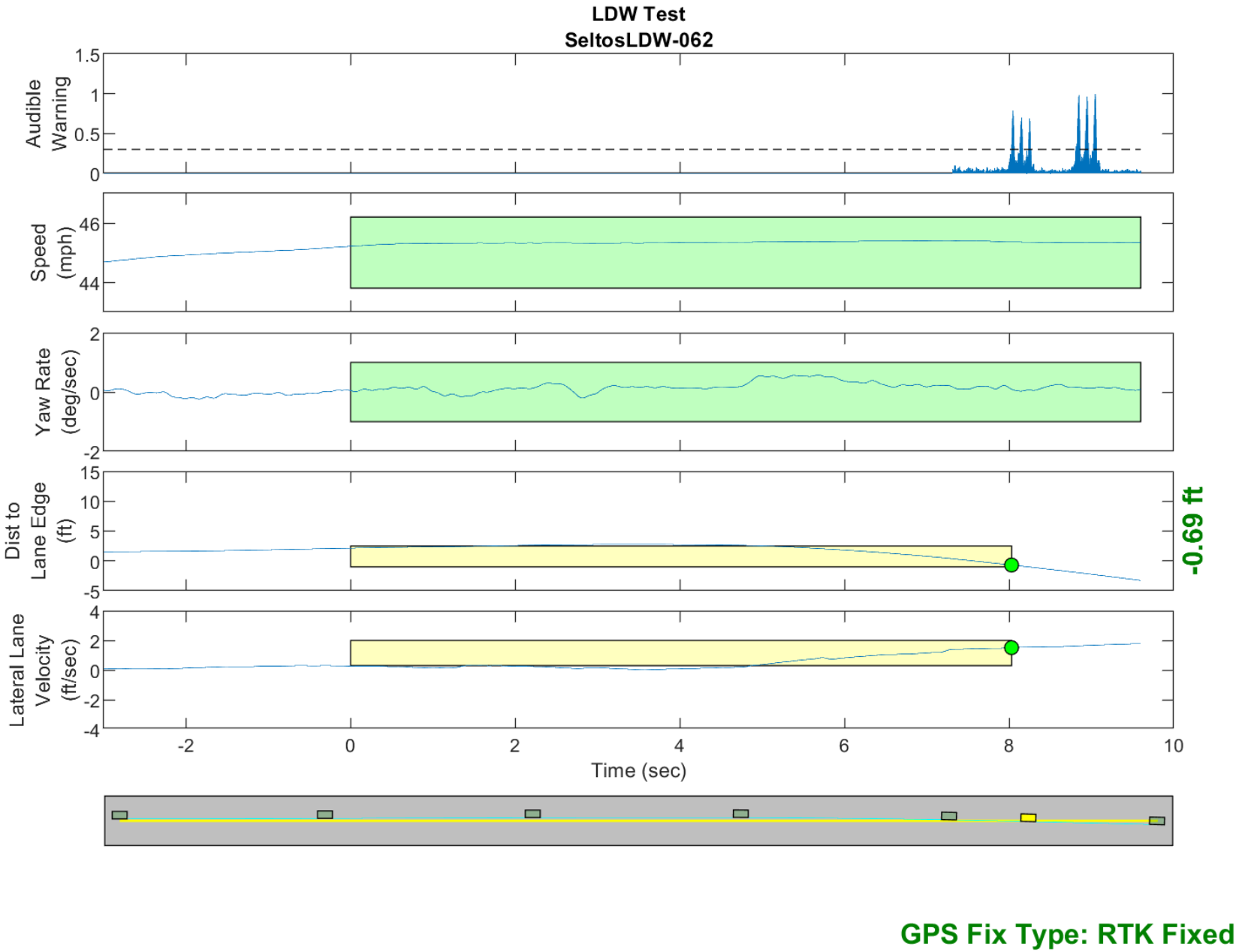

Figure D80. Time History for Run 62, Botts Dots, Right Departure, Auditory Warning

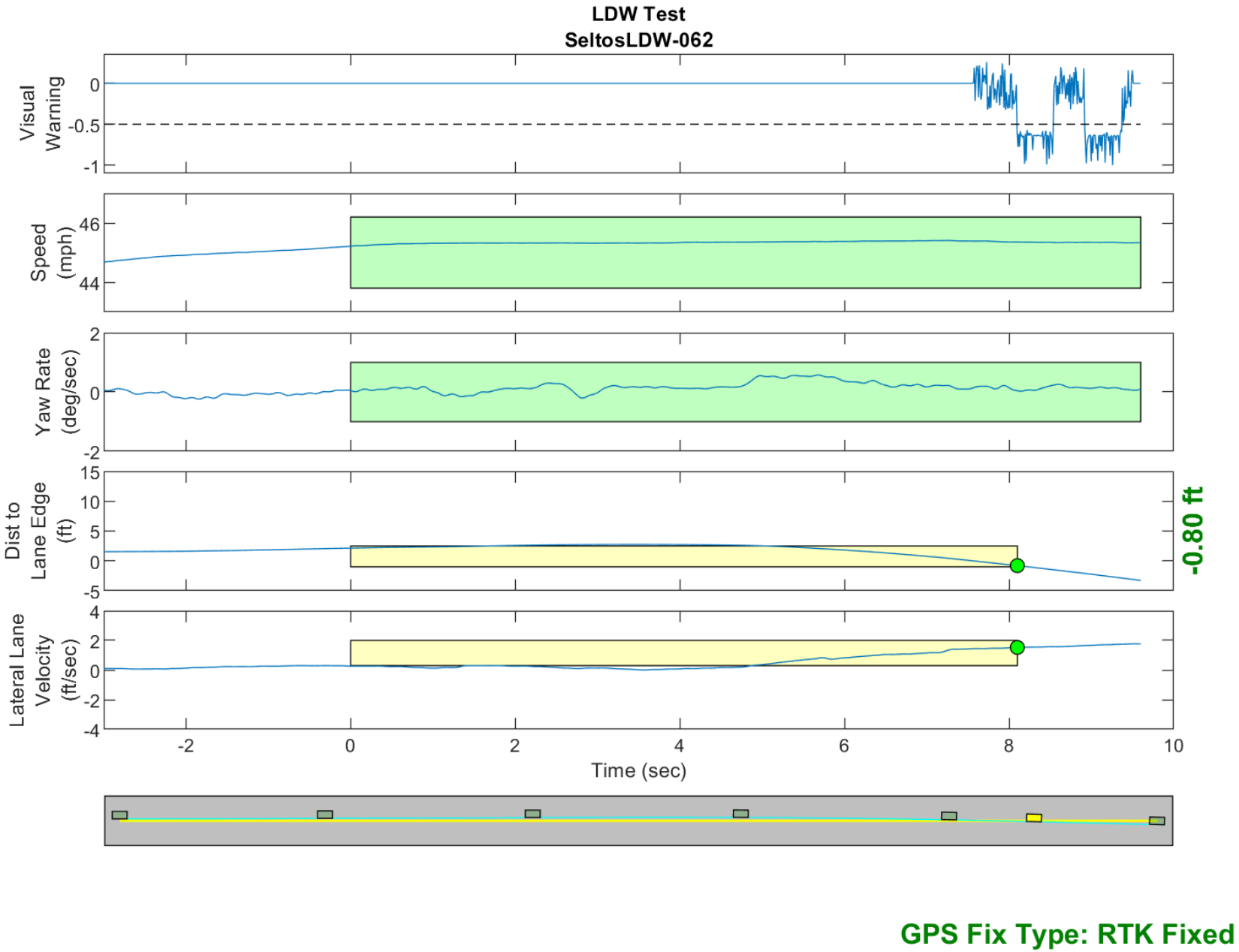

Figure D81. Time History for Run 62, Botts Dots, Right Departure, Visual Warning

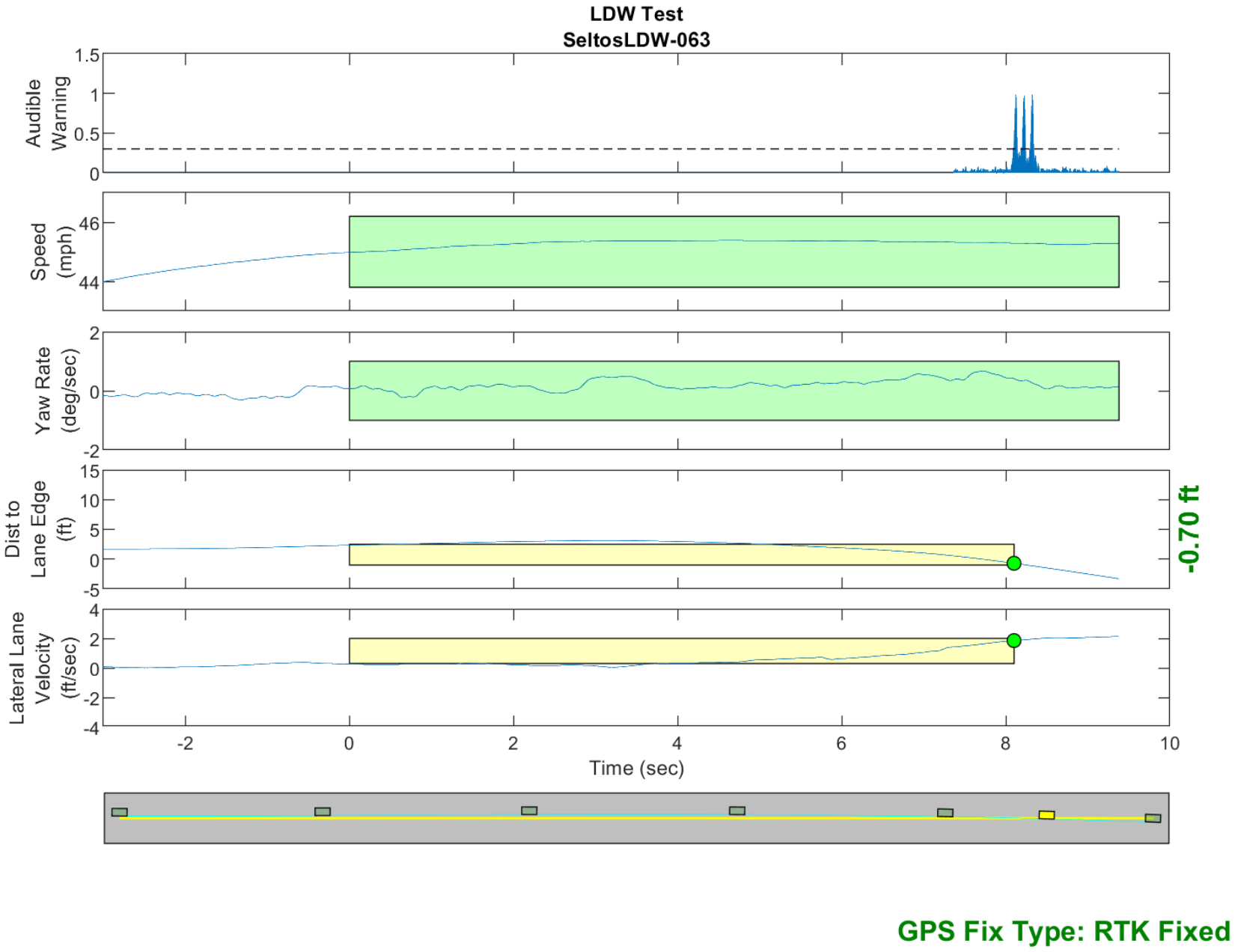

Figure D82. Time History for Run 63, Botts Dots, Right Departure, Auditory Warning

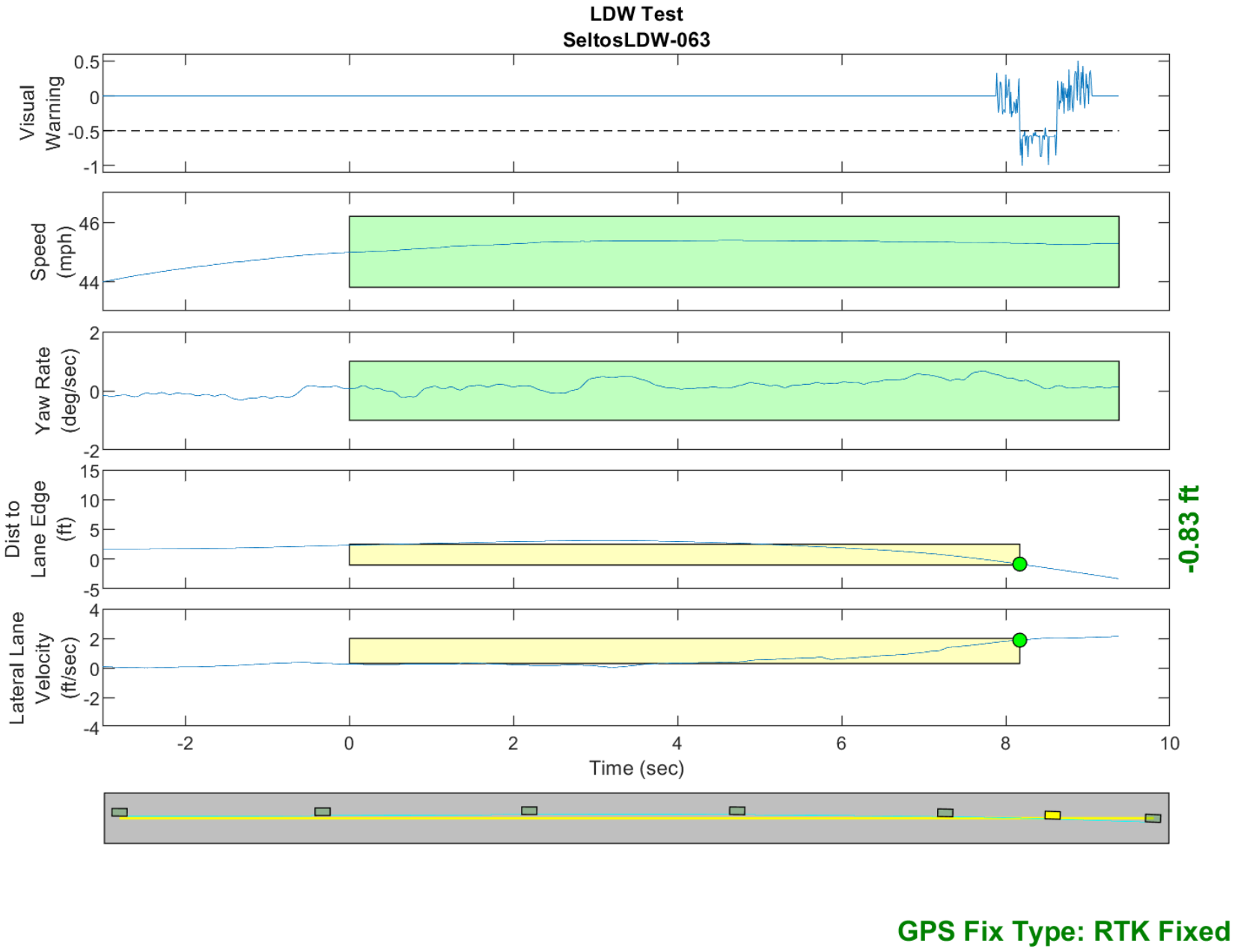

Figure D83. Time History for Run 63, Botts Dots, Right Departure, Visual Warning

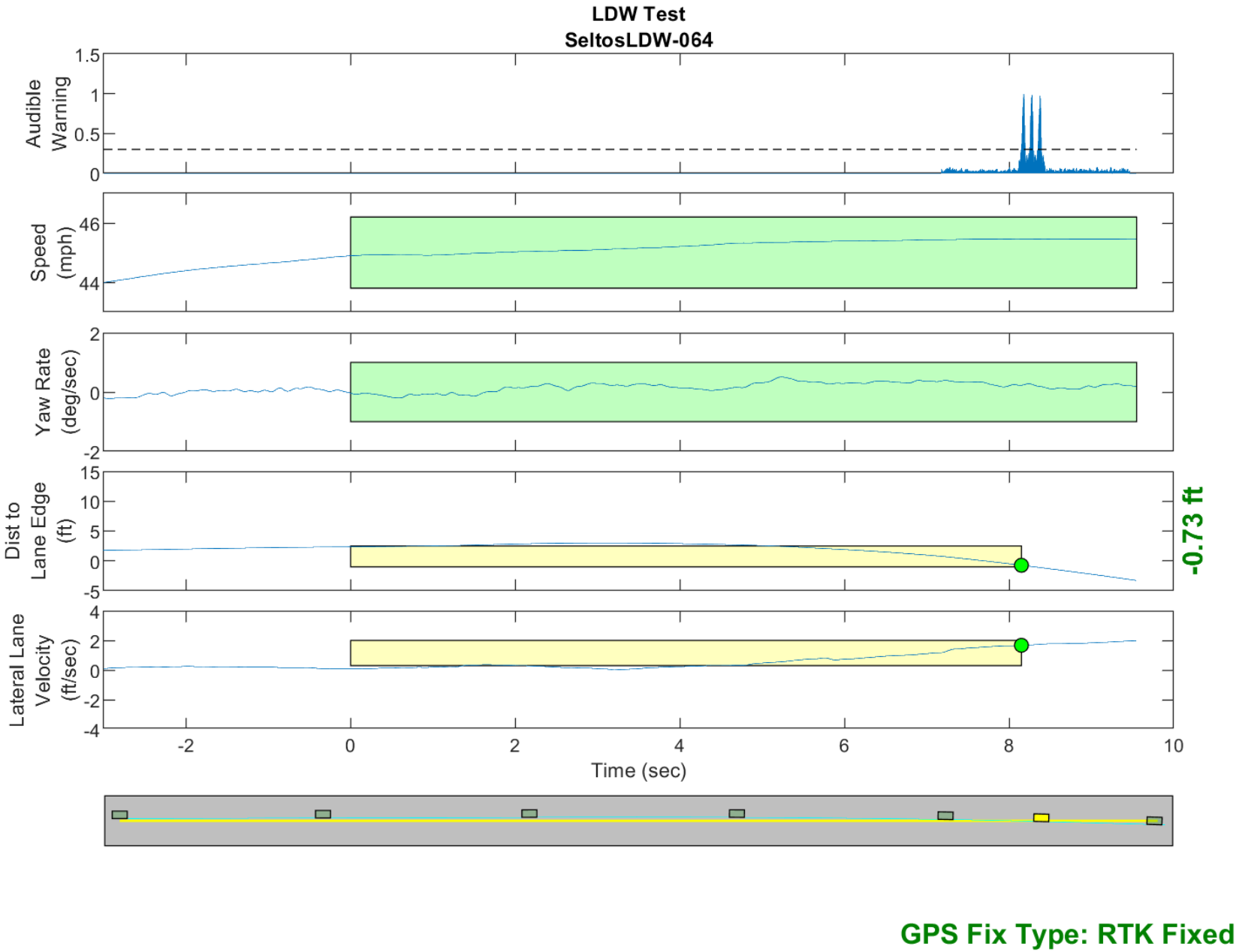

Figure D84. Time History for Run 64, Botts Dots, Right Departure, Auditory Warning

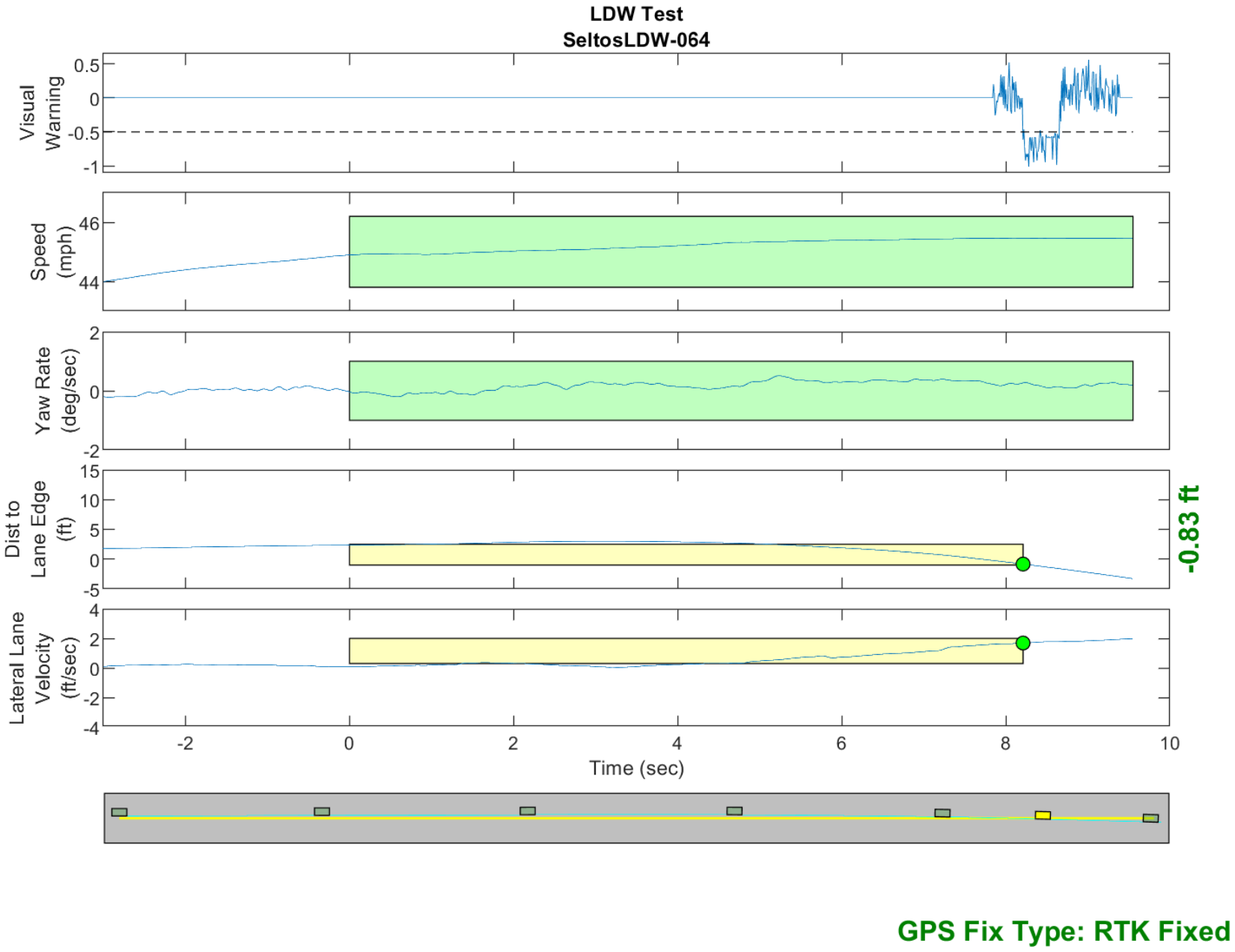

Figure D85. Time History for Run 64, Botts Dots, Right Departure, Visual Warning

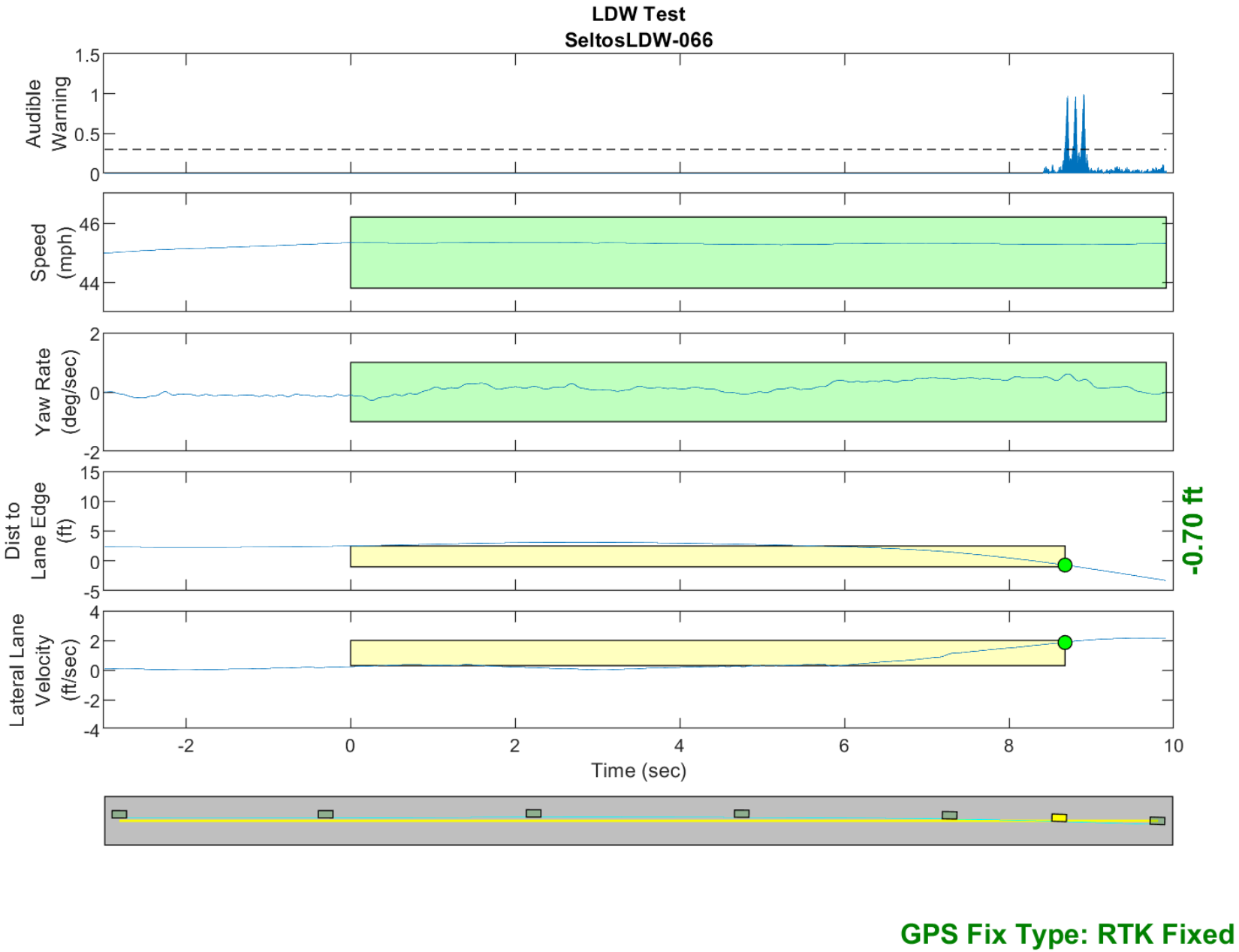

Figure D86. Time History for Run 66, Botts Dots, Right Departure, Auditory Warning

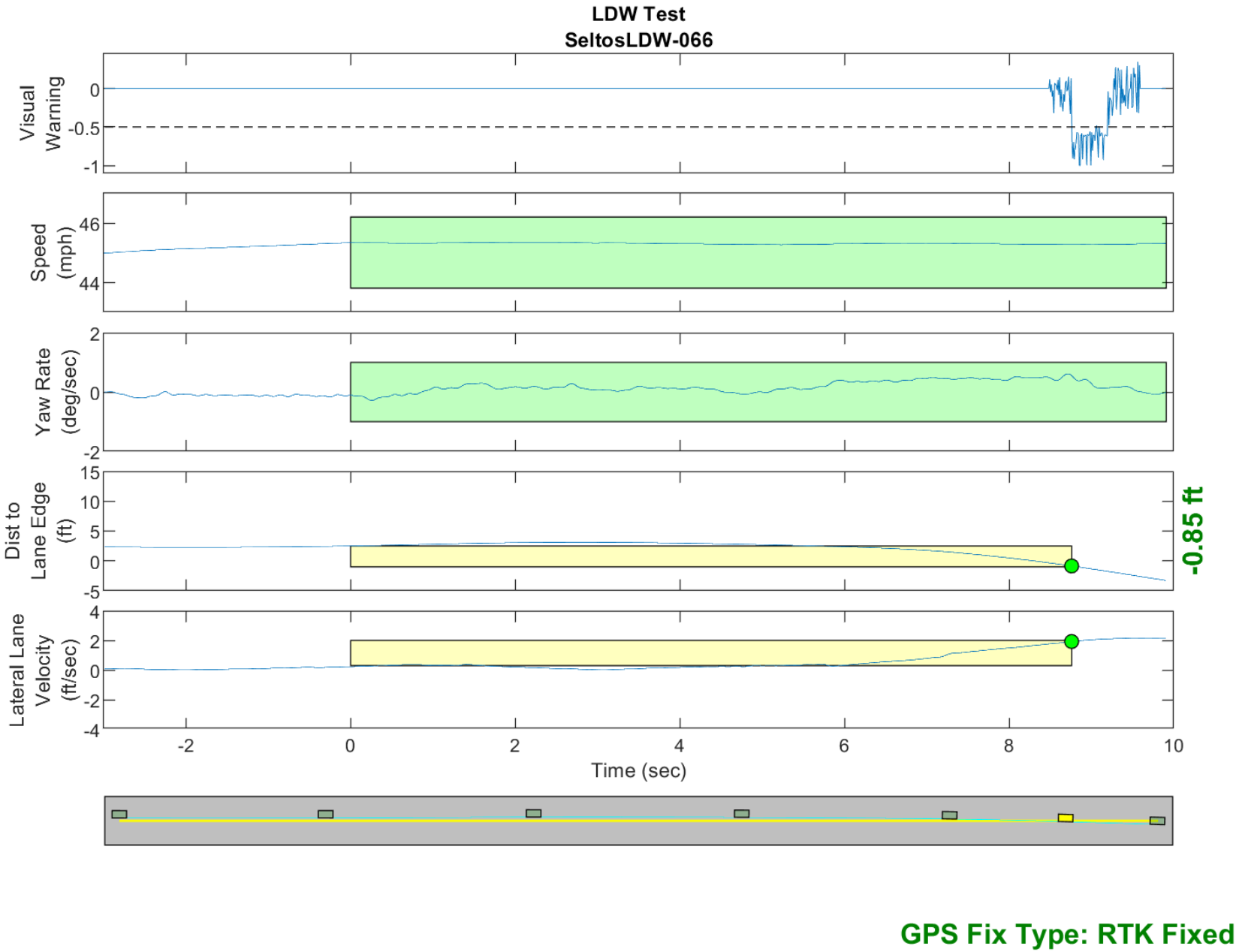

Figure D87. Time History for Run 66, Botts Dots, Right Departure, Visual Warning

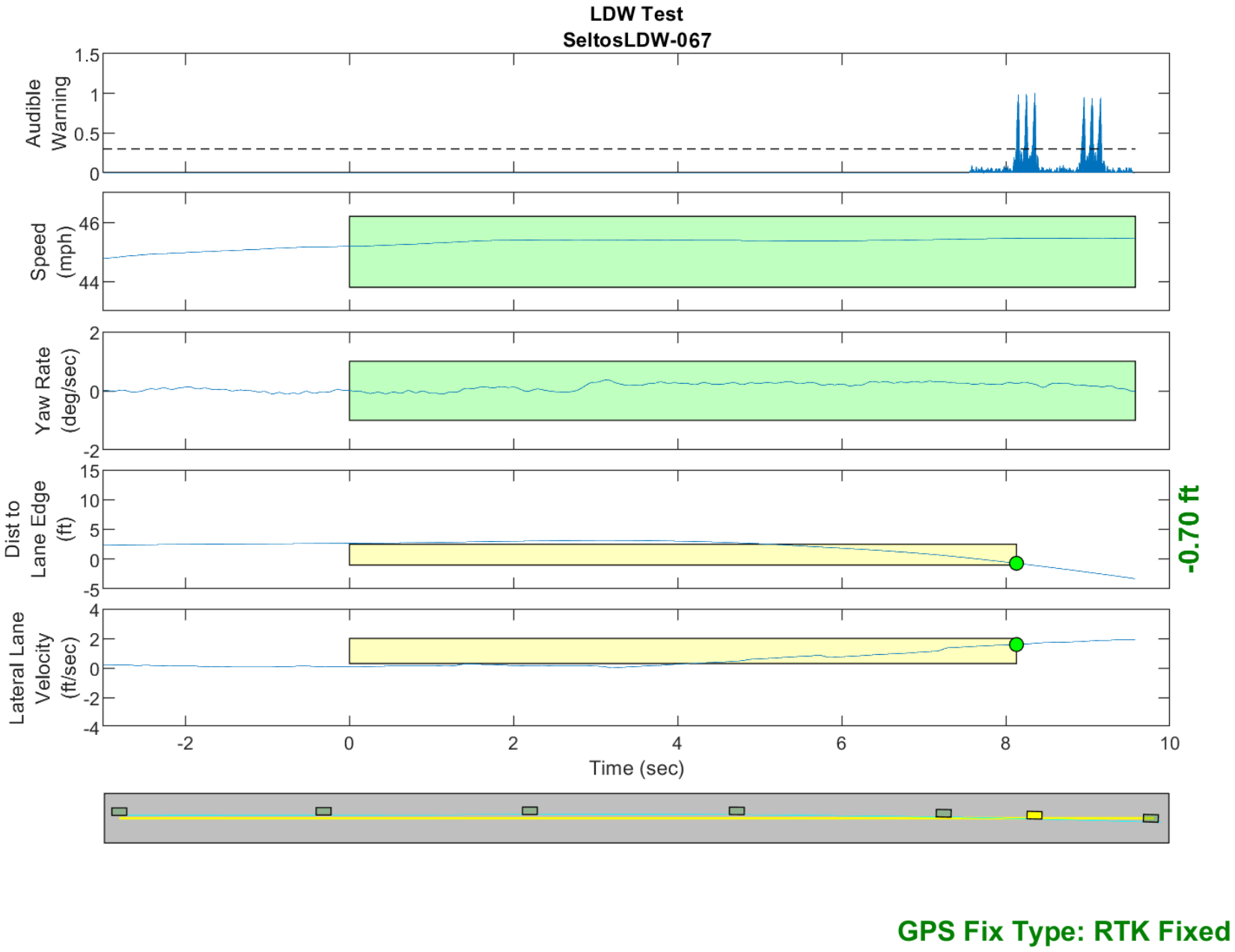

Figure D88. Time History for Run 67, Botts Dots, Right Departure, Auditory Warning

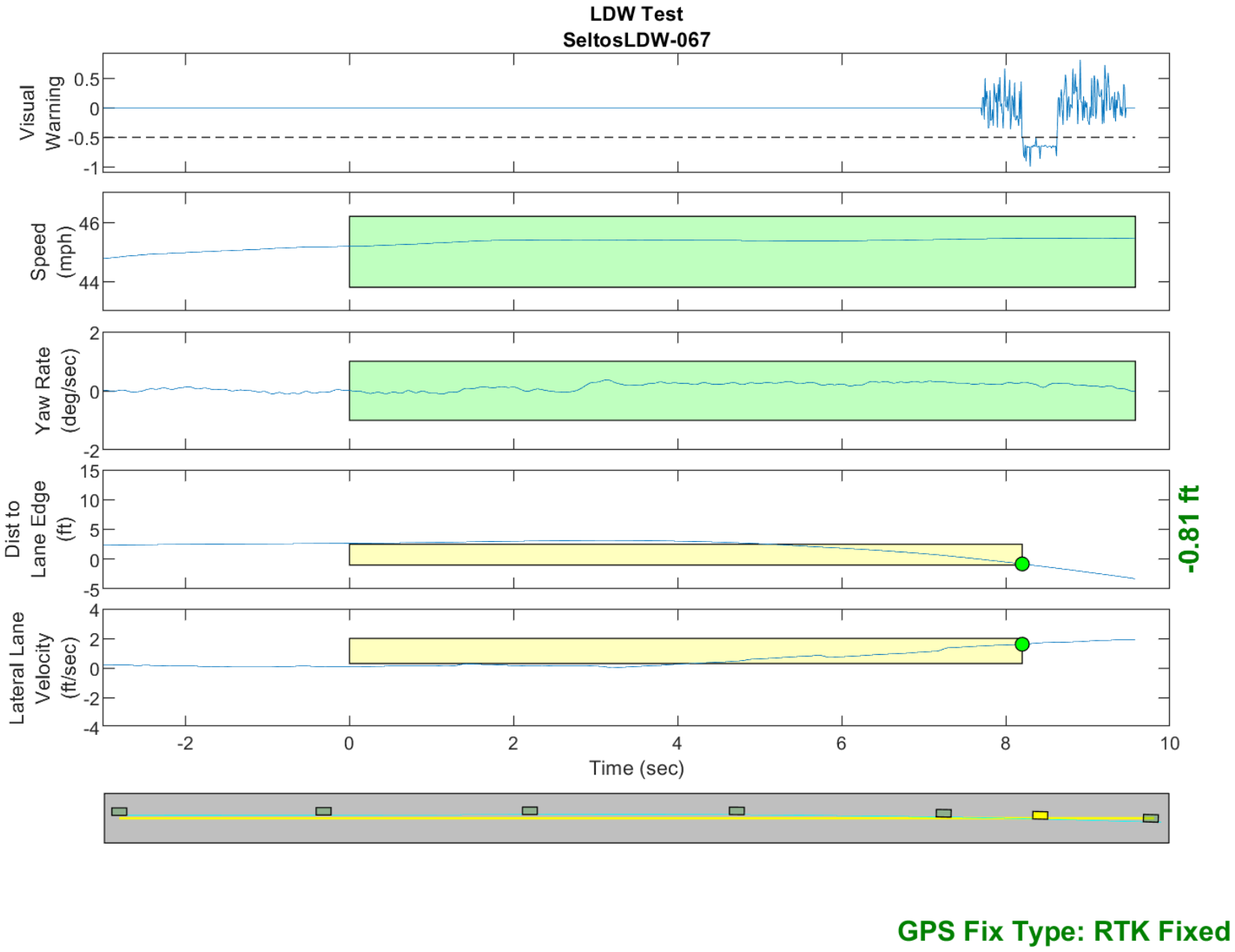

Figure D89. Time History for Run 67, Botts Dots, Right Departure, Visual Warning