



Advanced Highway Maintenance and Construction Technology Research Center

Department of Mechanical and Aerospace Engineering
University of California at Davis

Sand Spreader Testing Fall 2018

Wilderich White

Test Report

April 12, 2019

California Department of Transportation

Division of Research, Innovation and System Information

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Definition
AHMCT	Advanced Highway Maintenance and Construction Technology Research Center
Caltrans	California Department of Transportation
DOT	Department of Transportation
DRISI	Caltrans Division of Research, Innovation and System Information
DOM	Caltrans Division of Maintenance
DOE	Caltrans Division of Equipment

SAND SPREADER TESTING FALL 2018

Background

The California Department of Transportation (Caltrans) Division of Equipment (DOE) initiated the testing of sand spreaders to compare the spreading performance of traditional spreaders and newer designs from Henderson and Epoke. The newer designs can more accurately control spread rates. Advanced Highway Maintenance and Construction Technology (AHMCT) Research Center and DOE personnel performed this testing in the fall of 2018. This report presents the results of this testing.

Testing Procedure

Testing Parameters

The testing procedure was developed using the European Technical Specification CEN/TS 15597-2 (herein, specification 15597) as a guide. The specification can be used to certify spreaders, but it has not been verified that machines in Europe are actually delivered to this specification. Testing was limited to measurements of sand distribution on a grid, termed 'dynamic testing' within specification 15597.

General testing requirements were defined by Caltrans DOE and include the lane configurations in Table 1. Six test runs were performed for each configuration. Test runs were performed at two different sand spread rates (150 and 450 lb/lane mile (lb/lnmi)) and three vehicle speeds (18 mph, 25 mph and 37 mph). A total of 78 test runs were performed.

Caltrans typically uses a spread rate of 450 lb/lnmi for sand during typical chain control conditions. The speeds selected correspond approximately to the 30, 40, and 50 kph speeds used in specification 15597. During chain control conditions, traffic speeds are limited to 35 mph.

Table 1: Spreader type and spread configurations tested

Spreader Type	Left Lanes	Center Lane	Right Lanes	All Lanes
Tailgate	No	No	No	Yes
Vbody	Yes	Yes	Yes	Yes
FRS	Yes	Yes	Yes	Yes
Epoke	Yes	Yes	Yes	Yes

The grid pattern used to test the spreaders is shown in Figure 1 from specification 15597. The testing was performed by driving the spreader down the center for every pass. The center is the border between strips 6 and 7.

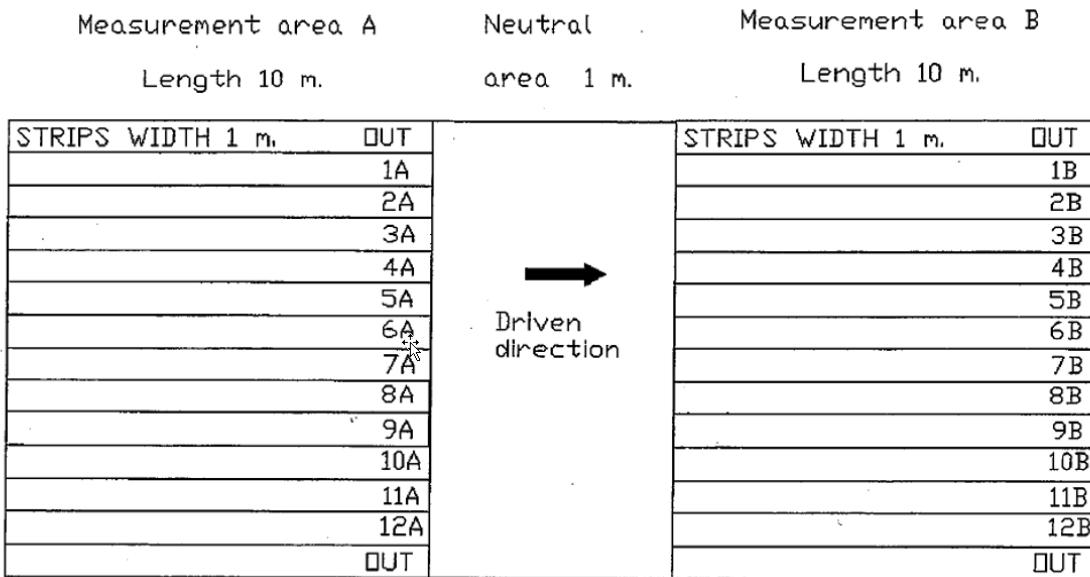


Figure 1: Layout of test strip grid (Figure 7c of CEN/TS 15597-2:2012)

For each spread configuration, four one-meter strips (13.1-ft) represents a single lane. The strips for each configuration are listed in Table 2 and are referred to as the target strips. Specification 15597 assigns one outer (out) strip bounded by a wall at the outer edge on each side of the set of target strips. For the spreader tests, walls were placed permanently at the outer edges of strips 0 and 13 and sand was collected in all the strips. The walls were fabricated by ripping sheets of 5/16 and 3/8-in plywood into approximately 1-ft (30.5-cm) strips. Specification 15597 recommends 30 cm maximum. The required 9.8-ft (3-m)-wide clear zone existed around the test area.

Table 2: Target strips for each spread configuration and corresponding lane width

	Spread Configuration			
	Left Lanes	Center Lane	Right Lanes	All Lanes
Target strips	1-8	5-8	5-12	1-12
Spread width (lanes)	2	1	2	3

Spread configurations are shown in Figure 2. The Right Lanes configuration is symmetrically opposite of the Left Lanes configuration shown in the figure.

Dale Greep of Caltrans arranged for access to an untraveled section of road with a useable length of approximately 0.31 mi on an old section of Kilzer Ave. at McClellan Park. The road runs north-south and the grid was placed at approximately (lat/long 38.643404°, -121.410414°). Figures 3 and 4 provide views of the track and grid.

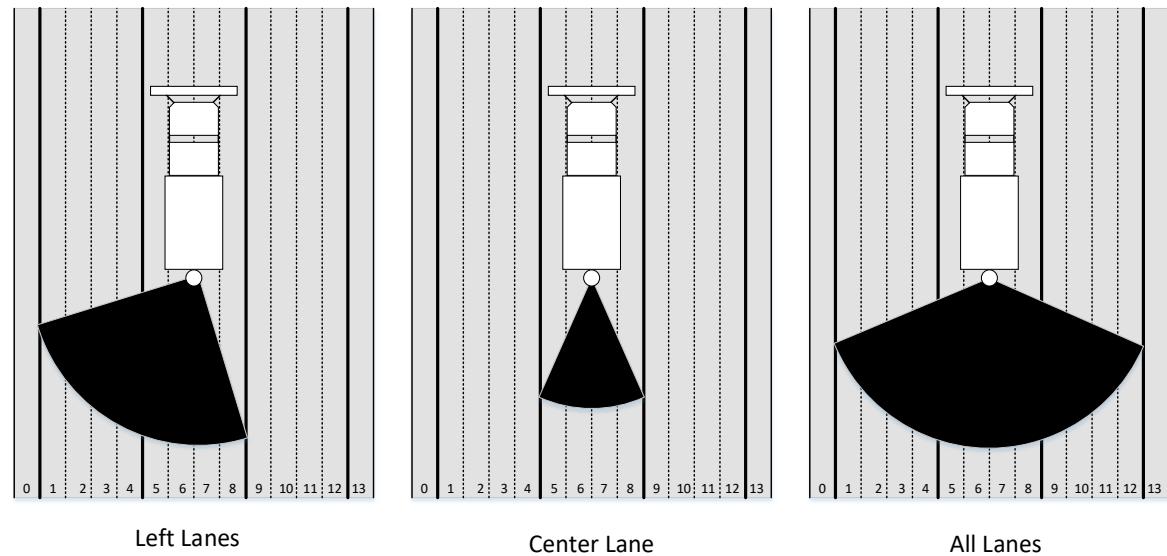


Figure 2: Spread configurations on grid used in testing (Right Lanes configuration is symmetric to Left Lanes configuration)



Figure 3: View of track and grid looking north



Figure 4: View of FRS test run looking south

Personnel

The following personnel were directly involved in facilitating and performing the tests:

Dale Greep, Statewide Equipment Manager, Division of Maintenance (DOM), Caltrans

James Henry, Equipment Engineer, DOE, Caltrans

Larry Baumeister, Project Manager, Division of Research, Innovation and System Information (DRISI), Caltrans

Victor Reveles, Research Technician, AHMCT, UC Davis

Wil White, Senior Research Engineer, AHMCT, UC Davis

Spreaders

The spreaders tested were new machines from DOE that were entering the Caltrans Maintenance fleet. James performed system calibrations and operated the spreaders. Figure 5 through Figure 8 show pictures of the spreaders on the test grid.



Figure 5: Swenson tailgate spreader, truck ID 7011282



Figure 6: Vbody Spreader - Henderson Model FSH, truck ID 7008268



Figure 7: Henderson FRS Spreader, truck ID 7010967



Figure 8: Epoke SH 4900 spreader, truck ID 7010966

Vacuum system and collection of sand

AHMCT developed and fabricated a vacuum cleaner (Figure 9) designed to collect the sand on the test grid. A two-cycle gas vacuum/blower (Stihl model SH 86) was selected to draw air through a cyclone separator (Oneida Super Dust Deputy 5"). The original design parameter imposed was a requirement to maintain a speed of 1500 ft/min in the airstream to collect material off the road surface. This speed was insufficient and the nozzle geometry was changed to increase the airstream speed to approximately 3000 ft/min. The nozzle width was reduced from 39 in to 20 in to increase flow in the nozzle to collect the larger particles.

Specification 15597 requires the collection of less than 1 gm/ m² on the test area between tests. This check was performed intermittently between tests. Measurements determined that 94% of the sand was collected in one pass. A second pass raised the percentage to 98%. Two passes of the vacuum cleaners were used when collecting samples during testing.

Specification 15597 requires cleaning between tests of the 165 ft (50 m) approach area in advance of the measurement area. This avoids contaminating the measurement area with material dragged in by the truck tires or air turbulence. Due to time and resource constraints, this requirement was not enforced, but backpack blowers were used to maintain a 25-ft wide clean approach corridor.

Initially, the limited cleaning of the approach area was determined to be adequate based on observations of the different dust patterns seen as the spreaders moved across both cleaned and not cleaned sections of the test track. The spreaders do raise a cloud of dust picked up from the road. Minimal dust was seen behind the spreader passing through the cleaned approach area. Some of the dust observed is dropped from the spreader itself.

During the course of testing, some spreader runs resulted in an aborted test run. Inspection and, in some cases, vacuuming of the grid after aborted runs validated that the approach area was sufficiently clean and the spreader did not drag in enough material to affect test results. In future testing, it may be of value to quantify the dust dragged in by air turbulence. This may justify a change in procedures, e.g. cleaning a shorter portion of the approach area, which could reduce the time spent cleaning the approach.



Figure 9: Sand collection vacuum

Description of Test Run Steps

A test run would take 45 to 60 minutes. The general sequence and activities for each run were as follows:

Step 1: (Approximately 10 minutes) Start truck and spreader controls. Blow off sand that has collected on the vehicle frame to limit contamination of test samples. Raise, level, and square the front plow to avoid off-centered draft from deflection of air. Start camera on spreader. Drive truck to far end while setting up and checking spreader controls. Use warning lights to indicate ready.

Install and straighten wall panels. Man left and right cameras.

Run the spreader truck at required speed (checked with laser handheld speed device). Start the spreader at the 165 ft (50 m) mark. Cross the test grid, then stop the spreader, and park the truck. Confirm success with review of video and inspection of track. Turn off cameras.

Step 2: (Approximately 45 minutes) Two people (usually Wil and Vic) collect the sand on the grid while a third (James) collects, bags, and weighs the samples, then enters the values into spreadsheet.

Clean advance area with backpack blowers. Refuel vacuums and blowers. Reinstall and straighten wall panels at the 1-m strip.

Results

a) Tabulation of Results

Appendix A contains the test results. These tests are a full complement of the 24 test runs each for the Vbody, FRS, and Epoke, and 6 test runs for the tailgate spreader. Each test run consists of 28 sand weight measurements, one for each strip in areas A and B.

The following differences between spreaders affected the testing procedures and results:

- The FRS and Epoke will adjust material feed rate automatically as lane width settings are changed, but the Vbody and tailgate spreaders do not. To minimize variables, the Vbody spread rate setting was not changed between one- and two-lane tests; therefore, the effective spread rate changes. As a result, the 24 tests of the Vbody are not directly comparable to the FRS and Epoke.
- The concept of a travel mile (trmi, as in vehicle mile traveled) is used to clarify the actual spread rate (lb/lnmi) used in a test. A spread rate stated in lb/trmi is a measure of total material fed out by the spreader as it moves forward independent of speed or lane width settings. The travel mile is referenced in the tables of Appendix A.
- The FRS cannot spread consistently at the setting of 150 lb/lnmi because of design limitations. Tests FRS 28 and 29 were run at a setting of 150 lb/lnmi and resulted in very low actual spread rates. The problem was discussed with the manufacturer who stated that the FRS does not operate consistently below 200 lb/lnmi . Treating this as an operating range limit, the FRS was then set at 200 lb/lnmi for the remaining 150 lb/lnmi tests.
- The tailgate spreader spread direction is not adjustable and it is directed to the left of center. The tailgate spreader is not comparable to the other three spreaders because of this limitation.

Tailgate spreader settings are shown in Table 3 for clarification.

Table 3: Tailgate spreader controller settings

Tailgate Test Name	Controller Settings
150 lb/lnmi All Lanes	Spread rate: 450 lb/trmi Lane width - 3 lanes (Resulting in 150 lb/lnmi (11.6 gm/m ²) across 3 lanes)
450 lb/lnmi All Lanes	Spread rate: 1350 lb/trmi Lane width: 3 lanes (same as above) (Resulting in 450 lb/lnmi (34.7 gm/m ²) across 3 lanes)

Vbody spreader settings are shown in Table 4. To complete a pattern of tests outlined, the operator makes multiple adjustments of Vbody controller settings and must mechanically adjust the positions of deflector flaps at the spinner. The spread rate was set to a fixed setting of three lanes wide and the flaps were used to adjust spread width and direction. The steps listed in the table describe this sequence used in this testing.

Table 4: Vbody spreader controller and deflector flap settings

Vbody Test Name	Controller and Deflector flap settings
	For all tests the spinner spread width setting was 3 lanes wide
150 lb/lnmi Right Lanes	A) Spread rate: 150 lb/trmi Flap settings: left down, center down, right up (Resulting in 75 lb/lnmi (5.8 gm/m ²) across 2 lanes)
150 lb/lnmi Center Lane	B) Same as A except Change flap settings: left down, center up, right down (Resulting in 150 lb/lnmi (11.6 gm/m ²) across 1 lane)
150 lb/lnmi Left Lanes	C) Same as A except Change flap settings: left up, center down, right down (Resulting in 75 lb/lnmi (5.8 gm/m ²) across 2 lanes)
150 lb/lnmi All Lanes	D) Same as A except Increase spread rate: 450 lb/trmi Change flap settings: left up, center up, right up (Resulting in 150 lb/lnmi (11.6 gm/m ²) across 3 lanes)
450 lb/lnmi Right Lanes	E) Spread rate: 450 lb/trmi Flap settings: left down, center down, right up (Resulting in 225 lb/lnmi (17.3 gm/m ²) across 2 lanes)
450 lb/lnmi Center Lane	F) Same as E except Change flap settings: left down, center up, right down (Resulting in 450 lb/lnmi (34.7 gm/m ²) across 1 lane)
450 lb/lnmi Left Lanes	G) Same as E except Change flap settings: left up, center down, right down (Resulting in 225 lb/lnmi (17.3 gm/m ²) across 2 lanes)
450 lb/lnmi All Lanes	H) Same as E except Increase spread rate: 1350 lb/trmi Change flap settings: left up, center up, right up (Resulting in 450 lb/lnmi (34.7 gm/m ²) across 3 lanes)

Compilation and Analysis

Each table in the appendix contains a summary section with the following values (refer to Figure 1 for test area details):

1a. Sum of Sand Weight in Area - The value is the sum of the weight in all strips 0-13 (column 1a). This measures the auger or chain material feed rate out of the hopper and is the simplest comparison between machines. Some losses resulted during the vacuuming process and due to the loss of sand over the walls. For comparisons, the value is converted to a percentage of the nominal value (column 1b) and used in Table 5. Sand weight in area (both weight and percentage of nominal) is the most important element in the results, and it is the value plotted in Appendix A Plots 1-26.

2a. Sum of Sand Weight in Target Strips and 2b. Fraction of Material in Target - This second value (column 2a and 2b) defines the fraction of sand that landed in the ‘targeted’ lanes. The spinner speed and height affects this value directly. Ideally all the sand is deposited in equal amounts in each of the target strips that make up the lanes being targeted. This value does not account for the distribution within the target lanes. It is used as a gross comparison and is included in Table 5.

Table 5: Average values comparing the machines

A. Ratio of the sum of sand weight in area divided by the selected application rate (nominal)				
	AVERAGE	STDEV.P	MIN	MAX
Vbody	214%	114%	59%	502%
FRS	86%	21%	57%	137%
Epoke	92%	49%	44%	225%
B. Fraction of material in target				
	AVERAGE	STDEV.P	MIN	MAX
Vbody	84%	9%	66%	97%
FRS	75%	17%	40%	93%
Epoke	87%	9%	76%	96%

Table 5 shows the average, standard deviation (population), minimum, and maximum values for all 24 runs of the Vbody, FRS, and Epoke. This can be used as a simple but incomplete comparison between machines. The values in Table 5 are calculated for every area (Areas A and B in every test run), a total of 48 values. Table 5A, the ratio of the sum of sand weight in area divided by the selected application rate (nominal), is derived from column 1b in the table of the Appendix. The values in Table 5B, the fraction of material in target, are similarly derived from column 2b in the table of the Appendix.

Plots in Figures 10 through 17 compare the sand distribution for all four spreaders in the eight different combinations of spread rate and lane configuration. A normalized *Average of 3 Test Runs* (average of runs at speeds 18, 25 and 37 mph) is plotted for each spreader. The normalization is performed by dividing the weight in each strip by the nominal strip weight for the associated spreader setting. For reference, the associated spreader setting is appended to the spreader name in the legend. The plots include a thick black line representing the nominal requirement and a dotted black line representing the minimum requirement in each strip as defined by specification 15597. The ideally efficient spreader would deposit sand at 100 % and none outside of these strips. Values above 100% are waste but specification 15597 does not define a maximum limit. Values under 100% would be considered insufficient and specification 15597 defines minimum values shown. Values above 0% beyond the ends of the line is waste. Complete testing to specification 15597, not performed here, does include other ratios that define additional limits.

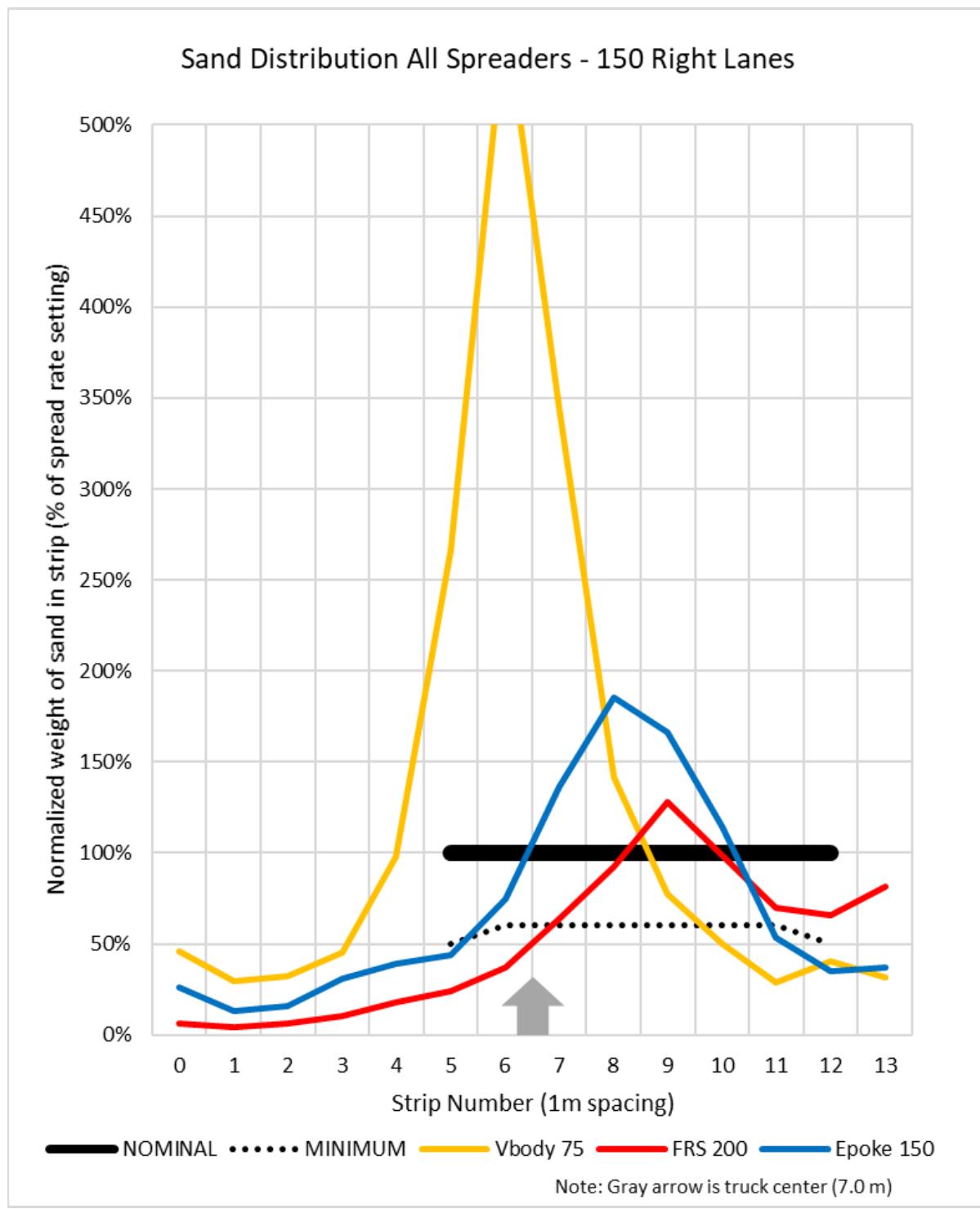


Figure 10: Sand distribution for all spreaders - 150 Right Lanes

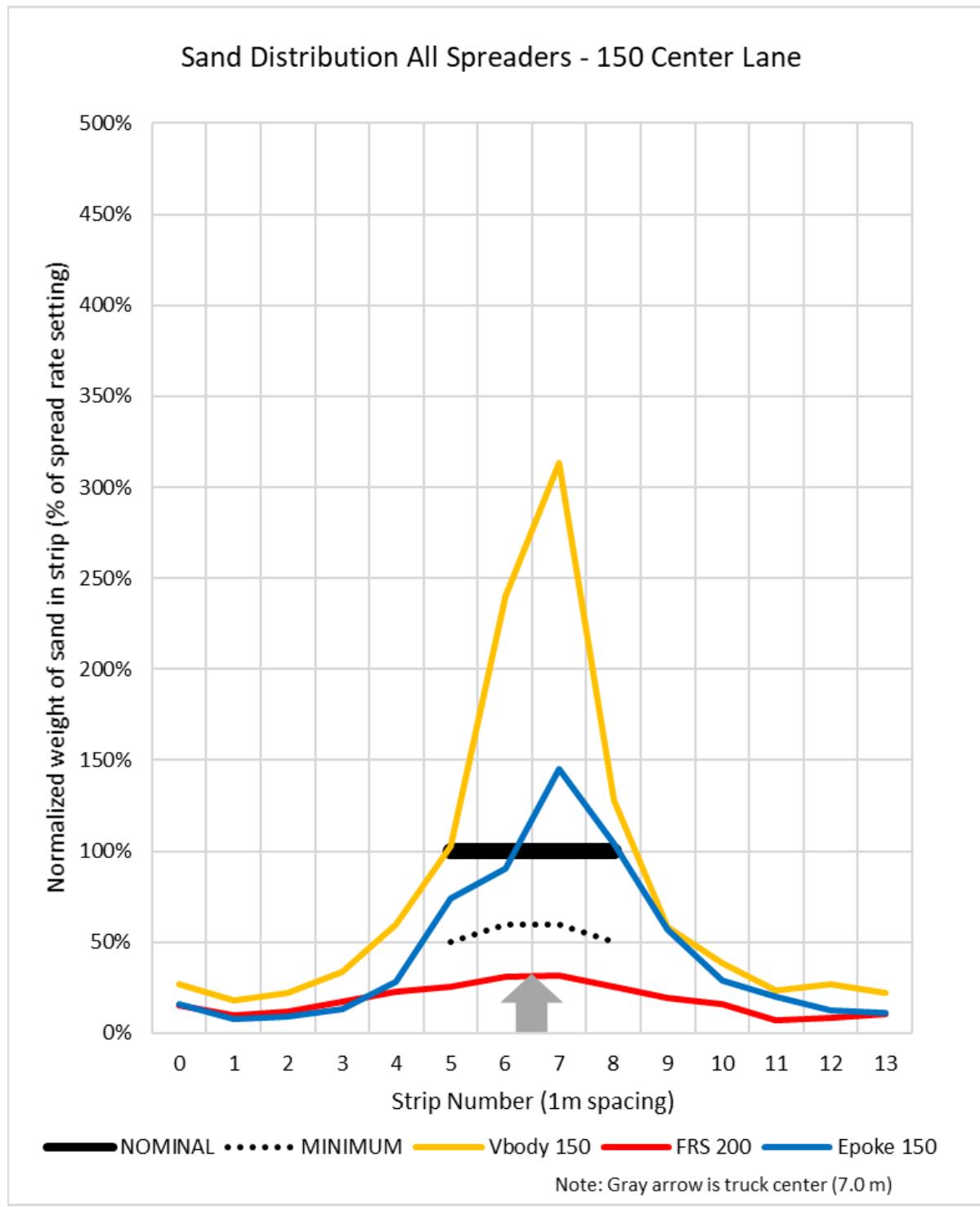


Figure 11: Sand distribution for all spreaders - 150 Center Lane

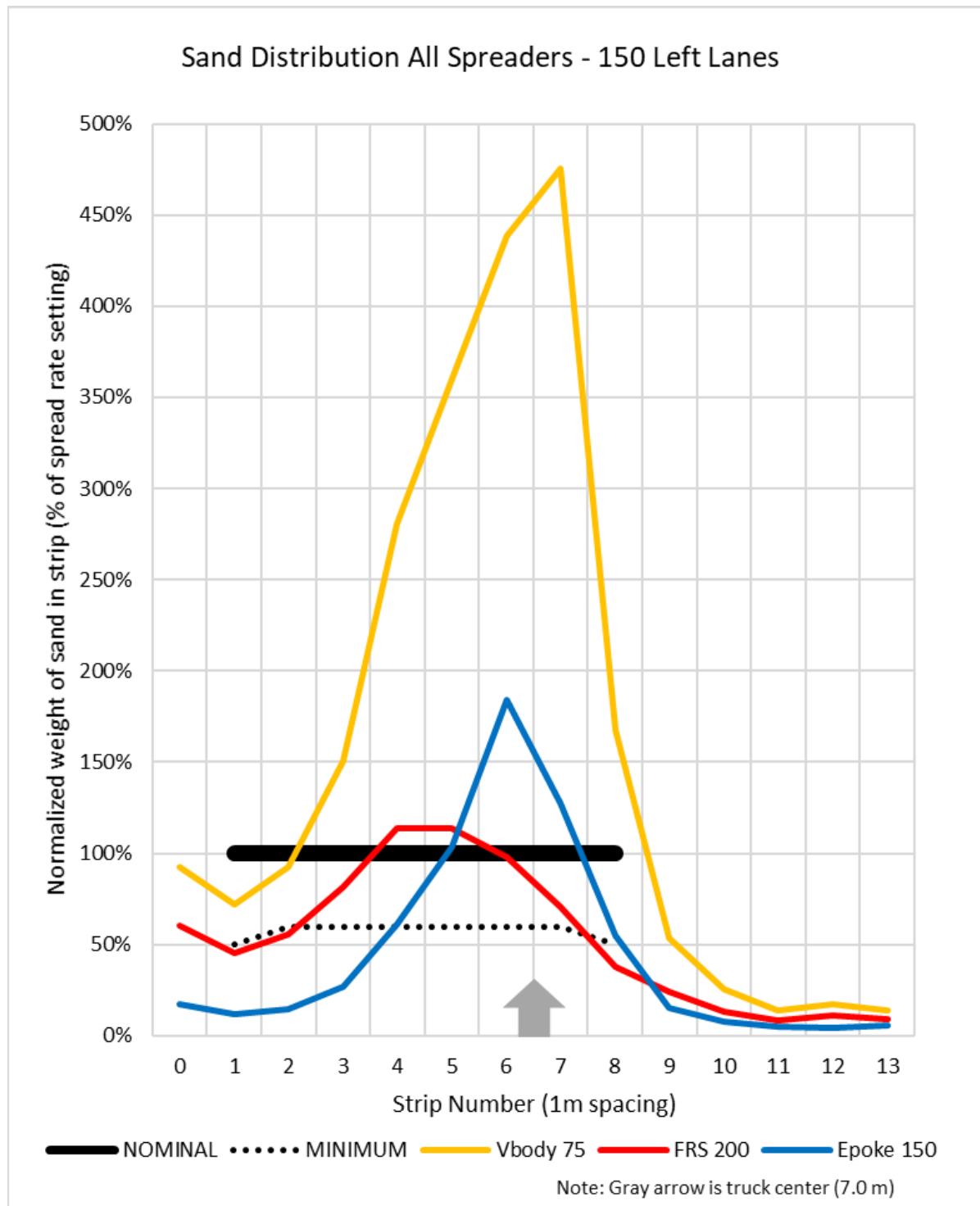


Figure 12: Sand distribution for all spreaders - 150 Left Lanes

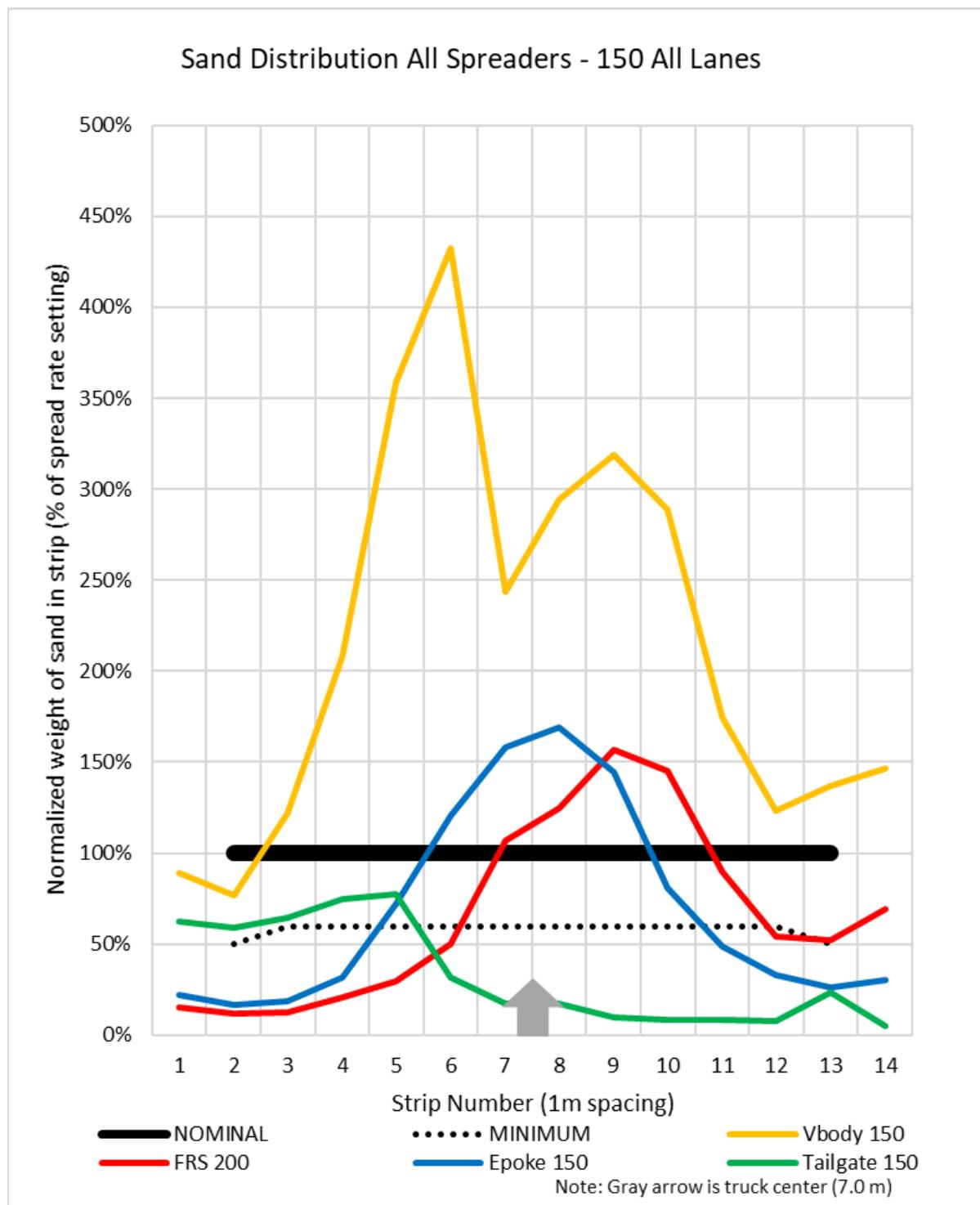


Figure 13: Sand distribution for all spreaders - 150 All Lanes

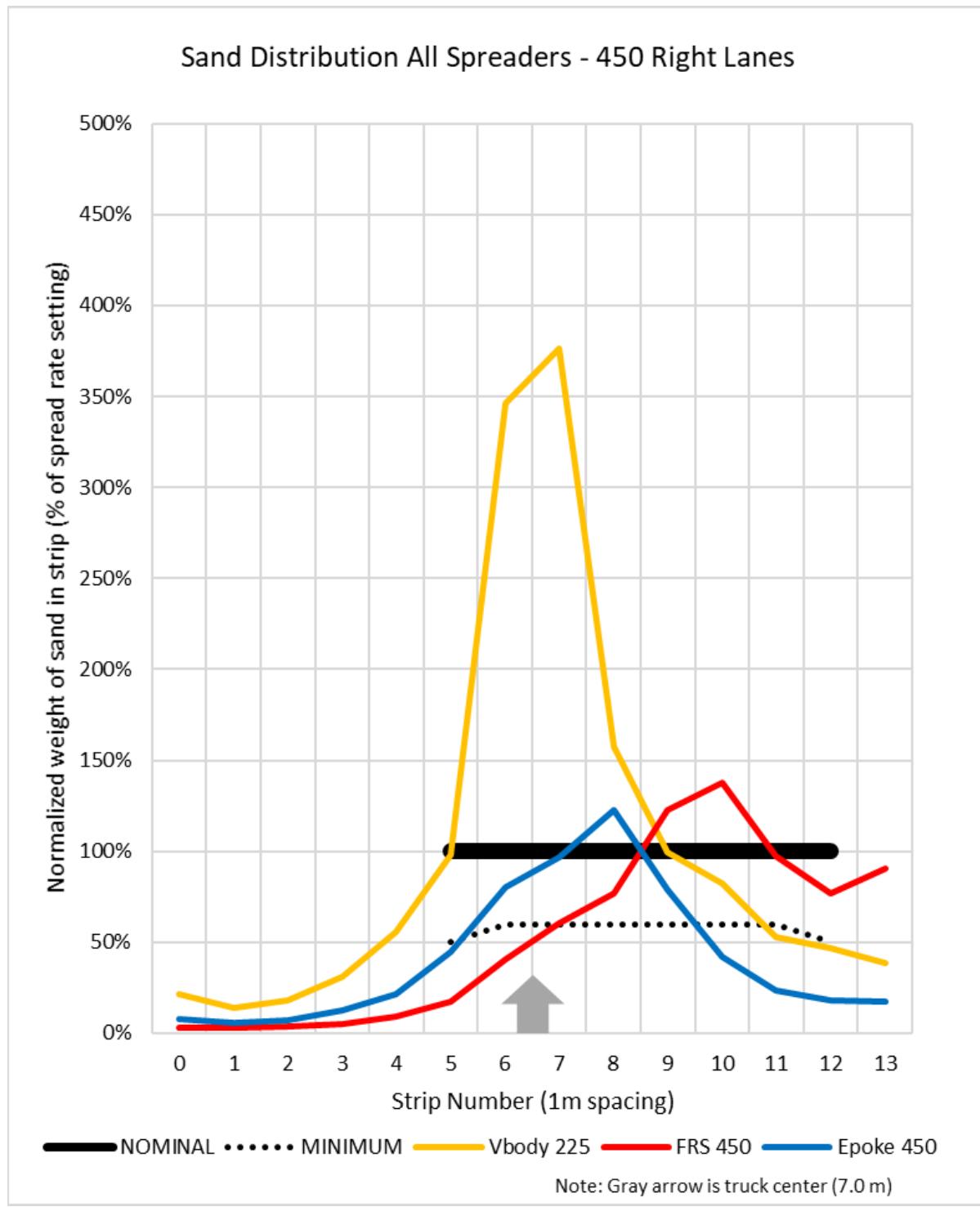


Figure 14: Sand distribution for all spreaders - 450 Right Lanes

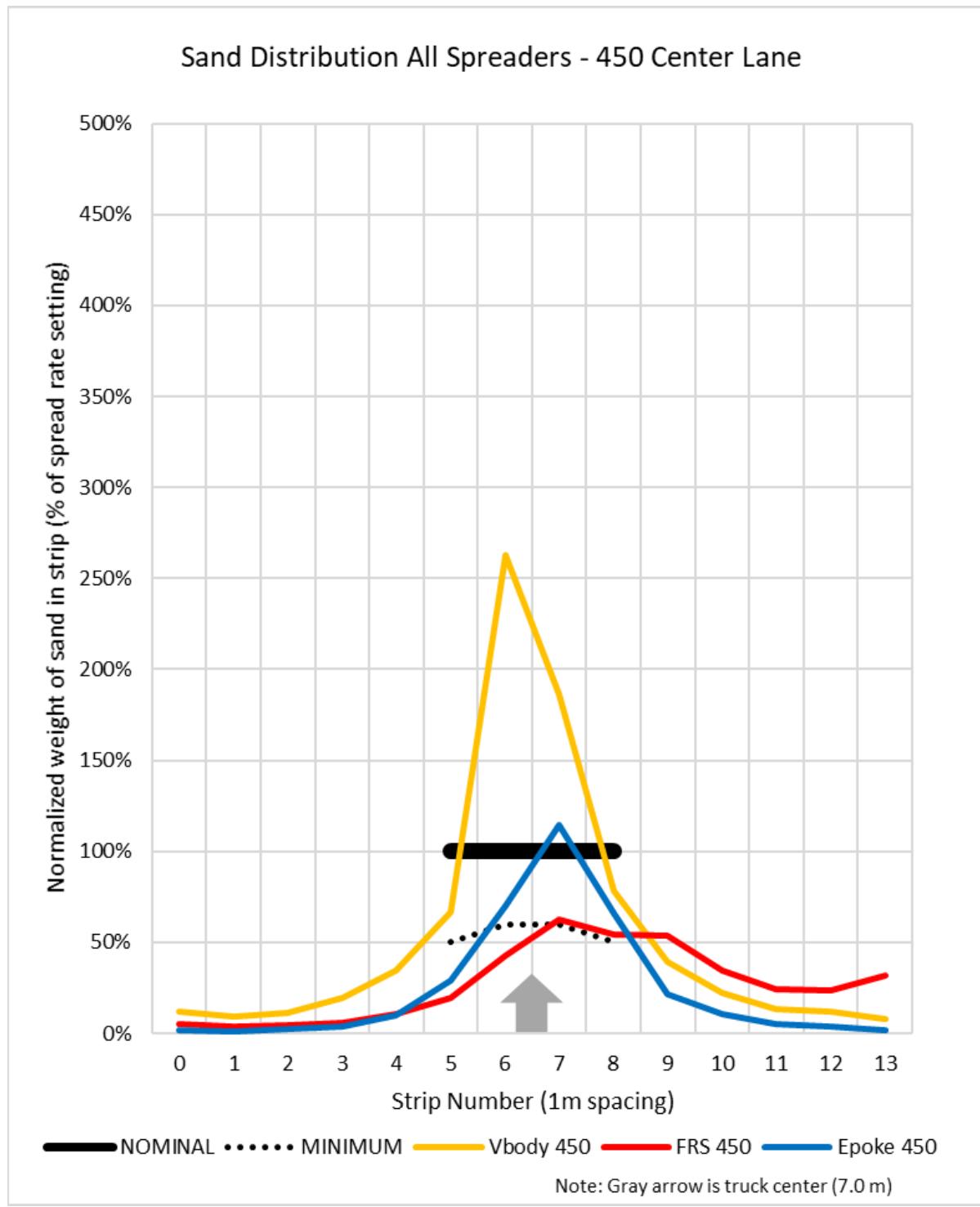


Figure 15: Sand distribution for all spreaders - 450 Center Lane

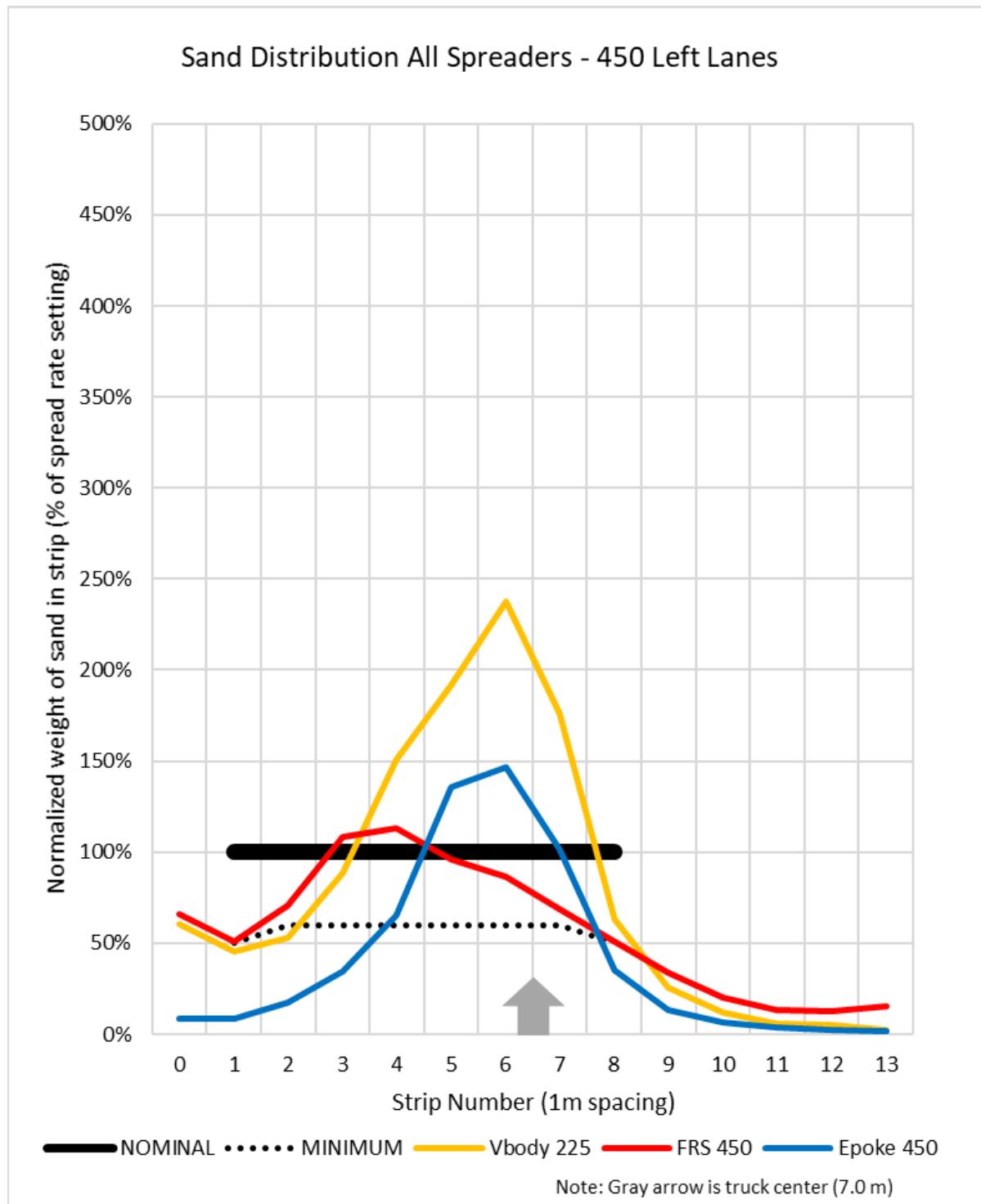


Figure 16: Sand distribution for all spreaders - 450 Left Lanes

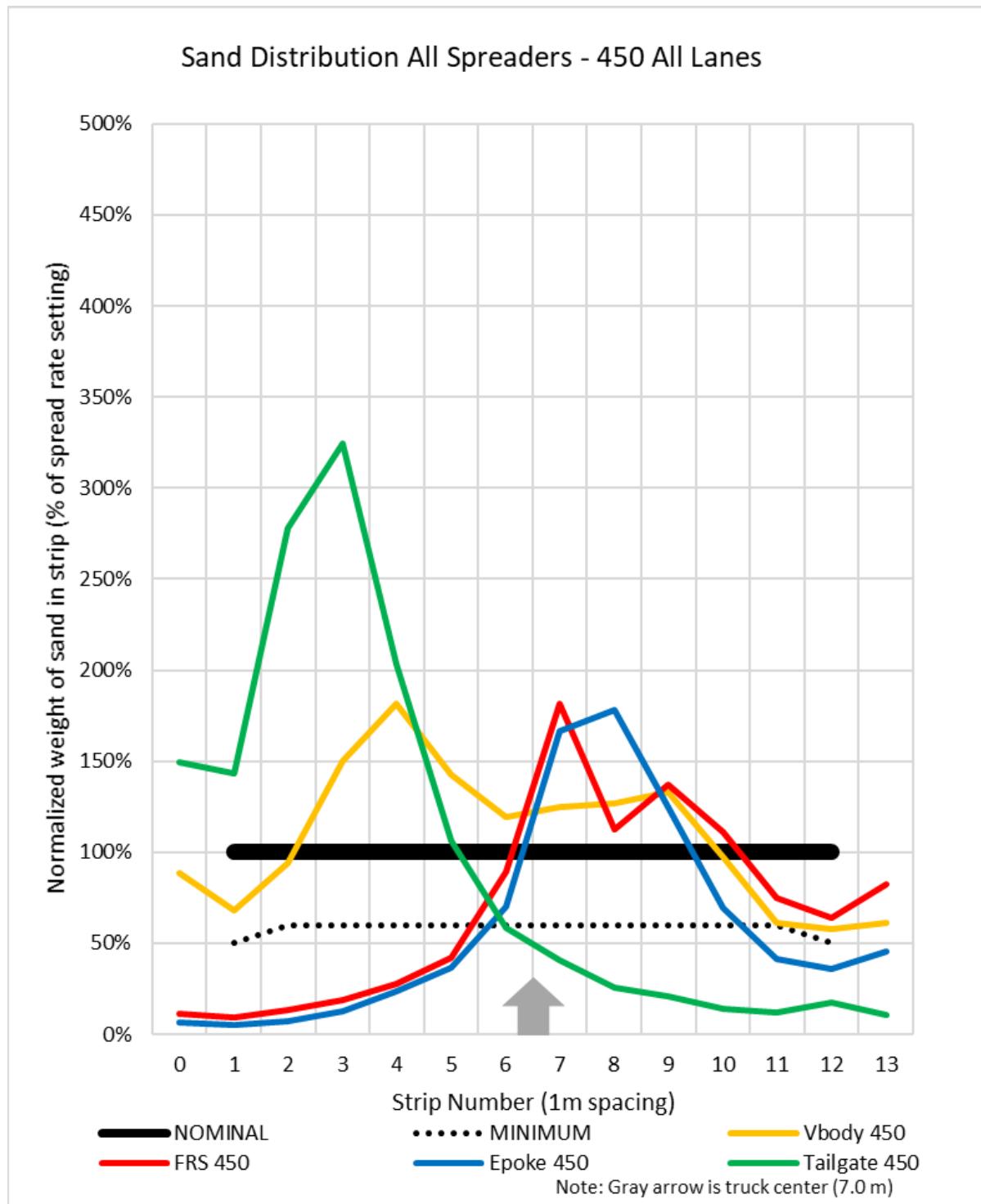


Figure 17: Sand distribution for all spreaders - 450 All Lanes

The following observations are noted:

Tailgate Spreader

- The actual spread rates range from 19% to 140% of the nominal values.
- The spinner has no mechanism to adjust the spread direction and it is permanently oriented to spread to the left which is useful if used on a two-lane highway (one lane each direction). In this case, the spread pattern is centered on the dividing stripe.
- Assuming the spreader is driving in the middle of its lane on a two-lane road, the spread pattern should be centered on the divider. This would be 6 ft (1.8 m) from truck center, at the 5.2-m mark on the grid. The spread pattern appears to be closer to the 3.5-m mark which is close to the center of the opposing lane. This suggests that the spread pattern needs to be modified.
- The spread rate drops as speed increases. The spreader rate is not compensated for vehicle speed.
- This spreader is not comparable to the other three.

Vbody

- James adjusted the values for spread rate and width and set the deflector flaps to match the test configurations. The flaps were either up or down but can be set at intermediate angles.
- Table 5A shows that material is deposited at twice the nominal rate and varies significantly between runs. The range of 59% to 502% is very problematic and not understood.
- Table 3B shows a reasonable percentage of the material has landed on the target. The plots show that wide areas of the target are not adequately sanded. The Vbody performs best in the center lane tests.
- The spread patterns seen in the plots are unique to this machine. The spread patterns seen in most of the plots illustrate the effect of the deflector flaps.

FRS

- The FRS spreader is a recently developed system, and DOE experienced problems with the machine. The customer is responsible for integrating the Muncie control system and hydraulics with the Henderson spreader components. Given the machine complexity, this is disadvantageous to the customer. Many problems were experienced during testing which could not be resolved until a technical support visit from Muncie personnel. After they resolved the issues and adjusted recalibration procedures, spreader operation improved dramatically. The first 27 tests were invalid due to problems with the spreader. These tests are not included in the appendix.
- Testing resumed but the FRS did not operate consistently at a spread rate of 150 lb/lnmi. During testing, Muncie confirmed that the machine does not operate consistently below 200 lb/lnmi. The first two tests were run at 150 lb/lnmi and the remainder were run at 200 lb/lnmi, the operating limit.

- The FRS would not start spreading within the 164-ft (50-m) distance of the approach. This is a requirement in specification 15597. A distance of at least 260 ft (79 m) was used instead.
- The FRS control system has no ability to set a parameter value to modify the spinner speed. This setting is recommended for adjusting spreading width for different material grain sizes. Compared to the Epoke, the FRS dispensed a significant amount of larger sand particles over the wall. This is not apparent in the data and the mechanism is not understood.
- Many of the plots indicate that the spread width is too wide.

Epoke

- The Epoke vendor distribution network changed recently and the technical support previously provided was not available. Thirteen tests were run before the Epoke vendor provided technical support. This improved the Epoke performance and the first 13 tests are omitted from the appendix.
- The current Epoke design is significantly different from that previously tested by AHMCT. An auger instead of a conveyor belt feeds material into the spinner chute. The Epoke spread rate varies considerably as the auger turns. The average spread rate is 92% of nominal, suggesting that the final calibration values are correct.
- Because the Epoke has been installed on a roll-off frame, the spinner height is about four inches too high, which increases the spread width. To reduce the spread width, spinner speed was adjusted to 50% of normal, the minimum. This setting may not be ideal.
- Many of the plots indicate that the spread width setting is too narrow.

Conclusions and Recommendations

The testing has demonstrated the potential improvement in spreader technology as demonstrated by the FRS and the Epoke designs. The following conclusions are made.

- The tailgate spreader is not competitive with any of the other machines. Spread rate is neither accurate nor consistent. The spread direction is fixed for use on a two-lane road. The center of the spread pattern is not aligned with the center stripe of a two-lane road, the expected alignment.
- The Vbody is not competitive with the FRS and Epoke. The Vbody feed rate is neither accurate nor consistent. When spreading to the right or left, the deflector flaps cause sand to be concentrated near the center of the vehicle.
- The FRS and Epoke spreaders are generally more accurate and effective at spreading than the V-body in most cases. Both the FRS and Epoke performed relatively poorly in the All Lanes test.
- The FRS did not spread consistently below 200 lb/lnmi.
- During this testing, the operation of the FRS and Epoke spreaders was not completely understood. The calibration process was especially problematic due to limited information.

- Poor performance of any of the machines could be the result of errors in operation or calibration. Further evaluation and testing to determine the cause will require manufacturer support.
- The experience and results highlight the need for a testing and qualification process for the new spreader technologies in the industries.

The following short-term actions are recommended:

- Review results with DOE. The recommended format is a brief presentation of results including appropriate video, followed by detailed discussion.
- Analyze the existing data set to compare performance directly to specification 15597. This assigns a minimum value for each strip in the target strips and outer strips providing a pass/fail for each run. This can be done for each test run and/or the averages. The values used can be normalized to better describe the Vbody spread patterns, possibly allowing a direct comparison to the FRS and Epoke spreaders.
- Review the videos to search for photographic evidence that explains the results seen in the data.
- Document the Vbody testing in greater detail to provide a definitive report quantifying its limitations. One of the goals of this testing is to establish the value of the FRS and Epoke spreaders compared to the simpler but much less expensive Vbody spreader. The Vbody deflector flaps direct the sand in surprisingly good spread patterns. The extreme variation in delivery rates is unacceptable. In an effort to assign a value to this spreader design, the fact that it delivered twice the material that was expected cannot be used without added details. Operators will modify the machine operation to avoid this kind of extreme operation. Some additional testing of a recalibrated system might be needed.
- Communicate with the FRS and Epoke technical design teams to detail the limitations of their machines. Clarity of documentation for both machines needs to be considerably improved. The current testing and associated video can support this effort.

The following long-term actions are recommended:

- Develop a standardized material. The ratio of grain sizes affects the spread pattern. The larger grains are thrown many times farther. Analysis of the samples from this series of tests could be used as a basis for developing a standardized material.
- Develop the basis for a testing specification that can be used in the purchase process and by customers to verify the capabilities of the modern spreaders. Specification 15597 is a contender but it is requires further development. In order to meet the specification, a vendor would have to 'tune' in their machine ahead of any test. The specification does not require the detail necessary to ensure that the machine will operate in the field as specified. Based on information collected by Caltrans and forwarded to AHMCT (prEN 15597-2 - Revised draft for revision from Mr. Giletta (2017-06)), it appears that the specification is under review. It is important to understand what is being changed and why.

- Develop simpler procedures for validating the spread patterns. The use of static spread patterns and other alternatives should be evaluated. This will be useful in the calibration of equipment.

APPENDIX A: TABLES AND PLOTS OF TEST RESULTS

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<u>Plot 26: Sand Distribution - Epoke 450 All Lanes</u>	<u>A36</u>

Table A1: Sand Distribution - Tailgate 150 All Lanes

TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 11.6gm/m^2	Nominal		116												
Tailgate 4 - 150 All 18mph	T4A(18)	134	100	122	155	181	64	34	18	10	14	10	9	21	6
	T4B(18)	143	102	129	160	199	72	29	30	15	11	9	12	46	7
Tailgate 5 - 150 All 25mph	T5A(25)	41	55	49	51	43	25	21	28	19	15	17	11	38	4
	T5B(25)	45	43	42	47	48	29	16	25	16	8	12	11	34	9
Tailgate 6 - 150 All 37mph	T6A(37)	36	62	63	59	42	22	14	7	4	6	8	5	14	4
	T6B(37)	36	47	44	50	26	11	8	13	4	5	6	5	12	3
Average of 3 Test Runs	Average	73	68	75	87	90	37	20	20	11	10	10	9	27	6

Summary

		1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)	2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)	3. Center of mass of weights of sand in all strips within the area	4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)	4c. Actual feedrate in 3a as a percentage of Nominal (%)
TEST RUN	AREA ID								
Spread rate: 11.6gm/m^2	Nominal	1392	100	928	67	7.0			
Tailgate 4 - 150 All 18mph	T4A(18)	879	63	180	20	3.8	707	1120	63
	T4B(18)	964	69	224	23	4.1	776	1120	69
Tailgate 5 - 150 All 25mph	T5A(25)	418	30	173	41	5.3	467	1556	30
	T5B(25)	386	28	152	39	5.3	432	1556	28
Tailgate 6 - 150 All 37mph	T6A(37)	347	25	80.2	23	4.0	573	2303	25
	T6B(37)	270	19	64.2	24	4.1	446	2303	19
Average of 3 Test Runs	Average	544	39	146	27	4.3			

Table A2: Sand Distribution -Tailgate 450 All Lanes

TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 34.7gm/m^2	Nominal		347												
Tailgate 1 - 450 All 18mph	T1A(18)	491	585	1215	1335	1005	615	181	95	91	55	29	33	53	45
	T1B(18)	499	585	1105	1365	845	427	323	193	81	69	51	41	63	57
Tailgate 2 - 450 All 25mph	T2A(25)	709	569	1322	1422	533	185	167	191	39	45	13	7	29	21
	T2B(25)	725	563	1125	1345	819	407	155	55	37	31	17	13	31	15
Tailgate 3 - 450 All 37mph	T3A(37)	309	375	507	513	507	327	269	213	140	157	121	77	91	47
	T3B(37)	381	305	521	777	527	257	119	101	140	77	63	79	103	33
Average of 3 Test Runs	Average	519	497	966	1126	706	370	202	141	88	72	49	42	62	36

Summary

		1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)	2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)	3. Center of mass of weights of sand in all strips within the area	4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)	4c. Actual feedrate in 3a as a percentage of Nominal (%)
TEST RUN	AREA ID								
Spread rate: 34.7gm/m^2	Nominal	4164	100	1388	33	7.0			
Tailgate 1 - 450 All 18mph	T1A(18)	5824	140	981	17	3.8	4688	3352	140
	T1B(18)	5700	137	1023	18	3.9	4588	3352	137
Tailgate 2 - 450 All 25mph	T2A(25)	5252	126	583	11	3.2	5872	4655	126
	T2B(25)	5339	128	655	12	3.3	5969	4655	128
Tailgate 3 - 450 All 37mph	T3A(37)	3652	88	949	26	4.9	6042	6889	88
	T3B(37)	3482	84	617	18	4.4	5760	6889	84
Average of 3 Test Runs	Average	4875	117	801	16	3.8			

Table A3: Sand Distribution - Vbody 150 One Right Lane		Settings: Spread rate is 150 lb/trmi. Target Strips are 5 - 12													
TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 5.8gm/m^2	Nominal						58	58	58	58	58	58	58	58	
Vbody 1 - 150 Right 18mph	V1A(18)	8	21	16	12	22	37	52	26	16	12	11	7	28	6
	V1B(18)	42	15	11	12	22	66	65	31	23	13	11	8	10	11
Vbody 3 - 150 Right 25mph	V3A(25)	38	12	19	38	108	410	885	505	188	68	25	9	11	12
	V3B(25)	46	13	21	43	96	271	823	496	148	60	30	14	14	8
Vbody 4 - 150 Right 37mph	V4A(37)	13	23	27	23	39	75	83	79	43	39	33	23	35	35
	V4B(37)	13	17	17	29	51	65	41	57	75	75	63	39	43	37
Average of 3 Test Runs	Average	27	17	18	26	56	154	325	199	82	45	29	17	23	18
Summary															
TEST RUN	AREA ID	1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)	2a. Sum of sand weight within target strips			2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)	3. Center of mass of weights of sand in all strips within the area			4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)	4c. Actual feedrate in 3a expressed as a percentage of		
Spread rate: 5.8gm/m^2	Nominal	464	100	464	100		9.0								
Vbody 1 - 150 Right 18mph	V1A(18)	273	59	189	69		6.7			220	373	59			
	V1B(18)	340	73	228	67		6.0			274	373	73			
Vbody 3 - 150 Right 25mph	V3A(25)	2328	502	2101	90		6.6			2602	519	502			
	V3B(25)	2084	449	1856	89		6.6			2330	519	449			
Vbody 4 - 150 Right 37mph	V4A(37)	569	123	409	72		7.3			941	768	123			
	V4B(37)	621	134	457	74		8.0			1027	768	134			
Average of 3 Test Runs	Average	1036	223	873	84		6.8								

Table A4: Sand Distribution - Vbody 150 Center Lane		Settings: Spread rate is 150 lb/trmi. Target Strips are 5 - 8													
TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 11.6gm/m^2	Nominal						116	116	116	116					
Vbody 6 - 150 Center 18mph	V6A(18)	9	17	15	15	27	61	193	433	197	45	21	13	17	7
	V6B(18)	5	9	7	9	21	39	107	199	137	39	21	19	23	13
Vbody 7 - 150 Center 25mph	V7A(25)	33	11	13	17	37	85	193	223	59	37	23	11	17	9
	V7B(25)	43	15	15	19	35	79	223	147	53	27	19	15	17	5
Vbody 8 - 150 Center 37mph	V8A(37)	45	39	57	75	119	201	499	655	289	163	121	63	65	73
	V8B(37)	53	35	49	99	175	253	459	525	159	95	65	45	47	49
Average of 3 Test Runs	Average	31	21	26	39	69	120	279	364	149	68	45	28	31	26
Summary															
TEST RUN	AREA ID	1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)	2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)	3. Center of mass of weights of sand in all strips within the area	4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)	4c. Actual feedrate in 3a as a percentage of Nominal (%)						
Spread rate: 11.6gm/m^2	Nominal	464	100	464	100	7.0	464	100	7.0	464	100	7.0	464	100	
Vbody 6 - 150 Center 18mph	V6A(18)	1069	230	884	83	7.3	860	373	230	521	373	139	521	373	
	V6B(18)	647	139	482	74	7.7	521	373	139	521	373	139	521	373	
Vbody 7 - 150 Center 25mph	V7A(25)	767	165	560	73	6.8	857	519	165	795	519	153	795	519	
	V7B(25)	711	153	502	71	6.5	795	519	153	795	519	153	795	519	
Vbody 8 - 150 Center 37mph	V8A(37)	2463	531	1644	67	7.3	4075	768	531	3486	768	454	3486	768	
	V8B(37)	2107	454	1396	66	6.8	3486	768	454	3486	768	454	3486	768	
Average of 3 Test Runs	Average	1294	279	911	70	7.1	4075	768	531	3486	768	454	3486	768	

Table A5: Sand Distribution - Vbody 150 One Left Lane		Settings: Spread rate is 150 lb/trmi. Target Strips are 1 - 8													
TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 5.8 gm/m^2	Nominal		58	58	58	58	58	58	58	58					
Vbody 9 - 150 Left 18mph	V9A(18)	23	61	61	109	171	211	385	511	99	27	13	7	11	9
	V9B(18)	27	19	19	29	57	71	111	145	61	15	9	5	7	5
Vbody 10 - 150 Left 25mph	V10A(25)	55	45	61	91	191	231	315	371	139	33	15	7	9	7
	V10B(25)	137	55	77	139	295	303	265	317	93	25	13	7	11	11
Vbody 11 - 150 Left 37mph	V11A(37)	27	27	43	59	111	227	255	189	115	51	25	13	13	9
	V11B(37)	53	43	61	95	149	205	191	117	75	35	15	9	9	7
Average of 3 Test Runs	Average	54	42	54	87	162	208	254	275	97	31	15	8	10	8
Summary															
TEST RUN	AREA ID	1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)	2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)	3. Center of mass of weights of sand in all strips within the area	4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)	4c. Actual feedrate in 3a as a percentage of Nominal (%)						
Spread rate: 5.8 gm/m^2	Nominal	464	100	464	100	5.0									
Vbody 9 - 150 Left 18mph	V9A(18)	1697	366	1607	95	6.2	1366	373	366						
	V9B(18)	579	125	511	88	6.2	466	373	125						
Vbody 10 - 150 Left 25mph	V10A(25)	1569	338	1443	92	6.0	1754	519	338						
	V10B(25)	1747	376	1543	88	5.4	1953	519	376						
Vbody 11 - 150 Left 37mph	V11A(37)	1163	251	1025	88	6.3	1924	768	251						
	V11B(37)	1063	229	935	88	5.6	1758	768	229						
Average of 3 Test Runs	Average	1303	281	1178	90	5.9									

Table A6: Sand Distribution - Vbody 150 All Lanes			Settings: Spread rate is 450 lb/trmi. Target Strips are 1 - 12													
TEST RUN	AREA ID		STRIP NUMBER AND SAND WEIGHT(gm)													
			0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 11.6gm/m^2	Nominal		116	116	116	116	116	116	116	116	116	116	116	116	116	
Vbody 12 - 150 All 18mph	V12A(18)	53	85	149	251	655	1085	443	473	571	511	219	105	93	109	
	V12B(18)	101	107	161	249	601	799	281	461	645	561	253	157	141	197	
Vbody 13 - 150 All 25mph	V13A(25)	133	107	195	377	575	381	289	335	403	473	313	173	169	181	
	V13B(25)	187	113	141	247	279	289	203	257	185	229	259	203	257	285	
Vbody 14 - 150 All 37mph	V14A(37)	71	65	129	199	157	173	173	157	217	133	85	63	63	73	
	V14B(37)	77	59	75	127	229	285	307	367	197	105	89	159	229	177	
Average of 3 Test Runs	Average	104	89	142	242	416	502	283	342	370	335	203	143	159	170	
Summary																
TEST RUN	AREA ID	1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)	2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)	3. Center of mass of weights of sand in all strips within the area	4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)	4c. Actual feedrate in 3a as a percentage of Nominal (%)							
Spread rate: 11.6gm/m^2	Nominal	1392	100	1392	100	7.0	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	
Vbody 12 - 150 All 18mph	V12A(18)	4801	345	4639	97	6.8	3864	1120	345	3.8	3.8	3.8	3.8	3.8	3.8	
	V12B(18)	4713	339	4415	94	7.1	3793	1120	339	3.7	3.7	3.7	3.7	3.7	3.7	
Vbody 13 - 150 All 25mph	V13A(25)	4103	295	3789	92	7.0	4586	1556	295	4.5	4.5	4.5	4.5	4.5	4.5	
	V13B(25)	3133	225	2661	85	7.5	3502	1556	225	3.5	3.5	3.5	3.5	3.5	3.5	
Vbody 14 - 150 All 37mph	V14A(37)	1757	126	1613	92	6.6	2906	2303	126	2.9	2.9	2.9	2.9	2.9	2.9	
	V14B(37)	2481	178	2227	90	7.6	4104	2303	178	4.1	4.1	4.1	4.1	4.1	4.1	
Average of 3 Test Runs	Average	3498	251	3224	92	7.1	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	

Table A7: Sand Distribution - Vbody 450 One Right Lane							Settings: Spread rate is 450 lb/trmi. Target Strips are 5 - 12										
TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)															
		0	1	2	3	4	5	6	7	8	9	10	11	12	13		
Spread rate: 17.3gm/m^2	Nominal						173	173	173	173	173	173	173	173	173		
Vbody 15 - 450 Right 18mph	V15A(18)	55	37	47	67	121	197	1065	1035	505	289	195	113	101	113		
	V15B(18)	37	27	29	47	75	129	573	593	241	163	109	91	61	47		
Vbody 16 - 450 Right 25mph	V16A(25)	33	21	31	55	95	237	579	767	207	151	125	79	89	75		
	V16B(25)	47	27	35	75	155	261	967	843	231	195	227	119	115	71		
Vbody 17 - 450 Right 37mph	V17A(37)	23	17	23	35	55	87	161	179	171	97	71	53	45	35		
	V17B(37)	27	19	23	41	75	105	247	489	281	141	131	93	75	57		
Average of 3 Test Runs	Average	37	25	31	53	96	169	599	651	273	173	143	91	81	66		
Summary																	
TEST RUN	AREA ID	1a. Sum of sand weight in area, strips 0-13 (gm)		1b. Sum in 1a expressed as percentage of Nominal (%)		2a. Sum of sand weight within target strips		2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)		3. Center of mass of weights of sand in all strips within the area		4a. Actual sand feedrate (gm/s)		4b. Nominal feedrate (gm/s)		4c. Actual feedrate in 3a as a percentage of Nominal (%)	
Spread rate: 17.3gm/m^2	Nominal	1384	100	1384	100	9.0											
Vbody 15 - 450 Right 18mph	V15A(18)	3939	285	3499	89	7.6		3170	1114	285							
	V15B(18)	2221	160	1959	88	7.5		1787	1114	160							
Vbody 16 - 450 Right 25mph	V16A(25)	2543	184	2233	88	7.5		2842	1547	184							
	V16B(25)	3367	243	2957	88	7.5		3764	1547	243							
Vbody 17 - 450 Right 37mph	V17A(37)	1051	76	863	82	7.7		1738	2290	76							
	V17B(37)	1803	130	1561	87	7.9		2983	2290	130							
Average of 3 Test Runs	Average	2487	180	2179	88	7.6											

Table A8: Sand Distribution - Vbody 450 Center Lane		Settings: Spread rate is 450 lb/trmi. Target Strips are 5 - 8													
TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 34.7gm/m^2	Nominal						347	347	347	347					
Vbody 18 - 450 Center 18mph	V18A(18)	47	41	53	85	155	239	1505	961	307	131	75	41	41	25
	V18B(18)	47	27	29	45	77	157	983	677	133	53	39	29	39	21
Vbody 19 - 450 Center 25mph	V19A(25)	35	25	31	59	99	203	987	711	303	163	97	55	43	35
	V19B(25)	55	49	57	85	163	301	1325	709	251	149	79	53	45	27
Vbody 20 - 450 Center 37mph	V20A(37)	25	23	25	43	55	115	209	327	185	95	73	41	35	25
	V20B(37)	33	25	39	83	163	379	467	493	451	227	101	57	51	35
Average of 3 Test Runs	Average	40	32	39	67	119	232	913	646	272	136	77	46	42	28
Summary															
TEST RUN	AREA ID	1a. Sum of sand weight in area, strips 0-13 (gm)		1b. Sum in 1a expressed as percentage of Nominal (%)		2a. Sum of sand weight within target strips		2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)		3. Center of mass of weights of sand in all strips within the area		4a. Actual sand feedrate (gm/s)		4b. Nominal feedrate (gm/s)	
Spread rate: 34.7gm/m^2	Nominal	1388	100	1388	100	7.0						4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)	4c. Actual feedrate in 3a as a percentage of Nominal (%)	
Vbody 18 - 450 Center 18mph	V18A(18)	3705	267	3012	81	6.9		2982	1117	267					
	V18B(18)	2355	170	1950	83	6.8		1895	1117	170					
Vbody 19 - 450 Center 25mph	V19A(25)	2845	205	2204	77	7.2		3180	1552	205					
	V19B(25)	3347	241	2586	77	6.8		3741	1552	241					
Vbody 20 - 450 Center 37mph	V20A(37)	1275	92	836	66	7.4		2109	2296	92					
	V20B(37)	2603	188	1790	69	7.2		4306	2296	188					
Average of 3 Test Runs	Average	2688	194	2063	77	7.0									

Table A9: Sand Distribution - Vbody 450 One Left Lane		Settings: Spread rate is 450 lb/trmi. Target Strips are 1 - 8													
TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 17.3 gm/m^2	Nominal		173	173	173	173	173	173	173	173					
Vbody 21 - 450 Left 18mph	V21A(18)	123	91	123	235	313	295	507	689	153	49	17	7	9	5
	V21B(18)	151	103	133	271	623	533	569	463	165	49	19	7	13	7
Vbody 22 - 450 Left 25mph	V22A(25)	109	81	99	143	231	389	859	281	121	45	27	11	9	5
	V22B(25)	213	151	153	247	439	541	705	589	239	97	33	15	9	3
Vbody 23 - 450 Left 37mph	V23A(37)	94	92	111	169	213	554	407	216	111	48	28	15	18	8
	V23B(37)	126	94	93	128	216	282	164	142	65	54	37	20	15	9
Average of 3 Test Runs	Average	136	102	119	199	339	432	535	397	142	57	27	12	12	6
Summary															
TEST RUN	AREA ID	1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)	2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)	3. Center of mass of weights of sand in all strips within the area	4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)	4c. Actual feedrate in 3a as a percentage of Nominal (%)						
Spread rate: 17.3 gm/m^2	Nominal	1384	100	1384	100	5.0									
Vbody 21 - 450 Left 18mph	V21A(18)	2615	189	2405	92	5.7	2105	1114	189						
	V21B(18)	3105	224	2859	92	5.4	2499	1114	224						
Vbody 22 - 450 Left 25mph	V22A(25)	2409	174	2203	91	5.7	2693	1547	174						
	V22B(25)	3433	248	3063	89	5.6	3837	1547	248						
Vbody 23 - 450 Left 37mph	V23A(37)	2085	151	1874	90	5.5	3449	2290	151						
	V23B(37)	1447	105	1186	82	5.2	2393	2290	105						
Average of 3 Test Runs	Average	2515	182	2265	90	5.6									

Table A10: Sand Distribution - Vbody 450 All Lanes		Settings: Spread rate is 1350 lb/trmi. Target Strips are 1 - 12													
TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 34.7gm/m^2	Nominal		347	347	347	347	347	347	347	347	347	347	347	347	
Vbody 24 - 450 All 18mph	V24A(18)	351	291	409	777	955	711	445	571	471	661	535	269	275	309
	V24B(18)	425	309	527	957	937	589	397	475	477	545	439	319	277	325
Vbody 25 - 450 All 25mph	V25A(25)	229	181	257	385	433	569	807	361	447	465	289	157	145	157
	V25B(25)	347	269	341	461	695	513	399	419	349	477	305	191	165	181
Vbody 26 - 450 All 37mph	V26A(37)	207	191	221	323	355	261	173	221	203	253	277	211	187	149
	V26B(37)	279	175	199	217	401	331	257	549	701	363	183	125	153	161
Average of 3 Test Runs	Average	306	236	326	520	629	496	413	433	441	461	338	212	200	214
Summary															
TEST RUN	AREA ID	1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)	2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)	3. Center of mass of weights of sand in all strips within the area	4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)	4c. Actual feedrate in 3a as a percentage of Nominal (%)						
Spread rate: 34.7gm/m^2	Nominal	4164	100	4164	100	7.0	4164	100	7.0	4164	100	7.0	4164	100	
Vbody 24 - 450 All 18mph	V24A(18)	7029	169	6369	91	6.6	5657	3352	169	5657	3352	169	5657	3352	
	V24B(18)	6997	168	6247	89	6.3	5632	3352	168	5632	3352	168	5632	3352	
Vbody 25 - 450 All 25mph	V25A(25)	4881	117	4495	92	6.6	5456	4655	117	5456	4655	117	5456	4655	
	V25B(25)	5111	123	4583	90	6.3	5713	4655	123	5713	4655	123	5713	4655	
Vbody 26 - 450 All 37mph	V26A(37)	3231	78	2875	89	6.7	5345	6889	78	5345	6889	78	5345	6889	
	V26B(37)	4093	98	3653	89	6.8	6771	6889	98	6771	6889	98	6771	6889	
Average of 3 Test Runs	Average	5223	125	4704	90	6.5	5223	125	6.5	5223	125	6.5	5223	125	

Table A11: Sand Distribution - FRS 200 Right Lanes

TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 15.4gm/m^2	Nominal						154								
FRS 31 -200 Right 18mph	S31A(18)	11	7	9	13	29	57	69	127	159	207	151	89	93	133
	S31B(18)	11	7	7	11	19	41	73	81	133	201	147	101	83	117
FRS 32 - 200 Right 25mph	S32A(25)	7	7	7	9	17	21	31	103	149	259	211	157	133	159
	S32B(25)	11	9	9	11	17	27	61	89	103	171	121	101	95	125
FRS 33 - 200 Right 37mph	S33A(37)	9	7	11	15	21	31	55	85	145	175	167	115	101	107
	S33B(37)	9	7	15	37	65	49	53	105	165	173	115	85	107	113
Average of 3 Test Runs	Average	9	7	9	16	28	37	57	98	142	197	152	108	102	125

Summary

		1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)	2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)	3. Center of mass of weights of sand in all strips within the area	4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)	4c. Actual feedrate in 3a as a percentage of Nominal (%)
TEST RUN	AREA ID								
Spread rate: 15.4gm/m^2	Nominal	1232	100	1232	100	9.0			
FRS 31 -200 Right 18mph	S31A(18)	1150	93	950	83	9.4	925	992	93
	S31B(18)	1028	83	858	83	9.5	827	992	83
FRS 32 - 200 Right 25mph	S32A(25)	1266	103	1062	84	10.1	1415	1377	103
	S32B(25)	946	77	766	81	9.7	1057	1377	77
FRS 33 - 200 Right 37mph	S33A(37)	1040	84	872	84	9.6	1720	2038	84
	S33B(37)	1094	89	850	78	9.1	1810	2038	89
Average of 3 Test Runs	Average	1087	88.2	893	82	9.6			

Table A12: Sand Distribution - FRS 200 Center Lane

TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 15.4gm/m^2	Nominal						154	154	154	154					
FRS 28 - 150 Center 18mph*	S28A(18)	29	19	21	31	29	51	65	83	51	45	49	21	19	21
	S28B(18)	43	23	29	33	43	63	95	87	75	75	55	25	31	39
FRS 29 - 150 Center 25mph*	S29A(25)	17	7	9	11	13	13	23	27	23	9	7	3	7	7
	S29B(25)	13	9	7	15	13	19	17	17	17	9	7	3	9	7
FRS 30 - 200 Center 37mph	S30A(37)	17	17	23	29	39	41	47	51	45	21	15	7	7	9
	S30B(37)	21	15	23	41	77	49	39	31	27	23	17	7	9	13
Average of 3 Test Runs	Average	23	15	18	26	35	39	47	49	39	30	25	11	13	16

Summary

*FRS 28 and 29 spread rate was 150 lb/inmi. This was increased to 200 lb/inmi for FRS 30. Rates are outside operating range for one lane.		1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)	2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)	3. Center of mass of weights of sand in all strips within the area	4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)	4c. Actual feedrate in 3a as a percentage of Nominal (%)
		616	100	616	100	7.0			
FRS 28 - 150 Center 18mph*	S28A(18)	530	86	249	47	7.1	426	496	86
	S28B(18)	712	116	319	45	7.2	573	496	116
FRS 29 - 150 Center 25mph*	S29A(25)	175	28	85.6	49	6.4	195	689	28
	S29B(25)	161	26	69.6	43	6.4	180	689	26
FRS 30 - 200 Center 37mph	S30A(37)	364	59	183	50	6.3	602	1019	59
	S30B(37)	388	63	145	37	5.9	642	1019	63
Average of 3 Test Runs	Average	388	63	175	45	6.7			

Table A13: Sand Distribution - FRS 200 Left Lanes			Settings: Spread rate is 200 lb/inmi (400 lb/trmi). Target Strips are 1 - 8													
TEST RUN	AREA ID		STRIP NUMBER AND SAND WEIGHT(gm)													
			0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 15.4 gm/m^2	<i>Nominal</i>		154	154	154	154	154	154	154	154	154					
FRS 34 - 200 Left 18mph	S34A(18)	113	77	99	167	259	223	235	117	67	39	23	15	19	19	
	S34B(18)	119	83	109	171	275	293	241	189	77	41	29	19	27	21	
FRS 35 - 200 Left 25mph	S35A(25)	73	55	68	91	110	78	112	81	29	16	11	9	12	9	
	S35B(25)	70	60	81	103	128	155	99	108	57	35	19	17	25	19	
FRS 36 - 200 Left 37mph	S36A(37)	93	79	89	133	219	243	171	75	45	35	23	13	17	13	
	S36B(37)	89	69	69	89	63	59	51	83	79	59	21	7	7	7	
Average of 3 Test Runs	Average	93	70	86	125	176	175	151	109	59	37	21	13	18	14	
Summary																
TEST RUN	AREA ID		1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)		2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)		3. Center of mass of weights of sand in all strips within the area		4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)		4c. Actual feedrate in 3a as a percentage of Nominal (%)		
Spread rate: 15.4 gm/m^2	<i>Nominal</i>		1232	100		1232	100		5.0							
FRS 34 - 200 Left 18mph	S34A(18)	1468	119		1242	85		5.2		1181	992	119				
	S34B(18)	1690	137		1436	85		5.4		1360	992	137				
FRS 35 - 200 Left 25mph	S35A(25)	753	61		624	83		5.0		842	1377	61				
	S35B(25)	976	79		791	81		5.5		1091	1377	79				
FRS 36 - 200 Left 37mph	S36A(37)	1244	101		1052	85		5.1		2058	2038	101				
	S36B(37)	748	61		560	75		5.2		1237	2038	61				
Average of 3 Test Runs	Average	1146	93.1		950	83		5.2								

Table A14: Sand Distribution - FRS 200 All Lanes

TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 15.4gm/m^2	Nominal		154	154	154	154	154	154	154	154	154	154	154	154	
FRS 37 - 200 All 18mph	S37A(18)	25	19	17	23	35	85	165	225	273	273	165	97	87	125
	V37B(18)	27	21	19	25	45	81	193	227	297	307	209	109	107	163
FRS 38 - 200 All 25mph	S38A(25)	15	13	15	31	45	97	111	143	301	285	149	85	83	107
	S38B(25)	25	19	15	21	35	59	123	175	191	171	125	95	79	107
FRS 39 - 200 All 37mph	S39A(37)	23	23	27	53	59	83	167	267	253	191	111	69	71	77
	S39B(37)	25	19	27	41	55	59	229	117	137	117	71	49	55	65
Average of 3 Test Runs	Average	23	19	20	32	45	77	164	192	242	224	138	84	80	107

Summary

		1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)	2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)	3. Center of mass of weights of sand in all strips within the area	4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)	4c. Actual feedrate in 3a as a percentage of Nominal (%)
TEST RUN	AREA ID								
Spread rate: 15.4gm/m^2	Nominal	1848	100	1848	100	7.0			
FRS 37 - 200 All 18mph	S37A(18)	1610	87	1460	91	8.7	1296	1487	87
	V37B(18)	1826	99	1636	90	8.9	1470	1487	99
FRS 38 - 200 All 25mph	S38A(25)	1476	80	1354	92	8.8	1650	2066	80
	S38B(25)	1236	67	1104	89	8.7	1381	2066	67
FRS 39 - 200 All 37mph	S39A(37)	1470	80	1370	93	8.1	2432	3057	80
	S39B(37)	1062	57	972	92	7.8	1757	3057	57
Average of 3 Test Runs	Average	1446	78.3	1316	91	8.6			

Table A15: Sand Distribution - FRS 450 Right Lanes

TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 34.7gm/m^2	Nominal						347								
FRS 40 - 450 Right 18mph	S40A(18)	9	5	9	13	23	47	157	249	263	451	383	247	207	271
	S40B(18)	7	7	9	11	21	57	123	187	143	565	545	381	289	397
FRS 41 - 450 Right 25mph	S41A(25)	13	13	17	25	37	71	131	173	357	443	531	377	255	311
	S41B(25)	11	11	11	17	37	59	139	215	257	321	535	361	271	355
FRS 42 - 450 Right 37mph	S42A(37)	9	11	17	21	37	63	161	263	375	433	351	263	243	245
	S42B(37)	11	11	13	17	31	71	138	171	201	339	519	399	343	303
Average of 3 Test Runs	Average	10	9	12	17	31	61	141	209	266	425	477	338	268	313

Summary

		1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)	2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)	3. Center of mass of weights of sand in all strips within the area	4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)	4c. Actual feedrate in 3a as a percentage of Nominal (%)
TEST RUN	AREA ID								
Spread rate: 34.7gm/m^2	Nominal	2776	100	2776	100	9.0			
FRS 40 - 450 Right 18mph	S40A(18)	2330	84	2002	86	9.8	1875	2234	84
	S40B(18)	2738	99	2288	84	10.3	2204	2234	99
FRS 41 - 450 Right 25mph	S41A(25)	2750	99	2336	85	10.0	3074	3103	99
	S41B(25)	2596	94	2156	83	10.1	2902	3103	94
FRS 42 - 450 Right 37mph	S42A(37)	2488	90	2150	86	9.6	4116	4593	90
	S42B(37)	2563	92	2179	85	10.2	4241	4593	92
Average of 3 Test Runs	Average	2577	92.8	2185	85	10.0			

Table A16: Sand Distribution - FRS 450 Center Lane

TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 34.7gm/m^2	Nominal						347	347	347	347					
FRS 50 - 450 Center 18mph	S50A(18)	19	17	19	21	45	75	147	229	215	183	117	81	87	117
	S50B(18)	19	13	17	17	35	69	161	223	137	235	177	119	109	155
FRS 49 - 450 Center 25mph	S49A(25)	19	15	15	21	33	39	125	341	283	217	137	95	91	129
	S49B(25)	17	11	15	21	33	65	157	207	201	225	159	109	99	141
FRS 51 - 450 Center 37mph	S51A(37)	17	13	17	21	35	65	137	153	167	171	73	55	59	63
	S51B(37)	15	9	13	25	39	91	165	155	125	91	63	45	53	51
Average of 3 Test Runs	Average	17	13	16	21	36	67	148	218	188	187	121	84	83	109
Summary															
TEST RUN	AREA ID	1a. Sum of sand weight in area, strips 0-13 (gm)		1b. Sum in 1a expressed as percentage of Nominal (%)		2a. Sum of sand weight within target strips		2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)		3. Center of mass of weights of sand in all strips within the area		4a. Actual sand feedrate (gm/s)		4b. Nominal feedrate (gm/s)	
		1388	100	1388	100	7.0									
FRS 50 - 450 Center 18mph	S50A(18)	1368	99	665	49	8.6		1101	1117	99					
	S50B(18)	1482	107	589	40	9.1		1193	1117	107					
FRS 49 - 450 Center 25mph	S49A(25)	1556	112	787	51	8.8		1739	1552	112					
	S49B(25)	1456	105	629	43	9.0		1627	1552	105					
FRS 51 - 450 Center 37mph	S51A(37)	1042	75	521	50	8.3		1724	2296	75					
	S51B(37)	936	67	535	57	8.0		1548	2296	67					
Average of 3 Test Runs	Average	1306	94.1	621	48	8.7									

Table A17: Sand Distribution - FRS 450 Left Lanes			Settings: Spread rate is 450 lb/inmi (900 lb/trmi). Target Strips are 1 - 8													
TEST RUN	AREA ID		STRIP NUMBER AND SAND WEIGHT(gm)													
			0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 34.7 gm/m^2	<i>Nominal</i>		347	347	347	347	347	347	347	347	347					
FRS 43 - 450 Left 18mph	S43A(18)	205	151	211	315	399	391	371	273	195	137	81	47	47	61	
	S43B(18)	237	155	225	433	459	341	299	287	173	119	67	43	41	39	
FRS 44 - 450 Left 25mph	S44A(25)	217	163	223	405	383	331	375	257	323	187	91	53	63	79	
	S44B(25)	187	139	223	409	479	373	269	229	137	115	95	71	69	93	
FRS 45 - 450 Left 37mph	S45A(37)	275	293	391	387	253	183	177	125	145	93	49	33	25	25	
	S45B(37)	255	167	199	303	385	383	315	257	89	59	33	27	25	27	
Average of 3 Test Runs	Average	229	178	245	375	393	333	301	238	177	118	69	45	45	54	
Summary																
TEST RUN	AREA ID		1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)		2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)		3. Center of mass of weights of sand in all strips within the area		4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)		4c. Actual feedrate in 3a as a percentage of Nominal (%)		
Spread rate: 34.7 gm/m^2	<i>Nominal</i>		2776	100		2776	100		5.0							
FRS 43 - 450 Left 18mph	S43A(18)	2880	104		2304	80		5.6		2318	2234	104				
	S43B(18)	2914	105		2370	81		5.2		2345	2234	105				
FRS 44 - 450 Left 25mph	S44A(25)	3146	113		2458	78		5.8		3517	3103	113				
	S44B(25)	2884	104		2256	78		5.6		3224	3103	104				
FRS 45 - 450 Left 37mph	S45A(37)	2450	88		1952	80		4.4		4053	4593	88				
	S45B(37)	2520	91		2096	83		4.9		4169	4593	91				
Average of 3 Test Runs	Average	2799	101		2239	80		5.3								

Table A18: Sand Distribution - FRS 450 All Lanes

TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 34.7gm/m^2	Nominal		347	347	347	347	347	347	347	347	347	347	347	347	
FRS 46 - 450 All 18mph	S46A(18)	19	19	23	31	59	121	317	493	425	793	523	307	257	339
	S46B(18)	25	19	23	37	61	125	269	585	353	551	501	337	257	387
FRS 47 - 450 All 25mph	S47A(25)	23	17	25	39	77	165	335	531	465	469	393	257	237	291
	S47B(25)	13	15	19	29	71	115	185	537	381	303	397	341	281	343
FRS 48 - 450 All 37mph	S48A(37)	105	79	111	119	119	95	413	1165	481	403	289	169	149	165
	S48B(37)	51	47	79	145	191	263	341	469	237	343	219	153	157	187
Average of 3 Test Runs	Average	39	32	46	66	96	147	310	630	390	477	387	260	223	285

Summary

		1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)	2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)	3. Center of mass of weights of sand in all strips within the area	4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)	4c. Actual feedrate in 3a as a percentage of Nominal (%)
TEST RUN	AREA ID								
Spread rate: 34.7gm/m^2	Nominal	4164	100	4164	100	7.0			
FRS 46 - 450 All 18mph	S46A(18)	3722	89	3364	90	9.4	2996	3352	89
	S46B(18)	3526	85	3114	88	9.4	2838	3352	85
FRS 47 - 450 All 25mph	S47A(25)	3320	80	3006	91	9.0	3711	4655	80
	S47B(25)	3026	73	2670	88	9.5	3383	4655	73
FRS 48 - 450 All 37mph	S48A(37)	3858	93	3588	93	7.9	6383	6889	93
	S48B(37)	2878	69	2640	92	7.9	4761	6889	69
Average of 3 Test Runs	Average	3388	81.4	3064	90	8.8			

Table A19: Sand Distribution - Epoke 150 Right Lanes

Settings: Spread rate is 150 lb/inmi (300 lb/trmi). Target Strips are 5 - 12

TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)												
		0	1	2	3	4	5	6	7	8	9	10	11	12
Spread rate: 11.6gm/m^2	Nominal						116							
Epoke 14 - 150 Right 18mph	E14A(18)	33	11	9	15	25	43	57	71	191	107	51	25	21
	E14B(18)	25	11	13	13	31	53	91	147	233	125	51	25	13
Epoke 15 - 150 Right 25mph	E15A(25)	21	11	11	21	27	27	29	109	147	153	59	25	21
	E15B(25)	31	7	19	33	37	47	73	141	165	109	51	29	23
Epoke 16 - 150 Right 37mph	E16A(37)	35	27	27	43	59	75	155	287	285	395	349	149	99
	E16B(37)	39	27	35	93	95	61	117	193	273	271	237	119	69
Average of 3 Test Runs	Average	30	15	19	36	45	51	87	158	215	193	133	62	41

Summary

		1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)	2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)	3. Center of mass of weights of sand in all strips within the area	4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)	4c. Actual feedrate in 3a as a percentage of Nominal (%)
TEST RUN	AREA ID								
Spread rate: 11.6gm/m^2	Nominal	928	100	928	100	9.0			
Epoke 14 - 150 Right 18mph	E14A(18)	684	74	564	82	8.0	550	747	74
	E14B(18)	844	91	736	87	7.8	679	747	91
Epoke 15 - 150 Right 25mph	E15A(25)	684	74	568	83	8.2	764	1037	74
	E15B(25)	778	84	636	82	7.6	869	1037	84
Epoke 16 - 150 Right 37mph	E16A(37)	2088	225	1792	86	8.8	3454	1535	225
	E16B(37)	1688	182	1338	79	8.2	2792	1535	182
Average of 3 Test Runs	Average	1127	121	939	83	8.2			

Table A20: Sand Distribution - Epoke 150 Center Lane

TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 11.6gm/m^2	Nominal						116	116	116	116					
Epoke 17 - 150 Center 18mph	E17A(18)	9	7	5	5	11	27	73	221	189	43	15	3	9	17
	E17B(18)	7	5	3	3	9	11	27	71	39	17	9	5	9	3
Epoke 18 - 150 Center 25mph	E18A(25)	8	4	5	7	11	32	63	163	105	34	18	14	8	6
	E18B(25)	6	3	4	6	12	57	85	108	71	37	16	8	5	5
Epoke 19 - 150 Center 37mph	E19A(37)	43	23	29	47	95	285	249	305	163	85	51	35	27	25
	E19B(37)	41	15	19	27	59	103	135	143	157	183	95	75	31	25
Average of 3 Test Runs	Average	19	9	11	16	33	86	105	168	120	66	34	23	15	13
Summary															
TEST RUN	AREA ID	1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)				2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)							
Spread rate: 11.6gm/m^2	Nominal	464	100		464	100		7.0							
Epoke 17 - 150 Center 18mph	E17A(18)	630	136		509	81		7.8		507	373	136			
	E17B(18)	214	46		147	69		7.5		172	373	46			
Epoke 18 - 150 Center 25mph	E18A(25)	477	103		363	76		7.7		534	519	103			
	E18B(25)	422	91		322	76		7.4		472	519	91			
Epoke 19 - 150 Center 37mph	E19A(37)	1458	314		1001	69		6.8		2412	768	314			
	E19B(37)	1104	238		537	49		7.8		1826	768	238			
Average of 3 Test Runs	Average	718	155		480	67		7.4							

Table A21: Sand Distribution - Epoke 150 Left Lanes			Settings: Spread rate is 150 lb/inmi (300 lb/trmi). Target Strips are 1 - 8													
TEST RUN	AREA ID		STRIP NUMBER AND SAND WEIGHT(gm)													
			0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 11.6 gm/m^2	<i>Nominal</i>		116	116	116	116	116	116	116	116	116	116				
Epoke 20 - 150 Left 18mph	E20A(18)	25	9	11	21	33	109	191	109	41	17	9	3	5	7	
	E20B(18)	15	11	11	27	61	173	287	201	107	21	11	5	7	5	
Epoke 21 - 150 Left 25mph	E21A(25)	11	11	19	27	55	115	299	227	49	15	7	5	1	7	
	E21B(25)	19	11	11	21	59	83	121	43	19	7	3	3	5	5	
Epoke 22 - 150 Left 37mph	E22A(37)	31	29	31	59	147	115	179	131	47	27	19	11	11	11	
	E22B(37)	21	15	21	33	73	129	205	177	119	21	7	9	5	5	
Average of 3 Test Runs	Average	20	14	17	31	71	120	213	148	63	18	9	6	5	6	
Summary																
TEST RUN	AREA ID		1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)		2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)		3. Center of mass of weights of sand in all strips within the area		4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)		4c. Actual feedrate in 3a as a percentage of Nominal (%)		
Spread rate: 11.6 gm/m^2	<i>Nominal</i>		928	100		928	100		5.0							
Epoke 20 - 150 Left 18mph	E20A(18)	586	63		522	89		6.3			471	747	63			
	E20B(18)	938	101		876	93		6.6			755	747	101			
Epoke 21 - 150 Left 25mph	E21A(25)	844	91		800	95		6.5			943	1037	91			
	E21B(25)	406	44		366	90		5.8			454	1037	44			
Epoke 22 - 150 Left 37mph	E22A(37)	844	91		736	87		6.0			1396	1535	91			
	E22B(37)	836	90		770	92		6.4			1383	1535	90			
Average of 3 Test Runs	Average	742	80		678	91		6.3								

Table A22: Sand Distribution - Epoke 150 All Lanes

TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate:11.6gm/m^2	Nominal		116	116	116	116	116	116	116	116	116	116	116	116	
Epoke 23 - 150 All 18mph	E23A(18)	27	20	22	30	65	139	222	223	202	97	52	31	27	28
	E23B(18)	17	14	15	23	58	124	203	191	186	90	47	30	25	28
Epoke 24 - 150 All 25mph	E24A(25)	25	19	19	31	61	99	193	285	249	151	75	41	31	33
	E24B(25)	23	17	21	27	53	87	159	133	133	87	47	33	19	25
Epoke 25 - 150 All 37mph	E25A(37)	23	21	23	43	88	144	171	237	143	81	61	44	35	45
	E25B(37)	41	27	31	68	178	246	151	109	95	59	60	51	47	55
Average of 3 Test Runs	Average	26	20	22	37	84	140	183	196	168	94	57	38	31	35

Summary

		1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)	2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)	3. Center of mass of weights of sand in all strips within the area	4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)	4c. Actual feedrate in 3a as a percentage of Nominal (%)
TEST RUN	AREA ID								
Spread rate:11.6gm/m^2	Nominal	1392	100	1392	100	7.0			
Epoke 23 - 150 All 18mph	E23A(18)	1185	85	1130	95	7.3	954	1120	85
	E23B(18)	1052	76	1007	96	7.4	847	1120	76
Epoke 24 - 150 All 25mph	E24A(25)	1308	94	1250	96	7.7	1462	1556	94
	E24B(25)	860	62	812	94	7.3	961	1556	62
Epoke 25 - 150 All 37mph	E25A(37)	1159	83	1091	94	7.3	1917	2303	83
	E25B(37)	1217	87	1121	92	6.8	2013	2303	87
Average of 3 Test Runs	Average	1130	81.2	1069	95	7.3			

Table A23: Sand Distribution - Epoke 450 Right Lanes

TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 34.7gm/m^2	Nominal						347								
Epoke 26 - 450 Right 18mph	E26A(18)	27	21	29	39	73	153	163	263	345	353	149	65	49	41
	E26B(18)	31	19	25	45	77	167	249	231	431	197	95	57	37	27
Epoke 27 - 450 Right 25mph	E27A(25)	27	19	25	51	75	217	393	399	481	253	131	75	51	45
	E27B(25)	31	23	25	43	75	149	371	273	421	241	145	83	55	51
Epoke 28 - 450 Right 37mph	E28A(37)	23	17	21	33	69	127	329	577	379	221	131	103	97	103
	E28B(37)	29	19	29	51	77	117	169	277	493	383	225	111	87	101
Average of 3 Test Runs	Average	28	19	25	43	74	155	279	336	425	274	146	82	62	61

Summary

		1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)	2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)	3. Center of mass of weights of sand in all strips within the area	4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)	4c. Actual feedrate in 3a as a percentage of Nominal (%)
TEST RUN	AREA ID								
Spread rate: 34.7gm/m^2	Nominal	2776	100	2776	100	9.0			
Epoke 26 - 450 Right 18mph	E26A(18)	1766	64	1538	87	8.0	1421	2234	64
	E26B(18)	1684	61	1462	87	7.6	1355	2234	61
Epoke 27 - 450 Right 25mph	E27A(25)	2238	81	1998	89	7.7	2502	3103	81
	E27B(25)	1982	71	1736	88	7.9	2215	3103	71
Epoke 28 - 450 Right 37mph	E28A(37)	2226	80	1962	88	8.1	3683	4593	80
	E28B(37)	2164	78	1860	86	8.5	3580	4593	78
Average of 3 Test Runs	Average	2010	72	1759	88	8.0			

Table A24: Sand Distribution - Epoke 450 Center Lane

TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 34.7gm/m^2	Nominal						347	347	347	347					
Epoke 29 - 450 Center 18mph	E29A(18)	3	3	5	7	17	49	167	493	259	59	25	9	7	3
	E29B(18)	5	3	3	7	13	35	109	487	253	69	27	11	9	3
Epoke 30 - 450 Center 25mph	E30A(25)	3	3	5	11	33	133	301	411	187	67	31	15	9	5
	E30B(25)	5	5	5	11	25	73	313	347	187	83	39	19	11	5
Epoke 31 - 450 Center 37mph	E31A(37)	7	7	11	19	55	125	223	279	301	85	47	25	23	13
	E31B(37)	13	7	15	31	67	187	353	375	193	81	51	25	19	13
Average of 3 Test Runs	Average	6	4	7	14	35	100	244	398	230	74	36	17	13	7

Summary

		1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)	2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)	3. Center of mass of weights of sand in all strips within the area	4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)	4c. Actual feedrate in 3a as a percentage of Nominal (%)
TEST RUN	AREA ID								
Spread rate: 34.7gm/m^2	Nominal	1388	100	1388	100	7.0			
Epoke 29 - 450 Center 18mph	E29A(18)	1102	79	967	88	7.6	887	1117	79
	E29B(18)	1031	74	884	86	7.8	829	1117	74
Epoke 30 - 450 Center 25mph	E30A(25)	1210	87	1031	85	7.3	1352	1552	87
	E30B(25)	1124	81	919	82	7.5	1256	1552	81
Epoke 31 - 450 Center 37mph	E31A(37)	1216	88	927	76	7.5	2012	2296	88
	E31B(37)	1426	103	1107	78	7.2	2359	2296	103
Average of 3 Test Runs	Average	1185	85.3	972	82	7.5			

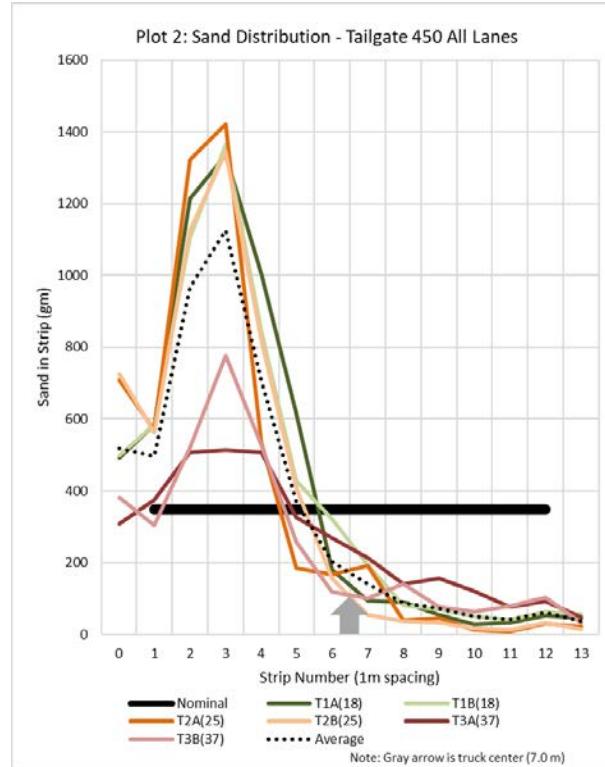
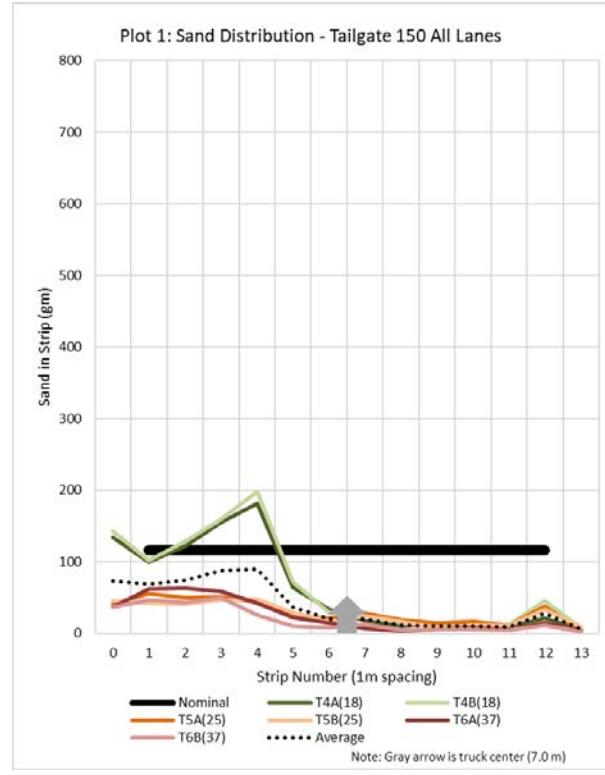
Table A25: Sand Distribution - Epoke 450 Left Lanes			Settings: Spread rate is 450 lb/inmi (900 lb/trmi). Target Strips are 1 - 8												
TEST RUN	AREA ID		STRIP NUMBER AND SAND WEIGHT(gm)												
			0	1	2	3	4	5	6	7	8	9	10	11	12
Spread rate: 34.7 gm/m^2	Nominal		347	347	347	347	347	347	347	347	347				
Epoke 32 - 450 Left 18mph	E32A(18)	15	15	37	79	229	547	585	311	91	25	13	11	5	5
	E32B(18)	15	19	35	85	227	607	557	405	107	33	13	7	5	3
Epoke 33 - 450 Left 25mph	E33A(25)	27	27	59	159	249	501	605	413	129	45	17	7	7	5
	E33B(25)	37	37	83	159	225	361	479	477	127	39	17	7	5	5
Epoke 34 - 450 Left 37mph	E34A(37)	35	39	71	123	211	391	385	273	97	57	39	23	17	9
	E34B(37)	49	47	75	115	227	425	451	237	179	83	43	21	13	11
Average of 3 Test Runs	Average	29	30	60	120	228	472	510	352	121	47	23	12	8	6
Summary															
TEST RUN	AREA ID		1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)		2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)		3. Center of mass of weights of sand in all strips within the area		4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)		4c. Actual feedrate in 3a as a percentage of Nominal (%)	
Spread rate: 34.7 gm/m^2	Nominal		2776	100		2776	100		5.0						
Epoke 32 - 450 Left 18mph	E32A(18)	1964	71		1892	96		6.1		1581	2234	71			
	E32B(18)	2114	76		2040	96		6.1		1701	2234	76			
Epoke 33 - 450 Left 25mph	E33A(25)	2246	81		2140	95		6.0		2511	3103	81			
	E33B(25)	2054	74		1946	95		6.0		2296	3103	74			
Epoke 34 - 450 Left 37mph	E34A(37)	1766	64		1588	90		6.0		2921	4593	64			
	E34B(37)	1972	71		1754	89		6.1		3262	4593	71			
Average of 3 Test Runs	Average	2019	72.7		1893	94		6.1							

Table A26: Sand Distribution - Epoke 450 All Lanes

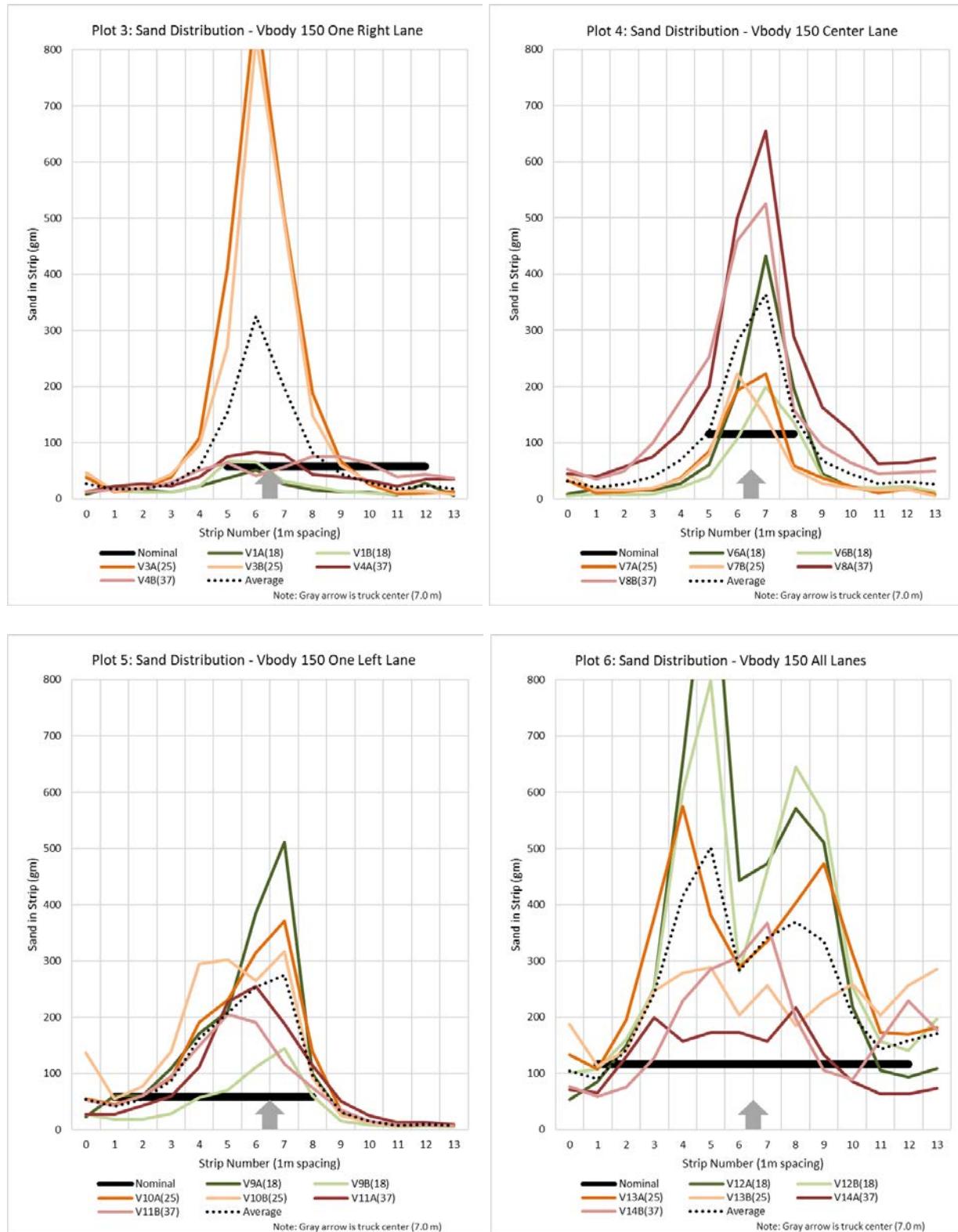
TEST RUN	AREA ID	STRIP NUMBER AND SAND WEIGHT(gm)													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
Spread rate: 34.7gm/m^2	Nominal		347	347	347	347	347	347	347	347	347	347	347	347	
Epoke 35 - 450 All 18mph	E35A(18)	15	11	13	25	53	97	213	515	579	521	269	143	115	147
	E35B(18)	17	11	11	19	43	97	215	385	615	553	329	175	137	175
Epoke 36 - 450 All 25mph	E36A(25)	13	11	15	21	51	107	241	943	753	493	253	147	137	195
	E36B(25)	13	11	15	19	37	89	247	675	661	417	223	143	133	185
Epoke 37 - 450 All 37mph	E37A(37)	31	29	59	99	155	227	311	493	397	241	157	107	99	111
	E37B(37)	47	33	41	87	149	141	229	459	703	381	211	153	129	143
Average of 3 Test Runs	Average	22	17	25	45	81	126	242	578	618	434	240	144	125	159

Summary

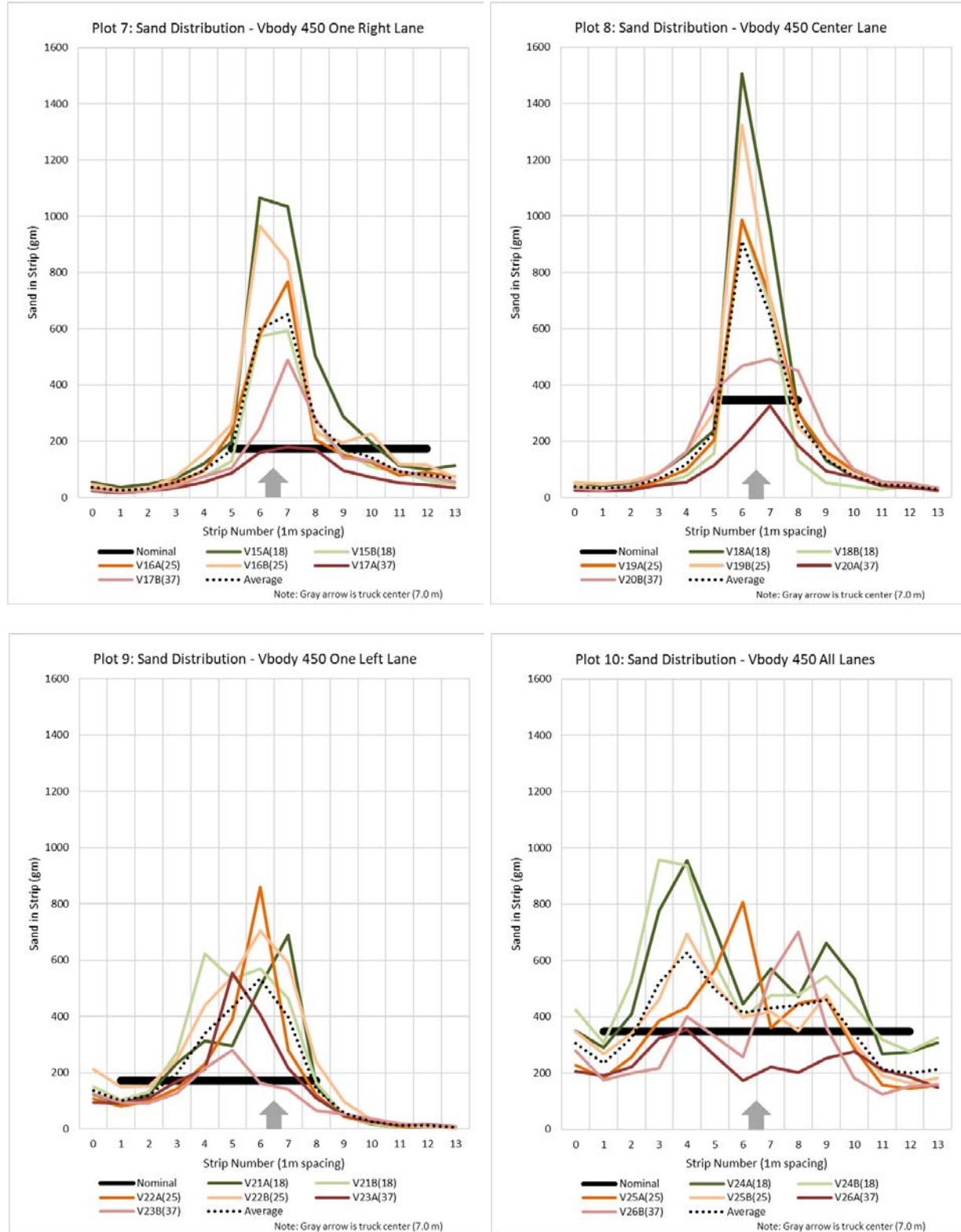
		1a. Sum of sand weight in area, strips 0-13 (gm)	1b. Sum in 1a expressed as percentage of Nominal (%)	2a. Sum of sand weight within target strips	2b. Fraction of material in target. Sum in 2a / area sum in 1a (%)	3. Center of mass of weights of sand in all strips within the area	4a. Actual sand feedrate (gm/s)	4b. Nominal feedrate (gm/s)	4c. Actual feedrate in 3a as a percentage of Nominal (%)
TEST RUN	AREA ID								
Spread rate: 34.7gm/m^2	Nominal	4164	100	4164	100	7.0			
Epoke 35 - 450 All 18mph	E35A(18)	2712	65	2550	94	8.8	2183	3352	65
	E35B(18)	2778	67	2586	93	9.0	2236	3352	67
Epoke 36 - 450 All 25mph	E36A(25)	3376	81	3168	94	8.7	3774	4655	81
	E36B(25)	2864	69	2666	93	8.8	3201	4655	69
Epoke 37 - 450 All 37mph	E37A(37)	2512	60	2370	94	7.8	4156	6889	60
	E37B(37)	2902	70	2712	93	8.3	4801	6889	70
Average of 3 Test Runs	Average	2857	68.6	2676	94	8.6			



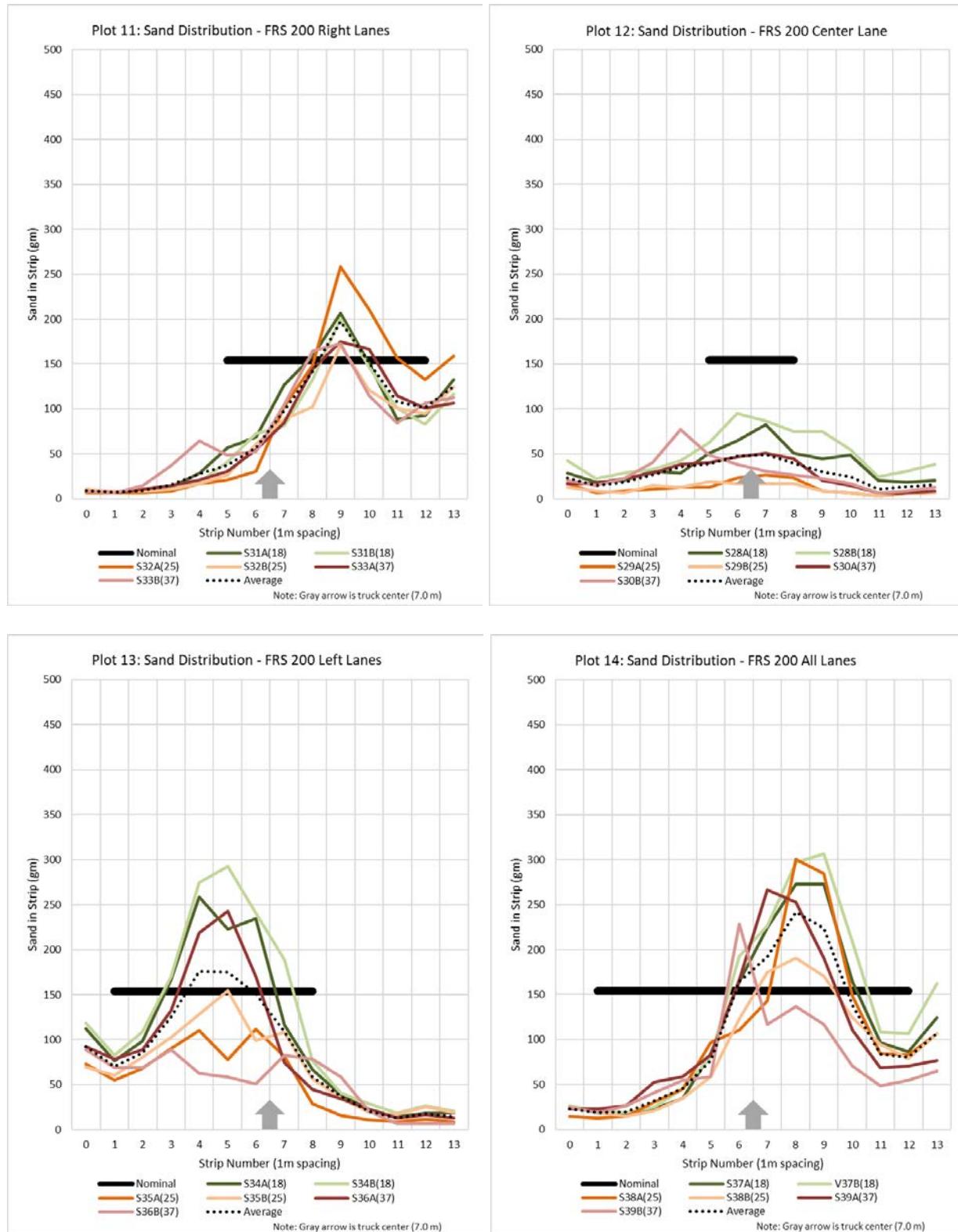
Sand Spreader Test Fall 2018



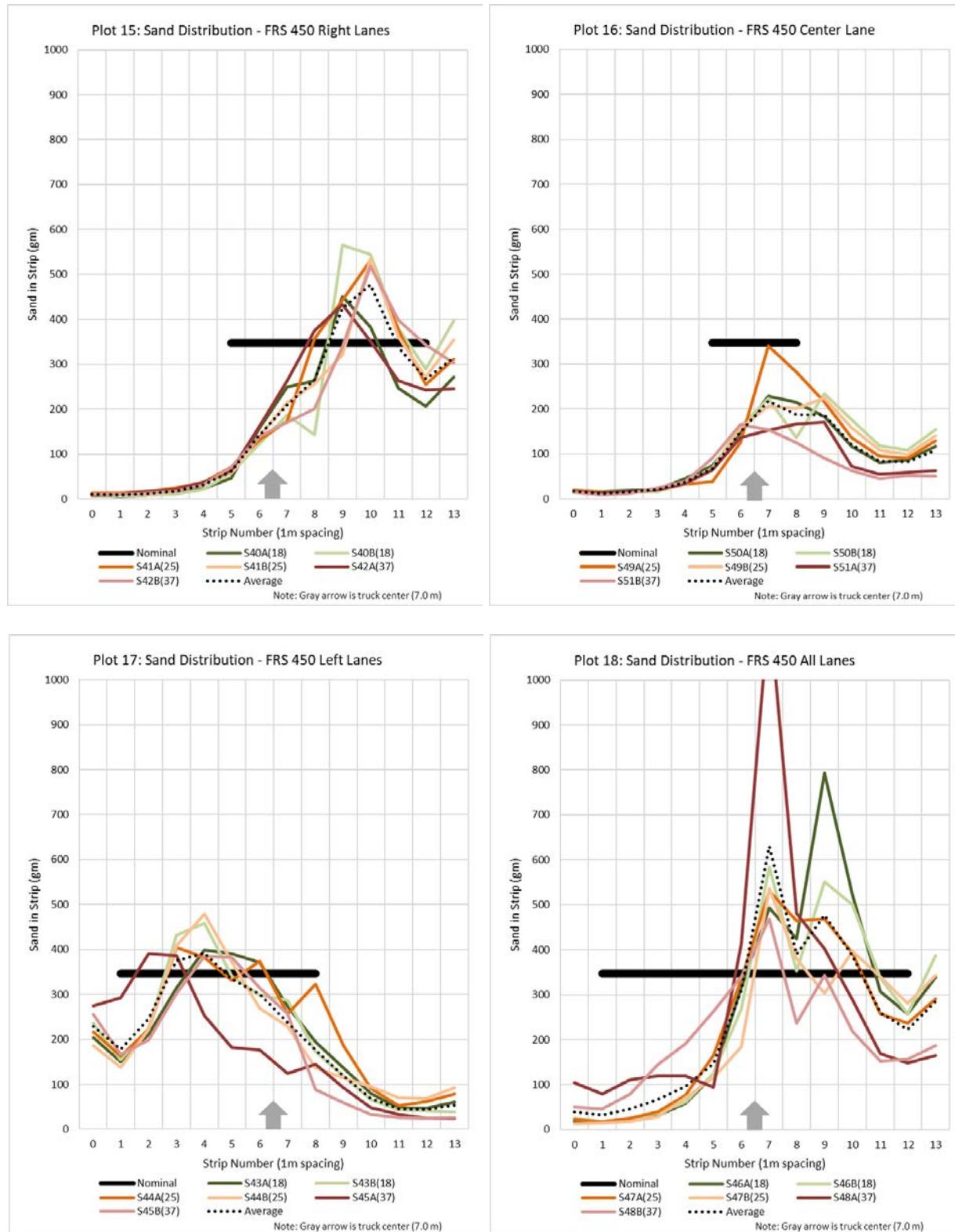
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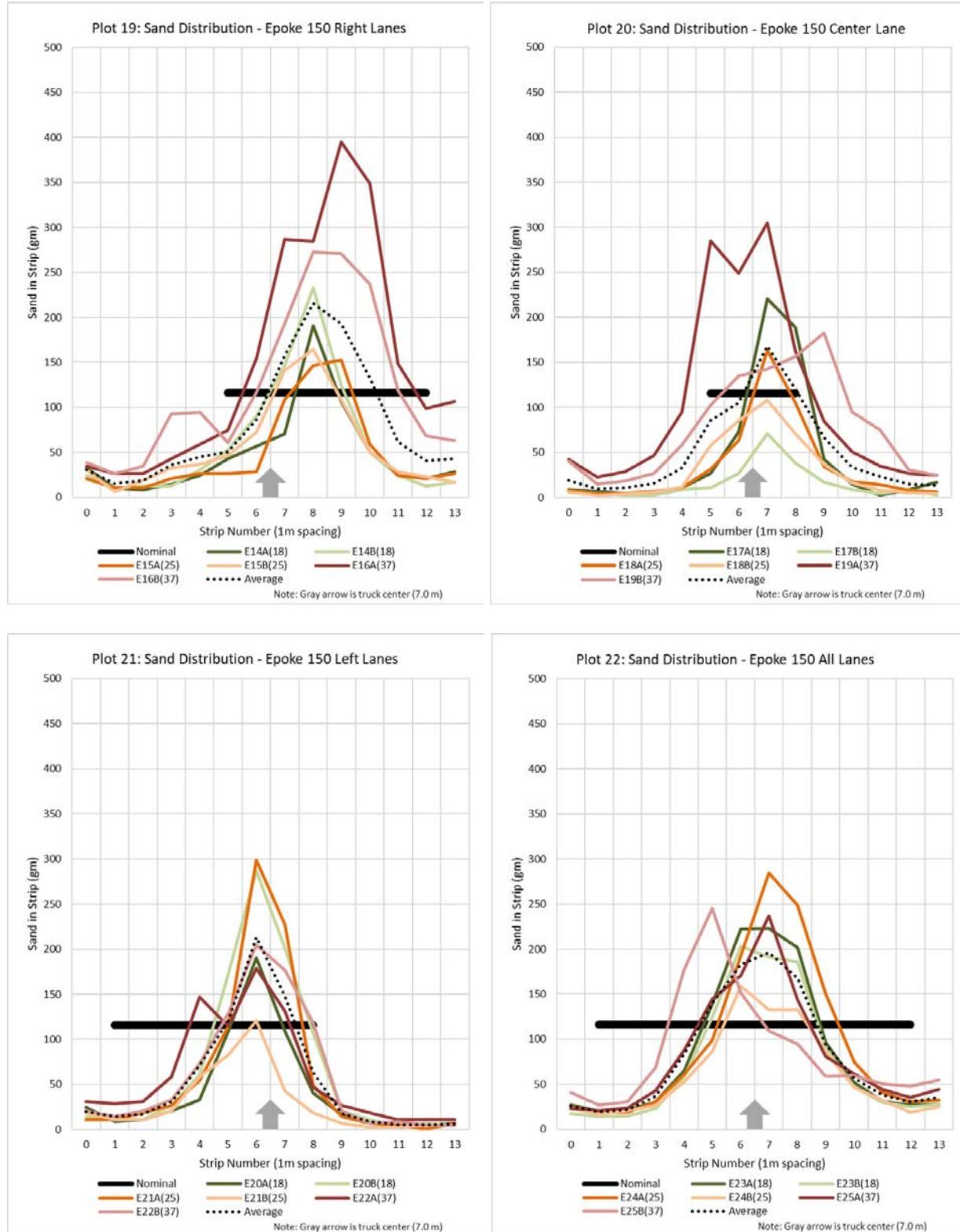
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