

**Friction Testing Survey Summary Report
Lincoln Alexander & Red Hill Valley Parkways
(Hamilton)**

November 20th, 2013



Prepared for:
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Friction Testing Survey

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I. Introduction

A special road friction testing project was undertaken on designated sections of the Lincoln Alexander and Red Hill Valley Parkways in Hamilton, Ontario.

Friction measurements for the present survey were made using a GripTester instrument (manufactured by Findlay Irvine Ltd. of Scotland) which is an ICAO listed and FAA approved runway friction measurement device and one that is used extensively by road authorities in the U.K., Australia and New Zealand. For the current survey, a tow vehicle owned and operated by Tradewind Scientific Ltd. was configured with a 500 litre flexible water tank and an electric pump and ball-valve flow regulation system in order to undertake the friction test runs under controlled self-watering conditions. Project coordination and on-site assistance was provided by Vimy Henderson, Pavement and Materials Engineer, Golder & Associates Ltd.

II. Survey Description

In Canada and the U.S., there are currently no directly applicable reference standards or guidelines with which to compare data collected by CFME (Continuous Friction Measurement Equipment) for roads and highways, although these are well established for airport runways. The U.K. transportation authorities have, however, developed a reference 'Investigatory Level' table for GripTester measurements on roads (values based on correlation with the standard SCRIM equipment) which is shown as Appendix I. While not explicitly recognized by the Ontario MTO or other provincial transportation authorities as being applicable to Canadian roads, the listed reference values for different types of road and highway surfaces provide an established and reasonable guideline with regard to interpreting the recorded data from the current survey. The company responsible for the maintenance of the Highway 407 Express Toll Route owns and operates a GripTester provided by Tradewind Scientific and uses the collected data to monitor friction levels along its entire route. Engineering companies and some provincial highway authorities in Canada have also used GripTester measurements to assess road surface friction performance.

GripTester Friction measurements were undertaken on the Lincoln Alexander and Red Hill Valley Parkways under standard test conditions of 50 km/hr and 0.25mm applied water film depth, using an ASTM 1844 Test Tire inflated to 140 KPa (20 psi).

It should be noted that friction tests under controlled self-watering conditions as performed during this survey are not suitable for the assessment of possible hydroplaning or flooding that could lead to the loss of vehicular control under natural rain-wet conditions.

Five full length test runs were completed on both the Lincoln Alexander and Red Hill Valley Parkways. One test run was conducted in the right hand wheel path of each lane of each road in both directions (Eastbound and Westbound) as well as a single reference centreline run in the right hand lane on both roads (Eastbound).

Figure 2 shows the approximate locations of the surveyed road sections, both of which are near the periphery of the city of Hamilton, Ontario, adjacent to the western end of Lake Ontario.

In order to ensure that the friction measurements met high standards of accuracy and repeatability, the GripTester was subjected to full primary load/drag calibration procedures prior to the test survey and both the load zero and drag zero offsets were verified following the work.

III. Friction Measurement Results

When compared to the available Risk Rating Table referring to Grip Number Data for UK Roads (see Appendix I), the average GripTester Friction Numbers of the tested sections of the Lincoln Alexander Parkway were found to be generally *comparable to or above* the reference Investigatory Level 2 (Grip Number = 48). The Investigatory Level 2 applies to Dual Carriageway lane sections on relatively straight and level roads. More stringent levels apply to road sections near intersections.

The measured average friction values on the Eastbound outside (right) lane right-hand wheel path and Westbound outside lane right-hand wheel path of the Lincoln Alexander Parkway had the same full-length values (GN of 53). The measured average friction values on the Eastbound inside lane left-hand wheel path and Westbound inside lane left-hand wheel path of the Parkway had slightly higher, but similar, full-length values (GN of 56 & 58, respectively).

The data from all four test runs in the wheel path areas of the Lincoln Alexander Parkway displayed remarkable consistency when subdivided into 100m section values. On the outside lane test runs, the values ranged from approximately 50-55, while on the inside lane test runs the values ranged from approximately 52-60. This narrow range in friction levels is notable for a single road surface of this length, and indicates a high level of uniformity in the surface texture and pavement composition along the full extent of the road. All areas of the road have friction values *above* the relevant UK Investigatory Level 2 (GN of 48). A close examination of the friction data extracted for the 100m sections indicated that the slightly lower numbers recorded in the outside lane areas of the Lincoln Alexander Parkway (in both the Eastbound and Westbound directions) are likely due to the higher traffic volume and increased wear-related texture loss in these lanes.

The GripTester measurements from the centre-of-lane reference test run (on the outside lane in-between the wheel paths) on the Lincoln Alexander Parkway also show very consistent values, ranging from approximately 52 to 60, with an overall full length average of 58. The overall pattern of the data from this run is similar to that from the test run in the adjacent right hand wheel path of the outside lane, with individual friction numbers being slightly higher for the centreline measurements. This is consistent with what would be expected from the wear-related texture loss that occurs primarily in the wheel track areas. All of the data from the centre-of-lane friction measurements on the Parkway were well above the relevant UK Investigatory Level.

When compared to the available Risk Rating Table referring to Grip Number Data for UK Roads (Appendix I), the average GripTester Friction Numbers of the tested sections of the Red Hill Valley Parkway were found to be generally *well below* the reference Investigatory Level 2. Most of the length of this road had Grip Numbers in the range of 30-40. Only a short section, approximately 600m in length, of the right hand wheel track of the right hand (outside) lanes near the southwest end of the Parkway had friction values above the UK Investigatory Level 2.

The measured average friction values on the Eastbound outside (right) lane right-hand wheel path and Westbound outside lane right-hand wheel path of the Red Hill Valley Parkway had essentially the same full-length values (GN of 35 & 36). The measured average friction values on the Eastbound inside lane left-hand wheel path and Westbound inside lane left-hand wheel path of the Parkway differed by some 5 points over the seven kilometer length of the facility (GN of 34 & 39, respectively).

The data from all four test runs in the wheel path areas of the Red Hill Valley Parkway was quite consistent when subdivided into 100m section values, but did show localized variations of 10-15 points over relatively short lengths. On the outside lane test runs, the values ranged from approximately 30-40 (except at the westernmost end of the road), while on the inside lane test runs the values ranged from approximately 30-45. This range in friction levels is not unusual for a single road surface of this length, and indicates significant variation in the surface texture and pavement composition along the extent of the facility. Nearly all areas of the road have friction values *below or well below* the relevant UK Investigatory Level 2 (GN of 48). A close examination of the friction data extracted for the 100m sections indicated only minor differences between the numbers recorded in the outside (right) lane areas of the Red Hill Valley Parkway (in both the Eastbound and Westbound directions) and limited evidence of increased wear-related texture loss in these lanes in comparison to the inside (left) lanes.

The GripTester measurements from the centre-of-lane reference test run (on the outside lane in-between the wheel paths) on the Red Hill Valley Parkway also show somewhat variable values, ranging from approximately 30 to 50 (except at the westernmost end of the road, where the GN values reached 60), with an overall full length average of 43. The overall pattern of the data from this run is similar to that from the test run in the adjacent right hand wheel path of the outside lane, with individual friction numbers being approximately 6-8 points higher for the centreline measurements. This is consistent with what would be expected from wear-related texture loss that occurs primarily in the wheel track areas, and indicates substantial loss of surface texture and friction due to vehicular traffic. Virtually of the data recorded from the centre-of-lane friction measurements on the Parkway was *below* the relevant UK Investigatory Level.

Reference SCRIM-equivalent values can be determined, if useful, by the equation developed by the UK Transportation Research Laboratory [SCRIM value = 0.786 * Grip Number - 0.049]. This formula results in SCRIM values being some 25% lower than the measured Grip Numbers. This formula may also be used to convert short-section results for a more detailed examination of each road surface along its full length.

Some additional friction testing was conducted on short sections of certain access ramps (Greenhill and Stonechurch), with the data being summarized in the table following.

Chainage (m)	Greenhill Off-ramp	Greenhill On-ramp	Stonechurch Off-ramp
0-100	51	60	38
100-200	48	60	40
200-300	68	52	33
300-400	77	42	39
Average:	61	54	38

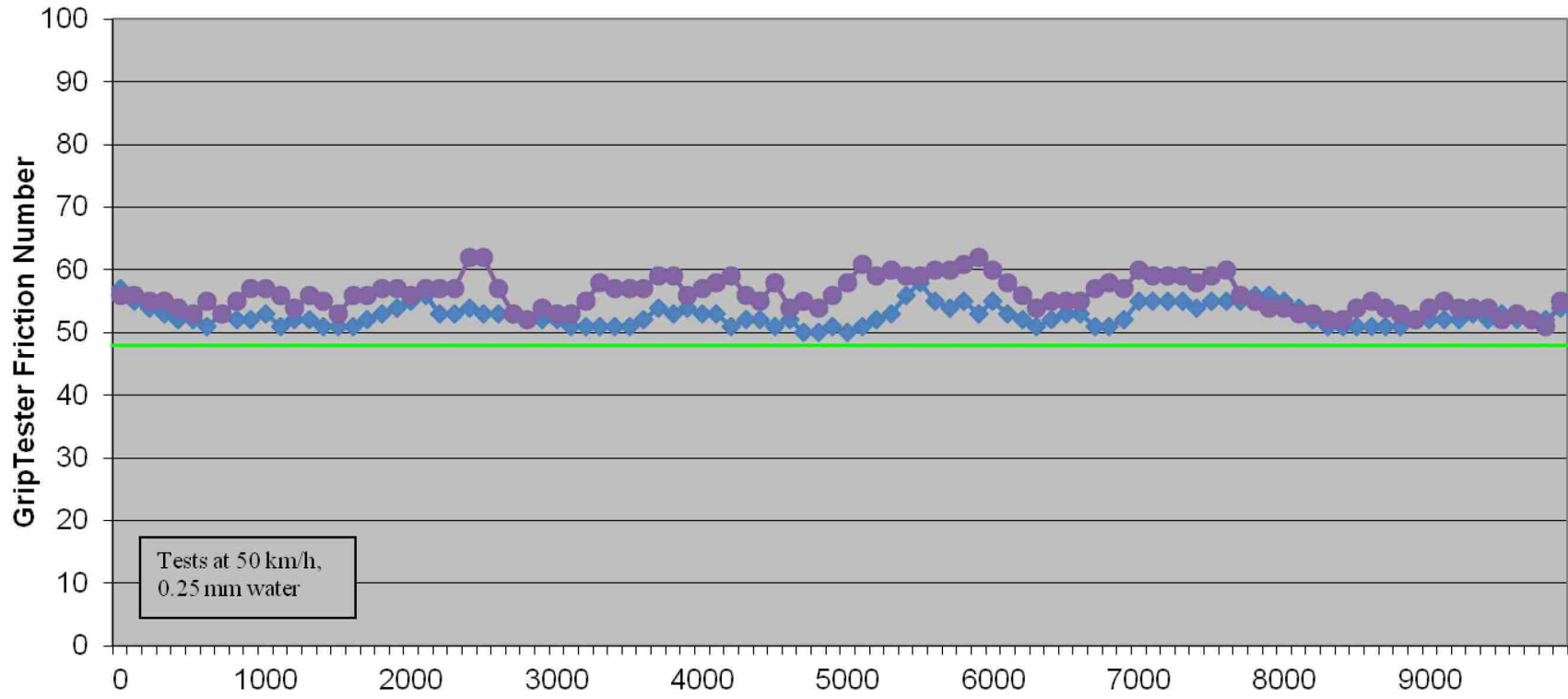
For both the Greenhill On and Off-ramp pavement sections, the 100m section friction values varied significantly from the start to the end of each 400m length. The overall average levels of 61 (On-ramp) and 54 (Off-ramp) are comparable to or slightly higher than the UK Investigatory Level 3 (GN 54), which applies to dual-carriageway roads near minor junctions. The corresponding Investigatory Level 4 for approaches and major junctions is 60. The recorded values from the Stonechurch Off-ramp were more consistent along its length than those of the other two access ramps tested, but considerably lower overall, with a 400m average of 38.

Friction measurements using the GripTester on four crosswalk sections were also conducted. As expected, the data from these very limited dimension pavement sections is inconclusive, due to the standard resolution of the testing technique using equipment being optimized for road and highway measurements with a tow vehicle. These localized areas should be tested with a more appropriate device or methodology, using the micro-GripTester or a normal GripTester configured for push-mode measurements.

Lincoln Alexander Parkway

November 20, 2013 [Eastbound]

Right Lane Right Wheel Left Lane Left Wheel

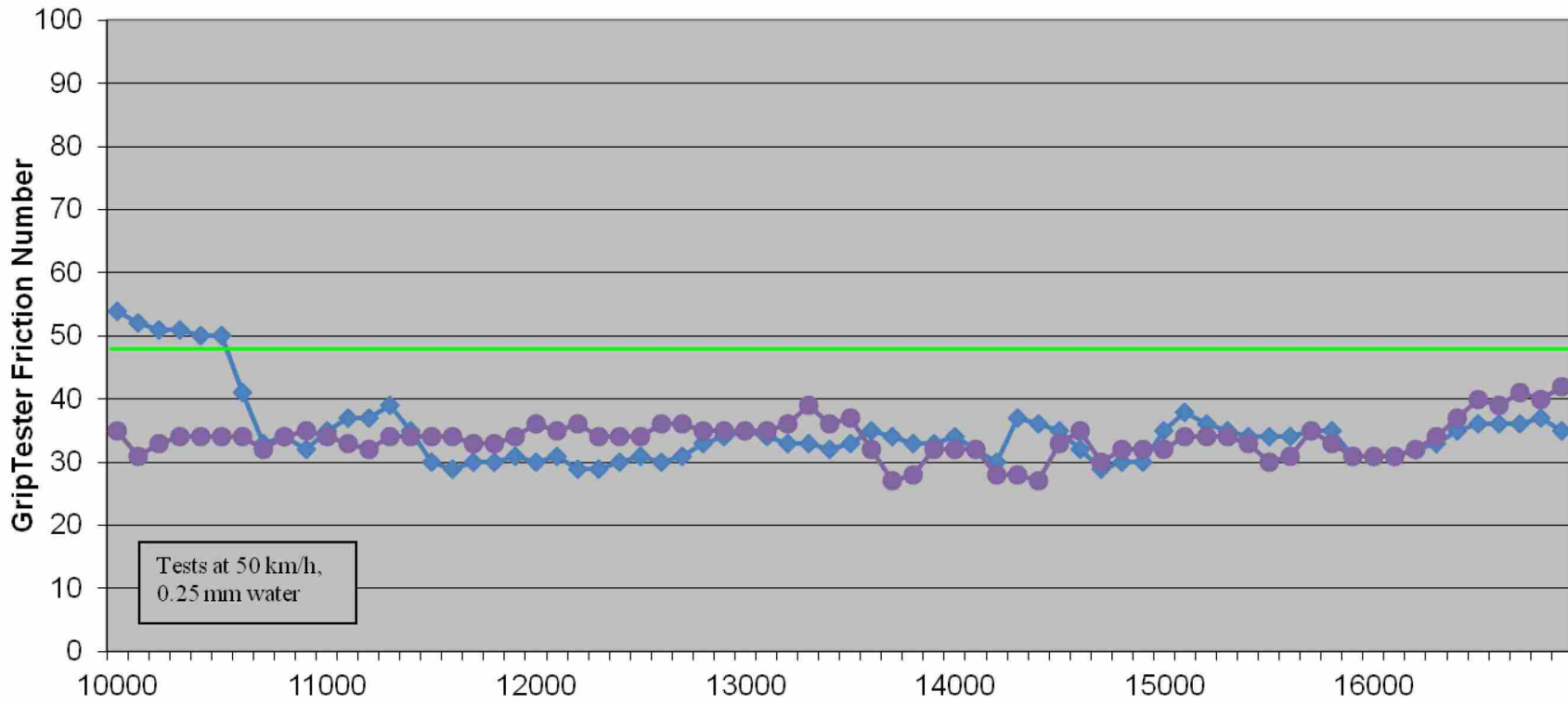


UK Investigatory Skidding Resistance Level (Dual Carriageway) = 48

Red Hill Valley Parkway

November 20, 2013 [Eastbound]

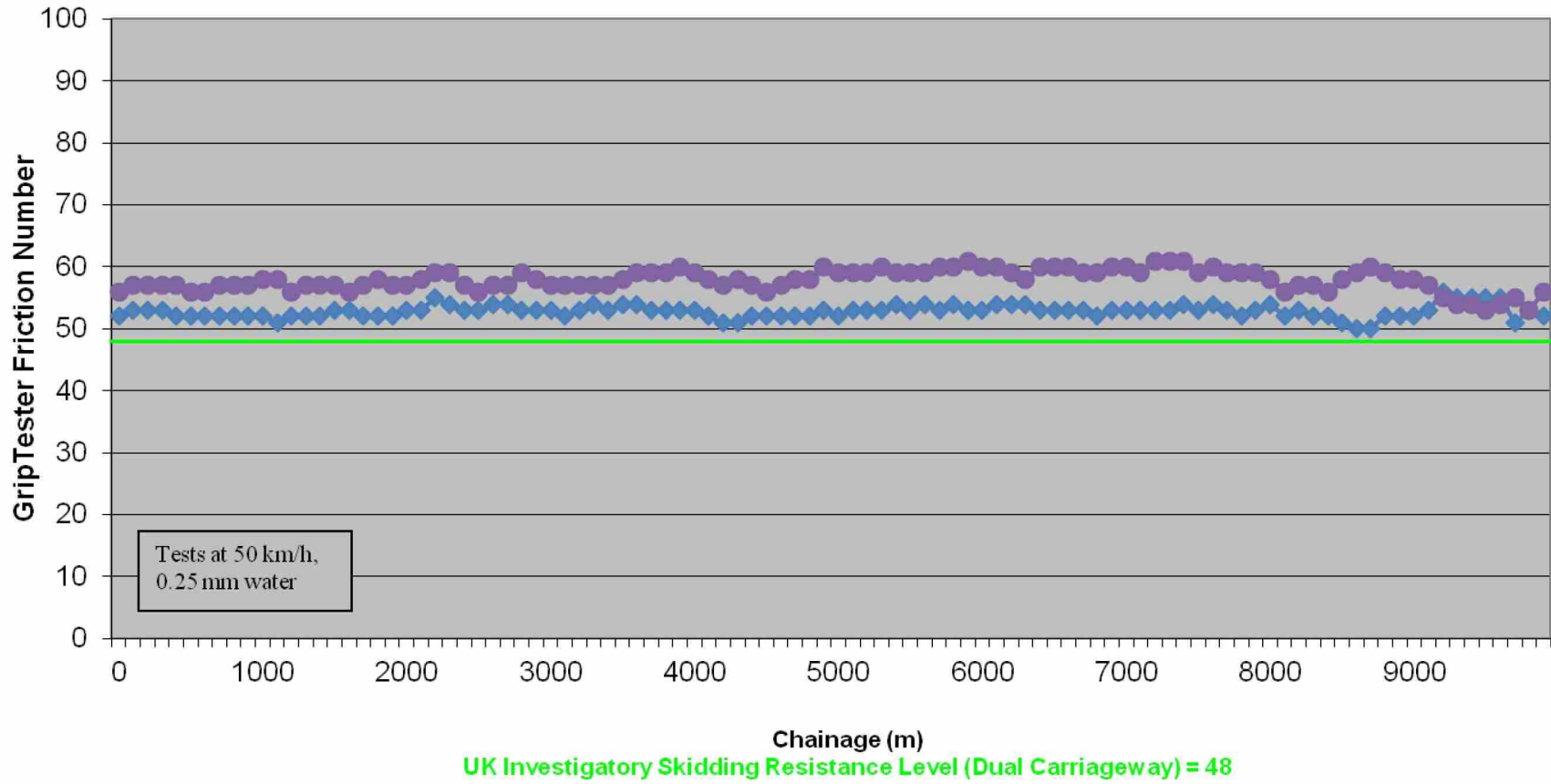
Right Lane Right Wheel Left Lane Left Wheel



UK Investigatory Skidding Resistance Level (Dual Carriageway) = 48

Lincoln Alexander Parkway November 20, 2013 [Westbound]

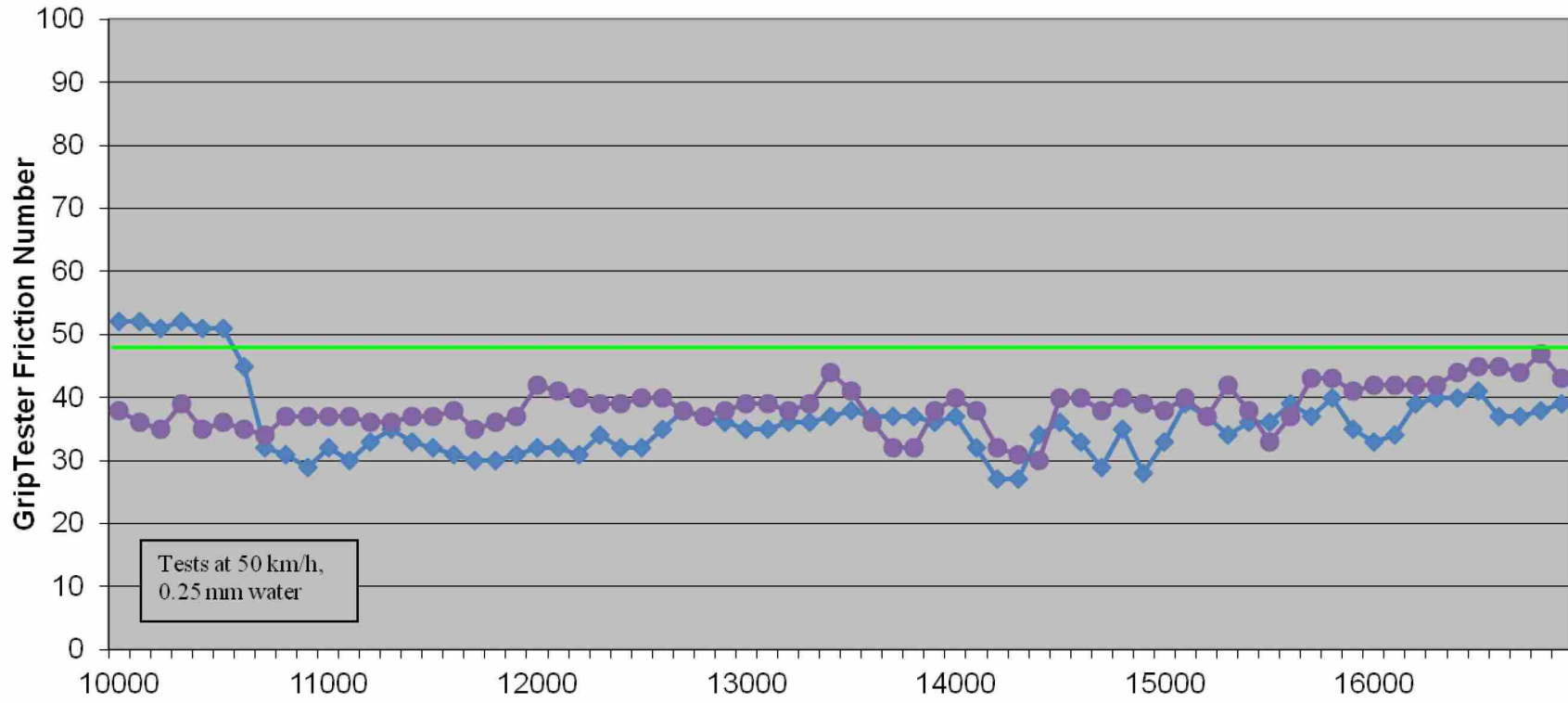
Right Lane Right Wheel Left Lane Left Wheel



Red Hill Valley Parkway

November 20, 2013 [Westbound]

Right Lane Right Wheel Left Lane Left Wheel

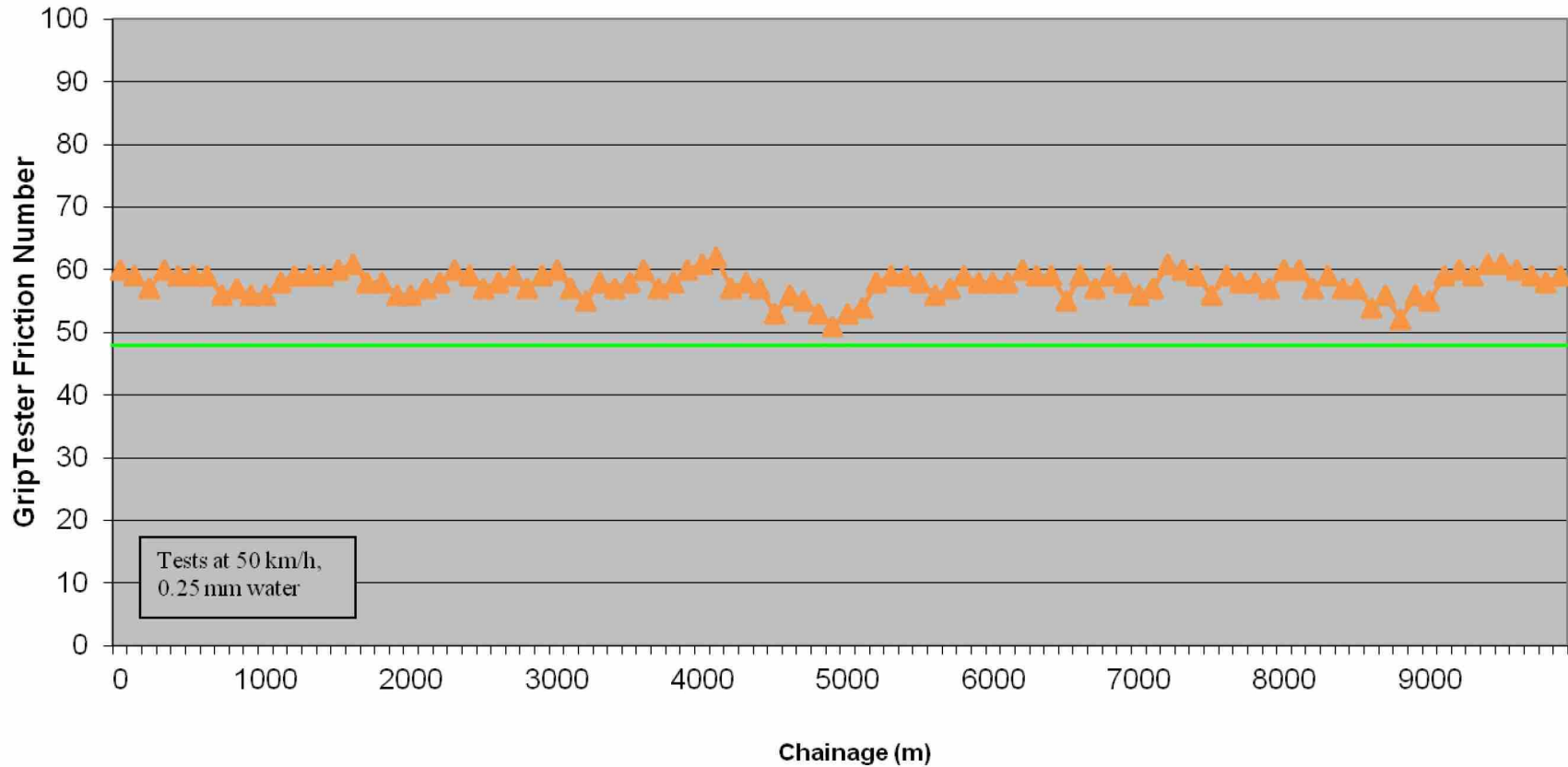


UK Investigatory Skidding Resistance Level (Dual Carriageway) = 48

Lincoln Alexander Parkway

November 20 2013, [Centre Reference]

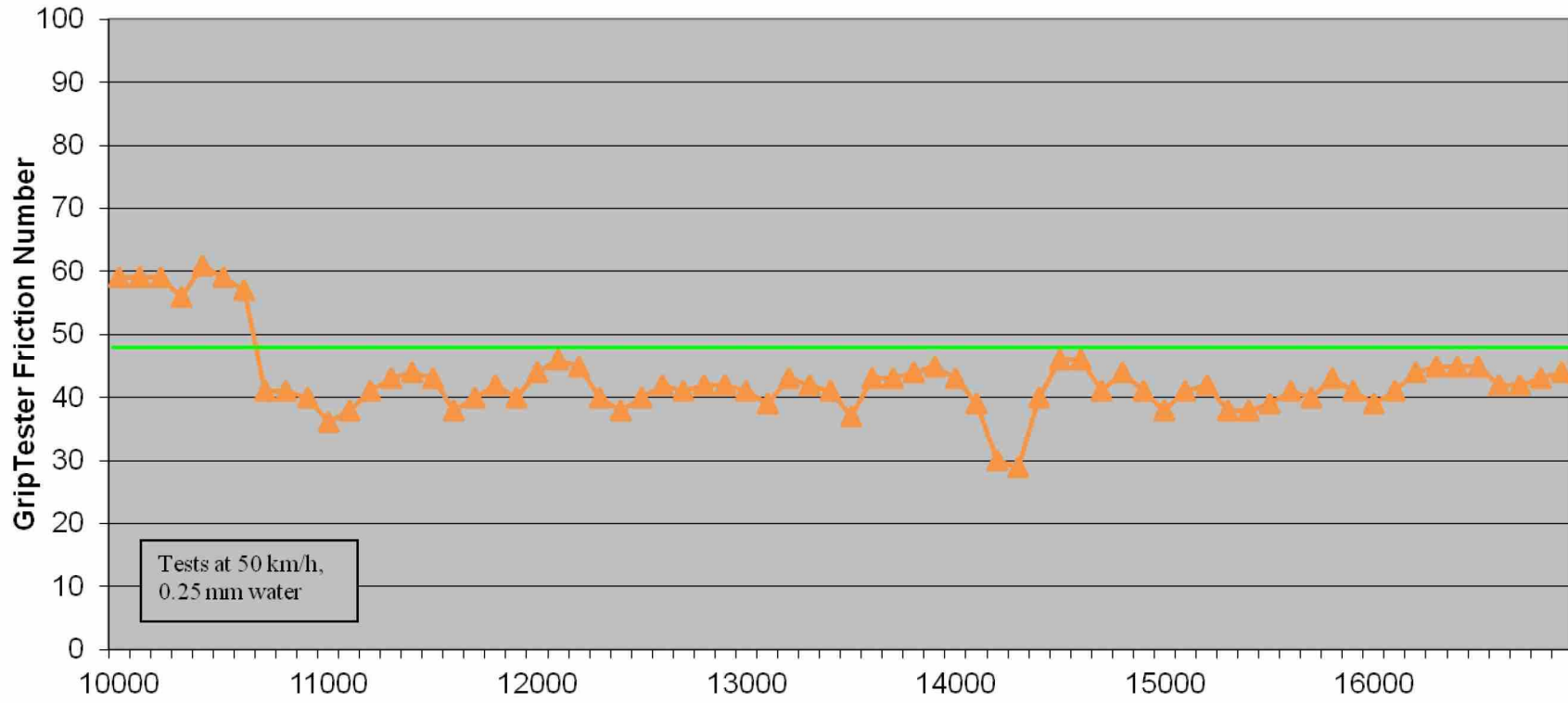
Centre Ref



Red Hill Valley Parkway

November 20 2013, [Centre Reference]

Centre Ref



Chainage (m)
UK Investigatory Skidding Resistance Level (Dual Carriageway) = 48



Figure 1: Findlay Irvine Mk 3 GripTester

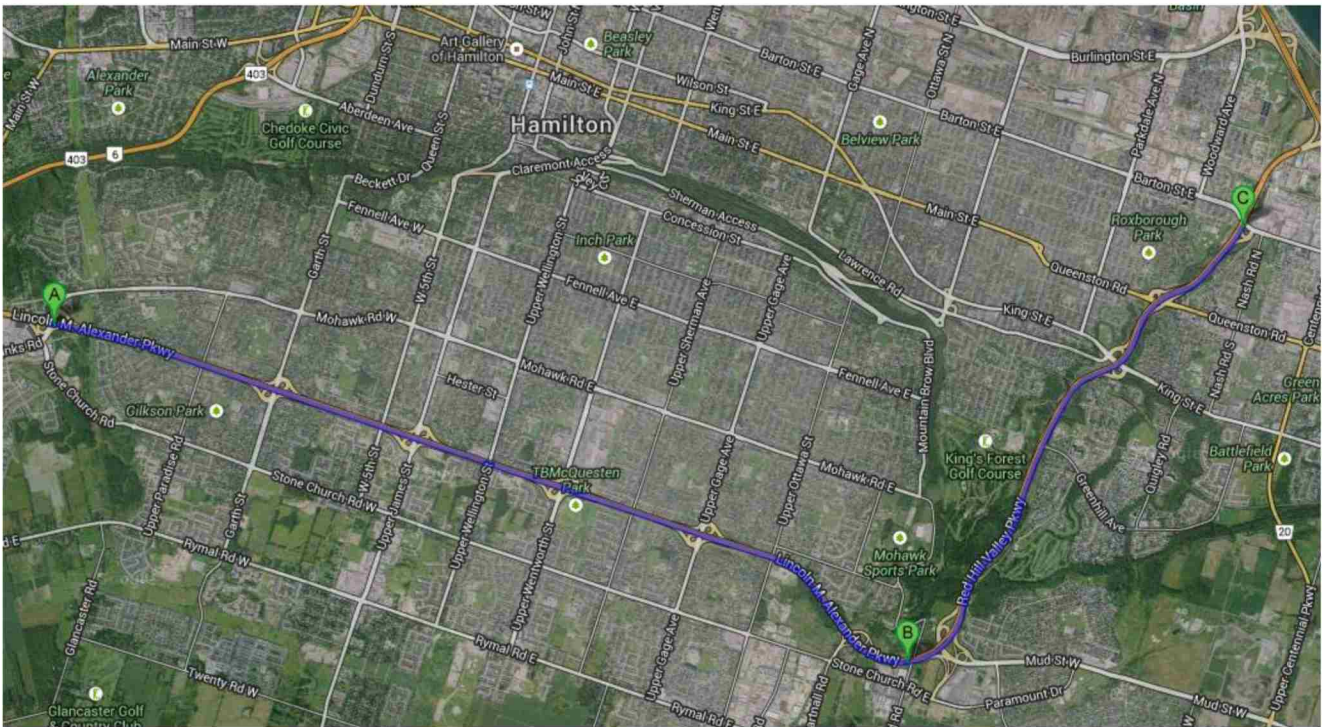


Figure 2 Approximate map of the tested portion of Lincoln Alexander (A→B) and Red Hill Valley (B→C) Parkways..
Courtesy of Google/DigitalGlobe.

V. Conclusions and Recommendations

In conclusion, the overall friction averages as measured by the GripTester on the designated lanes and sections of the Lincoln Alexander Parkway were *comparable to or above* the relevant UK Investigatory Level. The relatively consistent friction values across the different lane positions and along the full length of this facility indicate a generally uniform pavement surface texture and composition, with limited variation due to vehicular traffic wear.

However, the overall friction averages as measured by the GripTester on the designated lanes and sections of the Red Hill Valley Parkway were *below or well below* the same UK Investigatory Level 2. The overall low levels and the variability of friction values along the length of the Parkway indicate the need for a further examination of the pavement surface, composition and wear performance. It should be noted that, in addition to the overall low average Grip Number levels on this facility, there are some localized sections with quite low friction values, reaching 27-30 in several areas. We recommend that a more detailed investigation be conducted and possible remedial action be considered to enhance the surface texture and friction characteristics of the Red Hill Valley Parkway, based on the friction measurements recorded in the current survey.

We trust that the testing work was completed to your full satisfaction, and that this summary report will serve to assist your investigation. Please do not hesitate to contact us if you require any further information or documentation.

Signed,



C. Leonard Taylor

President

[M.Sc., Hon. B.Sc., B.Ed., C.Chem.]

APPENDIX I

Reference Grip Number Data for Roads: UK Investigatory Skidding Resistance Levels (Risk Rating) for different Categories of Site

Site Definition	Levels in terms of GN							
Risk Rating	0.42	0.48	0.54	0.60	0.66	0.72	0.78	0.84
	1	2	3	4	5	6	7	8
Motorway								
Dual Carriageway								
Single Carriageway								
Dual Carriageway – Minor Junctions								
Single Carriageway – Minor Junctions								
Approaches and Major Junctions								
Gradient 5% to 10%. Longer than 50m								
Gradient steeper than 10%. Longer than 50m								
Bend. Radius ≤250m								
Approach to Roundabout								
Approach to traffic signals, pedestrian crossings, Rail way crossings								

Note: The UK Highway Friction Investigatory Levels are based on GripTester Friction Numbers measured with an ASTM 1884 tire (140 kPa) at 50 km/hr with an applied water depth of 0.25. Table Courtesy Findlay Irvine Ltd.

GripTester Friction Number

City: Hamilton	Road: Lincoln Alexander Pkwy	Date: November 20, 2013
Weather: Clear	Temp: 7 C	Wind: Calm
Test Tire: 90-10-21	Speed: 50 km/h	Water: 0.25 mm

Chainage		No. 1	No. 2	No. 3	No. 4	No. 5
From	To	Eastbound-R	Eastbound-L	Westbound-R	Westbound-L	Centre Ref
0	100	57	56	52	56	60
100	200	55	56	53	57	59
200	300	54	55	53	57	57
300	400	53	55	53	57	60
400	500	52	54	52	57	59
500	600	52	53	52	56	59
600	700	51	55	52	56	59
700	800	53	53	52	57	56
800	900	52	55	52	57	57
900	1000	52	57	52	57	56
1000	1100	53	57	52	58	56
1100	1200	51	56	51	58	58
1200	1300	52	54	52	56	59
1300	1400	52	56	52	57	59
1400	1500	51	55	52	57	59
1500	1600	51	53	53	57	60
1600	1700	51	56	53	56	61
1700	1800	52	56	52	57	58
1800	1900	53	57	52	58	58
1900	2000	54	57	52	57	56
2000	2100	55	56	53	57	56
2100	2200	56	57	53	58	57
2200	2300	53	57	55	59	58
2300	2400	53	57	54	59	60
2400	2500	54	62	53	57	59
2500	2600	53	62	53	56	57
2600	2700	53	57	54	57	58
2700	2800	53	53	54	57	59
2800	2900	52	52	53	59	57
2900	3000	52	54	53	58	59
3000	3100	52	53	53	57	60
3100	3200	51	53	52	57	57
3200	3300	51	55	53	57	55
3300	3400	51	58	54	57	58
3400	3500	51	57	53	57	57
3500	3600	51	57	54	58	58
3600	3700	52	57	54	59	60
3700	3800	54	59	53	59	57
3800	3900	53	59	53	59	58
3900	4000	54	56	53	60	60
4000	4100	53	57	53	59	61
4100	4200	53	58	52	58	62
4200	4300	51	59	51	57	57
4300	4400	52	56	51	58	58
4400	4500	52	55	52	57	57
4500	4600	51	58	52	56	53
4600	4700	52	54	52	57	56
4700	4800	50	55	52	58	55
4800	4900	50	54	52	58	53
4900	5000	51	56	53	60	51

5000	5100	50	58	52	59	53
5100	5200	51	61	53	59	54
5200	5300	52	59	53	59	58
5300	5400	53	60	53	60	59
5400	5500	56	59	54	59	59
5500	5600	58	59	53	59	58
5600	5700	55	60	54	59	56
5700	5800	54	60	53	60	57
5800	5900	55	61	54	60	59
5900	6000	53	62	53	61	58
6000	6100	55	60	53	60	58
6100	6200	53	58	54	60	58
6200	6300	52	56	54	59	60
6300	6400	51	54	54	58	59
6400	6500	52	55	53	60	59
6500	6600	53	55	53	60	55
6600	6700	53	55	53	60	59
6700	6800	51	57	53	59	57
6800	6900	51	58	52	59	59
6900	7000	52	57	53	60	58
7000	7100	55	60	53	60	56
7100	7200	55	59	53	59	57
7200	7300	55	59	53	61	61
7300	7400	55	59	53	61	60
7400	7500	54	58	54	61	59
7500	7600	55	59	53	59	56
7600	7700	55	60	54	60	59
7700	7800	55	56	53	59	58
7800	7900	56	55	52	59	58
7900	8000	56	54	53	59	57
8000	8100	55	54	54	58	60
8100	8200	54	53	52	56	60
8200	8300	52	53	53	57	57
8300	8400	51	52	52	57	59
8400	8500	51	52	52	56	57
8500	8600	51	54	51	58	57
8600	8700	51	55	50	59	54
8700	8800	51	54	50	60	56
8800	8900	51	53	52	59	52
8900	9000	52	52	52	58	56
9000	9100	52	54	52	58	55
9100	9200	52	55	53	57	59
9200	9300	52	54	56	55	60
9300	9400	53	54	55	54	59
9400	9500	52	54	55	54	61
9500	9600	53	52	55	53	61
9600	9700	52	53	55	54	60
9700	9800	52	52	51	55	59
9800	9900	52	51	53	53	58
9900	10000	54	55	52	56	59

Low 100 m Section:

50

51

50

53

51

Runway Average:

53

56

53

58

58

Tradewind Scientific Ltd. - GT 081

GripTester Friction Number

City: Hamilton	Road: Red Hill Valley Pkwy	Date: November 20, 2013
Weather: Clear	Temp: 7 C	Wind: Calm
Test Tire: 90-10-21	Speed: 50 km/h	Water: 0.25 mm

Chainage		No. 1	No. 2	No. 3	No. 4	No. 5
From	To	Eastbound-R	Eastbound-L	Westbound-R	Westbound-L	Centre Ref
10000	10100	54	35	52	38	59
10100	10200	52	31	52	36	59
10200	10300	51	33	51	35	59
10300	10400	51	34	52	39	56
10400	10500	50	34	51	35	61
10500	10600	50	34	51	36	59
10600	10700	41	34	45	35	57
10700	10800	33	32	32	34	41
10800	10900	34	34	31	37	41
10900	11000	32	35	29	37	40
11000	11100	35	34	32	37	36
11100	11200	37	33	30	37	38
11200	11300	37	32	33	36	41
11300	11400	39	34	35	36	43
11400	11500	35	34	33	37	44
11500	11600	30	34	32	37	43
11600	11700	29	34	31	38	38
11700	11800	30	33	30	35	40
11800	11900	30	33	30	36	42
11900	12000	31	34	31	37	40
12000	12100	30	36	32	42	44
12100	12200	31	35	32	41	46
12200	12300	29	36	31	40	45
12300	12400	29	34	34	39	40
12400	12500	30	34	32	39	38
12500	12600	31	34	32	40	40
12600	12700	30	36	35	40	42
12700	12800	31	36	38	38	41
12800	12900	33	35	37	37	42
12900	13000	34	35	36	38	42
13000	13100	35	35	35	39	41
13100	13200	34	35	35	39	39
13200	13300	33	36	36	38	43
13300	13400	33	39	36	39	42
13400	13500	32	36	37	44	41
13500	13600	33	37	38	41	37
13600	13700	35	32	37	36	43
13700	13800	34	27	37	32	43
13800	13900	33	28	37	32	44
13900	14000	33	32	36	38	45
14000	14100	34	32	37	40	43
14100	14200	32	32	32	38	39
14200	14300	30	28	27	32	30
14300	14400	37	28	27	31	29
14400	14500	36	27	34	30	40
14500	14600	35	33	36	40	46
14600	14700	32	35	33	40	46
14700	14800	29	30	29	38	41
14800	14900	30	32	35	40	44
14900	15000	30	32	28	39	41

15000	15100	35	32	33	38	38
15100	15200	38	34	39	40	41
15200	15300	36	34	37	37	42
15300	15400	35	34	34	42	38
15400	15500	34	33	36	38	38
15500	15600	34	30	36	33	39
15600	15700	34	31	39	37	41
15700	15800	35	35	37	43	40
15800	15900	35	33	40	43	43
15900	16000	31	31	35	41	41
16000	16100	31	31	33	42	39
16100	16200	31	31	34	42	41
16200	16300	32	32	39	42	44
16300	16400	33	34	40	42	45
16400	16500	35	37	40	44	45
16500	16600	36	40	41	45	45
16600	16700	36	39	37	45	42
16700	16800	36	41	37	44	42
16800	16900	37	40	38	47	43
16900	17000	35	42	39	43	44

Low 100 m Section:	29	27	27	30	29
Runway Average:	35	34	36	39	43

Tradewind Scientific Ltd. - GT 081