RESEARCH

UDOT CONNECTING COMMUNITIES

Utah Department of Transportation - Research Division
4501 South 2700 West, Box 148410 - Salt Lake City, Utah 84114-8410

Report No. UT-10.10

GILSONITE AS AN ANTI-STRIPPING AGENT IN HOT MIX ASPHALT

Experimental Feature No. X(03)09

FINAL REPORT

Prepared For:

Utah Department of Transportation
Research Division

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Utah Department of Transportation
Research Division

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16. Abstract

For a given overlay project, the use of lime as an anti-stripping agent was marginal with current mix design practices, and Aggcoate (Gilsonite Pellets) proved in mix design criteria to be more successful. Aggcoate was then used in a test section and compared to the lime used in hot mix asphalt as anti-stripping agents. Report represents the four year findings of each. Test section located on US 40, MM 150 +/-, in the Naples, Utah area.

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1.0 INTRODUCTION

The Utah Department of Transportation (UDOT), Region Three Construction sponsored a limited application of an old and widely used product, powdered gilsonite, by melting and blending with additives to make a liquid sealant. It has now been offered to be used as an anti-stripping agent in Hot Mix Asphalt (HMA) under the brand name Aggcoate, provided by American Gilsonite Company. Gilsonite is mined locally and has been used for over 30 years as a seal coat by powdering the product and then liquefying it by heat and mix to apply and has been successful in this arena. Currently UDOT specifies a slurried hydrated lime. The success of this application will offer two rather than one type of anti-strip used in HMA. Often choices produce economies in price paid for HMA. The goal in this application is to make available another anti-stripping product. The study was prompted because the pit designated for the project was marginal in the grading and there were problems developing a mix design using lime as an anti-stripping agent, causing this design to not pass the design criteria. Aggcoate pellets were introduced into a mix design using the pellets to replace the lime. The test using the Aggcoate passed and the Project Manager wrote a change order using the Aggcoate HMA mix design in a specified test section.

2.0 TEST SECTION AND PRODUCT INSTALLATION

The project is located on southbound US 40 from mile marker (MM) 149.77 to MM 151.1 in the Naples, Utah area. A 2 inch overlay using Aggcoate was installed. The overlay was 24 feet wide on the outside traveled way heading southbound the full length of the project test section. The 2 inch overlay of HMA with Aggcoate was placed on 4 inches of HMA with lime.

Installation commenced October 21, 2003. The powdered Aggcoate was introduced in the asphalt mix at the plant at 1% by weight and was introduced into the counter-flow continuous mix asphalt plant where usually recycled asphalt is added. There was little problem with this application and the mix was not changed. The Aggcoate people asked for a little hotter mixing temperature, about 335 degrees Fahrenheit. The plant operator estimated the capacity was increased at least 10%; this does not include the BTU consumption of the heater/dryer that was decreased. The HMA was delivered to the job site and placed with normal paving procedures. Paving equipment consisted of shuttle buggy, paving machine and two vibrating rollers. Paving conditions were consistent with UDOT approved practices, and paving conditions mirrored the lime slurry treated HMA.

Figures 1 through 4 include photographs of the field installation.

Figure 1: Tacked HMA/Lime

Figure 2: Southbound US 40 Prepared

Figure 3: HMA Mat

Figure 4: Aggcoate Feed Process

3.0 FIELD AND LABORATORY TESTING

Field and laboratory testing associated with the test section is described below:

1. Nuclear density testing was performed by the project quality assurance/quality control (QA/QC) testing laboratory.
2. Sample testing for gradation, Voids in Mineral Aggregates (VMA), Voids, Voids Filled with Asphalt (VFA), Hamburg, Rut and Fatigue tests was performed by UDOT Materials-Central.
3. Obtaining roadway samples and testing for stripping with the Hamburg Wheel Tracker Test were performed by UDOT Materials-Central and Region Three from 2004 to 2008.

It is noted that Falling Weight Deflectometer (FWD), Structural Adequacy, Rut Depth, Road Profile and International Roughness Index (IRI), and Pavement roughness were not performed as stated in the work plan because there was no full depth HMA that included Aggcoate on the project. The HMA with Aggcoate was a 2 inch overlay on HMA with lime for anti-stripping. Tests obtained each year for the Hamburg Wheel resulted in showing how this 2 inch Aggcoate treated overlay worked when placed on 4 inches of lime treated HMA. Twelve-inch cores were obtained and the 1 inch surface was removed leaving a core with 6 inches of lime treated HMA and 4 inches lime treated HMA and 2 inches of Aggcoate treated HMA.

4.0 ANALYSIS

In June 2006 the Planning Division at the Development Section's request ran FWD tests on the overlay with gilsonite and the overlay with lime. The findings based upon cross section assumptions of 1" Seal Coat, 6" HMA, 5" UTBC and 12" GB to determine a structural number, indicated the gilsonite reading was 5.62 and the lime was 5.77 compared to 4.26 design strength. The comparison is not dramatic or absolute but they have a similar strength.

Six cores were cut from the roadway in 2004, three in the hot mix asphalt that used lime as an anti-stripping agent and three cores where the gilsonite was used as an anti-strip. The result of the Hamburg rut test shown in Figure 5 indicates that there is very little difference after a year in place. All samples passed the 10 millimeter criterion allowed, as shown in the Appendix. Other than sample numbers 1 and 1a, the results were nearly identical. The early comparison between lime and Aggcoate treatments appeared, after one physical test, to perform equally. This study lasted for another four years (three additional sampling and testing events) in order to develop some comparison curves with more than one point and to verify the results over time did not markedly change.

Five more cores were cut from the roadway in June 2006, three in the HMA that used lime as an anti-stripping agent and three cores where the Aggcoate was used as an anti-strip. The 2006 results of Hamburg tests on these samples and those from 2004 are shown below in Figure 5.

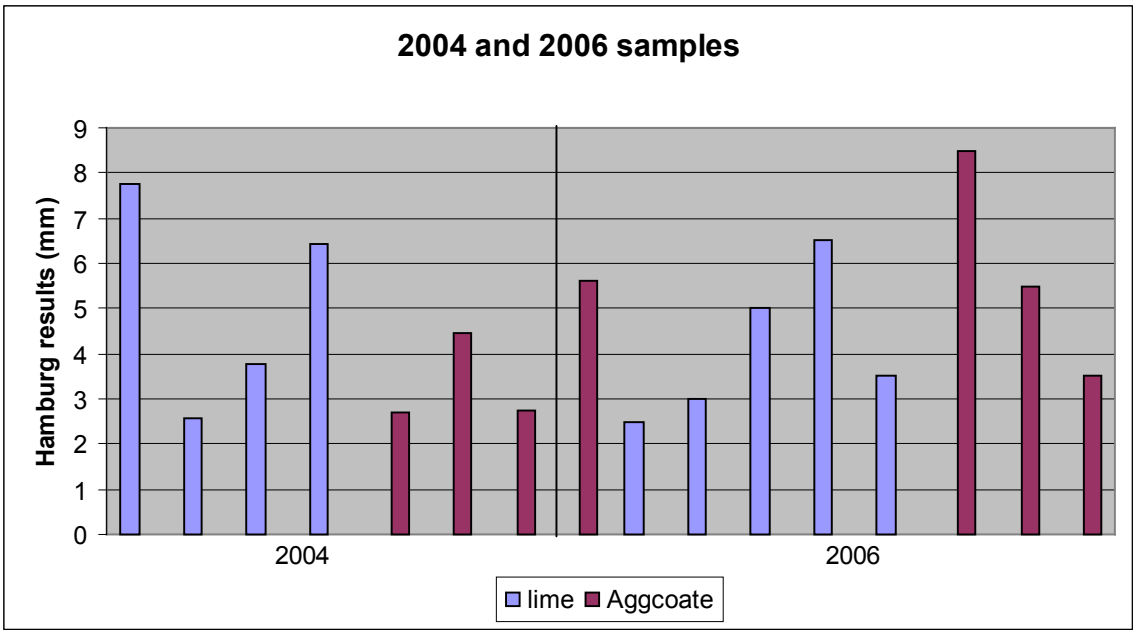


Figure 5: 2004 and 2006 Hamburg Test Results

The results from 2004 and 2006 of the cores cut from the pavement and run on the Hamburg Wheel Tracker to determine the potential for stripping indicate that both products were well within the failure depth of 10 mm. Additional years were planned to provide more enlightening data.

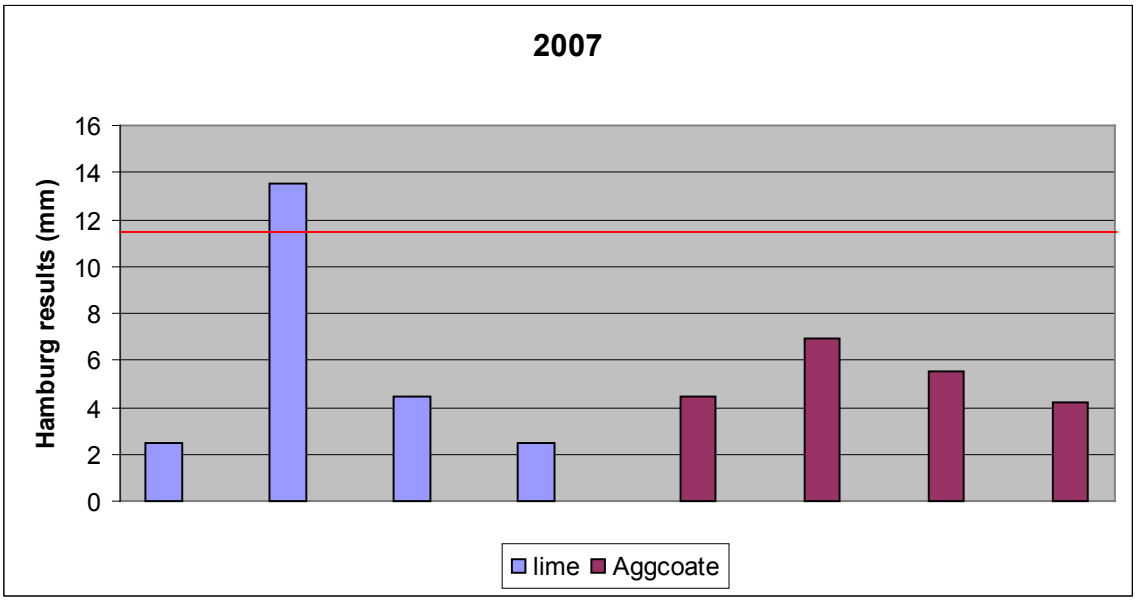


Figure 6: 2007 Hamburg Test Results

The 2007 year as shown in Figure 6 has some interesting results, in that at least with three points from different years a curve may be drawn, and exhibits an early potential stripping problem with the lime anti-strip. This result indicated that a fourth year ought to be considered for more points.

One possible explanation for the 2007 data is: the oil business was booming in the Naples, Utah area and the rapid stripping may be because the truck traffic had increased two to three times from the initial design counts. The original traffic count performed by Traffic & Safety was 3,000 to 4,000 vehicles per day in 2004. The 2007 traffic count on US 40 at 500 South in Naples was at 10,000 vehicles per day per Traffic & Safety short term count and is not annualized.

The test results from the 2008 Hamburg test are compared below in Figure 7. The fourth year results indicate relatively equal performance by the lime and Aggcoate anti-stripping additives for HMA application.

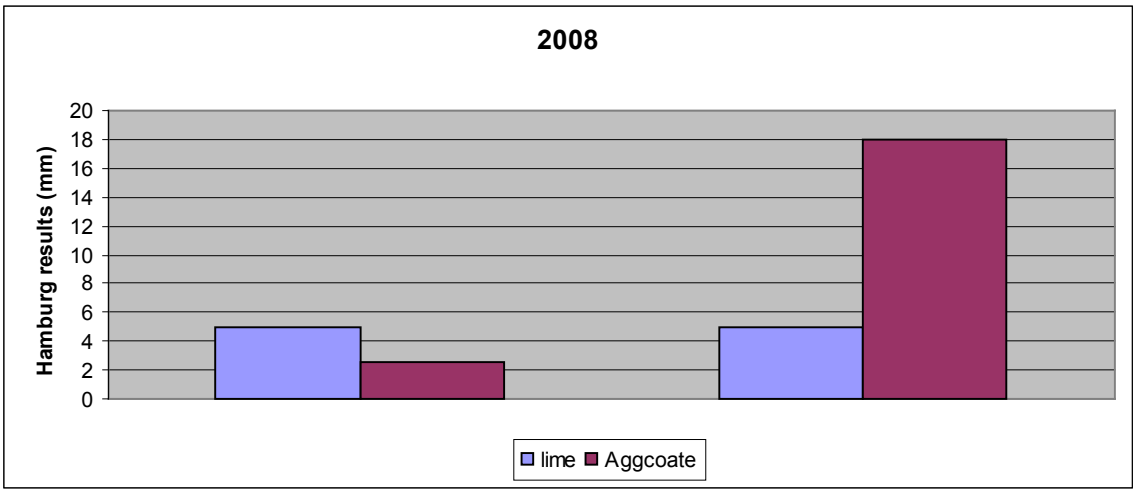


Figure 7: 2008 Hamburg Test Results

With the 2008 test data, at least four years of testing was achieved and the results as shown in Figure 8 indicate equal performance by lime and pelletized Aggcoate used as

anti-stripping additives for asphalt pavement applications. Note the red line at 10 mm indicates the failure limit.

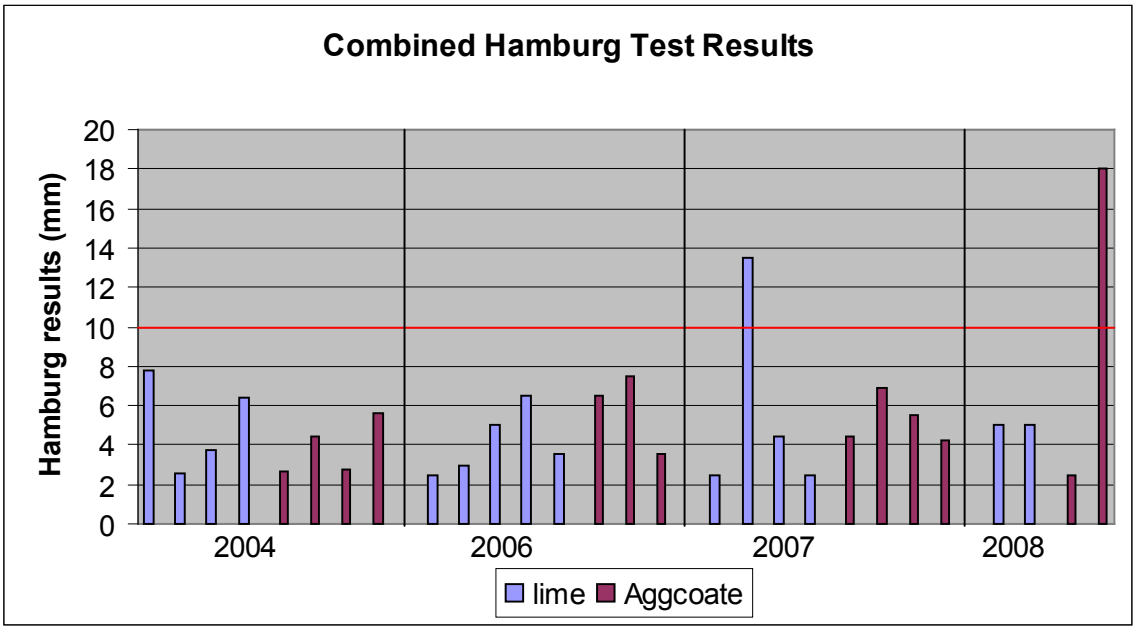


Figure 8: 2004 to 2008 Combined Hamburg Test Results

5.0 CONCLUSIONS

In summary the four years of comparisons of testing similar samples exhibited consistent and similar results from the Hamburg Wheel Tracker measuring the potential for stripping of HMA. Two of the test samples exceeded the specified limit, one of which used lime-slurry and one used the Aggcoate. Two sample failures out of 28 tests is a reasonable failure rate. The other 26 samples were well within the limiting guidelines.

Through the cooperation of Burdick Paving (contractor) and UDOT, Region Three Materials, the Aggcoate HMA mix design was utilized as the report states and evidences about 5% decrease in cost at the production level with less fuel used for this process and in time may be passed on to the consumer. With less fuel consumed to dry and mix HMA with Aggcoate, part of the 5% savings may be attributed to saving the environment by using less fuel to process a ton of HMA. This savings ultimately provides an alternative to using lime as an anti-stripping agent and creates a two source anti-strip choice and, under certain conditions, creates a competitive spirit. Generally competition reduces the price for either product as time passes.

Based on this product evaluation, it is recommended using Aggcoate in a HMA mix design where the raw material is in question regarding border line gradations on the fine side. Aggcoate is a viable alternative in all HMA mix designs and worked equally as well as the lime slurry in the subject test section, and UDOT is on notice of a new approach to HMA anti-stripping agent.

APPENDIX

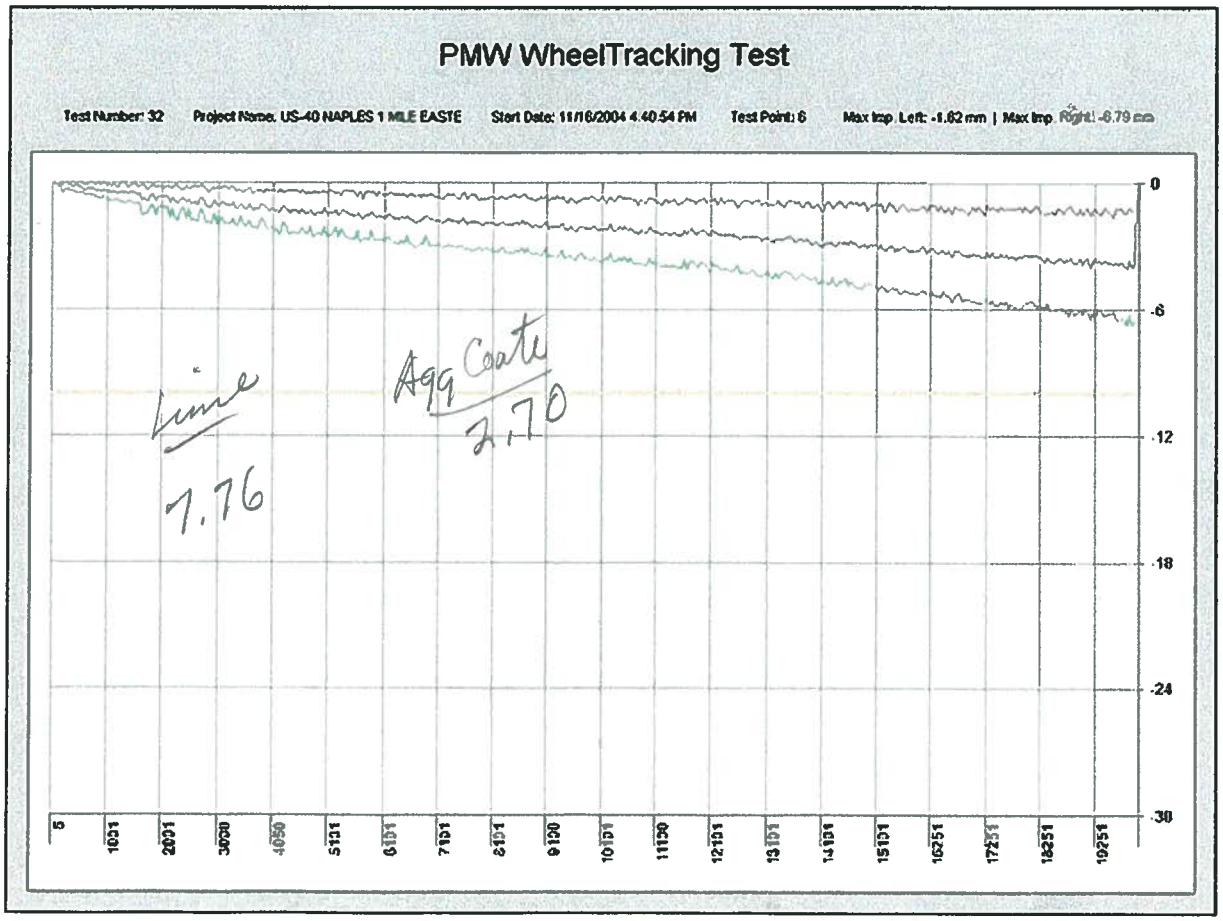
The following pages include test results from the Hamburg Wheel Tracker testing of asphalt core samples from the project site.

UTAH DEPARTMENT OF TRANSPORTATION
REGION THREE LAB OREM UTAH
(1 M.P. 149.970 18' RT CL 0" to 1 5/8")(1-A M.P. 149.970 18' RT OF CL 2 5/8" to 4 1/4")

Project Name:	US-40 NAPLES 1 MILE EASTE	**Date:**	11/16/2004
Project Number:	NO NUMBER	**Date Sampled:**	11/16/2004
Job Number:		**Lab Number:**	
Project Engineer:		**Mix Type:**	
Submitted By:		**Asphalt Grade:**	????
		Pit Source:	

	Layer Below Aggcoate CORE #1-A	Aggcoate CORE #1	
	Right	**Left**	**Average**
Maximum Impressions:	-7.76 mm	-2.70 mm	-5.23 mm
	Pass #: 19951	**Pass #: 19001**	

Failure Depth: 10 mm PASSED



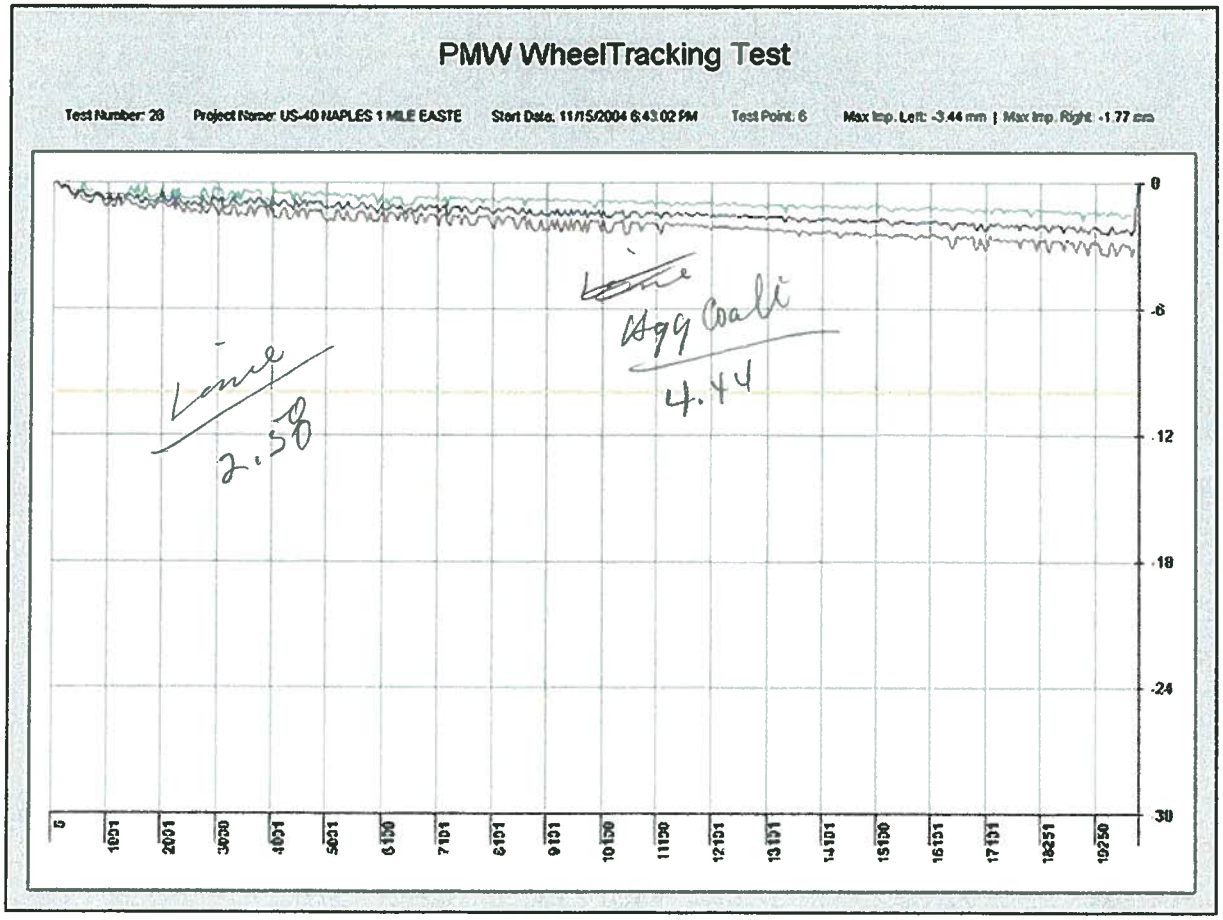
cc: clear 02-09 **MARK WHITE**

UTAH DEPARTMENT OF TRANSPORTATION
REGION THREE LAB OREM UTAH
(CORE #3 M.P. 150.164 18' RT CL)(CORE #4 M.P. 150.164 8' RT CL)

Project Name:	US-40 NAPLES 1 MILE EASTE	**Date:**	11/15/2004
Project Number:	NO NUMBER	**Date Sampled:**	11/15/2004
Job Number:		**Lab Number:**	
Project Engineer:		**Mix Type:**	?????
Submitted By:	MACK HALL	**Asphalt Grade:**	????
		Pit Source:	??????

	Aggcoate CORE #4	Aggcoate CORE #3	
	Right	**Left**	**Average**
Maximum Impressions:	-2,58 mm	-4.44 mm	-3.51 mm
	Pass #: 20001	**Pass #: 19651**	

Failure Depth: 10 mm PASSED



cc:

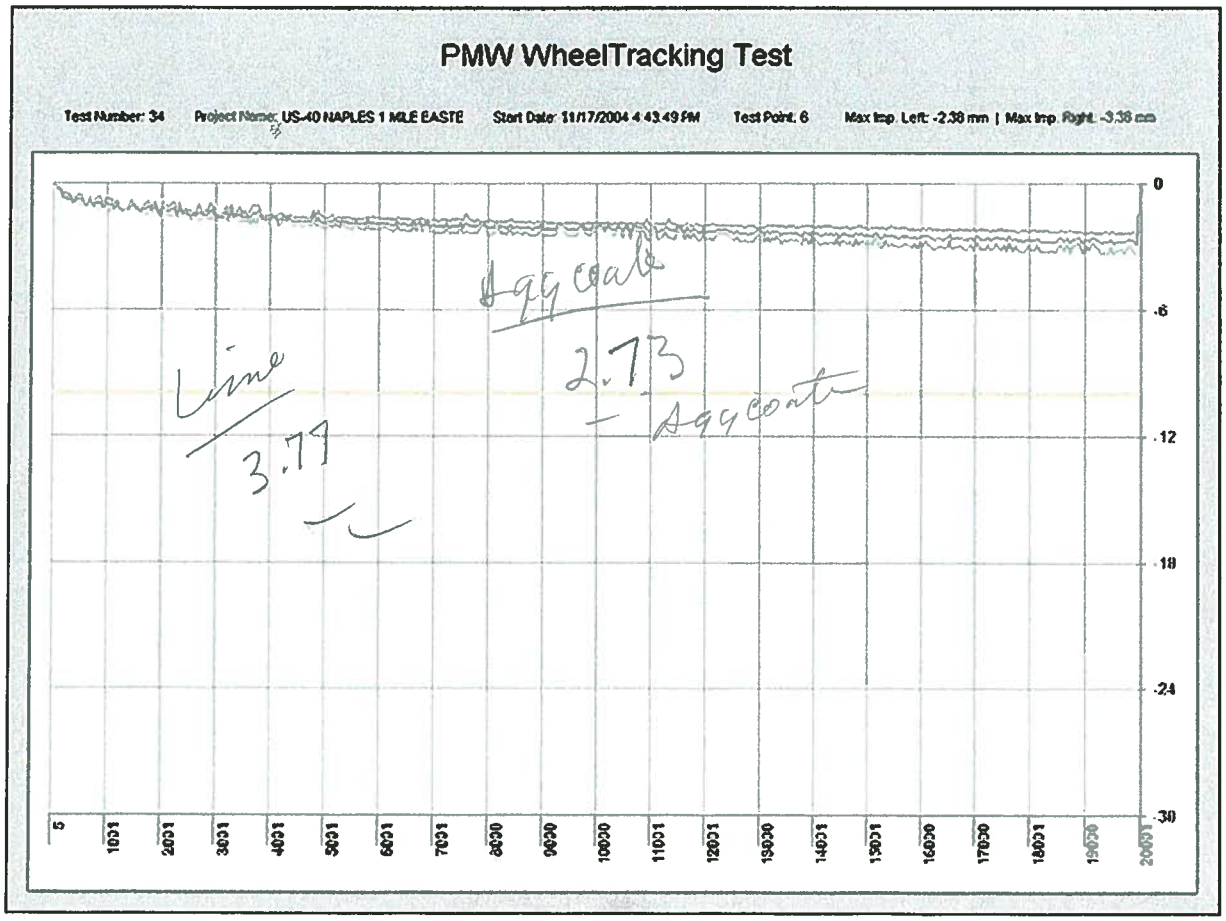
WILLIAM LARSON

DEPARTMENT OF TRANSPORTATION
REGION THREE LAB OREM UTAH
M.P. 150.412(CORE 5 0" to 1 5/8" 18' RT CL)(CORE 6 0" to 1 5/8" 9' RT CL)

Project Name:	US-40 NAPLES 1 MILE EASTE	**Date:**	11/17/2004
Project Number:	NO NUMBER	**Date Sampled:**	11/17/2004
Job Number:		**Lab Number:**	
Project Engineer:		**Mix Type:**	
Submitted By:		**Asphalt Grade:**	????
		Pit Source:	

	Right	Left	Average
	Agg Coate Core #6	Aggcoate Core #5	
Maximum Impressions:	-3.77 mm	-2.73 mm	-3.25 mm
	Pass #: 20001	Pass #: 19851	

Failure Depth: 10 mm PASSED



cc:

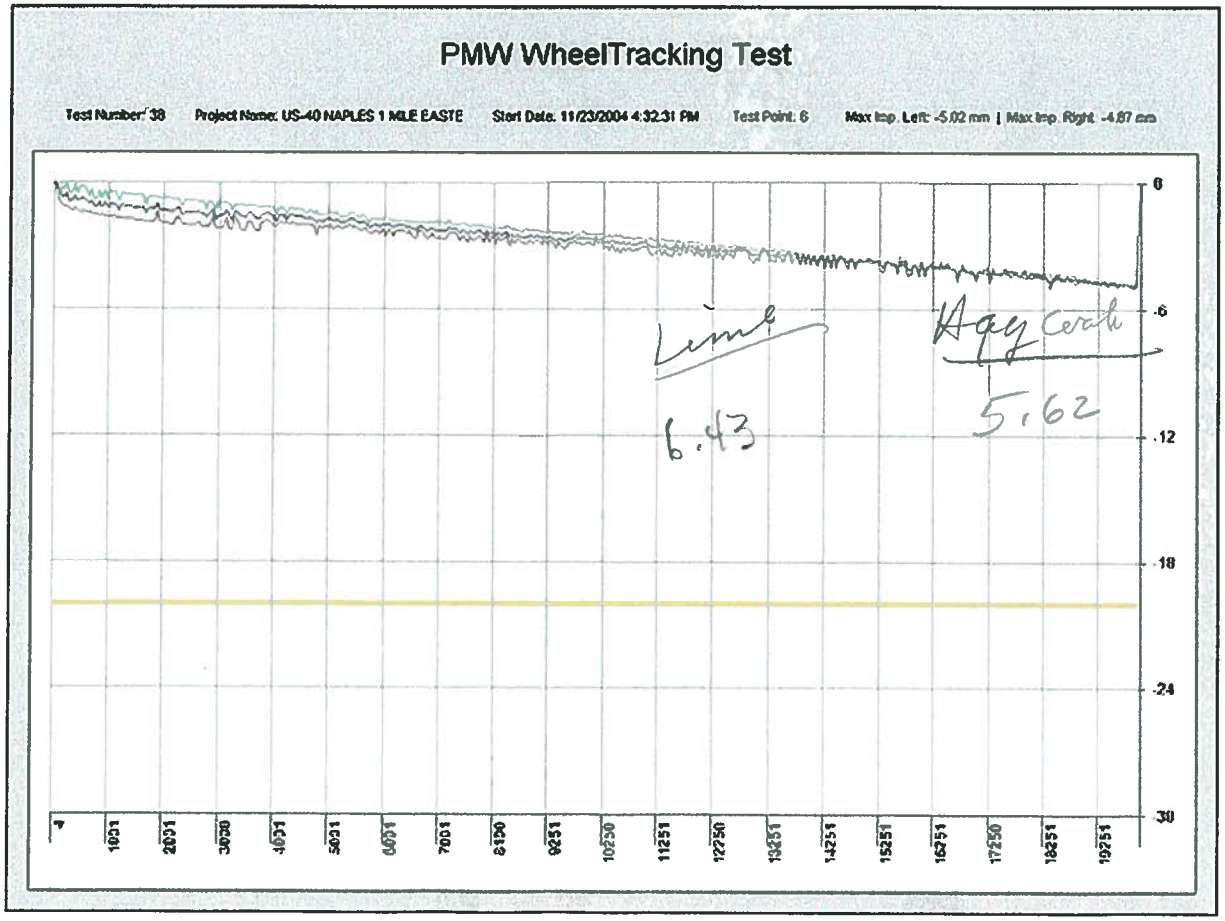
William Larson

UTAH DEPARTMENT OF TRANSPORTATION
REGION THREE LAB OREM, UTAH
M.P. 149.970(CORE 2 0" TO 1 5/8" 9' Rt CL)(CORE 2-A 2 5/8" TO 3 1/4" 9' Rt CL)

Project Name:	US-40 NAPLES 1 MILE EASTE	**Date:**	11/23/2004
Project Number:	NO NUMBER	**Date Sampled:**	11/23/2004
Job Number:		**Lab Number:**	
Project Engineer:		**Mix Type:**	
Submitted By:		**Asphalt Grade:**	????
		Pit Source:	

	Layer Below Aggcoate CORE#2A	Aggcoate CORE #2	
	Right	**Left**	**Average**
Maximum Impressions:	-6.43 mm	-5.62 mm	-6.03 mm
	Pass #: 19900	Pass #: 19950	

Failure Depth: 20 mm PASSED

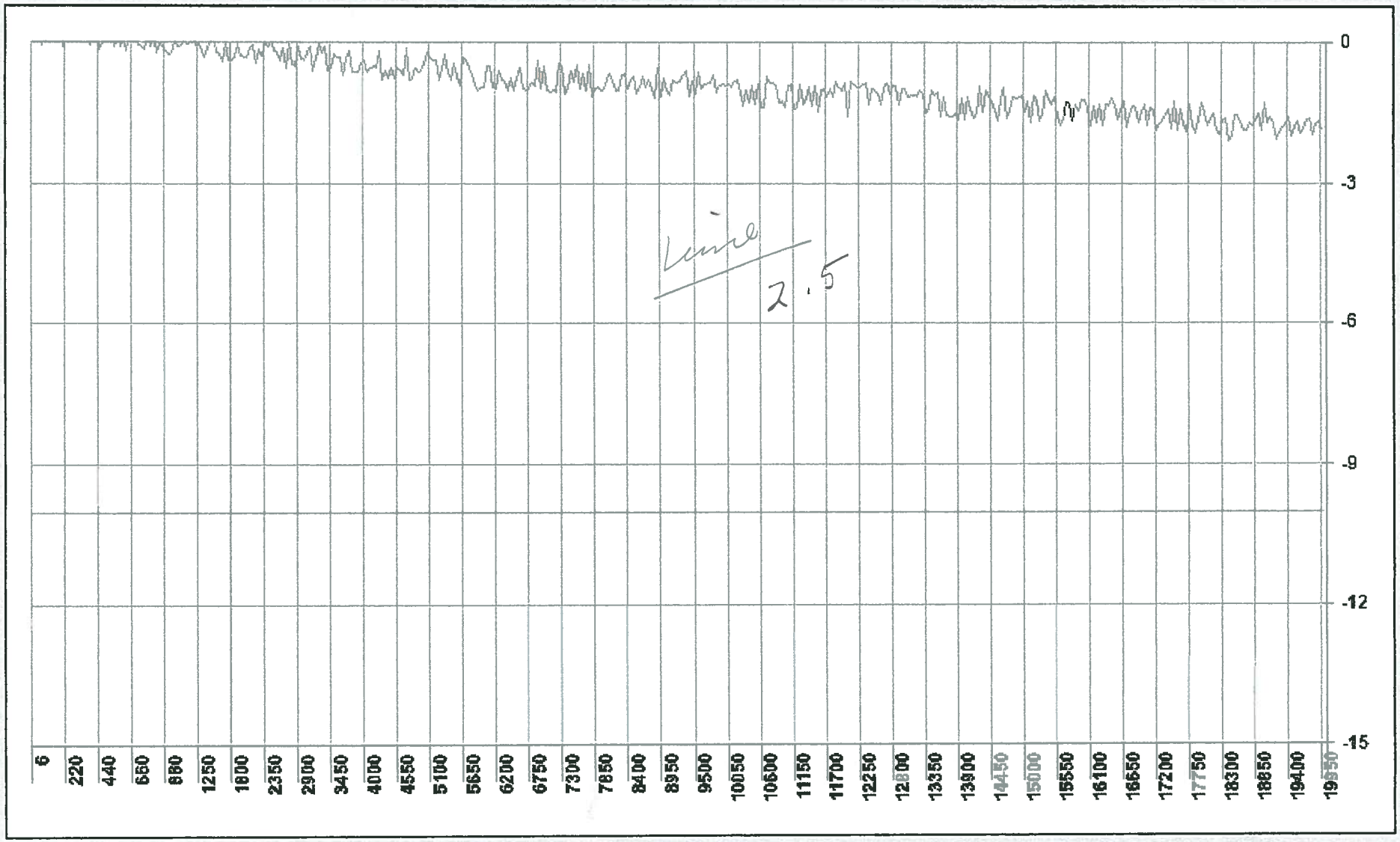


cc:

WILLIAM LARSON

PMW WheelTracking Test

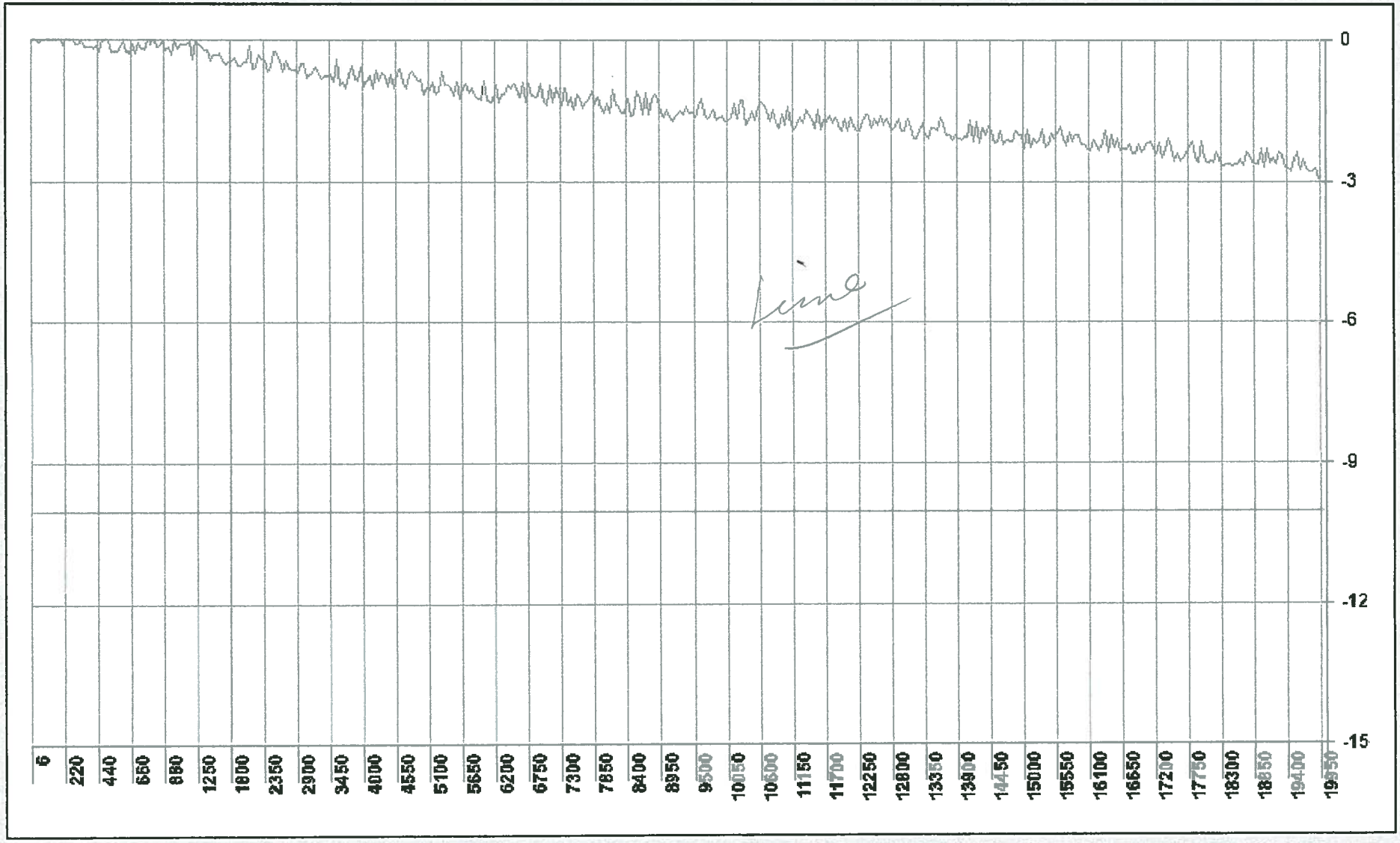
Test Number: 08 Project Name: US-40 NAPLES GILSONITE PR Start Date: 8/8/2006 7:56:33 PM Test Point: 3 Max Imp. Left: -2.07 mm



— Left Wheel — Failure Depth

PMW WheelTracking Test

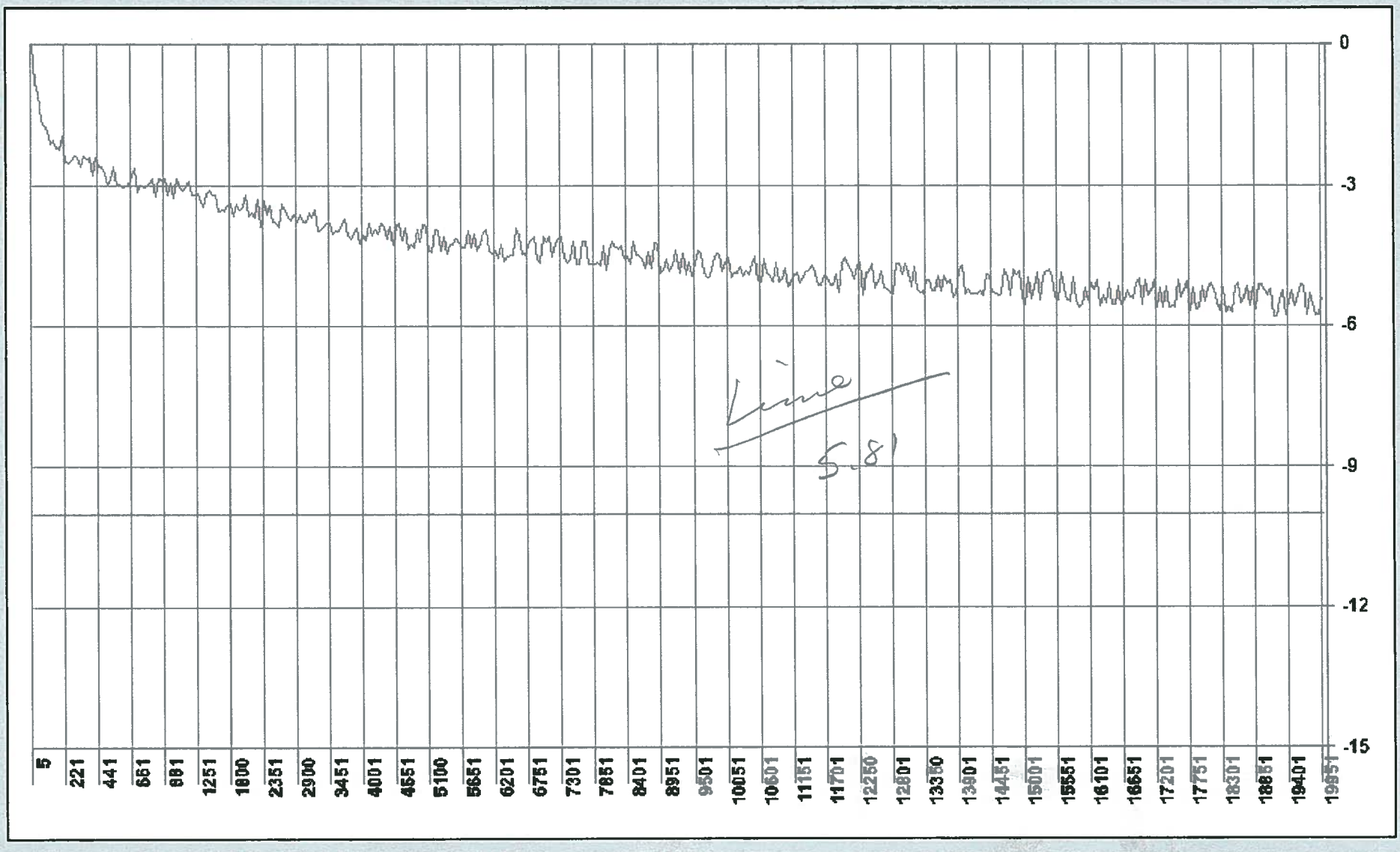
Test Number: 08 Project Name: US-40 NAPLES GILSONITE PR Start Date: 8/8/2006 7:56:33 PM Test Point: 4 Max Imp. Left: -2.94 mm



— Left Wheel — Failure Depth

PMW WheelTracking Test

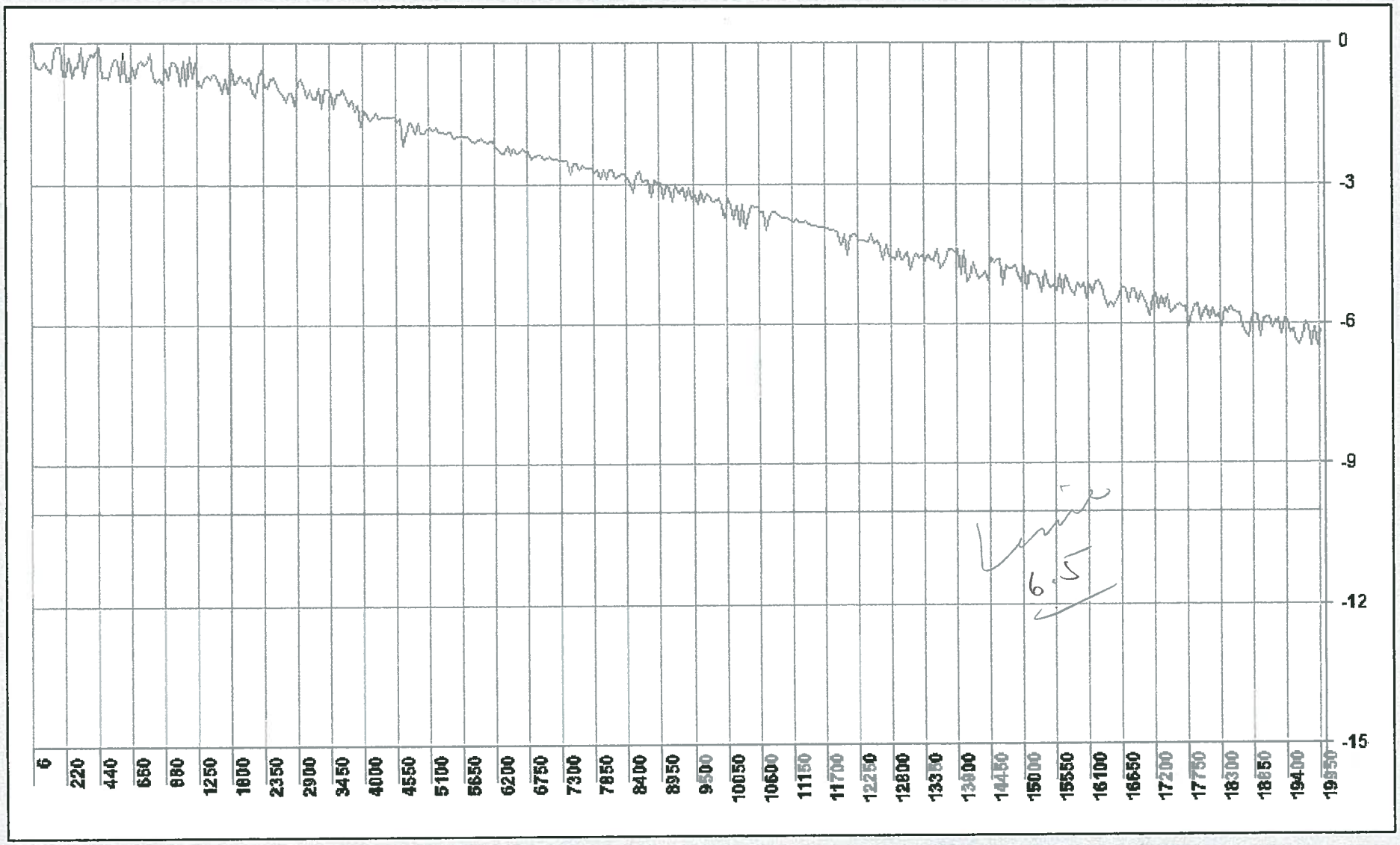
Test Number: 08 Project Name: US-40 NAPLES GILSONITE PR Start Date: 9/5/2006 2:43:50 PM Test Point: 7 Max Imp. Left: -5.81 mm



— Left Wheel — Failure Depth

PMW WheelTracking Test

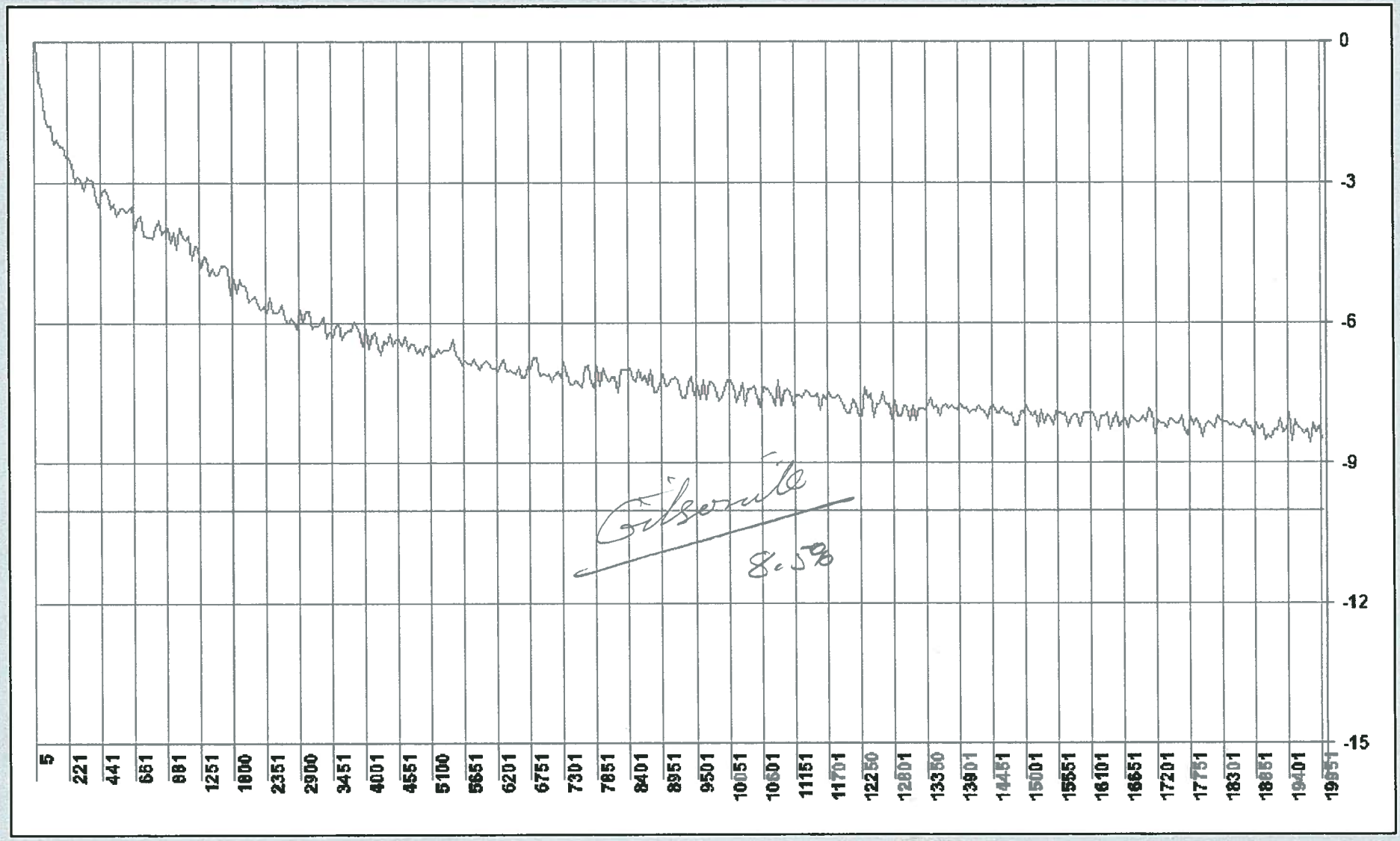
Test Number: 08 Project Name: US-40 NAPLES GILSONITE PR Start Date: 8/8/2006 7:56:33 PM Test Point: 8 Max Imp. Left: -6.49 mm



— Left Wheel — Failure Depth

PMW WheelTracking Test

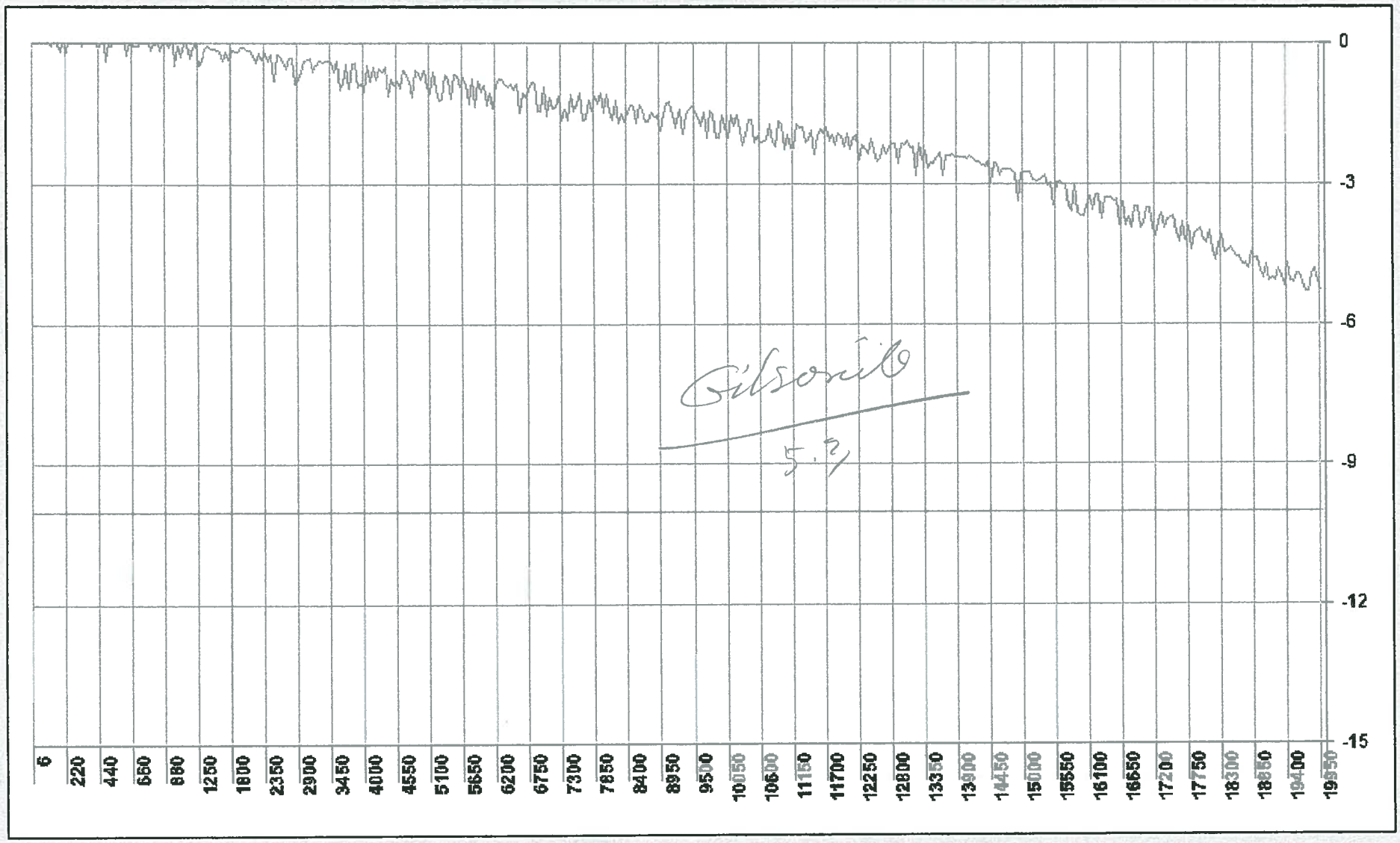
Test Number: 08 Project Name: US-40 NAPLES GILSONITE PR Start Date: 9/5/2006 2:43:50 PM Test Point: 4 Max Imp. Left: -8.58 mm



— Left Wheel — Failure Depth

PMW WheelTracking Test

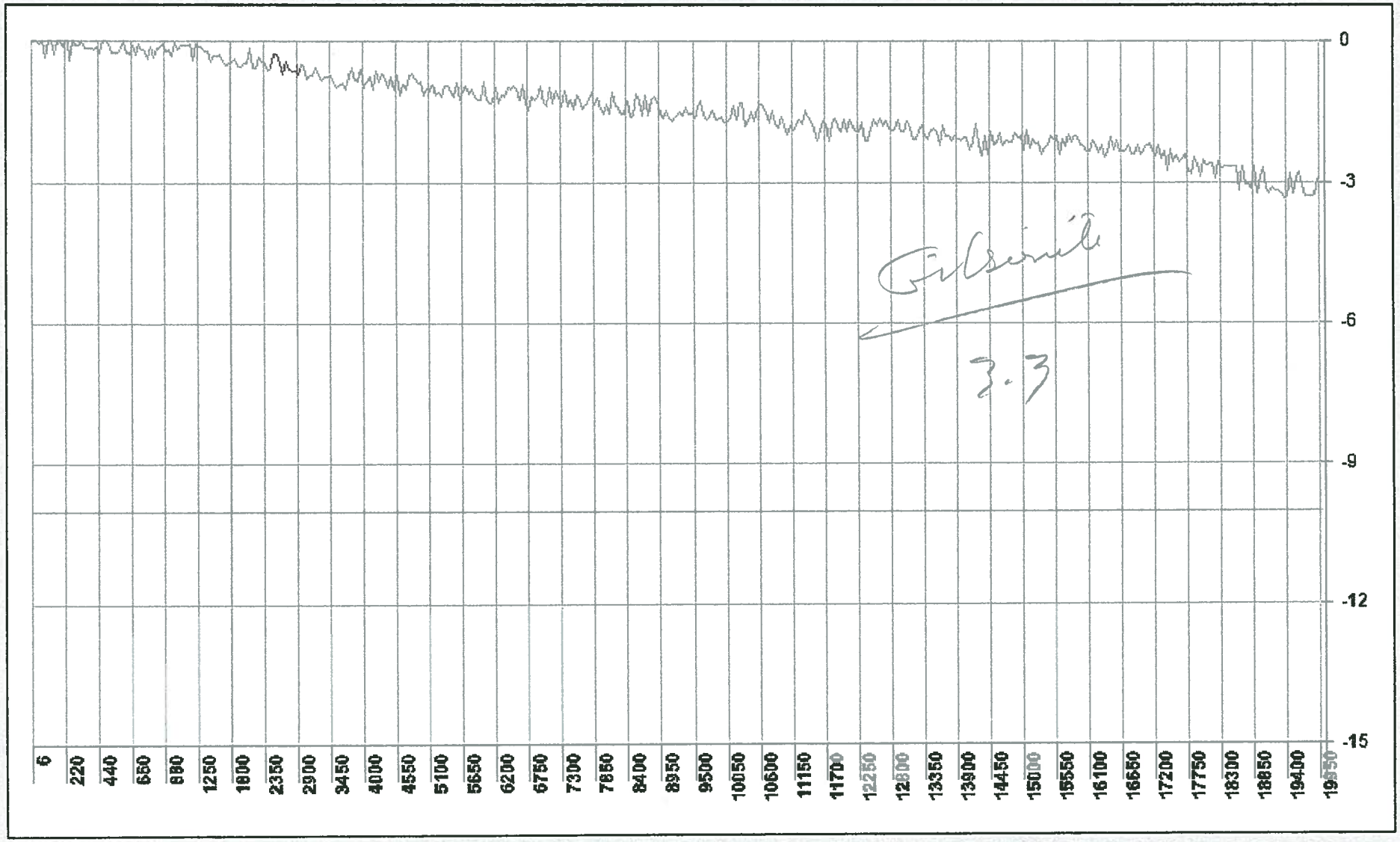
Test Number: 08 Project Name: US-40 NAPLES GILSONITE PR Start Date: 8/8/2006 7:56:33 PM Test Point: 6 Max Imp. Left: -5.3 mm



— Left Wheel — Failure Depth

PMW WheelTracking Test

Test Number: 08 Project Name: US-40 NAPLES GILSONITE PR Start Date: 8/8/2006 7:56:33 PM Test Point: 5 Max Imp. Left: -3.33 mm

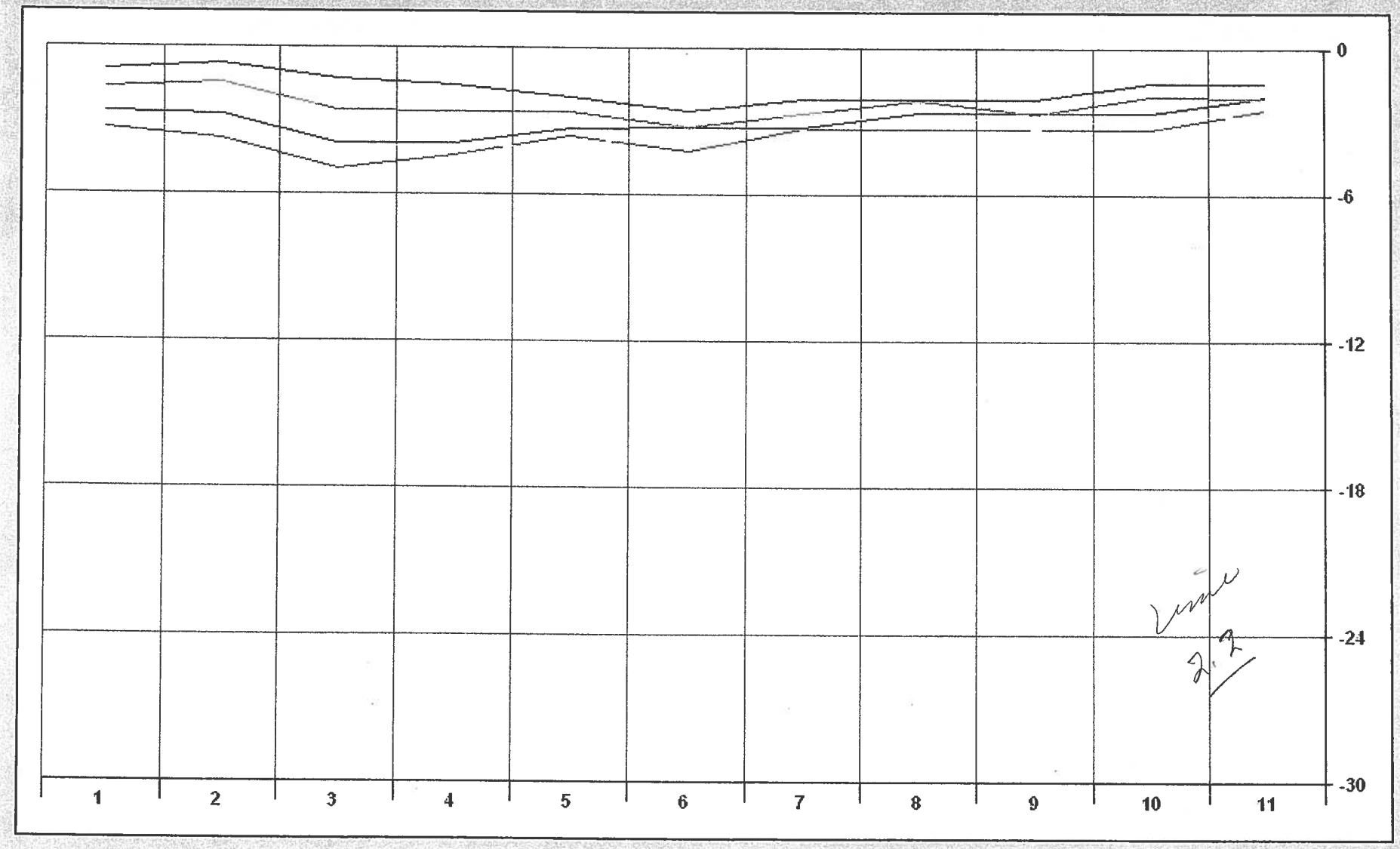


— Left Wheel — Failure Depth

PMW WheelTracking Test :: Sample Profiles

1 5/8" down

Test Number: 24 Project Name: US-40 Naples gilsonite project tests Start Date: 12/27/2007 2007-R3-A-81 Lt Side



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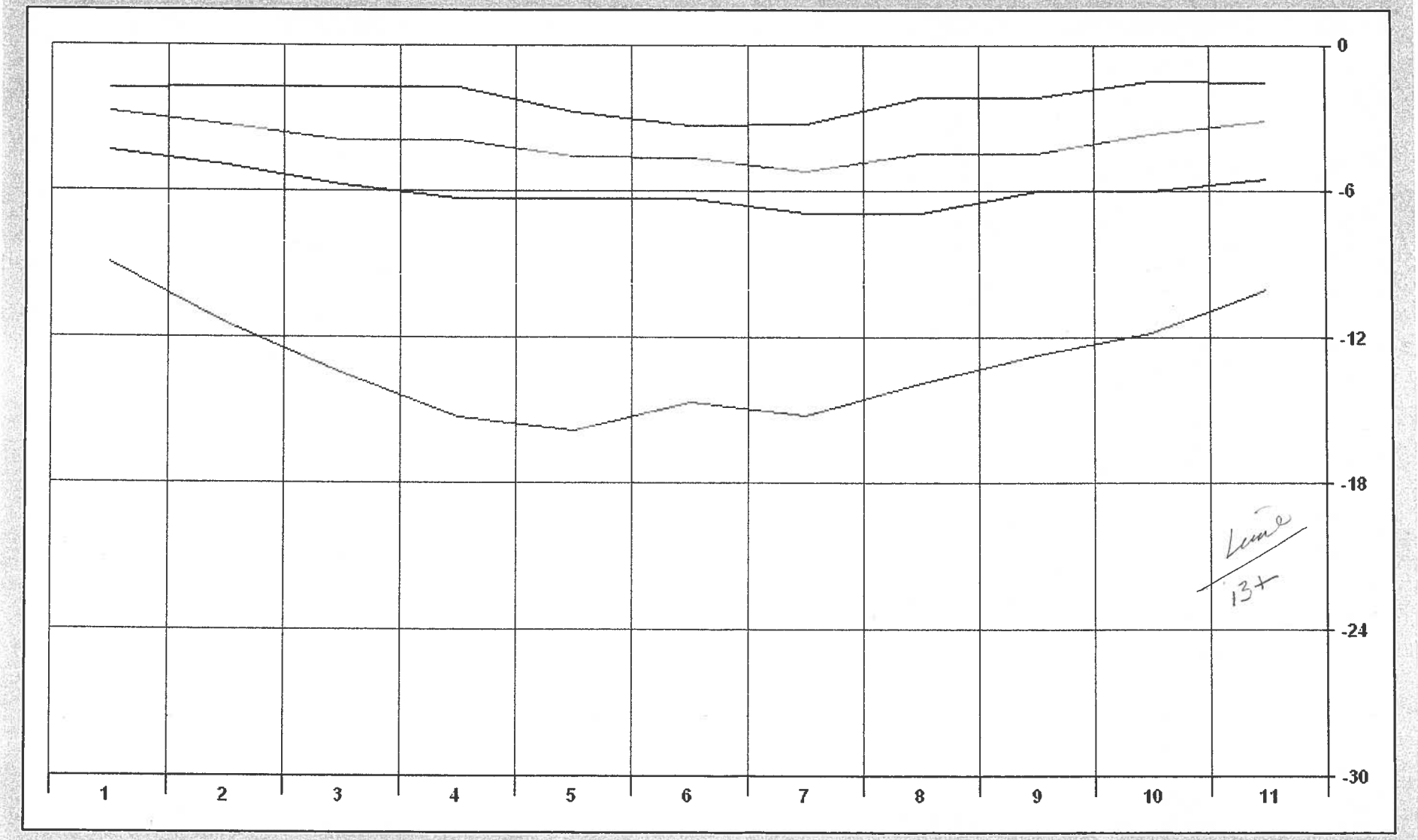
PMW WheelTracking Test :: Sample Profiles

Test Number: 20 Project Name: US-40 Naples gilsonite project tests Start Date: 10/10/2007 2007-R3-A-73 Lt Side



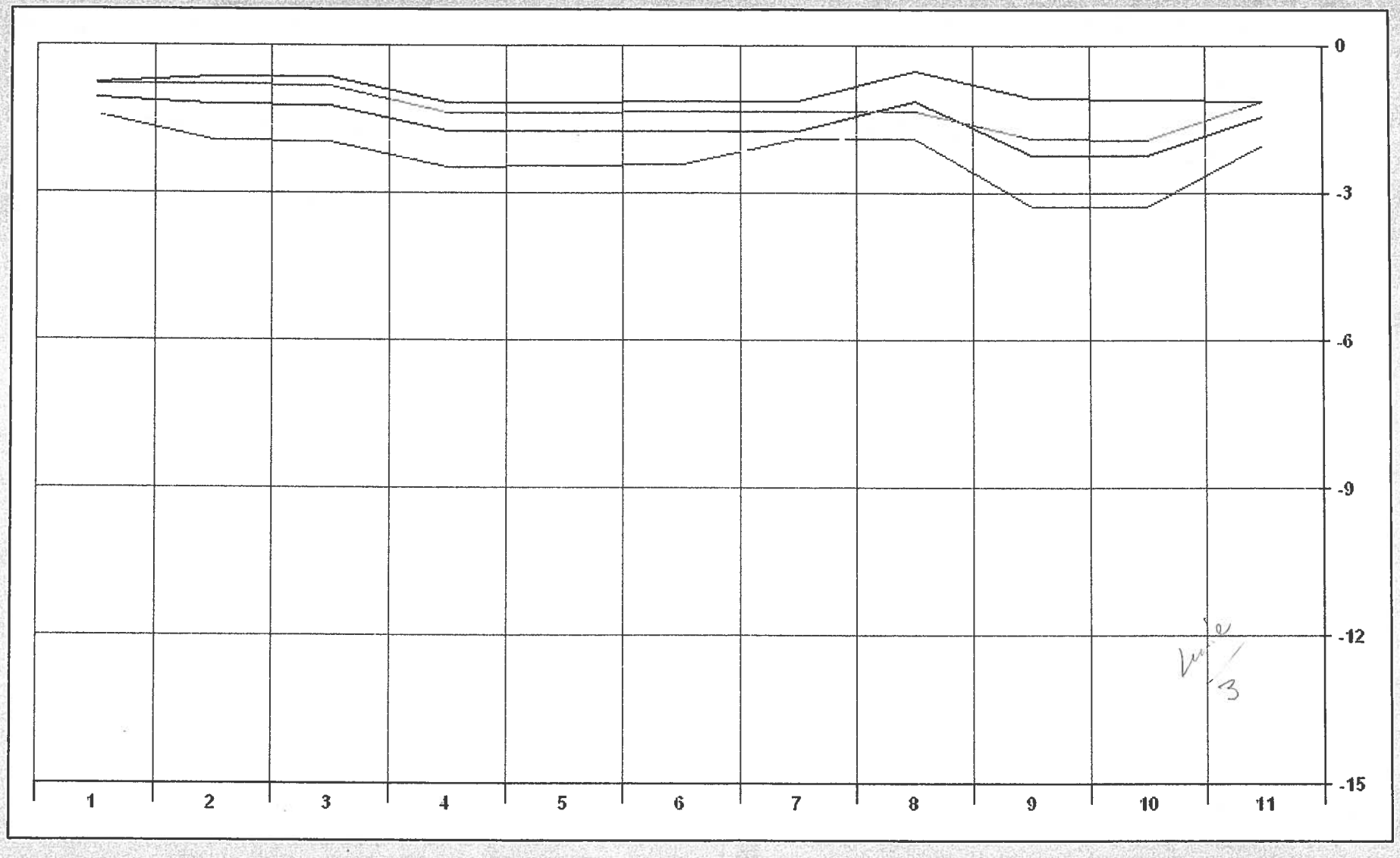
— 1000 — 5000 — 10000 15000 — 19900

PMW WheelTracking Test :: Sample Profiles

1 5/8" down

Test Number: 21 Project Name: US-40 Naples gilsonite project tests Start Date: 10/11/2007

2007-R3-A-74 Lt side



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PMW WheelTracking Test :: Sample Profiles

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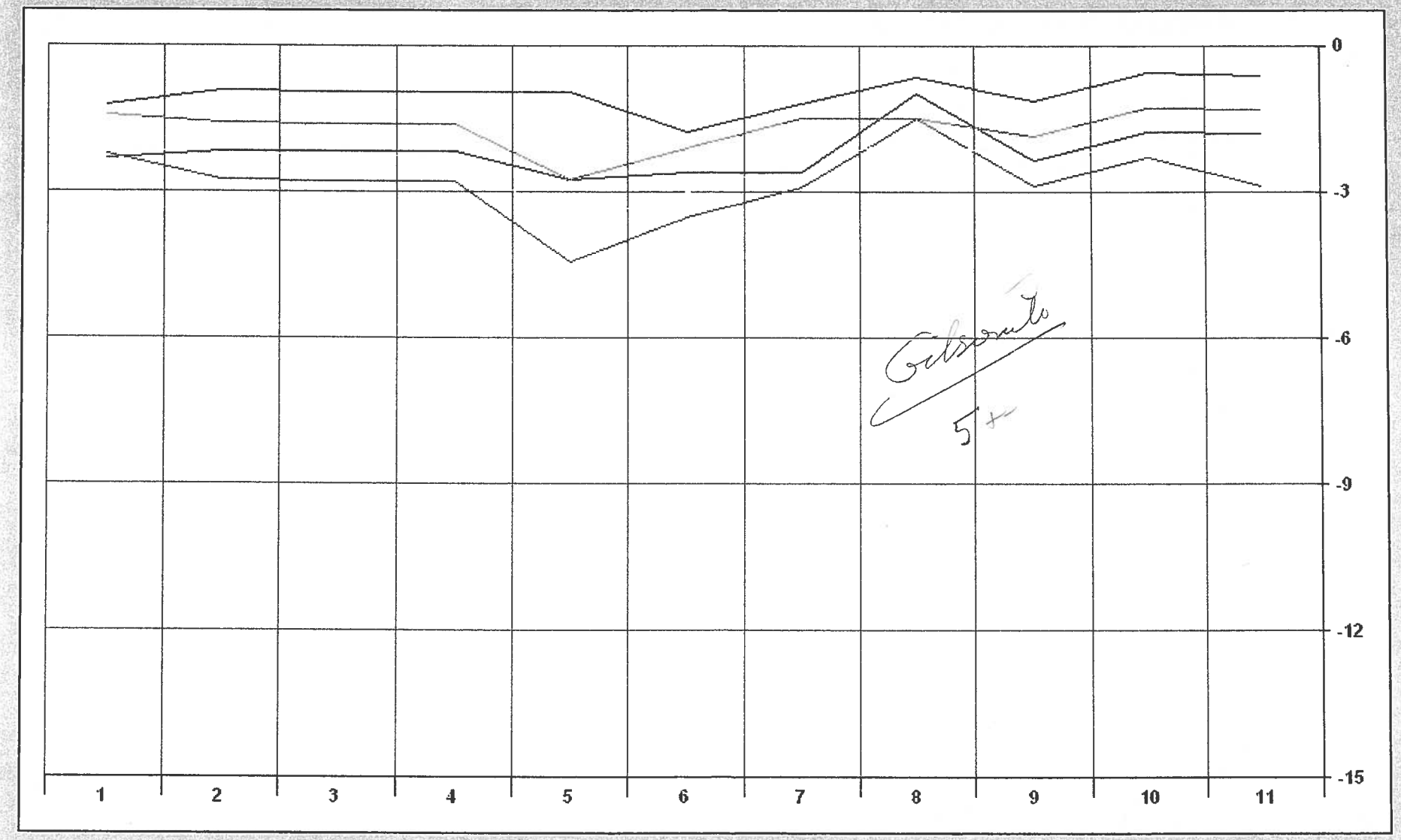
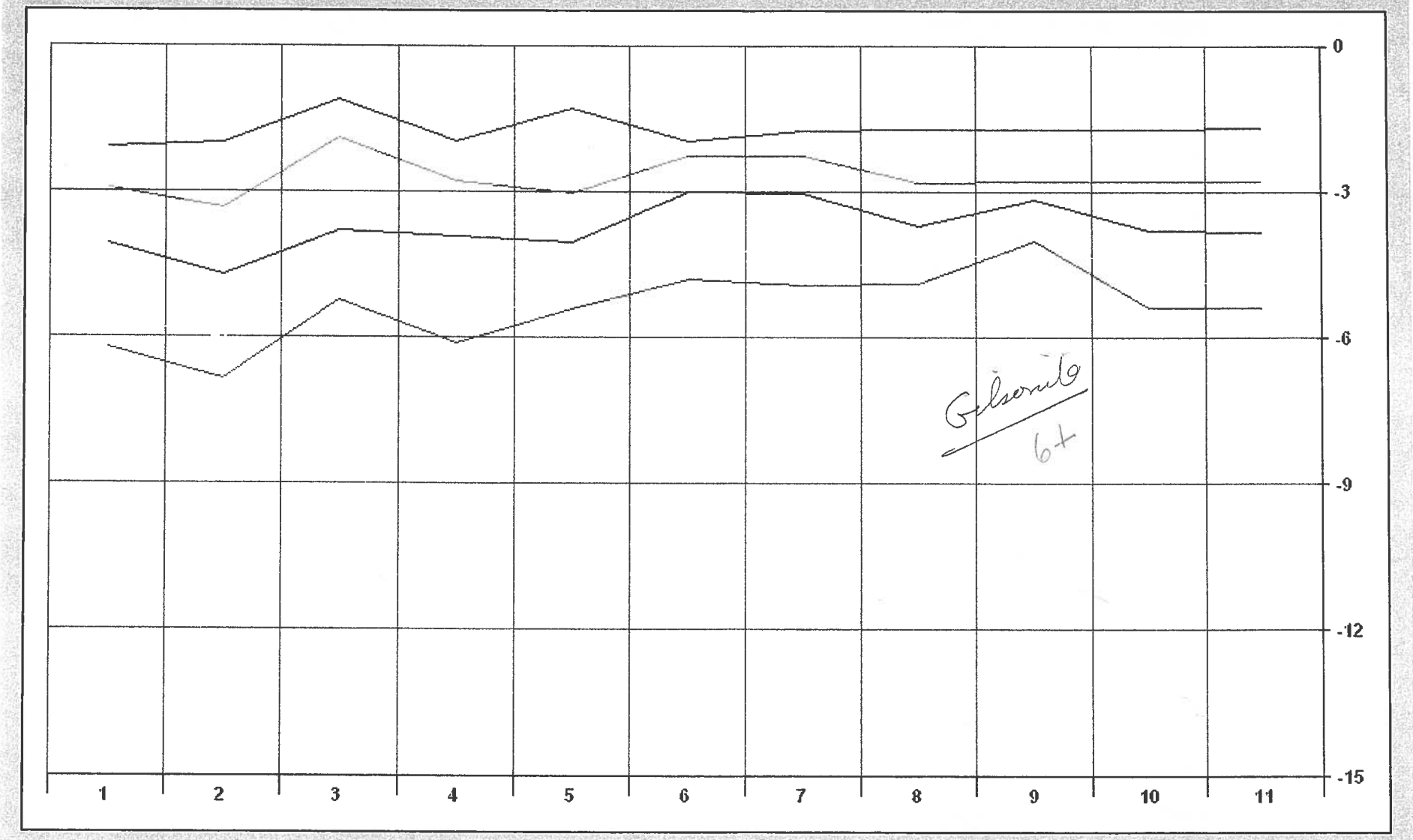


— 1000 — 5000 — 10000 — 15000 — 19750

PMW WheelTracking Test :: Sample Profiles

Test Number: 20 Project Name: US-40 Naples gilsonite project tests Start Date: 10/10/2007 2007-R3-A-73 Rt side



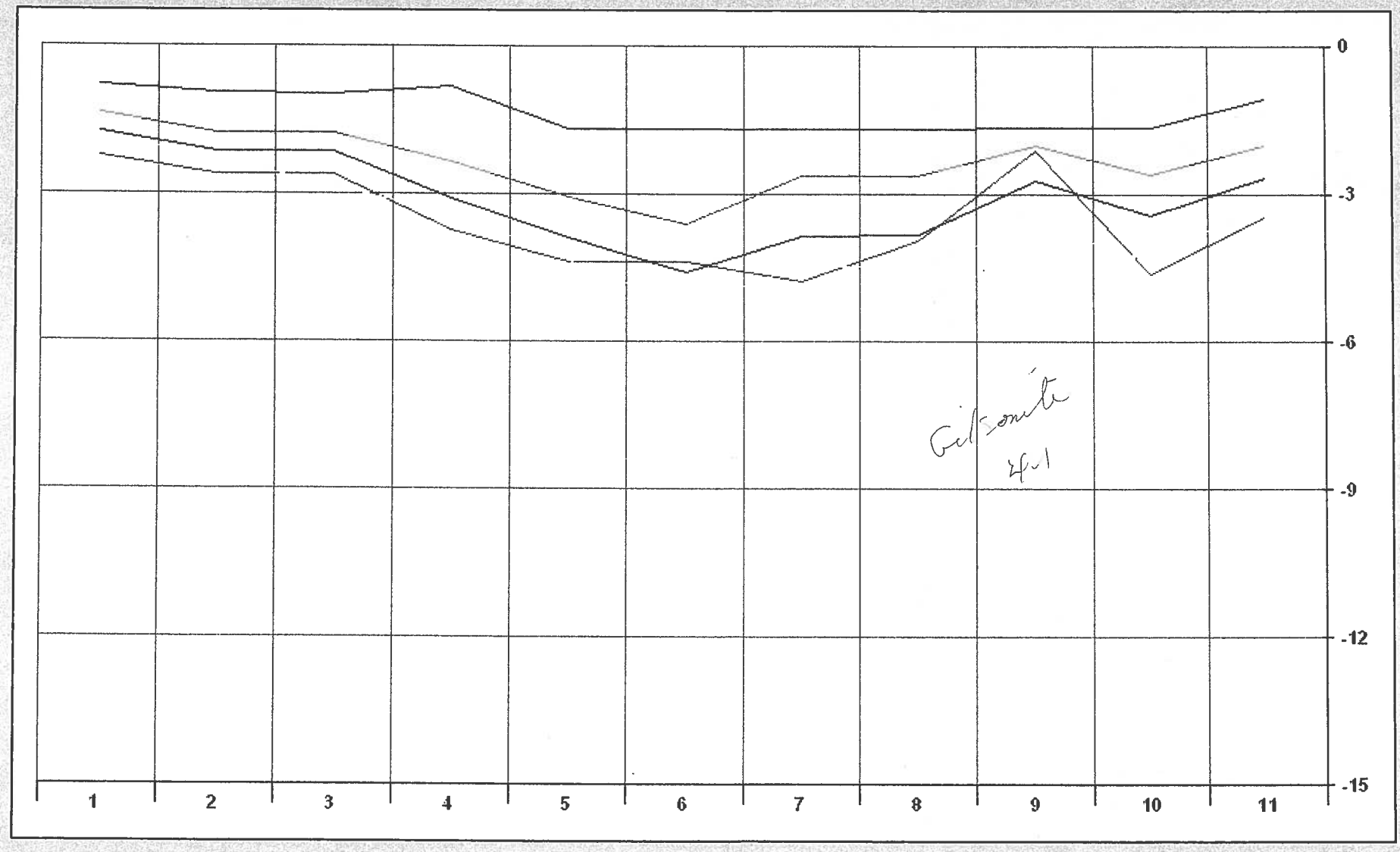
— 1000 — 5000 — 10000 15000 — 19750

PMW WheelTracking Test :: Sample Profiles

Top OGSC

Test Number: 24 Project Name: US-40 Naples gilsonite project tests Start Date: 12/27/2007

2007-R3-A-81 Rt Side



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PMW WheelTracking Test :: Sample Profiles

OGSC

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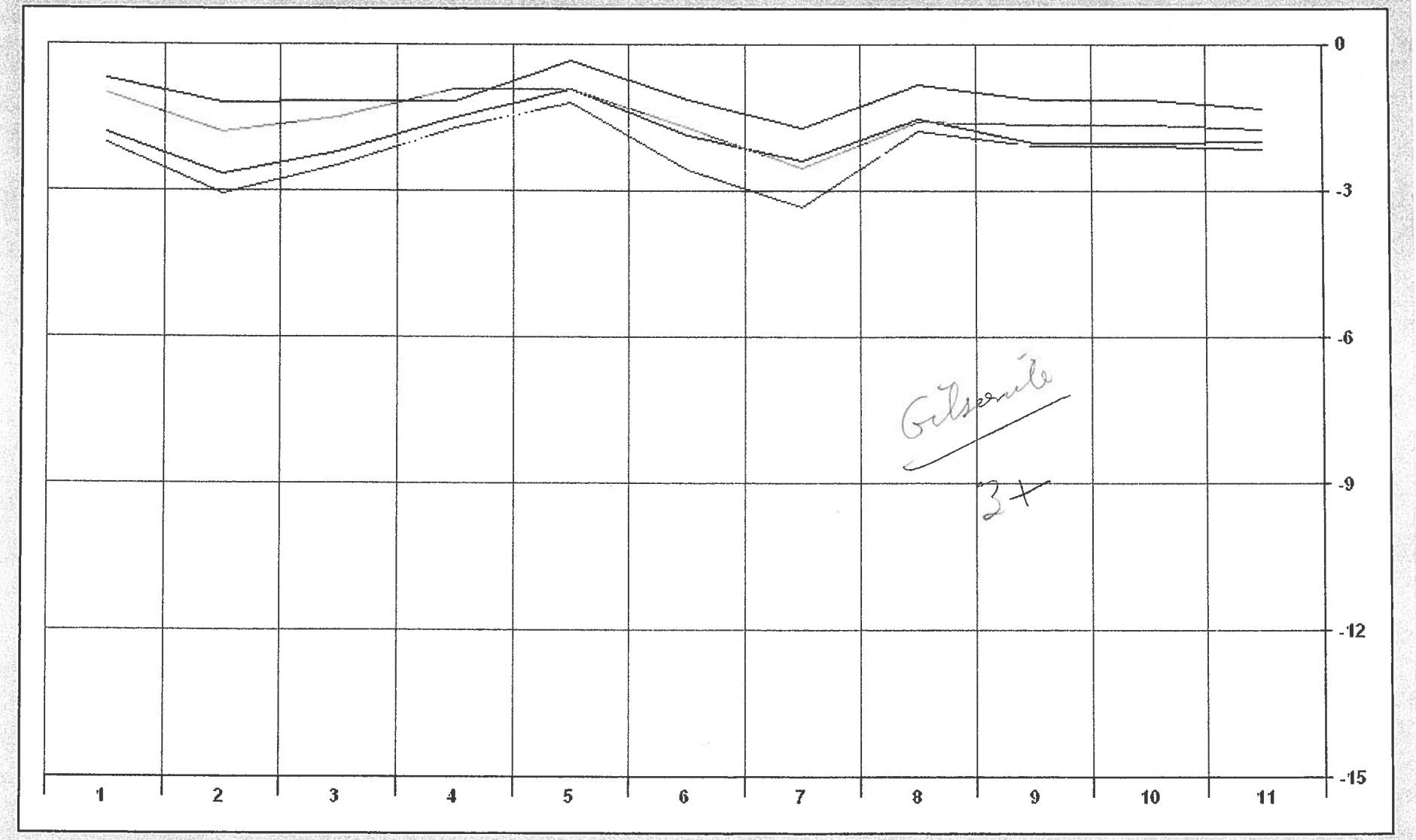


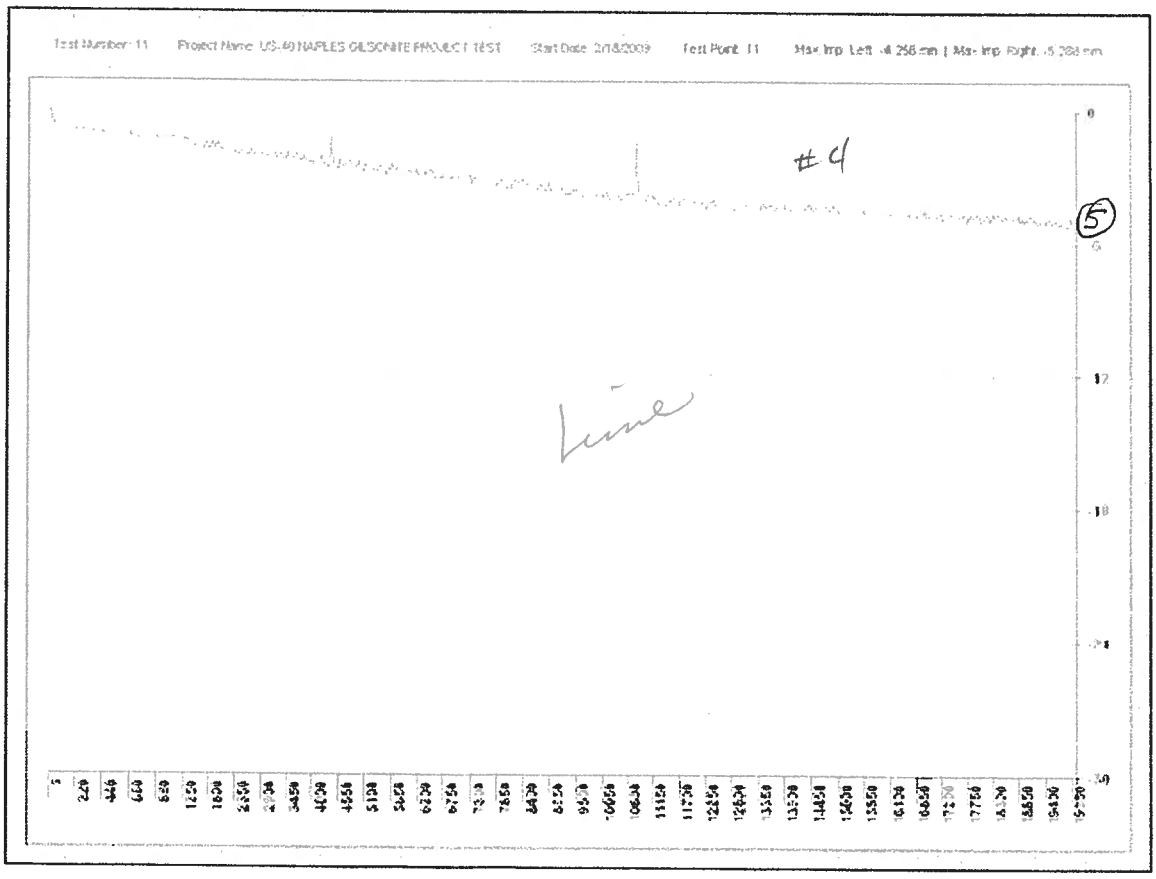
— 1000 — 5000 — 10000 15000 — 19950

UTAH DEPARTMENT OF TRANSPORTATION
Region 3 Lab Orem Utah
Left is R.P. 148.85 11.7' from center line EBL Right R.P. 149.10 10.3' FRom center EBL

Project Name:	US-40 NAPLES GILSONITE PROJECT TEST	**Date:**	3/4/2009
Project Number:	8RD0763H	**Date Sampled:**	2/18/2009
Job Number:		**Lab Number:**	2009-R3-A-3/4
Project Engineer:		**Mix Type:**	3/4" HMA w/gilsonite
Submitted By:	RICHARD SHARP	**Asphalt Grade:**	
		Pit Source:	

Maximum Impression: Right 0.00 mm
Pass #: 0

Failure Depth: 10.00 mm PASSED



cc:

William Larson
Region 3 Lab Manager

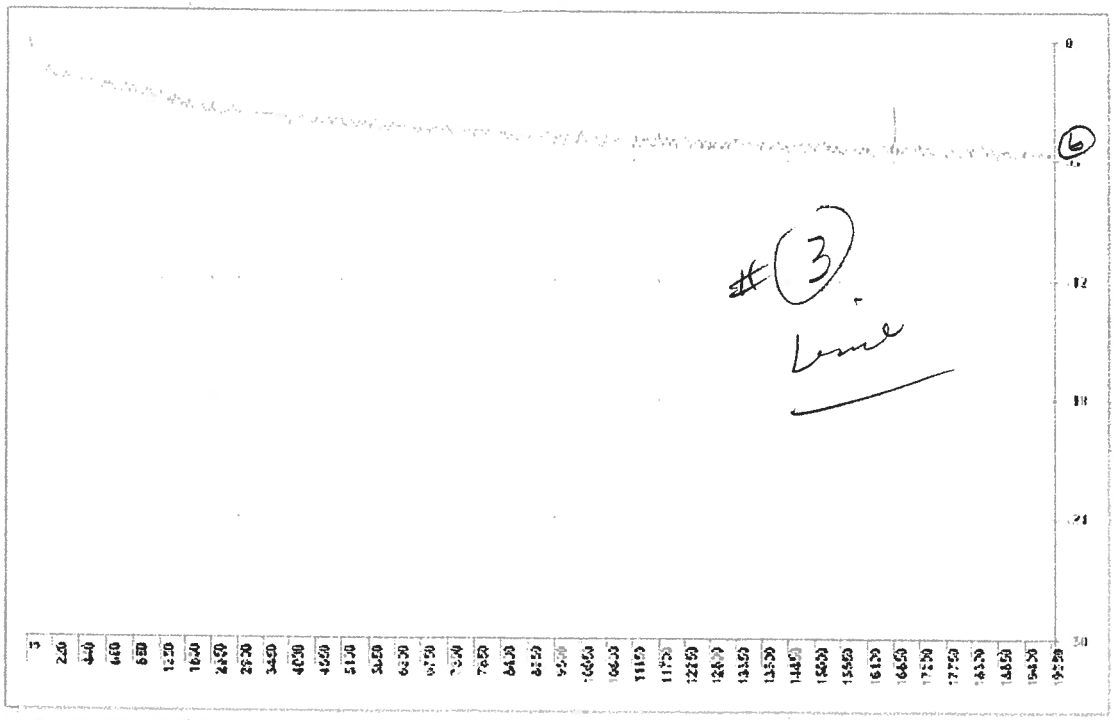
UTAH DEPARTMENT OF TRANSPORTATION
Region 3 Lab Orem Utah
Left R.P. 148.85 11.7' from center line E.B.L.

Project Name:	US-40 NAPLES GILSONITE PROJECT TEST	**Date:**	3/4/2009
Project Number:	8RD0763H	**Date Sampled:**	2/18/2009
Job Number:		**Lab Number:**	2009-R3-A-3
Project Engineer:		**Mix Type:**	3/4" HMA w/gilsonite
Submitted By:	RICHARD SHARP	**Asphalt Grade:**	
		Pit Source:	

Maximum Impression: Left -5.86 mm
Pass #: 19800

Failure Depth: 10.00 mm PASSED

PMW WheelTracking Test



cc:

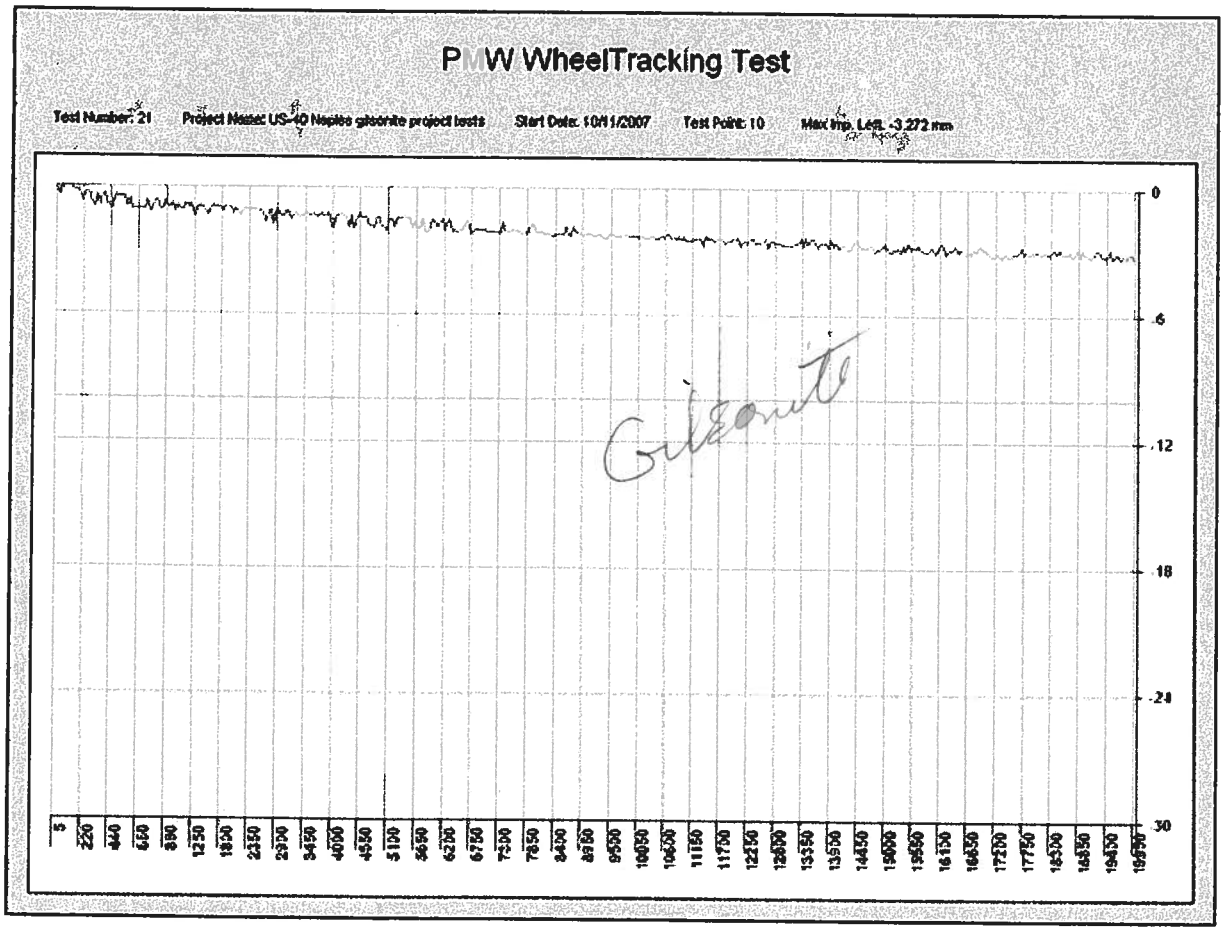
William Larson
Region 3 Lab Manager

UTAH DEPARTMENT OF TRANSPORTATION
Region 3 Lab Orem Utah
Lt gilsonite layer Rt seal coat layer R.P. 148.71 EBL

Project Name:	US-40 Naples gilsonite project tests	**Date:**	1/7/2008
Project Number:	8RD0763H	**Date Sampled:**	10/11/2007
Job Number:		**Lab Number:**	2007-R3-A-74
Project Engineer:		**Mix Type:**	3/4" HMA w/gilsonite
Submitted By:	Richard Sharp	**Asphalt Grade:**	
		Pit Source:	

Maximum Impression: Left -3.27 mm
Pass #: 19650

Failure Depth: 10 mm **PASSED**



cc:

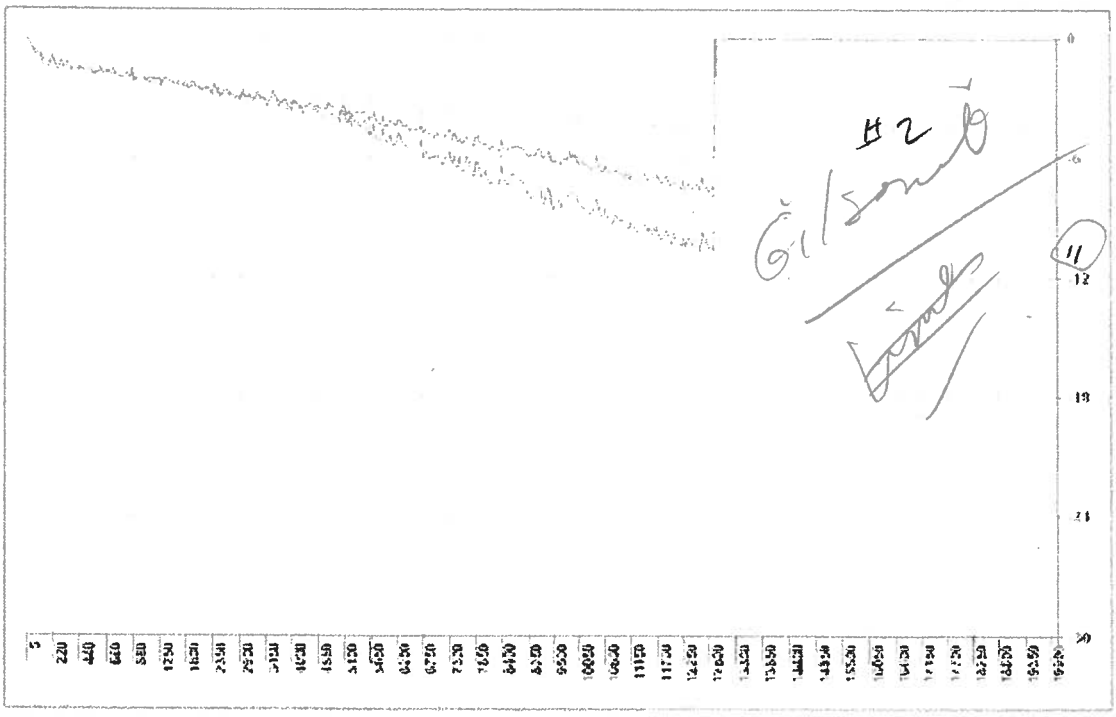
William Larson
Region 3 Lab Manager

UTAH DEPARTMENT OF TRANSPORTATION
Region 3 Lab Orem Utah
R.P. 148.71 10.6' from center line E.B.L.

Project Name:	US-40 NAPLES GILSONITE PROJECT TEST	**Date:**	3/4/2009
Project Number:	8RD0763H	**Date Sampled:**	2/10/2009
Job Number:		**Lab Number:**	2009-R3-A-2
Project Engineer:		**Mix Type:**	3/4" HMA w/gilsonite
Submitted By:	RICHARD SHARP	**Asphalt Grade:**	
		Pit Source:	

	Right	Left	Average
Maximum Impressions:	-5.03 mm Pass #: 19800	-10.83 mm Pass #: 12600	-7.93 mm
Failure Depth: 10.00 mm	PASSED	FAILED	

PMW WheelTracking Test



cc:

William Larson
Region 3 Lab Manager