HANDEX®
Practical Environmental Solutions

June 6, 2001

Mr. Daniel Shine
Sunoco, Inc.
Blue Ball & Post Road
P.O. Box 1135
Marcus Hook, PA 19061

RE: NAPL Recovery Tests and Pumping/Pump Tests Results
Belmont Terminal
2700 Passyunk Avenue
Philadelphia, Pennsylvania

Dear Mr. Shine:

This letter report has been prepared to summarize the results of non-aqueous phase liquid (NAPL) recovery tests and pumping tests conducted on select monitoring wells at the above referenced site. The testing was conducted to determine if the recently installed potential recovery wells will produce recoverable amounts of NAPL and at what sustained rates.

NAPL Recovery Tests

On March 2, 2001, NAPL recovery tests were conducted on monitoring wells MW-22, MW-23, MW-24, MW-26, MW-27, and MW-29. The tests were conducted to determine the approximate daily NAPL recovery rate for the tested wells (see the attached site plan for well locations). The NAPL recovery test methodology is as follows:

- Depth to NAPL and water were measured at static conditions using an oil/water interface probe.
- Using a bailer and rope, as much NAPL as possible was removed from the well without removing water.
- Once the maximum amount of NAPL was removed, the test began (time = 0). Depth to NAPL and depth to water were recorded as a function of time.
- As the recharge slowed, readings were taken less frequently.

The NAPL recovery test data was interpreted using the following procedure:

- Graphs of NAPL thickness versus elapsed time were created (attached).
- Using the graphs, the 80% (of the original thickness) recovery rates were calculated for each well using the EPA document "How to Effectively Recover Free Product At Leaking Underground Storage Tank Sites" (September 1996):
  - At 80% NAPL recovery, the NAPL thickness and corresponding time were determined using the graphs for each well.
  - The NAPL thickness was converted to a volume.
  - An initial NAPL recovery rate was calculated by dividing the volume by the elapsed time at 80% thickness.

The following table summarizes the recovery data for the tested wells:

	MW-22	MW-26	MW-27	MW-29
Maximum NAPL Thickness (feet)	0.64	2.40	1.59	1.54
Thickness of NAPL Removed (feet)	0.46	1.75	1.57	0.44
80% NAPL Recovery (feet)	0.60	2.05	1.28	1.45
Time Corresponding to 80% Recovery (min)	46.00	35.93	4.24	21.45
Gallons per Foot of NAPL Thickness (gal/ft)	2.61	.65	.65	.65
Average Initial Recovery Rate (gal/day)	49.02	53.40	282.57	63.27

NOTE: the 80% NAPL recovery is 80% of the original thickness.

The test data collected from wells MW-23 and MW-24 indicated that as NAPL was removed from the well, the water level within the well rose, which made the data unusable. As such, the data from these wells was not be used to calculate recovery rates.

Pumping Test Results

Pumping tests were conducted on two potential recovery wells, MW-22 and MW-24, on April 18 through May 29, 2001. The tests were conducted to determine if the potential recovery wells could be used effectively for NAPL recovery. See the attached site plan for well locations.

MW-22 Results

MW-22 was tested from April 18 through May 4, 2001. Separate pumps were used for water and NAPL recovery. A Clean Environment Equipment (CEE) bottom loading pneumatic pump was used for water recovery; while a CEE pneumatic bladder pump attached to a specific gravity skimmer was used for NAPL recovery. Recovered ground water was treated via an oil/.water separator before discharging to the refinery storm sewer. The following table summarizes the results of the MW-22 pumping test:

Static NAPL depth (feet)	22.59
Static water depth (feet)	23.10
Static NAPL thickness (feet)	0.51
Average pumping NAPL depth (feet)	31.80
Average pumping water depth (feet)	31.99
Average pumping NAPL thickness (feet)	0.20
Average pumping water level drawdown (feet)	8.59
Total length of test (hours)	386.5
Total volume of water recovered (gallons)	4,337
Average water recovery rate (gallons per minute)	0.19
Total volume of NAPL recovered (gallons)	416.9
Average NAPL recovery rate (gallons per day)	25.89

NOTE: NAPL recovered is via the NAPL recovery pump only.

Nearby wells RW-7, MW-23, MW-24, and MW-26 were monitored periodically during the pumping test to determine if pumping MW-22 influenced the monitored wells. The monitored wells are 72 feet, 82, 115, and 156 feet from MW-22, respectively. Over the course of the pumping test, no influence was observed in the monitored wells. In all cases, the depth to both NAPL and water decreased (NAPL and water levels rose within the well).

MW-24 Results

MW-24 was tested from May 4 through May 7, and again between May 10 and May 14, 2001. The same pumps were used for the MW-24 pumping test as were used for the MW-22 pumping test. Due to the deterioration of the tubing connecting the specific gravity skimmer float to the NAPL recovery pump, the NAPL recovery pump did not work properly for the majority of the MW-24 testing periods. As such, the pumping test was stopped on May 7 through May 10, and again on May 14 due to the accumulation of NAPL in the oil/water separator. Initially, the water and NAPL recovery pumps were configured so that NAPL would not be recovered by the water pump. However, when the NAPL recovery pump failed, the NAPL thickness in the monitoring well increased to a point that the NAPL/water interface was depressed below the water pump intake.

Due to the failure of the NAPL recovery pump, NAPL recovery data is not available for the MW-24 pumping test. The average ground water recovery rate was approximately 1.60 gallons per minute.

Due to the NAPL accumulation in the well while pumping, and NAPL recovery by the water recovery pump, a CEE pneumatic top loading, total fluids pump was tested from May 24 through May 29, 2001. Recovered ground water was treated via an oil/.water separator before discharging to the refinery storm sewer NAPL was removed from the total fluids by the oil/water separator and stored in a 550-gallon holding tank. The following table summarizes the results of the MW-24 total fluids pumping test:

Static NAPL depth (feet)	22.90
Static water depth (feet)	23.43
Static NAPL thickness (feet)	0.53
Average pumping NAPL depth (feet)	29.05
Average pumping water depth (feet)	29.05
Average pumping NAPL thickness (feet)	Film
Average pumping water level drawdown (feet)	5.62
Total length of test (hours)	114
Total volume of water recovered (gallons)	28,518
Average water recovery rate (gallons per minute)	4.21
Total volume of NAPL recovered (gallons)	405
Average NAPL recovery rate (gallons per day)	55.19

NOTE: The NAPL recovery rate is based on data collected after the water level in the well was drawn down to the pump intake.

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Pump Test Results

In conjunction with the pumping test, the ground water recovery and NAPL recovery pumps were being tested for possible use in an additional NAPL recovery system at the Belmont Terminal. The pumps tested were pneumatic pumps manufactured by CEE. The pumps are described below:

- NAPL and Water Extraction Pump System:
  - Ground Water Recovery Pump: The CEE AP-3 BL is a 3-inch diameter bottom loading pump.
  - NAPL Recovery Pump: The CEE GNE-24 is a controllerless, down-well, bladder pump. The GNE-24 is connected to a 2-inch specific gravity skimmer that will track the NAPL/water interface over a 40-inch range.
- Total Fluids Pump:
  - CEE AP-4 top loading, short body pump.

Based on the results of the two pumping tests using the above described pumps, Handex recommends the total fluids pump over the pump system. The total fluids pump recovered more NAPL in less time than the pump system did. However, the difference in NAPL recovery rates may have been a result of the tests being conducted on different wells, and also because the NAPL recovery pump malfunctioned during the MW-24 test. In addition, the total fluids pump was found to be easier to maintain and operate.

If you have any questions on the NAPL recovery tests or pumping tests, please feel free to contact either of the undersigned at (410) 674-3200.

Sincerely,

David M. Leety
Senior Geologic Scientist

Troy A. Carrington
Senior Project Manager

Attachments

cc: Mr. James Oppenheim, Sunoco, Inc. (R&M), Philadelphia, Pennsylvania

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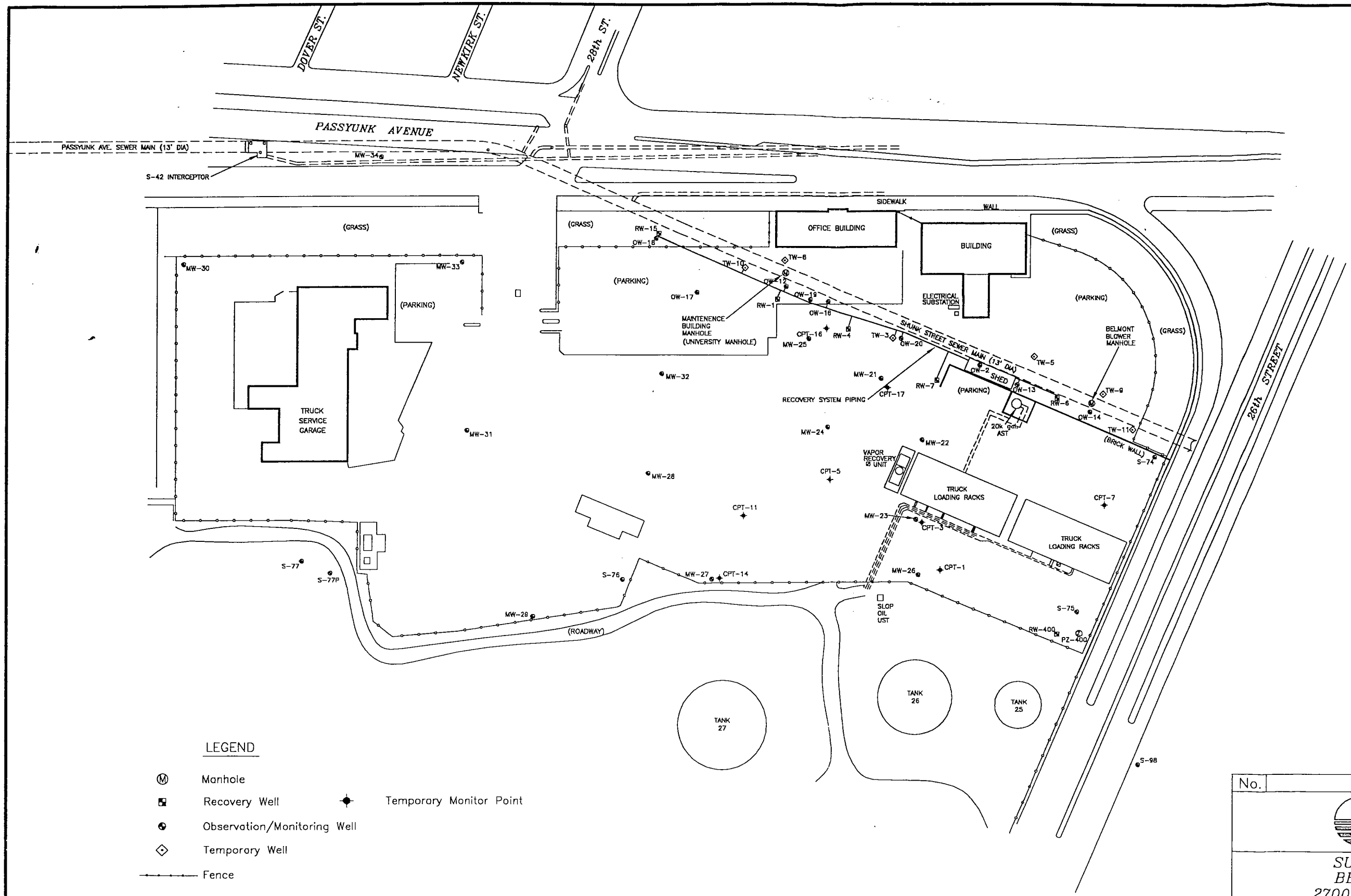


LEGEND

- Manhole
- Recovery Well
- Observation/Monitoring Well
- Temporary Well
- Fence
- Temporary Monitor Point
- Product Lines below grade

The utilities shown on this drawing are approximated and should be verified in the field.

0 60 120

SCALE 1 : 120'

No.	REVISION	DATE

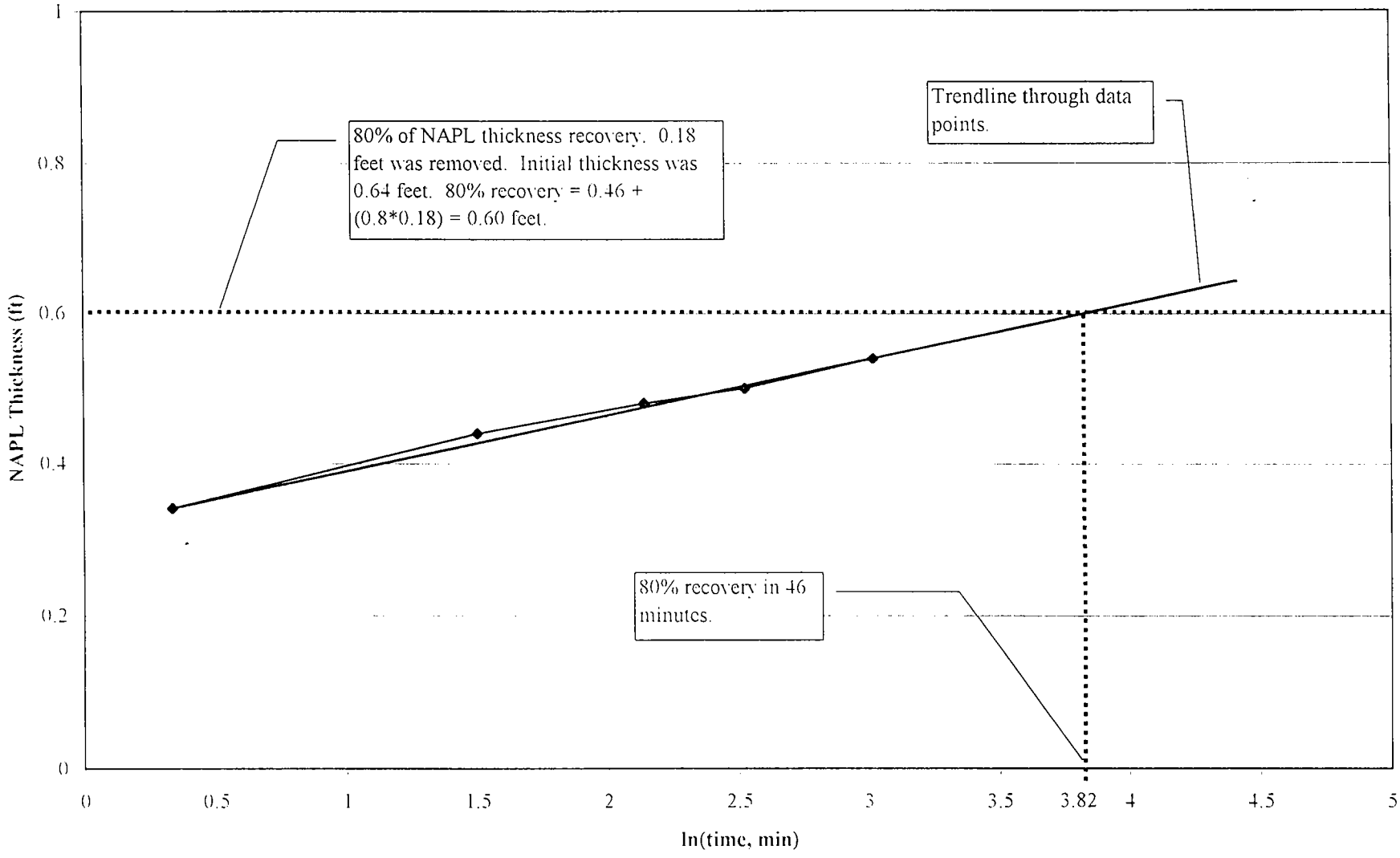
Handex

SUNOCO, INC. (R&M)
BELMONT TERMINAL
2700 PASSYUNK AVENUE
PHILADELPHIA, PENNSYLVANIA

SITE PLAN

SCALE – 1" = 120'	JOB No. – 110535.032
DRAWN: J. Thomson	REV. 1-2-01 J.T.
CHECKED BY –	DWG. NAME –1105351B
DATE – 4-4-00	DWG. No. –

NAPL Recovery Test, MW-22



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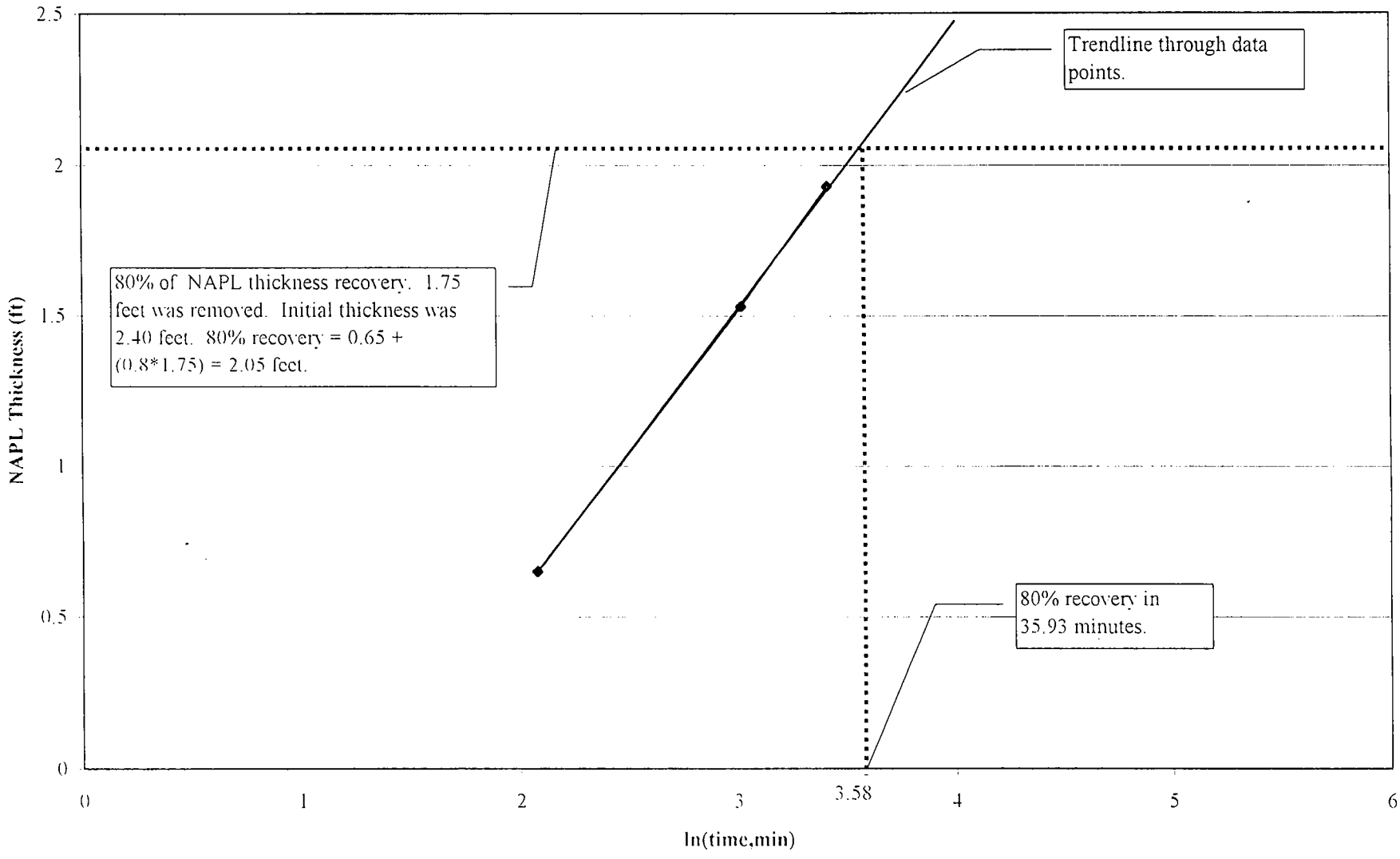
NAPL Recovery Test, MW-26



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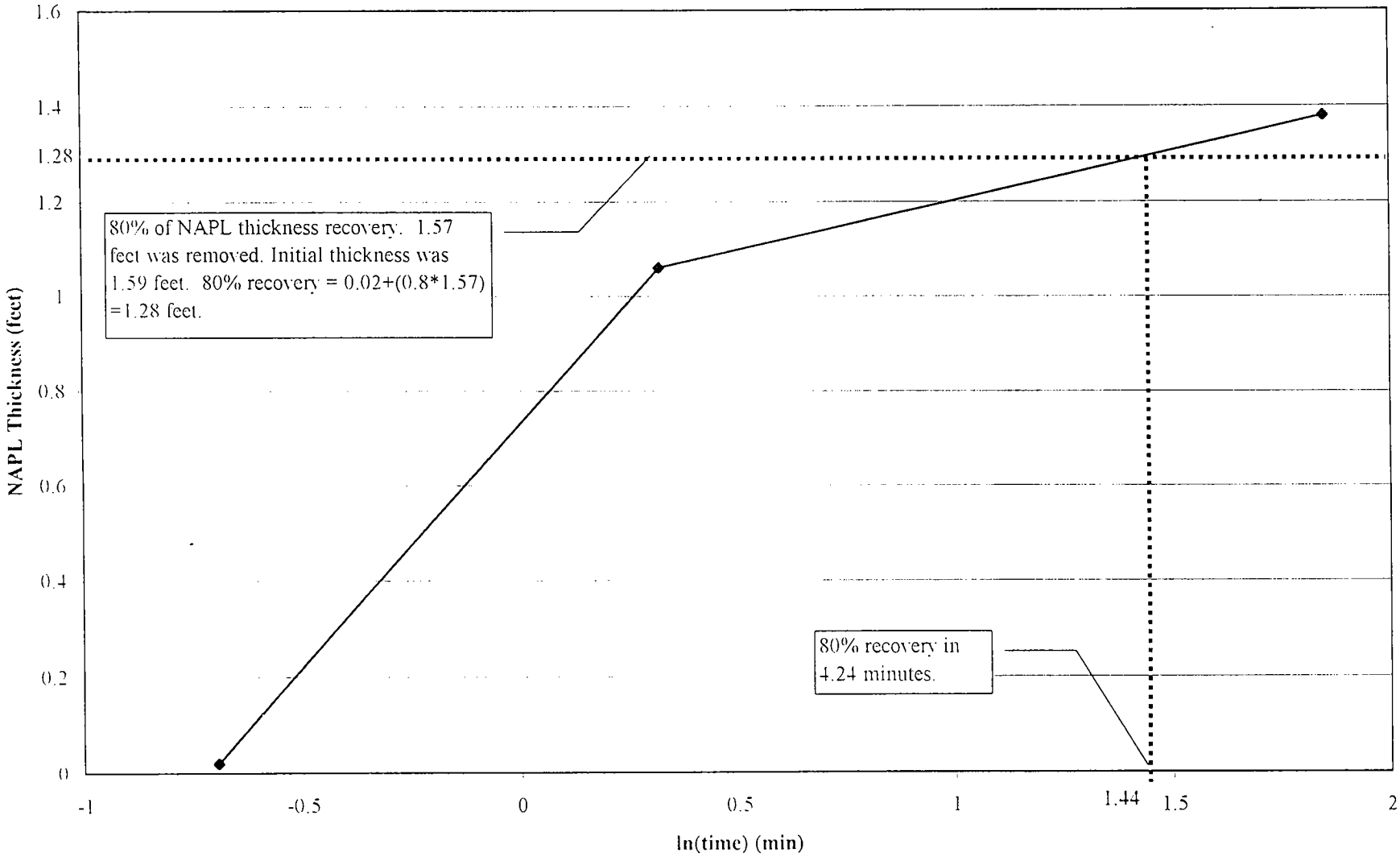
NAPL Recovery Test, MW-27



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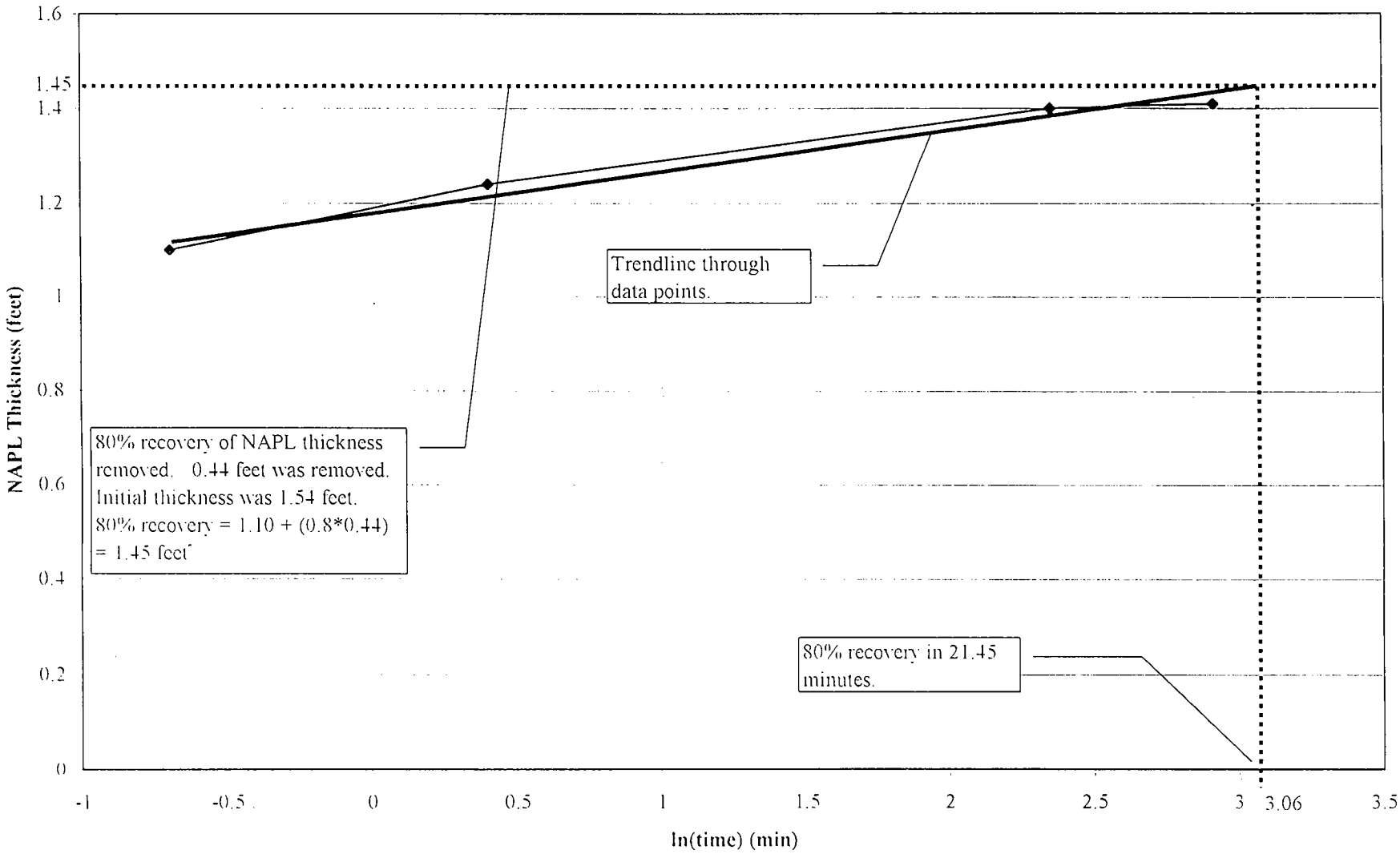
NAPL Recovery Test, MW-29



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