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Beede
3.7

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RACI-EPA-5272

Contract No. 68-W6-0045

July 27, 2004

Mr. James Chow
U.S. Environmental Protection Agency
One Congress Street, Suite 1100, HBO
Boston, Massachusetts 02114-2023

Subject: Oil Recovery and Oil Thickness Evaluation (February 2000 – July 2003)
Beede Waste Oil Site, Non-Time Critical Removal Action
RAC I W.A. No. 105-NARV-011T

Dear Mr. Chow:

This letter presents the results of our evaluation of the progress of the Non-Time-Critical Removal Action (NTCRA) at the Beede Waste Oil Site through July 2003, which you recently requested. This evaluation looked at the thickness of the oil plumes remaining on site and trends in oil and water extraction by the Vacuum Enhanced Extraction (VEE) system and oil recovery trench from system start-up in February 2000 through July 2003.

Oil Thickness Evaluation

Evaluating the progress of the removal action through comparisons of the oil thickness in the VEE system extraction wells is complicated by several factors including potential measurement error for thick oils, varying oil thickness exaggeration in wells, and seasonal variations in the elevation of groundwater. The variation in groundwater elevation appears to be the most significant factor affecting changes in measured oil thickness in individual wells.

Evaluation of site data indicates that in general, the oil thickness in the wells increases as the groundwater elevation drops and decreases as the groundwater elevation rises (see Chart 1). The explanation for this observation is that the capillary zone, on which the product layer rests, recedes more slowly than the saturated zone surface when the groundwater elevation drops, causing a temporary increase in the thickness of the capillary zone. The increased thickness of the capillary zone in the formation exaggerates the thickness of oil in the well because the oil flows into the well, occupying the thickness of the capillary zone in addition to the actual thickness of the mobile product layer.

Because of this relationship between oil thickness and groundwater elevation, when evaluating changes in oil thickness it is necessary to compare time periods that have similar groundwater elevations. Chart 1 was used to select comparable monitoring events to evaluate removal action progress. The following monitoring events were compared: May 2003 vs. May 2001 vs. April-May 2000; and July 2003 vs. March 2002. During each monitoring event, all 143 extraction wells were monitored with an electronic oil/water interface probe to determine the groundwater elevation and oil thickness.

The monitoring data were used to prepare oil thickness contour figures for each of the monitoring periods (see attached figures). Comparison of the figures shows that the thickness of the oil plumes has decreased over time, but the areal extent of the plumes may not have changed

significantly. The decrease in plume thickness is clearly illustrated by the decrease in the size of areas with oil thickness greater than 1 and 2 feet in the later monitoring periods. The change in overall plume area is more difficult to assess because several wells show no measurable oil during some periods and then have a measurable thickness in some subsequent periods. The contours have been drawn to show these wells and the surrounding areas as having no oil when no measurable oil was observed; however, the presence of oil in these areas during subsequent periods indicates that the plume may actually be continuous, but very thin (a sheen too thin to measure) in these areas.

These conclusions are supported by the following tabulation of well counts. For each set of monitoring periods compared, the number of wells in nearly every oil thickness bracket has decreased over time, illustrating an overall decrease in oil thickness. In May and July 2003, the number of wells with oil less than 0.5 feet thick has increased and now constitutes the majority of wells. The slight increase in the number of wells with oil present (greater than 0 ft) indicates that the overall areal extent of the plumes may not have changed significantly.

Oil Thickness	**Number of Wells With Stated Oil Thickness**				
	Apr-May-00	May-01	May-03	Mar-02	Jul-03
5 ft to 6 ft	1	0	0	0	0
4 ft to 5 ft	1	0	0	2	0
3 ft to 4 ft	3	2	1	5	0
2 ft to 3 ft	6	2	1	12	1
1.5 ft to 2 ft	5	3	4	8	7
1 ft to 1.5 ft	9	6	2	13	8
0.5 ft to 1 ft	24	17	14	17	22
>0 ft to 0.5 ft	44	75	72	43	67
Total > 0 ft	93	105	94	100	105

Oil and Water Extraction Evaluation

The evaluation of extraction rates considered the volume of oil and water extracted by the NTCRA and the ratio of water to oil extracted. Through July 2003, approximately 75,000 gallons of oil and 250,000 gallons of water have been extracted and separated by the VEE system and recovery trench and transported off site for treatment/disposal. The overall ratio of water to oil extracted is approximately 3.4 to 1. Several charts are presented and described below to illustrate trends in extraction.

Chart 2 shows the cumulative oil and water extracted by the system from February 2000 through July 2003. It appears that the rate of oil recovery is slowing while the rate of water recovery is similar to or slightly greater than previous rates

Chart 3 shows the average daily volumes of oil and water extracted each month. The average volumes have fluctuated from month to month. Water extraction rates don't exhibit a clear trend. Other than seasonal variations, no trend was evident in oil extraction rates through 2002. However, beginning in January 2003, the average daily oil extraction rates appear to have decreased. In the 35 months of operation through December 2002, average oil extraction volumes of less than 90 gallons per day occurred only twice (82 and 86 gallons/day). However, in the seven months evaluated in 2003, the average oil extraction rates ranged from 42 to 66 gallons per day.

Chart 4 shows the average water to oil extraction ratios versus the average daily volumes of oil extracted each month. This figure shows a clear increase in the water/oil ratios in the last 5 months of the evaluation period as the oil volumes decreased.

It appears that the rate of oil recovery slowed in the latter months of the evaluation period (January to July 2003), while the rate of water extraction has remained similar to earlier periods or increased, thereby increasing the ratio of water to oil extracted. This is likely caused by the decrease in oil thickness in the plume. As the oil thickness in the plume and extraction wells decreases it becomes more difficult to extract the oil from the water surface without extracting more water. System operation during this time period has required more frequent well/drop-tube adjustments to optimize system operation, extracting as much oil and as little water as possible. The drop in oil extraction rates and rise in water/oil ratios has occurred despite more intensive monitoring and adjustment.

Overall, the system is still operating well and extracting a considerable volume of oil – an average of 40 to 70 gallons per day during the last seven months of the evaluation period . Despite the increase in the daily water/oil ratios during this period, the overall ratio (approximately 3.4 to 1) remains lower than the average ratio of 6 to 1 projected during design.

If you have any questions about this evaluation or system operation, please contact me.

Very truly yours,

Diane M. Baxter

Diane M. Baxter
Project Manager

PMO -

DB:rp

Attachments

c: H. Horahan (EPA) w/o attach.
A. Ostrofsky (TtNUS) w/attach.
File N4103-1.0 w/attach.

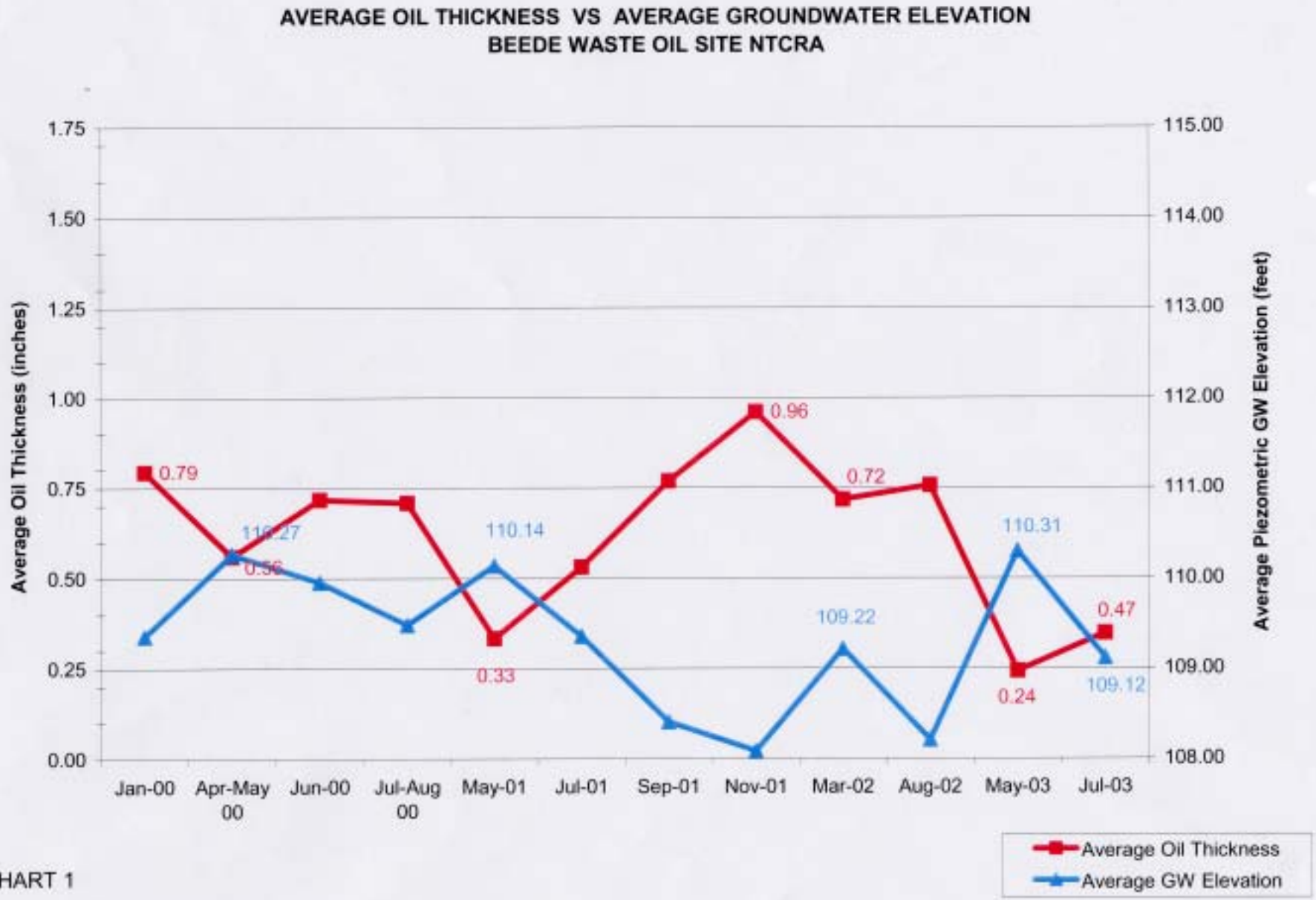

AVERAGE OIL THICKNESS VS AVERAGE GROUNDWATER ELEVATION
BEEDE WASTE OIL SITE NTCRA
Average Oil Thickness (inches)
Average Piezometric GW Elevation (feet)
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
115.00
114.00
113.00
112.00
111.00
110.00
109.00
108.00
0.79
0.56
0.33
0.96
0.72
0.24
0.47
110.27
110.14
109.22
110.31
109.12
Jan-00
Apr-May 00
Jun-00
Jul-Aug 00
May-01
Jul-01
Sep-01
Nov-01
Mar-02
Aug-02
May-03
Jul-03
Average Oil Thickness
Average GW Elevation

CHART 1

CUMULATIVE OIL AND WATER EXTRACTED THROUGH JULY 2003
BEEDE WASTE OIL SITE NTCRA

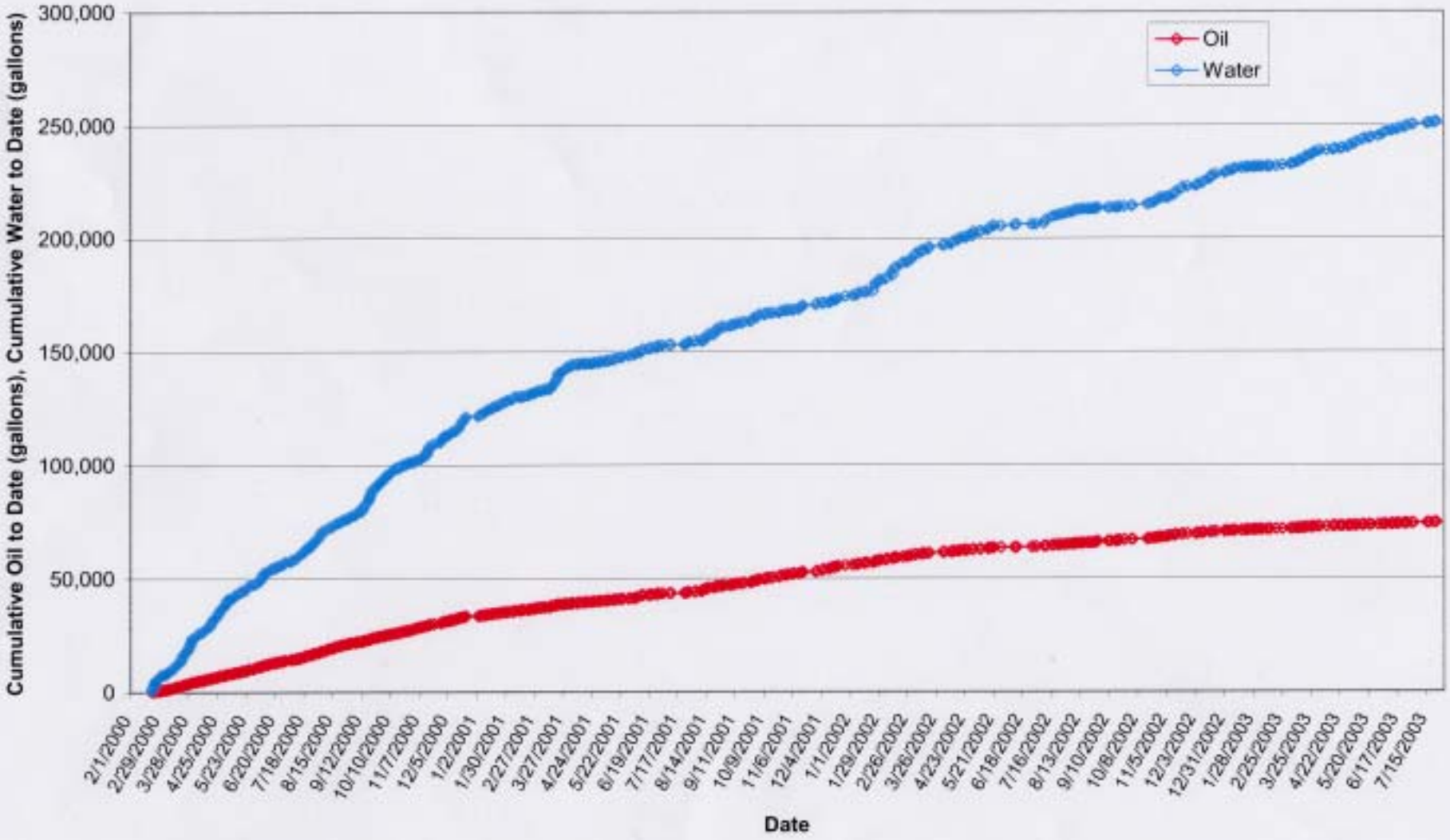
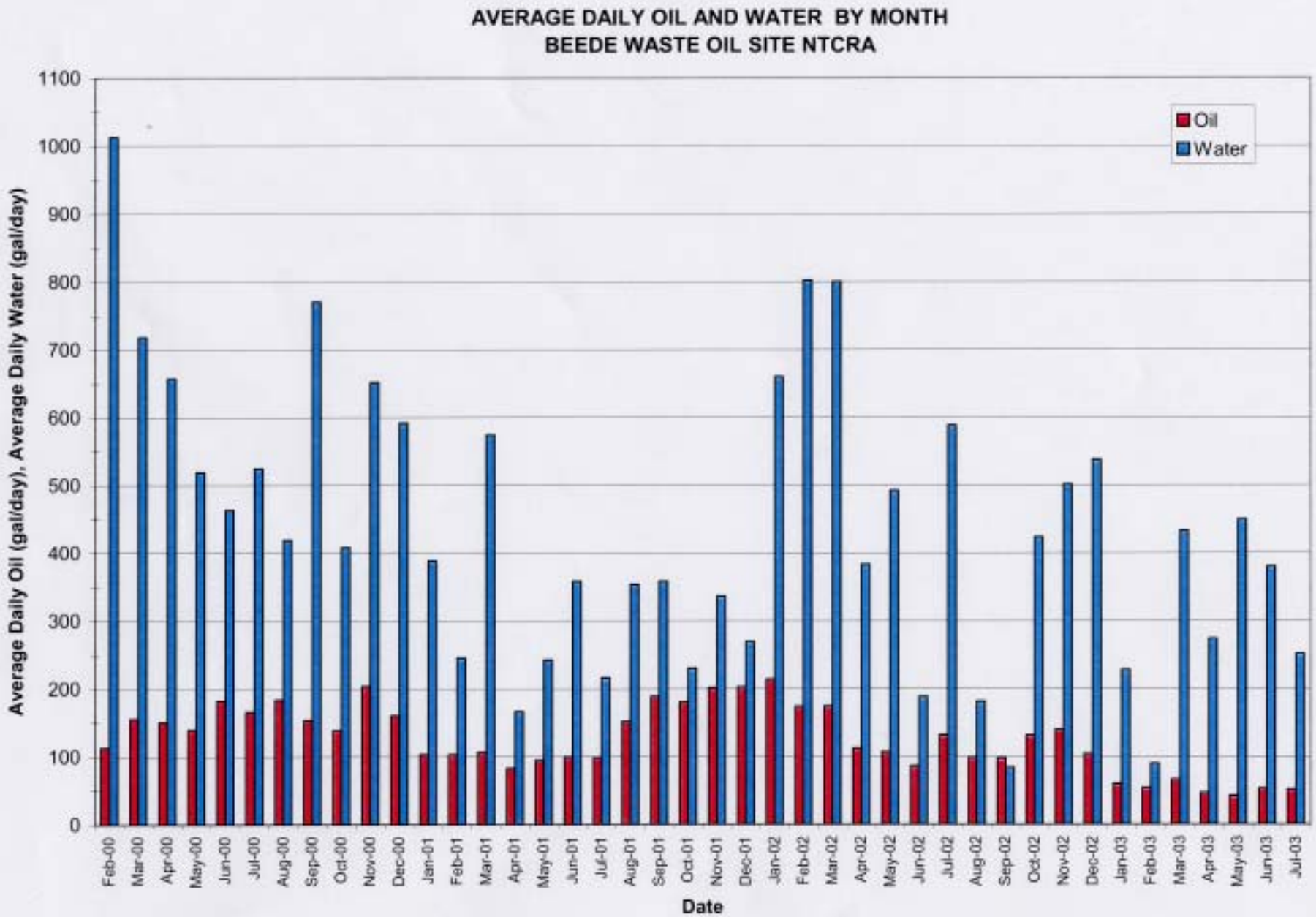


CHART 2


AVERAGE DAILY OIL AND WATER BY MONTH
BEEDE WASTE OIL SITE NTCRA
Oil
Water
Average Daily Oil (gal/day), Average Daily Water (gal/day)
0
100
200
300
400
500
600
700
800
900
1000
1100
Feb-00
Mar-00
Apr-00
May-00
Jun-00
Jul-00
Aug-00
Sep-00
Oct-00
Nov-00
Dec-00
Jan-01
Feb-01
Mar-01
Apr-01
May-01
Jun-01
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Jul-02
Aug-02
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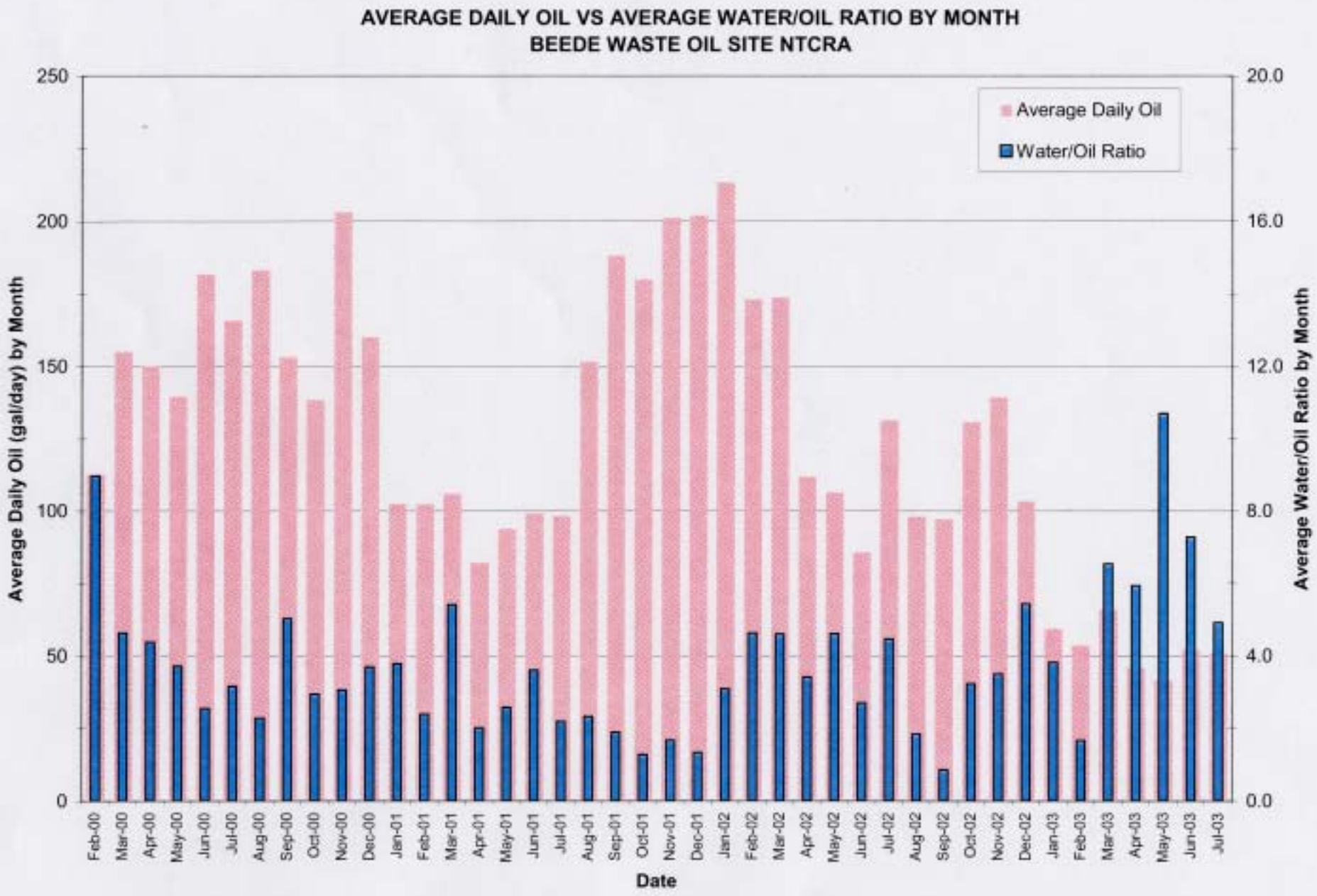
Dec-02
Jan-03
Feb-03
Mar-03
Apr-03
May-03
Jun-03
Jul-03
Date

CHART 3


AVERAGE DAILY OIL VS AVERAGE WATER/OIL RATIO BY MONTH
BEEDE WASTE OIL SITE NTCRA
Average Daily Oil
Water/Oil Ratio
Average Daily Oil (gal/day) by Month
Average Water/Oil Ratio by Month
Date
250
200
150
100
50
0
20.0
16.0
12.0
8.0
4.0
0.0
Feb-00
Mar-00
Apr-00
May-00
Jun-00
Jul-00
Aug-00
Sep-00
Oct-00
Nov-00
Dec-00
Jan-01
Feb-01
Mar-01
Apr-01
May-01
Jun-01
Jul-01
Aug-01
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Jun-02
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Aug-02
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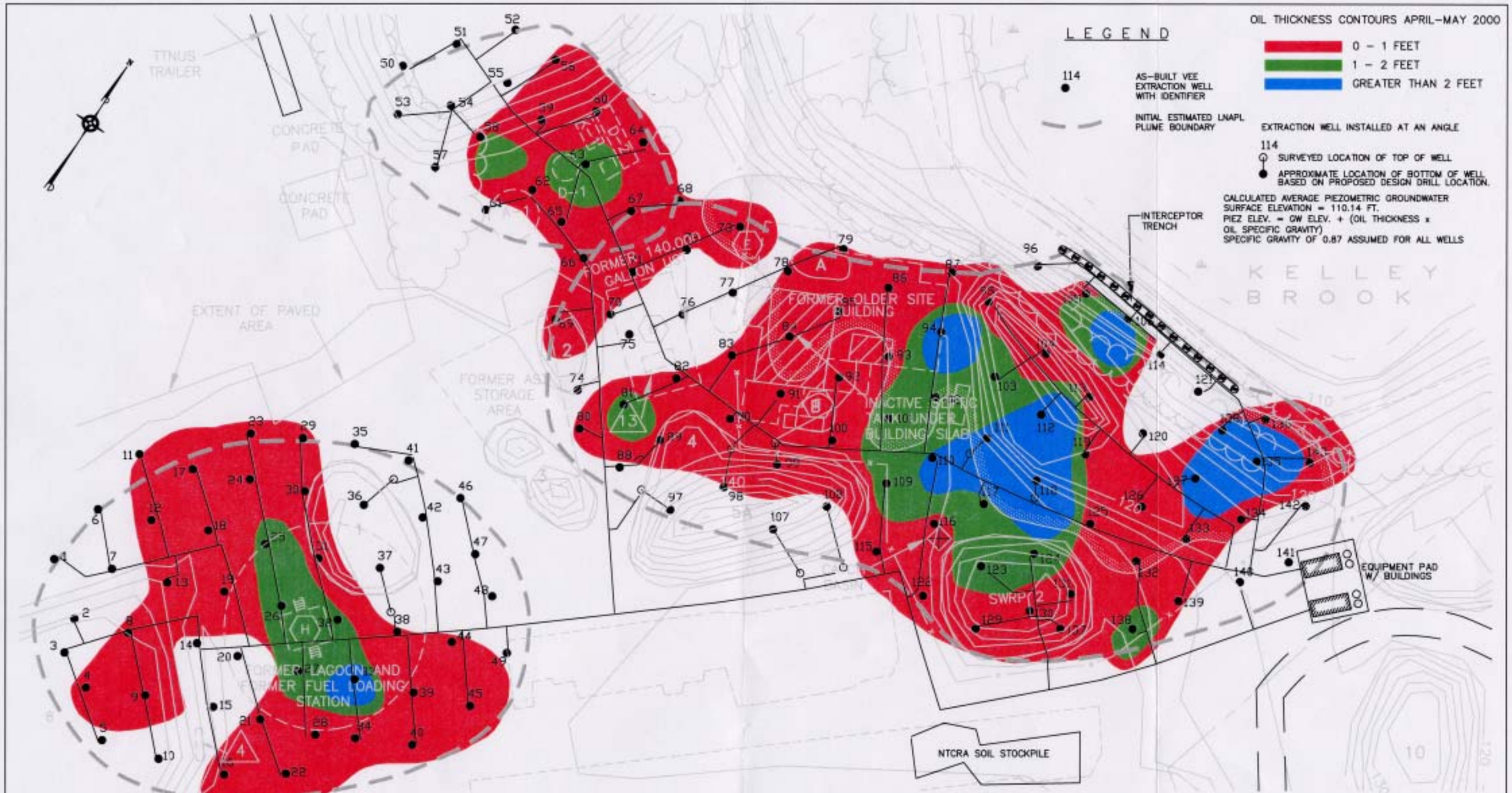
Jan-03
Feb-03
Mar-03
Apr-03
May-03
Jun-03
Jul-03

CHART 4



NOTES:

1. ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
2. PLAN NOT TO BE USED FOR DESIGN.

GRAPHIC SCALE

0' 50' 100'

OIL THICKNESS CONTOUR – APRIL–MAY 2000			
NON–TIME CRITICAL REMOVAL ACTION			
BEEDE WASTE OIL SITE – PLAISTOW, NEW HAMPSHIRE			
DRAWN BY:	D.W. MACDOUGALL	REV.:	0
CHECKED BY:	D. BAXTER	DATE:	JULY 27, 2004
SCALE:	AS SHOWN	FILE NO.:	DWG\4103\1020\0500.DWG

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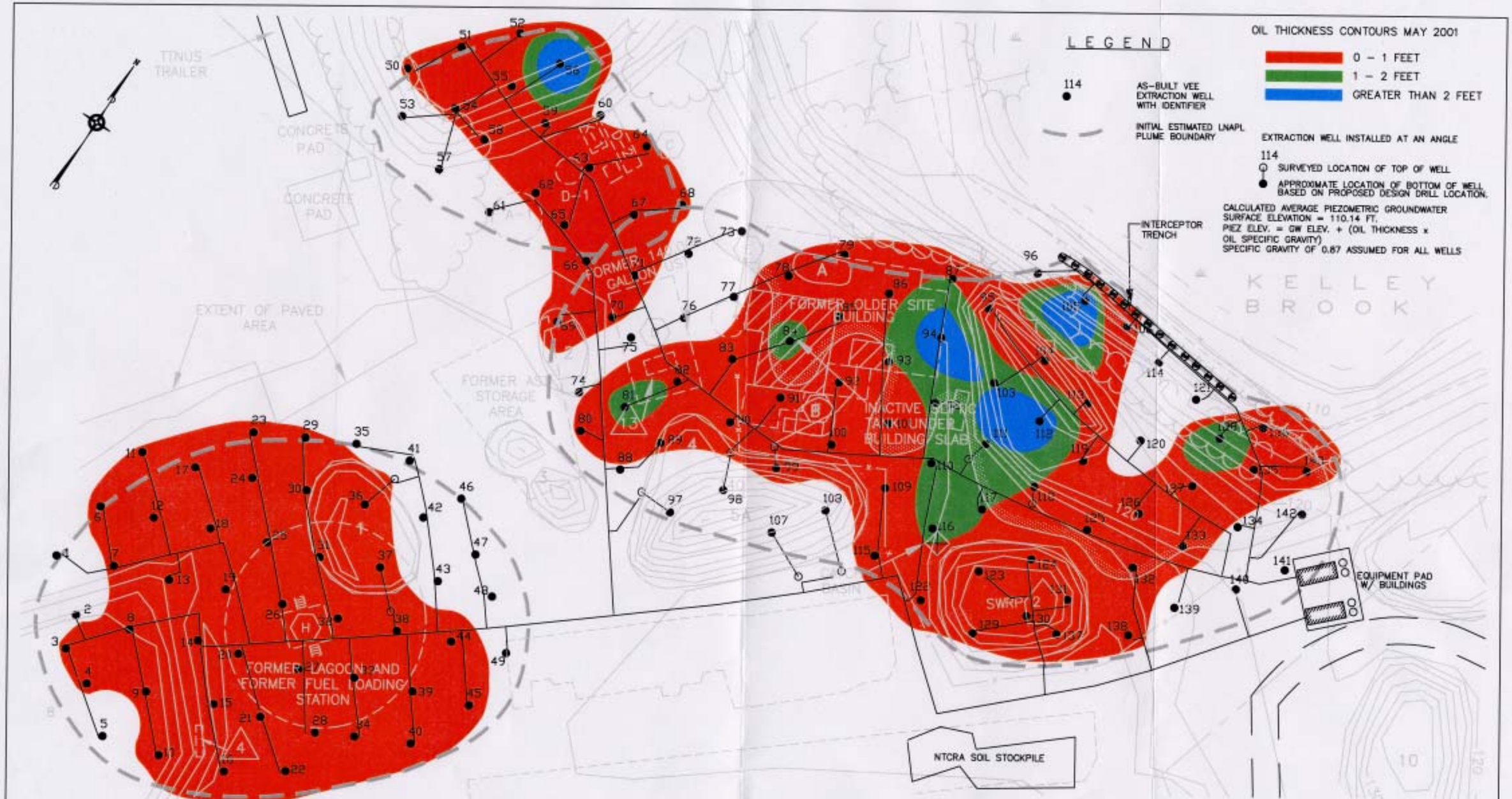

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OIL THICKNESS CONTOUR – MAY 2001			
NON–TIME CRITICAL REMOVAL ACTION			
BEEDE WASTE OIL SITE – PLAISTOW, NEW HAMPSHIRE			
DRAWN BY:	D.W. MACDOUGALL	REV.:	0
CHECKED BY:	D. BAXTER	DATE:	JULY 27, 2004
SCALE:	AS SHOWN	FILE NO.:	DWG\4103\1020\0501.DWG

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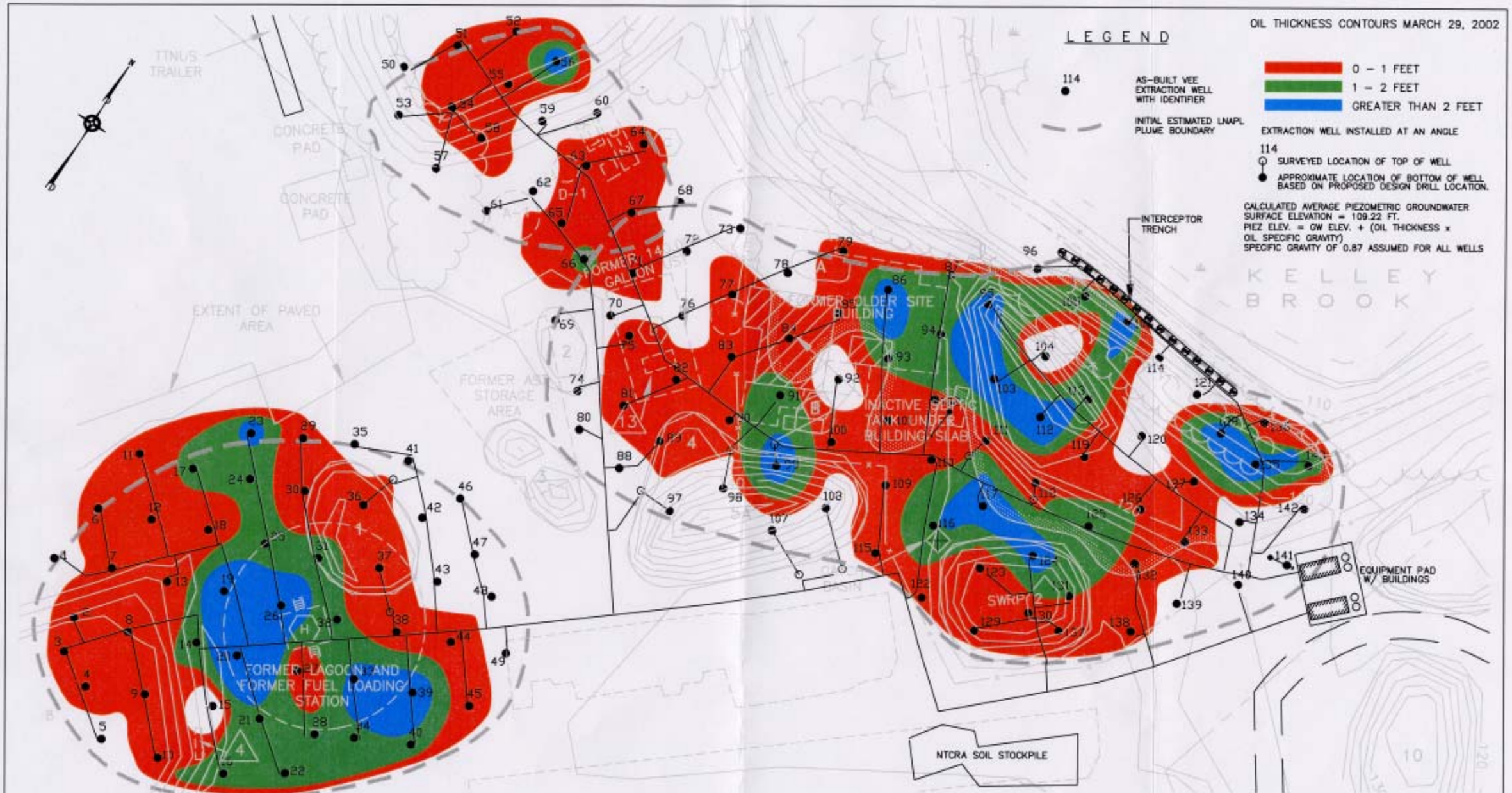

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GRAPHIC SCALE

0' 50' 100'

OIL THICKNESS CONTOUR – MARCH 2002			
NON–TIME CRITICAL REMOVAL ACTION			
BEEDE WASTE OIL SITE – PLAISTOW, NEW HAMPSHIRE			
DRAWN BY:	D.W. MACDOUGALL	REV.:	0
CHECKED BY:	D. BAXTER	DATE:	JULY 27, 2004
SCALE:	AS SHOWN	FILE NO.:	DWG\4103\1020\0302.DWG

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OIL THICKNESS CONTOURS MAY 1, 2003

LEGEND

114 AS-BUILT VEE EXTRACTION WELL WITH IDENTIFIER

INITIAL ESTIMATED LNAPL PLUME BOUNDARY

0 – 1 FEET

1 – 2 FEET

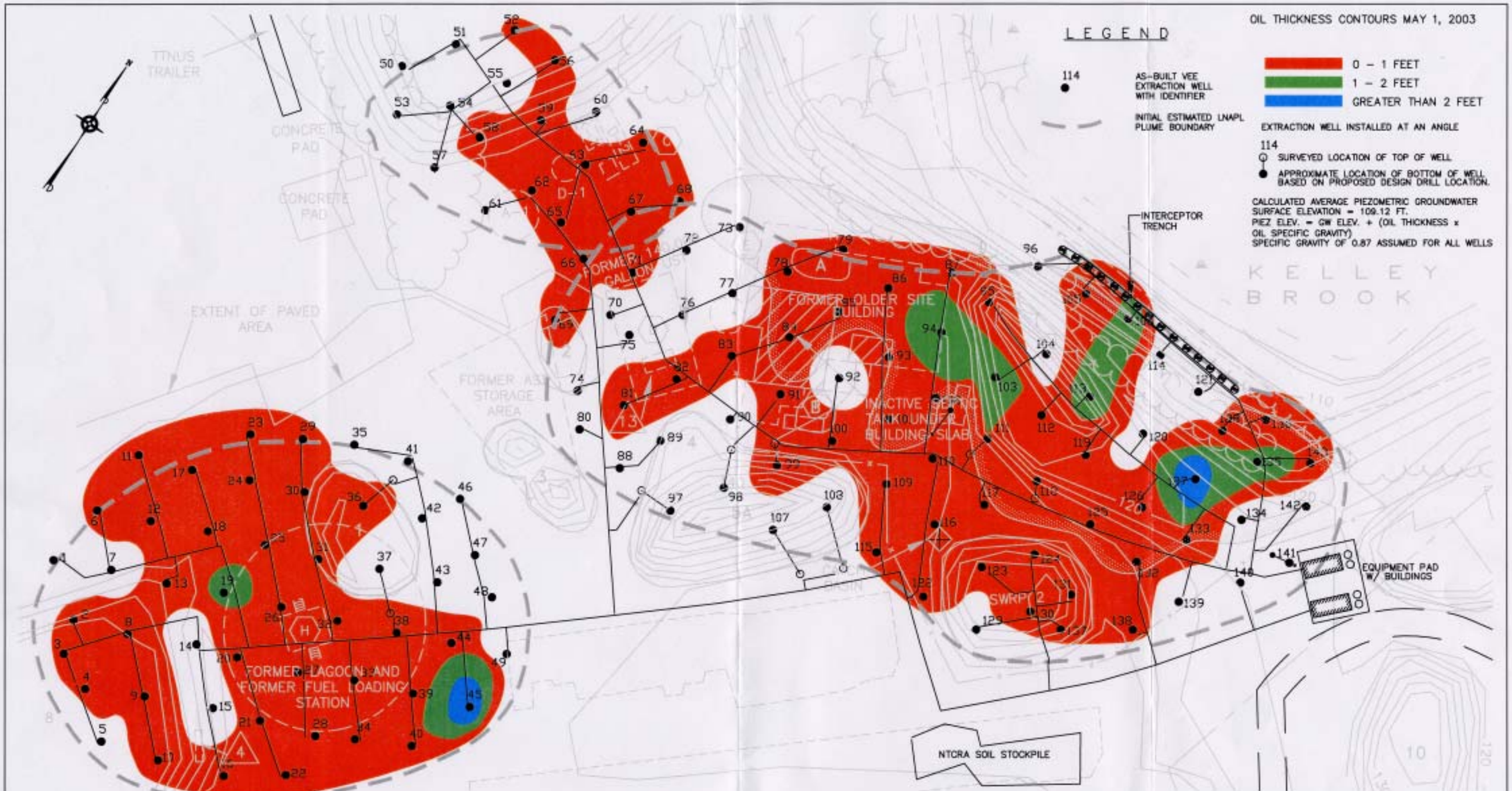
GREATER THAN 2 FEET

EXTRACTION WELL INSTALLED AT AN ANGLE

114 SURVEYED LOCATION OF TOP OF WELL

APPROXIMATE LOCATION OF BOTTOM OF WELL BASED ON PROPOSED DESIGN DRILL LOCATION.

CALCULATED AVERAGE PIEZOMETRIC GROUNDWATER SURFACE ELEVATION = 109.12 FT.
PIEZ ELEV. = GW ELEV. + (OIL THICKNESS x OIL SPECIFIC GRAVITY)
SPECIFIC GRAVITY OF 0.87 ASSUMED FOR ALL WELLS



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GRAPHIC SCALE

0' 50' 100'

OIL THICKNESS CONTOUR – MAY 2003			
NON–TIME CRITICAL REMOVAL ACTION			
BEEDE WASTE OIL SITE – PLAISTOW, NEW HAMPSHIRE			
DRAWN BY:	D.W. MACDOUGALL	REV.:	0
CHECKED BY:	D. BAXTER	DATE:	JULY 27, 2004
SCALE:	AS SHOWN	FILE NO.:	DWG\4103\1020\0503.DWG

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OIL THICKNESS CONTOURS JULY 29, 2003

LEGEND

114 AS-BUILT VEE EXTRACTION WELL WITH IDENTIFIER

INITIAL ESTIMATED LNAPL PLUME BOUNDARY

0 – 1 FEET

1 – 2 FEET

GREATER THAN 2 FEET

EXTRACTION WELL INSTALLED AT AN ANGLE

114

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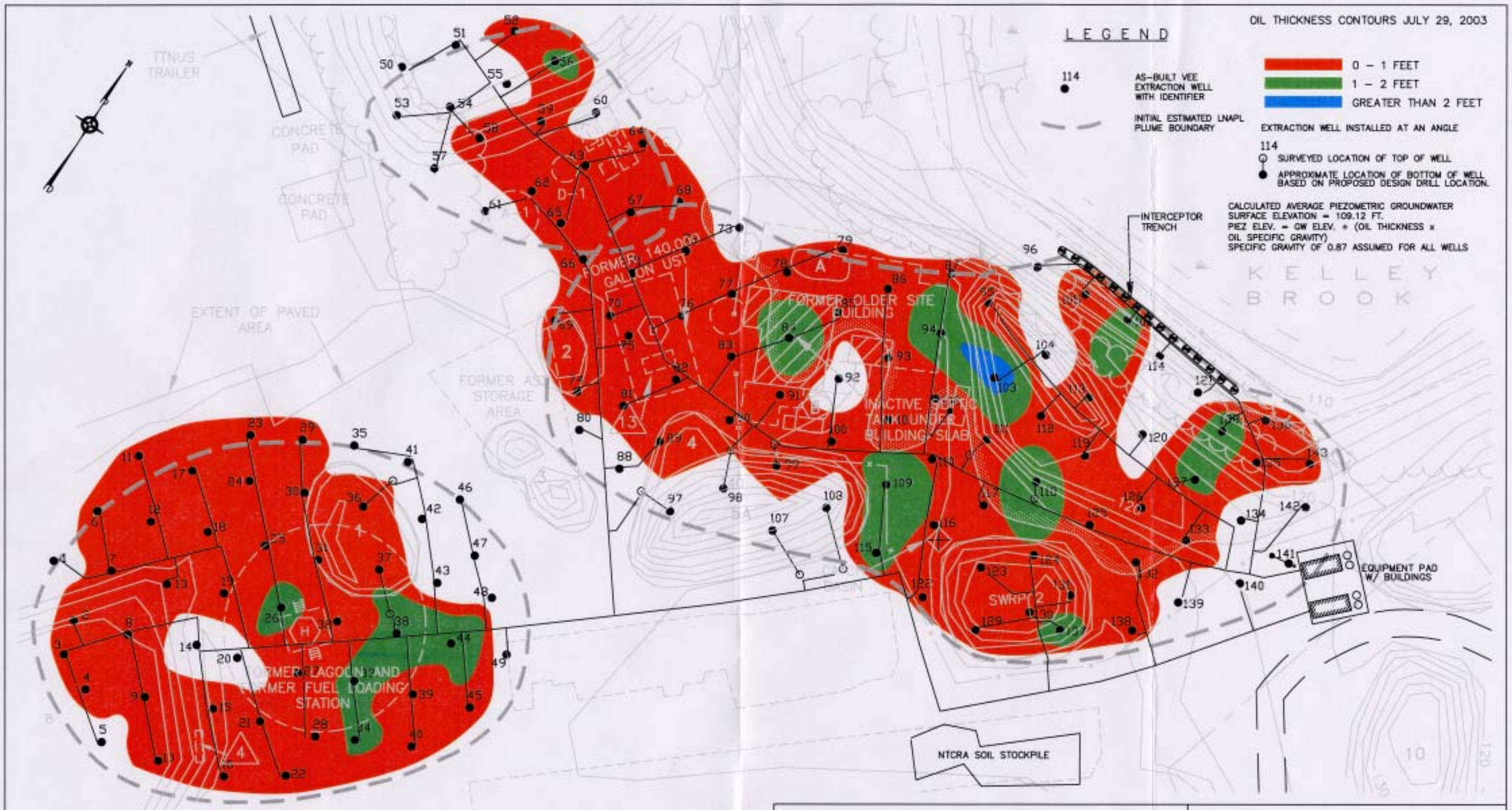

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OIL THICKNESS CONTOUR – JULY 2003			
NON–TIME CRITICAL REMOVAL ACTION			
BEEDE WASTE OIL SITE – PLAISTOW, NEW HAMPSHIRE			
DRAWN BY:	D.W. MACDOUGALL	REV.:	0
CHECKED BY:	D. BAXTER	DATE:	JULY 27, 2004
SCALE:	AS SHOWN	FILE NO.:	DWG\4103\1020\0703.DWG

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