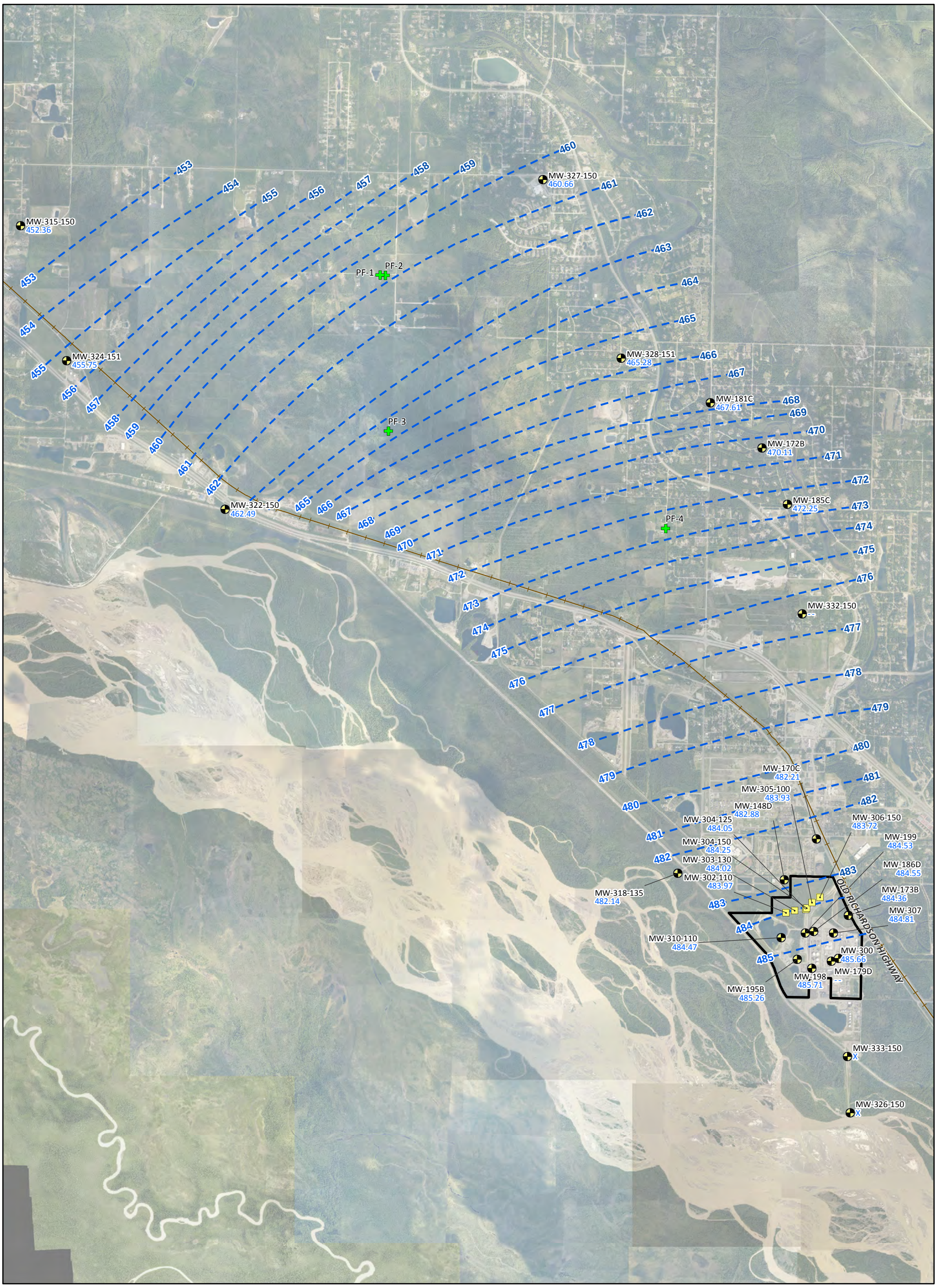
CITY: SF DIV/GROUP: ENV/IM DB: BGRIFFITH LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: W:\ArcGisData\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2013_Q1\MXD\Fig 4-6 GW_Contours-90-160ft.mxd 5/16/2013 11:46:25 AM



Legend

- Monitoring Well
- Vertical Profile Transect Well
- Permafrost Boring
- 480 Groundwater Elevation Contours in Feet Above Mean Sea Level (Dashed where Inferred)
- FHRA Property Boundary
- -- Well Frozen or Obstructed
- X Not gauged due to weather

0 3,000 6,000
SCALE IN FEET

Notes:
Results for groundwater elevation are in feet
The most shallow VPT wells at 90-160 feet below the water table were used for groundwater elevation contouring
Image provided courtesy of Pictometry International 2012

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FIRST QUARTER 2013
GROUNDWATER MONITORING REPORT

GROUNDWATER CONTOUR MAP-
ON AND OFF-SITE WELLS AT 90-160 FEET
BELOW WATER TABLE

ARCADIS

FIGURE
4-6

CITY: HIGHLANDS RANCH, CO DIV/GROUP: ENV/IM DB: BGRIFFITH LD: G FRANCE
PATH: W:\ARCGISDATA\GISPROJECTS_ENV\FHR_AK\NORTHPOLEREFINERY\GW_MONITORING\2013_Q1\MXD\FIG 4-7 LNAPL_THICKNESS.MXD DATE: 4/30/2013 TIME: 2:28:58 PM

Legend

- Monitoring Well
- Observation Well
- Recovery Well
- FHRA Property Boundary
- -- No LNAPL observed
- 1.39 LNAPL Thickness (feet)
- NM Not Measured
- Sheen An interface probe was used. No measurable LNAPL was present, but LNAPL sheen was observed visually.

0 250 500
SCALE IN FEET

Notes:

LNAPL results posted on figure are in feet.
The maximum LNAPL thickness was used from monthly measurements collected during the reporting period.
Image provided courtesy of Pictometry International 2012

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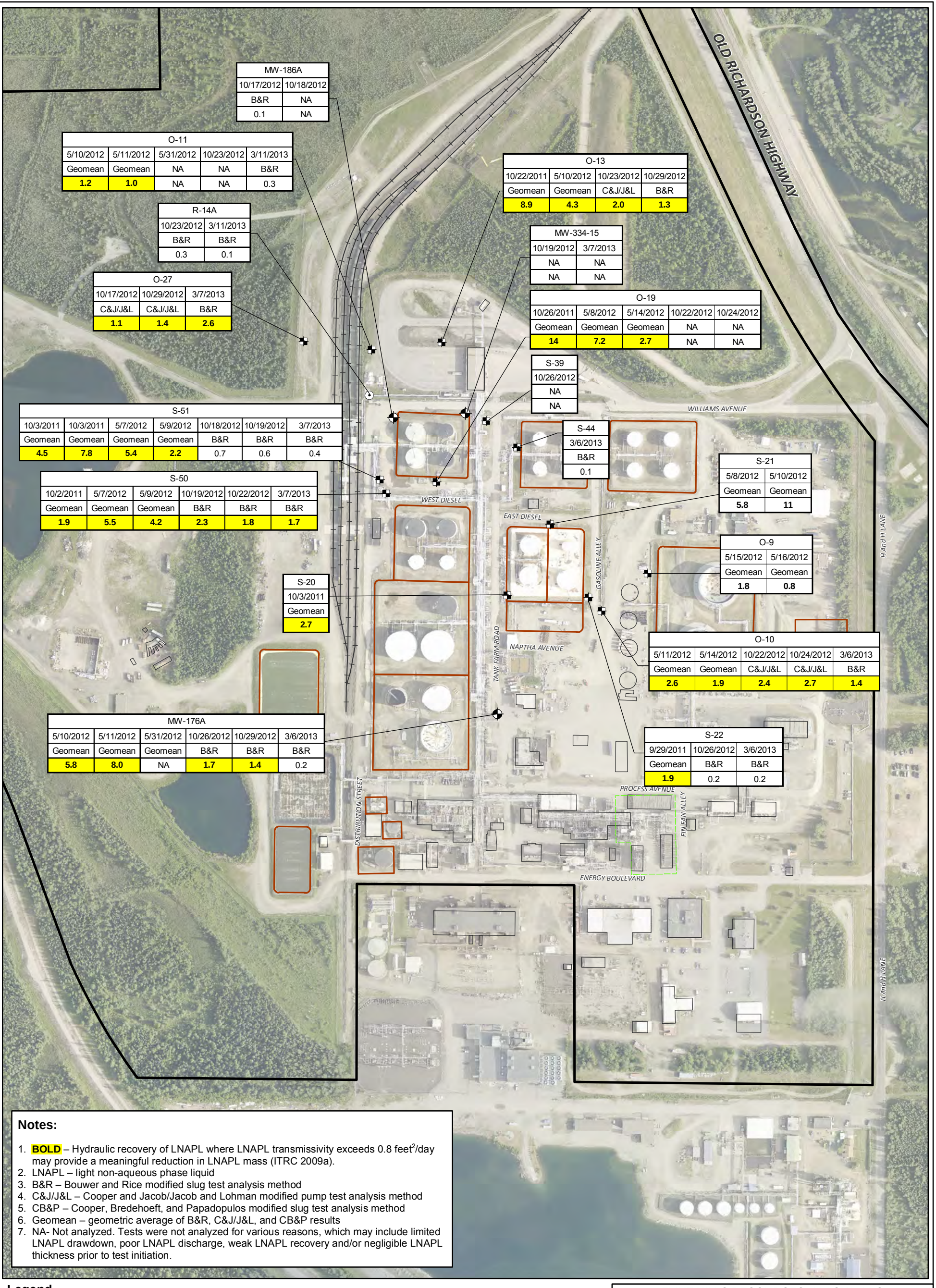
GROUNDWATER MONITORING REPORT

LNAPL MONITORING DATA

ARCADIS

FIGURE
4-7

CITY: SF DIV/GROUP: ENV/IM DB: BGRIFFITH LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: W:\ArcGisData\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2013_Q1\MXD\Fig 4-8 Transmissivity_2011-13.mxd 5/15/2013 2:56:49 PM



Notes:

1. **BOLD** – Hydraulic recovery of LNAPL where LNAPL transmissivity exceeds 0.8 feet^2/day may provide a meaningful reduction in LNAPL mass (ITRC 2009a).
2. LNAPL – light non-aqueous phase liquid
3. B&R – Bouwer and Rice modified slug test analysis method
4. C&J/J&L – Cooper and Jacob/Jacob and Lohman modified pump test analysis method
5. CB&P – Cooper, Bredehoeft, and Papadopulos modified slug test analysis method
6. Geomean – geometric average of B&R, C&J/J&L, and CB&P results
7. NA- Not analyzed. Tests were not analyzed for various reasons, which may include limited LNAPL drawdown, poor LNAPL discharge, weak LNAPL recovery and/or negligible LNAPL thickness prior to test initiation.

Legend

- Monitoring Well
- Observation Well
- Recovery Well
- Bermed Containment Areas (CA)
- Approximate Areas
- FHRA Property Boundary

Well ID
Date
Analysis Method
LNAPL Transmissivity, (feet^2/day)

0 300 600
SCALE IN FEET

Notes:
Image provided courtesy of Pictometry International 2012

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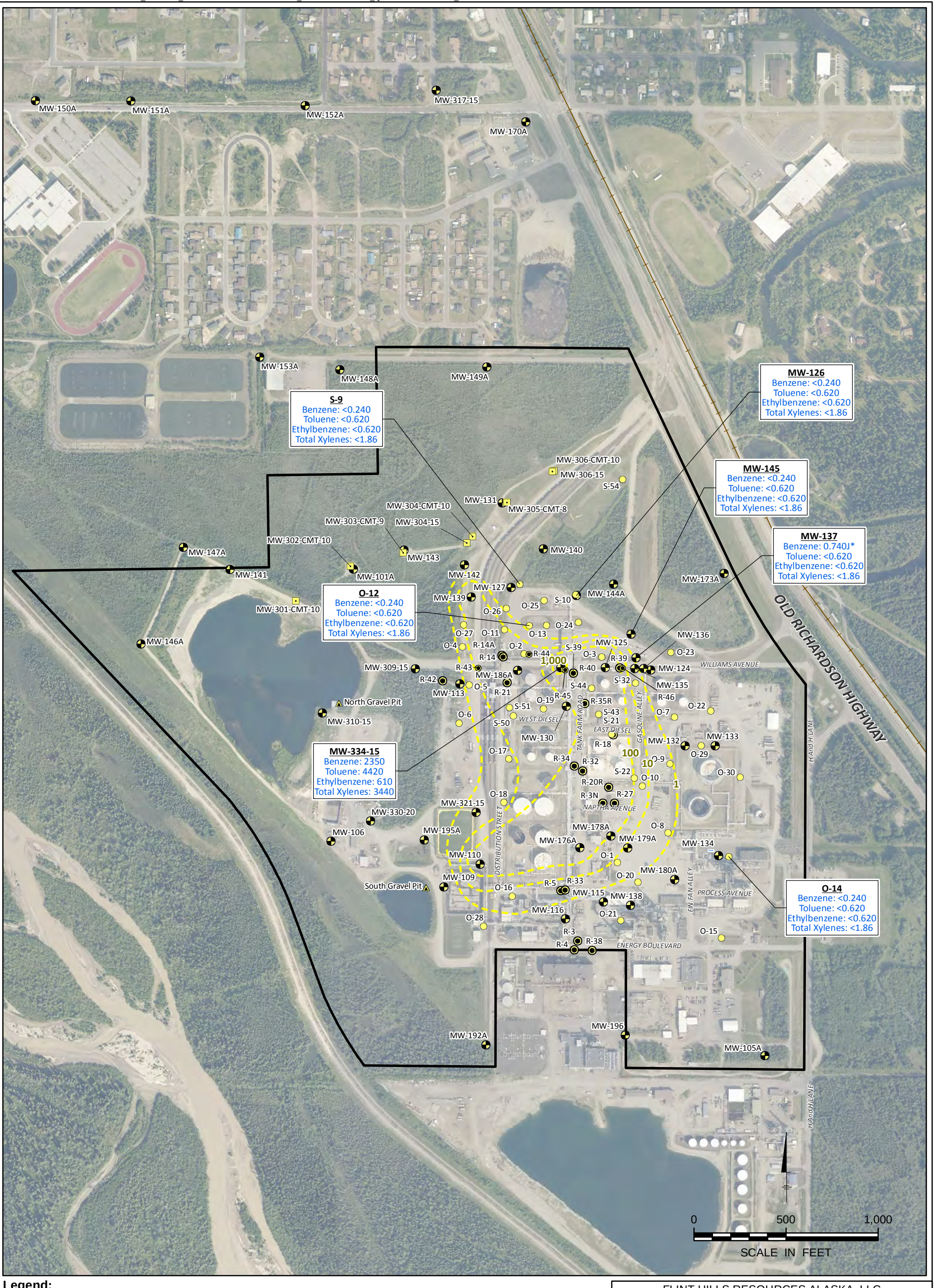
FIRST QUARTER 2013
GROUNDWATER MONITORING REPORT

2011 - 2013
LNAPL TRANSMISSIVITY

ARCADIS

FIGURE
4-8

CITY: HIGHLANDS RANCH, CO DIV/GROUP: ENV/IM DB: BGRIFFITH LD: G FRANCE
PATH: W:\ARCGISDATA\GISPROJECTS_ENV\FHR_AK\NORTHPOLEREFINERY\GW_MONITORING\2013_Q1\MXD\FIG 4-9 BTEX_RESULTS-WATERTABLE.MXD DATE: 5/17/2013 TIME: 9:01:49 AM



Legend:

BTEX Results

- Monitoring Well
- Observation Well
- Recovery Well
- Vertical Profile Transect Well
- Surface Water
- Benzene Isopleth in µg/L (Dashed where inferred)
- FHRA Property Boundary

Notes:

Results are displayed in µg/L
BTEX Benzene, toluene, ethylbenzene and total xylenes
< Not detected; detection limit listed
- - Not sampled due to well being frozen or obstructed
J* Result is considered estimated (no direction of bias) due to QC failures (flagged by SWI)
Benzene isopleth retained from the Fourth Quarter 2013 Groundwater Monitoring Report. Isopleth changes were made, as necessary, with BTEX data from the reporting period

Image provided courtesy of Pictometry International 2012

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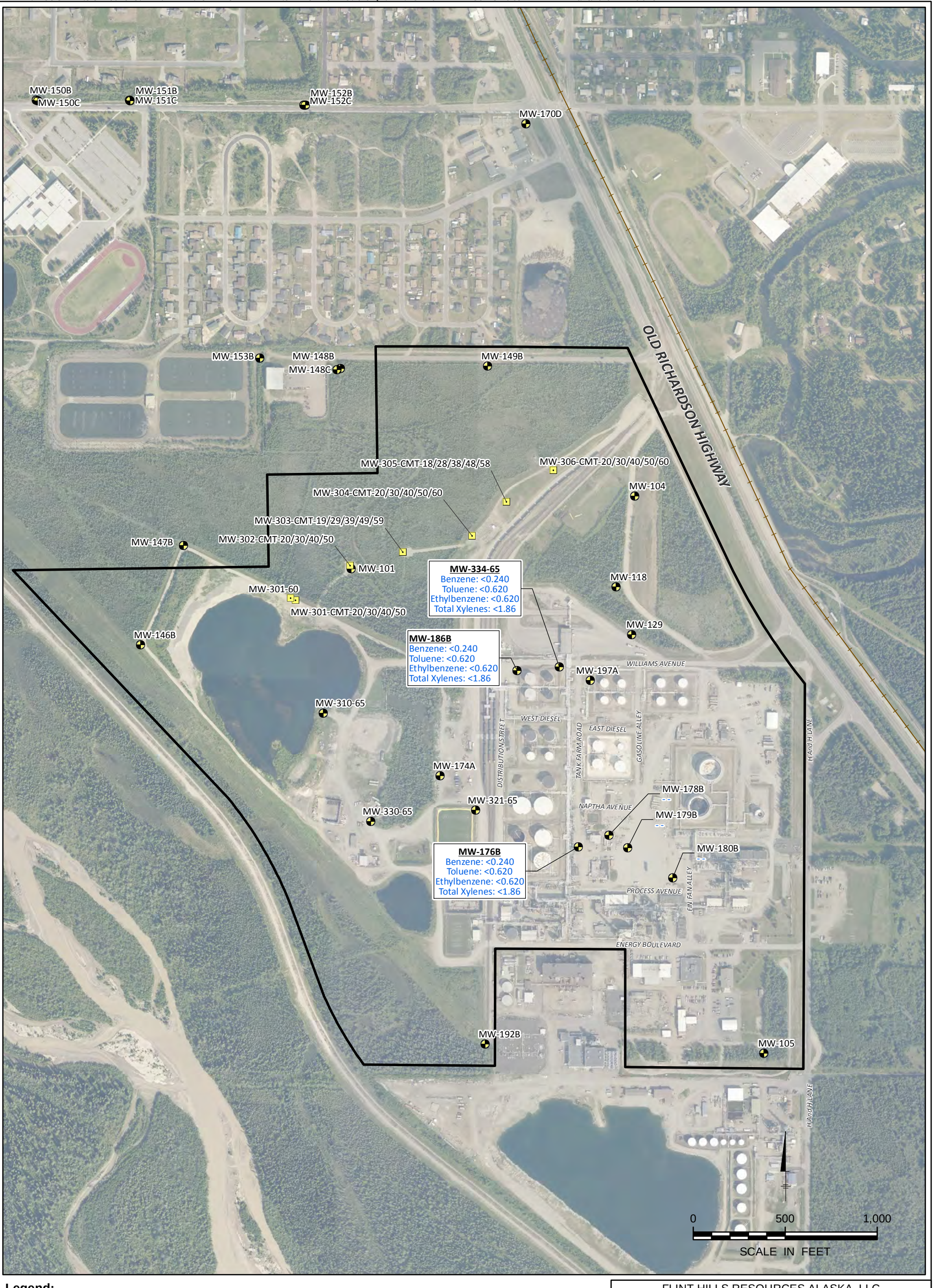
FIRST QUARTER 2013
GROUNDWATER MONITORING REPORT

ANALYTICAL RESULTS FOR BTEX AT WATER TABLE

ARCADIS

FIGURE
4-9

CITY: HIGHLANDS RANCH, CO DIV/GROUP: ENV/IM DB: BGRIFFITH LD: G FRANCE
PATH: W:\ARCGISDATA\GISPROJECTS\ ENV\FHR AK\NORTHPOLEREFINERY\GW MONITORING\2013 Q1\MXD\FIG 4-10 BTEX RESULTS 10-55FT.MXD DATE: 5/15/2013 TIME: 5:04:37 PM



Legend:

BTEX Results

- Monitoring Well
- Vertical Profile Transect Well
- Benzene Isopleth in µg/L (Dashed where inferred)
- FHRA Property Boundary

Notes:

Results are displayed in µg/L
BTEX Benzene, toluene, ethylbenzene and total xylenes
< Not detected; detection limit listed
- - Not sampled due to well being frozen or obstructed

Image provided courtesy of Pictometry International 2012

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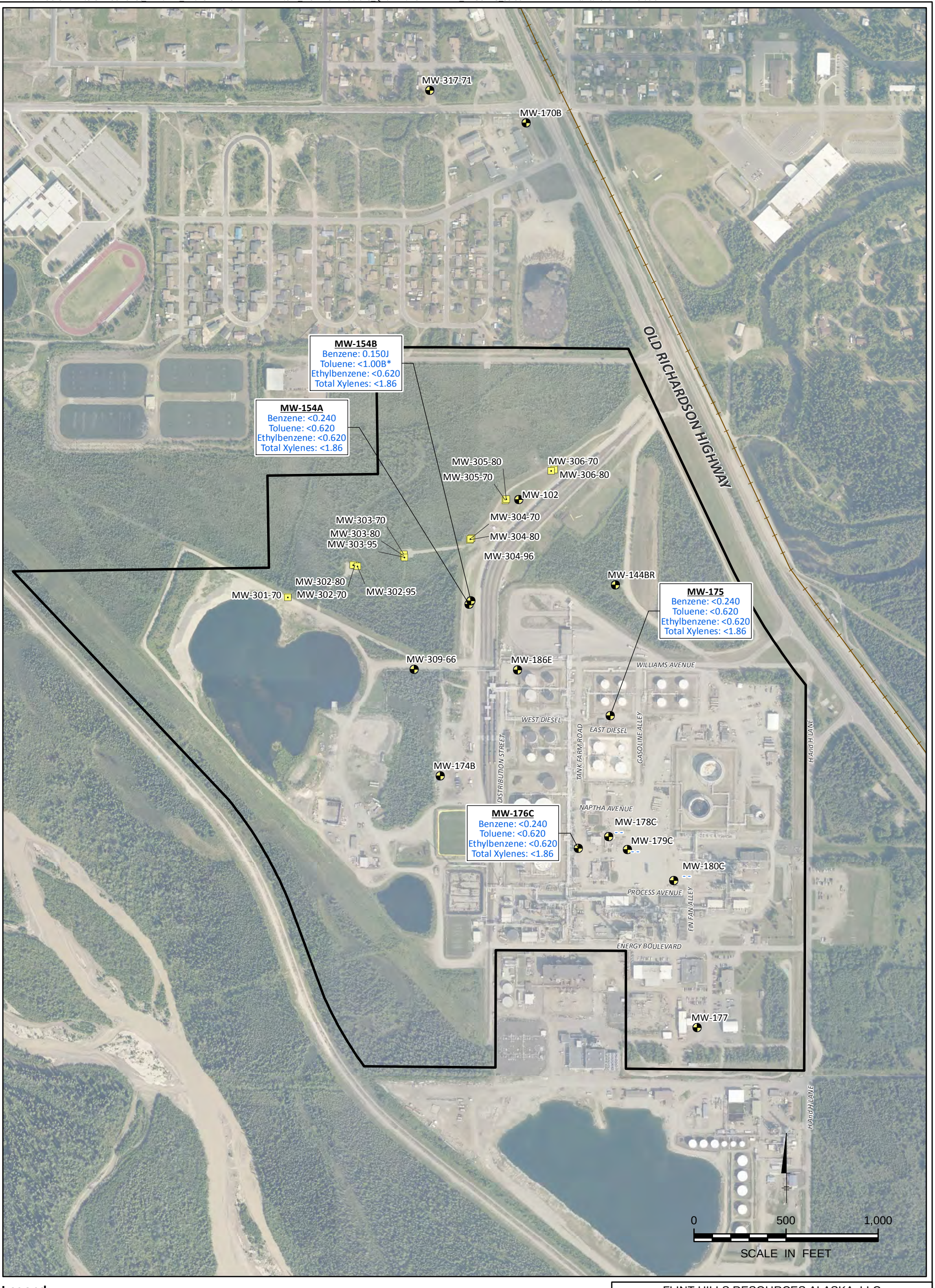
FIRST QUARTER 2013
GROUNDWATER MONITORING REPORT

ANALYTICAL RESULTS FOR BTEX
10 - 55 FEET BELOW WATER TABLE

ARCADIS

FIGURE
4-10

CITY: HIGHLANDS RANCH, CO DIV/GROUP: ENV/IM DB: BGRIFFITH LD: G FRANCE
PATH: W:\ARCGISDATA\GISPROJECTS_ENV\FHR_AK\NORTHPOLEREFINERY\GW_MONITORING\2013_Q1\MXD\FIG 4-11 BTEX_RESULTS_55-90FT.MXD DATE: 5/15/2013 TIME: 5:06:52 PM



Legend:

BTEX Results

- Monitoring Well
- Vertical Profile Transect Well
- Benzene Isopleth in µg/L (Dashed where inferred)
- FHRA Property Boundary

Notes:

Results are displayed in µg/L

BTEX	Benzene, toluene, ethylbenzene and total xylenes
<	Not detected; detection limit listed
- -	Not sampled due to well being frozen or obstructed
B*	Result is considered not detected due to contamination identified in the trip blank
J	Estimated concentration, detected above the detection limit (DL) and below the limit of quantitation (LOQ)

Image provided courtesy of Pictometry International 2012

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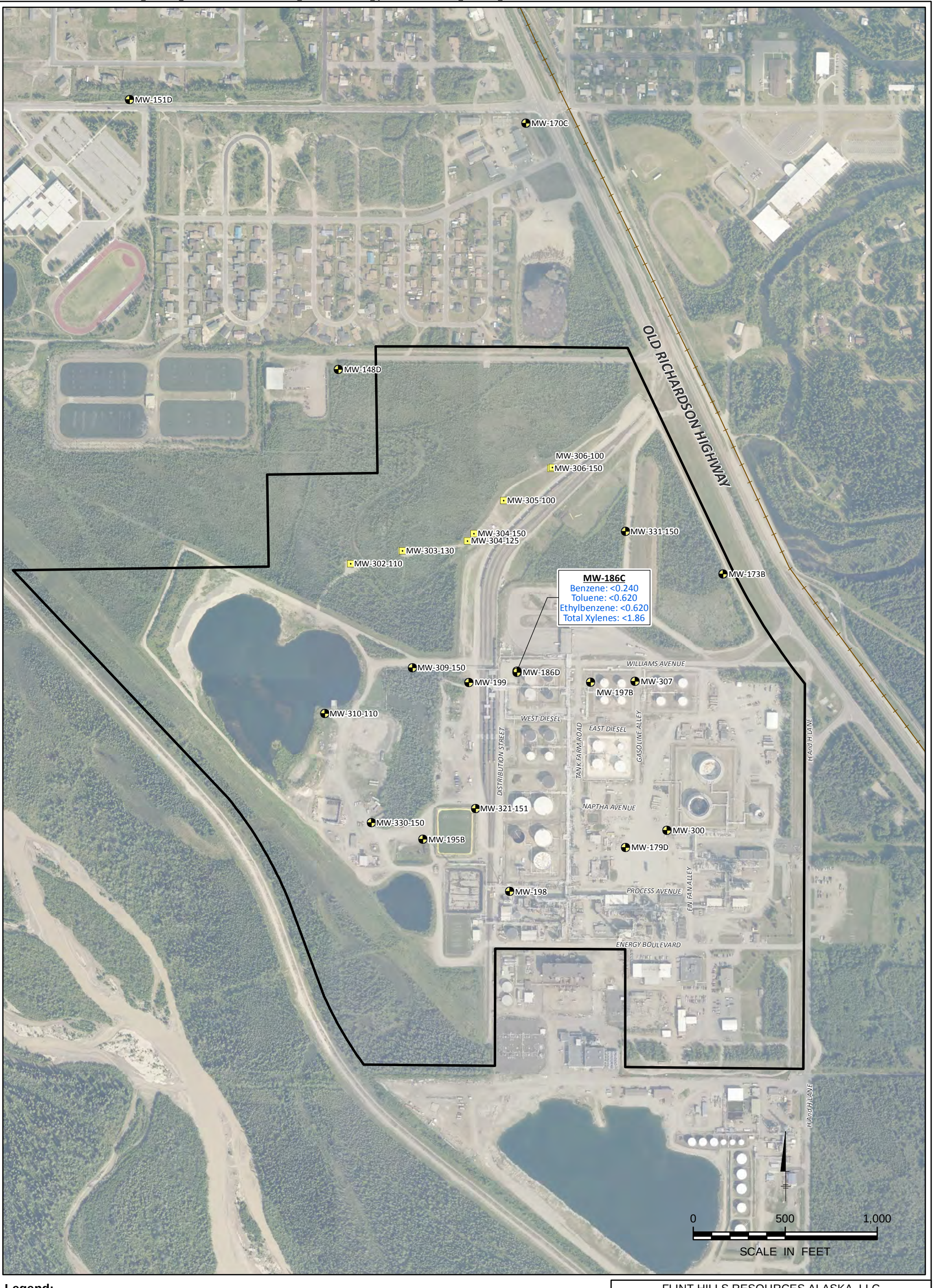
FIRST QUARTER 2013
GROUNDWATER MONITORING REPORT

ANALYTICAL RESULTS FOR BTEX
55 - 90 FEET BELOW WATER TABLE

ARCADIS

FIGURE
4-11

CITY: HIGHLANDS RANCH, CO DIV/GROUP: ENV/IM DB: BGRIFFITH LD: G FRANCE
PATH: W:\ARCGISDATA\GISPROJECTS_ENV\FHR_AK\NORTHPOLEREFINERY\GW_MONITORING\2013_Q1\MXD\FIG 4-12 BTEX_RESULTS_90-160FT.MXD DATE: 5/15/2013 TIME: 5:08:14 PM



Legend:

BTEX Results

- Monitoring Well
- Vertical Profile Transect Well
- Benzene Isopleth in µg/L (Dashed where inferred)
- FHRA Property Boundary

Notes:

Results are displayed in µg/L
BTEX Benzene, toluene, ethylbenzene and total xylenes
< Not detected; detection limit listed

Image provided courtesy of Pictometry International 2012

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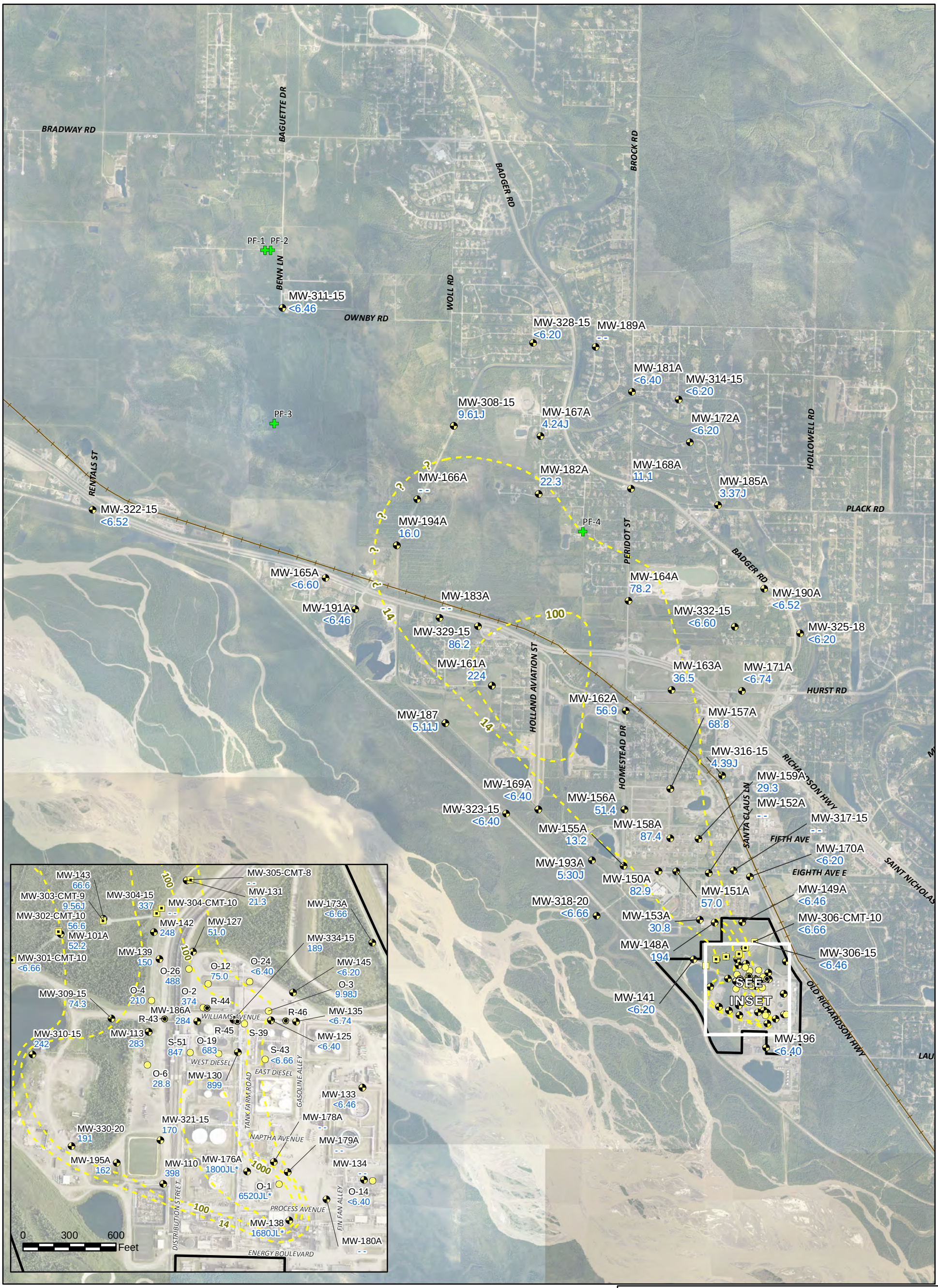
FIRST QUARTER 2013
GROUNDWATER MONITORING REPORT

ANALYTICAL RESULTS FOR BTEX
90 - 160 FEET BELOW WATER TABLE

ARCADIS

FIGURE
4-12

CITY: SF DIV/GROUP: ENV/IM DB: BGRIFFITH LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: W:\ArcGisData\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2013_Q1\MXD\Fig 4-13 Sulfolane_WaterTable.mxd 5/15/2013 5:19:56 PM



Legend

- Monitoring Well
- Vertical Profile Transect Well
- Observation Well
- Recovery Well
- Permafrost Boring
- Approximate Sulfolane Isopleth in µg/L
- FHRA Property Boundary

22.5 Sulfolane Concentration (µg/L)
J Estimated concentration, detected above the detection limit (DL) and below the limit of quantitation (LOQ)
JL* Result is considered estimated, biased low, due to QC failures (flag applied by SWI)
< Not detected; detection limit listed
-- Well frozen or obstructed

Notes:
Samples with duplicate data are represented by the greater of the two results.
Sulfolane was analyzed by EPA Method 1625B with iso-dilution
Image provided courtesy of Pictometry International 2012

0 2,700 5,400
SCALE IN FEET

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FIRST QUARTER 2013
GROUNDWATER MONITORING REPORT

ANALYTICAL RESULTS FOR SULFOLANE AT WATER TABLE

ARCADIS

FIGURE
4-13

CITY: SF DIV/GROUP: ENV/IM DB: BGRIFFITH LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: W:\ArcGisData\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2013_Q1\MXD\Fig 4-14 Sulfolane_10-55ft.mxd 5/20/2013 12:14:14 PM

Legend

- Monitoring Well
- Vertical Profile Transect Well
- Permafrost Boring
- Point-of-entry treatment system sample collected
- FHRA Property Boundary

Private Well Sulfolane Results

- Not Detected
- 3.2 µg/L - 10 µg/L (J-flagged)
- 10µg/L - 14 µg/L
- 14µg/L - 100 µg/L
- 100µg/L - 500 µg/L
- Greater than 500 µg/L

Approximate Sulfolane Isopleth in µg/L

- 22.5 Sulfolane Concentration (µg/L)
- J Estimated concentration, detected above the detection limit (DL) and below the limit of quantitation (LOQ)
- JH* Estimated results biased high due to sulfolane-d8 surrogate failure (flag applied by SWI
- J* Result is considered estimated (no direction of bias) due to QC failures (flag applied by SWI)
- < Not detected; detection limit listed
- - - Well frozen or obstructed

Notes:

Samples with duplicate data are represented by the greater of the two results.
Sulfolane was analyzed by EPA Method 1625B with iso-dilution
Sulfolane results for private wells are shown from April 1, 2012 to March 31, 2013
Image provided courtesy of Pictometry International 2012

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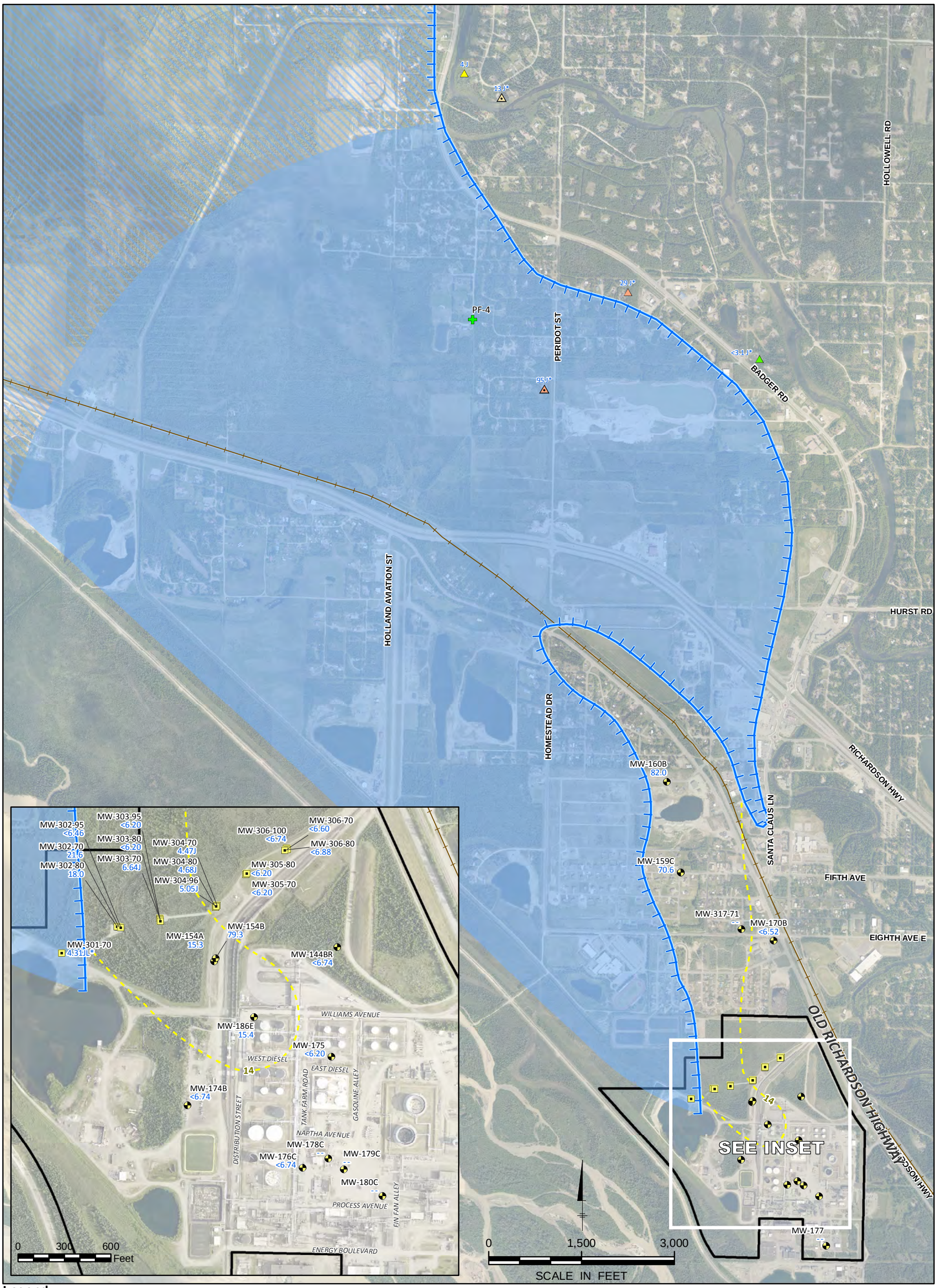
FIRST QUARTER 2013
GROUNDWATER MONITORING REPORT

ANALYTICAL RESULTS FOR SULFOLANE 10-55 FEET BELOW WATER TABLE

ARCADIS

FIGURE
4-14

CITY: SF DIV/GROUP: ENV/IM DB: BGRIFFITH LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: W:\ArcGisData\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2013_Q1\MXD\Fig 4-15 Sulfolane_55-90ft.mxd 5/20/2013 12:23:15 PM



Legend

- Monitoring Well
- Vertical Profile Transect Well
- Permafrost Boring
- Point-of-entry treatment system sample collected
- FHRA Property Boundary

Private Well Sulfolane Results

- Not Detected
- 3.2 µg/L - 10 µg/L (J-flagged)
- 10µg/L - 14 µg/L
- 14µg/L - 100 µg/L
- 100µg/L - 500 µg/L
- Greater than 500 µg/L

- Approximate Sulfolane Isopleth in µg/L
- Aquifer Frozen at 55' Below the Water Table

22.5 Sulfolane Concentration (µg/L)
J Estimated concentration, detected above the detection limit (DL) and below the limit of quantitation (LOQ)
JL* Result is considered estimated, biased low, due to QC failures (flag applied by SWI)
J* Result is considered estimated (no direction of bias) due to QC failures (flag applied by SWI)
< Not detected; detection limit listed
-- Well frozen or obstructed

Notes:
Samples with duplicate data are represented by the greater of the two results.
Sulfolane was analyzed by EPA Method 1625B with iso-dilution
Sulfolane results for private wells are shown from April 1, 2012 to April 30, 2013
Image provided courtesy of Pictometry International 2012

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GROUNDWATER MONITORING REPORT

ANALYTICAL RESULTS FOR SULFOLANE 55-90 FEET BELOW WATER TABLE

ARCADIS

FIGURE
4-15