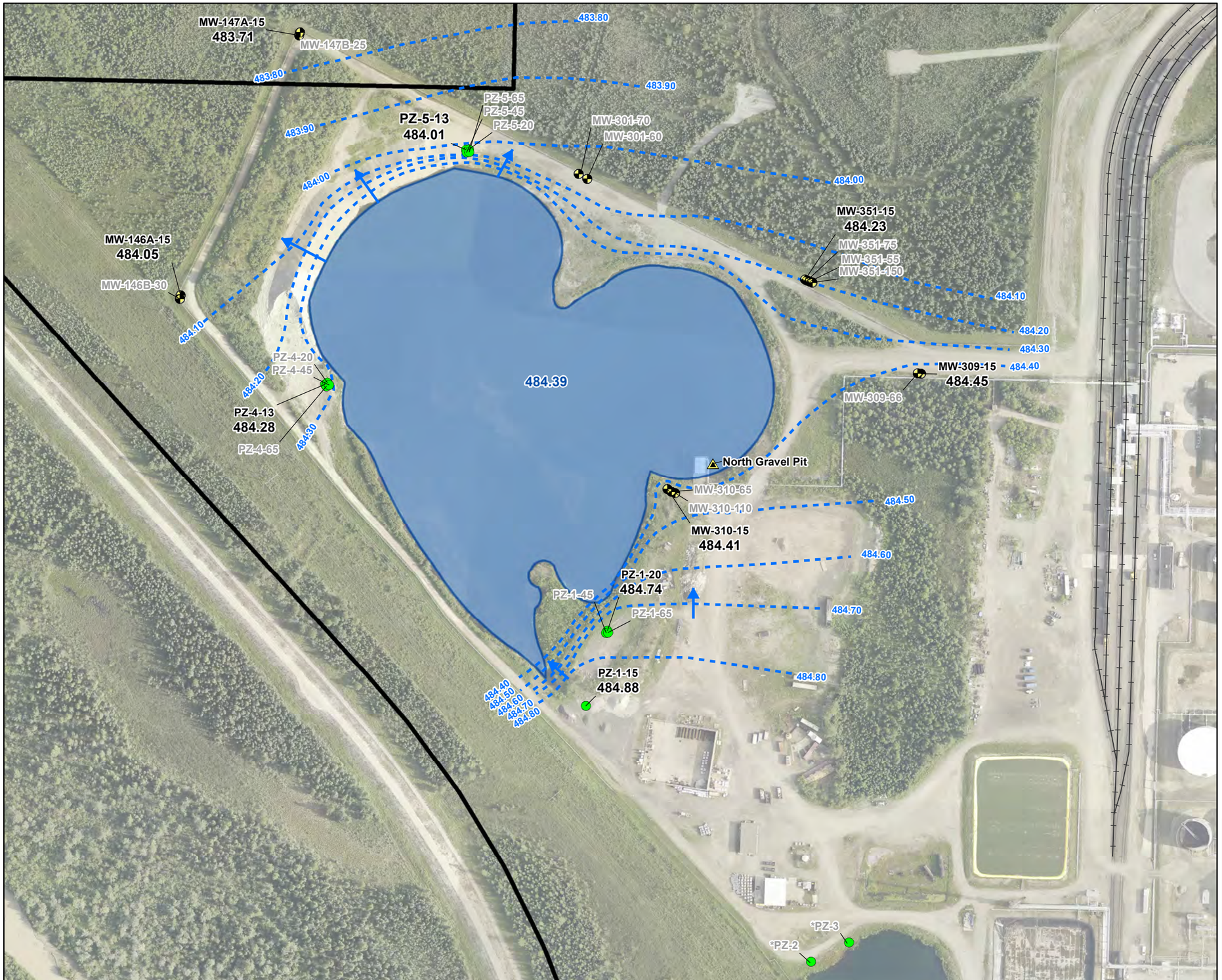


Legend

- Monitoring Well
- Piezometer
- Surface Water
- Groundwater Elevation Contours in feet above mean sea level (dashed where inferred)
- Extent of North Gravel Pit at the water table
- FHRA Property Boundary
- Groundwater flow direction
- **484.45** Measured Groundwater Elevation
- **484.39** North Gravel Pit surface water elevation
- MW-351-150 Well not used during contouring

Notes:
1) Image provided courtesy of Pictometry International 2012.
2) Water level results from 11/25/2013
3) Contours extrapolated east of NGP based on groundwater contour map - onsite wells at water table.
4) *Locations are approximate

0 200 400
SCALE IN FEET

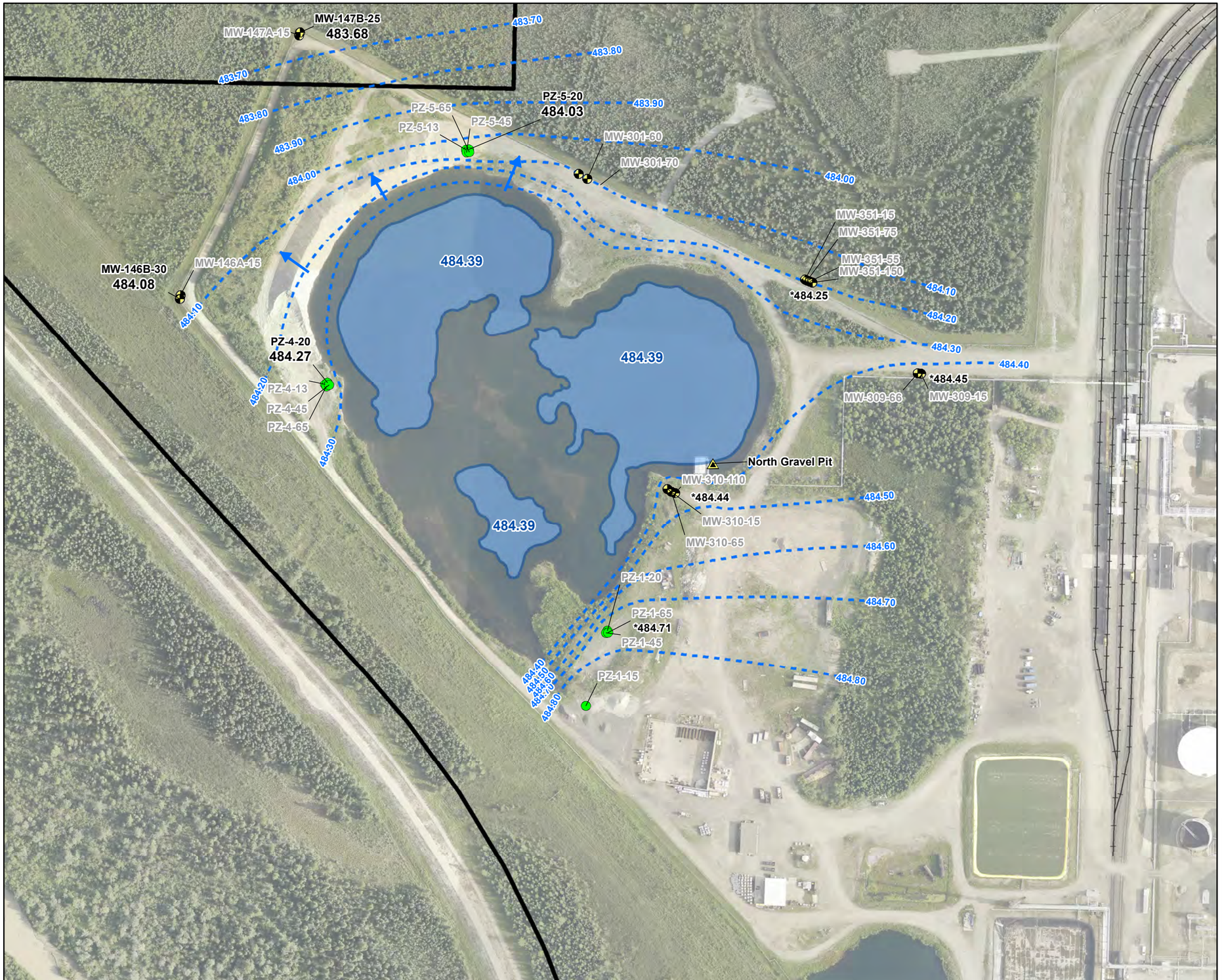
FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
FOURTH QUARTER 2013
GROUNDWATER MONITORING REPORT

NORTH GRAVEL PIT GROUNDWATER CONTOUR MAP – ONSITE WELLS AND PIEZOMETERS AT THE WATER TABLE

ARCADIS

FIGURE
4-7

CITY:Highlands Ranch, CO DIV/GROUP:(ENV/GIS) DB: BGriffith
Path: W:\GISPrj\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2013_Q4\MXD\Fig 4-7 NGP_Onsite_WaterTable.mxd Date: 1/31/2014 Time: 11:13:58 AM



Legend

- Monitoring Well
- Piezometer
- Surface Water
- Groundwater Elevation Contours in feet above mean sea level (dashed where inferred)
- Approximate interface between North Gravel Pit Surface Water and Groundwater at 10-20 feet below the water table
- Extent of North Gravel Pit at 10-20 feet below the water table
- FHRA Property Boundary
- Groundwater flow direction
- **484.03** Measured Groundwater Elevation
- **484.39** North Gravel Pit surface water elevation
- MW-309-66 Well not used during contouring

Notes:
1) Image provided courtesy of Pictometry International 2012.
2) Water level results from 11/25/2013
3) Contours extrapolated east of NGP based on groundwater contour map - onsite wells at 10-55 feet below water table.
4) *Groundwater elevation estimated from well nest.

0 200 400
SCALE IN FEET

FLINT HILLS RESOURCES ALASKA, LLC
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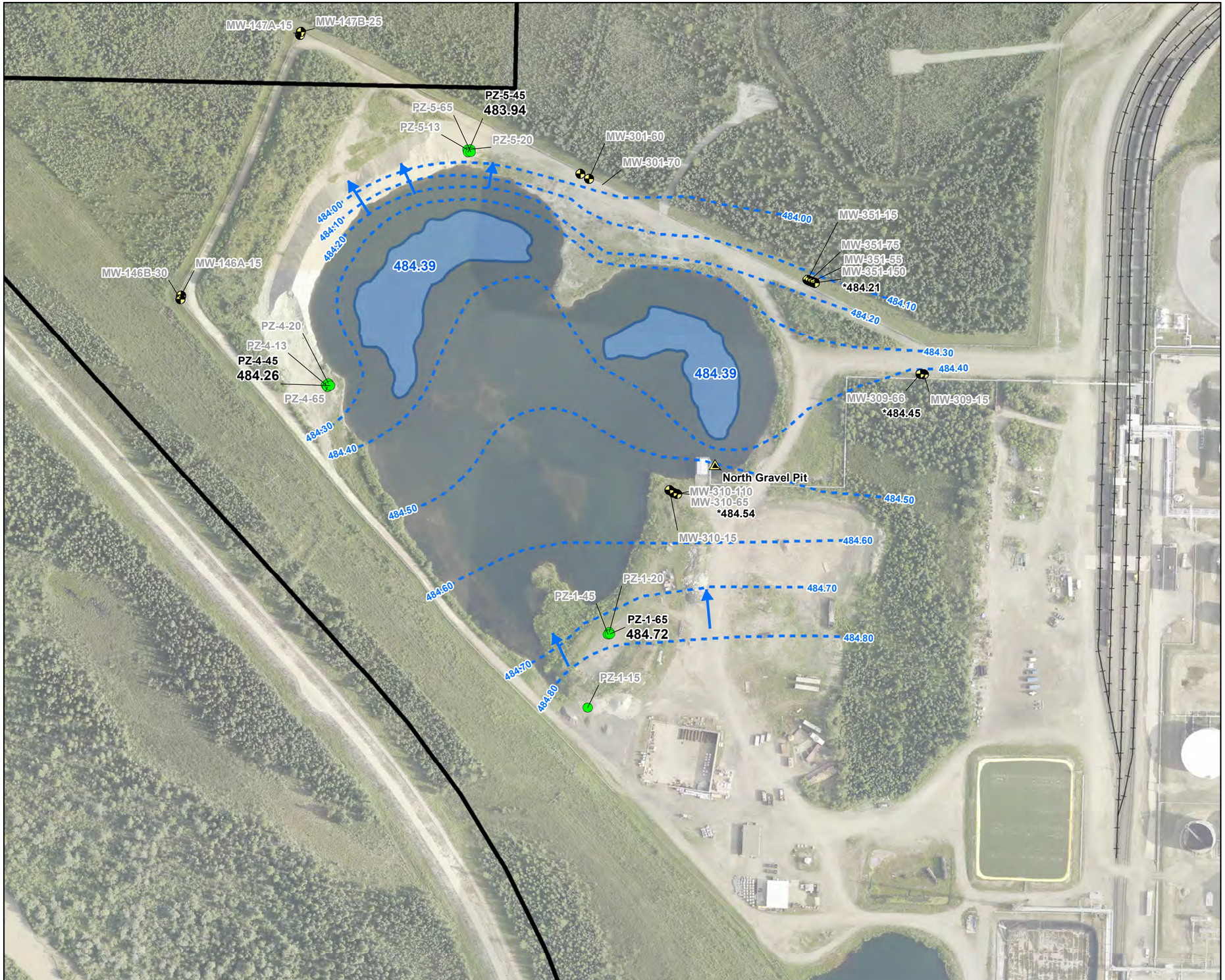
FOURTH QUARTER 2013
GROUNDWATER MONITORING REPORT

NORTH GRAVEL PIT GROUNDWATER CONTOUR MAP – ONSITE WELLS AND PIEZOMETERS AT 10 – 20 FT BELOW THE WATER TABLE

ARCADIS

FIGURE
4-8

CITY:Highlands Ranch, CO DIV/GROUP:(ENV/GIS) DB: BGriffith
Path: W:\GISPrj\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2013_Q4\MXD\Fig 4-8 NGP_Onsite_10to20.mxd Date: 1/30/2014 Time: 3:00:11 PM



Legend

- Monitoring Well
- Piezometer
- Surface Water
- Groundwater Elevation Contours in feet above mean sea level (dashed where inferred)
- Approximate interface between North Gravel Pit Surface Water and Groundwater at 20-40 feet below the water table
- Extent of North Gravel Pit at 20-40 feet below the water table
- FHRA Property Boundary
- Groundwater flow direction
- **483.94** Measured Groundwater Elevation
- **484.39** North Gravel Pit surface water elevation
- MW-309-15 Well not used during contouring

Notes:
1) Image provided courtesy of Pictometry International 2012.
2) Water level results from 11/25/2013
3) Contours extrapolated east of NGP based on groundwater contour map - onsite wells at 10-55 feet below water table.
4) *Groundwater elevation estimated from well nest.

0 200 400
SCALE IN FEET

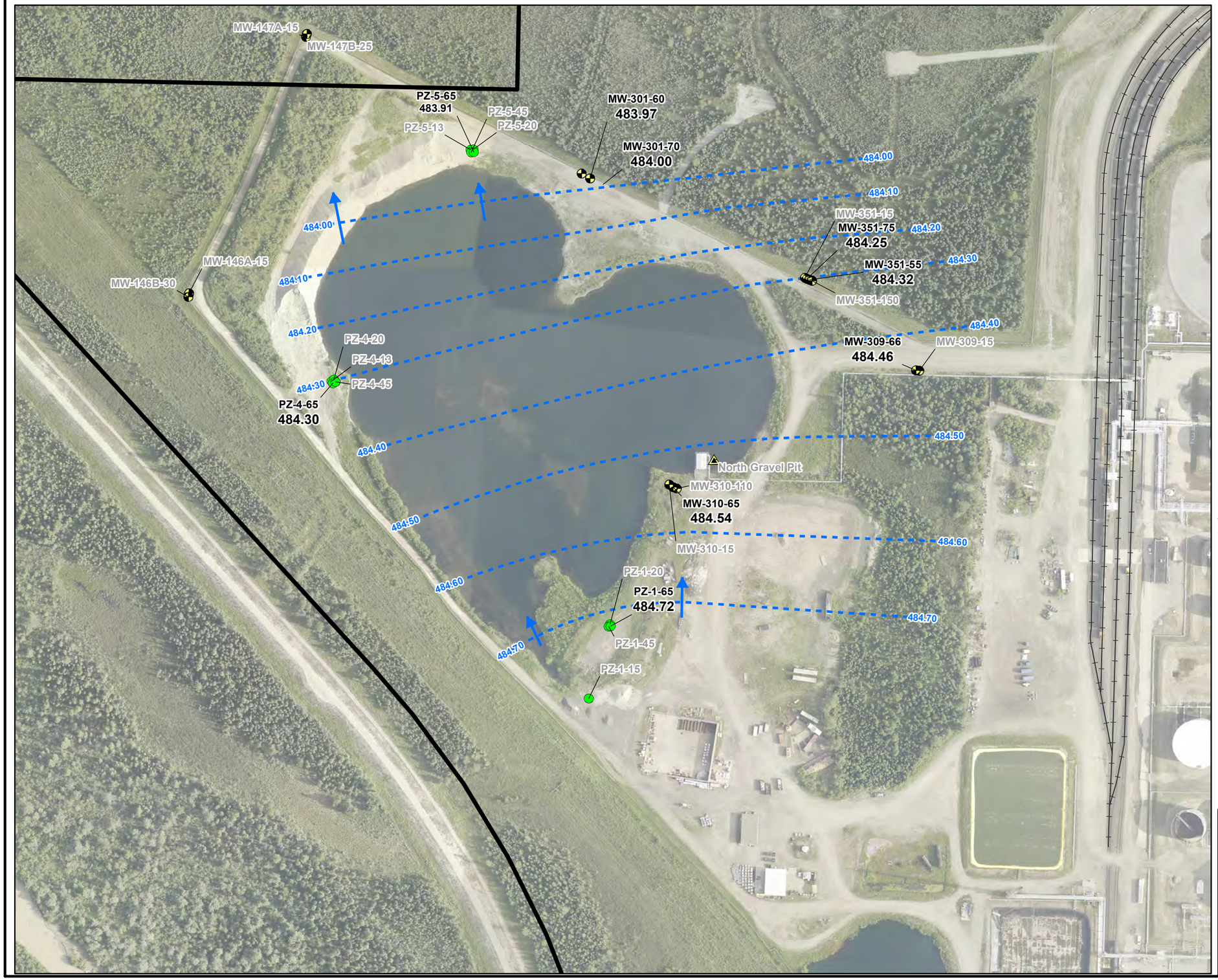
FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
FOURTH QUARTER 2013
GROUNDWATER MONITORING REPORT

NORTH GRAVEL PIT GROUNDWATER CONTOUR MAP – ONSITE WELLS AND PIEZOMETERS AT 20 – 40 FT BELOW THE WATER TABLE

ARCADIS

FIGURE
4-9

CITY:Highlands Ranch, CO DIV/GROUP:(ENV/GIS) DB: BGriffith
Path: W:\GISPrj\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2013_Q4\MXD\Fig 4-9 NGP_Onsite_20to40.mxd Date: 1/30/2014 Time: 2:59:21 PM



Legend

- Monitoring Well
- Piezometer
- Surface Water
- Groundwater Elevation Contours in feet above mean sea level (dashed where inferred)
- FHRA Property Boundary
- Groundwater flow direction
- **484.32** Measured Groundwater Elevation
- MW-309-15 Well not used during contouring

Notes:
1) Depth of gravel pit is limited to approximately 46 feet
2) Image provided courtesy of Pictometry International 2012.
3) Water level results from 11/25/2013
4) Contours extrapolated east of NGP based on groundwater contour map - onsite wells at 10-55 feet below water table.

0 200 400
SCALE IN FEET

FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
FOURTH QUARTER 2013
GROUNDWATER MONITORING REPORT

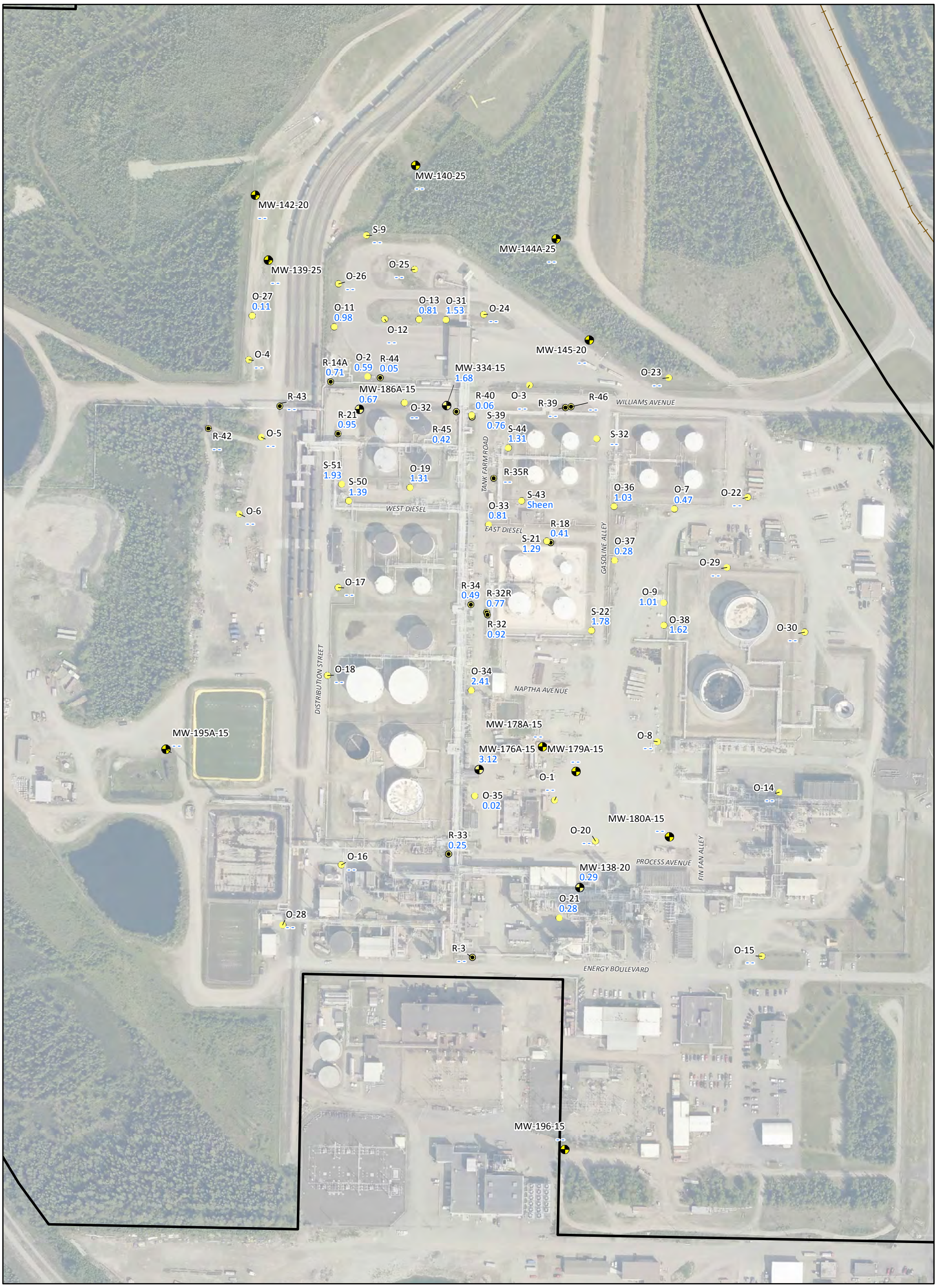
NORTH GRAVEL PIT GROUNDWATER CONTOUR MAP – ONSITE WELLS AND PIEZOMETERS AT 40 – 70 FT BELOW THE WATER TABLE

ARCADIS

FIGURE
4-10

CITY:Highlands Ranch, CO DIV/GROUP:(ENV/GIS) DB: BGriffith
Path: W:\GISprj\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2013_Q4\MXD\Fig 4-10 NGP_Onsite_40to70.mxd Date: 1/30/2014 Time: 3:02:00 PM

CITY: HIGHLANDS RANCH, CO DIV/GROUP: ENV/IM DB: BGRIFFITH LD: G FRANCE
PATH: W:\GISPRJ\GISPROJECTS_ENV\FHR_AK\NORTHPOLEREFINERY\GW_MONITORING\2013_Q4\MXD\FIG 4-11 LNAPL_MONITORINGDATA.MXD DATE: 1/22/2014 TIME: 8:44:44 AM



Legend

- Monitoring Well
- Observation Well
- Recovery Well
- FHRA Property Boundary
- 1.39 LNAPL Thickness (feet)
- Sheen An interface probe was used. No measurable LNAPL was present, but LNAPL sheen was observed visually.
- -- No LNAPL measured or sheen observed

Notes:
LNAPL = Light Non-Aqueous Phase Liquid
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

0 250 500
SCALE IN FEET

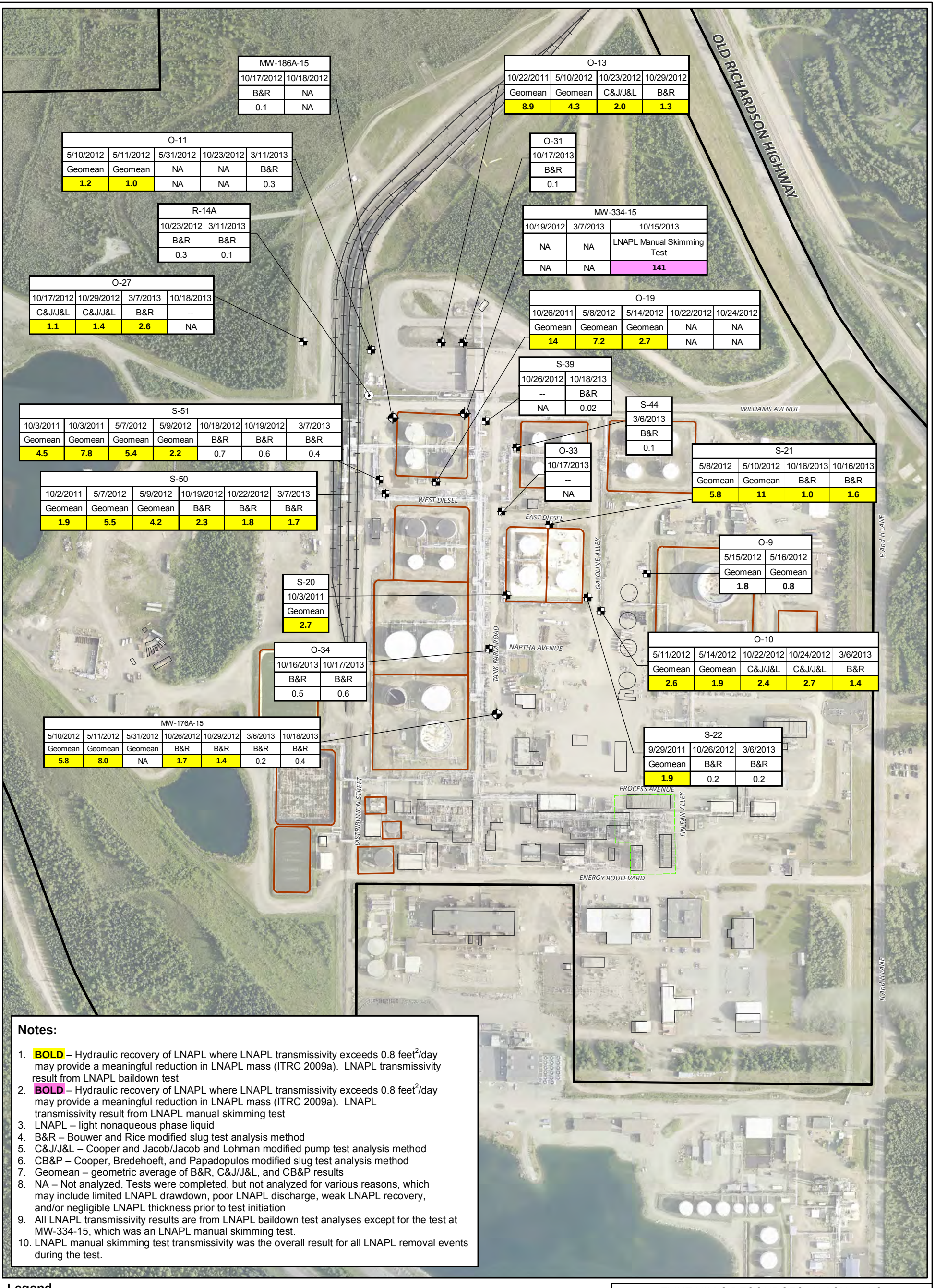
FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
FOURTH QUARTER 2013
GROUNDWATER MONITORING REPORT

LNAPL MONITORING DATA

ARCADIS

FIGURE
4-11

CITY: SF DIV/GROUP: ENV/IM DB: BGRIFFITH LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: W:\GISPrj\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2013_Q4\MXD\Fig 4-12 Transmissivity_2011-13.mxd 1/22/2014 8:43:53 AM



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). LNAPL transmissivity result from LNAPL baildown test
2. **BOLD** – Hydraulic recovery of LNAPL where LNAPL transmissivity exceeds 0.8 feet^2/day may provide a meaningful reduction in LNAPL mass (ITRC 2009a). LNAPL transmissivity result from LNAPL manual skimming test
3. LNAPL – light nonaqueous phase liquid
4. B&R – Bouwer and Rice modified slug test analysis method
5. C&J/J&L – Cooper and Jacob/Jacob and Lohman modified pump test analysis method
6. CB&P – Cooper, Bredehoeft, and Papadopulos modified slug test analysis method
7. Geomean – geometric average of B&R, C&J/J&L, and CB&P results
8. NA – Not analyzed. Tests were completed, but 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
9. All LNAPL transmissivity results are from LNAPL baildown test analyses except for the test at MW-334-15, which was an LNAPL manual skimming test.
10. LNAPL manual skimming test transmissivity was the overall result for all LNAPL removal events during the test.

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

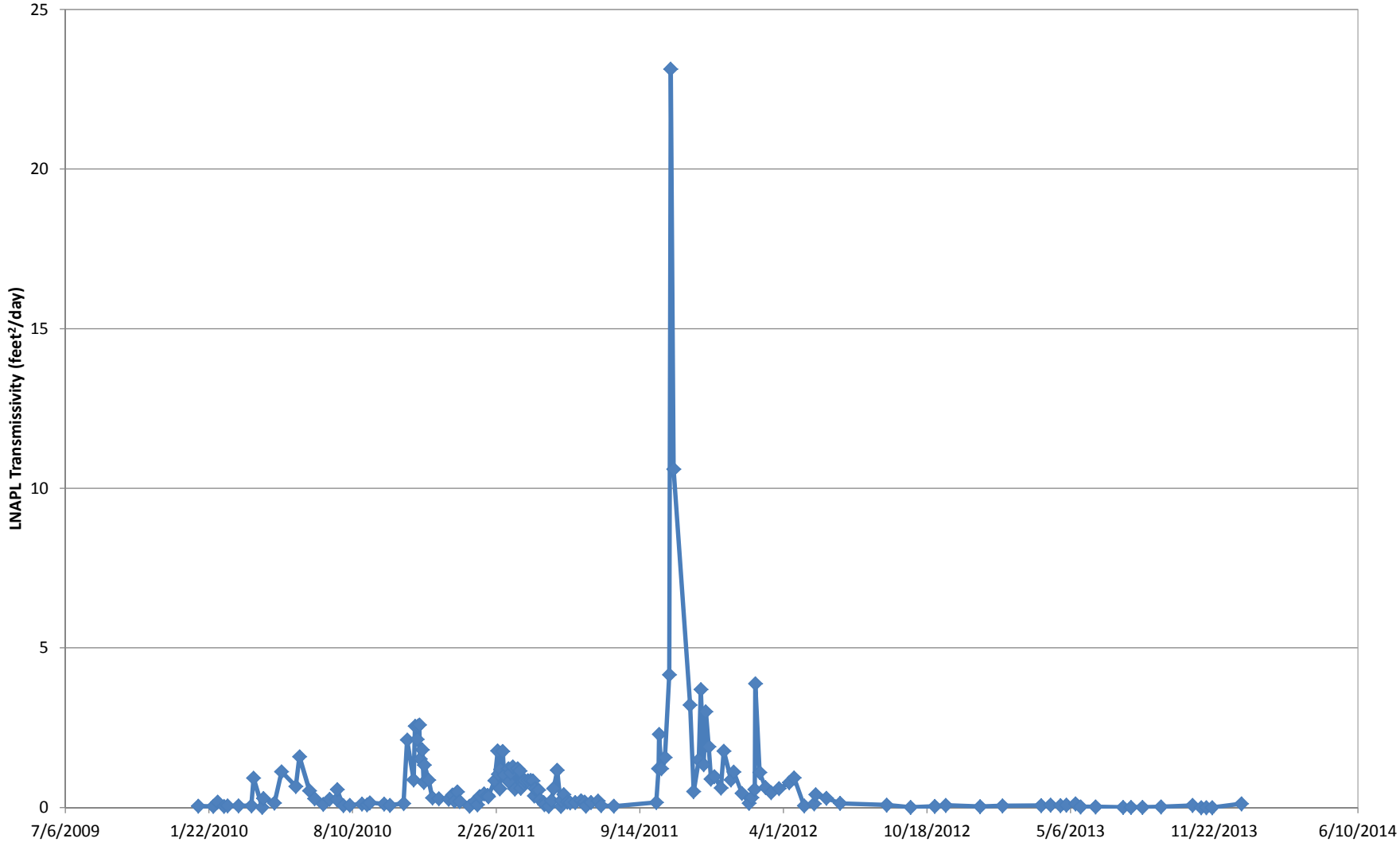
FLINT HILLS RESOURCES, ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA

FOURTH QUARTER 2013 GROUNDWATER MONITORING REPORT

LNAPL TRANSMISSIVITY 2011 - 2013

ARCADIS

FIGURE
4-12



NOTES:
LNAPL = LIGHT NONAQUEOUS PHASE LIQUID
DATA INCLUDES LNAPL TRANSMISSIVITY ESTIMATES USING SEPARATE EQUATIONS FOR SMALL RELATIVE LNAPL DRAWDOWN (LNAPL TO GROUNDWATER DRAWDOWN IS LESS THAN 10 PERCENT) AND LARGE RELATIVE DRAWDOWN (LNAPL TO GROUNDWATER DRAWDOWN IS MORE THAN 10 PERCENT). METHODOLOGY IS AVAILABLE IN APPENDIX 7-D OF THE ONSITE ADDENDUM (ARCADIS 2013C).

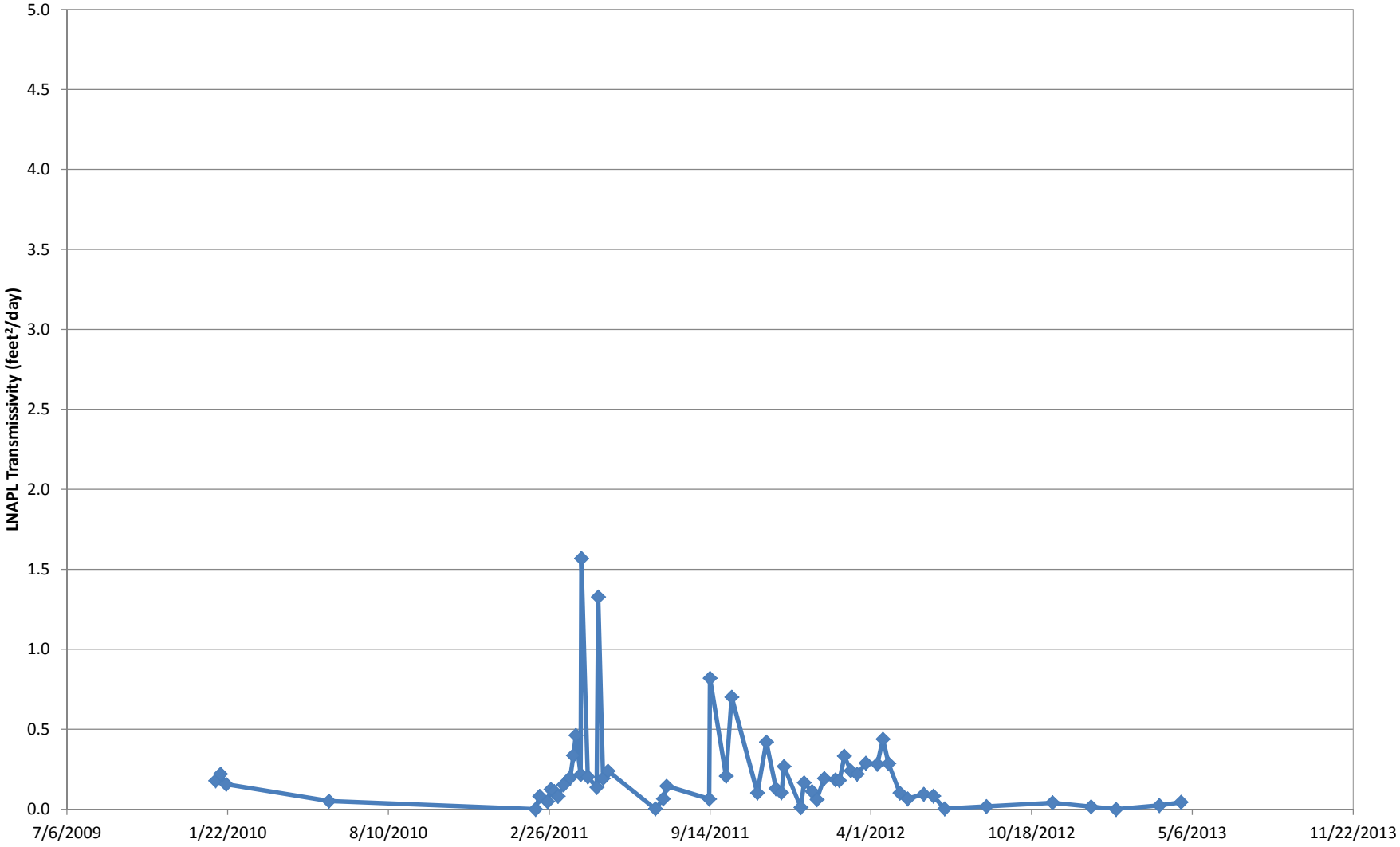
DATA COLLECTED ON OCTOBER 27, 2011 RESULTED IN A HIGH T_N VALUE OF 23.13 FEET^2/DAY DUE TO HIGHER IN-WELL LNAPL THICKNESS ALONG WITH LOWER WATER TABLE AT THE TIME OF THE TEST, WHICH RESULTEED IN HIGHER LNAPL DRAINAGE FROM THE PORE SPACE AND SUBSEQUENT RECOVERY.

FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
FOURTH QUARTER 2013 GROUNDWATER MONITORING REPORT

WELL R-21
WATER-ENHANCED RECOVERY

ARCADIS

FIGURE
4-13A



NOTES:
LNAPL = LIGHT NONAQUEOUS PHASE LIQUID
DATA INCLUDES LNAPL TRANSMISSIVITY ESTIMATES USING SEPARATE EQUATIONS FOR SMALL RELATIVE LNAPL DRAWDOWN (LNAPL TO GROUNDWATER DRAWDOWN IS LESS THAN 10 PERCENT) AND LARGE RELATIVE DRAWDOWN (LNAPL TO GROUNDWATER DRAWDOWN IS MORE THAN 10 PERCENT).
METHODOLOGY IS AVAILABLE IN APPENDIX 7-D OF THE ONSITE ADDENDUM (ARCADIS 2013C).

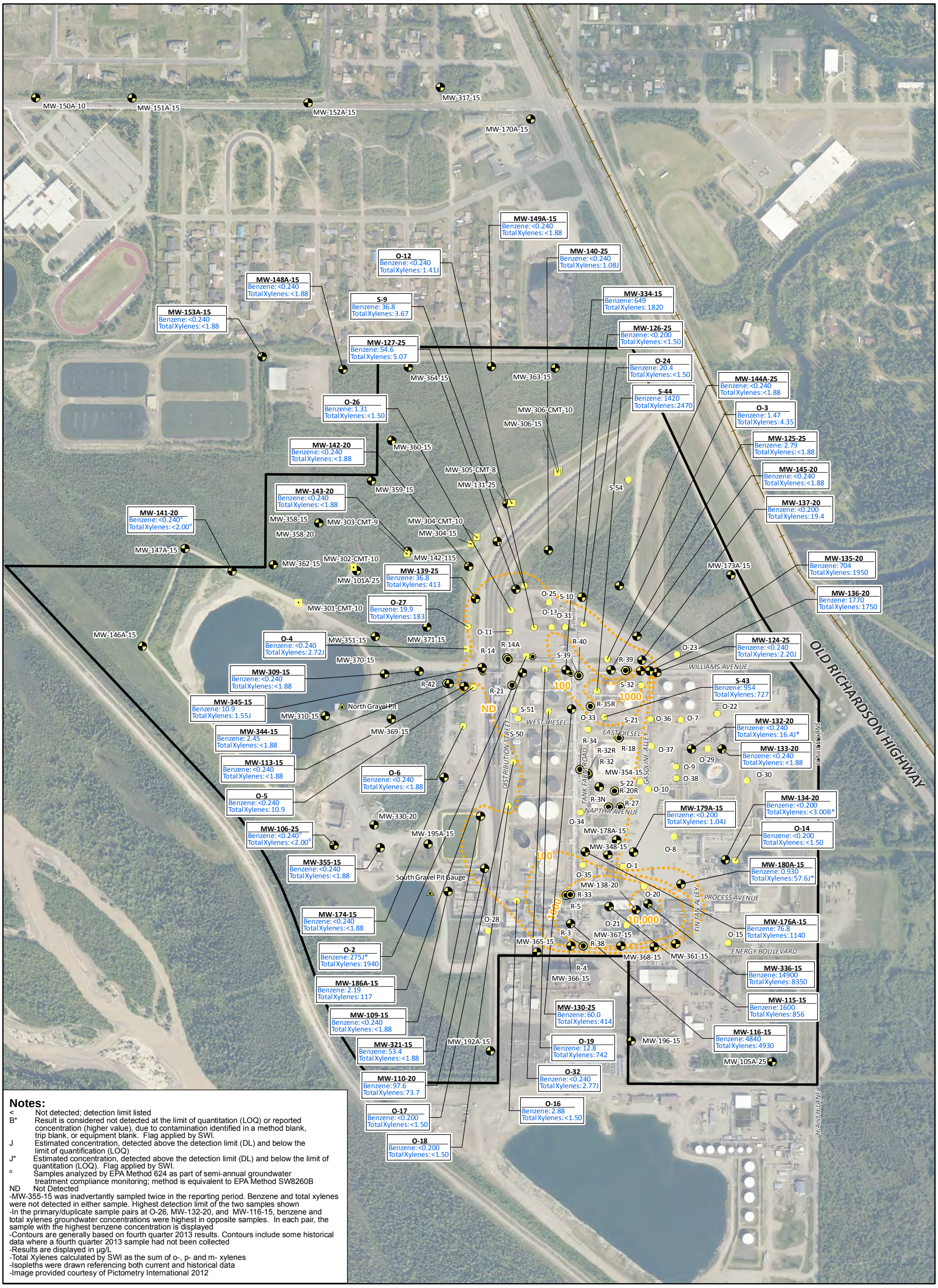
FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
FOURTH QUARTER 2013 GROUNDWATER MONITORING REPORT

WELL R-40
WATER-ENHANCED RECOVERY

ARCADIS

FIGURE
4-13B

CITY: HIGHLANDS RANCH, CO DIV/GROUP: ENV/IM DB: BGRIFFITH LD: G FRANCE
PATH: W:\GISPRJ\GISPROJECTS_ENV\FHR_AK\NORTHPOLEREFINERY\GW_MONITORING\2013_Q4\MXD\FIG 4-14 BX_RESULTS-WATERTABLE.MXD DATE: 1/29/2014 TIME: 1:48:38 PM



Notes:

< Not detected; detection limit listed
B* Result is considered not detected at the limit of quantitation (LOQ) or reported concentration (higher value), due to contamination identified in a method blank, trip blank, or equipment blank. Flag applied by SWI.
J Estimated concentration, detected above the detection limit (DL) and below the limit of quantification (LOQ)
J* Estimated concentration, detected above the detection limit (DL) and below the limit of quantitation (LOQ). Flag applied by SWI.
α Samples analyzed by EPA Method 624 as part of semi-annual groundwater treatment compliance monitoring; method is equivalent to EPA Method SW8260B
ND Not Detected
-MW-355-15 was inadvertantly sampled twice in the reporting period. Benzene and total xylenes were not detected in either sample. Highest detection limit of the two samples shown
-In the primary/duplicate sample pairs at O-26, MW-132-20, and MW-116-15, benzene and total xylenes groundwater concentrations were highest in opposite samples. In each pair, the sample with the highest benzene concentration is displayed
-Contours are generally based on fourth quarter 2013 results. Contours include some historical data where a fourth quarter 2013 sample had not been collected
-Results are displayed in µg/L
-Total Xylenes calculated by SWI as the sum of o-, p- and m- xylenes
-Isopleths were drawn referencing both current and historical data
-Image provided courtesy of Pictometry International 2012

Legend:

- Monitoring Well
- Observation Well
- Recovery Well
- Vertical Profile Transect Well
- Surface Water
- Inferred benzene isopleth in microgram per liter (µg/L)
- FHRA Property Boundary

0 500 1,000
SCALE IN FEET

FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA

FOURTH QUARTER 2013 GROUNDWATER MONITORING REPORT

ANALYTICAL RESULTS FOR BENZENE AND TOTAL XYLENES AT WATER TABLE

ARCADIS

FIGURE
4-14

CITY: HIGHLANDS RANCH, CO DIV/GROUP: ENV/IM DB: BGRIFFITH LD: G FRANCE
PATH: W:\GISPRJ\GISPROJECTS\ ENV\FHR AK\NORTHPOLEREFINERY\GW MONITORING\2013 Q4\MXD\FIG 4-15 BX RESULTS 10-55FT.MXD DATE: 1/29/2014 TIME: 1:55:43 PM

Legend:

- Observation Well
- Recovery Well
- Injection Well
- Monitoring Well
- Vertical Profile Transect Well
- Inferred benzene isopleth in micrograms per liter (µg/L)
- FHRA Property Boundary

Notes:

< Not detected; detection limit listed
-Results are displayed in µg/L
-Total Xylenes calculated by SWI as the sum of o-, p- and m- xylenes.
-MW-355-55 was inadvertently sampled twice in the reporting period. Benzene and total xylenes were not detected in both samples. Highest detection limit is shown
-Image provided courtesy of Pictometry International 2012

0 500 1,000
SCALE IN FEET

FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA

FOURTH QUARTER 2013 GROUNDWATER MONITORING REPORT

ANALYTICAL RESULTS FOR BENZENE AND TOTAL XYLENES 10 - 55 FEET BELOW WATER TABLE

ARCADIS

FIGURE
4-15