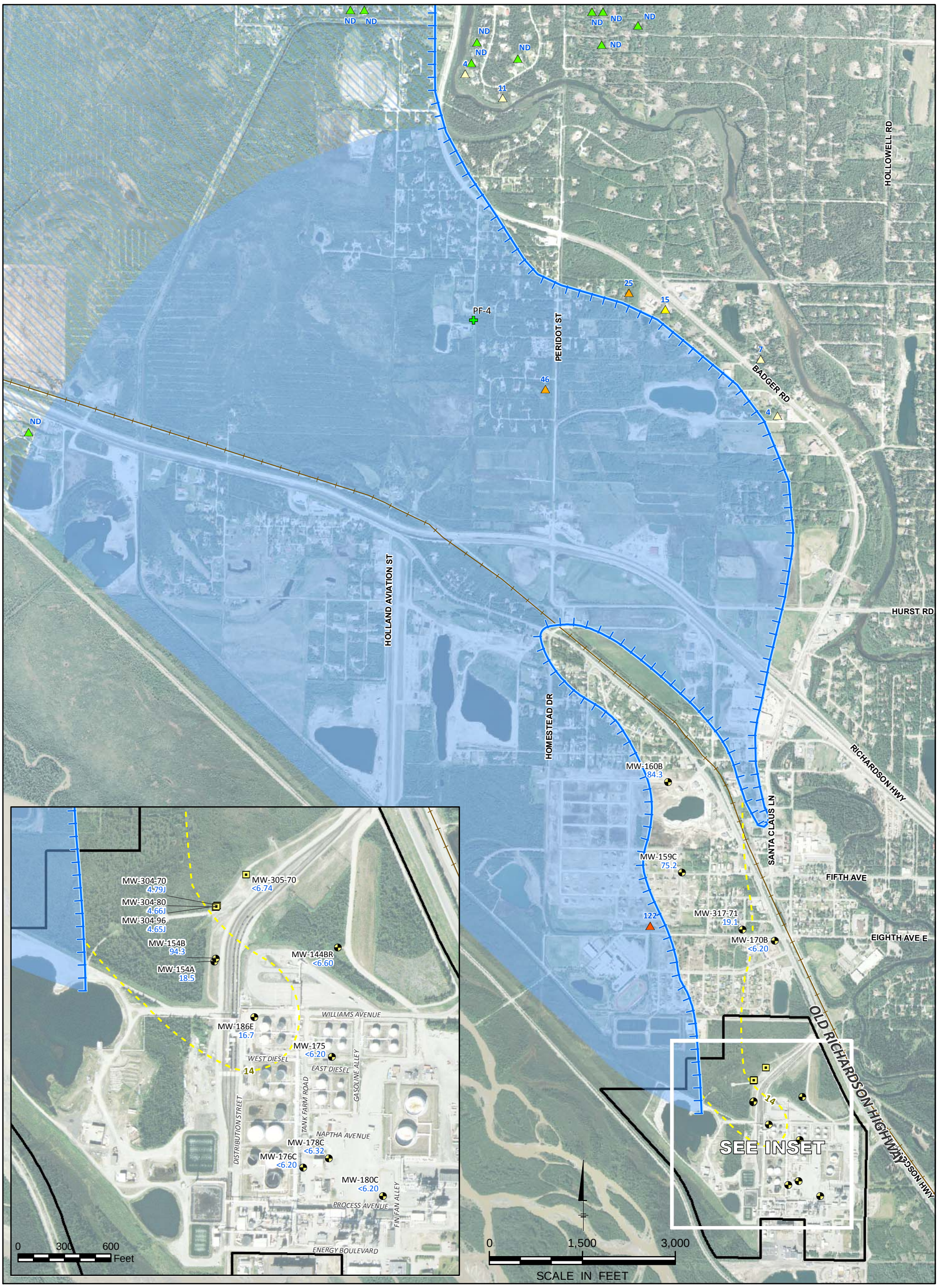
CITY: SF DIV/GROUP: ENV/IM DB: KERNST LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: H:\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2012_Q4\MXD\Fig20-Sulfolane_55-90ft.mxd 2/28/2013 10:45:15 AM



Legend

Sulfolane Results
- Monitoring Well
- Vertical Profile Transect Well
- Observation Well
- Permafrost Boring
- FHRA Property Boundary

Private Well Sulfolane Results
- Not Detected
- 3.2 µg/L - 14 µg/L (J-flagged)
- 14 µg/L - 25 µg/L
- 25 µg/L - 100 µg/L
- Greater than 100 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)
- < Not detected; detection limit listed

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 regardless of sampling date
Image Date: June 9, 2007

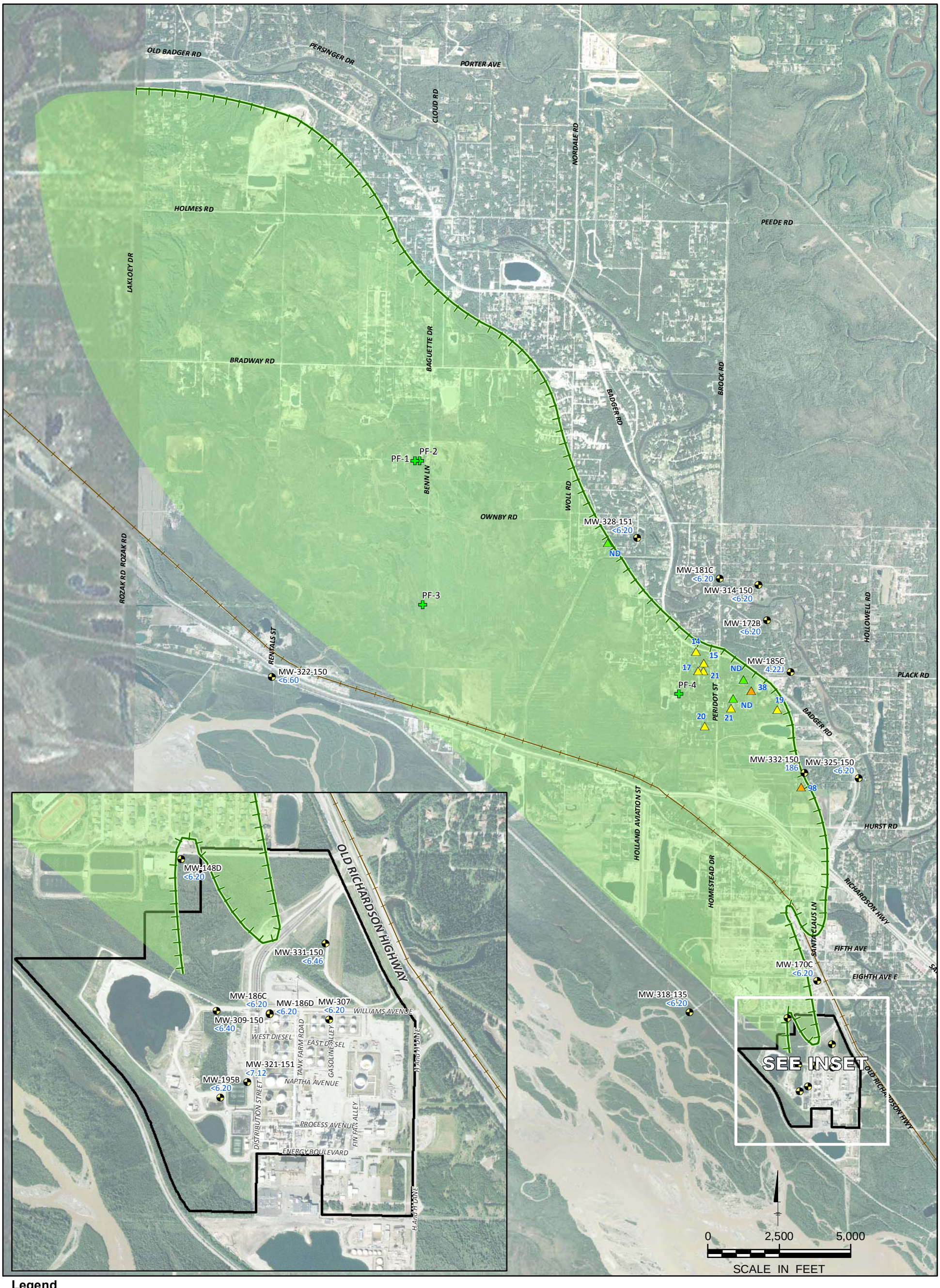
FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
FOURTH QUARTER 2012
GROUNDWATER MONITORING REPORT

ANALYTICAL RESULTS FOR SULFOLANE 55-90 FEET BELOW WATER TABLE

ARCADIS

FIGURE
4-15

CITY: SF DIV/GROUP: ENV/IM DB: KERNST LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: H:\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2012_Q4\MXD\Fig21-Sulfolane_90_160ft.mxd 2/28/2013 10:47:23 AM



Legend

Sulfolane Results
- Monitoring Well
- Observation Well
- Permafrost Boring
- FHRA Property Boundary

Private Well Sulfolane Results
- Not Detected
- 3.2 µg/L - 14 µg/L (J-flagged)
- 14 µg/L - 25 µg/L
- 25 µg/L - 100 µg/L
- Greater than 100 µg/L

- Approximate Sulfolane Isopleth in µg/L
- Permafrost Encountered Before Well Boring Reached Monitoring Zone

22.5 Sulfolane concentration (µg/L)
J Estimated concentration, detected above the detection limit (DL) and below the limit of quantitation (LOQ)
< Not detected; detection limit listed

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 regardless of sampling date
Image date: June 9, 2007

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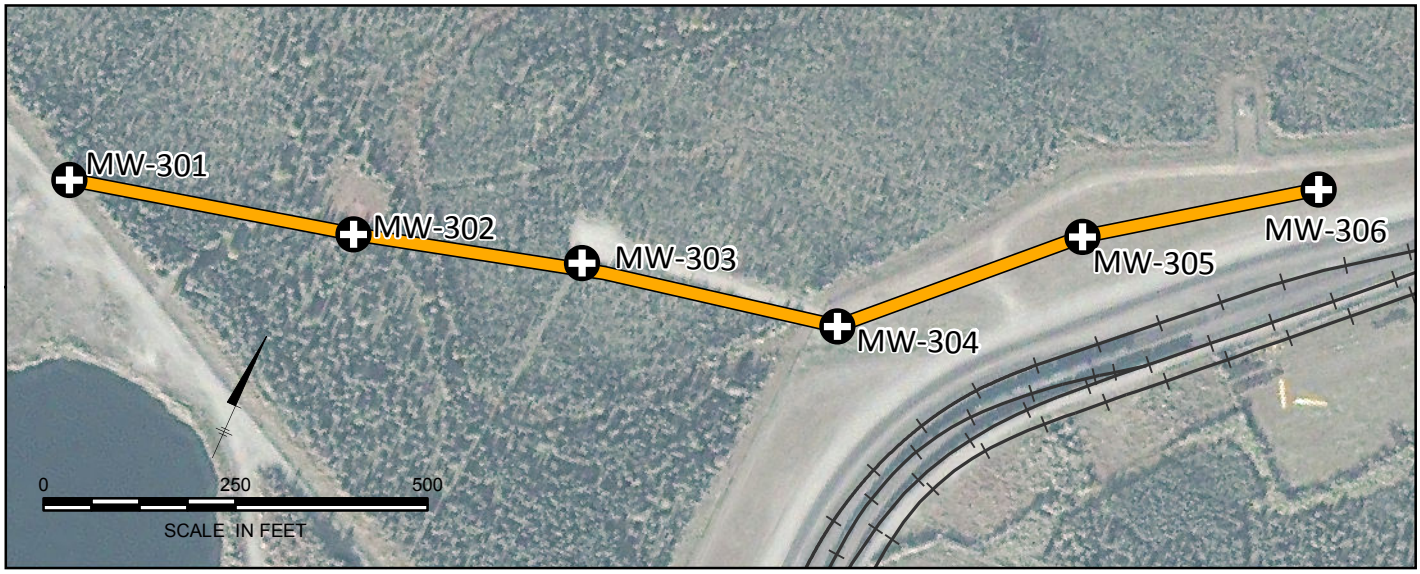
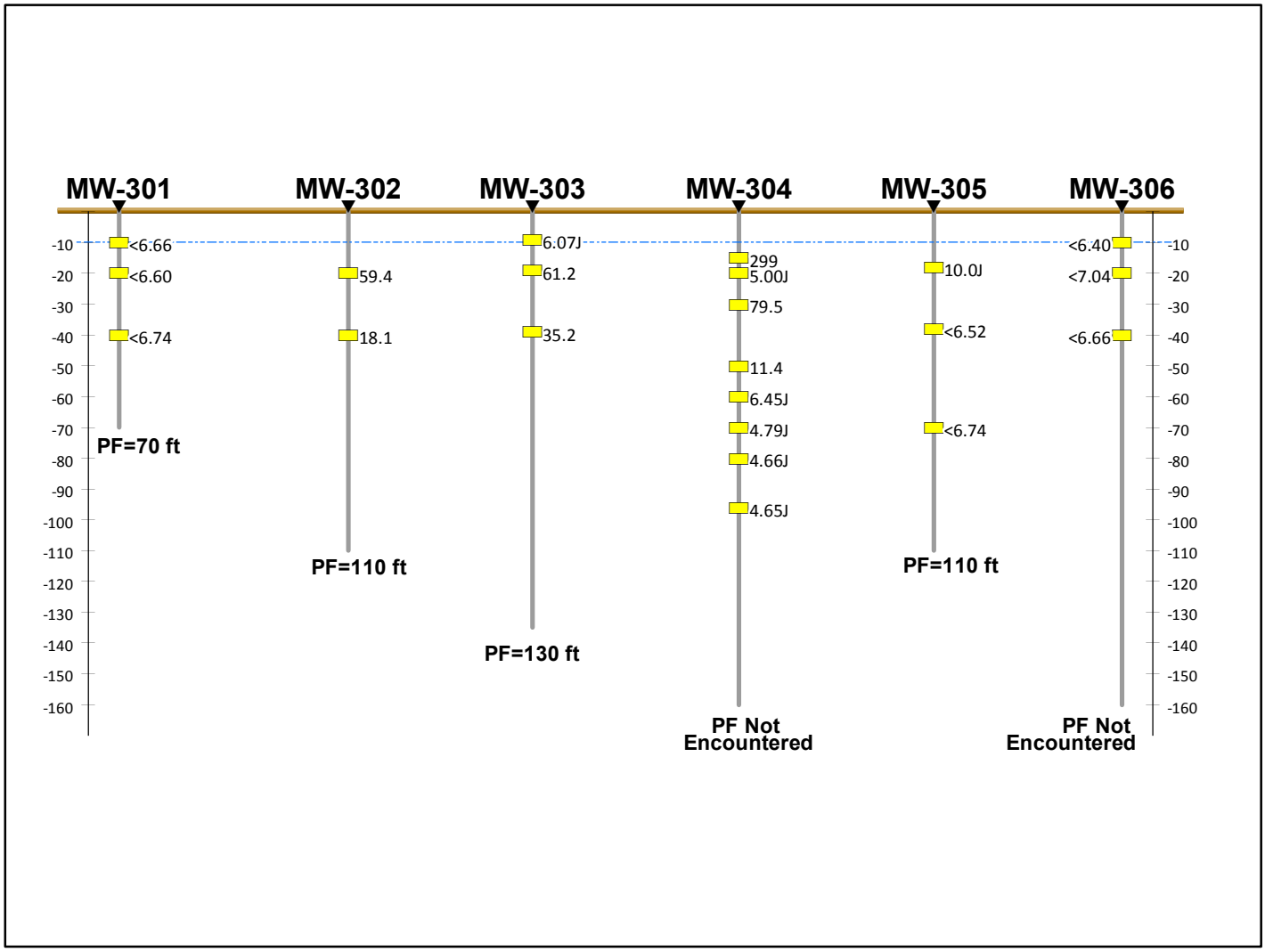
FOURTH QUARTER 2012
GROUNDWATER MONITORING REPORT

ANALYTICAL RESULTS FOR SULFOLANE 90-160 FEET BELOW WATER TABLE

ARCADIS

FIGURE
4-16



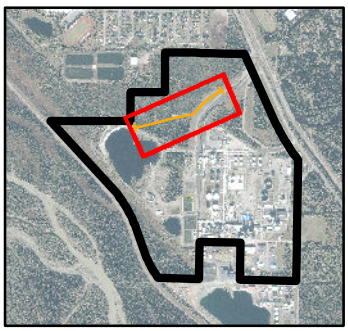


LEGEND:

- Sulfolane Results
- Ground Surface
- Approximate Groundwater Surface
- Well Profile

NOTES:

Profile has a vertical exaggeration of 5x
J = Estimated concentration
PF= Permafrost encountered at bottom of boring.



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

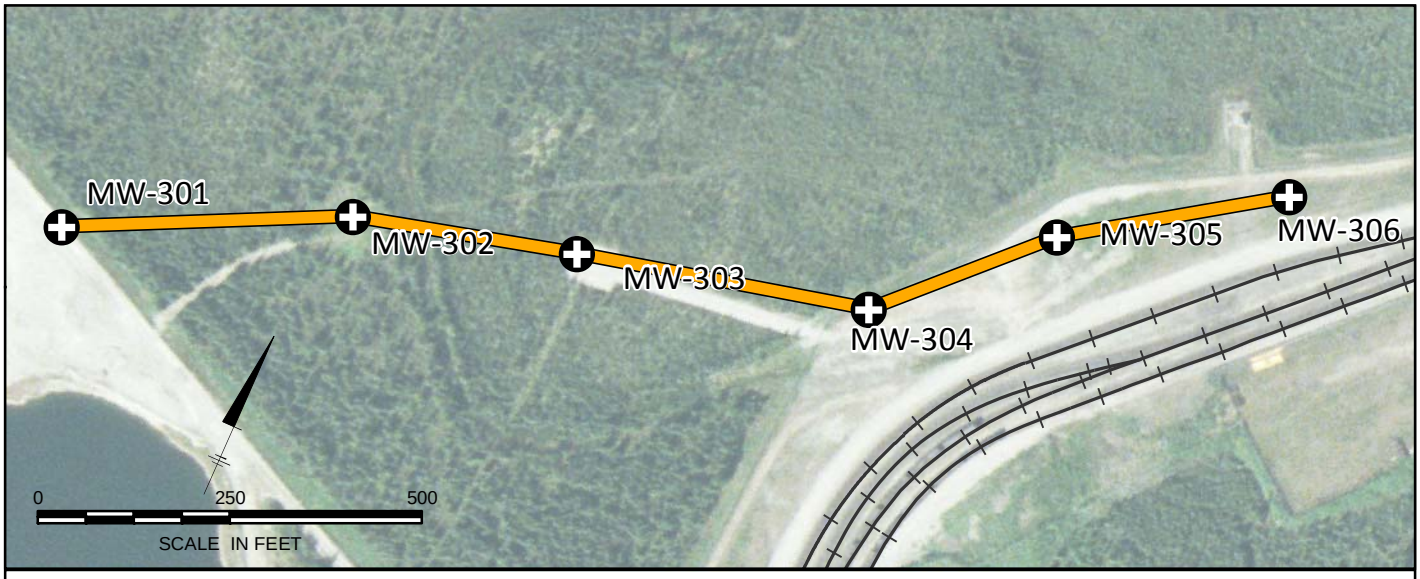
FOURTH QUARTER 2012 GROUNDWATER MONITORING REPORT

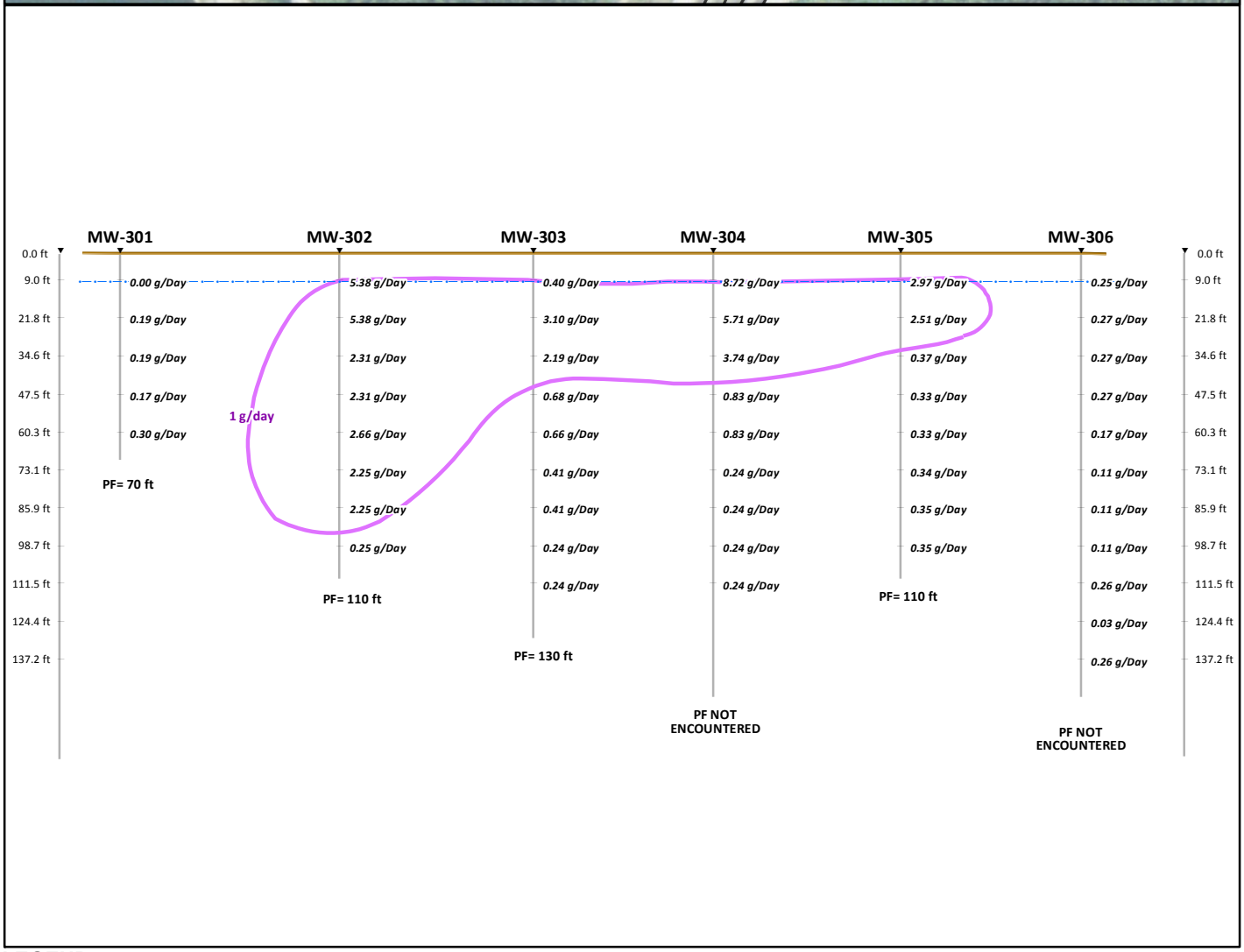
SULFOLANE AT THE VERTICAL PROFILING TRANSECT

ARCADIS

FIGURE
4-17

CITY: SF DIV/GROUP: ENV/IM DB:K ERNST LD: G FRANCE PIC: A OHRT PM: TM:
PROJECT:
Path: H:\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2012_Q4\MXD\Fig17-Sulfolane_VPT_Profile.mxd Date Saved: 1/30/2013 11:38:17 AM



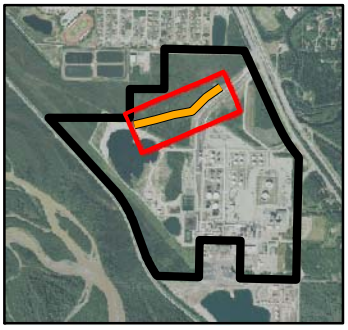


LEGEND:

- Vertical Profile Transect Well
- Ground Surface
- Approximate Groundwater Surface
- Mass Flux Contour
- Well Profile

Notes:

Mass flux values shown were calculated using the Mass Flux Toolkit.
Depths associated with flux values were determined by the Toolkit.
PF = Permafrost encountered at bottom of boring.



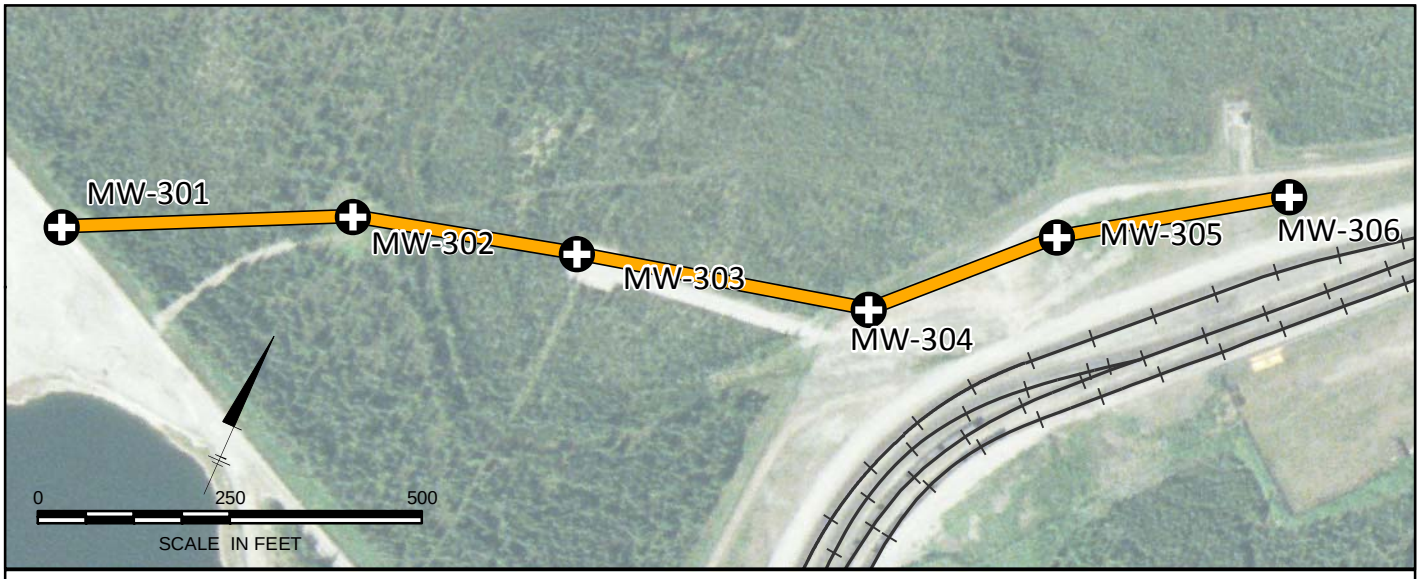
FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
FOURTH QUARTER 2012 GROUNDWATER MONITORING REPORT

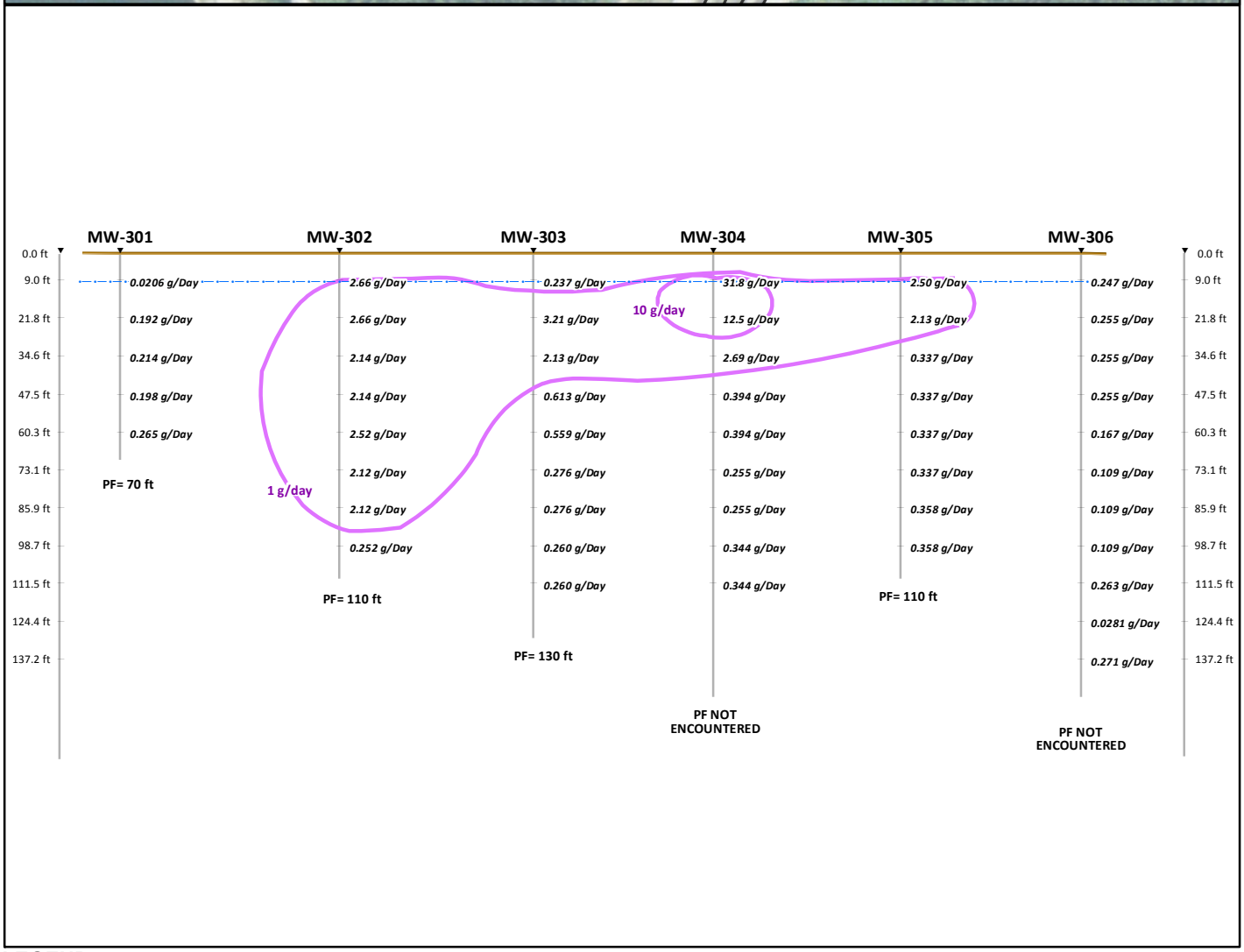
SULFOLANE MASS FLUX RATES 1ST QUARTER 2012

ARCADIS

FIGURE
4-18

CITY: SAN FRANCISCO DIV/GROUP: ENV/IM DB: KERNST LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: H:\GIS\PROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2012_Q4\MXD\Sulfolane_MassFlux_2012Q1.mxd 2/15/2013 2:02:36 PM



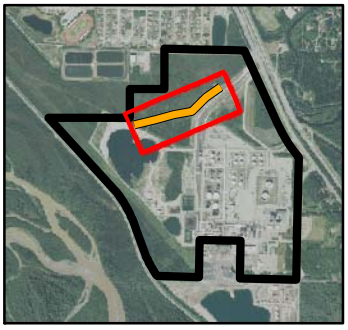


LEGEND:

- Vertical Profile Transect Well
- Ground Surface
- Approximate Groundwater Surface
- Mass Flux Contour
- Well Profile

Notes:

Mass flux values shown were calculated using the Mass Flux Toolkit.
Depths associated with flux values were determined by the Toolkit.
PF = Permafrost encountered at bottom of boring.



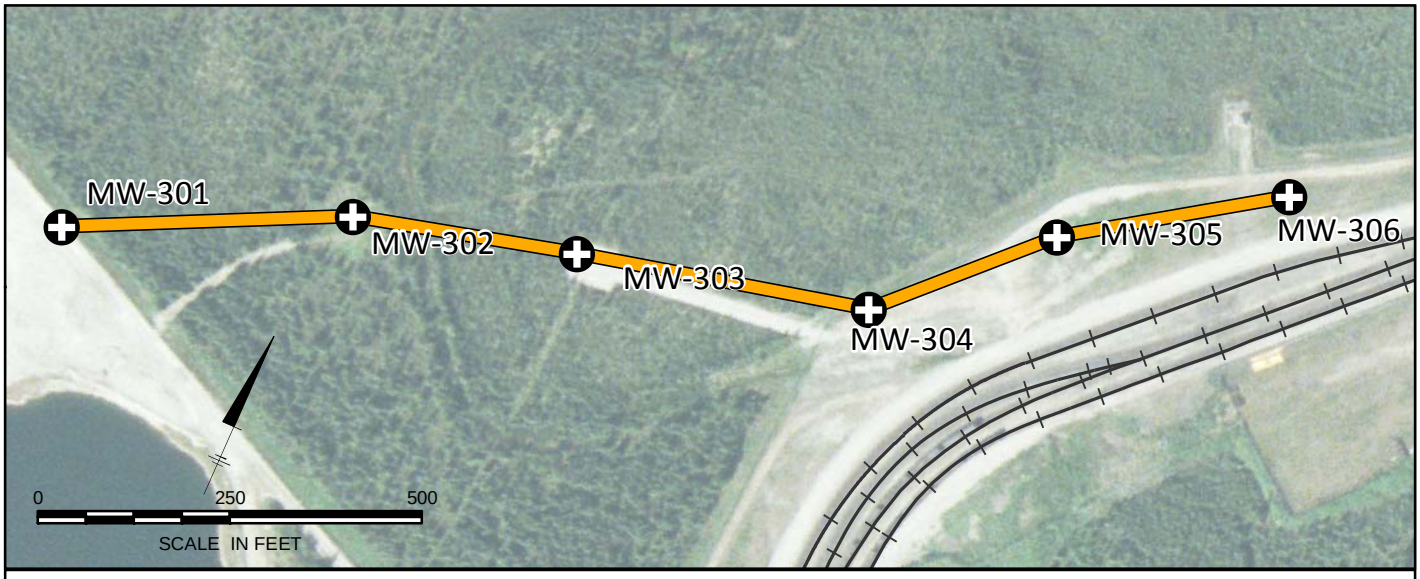
FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
FOURTH QUARTER 2012 GROUNDWATER MONITORING REPORT

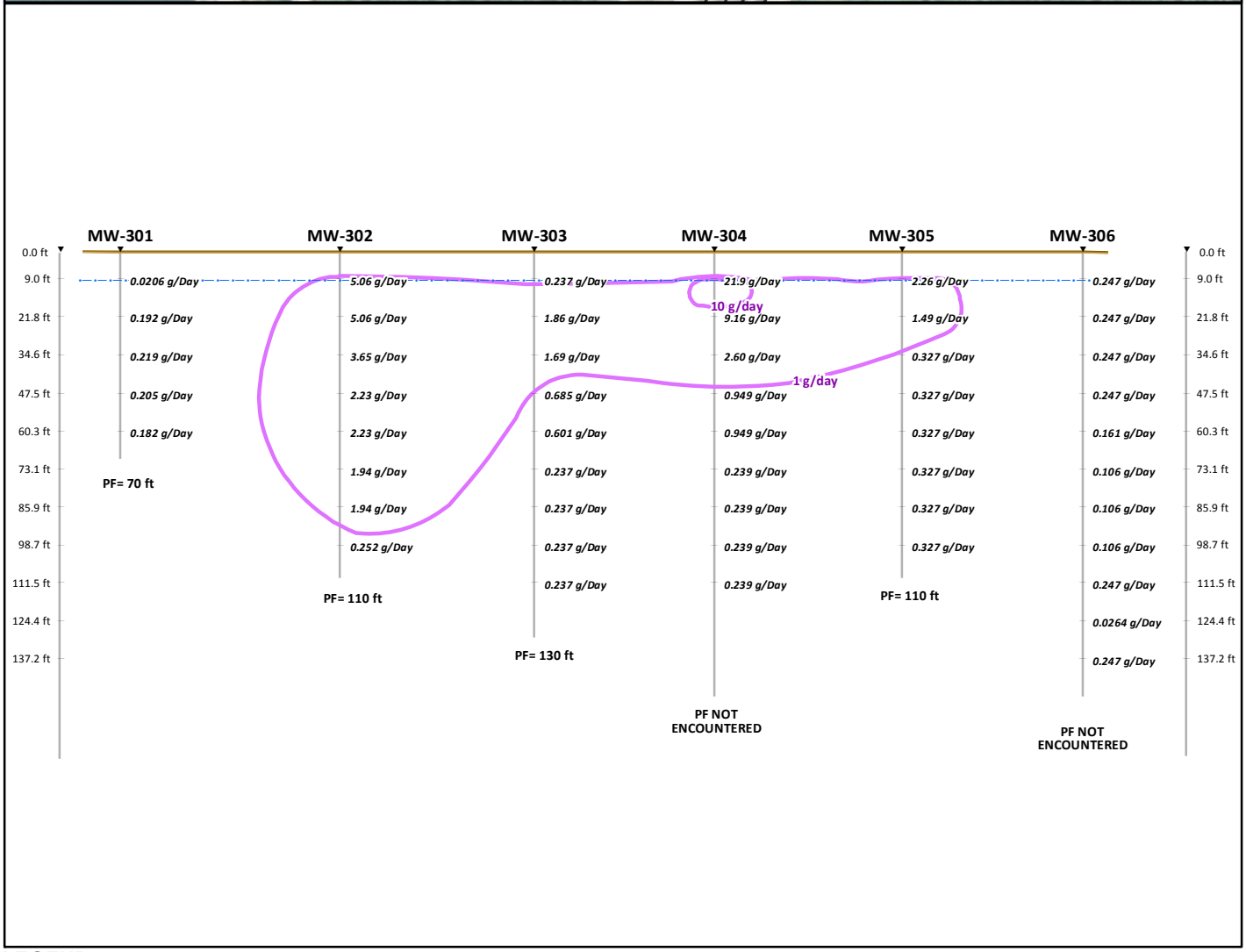
SULFOLANE MASS FLUX RATES 2ND QUARTER 2012

ARCADIS

FIGURE
4-19

CITY: SAN FRANCISCO DIV/GROUP: ENV/IM DB: KERNST LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: H:\GIS\PROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2012_Q4\MXD\Sulfolane_MassFlux_2012Q2.mxd 2/15/2013 2:17:01 PM



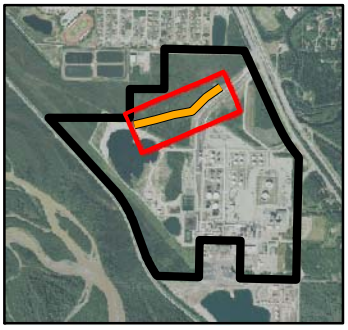


LEGEND:

- Vertical Profile Transect Well
- Ground Surface
- Approximate Groundwater Surface
- Mass Flux Contour
- Well Profile

Notes:

Mass flux values shown were calculated using the Mass Flux Toolkit.
Depths associated with flux values were determined by the Toolkit.
PF = Permafrost encountered at bottom of boring.



FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
FOURTH QUARTER 2012 GROUNDWATER MONITORING REPORT

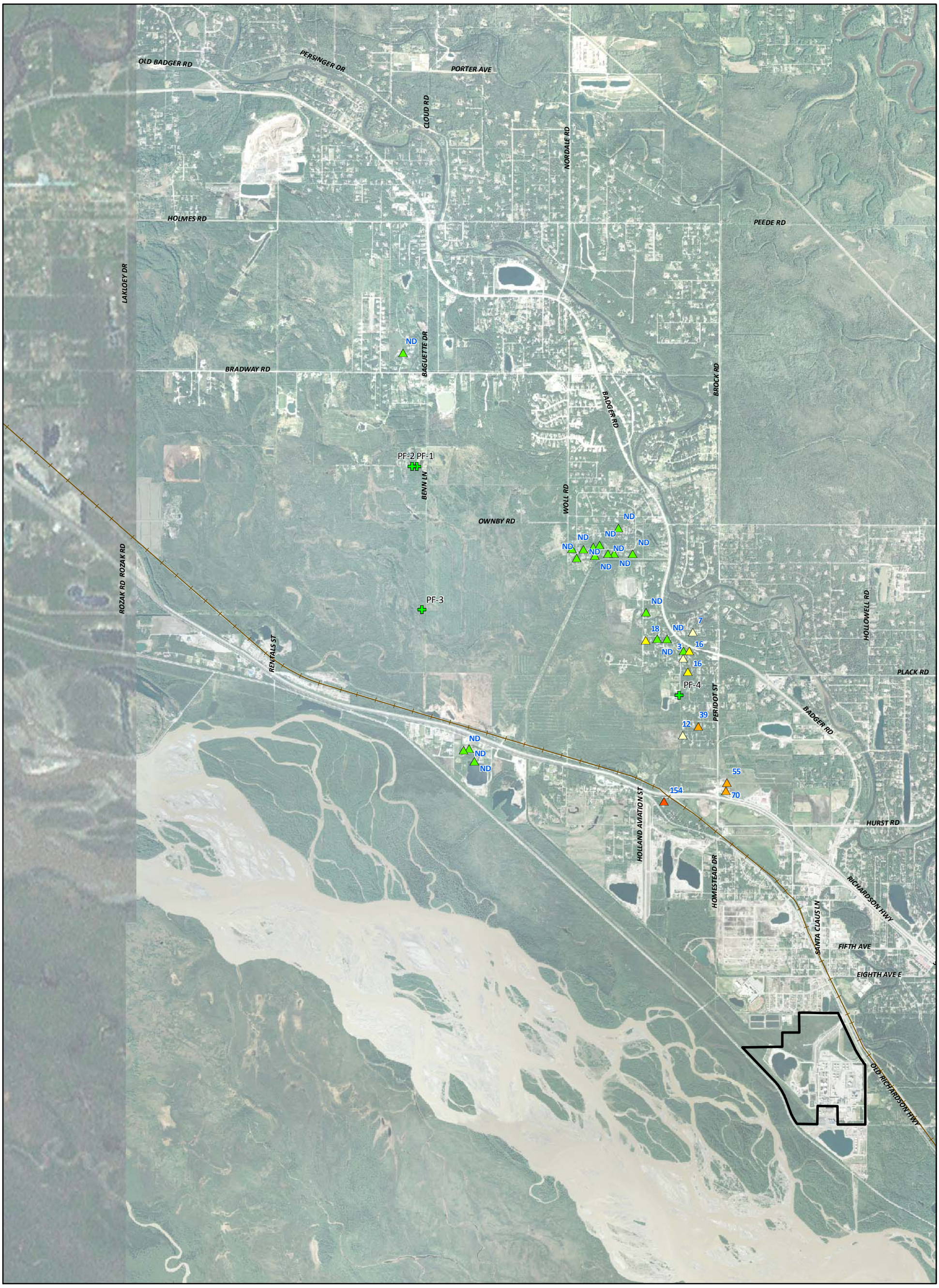
SULFOLANE MASS FLUX RATES 3RD QUARTER 2012

ARCADIS

FIGURE
4-20

CITY: SAN FRANCISCO DIV/GROUP: ENV/IM DB: KERNST LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: H:\GIS\PROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2012_Q4\MXD\Sulfolane_MassFlux_2012Q3.mxd 2/15/2013 2:26:56 PM

CITY: SF DIV/GROUP: ENV/IM DB: KERNST LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: H:\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2012_Q4\MXD\Fig22-Sulfolane_below160ft.mxd 2/28/2013 10:51:04 AM



Legend

Private Well Sulfolane Results
- Not Detected
- 3.2 µg/L - 14 µg/L (J-flagged)
- 14 µg/L - 25 µg/L
- 25 µg/L - 100 µg/L
- Greater than 100 µg/L

- Permafrost Boring
- FHRA Property Boundary
- 22.5 Sulfolane Concentration (µg/L)

0 2,500 5,000
SCALE IN FEET

Notes:
Sulfolane was analyzed by EPA Method 1625B with iso-dilution
Sulfolane results for private wells are shown regardless of sampling date
Image date June 9, 2007

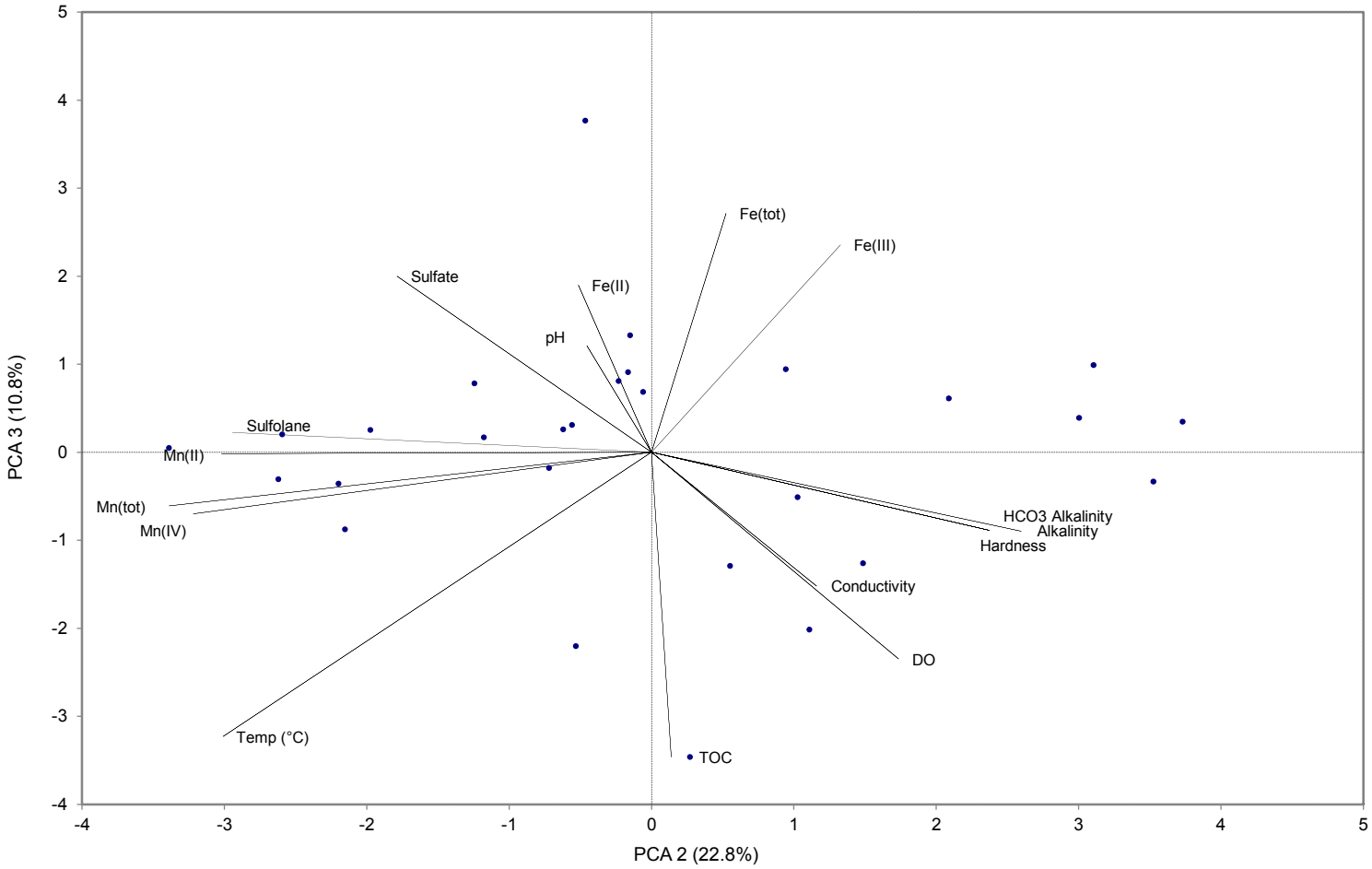
FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA

FOURTH QUARTER 2012
GROUNDWATER MONITORING REPORT

ANALYTICAL RESULTS FOR SULFOLANE GREATER THAN 160 FEET BELOW WATER TABLE

ARCADIS

FIGURE
4-21



Legend

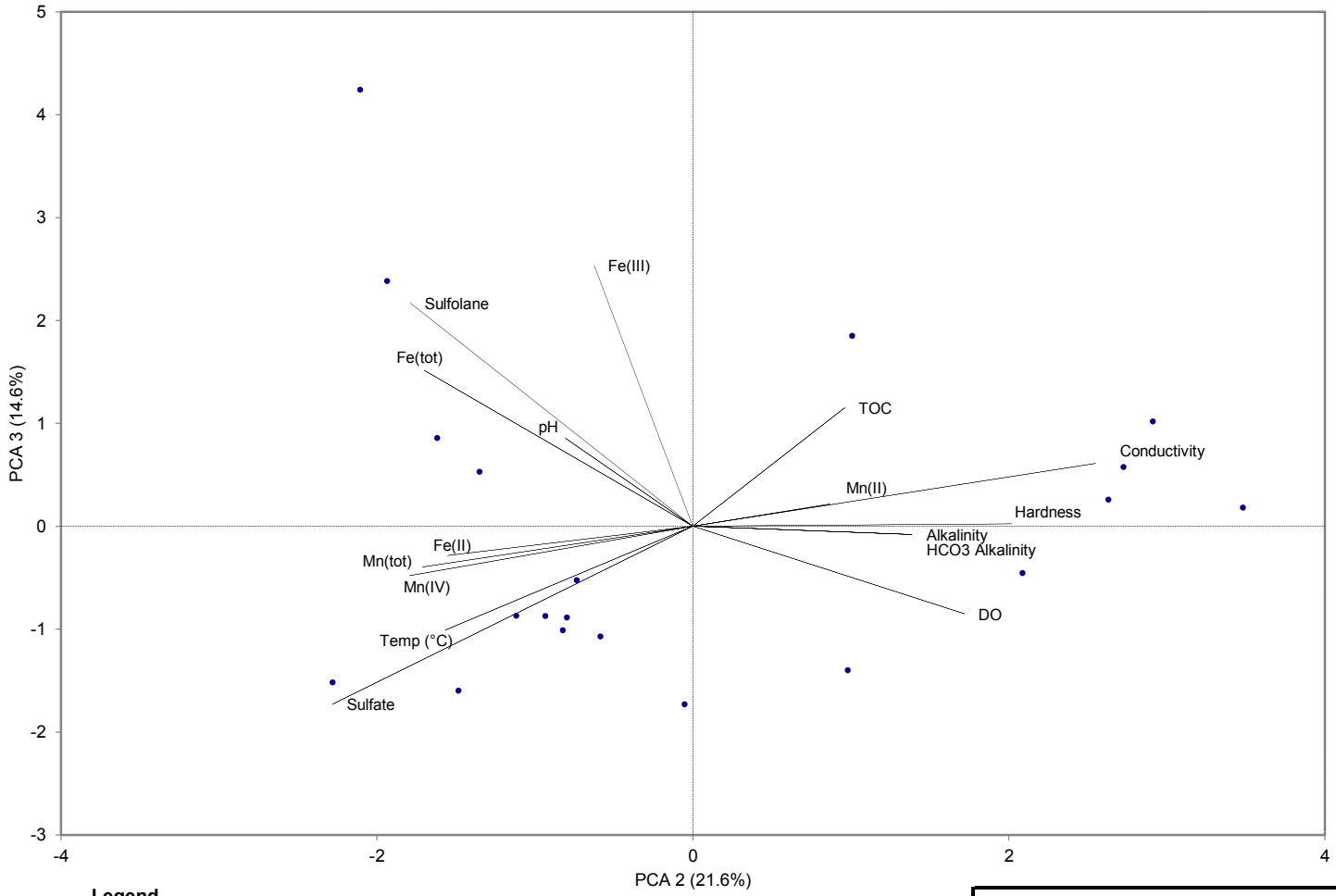
Mn	Manganese
Fe	Iron
TOC	Total Organic Carbon
DO	Dissolved Oxygen
HCO_3	Bicarbonate
°C	Degrees celsius
tot	total
Fe(II), Fe(III)	Valence states of iron
Mn(II), Mn(IV)	Valence states of manganese
PCA	Principal Component Analysis

FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
FOURTH QUARTER 2012
GROUNDWATER MONITORING REPORT

PRINCIPAL COMPONENT PLOT
TRANSECT 1

ARCADIS

FIGURE
4-22



Legend

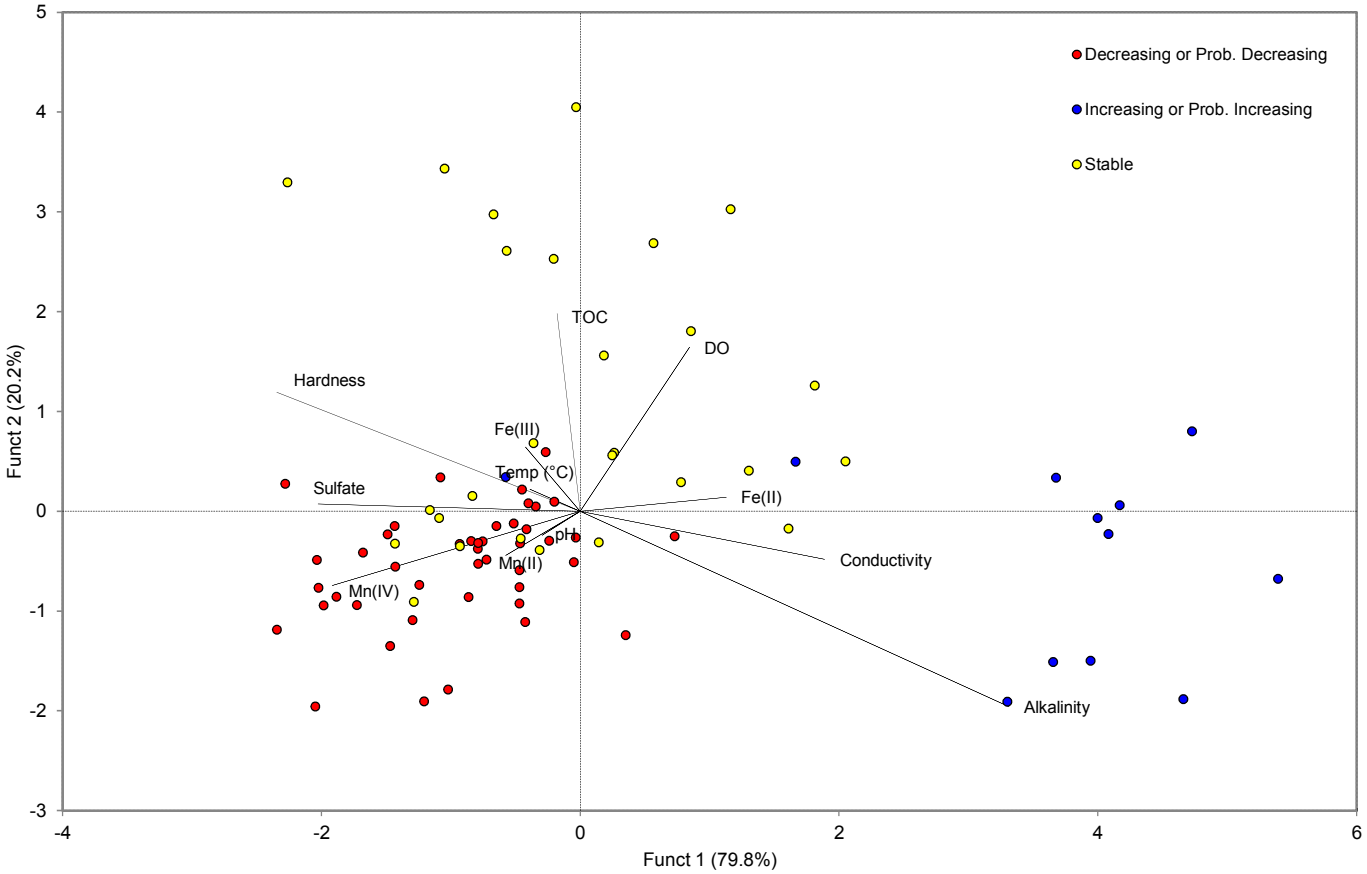
Mn	Manganese
Fe	Iron
TOC	Total Organic Carbon
DO	Dissolved Oxygen
HCO_3	Bicarbonate
°C	Degrees celsius
tot	total
Fe(II), Fe(III)	Valence states of iron
Mn(II), Mn(IV)	Valence states of manganese
PCA	Principal Component Analysis

FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
FOURTH QUARTER 2012
GROUNDWATER MONITORING REPORT

PRINCIPAL COMPONENT PLOT
TRANSECT 2

ARCADIS

FIGURE
4-23



Legend

Mn	Manganese
Fe	Iron
TOC	Total Organic Carbon
DO	Dissolved Oxygen
°C	Degrees celsius
Fe(II), Fe(III)	Valence states of iron
Mn(II), Mn(IV)	Valence states of manganese

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NORTH POLE REFINERY, NORTH POLE, ALASKA
FOURTH QUARTER 2012
GROUNDWATER MONITORING REPORT

DISCRIMINANT ANALYSIS PLOT

ARCADIS

FIGURE
4-24

CITY: SF DIV/GROUP: ENV/IM DB: KERNST LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: H:\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2012_Q4\MXD\AirSparge_PilotTest_Layout.mxd 2/19/2013 1:15:53 PM

Legend

- Monitoring Well
- Air Sparge
- Sparge Monitoring Point
- Air Distribution Piping
- Blower Building

0 20 40
SCALE IN FEET

Notes:

Image date 2010

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NORTH POLE REFINERY, NORTH POLE, ALASKA

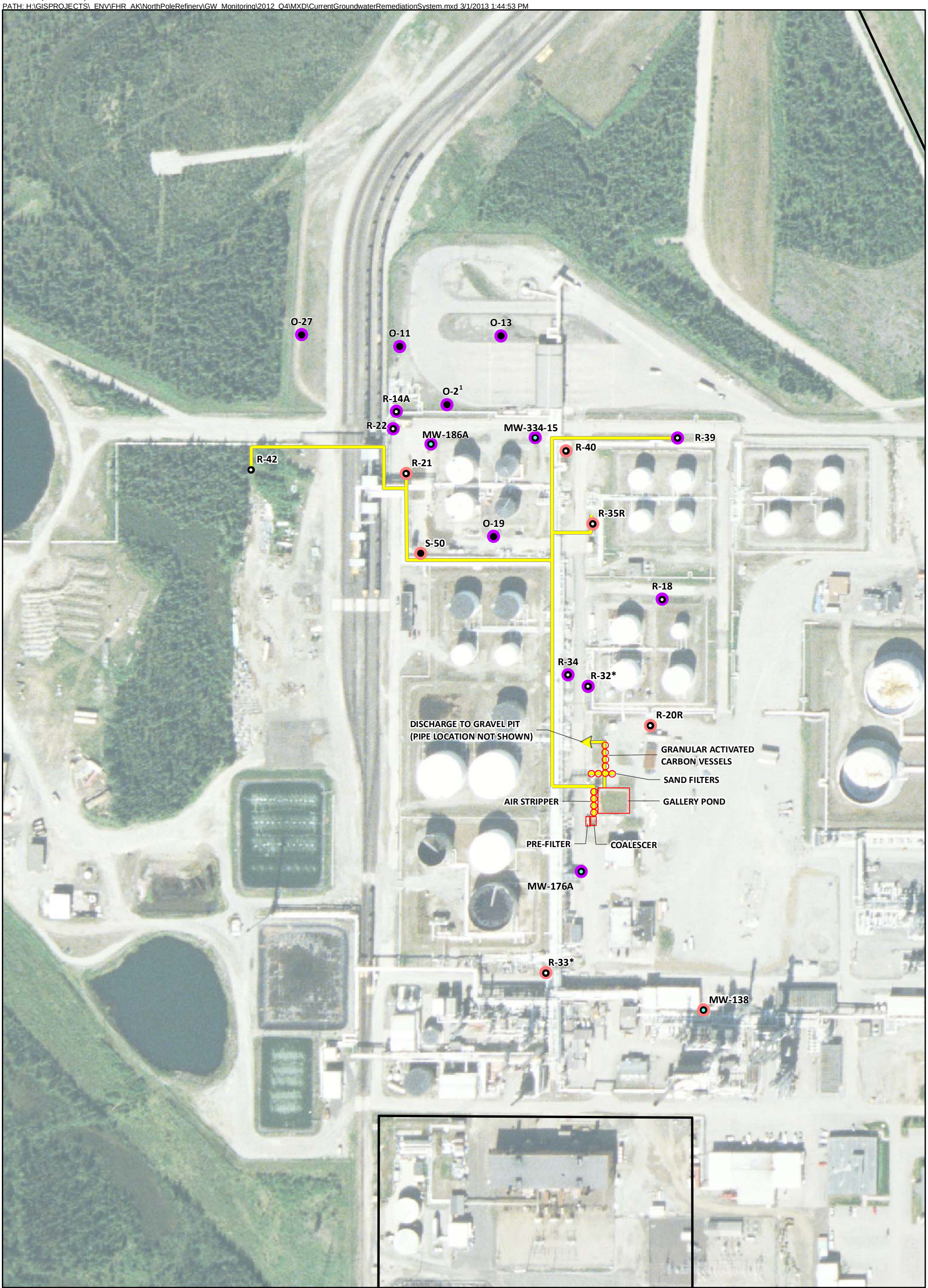
FOURTH QUARTER 2012
GROUNDWATER MONITORING REPORT

AIR SPARGE PILOT TEST
SITE LAYOUT

ARCADIS

FIGURE
4-25

CITY: SF DIV/GROUP: ENV/IM DB: KERNST LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: H:\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2012_Q4\MXD\CurrentGroundwaterRemediationSystem.mxd 3/1/2013 1:44:53 PM



Legend

- Monitoring Well
- Recovery Well
- Observation Well
- Installed Product Recovery System
- Manual Product Recovery
- Remediation System Piping
- FHRA Property Boundary

0 200 400
SCALE IN FEET

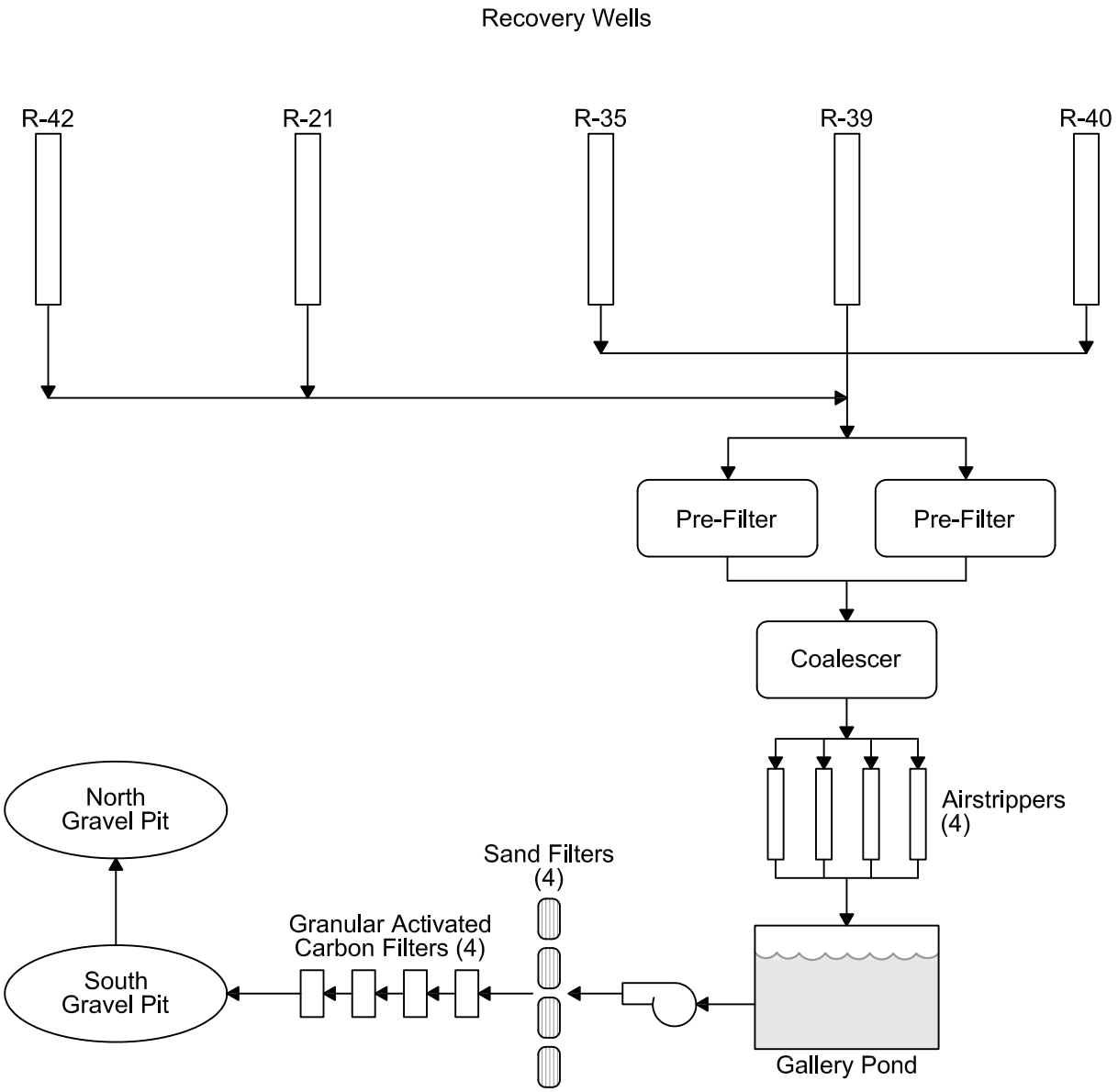
Notes:
*Product recovery systems installed in wells R-32 and R-33 are under evaluation.
Manual product recovery is completed with a vacuum truck or portable product pump.
Image Date: June 9, 2007
[1]Manual product recovery. An installed product recovery system was previously used.

FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
FOURTH QUARTER 2012
GROUNDWATER MONITORING REPORT

CURRENT GROUNDWATER RECOVERY AND TREATMENT SYSTEM LAYOUT

ARCADIS

FIGURE
5-1



NORTH POLE REFINERY
FLINT HILLS RESOURCES ALASKA, LLC
FOURTH QUARTER 2012
GROUNDWATER MONITORING REPORT

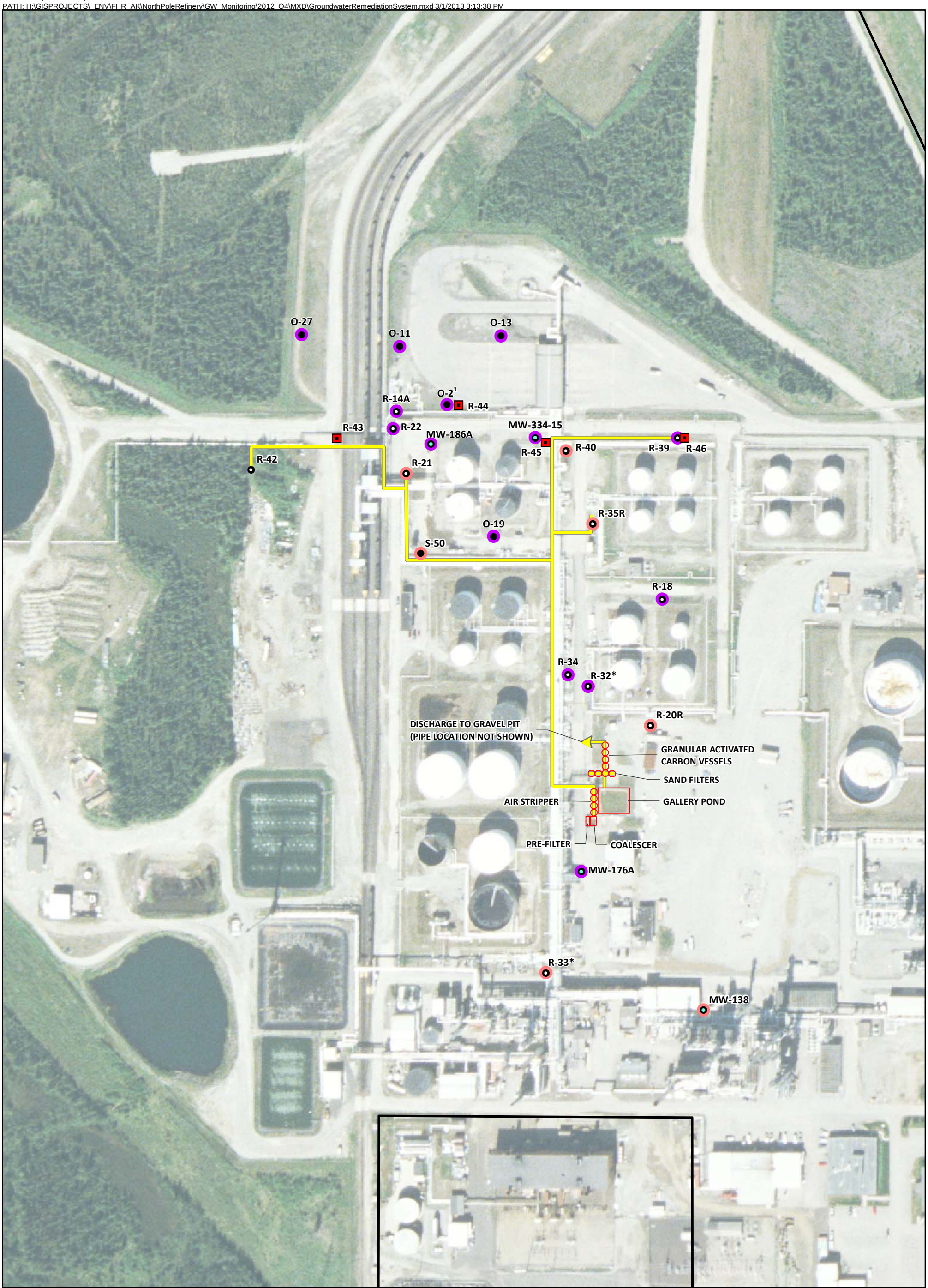
CURRENT PROCESS FLOW DIAGRAM-GROUNDWATER CAPTURE AND TREATMENT SYSTEM

ARCADIS

FIGURE
5-2

CITY: PETALUMA, CA GROUP: ENVCAD DB: (P. WISTED), J. HARRIS
G:\ENVCAD\Petaluma\ACT\B0081981\0030\00001\4Q12\DWG\81981T02.dwg LAYOUT: X SAVED: 2/19/2013 11:30 AM ACADVER: 18.1S (LMS TECH) PAGESETUP: SETUP1 PLOTSTYLETABLE: ARCADIS.CTB PLOTTED: 2/19/2013 11:30 AM BY: HARRIS, JESSICA
XREFS: IMAGES: PROJECTNAME: ---
Fig 2-2 Process Flow Diagram_harris.jpg

CITY: SF DIV/GROUP: ENV/IM DB: KERNST LD: PIC: PM: TM: TR:
PROJECT: (PROJECT #)
PATH: H:\GISPROJECTS_ENV\FHR_AK\NorthPoleRefinery\GW_Monitoring\2012_Q4\MXD\GroundwaterRemediationSystem.mxd 3/1/2013 3:13:38 PM



Legend

- Monitoring Well
- Observation Well
- Recovery Well
- Proposed Recovery Well
- Installed Product Recovery System
- Manual Product Recovery
- Remediation System Piping
- FHRA Property Boundary

0 200 400
SCALE IN FEET

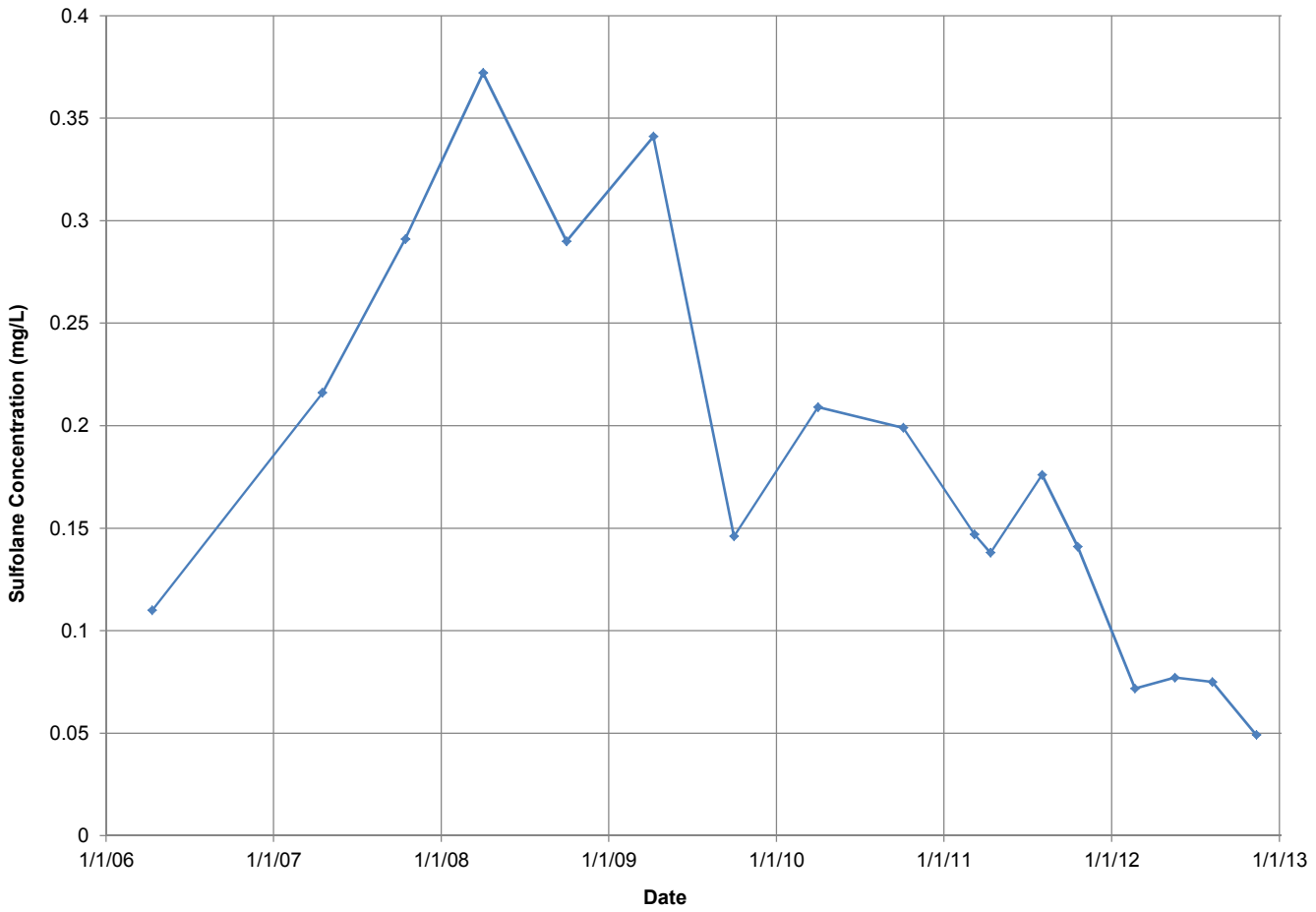
Notes:
*Product recovery systems installed in wells R-32 and R-33 are under evaluation.
Manual product recovery is completed with a vacuum truck or portable product pump.
Image Date: June 9, 2007
[1]Manual product recovery. An installed product recovery system was previously used.

FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
FOURTH QUARTER 2012
GROUNDWATER MONITORING REPORT

GROUNDWATER RECOVERY AND TREATMENT SYSTEM – PROPOSED RECOVERY WELLS

ARCADIS

FIGURE
5-3

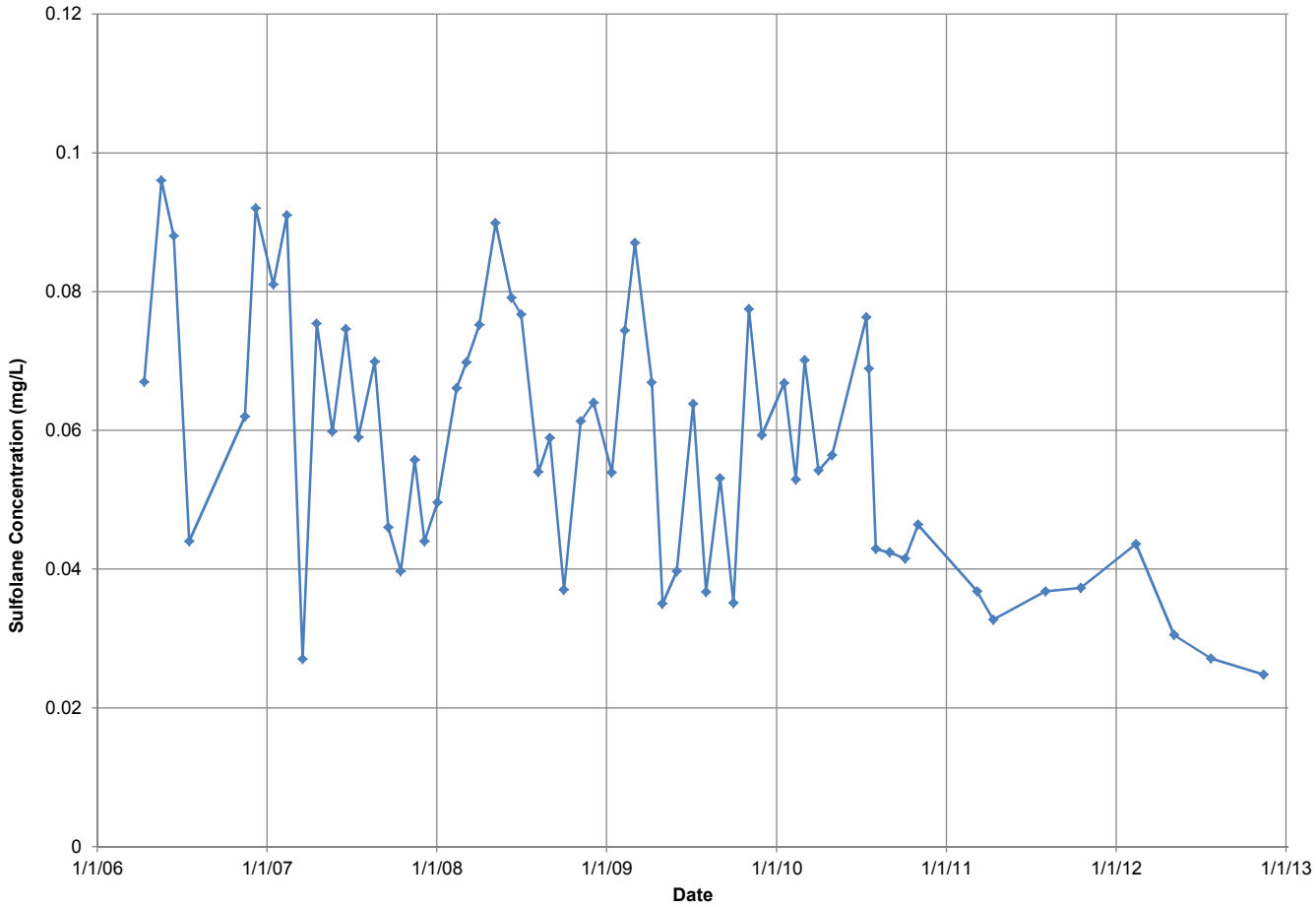


FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
FOURTH QUARTER 2012
GROUNDWATER MONITORING REPORT

MW-127
SULFOLANE ANALYTICAL DATA

ARCADIS

FIGURE
5-4

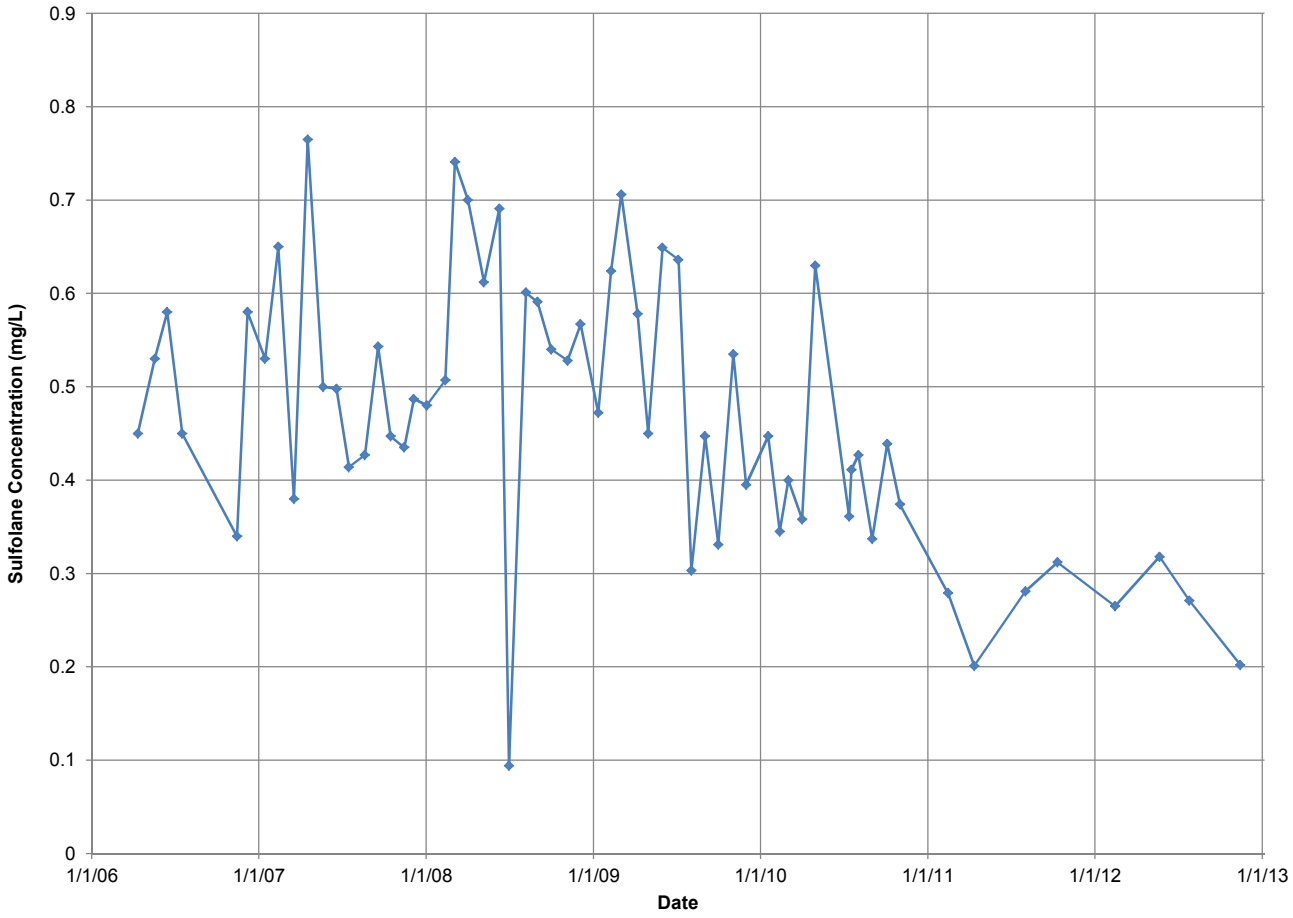


FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
FOURTH QUARTER 2012
GROUNDWATER MONITORING REPORT

MW-131
SULFOLANE ANALYTICAL DATA

ARCADIS

FIGURE
5-5

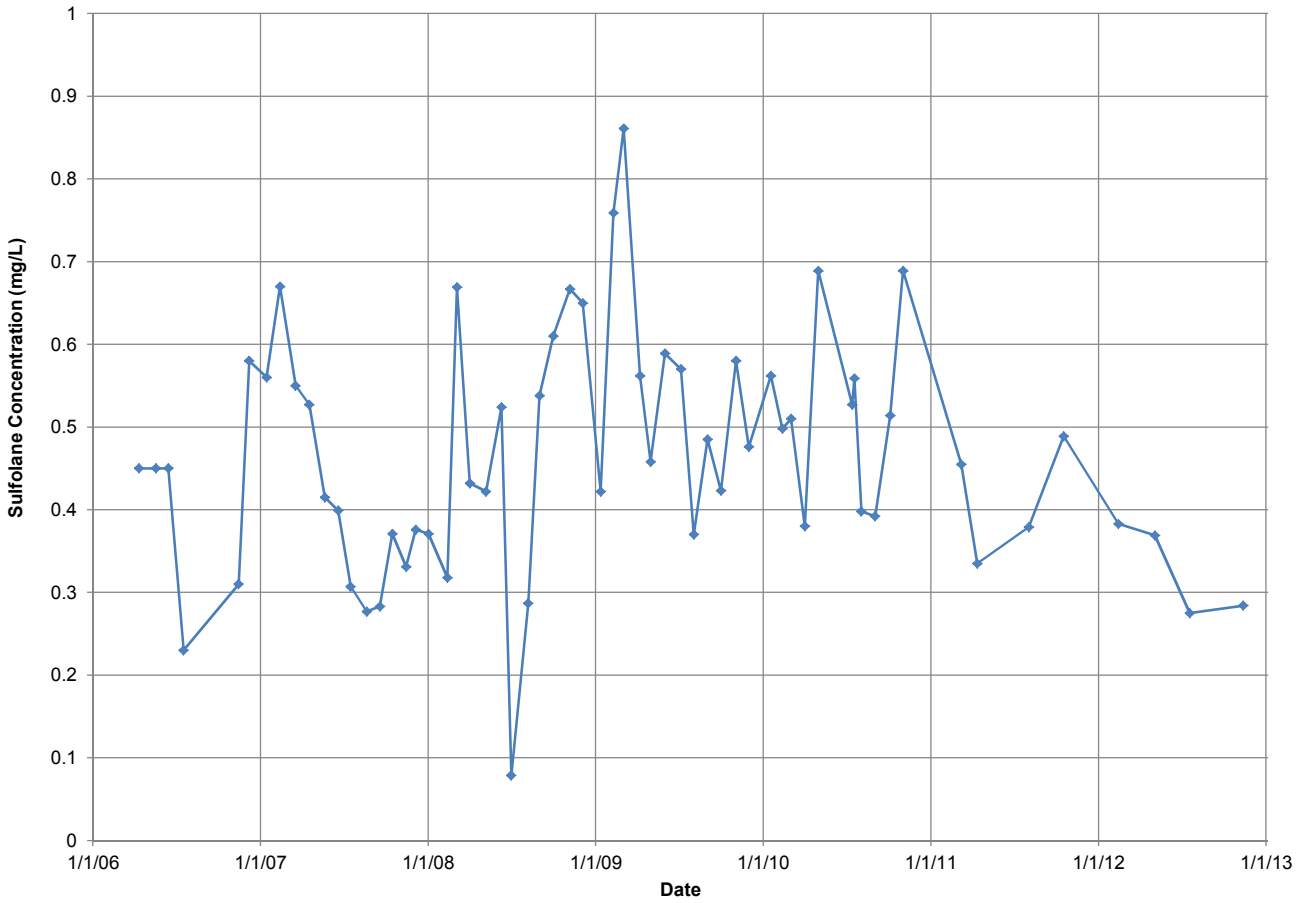


FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
FOURTH QUARTER 2012
GROUNDWATER MONITORING REPORT

MW-139
SULFOLANE ANALYTICAL DATA

ARCADIS

FIGURE
5-6

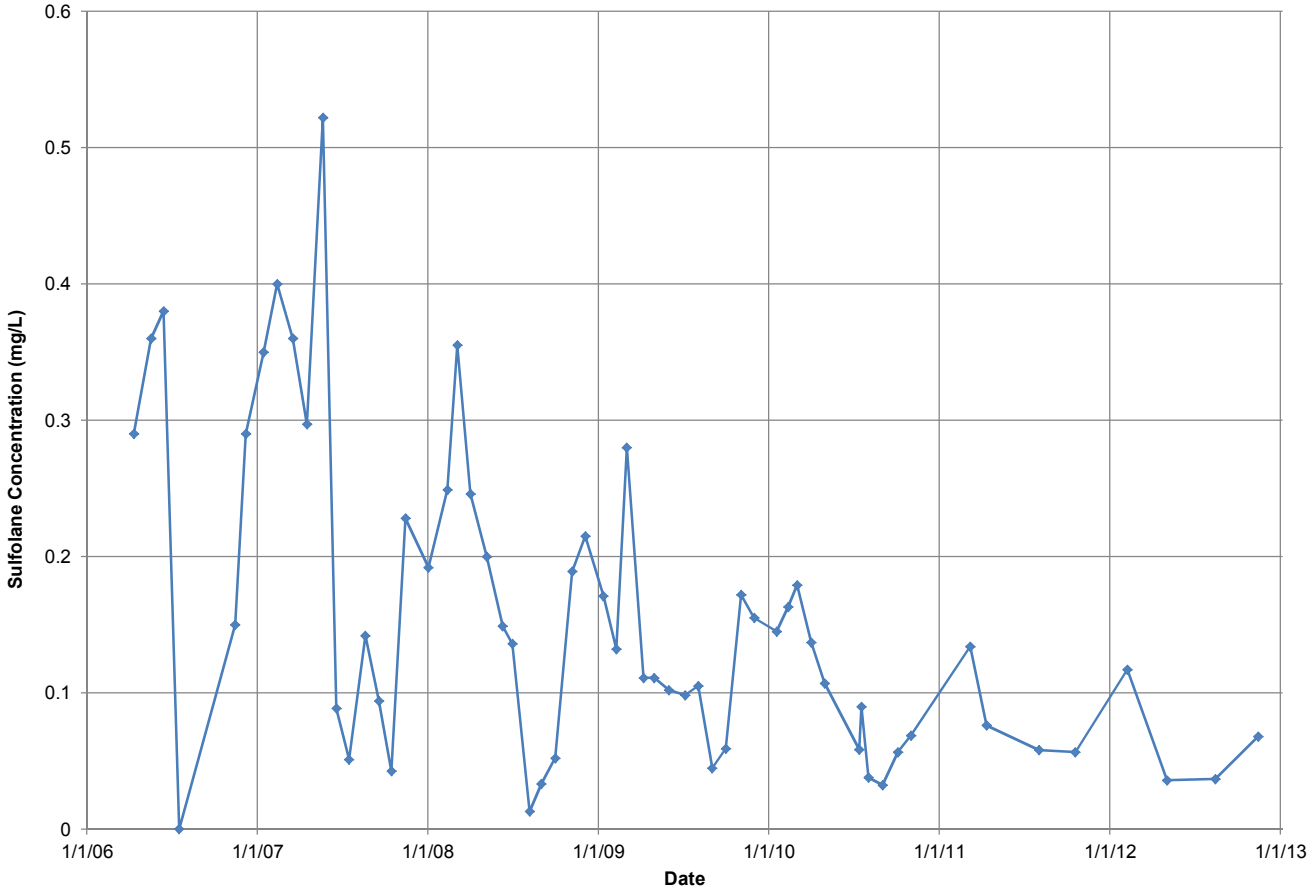


FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
FOURTH QUARTER 2012
GROUNDWATER MONITORING REPORT

MW-142
SULFOLANE ANALYTICAL DATA

ARCADIS

FIGURE
5-7



FLINT HILLS RESOURCES ALASKA, LLC
NORTH POLE REFINERY, NORTH POLE, ALASKA
FOURTH QUARTER 2012
GROUNDWATER MONITORING REPORT

MW-143
SULFOLANE ANALYTICAL DATA

ARCADIS

FIGURE
5-8