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FINAL REMEDIAL INVESTIGATION REPORT
INSTALLATION RESTORATION PROGRAM SITE 27

DCN: SEST-1104-0054-0108

Naval Weapons Station Seal Beach
Detachment Fallbrook
Fallbrook, California

September 2012

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LIST OF ACRONYMS AND ABBREVIATIONS

%	Percent
’	Minute
”	Second
°	Degree
°F	Degree Fahrenheit
µg/L	Microgram per liter
$\mu g/m^3$	Microgram per cubic meter
3D	Three-dimensional
ADD	Average daily dose
AL	Allowable limit
ARAR	Applicable or relevant and appropriate decision
ASTM	ASTM International
AUF	Area use factor
BAMP	Biological Avoidance and Minimization Plan Addendum
BW	Body weight
CAGN	Coastal California gnatcatcher
Cal-EPA	California Environmental Protection Agency
CAS	Columbia Analytical Services
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	Conversion factor
CH_4	Methane
CHHSL	California Human Health Screening Level
cm/sec	Centimeter per second
CO_2	Carbon dioxide
COPC	Constituent of potential concern
C_{soil}	Contaminant concentration in soil
CSM	Conceptual site model
C_{SW}	Concentration in storm water
CTO	Contract Task Order
DDT	Dichlorodiphenyltrichloroethane
Det. Fallbrook	Detachment Fallbrook
DHS	California Department of Health Services
Dig Alert	Underground Service Alert of California

LIST OF ACRONYMS AND ABBREVATIONS (Continued)

$Dose_{oral}$	Daily dose contaminants ingested
$Dose_{prey}$	Dose oral calculated for prey item
DTSC	California Department of Toxic Substance Control
DWI	Daily water ingestion
Eh	Oxidation-reduction potential
EMAX	EMAX Laboratory
EPA	U.S. Environmental Protection Agency
ERAGS	Ecological Risk Assessment Guidance for Superfund
ESL	Ecological screening level
EVS	Environmental Visualization Software
FD	Fraction of dietary intake
FS	Feasibility Study
FI	Food ingestion rate
ft	Foot
ft^2	Square foot
ft amsl	Feet above mean sea level
ft bgs	Feet below ground surface
Geosyntec	Geosyntec Consultants, Inc.
gpm	Gallon per minute
gpm/ft	Gallon per minute per foot (or feet)
GPS	Global positioning system
H_2S	Hydrogen sulfide
HHRA	Human health risk assessment
HQ	Hazard quotient
IAS	Initial assessment study
IDW	Investigation-derived waste
in.	Inch
IR	Inhalation rate
IRP	Installation Restoration Program
kg	Kilogram
K_s	Saturated hydraulic conductivity
L	Liter
LandGEM	Landfill Gas Emissions Model
LBV	Least Bell's vireo
LFG	Landfill gas

LIST OF ACRONYMS AND ABBREVATIONS (Continued)

m^3/day	Cubic meter per day
MARRS	MARRS Services, Inc.
MCB	Marine Corps Base
MCL	Maximum contaminant level
mg/kg	Milligram per kilogram
ms/msd	Matrix spike/matrix spike duplicate
MW	Monitoring well
N_2	Nitrogen
NAVFAC SW	Naval Facilities Engineering Command Southwest
NAVWPNSTA	Naval Weapons Station
NCEP	National Centers for Environmental Prediction
ND	Not detected
NDMA	N-nitrosodimethylamine
NEESA	Naval Energy and Environmental Support Activity
NELAP	National Environmental Laboratory Accreditation Program
ng/L	Nanogram per liter
No.	Number
NOAEL	No Observable Adverse Effect Level
NP	Non Plastic
NPDES	National Pollutant Discharge Elimination System
O_2	Oxygen
OF	Occupancy factor
OSWER	Office of Solid Waste and Emergency Response
PAL	Project Action Limit
PBDE	Polybrominated diphenylether
PCB	Polychlorinated biphenyl
pH	Potential hydrogen
PPE	Personal protective equipment
PVC	Polyvinyl chloride
QA/QC	Quality assurance/quality control
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RL	Reporting limit
RSL	Regional Screening Level

LIST OF ACRONYMS AND ABBREVATIONS (Continued)

RTC	Response to Comments
RWQCB	Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
SB	Seal Beach
SC	Clayey sand
SC-SM	Silty clayey sand
SES-TECH	Sealaska Environmental Services, LLC and Tetra Tech EC, Inc.
SI	Site Inspection
SKR	Stephen's kangaroo rat
SLERA	Screening Level Ecological Risk Assessment
SM	Silty sand
SoI	Soil ingestion rate
SVOC	Semivolatile organic compound
TPH	Total petroleum hydrocarbon
TRV	Toxicity reference value
UF	Uptake factor
U.S. EPA	United States Environmental Protection Agency
U.S.	United States
UCL	Upper confidence limit
USCS	Unified Soil Classification System
UTL	Upper tolerance limit
VOC	Volatile organic compound
WDRS	Waste Discharge Requirements for Storm Water
yd^3	Cubic yard

EXECUTIVE SUMMARY

The Remedial Investigation (RI) Report presents the findings, conclusions and recommendations for activities conducted at Naval Weapons Station Seal Beach Detachment Fallbrook Installation Restoration Program (IRP) Site 27, Eucalyptus Grove Landfill in Fallbrook, California (Site). The purpose of the RI is to address data gaps remaining from the *Final Site Inspection (SI) Report, IRP Site 27* (MARRS Services, Inc. [MARRS] 2009) and address concerns brought up in the San Diego Regional Water Quality Control Board (RWQCB) letter dated July 3, 2008. Investigations performed during the RI to further characterize the surface and subsurface of the landfill included:

- Soil: re-sampling of an anomalous soil concentration detected above screening levels for Arsenic based on SI results;
- Soil Gas: characterization of soil gas within the landfill and potential for off-site migration;
- Groundwater: verification of groundwater gradient and flow direction, and analysis of groundwater quality and potential source/s for constituents of potential concern (COPC);
- Surface Water: evaluation of impacts to surface water quality by landfill; and
- Landfill Cover Integrity: evaluation of landfill cover thickness.

Revised screening level human health and ecological risk assessments were conducted that incorporated the RI data. The screening level human health risk assessment (HHRA) and screening level ecological risk assessment (SLERA) were based upon the United States (U.S.) Environmental Protection Agency (EPA) guidance and consistent with the approach used in the previous screening level human health and ecological risk assessment (MARRS, 2009). The RI HHRA and SLERA incorporate the new groundwater, landfill gas, soil, storm-water, and soil gas data collected in the RI. A revised Conceptual Site Model encompasses historical and new data obtained at the Site.

The landfill is covered with approximately two feet of soil, which minimizes direct human and ecological exposure to the waste. The total estimated volume of refuse in the landfill is 24,000 cubic yards based on the SI (MARRS, 2009). During its time as a

landfill, IRP Site 27 accepted 20 to 30 dumpsters of refuse per week. The estimated 24,000 cubic yards of waste would be equal to approximately 18.5 cubic yards per day over the approximate 5 year life of the landfill. The potential for groundwater, soil, storm water, and soil vapor impacts from IRP Site 27 were identified in the SI (MARRS, 2009) based on the disposal of small quantities of hazardous waste, including empty paint cans with dried paint residues, fluorescent lights, fluorescent light ballasts, spent silica sandblast grit containing paint chips, paint booth residue, rags with solvent residue, used paint brushes, and asbestos. Metal and pallets that were potentially treated with pentachlorophenol were also disposed of at IRP Site 27. The waste prism is the area where the waste material exists as a significant percent of the matrix in the soil, is not defined by a contaminant plume in groundwater and incorporates areas where daily cover, interim cover, and soil cover overlie the disposed waste. The waste prism identifies the areas where waste placement occurred such as trench and fill or ravine infilling.

Investigation activities were performed in accordance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as discussed in the U.S. EPA *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988). Naval Facilities Engineering Command Southwest (NAVFAC SW) is responsible for directing the proposed work, and per NAVFAC SW directives, SES-TECH is responsible for completing the work. The San Diego RWQCB and the California Department of Toxic Substance Control (DTSC) provided regulatory oversight for this project.

The RI was completed in accordance with the procedures and methods listed in the RI Work Plan and Sampling Analysis Plan. In reviewing the data from the RI sampling and in addition, the results from the HHRA and SLERA, the following determinations have been made:

- No further action is required for arsenic in soil within the waste prism. The elevated arsenic concentration was determined to be an anomalous value and the concentration in IRP27-SS-1 (2.79 milligrams per kilogram [mg/kg]) is well below the DTSC background level of 12 mg/kg for southern California sites (Cal-EPA DTSC, 2007).
- No further action is required for soil gas. Soil gas sampling results did not exceed the Project Action Limits (PAL) (established in the Sampling and Analysis Plan (SAP) [Sealaska, 2010] and are based on the DTSC Industrial

California Human Health Screening Levels (CHHSLs) for industrial sites [Cal-EPA 2005]) for soil gas. The soil gas data showed that conditions are aerobic within the waste and outside the waste limits, with evidence of aerobic decomposition of organic matter observed in data for the deeper samples from within the waste. Consistent with the aerobic conditions at the Site, hydrogen sulfide was not detected within the waste or outside it.

- There is no evidence in the data for the presence of waste at or near the location of samples SG 3-5 and SG 3-8, and those locations seem to be north of the northernmost extent of waste.
- Groundwater elevation data collected from the eight-well network suggests that groundwater flow direction is to the northeast and the groundwater gradient ranges from 0.0038 to 0.0128.
- Groundwater analytical data shows detected concentrations above the secondary maximum contaminant level (MCL) for manganese, the PAL for this constituent (which were defined in the SAP [Sealaska, 2010] and are based on MCLs or secondary MCLs). Additional groundwater data needs to be collected to provide statistical evidence that groundwater is not impacted and that manganese impacts are naturally occurring based on the presence of manganese in the upgradient well, MW-12.
- Landfill cover material is fine-grained soil with a thickness of the soil cover which averages approximately two feet.
- Surface water impacts do not pose a threat based on the human health risk assessment and the screening level ecological risk assessment.
- Approximate maximum waste volume calculated, based on several lines of data, ranged from 65,728 to 93,619 cubic yards.
- The landfill does not appear to consistently impact downgradient water quality as supported by the two rounds of groundwater sampling to date. The only COPC above screening levels in downgradient wells is manganese, and these results have not been consistent over the two sampling events.

Methodology, field activities, and discussion of the findings, conclusions, and recommendations are presented in the RI Report.

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1.0 INTRODUCTION

1.1 Purpose

This Remedial Investigation (RI) Report presents the findings for the investigation activities at the Naval Weapons Station (NAVWPNSTA) Seal Beach Detachment Fallbrook (Det. Fallbrook) Installation Restoration Program (IRP) Site 27, Eucalyptus Grove Landfill in Fallbrook, California (Figure 1). This RI Report was prepared by SES-TECH, a joint venture between Sealaska Environmental Services, LLC and Tetra Tech EC, Inc., and their subcontractor, Geosyntec Consultants, Inc. (Geosyntec), under Naval Facilities Engineering Command Southwest (NAVFAC SW) Indefinite Delivery/Indefinite Quantity Remediation Contract Number (No.) N68711-04-D-1104, Contract Task Order (CTO) No. 0054. Investigation activities were performed in accordance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as discussed in the United States (U.S.) Environmental Protection Agency (EPA) *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988) and *Remedial Investigation Work Plan Installation Restoration Program Site 27* NAVWPNSTA Seal Beach Det. Fallbrook, Fallbrook, California (SESTECH, 2010). NAVFAC SW were responsible for directing the work and, per NAVFAC SW directives, SES-TECH was responsible for completing the work. The San Diego Regional Water Quality Control Board (RWQCB) and the California Environmental Protection Agency (Cal-EPA) Department of Toxic Substance Control (DTSC) provide regulatory oversight for this project.

The purpose of the RI is to address data gaps remaining from the *Final Site Inspection (SI) Report, IRP Site 27* (MARRS Services, Inc. [MARRS] 2009) and address concerns brought up in the RWQCB letter dated July 3, 2008. (Appendix A). The Final SI Report (included as Appendix B) recommended verification of the groundwater gradient, evaluation of potential soil gas issues, identification of the source of elevated metals concentrations in groundwater and the potential for off-site migration of metal impacts, evaluation of the existing landfill cover integrity; and assessment of potential surface water impacts. In addition to the actions recommended in the Final SI Report, this investigation evaluated groundwater concentrations for additional analytes at the perimeter and interior of the landfill and assessed an elevated arsenic concentration detected in a single soil sample (IR27B02) within the waste prism which was identified in the SI (MARRS, 2009). Additional investigation components included new geophysical survey of the landfill to satisfy SI data gaps and further refine the limits of waste, completion of a recent topographic survey of the Site, installation of new

monitoring wells (MW)-4A, -5A, -7, and -9A to evaluate groundwater quality and groundwater gradient, installation of MW-12 to evaluate upgradient water quality, and potholing of the landfill cover to evaluate the cover thickness. The RI investigation included soil gas probes within and around the perimeter of the waste prism to evaluate soil gas at the Site. Storm water sampling was completed upgradient, downgradient, and on the landfill cover.

1.2 Report Format and Organization

This RI Report is organized into the following sections after this introductory section:

- Section 1 – "Introduction" provides an overview of the project and field activities conducted during the RI;
- Section 2 – "Project Background" provides an overview of the IRP Site 27 background information, including Site operations, waste disposed, and past investigations;
- Section 3 – "General Physical Setting" addresses Site topography, surrounding land uses, climate, biology, geology and hydrogeology, and contaminant sources;
- Section 4 – "Hydrogeologic Investigation" provides a summary of the groundwater field activities, a summary discussion of groundwater analytical results, and groundwater levels and gradients, which is supplemented by tables, figures, and appendices;
- Section 5 – "Soil Gas Field Activities" provides a summary and brief explanation of the soil gas investigation and soil gas analytical results;
- Section 6 – "Soil Sampling Field Activities" provides a discussion of the historical and present analytical data regarding the elevated arsenic value identified in the SI data set;
- Section 7 – "Landfill Cover and Surface Water Evaluation" provides a discussion of the geotechnical data from soil samples collected from the cover material, a discussion on the landfill cover thickness and extent, and storm water field activities and analytical results;
- Section 8 – "Nature and Extent" summarizes area and extent of constituents of potential concern (COPC) based on analytical data, also evaluates the three-dimensional (3D) volume of the waste prism using available data;

- Section 9 – “Risk Assessment” provides screening level risk assessment analysis to evaluate potential risks to public health and safety and to the environment;
- Section 10 – “Summary and Conclusions” provides findings and conclusions for respective elements of the investigation;
- Section 11 – “Recommendations” provides recommendations for further investigation as a result of findings; and
- Section 12 – “References” provides references cited in this RI Report.

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2.0 PROJECT BACKGROUND

2.1 Site Description

Det. Fallbrook is located on the interior side of Marine Corps Base (MCB) Camp Pendleton in the northern area of San Diego County adjacent to the unincorporated area of Fallbrook (Figure 1). NAVWPNSTA Seal Beach Det. Fallbrook is a facility which has supported a variety of activities, including providing ordnance, inspection, maintenance, research, testing, and storage for the Navy fleet. IRP Site 27 is located within the south magazine area of Det. Fallbrook, near Building 366. IRP Site 27 is also referred to as the Eucalyptus Grove Landfill because eucalyptus trees were planted in the cover when the landfill was closed in 1974. The landfill is located within a dry ravine that trends south to north (Figure 2). The elevation at the south end of the landfill is approximately 640 feet above mean sea level (ft amsl) and the northern end of the landfill is at approximately 580 ft amsl.

2.2 Site History and Operations

Based on historical information presented in the initial assessment study (IAS), the Site was up to 1,000 feet (ft) long by 300 ft wide with a depth of around four ft. Records indicate that the total estimated volume of refuse in the landfill is approximately 24,000 cubic yards (yd^3) based on an estimated 20 to 30 dumpsters of refuse disposed of per week at the Site (MARRS, 2009). Based on an approximate five-year life for the landfill, this span would amount to approximately 10 to 15 yd^3 per day of disposal. The landfill was operated from the late 1960's until 1974 when the Navy began shipping waste off site and the landfill was closed (MARRS, 2009). RI evaluation of the Site refined the Site surface dimensions to an approximate area of 80,902 square feet (ft^2) based on the revised inferred landfill extent. Depth to waste encountered in the potholes, soil gas probes, and soil sampling ranged from approximately one to three ft, indicating an average cover thickness of approximately two ft. Maximum potential waste volume within the ravine was estimated based on thickness differentials present before the existence of the landfill and after the closure of the landfill (discussed in Section 7). The maximum potential waste volume is estimated at 65,728 yd^3 based on the revised 3D modeling of the landfill extent.

The potential for groundwater, soil, and soil vapor impacts to IRP Site 27 were identified based on the disposal of small quantities of hazardous waste, including empty

paint cans with dried paint residues, fluorescent lights, fluorescent light ballasts, spent silica sandblast grit containing paint chips, paint booth residue, rags with solvent residue, used paint brushes, and asbestos. Metal and pallets that were potentially treated with pentachlorophenol were also disposed of at IRP Site 27 (MARRS, 2009).

2.3 Past Investigations and Reports

In 1985, Naval Energy and Environmental Support Activity (NEESA) conducted an IAS of NAVWPNSTA Seal Beach sites, including 12 located at Det. Fallbrook. The IAS recommended additional evaluation at each of the Det. Fallbrook sites. In response to the IAS, the U.S. EPA and the California Department of Health Services (DHS) recommended additional soil and groundwater investigations to evaluate contaminants of concern, contaminant migration, and the potential exposure pathways (MARRS, 2009).

In response to these comments, NAVWPNSTA Seal Beach Det. Fallbrook requested NEESA to prepare an addendum to the IAS. The addendum (completed in 1990) evaluated the recommendations of the U.S. EPA and DHS and recommended an SI be conducted at IRP Site 27 because hazardous wastes had been disposed of at the landfill.

In 2005, MARRS finalized a Work Plan to conduct an SI as described in the addendum. In 2007, MARRS implemented the work outlined in the Work Plan to determine the extent of the landfill and to assess the presence of COPCs and their potential risk to human health and ecological receptors. The Final SI Report is provided as Appendix B. During the SI, 38 soil samples and three groundwater samples were collected within the estimated extent of the landfill. Analytes detected in soil samples included hexavalent chromium, polybrominated diphenyl ether, semivolatile organic compounds (SVOC), pesticides, polychlorinated biphenyls (PCB), and metals. Detected concentrations of these analytes in soil were below screening levels as reported in the SI Report (MARRS, 2009).

Analytes detected at concentrations above secondary maximum contaminant levels (MCLs) in groundwater samples collected from wells within the inferred landfill footprint included aluminum, iron, and manganese. In addition, N-nitrosodimethylamine (NDMA) and total petroleum hydrocarbons (TPH), which do not have established MCLs, were detected. The analytes detected during the SI at concentrations greater than their screening levels in the groundwater wells are presented

in Figure 3. These included iron ranging from 1,670 micrograms per liter (µg/L) to 7,900 µg/L, manganese from 77 µg/L to 2,070 µg/L, and aluminum ranging from 1,380 µg/L to 6,250 µg/L (MARRS, 2009).

As part of the SI, MARRS developed a conceptual site model (CSM) that included the geology and hydrogeology of IRP Site 27 and the exposure pathways for humans and other ecological receptors. In the basic hydrogeologic conceptual model presented in the SI, groundwater is migrating along the soil-bedrock interface and accumulating in the topographically low portion of the landfill at the northern extent. According to the SI, COPCs have been detected in the soil at IRP Site 27, but it is unlikely that the COPCs present a risk to an on-site industrial worker, construction worker, resident, or off-site adult or child farmer (MARRS, 2009). In addition, the SI concludes that it is unlikely that the COPCs detected pose a significant risk to ecological receptors. Despite this conclusion, the Final SI Report as well as a letter from the RWQCB dated July 3, 2008 (Appendix A) recommended that an investigation be conducted at IRP Site 27 to address remaining data gaps (MARRS, 2009). This RI has been conducted to address these data gaps.

These data gaps included:

1. Soil: re-sampling of an anomalous soil result above screening level for Arsenic based on SI results;
2. Soil Gas: characterization of soil gas within the landfill and potential for off-site migration;
3. Groundwater: verification of groundwater gradient and flow direction, and analysis of groundwater quality and potential source/s for COPCs;
4. Surface Water: evaluation of impacts to surface water quality by landfill;
5. Landfill Cover Integrity: Evaluations of landfill cover thickness; and
6. Waste Prism: Evaluate the extent of the landfill waste prism.

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3.0 GENERAL PHYSICAL SETTING

3.1 Topography and Surface Features

Det. Fallbrook is situated at latitude 33 degrees (°) 22 minutes (’) 18 seconds (”) North and longitude 117° 14’ 10” West. Det. Fallbrook is located in the northern area of San Diego County adjacent to the unincorporated area of Fallbrook and bordered on three sides by MCB Camp Pendleton. Det. Fallbrook lies between the San Onofre and Santa Margarita Mountain ranges and has a moderate topography characterized by alluvial bottom lands of the Santa Margarita River to flat plateaus, steep ridges, and bluffs between the ranges (MARRS, 2009).

Site 27 is located within a north-south ravine with over 60 ft of elevation drop from south to north over the length of the landfill. The west side of the Site is bounded by a ravine ranging from less than one to approximately six feet deep and joining a second smaller ravine in the north. The eastern side of the Site is bounded by rocky outcrops covered by a thin layer of vegetation.

3.2 Adjacent Land Uses

Much of the area adjacent to Det. Fallbrook is sparsely populated and the dominant local activity is agricultural, including avocado farming, nurseries, and some ranching (MARRS, 2009). Det. Fallbrook is a facility which has supported a variety of activities including providing ordnance, inspection, maintenance, research, testing, and storage for the Navy fleet.

IRP Site 27 is located in the southeastern portion of Det. Fallbrook, south of Ammunition Road within the area designated as the South Magazine. Access to the Site and surrounding area is controlled 24/7 via video monitored gates and fencing. Historically, this area has also been used for cattle grazing. Grazing operations were suspended from 2004 to 2010, but have resumed as part of fire suppression efforts and habitat protection for the endangered species (Smith, 2010).

3.3 Climate

The area climate is classified as Mediterranean with mild winters and warm to hot summers. Temperatures range from winter lows in the 40s to 50s degrees Fahrenheit (°F) to summer highs in the 70s-80s °F. Annual precipitation averages 12 inches (in.), with approximately 90 percent (%) occurring between the months of November and

April. Prevailing winds average 3.8 miles per hour from the west. Occasional strong, dry winds from the northeast, known as the "Santa Ana's," occur in the fall, winter, and early spring (MARRS 2009).

3.4 Biological Survey

Three federally listed endangered animal species and one federally threatened animal species, which include Stephen's kangaroo rat (SKR, *Dipodomys stephensi*), coastal California gnatcatcher (CAGN, *Polioptila californica*), Arroyo toad (*Bufo californicus*), and Least Bell's vireo (LBV, *Vireo bellii pusillus*), inhabit Det. Fallbrook. Three of the four species, SKR, CAGN, and LBV, dwell in the vicinity of IRP Site 27 (Biological Avoidance and Minimization Plan Addendum [BAMP], 2010). The remaining specie, the Arroyo toad, has not been reported as residing in the vicinity of IRP Site 27 and is unlikely to be found because there is a lack of suitable habitat.

Focused species surveys in the last 10 years have not documented LBV within the project footprint. However, it has been found that suitable habitat occurs adjacent to IRP Site 27 (BAMP, 2010). Although the CAGN was not observed within the boundary of IRP Site 27 in the most recent field survey performed in 2009, it has been found that suitable habitat occurs on and adjacent to IRP Site 27 and CAGN was observed between IRP Site 27 and the adjacent road (BAMP, 2010). A biologist completed a SKR survey at the Site prior to field work and identified suitable habitat adjacent to Site 27 but no active SKR burrows. Avoidance measures were implemented to reduce impacts to SKR, including avoidance of the SKR flagged areas and limited access routes into and out of the Site. To minimize noise and reduce potential negative impacts on endangered bird species with breeding seasons that overlap the rainy season, sampling teams used bladder pumps during groundwater sampling. The majority of field work occurred outside the recognized breeding season (February 15 to August 15) to significantly reduce impact.

To reduce potential negative impacts on endangered species, their habitats, and flora at IRP Site 27, SES-TECH and Geosyntec implemented avoidance and minimization measures during field work as outlined in the BAMP (Attachment 1). Ingress and egress routes were marked by the Site Biologist to minimize impacts to vegetation. Field work was conducted with consideration for the surrounding flora and fauna. A biologist was on Site during field work to monitor compliance with the BAMP and assist in resolving access issues as they occurred.

3.5 Site Geology

Site lithology consists of an upper layer of alluvium, comprised of clays, silts, and sands, fill, residuum, weathered bedrock, and bedrock. The landfill cover materials consist of weathered soil from the site. Alluvium is underlain by an interval of moderately to highly weathered decomposed granitic material (residuum), which is then underlain by bedrock consisting of quartz-granodiorite to tonalite. Bedrock is found approximately five to 41 feet below ground surface (ft bgs) [Table 3-1]. The bedrock in this area appears to be highly fractured. The Elsinore Fault Zone is located approximately 12 miles northeast of IRP Site 27 (MARRS 2009). During RI field activities, fracture orientations were measured at several outcrops (Figure 4). The outcrops were dispersed throughout the landfill area and were not part of a continuous stratigraphic unit, it is unclear whether the orientations measured represent the definite attitudes of the underlying bedrock jointing or fracture system or represent outcrops that were previously displaced. Based on attitudes collected, the general fracture orientation strikes to the northeast and dips to the southeast as is shown in the table below. This general lineation pattern is consistent with the flow direction of the first occurrence of groundwater, which flows to the northeast at the Site. Multiple fractures with similar orientation were observed in the drainage ditch west of the Site. Therefore, fracture orientations appear to be consistent with the groundwater flow direction obtained during RI field activities indicating a northeastern groundwater flow direction.

Observations showed that Fracture 5 was filled with plagioclase feldspar. Impacts of minerals found in bedrock will be discussed in Section 8 as part of the chemical analysis of native material and the potential effects on groundwater.

Fracture Identification	Fracture Location	Strike	Dip
Fracture 1	~100-150 feet North of MW-7	N 36° East	50° Southeast
Fracture 2	East of Fracture 1	N 42° East	37° Southeast
Fracture 3	~100 feet West of MW-7	N 20° West	53° Northeast
Fracture 4	East of MW-10B and IRP27-LCE-1	N 5° West	54° East
Fracture 5	West of IRP27-SS-1	N 40° East	56° Southeast

3.6 Regional and Local Hydrogeology

Det. Fallbrook lies within the Santa Margarita River watershed (MARRS 2009). The Santa Margarita River watershed contains alluvial river basins with a source of water-bearing sediments bounded by hills of non-water-bearing crystalline rocks (MARRS 2009). As part of the Water Quality Control Board Plan developed for the San Diego Basin, the San Diego RWQCB defines the Santa Margarita watershed as the Santa Margarita Hydraulic Unit (MARRS 2009). IRP Site 27 is located in the Upper Ysidora Area, which has beneficial uses for municipal, domestic, and industrial water supplies (MARRS 2009).

Groundwater within the Santa Margarita Hydrologic Unit is mainly unconfined; however, there are some areas that have been identified as being under pressure (MARRS 2009). The storage capacity of the watershed is 61,600 acre-feet of which 24,000 acre-feet are usable as a water resource (MARRS 2009). The most developed regions are those within the alluvial basins, such as the Santa Margarita River Basin within MCB Camp Pendleton to the west and southwest (MARRS 2009). The average yield of wells that are completed in the Santa Margarita River Basin, within the Chappo Subarea of the Upper Ysidora Area, ranges from 600 to 1,800 gallons per minute (gpm) with specific capacities ranging from 10 to 21 gpm per foot (gpm/ft) (MARRS 2009).

Site 27 drains into the Santa Margarita River watershed; however, the river is approximately 2.5 miles away and the site itself is a thin veneer of residuum over hard bedrock. This site neither produces very much water, nor does it store water. The Site 27 potential impact it has on the watershed is insignificant. The Site 27 drainage is approximately 20 acres versus the drainage to the east for the upstream watershed which is approximately 500 acres. The wells produce on average 0.46 gpm based on the wells that are currently on site, thus their contribution is very small compared to the 600 to 1,800 gpm produced further east at MCB Camp Pendleton.

The fill, alluvial and residuum layer is underlain by fractured granitic bedrock. Groundwater flow is controlled by fractures in the granitic bedrock and locally within alluvial/residuum deposits (MARRS 2009). As noted in the borehole logs of the Final SI Report, groundwater was encountered between 21 and 41 ft bgs. Based on the three wells installed in the SI (MW-1, MW-2, and MW-3) [Figure 5], groundwater appeared to flow to the northwest (Figure 6). The three wells used to make this determination, however, were installed approximately in a straight line perpendicular to the reported flow direction. The linear array of the SI monitoring wells may have provided an

inaccurate flow direction. Subsequent measurements of the RI and SI monitoring wells have consistently indicated a northeastern groundwater gradient. Groundwater appears to be migrating along the soil-bedrock interface and accumulating in the topographically low northern portion of the landfill. In the southern portion of the landfill, granitic bedrock was encountered at 23 ft bgs (MARRS 2009) and 10 to 12 ft bgs in RI boreholes.

During RI borehole drilling, depth to granitic bedrock ranged from 5 ft bgs at MW-4A to 23 ft bgs at MW-7 (Table 3-1). In October 2010, prior to start of drilling, groundwater elevations in monitoring wells MW-1, MW-2, and MW-3 were 577.16 ft amsl, 576.41 ft amsl, and 575.10 ft amsl, respectively, with an apparent northeast flow direction (Figure 7). In November 2010, groundwater elevations ranged from 577.03 ft amsl in MW-1 to 574.90 ft amsl in MW-7 with an apparent northeast flow direction (Figure 8). In February 2011, groundwater elevations ranged from 579.93 ft amsl in MW-1 to 578.24 ft amsl in MW-7 (Figure 9) with an apparent northeast flow direction. In May 2011, groundwater elevations ranged from 582.60 ft amsl in MW-12 to 578.49 ft-amsl in MW-7 with an apparent northeast groundwater flow direction (Figure 10) and in October 2011, groundwater elevations ranged from 583.53 ft amsl in MW-12 to 577.57 ft amsl in MW-7 (Figure 11) with an apparent northeast flow direction. Groundwater elevations are also presented in Table 3-2. Groundwater flow direction is consistent with the fracture alignment attitudes measured during the fracture investigation. Based on depth to bedrock, depth to groundwater, fracture orientations, former ravine alignment, and groundwater flow direction obtained during RI field activities, groundwater appears to be migrating within the weathered bedrock and with a northeastern flow direction consistent with the fracture orientations observed in the RI and from the borehole SB-13 obtained during the SI.

Based on observations during storm water sampling, surface water drains from south to north along the western edge of the landfill area. IRP Site 27 drains to a ravine that crosses to the north of the Site 27 boundary. The ravine to the north drains to the northwest and is heavily vegetated. The ravine to the north is outside the IRP Site 27 boundary and did not contain water during Site visits in 2009, 2010, or 2011.

3.7 Sources for Chemicals of Concern

Potential sources for chemicals of concern may originate from the waste disposed of at IRP Site 27 including small quantities of potentially hazardous waste, including empty paint cans with dried paint residues, fluorescent lights, fluorescent light ballasts, spent

silica sandblast grit containing paint chips, paint booth residue, rags with solvent residue, used paint brushes, and asbestos. Metal and pallets that were potentially treated with pentachlorophenol were also disposed of at IRP Site 27 (MARRS, 2009). Natural sources of manganese and iron may also be derived from pegmatite rock within fractures at the Site.

Potential sources of NDMA include nitrates from cattle manure (which graze at the site) which can be a source (Ayanaba & Alexander, 1974) and diesel fuels, such as AvGas, JP-4, JP5, diesel (Goff, 1980). NDMA in diesel exhaust could reach groundwater through dissolution of highly soluble NDMA in moisture in air (fog, rain, etc.), and the infiltrating moisture can carry the NDMA with it to reach the groundwater. U. S. Geological Survey scientists and others have published articles describing this transport process to groundwater (Baehr et al, 1999; Pankow et al, 1997).

The United States Environmental Protection Agency (U.S. EPA) municipal solid waste decay studies indicate that landfills achieve their maximum decay rate between 5 and 15 years after waste placement (U.S. EPA, 2005). Based on the age of the waste in the landfill (35+ years), the waste decay cycle should have already reached its peak and therefore contaminants from the waste should have reached their maximum levels. The U.S. EPA (2005) has developed a predictive model for landfill gas generation, the Landfill Gas Emissions Model (LandGEM). The equation that is the basis of the model (page 4 of the user's guide) predicts that the maximum rate of gas production from waste is in the first year after waste placement.

4.0 HYDROGEOLOGIC INVESTIGATION

4.1 SI Well Installation and Groundwater Sampling Data

Three wells were installed as part of the SI (MARRS, 2009) at IRP Site 27. Analytes detected in SI groundwater samples collected from wells within the inferred landfill footprint included aluminum, iron, and manganese which were reported above the MCLs. In addition, NDMA and TPH, which do not have established MCLs, were detected. The analytes detected at concentrations greater than their screening levels in the groundwater wells during the SI are presented in Figure 3 and Table 4-1. Table 4-2 lists analytes evaluated during the SI and RI.

4.2 RI Monitoring Well Installation, Water Level Gauging, and Surveying

The aim of the hydrogeologic investigation was to determine the groundwater gradient and flow direction, to evaluate the first occurrence of groundwater at the Site, to address the analysis of groundwater quality for specific COPCs, to provide an upgradient groundwater sampling point, and to evaluate the source of COPCs.

4.2.1 Utility Clearance

Prior to the commencement of subsurface work, each boring location was marked in the field with spray paint and surveyor stakes/flags. The locations were identified from visual comparison to Site landmarks and were cross referenced using global positioning system (GPS) to confirm locations prior to drilling.

Underground Service Alert of California (Dig Alert) was contacted 48 hours before subsurface work began. Boring locations were cleared using a geophysical survey prior to the commencement of drilling. All boreholes were hand augered to five feet as an additional precaution. No utilities were identified within the Site boundary.

4.2.2 Groundwater Well Installation (First Mobilization)

The installations of seven new wells were proposed prior to start of field activities to provide Site-specific background and downgradient data (RI Work Plan, Appendix C). The first mobilization occurred from October 19, 2010 through October 28, 2010. Ten soil borings were advanced using a hollow-stem auger drill rig to depths ranging from nine to 45 ft bgs. Four of the 10 soil borings encountered groundwater and after

discussions and concurrence from the Navy, wells were installed at these locations. The four new wells included MW-4A, MW-5A, MW-7, and MW-9A (Figure 5). New wells were constructed of 4-in. nominal diameter schedule 40 polyvinyl chloride (PVC), with 10 ft of 0.01-in. slotted screen. Screen intervals varied as groundwater was encountered at different elevations for each new well location (Table 4-3). Wells were completed with a 12 in. diameter steel monument seated within a five ft by five ft concrete pad.

Soil samples were collected at least every five ft, and lithology was logged using the Unified Soil Classification System (USCS). In addition, soil samples were collected at changes in lithology during the drilling process. Boring logs and well construction diagrams are included in Appendix D.

4.2.3 Groundwater Well Installation (Second Mobilization)

A change order in March 2011, proposed the installation of two additional groundwater monitoring wells which would serve as upgradient and/or background wells. The proposed MW-11 is located upgradient and east of the landfill. MW-11 was drilled to a total depth of 30 ft bgs and hit decomposed granite at approximately 27 ft bgs. No water was encountered at MW-11, and after discussions with the Project Team, it was determined that this location was not a viable location for the installation of a groundwater monitoring well. The borehole was backfilled with drill cuttings and sealed with bentonite. The second location, MW-12, is upgradient of the landfill and southwest of MW-1. MW-12 was drilled to a total depth of 42.7 ft bgs. Upon reaching total depth the borehole was allowed to sit for 30 minutes. After 30 minutes, a water level meter was used to check for water and a small amount had accumulated in the bottom of the borehole. After concurrence from the Project Team, drillers were instructed to install a well at MW-12 (Figure 5). The new well was constructed with 4-in. nominal diameter schedule 40 PVC, with 10 ft of 0.01-in. slotted screen. The screen interval is 32-42 ft bgs (Table 4-3). The well was completed with a 12-in. diameter steel monument seated within a 5-ft by 5-ft concrete pad.

4.2.4 Groundwater Well Development

All new wells were developed to achieve sediment-free water. Due to the small volume of groundwater water and slow recharge rate in MW-12, this standard was not met. In addition, existing wells were redeveloped to maintain or improve yield. Well development consisted of bailing, surging, and, purging at least 10 casing

volumes, and/or until water quality parameter (potential hydrogen [pH], temperature, conductivity, turbidity) stabilization (three consecutive readings within 10% variation). MW-12 had approximately 2.6 ft of water in the well and yielded a total of nine gallons of water was bailed during development efforts. Three rounds of surging and bailing were performed on the well, between each round there was a two hour recharge period. After discussions with the Project Team, development efforts ceased prior to meeting standards outlined in the Work Plan due to low recharge rate in the well. Well development pumping rates ranged from 0.37 gpm at MW-1 to 0.58 gpm at MW-4A. The development logs are provided in Appendix D. Well development data is presented in Table 4-3.

4.2.5 Surveying

A registered State of California surveyor performed a well survey of the three existing and four new groundwater monitoring wells, the soil vapor probe locations, potholing locations, and soil sampling locations in November 2, 2010 during the first mobilization. The new well, MW-12 and borehole drilled (MW-11/SB-11) during the second mobilization event were surveyed in May 31, 2011 and the three northernmost potholing locations, IRP27-LCE-8, IRP27-LCE-9, and IRP27-LCE-10, were re-surveyed on June 1, 2011. Horizontal and vertical positions were determined for each well at the center of the well cover and at the top of the casing. The north side of the casing was marked and used as the reference point. Monitoring well locations were tied into North American Datum 83, and the units were recorded in ft. Vertical control was tied to North Geodetic Vertical Datum 29 control. The survey report is included as Appendix E. Well location data is provided in Table 3-2.

4.2.6 Geophysical Survey

A two-dimensional electrical resistivity imaging, an Induced Polarization, and a magnetic and electromagnetic geophysical survey were conducted to define the landfill limits. The geophysical survey objectives were to define the lateral limits of the waste, assist in evaluating the waste thickness, and to provide data on potential drilling locations for upgradient monitoring well locations. For the waste delineation, grids of 20 lines were laid out over the ravine landfill. The line limits were defined based on visual and existing data from both SI and RI which were used to supply an additional layer of evidence to define the inferred limits of waste. The lines were extended past the potential edges of waste to provide complete coverage. The geophysical survey was

also used to help identify potential sources of groundwater and aid in choosing potential locations for the two new wells attempted during the second mobilization event on May 23 and 24, 2011. The geophysical report is included in Appendix F.

4.2.7 Groundwater Level Gauging

Groundwater levels were gauged for the three existing wells (MW-1, MW-2, and MW-3) once on October 14, 2010 in order to evaluate and adjust planned monitoring well locations. On November 8, 2010 groundwater levels were gauged again when the new wells (MW-4A, MW-5A, MW-7, and MW-9A) were installed. On February 11, 2011 groundwater level measurements were collected to evaluate the effect significant rainfall during December 2010 may have had on the groundwater levels. On May 31, 2011, groundwater levels were gauged for all well locations, including MW-12, prior to the second round of groundwater sampling and served as the wet season groundwater levels (Table 3-2). On October 6, 2011, groundwater levels were gauged as part of the second round of groundwater sampling for MW-12. This gauging event represented the end of summer, dry season groundwater levels.

4.3 Groundwater Gradient and Elevation Trends

4.3.1 Groundwater Flow Direction and Gradient

A previous investigation (SI Report) indicated that the groundwater flow direction in this area is to the northwest (Figure 6) and that water in the alluvial aquifer is restricted to the northern portion of IRP Site 27. Groundwater elevation data was collected on five occasions as mentioned in Section 4.2.7 (Table 3-2). However, water level data collected from the full seven well network supports that groundwater flow direction is to the northeast (Figures 7 through 11). MW-4A and MW-9A are located in areas that may represent non-impacted conditions. Based on groundwater flow direction, well MW-4A appears to be upgradient of the waste prism (Figure 12). MW-12 represents an upgradient well of the waste prism based on the northeasterly groundwater flow direction. Existing groundwater wells were gauged prior to installation of the new monitoring wells to verify groundwater flow direction and better select monitoring well locations. Bedrock fracture data (Figure 4) is consistent with the groundwater flow direction obtained during the RI. The groundwater gradient was calculated based on the groundwater elevation measurements. The groundwater gradient ranges from 0.0038 to 0.0128 during the RI field activities (Figures 7 through 11).

4.3.2 Groundwater Levels and Seasonal Fluctuations

Groundwater elevations measured on five occasions during the RI, and are shown in addition to the SI groundwater elevations in Table 3-2. Figure 13 shows a chart with the groundwater elevation trend for each well during the RI water level measurements. The November 8, 2010 groundwater level measurements were gauged during the dry season. On February 11, 2011 groundwater level measurements were collected to evaluate the effect the significant December 2010 storm event may have had on the groundwater levels. February 2011 groundwater levels were approximately 2.88 ft to 3.34 ft higher than the measurements taken in November 2010 and the groundwater flow direction remained to the northeast (Figure 12).

The wet season groundwater levels were gauged in May 2011. During the May 2011 gauging event, groundwater elevation levels increased 0.25 ft to 1.22 ft from the February 2011 gauging event and still showed the groundwater flow direction trending northeast. Representation of each groundwater gauging event showing season fluctuation, groundwater gradients, and groundwater flow directions are shown on Figure 12.

Groundwater levels were gauged on October 6, 2011 after a dry summer season and represented a second dry season groundwater elevation event. During the October, 2011 event, groundwater elevation levels decreased 0.36 ft to 0.92 ft from the May 2011 event. However, the groundwater level increased by 0.93 ft in MW-12. October 2011 gauging event still showed the groundwater flow direction trending northeast.

The November 2010 and October 2011 groundwater elevations represent the dry season gauging events, whereas the February and May, 2011 elevations represent the wet season gauging events. Groundwater elevations were generally lower during the dry season gauging event in relation to the wet season events. The elevated water levels encountered during the wet season gauging event represent delayed winter rain water infiltration into the aquifer. The delayed infiltration rate is controlled by degree of mechanical and chemical weathering of the bedrock and hydraulic conductivity of unconsolidated alluvial soils. The increased groundwater elevations may also reflect the local increase associated with the surrounding area recharge and drainage just north of Site 27 (Figure 2).

4.4 Groundwater Sampling

4.4.1 Groundwater Sampling Events

Groundwater sampling was conducted in accordance with the approved RI Work Plan and Standard Operating Procedures. Two rounds of groundwater sampling were planned, the first sampling event took place on November 8 and 9, 2010, as the dry season sampling event; and the second event took place during the wet season on May 31 and June 1, 2011 to better assess the potential for migration of COPCs in groundwater. During the first round of sampling, the four new (MW-4A, MW-5A, MW-7, MW-9A) and three existing wells (MW-1, MW-2, MW-3) were sampled no sooner than one week following well development, with the exception of MW-5A which was sampled six days after development. The second groundwater sampling event conducted on May 31 through June 1, 2011, followed the same procedure. However, MW-12 was sampled five days after development. During the May-June 2011 sampling event a total of eight wells were sampled, the seven existing wells, and one new well (MW-12). Groundwater field parameters collected during groundwater sampling are shown on Table 4-4. To minimize noise and reduce potential negative impacts on endangered bird species during breeding seasons and to minimize variation between sampling events, groundwater purging and sampling were conducted with bladder pumps.

The samples were collected in pre-cleaned, pre-preserved containers supplied by EMAX Laboratory (EMAX), Maxxam, and Columbia Analytical Services (CAS); all three are National Environmental Laboratory Accreditation Program (NELAP) and National Environmental Laboratory Accreditation Conference – accredited laboratories. Samples were logged on a laboratory chain-of-custody form and placed in ice-filled chests. Samples collected during the first and second rounds of groundwater sampling were analyzed for volatile organic compounds (VOC) (by EPA 8260B), metals (by EPA 6020A), pesticides (by EPA 8081A), PCBs (by EPA 8082), SVOCs (by EPA 8270C), hydrazine (by ASTM International [ASTM] D1385), TPH (gasoline, diesel, motor oil, and Stoddard solvent) (by EPA 8015B), and general chemistry (nitrate, nitrite, sulfate, ammonia, and sulfide). During both rounds of sampling, samples collected from interior wells were analyzed for NDMA (by EPA 1625C). In addition, during the second round of sampling, samples were also collected from perimeter wells and analyzed for NDMA.

4.5 Laboratory Results

Groundwater concentrations above screening levels detected during the first round of RI sampling (November 8 – 9, 2010) were limited to three metals – arsenic, iron, and manganese. Arsenic and iron concentrations above screening levels only occurred in the sample from well MW-2. Manganese concentrations above screening levels were observed for well MW-2, well MW-4A, well MW-5A, and well MW-7. Groundwater concentrations above screening levels detected during the second round of RI sampling (May 31 – June 1, 2011) were also limited to arsenic, iron, manganese, and Nitrate (as Nitrogen). Arsenic and iron concentrations above screening levels were only observed in the sample from well MW-2. Manganese concentrations detected above screening levels occurred in well MW-2, well MW-3, and well MW-12. There was a single detected concentration above screening levels for Nitrate (as Nitrogen) at the sample collected from MW-1. NDMA results are below the Navy revised screening level of 3 nanograms per liter (ng/L) (Table 4-5) and further action is not required (Figure 14). Additional assessment and analysis will be determined in the Feasibility Study (FS). Table 4-1 presents the arsenic, iron, manganese, and nitrate (as nitrogen) concentrations above screening levels for the wells sampled during both rounds of the RI. Laboratory analytical data is discussed in Section 8.

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5.0 SOIL GAS FIELD ACTIVITIES

5.1 Soil Gas Probe Installation

Soil gas probes were installed at five locations (SG-4 to SG-8) around the perimeter of the inferred landfill extent during the RI on October 19, 2010 and October 21, 2010. The perimeter soil gas probes were installed in accordance with CCR Title 27 §20925. Boreholes were advanced using direct push technology with total depths of five ft bgs in SG-4, SG-6, SG-7, and SG-8 (Figure 15). As a result of repeated refusal prior to reaching the target depth of five ft bgs SG-5 was set at three ft bgs.

In addition to the five probes outside the SI inferred landfill extent, six gas probes were installed at three locations (SG-1 to SG-3) within the SI inferred landfill extent (Figure 15) using direct push technology on October 21, 2010. At each location, one probe was installed at 5 ft bgs. In SG-1 and SG-2, a second probe was installed at 10 ft bgs. In SG-3, the second probe was installed at 8 ft bgs due to refusal encountered during probe installation. Boring and construction logs for soil gas probes are included in Appendix D.

Soil gas probe locations were chosen to maximize the likelihood of identifying potential landfill gas (LFG) generated by the Site and to comply with federal regulations requiring perimeter LFG monitoring points 1,000 ft or less apart in non-residential settings (27 CCR, 2010). LFG generates anaerobic conditions that would prevent tree growth, so the presence of large mature trees is evidence that LFG generation is not occurring in the southern portion of the Site. Based on this, soil gas probe installation focused on the northern portion of the landfill. One soil gas probe (SG-8) was installed just south of the southern extent of waste to maintain the 1,000 ft or less spacing between perimeter probes and to establish background concentrations. SG-8 was located within the eucalyptus grove and just south of and outside of the landfill cover pothole location LCE-1 (where waste was identified). Based on previously collected data, the waste in the southern portion of the landfill is not in contact with groundwater. Moisture within the waste prism is a major factor in the capacity of the waste to generate LFG. Therefore, probe SG-8 represents conditions which are not influenced by the landfill waste.

5.2 Sample Collection and Analysis

Soil gas samples were collected October 27, 2010 to November 1, 2010 in general accordance with the California DTSC and Los Angeles RWQCB joint guidance *Advisory – Active Soil Gas Investigations* (DTSC/Los Angeles RWQCB 2003). Samples were collected into 1-liter (L) tedlar bags to be analyzed for hydrogen sulfide (H_2S) by ASTM D 5504 and six 1-L Summa Canisters to be analyzed for VOCs by EPA Method TO-15 and fixed gases by EPA Method 3C. Samples were sent to CAS, a NELAP certified laboratory. Laboratory reports are provided in Appendix G.

5.3 Data Evaluation

5.3.1 VOCs

No VOCs were detected in soil gas samples at the Site at concentrations greater than Project Action Limits (PAL) established in the Sampling and Analysis Plan (SAP). The PALs are based on the DTSC Industrial California Human Health Screening Levels (CHHSLs) for industrial sites (Cal-EPA 2005). A number of VOCs were detected which do not have established CHHSLs (Table 5-1). Although these do not have PALs as established in the SAP, they are included in the risk assessment presented in Section 9.

5.3.2 Methane and Fixed Gases

The table below shows results for carbon dioxide (CO_2), oxygen (O_2), nitrogen (N_2), and methane (CH_4); methane was only detected at the Site at concentrations above the reporting limit (RL) in SG-1-9.5. A concentration of 5% by volume is commonly used for compliance evaluation of LFG probe data (Title 27§20921 (a)(2)) and was used in this report as the screening level for methane (CH_4). The concentration of 0.688% methane in SG-1-9.5 falls well below this standard. This is consistent with limited methane production in the waste from isolated methanogenic zones. Additionally, the data are not consistent with adequate gas production to drive methane or VOC migration from the waste.

Sample	CH_4 (%)	CO_2 (%)	O_2 (%)	N_2 (%)
SG 1-5	ND[a]	5.71	16.1	78.2
SG 1-9.5	0.688	19.8	2.86	76.7
SG 2-5	ND	8.29	15.7	76.0

Sample	CH_4 (%)	CO_2 (%)	O_2 (%)	N_2 (%)
SG 2-10	ND	2.66	19.4	77.9
SG 3-5	ND	0.544	21.6	77.8
SG 3-5(dup)	ND	0.514	21.6	77.8
SG 3-8	ND	2.22	20.7	77.1
SG 4-5	ND	1.04	21.1	77.9
SG 5-5	ND	1.37	20.9	77.7
SG 6-5	ND	0.555	21.1	78.3
SG 7-5	ND	0.85	21.0	78.1
SG 8-5	ND	2.18	20.4	77.4

[a] ND: Not detected

Detected oxygen concentrations at the 5 ft depth for the samples within the SI estimated waste footprint (SG-1, SG-2, and SG-3) ranged from 15.7% to 21.6%. The deeper probe oxygen concentrations were lower, with SG-1-9.5 at 2.86%, SG-2-10 at 19.4% and SG-3-8 at 21.1%. This shows that conditions at these locations are aerobic, even in the sample (SG-1-9.5) where methane was detected. The presence of oxygen precludes methane production, and the simultaneous detection of methane and oxygen in the SG 1-9.5 sample is evidence that the sample was a mixture of gas from anaerobic and methanogenic zones. This supports methane production that is limited to small localized anaerobic zones. The lack of methane in SG-1-5, just above SG-1-9.5 shows that methane is readily degraded within the waste under the aerobic Site conditions.

Oxygen concentrations for the samples outside the SI estimated waste footprint (SG-4, SG-5, SG-6, SG-7, and SG-8 at 5 ft bgs ranged from 20.4% to 21.1%, consistent with the atmospheric concentration of 20.9% [Bremner and Blackmer, 1982]. This shows that Site soils are fully aerated. For fixed gases, these samples represent background conditions.

Within the estimated waste footprint, carbon dioxide concentrations at sample locations SG-1, -2 and -3 at 5 ft bgs ranged from 0.51% to 8.29%. Concentrations from samples collected deeper within the estimated waste footprint were 2.22% to 19.8%. Outside the estimated waste footprint, carbon dioxide concentrations ranged from 0.55% at SG-6 to 2.18% at SG-8.

Carbon dioxide is a major constituent of landfill gas, but can also be produced through aerobic decomposition of organic matter. Due to the aerobic conditions observed

within the waste, elevated carbon dioxide concentrations in samples without methane detections can be attributed to aerobic decomposition of organic matter. Because concentrations of methane and carbon dioxide are approximately equal in LFG [Christensen, et al., 1996] the 19.8% carbon dioxide and 0.688% methane of SG 1-9.5 suggest that most of the carbon dioxide was produced through aerobic decomposition of organic matter rather than methanogenesis. If aeration were curtailed (such as through the installation of an impermeable cover), the decomposition could become anaerobic and methanogenic.

Five-foot samples from within the waste prism have higher carbon dioxide concentrations than the background samples (SG-4 to SG-8) located outside the waste. This is evidence for aerobic decomposition of organic matter at or near those sample locations. Sample SG-3-5 has a carbon dioxide concentration just below the background range, along with oxygen concentrations equivalent to atmospheric air. This suggests that decomposition of waste is not occurring at or near this sample location. Based on these soil gas data and the boring logs, the sample location SG-3 seems to be located north of the extent of waste.

5.3.3 Hydrogen Sulfide

Although no screening level was established in the SAP, hydrogen sulfide concentrations in soil gas samples were evaluated to assess processes within the waste and in the adjacent vadose zone. No concentrations of hydrogen sulfide above the RL of 7 micrograms per cubic meter ($\mu g/m^3$) were observed for the samples within and outside the waste. This is consistent with the aerobic conditions observed in the waste vicinity and outside of waste limits.

5.4 Summary

In summary, no detected concentrations above screening levels were observed for the soil gas data. The soil gas data showed that conditions are aerobic within the waste and outside the waste limits, with evidence of aerobic decomposition of organic matter observed in data for the deeper samples from within the waste. Based on these data, curtailing aeration of the waste by an impermeable cover or other measures could cause the aerobic decomposition of organic matter to become methanogenic, producing landfill gas (methane and carbon dioxide.) Consistent with the aerobic conditions at the Site, hydrogen sulfide was not detected within the waste or outside it. There is no

evidence in the data for the presence of waste at or near the location of samples SG 3-5 and SG 3-8 and those locations seem to be north of the northernmost extent of waste. Figure 17 reflects the revised inferred waste extents.

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6.0 SOIL SAMPLING FIELD ACTIVITIES

6.1 Soil Sampling

During the SI (MARRS, 2009), the detected arsenic concentration in a single soil sample located within the waste prism was higher (28.4 milligrams per kilogram [mg/kg]) than screening levels (Figure 18). The location of boring IR27B02 was found using a portable GPS unit based on the sample coordinates documented in the SI and markings remaining on Site from the SI (a metal stake). The location of the single soil sample was re-occupied and re-sampled (IRP27-SS-1) on October 19, 2010, and analyzed for arsenic during the RI field investigation. In addition, four step-out samples were collected 5 ft east, west, north, and south of IRP27-SS-1 at 5 ft bgs and placed on hold to delineate the extent of elevated arsenic concentrations if needed. The soil samples were collected using a direct push rig to reach the same depth where the previous sample was collected. Soil characteristics were logged using the USCS. Soil sample IRP27-SS-1 was sent to CAS, a NELAP certified laboratory, and analyzed for arsenic.

6.2 Laboratory Analysis

Arsenic was detected at 2.79 mg/kg in sample IRP27-SS-1 (Table 6-1). During the SI investigation, arsenic was detected at 28.4 mg/kg in sample IR27B02. For arsenic in soil, the DTSC screening level of 12 mg/kg is considered the background screening criteria for southern California sites (Cal-EPA DTSC, 2007). The laboratory report is included in Appendix H. The elevated SI arsenic concentration was determined to be an anomalous value and the concentration in IRP27-SS-1 is well below background screening levels at other sites. Therefore, no further analysis is required to delineate this area.

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7.0 LANDFILL COVER AND SURFACE WATER EVALUATION

7.1 Field Exploration and Potholing

The landfill cover evaluation for surface and subsurface investigations included excavation of ten exploratory potholes, hydraulic conductivity tests, *in situ* density and moisture content tests (using nuclear moisture density methods), the collection of soil samples for physical property laboratory testing, and storm water sampling.

7.1.1 In Situ Density and Moisture Content

Field activities included nuclear gauge density and moisture testing which were co-located at each pothole location (Figure 19). The nuclear gauge was calibrated and a pad was cleared using a backhoe at each pothole location to test the density and moisture before excavation occurred. Field parameters and waste encountered were documented on the field logs and photographs were taken at each pothole location (Appendix I).

7.1.2 Potholing

Potholing field activities were conducted to determine the thickness of the landfill cover and re-evaluate the extent of the waste prism. Potholing was conducted at 10 locations, which were chosen based on the review of existing documentation and previous studies (Figure 19). The locations of the potholes were recorded using a portable GPS unit. Exploratory potholes were advanced vertically to a maximum depth of eight ft, undisturbed native rock, refusal, or contact with waste. Waste was encountered at shallow depths, approximately one to two ft bgs, at IRP27-LCE-7 and at successive pothole locations going south along the landfill. Waste included metal wire, plastic bags, cloth, soda cans, rubber debris, Styrofoam™, and wood. IRP27-LCE-8 was excavated to a depth of eight ft bgs and fragments of bedrock were encountered. Waste was not encountered at the northern pothole locations, IRP27-LCE-8 through IRP27-LCE-10. Each pothole was logged and included a description of the encountered soils in accordance with the USCS and standard practice for description and identification of soils (Appendix I). One representative soil sample was retrieved from the upper few feet (potential cover) at each exploratory pothole location for physical property testing. Potholes were backfilled with the excavated soil materials. Soil samples were sealed, packaged, and sent to a qualified geotechnical laboratory, PTS Laboratories, for testing.

Laboratory testing – Laboratory tests of the representative soil samples included laboratory classification (by ASTM D2487-93), infiltration rate of soils in the field (by ASTM D3385-94 [9/94]), sieve analysis (by ASTM D422), Atterberg Limits (by ASTM D4318), *in situ* density and moisture content (by ASTM D2216/2937), specific gravity (by ASTM D854), maximum dry density and optimum moisture content (by ASTM D1557), hydraulic conductivity (by ASTM D5084), and unsaturated hydraulic conductivity function (by Soil Science Society of America and ASTM methods for selected representative samples). Laboratory reports are included in Appendix I.

7.1.3 Landfill Cover Lithology and Thickness

The existing surface soils on the landfill primarily consist of sand and silt, with trace amounts of clay. Bedrock was encountered at IRP27-LCE-8 at eight ft bgs. Based on the depth of soil to waste found during trenching, the landfill cover thickness ranges from one ft bgs at IRP27-LCE-2 to three ft bgs at IRP27-LCE-7 (Figure 19, Table 7-1).

7.1.4 Extent of Waste Prism

Based on trenching activities, waste was encountered at pothole locations IRP27-LCE-1 through IRP27-LCE-7. Trash was not encountered at the northern potholing locations, IRP27-LCE-8, IRP27-LCE-9, and IRP27-LCE-10. Figure 16 shows the inferred limits of the landfill defined by fieldwork as well as highlighted locations where no waste was encountered based on the soil boring and pothole logs. Figure 17 shows the inferred limits of the landfill based on historical and present data as well as a bedrock outcrop barrier on the east side that constrains the waste in this area of the landfill.

7.2 Existing Landfill Cover Characterization

7.2.1 General

The objective of this section is to characterize and evaluate the existing soil cover and to determine the in-situ and laboratory hydraulic properties and other general soil characteristics of the existing soil cover on the IRP Site 27. Data from this evaluation will be used to determine the performance of the existing soil cover. The results of the evaluation will be used to qualify the existing soil cover, in-place.

7.2.2 Review of Available Data

Prior to start of field investigation activities, SES-TECH and Geosyntec reviewed the Final Site Inspection Report (MARRS, 2009) [Appendix B].

7.2.3 Field Exploration

Prior to commencing the field exploration program to evaluate the existing soil cover for IRP Site 27, SES-TECH and Geosyntec prepared a work plan for the proposed field work [SES-TECH/Geosyntec, 2010]. This work plan is included herein as Appendix C. The field exploration included surface and subsurface investigations of the existing soil cover. Figure 17 shows the limit of the study area for the scope of work discussed in this section.

7.2.4 Exploratory Potholes

The field exploration program consisted of excavation of exploratory test potholes. A total of 10 exploratory potholes were excavated in IRP Site 27, Eucalyptus Grove Landfill in Det. Fallbrook.

Given that the total area of IRP Site 27 is approximately two acres, the frequency of the excavated exploratory pothole is approximately five exploratory potholes per acre. The locations of the exploratory potholes were selected by SES-TECH and Geosyntec field personnel. The locations of the exploratory potholes were recorded by using a portable GPS unit and are shown on Figure 19.

The thickness of the existing soil cover (measured vertically) encountered during the field exploration (and as documented by the exploratory pothole logs) ranged from 1.5 ft to more than 3 ft. Table 7-1 presents summary information about the exploratory potholes excavated to evaluate the existing soil cover in IRP Site 27 and encountered cover thickness at each exploratory pothole location.

Additionally, as part of the field exploration program, the Navy conducted in-situ maximum density and moisture content tests to determine the in-situ density and moisture content of the existing soil cover system. The in-situ density and moisture content tests were performed by using a nuclear density gauge, per ASTM D 2937. The results of the in-situ density and moisture contents are summarized in Table 7-1 of

this report. Figure 19 shows the locations of the density test conducted on the IRP Site 27 cover.

7.2.5 Sampling and Logging

The field exploration program also included collection of representative soil samples for laboratory testing, soil classification, and characterization purposes. At a minimum, one soil sample of the cover material within the upper five ft in depth was retrieved from each exploratory pothole location. The actual sampling frequency is shown on the exploratory pothole logs included in Appendix I of this report. A discussion of the type of soil samples collected and a summary of the laboratory test results are included in Section 7.1.3 of this report. Detailed laboratory test results are presented in Appendix I of this report.

7.2.6 Laboratory Testing Program

Upon completion of the field exploration program as discussed in Section 7.1.2 of this report, soil samples were reviewed to determine potential variability, sealed, packaged, and sent to PTS Laboratory, Inc. for testing. The following laboratory tests were performed on selected soil samples to characterize the different soil types encountered in the existing soil cover:

Test	Test Standard	Number of Tests
Laboratory Classification	ASTM D2487	10
Sieve Analysis	ASTM D422/D4464	10
Atterberg Limits	ASTM D4318	10
Specific Gravity	ASTM D854	10
In-situ Moisture Content	ASTM D2216	10
In-situ Dry Density	ASTM D2937	10
Maximum Dry Density and Optimum Moisture Content	ASTM D1557	10
Hydraulic Conductivity	ASTM D5084	10

The relative compaction for each representative sample/test location was calculated based on the in-situ conditions (moisture content and dry density), as determined in the field, and the maximum dry density optimum moisture content was determined from laboratory testing on the corresponding bulk sample. The calculated relative compaction values measured at various locations in the existing cover are summarized in Table 7-1.

7.3 Geotechnical Properties of Existing Soil Cover

7.3.1 Soil Classification and Index Properties

Based on a review of the boring logs and results of laboratory soil classification tests within IRP Site 27, Eucalyptus Grove Landfill in Det. Fallbrook, the existing soil cover consists predominantly of clayey sand (SC), silty clayey sand (SC-SM), and silty sand (SM).

The average range of key geotechnical parameters for soil classification based on the test results in Appendix I are summarized below:

Parameter	Predominant Results (%)	Range (%)
Fines Content (% passing #200 sieve)	44	22.9 to 44.6
Clay Content (finer than 0.002 mm)	8.5	7.5 to 12.5
Liquid Limit	18	13 to 33.5
Plasticity Index	13	16 to 18.8
Plastic Limit	6	NP to 15

The test results show the range of fines content (% passing #200 sieve) is 22.9 to 44.6% with an average of 27.4% and standard deviation of 6.9. The predominant fines contents results (i.e. 44% of the total number of tests) are in the range of 23 to 24%.

Predominant results are the highest percentage of test results with the same or similar results.

7.3.2 In-Situ Density/Moisture Content Conditions

In addition to the soil type, another key geotechnical parameter that would influence the hydraulic characteristics of the existing soil cover is the state of in-situ relative compaction and moisture content. In-situ dry density and moisture content, laboratory maximum density, and optimum moisture content were determined on selected soil samples from the 10 exploratory potholes.

7.3.3 Saturated Hydraulic Conductivities

The saturated hydraulic conductivity (K_s) of the existing soil cover, as determined by laboratory flexible wall conductivity tests (ASTM D5084), are summarized in Table 7-2. The results show that the laboratory K_s values range from 1.47×10^{-6} centimeters per second (cm/sec) to 1.79×10^{-7} cm/sec with an average (geometric mean) of 6.58×10^{-7} cm /sec.

Laboratory saturated hydraulic conductivity tests (ASTM D5084) were performed at an effective confining pressure of 25 pounds per square inch. These tests were performed on the remolded soil samples. The selected representative remolding moisture content was approximately minus 1 percentage points of the moisture content measured in the field. Table 7-2 lists the in-situ dry density and moisture contents measured in the field and the relative compaction corresponding to each tested location. Remolding compaction and moisture content for each soil sample tested for hydraulic conductivity are also listed in Table 7-2.

Conclusion of Existing Cover Evaluation and Recommendations

This section presents the results of the existing cover characterization and evaluation for IRP Site 27, Eucalyptus Grove Landfill in Det. Fallbrook. The existing soil cover evaluation on the approximately 2-acre IRP Site 27, Eucalyptus Grove Landfill in Det. Fallbrook was performed by excavation and sampling of 10 exploratory potholes, conducting in-situ compaction moisture content testing, and performing a suite of laboratory geotechnical and hydraulic tests on selected representative samples obtained from the exploratory potholes. The tests for geotechnical/hydraulic characterization of the existing soil cover included classification and index properties (gradation, Atterberg

Limits), in-situ conditions (in-situ moisture content, density and relative compaction), and saturated hydraulic conductivity.

The results of the field and laboratory testing of the existing soil cover materials discussed in preceding sections of this report have led to the following conclusions:

- The existing soil cover mainly consists of sandy clay, and silty sand. The fines content was in the range of 25 to 40%;
- The relative compaction of the soil cover ranged from approximately 80 to over 100%;
- The laboratory saturated hydraulic conductivity, K_S, of cover soils, as determined by ASTM D5084, ranged from 1.47×10^{-6} cm/sec to 1.79×10^{-7} cm/sec with an average (geometric mean) of 6.58×10^{-7} cm /sec;
- The FS should evaluate improvement of the surface water management features at the Site to divert water flow away from the Site cover; and
- The FS should evaluate response actions, including those relevant to landfill cover integrity and surface water erosion channels efficacy.

7.4 Storm Water Collection

Surface water sampling was conducted to identify potential impacts from landfill waste to surface water. Surface water drainage at IRP Site 27 trends from south to north along the western edge of the landfill area. IRP Site 27 drains to a ravine that crosses the northern edge of the Site boundary. The ravine to the north drains to the northwest and is heavily vegetated. The ravine to the north is also outside the IRP Site 27 boundary and did not contain water during Site visits in 2009, 2010, and 2011.

Surface water quality evaluation was conducted to meet the substantive requirements of Water Quality Order No. 97-03-DWQ National Pollutant Discharge Elimination System (NPDES) General Permit Number CAS000001 (RWQCB 1997). There is an impoundment down-stream and across the drainage to the northwest of the site, approximately 1,800 ft downstream of the site boundary. This impoundment is outside IRP Site 27 boundaries. Surface water collection points were confined to the Site's boundaries. Samples were collected at three locations (upgradient of the landfill, on the surface of the landfill, and downgradient of the landfill [Figure 20]).

The storm water sampling event was performed on December 21, 2010 during a significant storm event. Storm totals for the San Diego area during this storm event (December 17, 2010 – December 23, 2010) were 5.36 in. (National Centers for Environmental Prediction, [NCEP] website http://www.hpc.ncep.noaa.gov/discussions/nfdscc5.html). This storm produced sufficient sample volume for the recommended analyses and to meet NPDES general permit requirements. Storm water runoff sampling was performed on the third day of the storm event.

It rained continuously during sample collection. The first sample (IRP27-SW-1) was collected upgradient of the landfill from water that had pooled at the end of a small northwest trending drainage ditch. The second sample (IRP27-SW-2) was collected on the surface of the landfill just southeast of IRP27-MW-1. The third sample (IRP27-SW-3) was collected downgradient of the landfill from water flowing into a drainage ditch northwest of IRP27-MW-7. Storm water samples were analyzed for VOCs (by EPA 8260B), metals (by EPA 6020A), pesticides (by EPA 8081A), PCBs (by EPA 8082), SVOCs (by EPA 8270C), hydrazine (by ASTM D1385), TPH (gasoline, diesel, motor oil, and Stoddard solvent) (by EPA 8015B), and general chemistry (anions, ammonia, and sulfide).

Surface water concentrations detected above screening levels during the RI was limited to manganese. A single manganese concentration above screening level (secondary MCL) occurred in the sample from landfill cover sample, IRP27-SW-2 (55.4 µg/L) [Table 7-3]. There are no established threshold criteria for storm water analytes, therefore values based on the groundwater threshold criteria were used for screening the storm water samples. IRP27-SW-2 represented the sample on the surface of the landfill. Laboratory results are presented in Appendix J. The downgradient surface water sample did not exceed the action level.

7.5 Topographic Survey

Historical surface elevations/features of the Site were obtained from a 1949 Topographic Map. Search for post-1974 topographic data was unsuccessful, therefore, surveyed data points from the SI and RI field investigations were used to better define the surficial features of the landfill. As a result, a rough interpretation of landfill surface features was developed. To provide additional data and better delineate landfill surface features, areas such as breaks in slopes/gullies were identified for survey. The topographic survey was conducted by California licensed surveyors during

the RI and followed standard protocol as part of a landfill investigation (Appendix E). As a result of the topographic survey, a comparison of historical and current landfill topography was performed to provide the maximum volume within the landfill (93,619 yd^3) (Figure 21). The difference plot of these two surfaces provides an initial estimate of the volume of fill that may have occurred within the landfill area.

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8.0 NATURE AND EXTENT

8.1 RI Analytical Results

Groundwater concentrations detected above screening levels during the first round of RI sampling were limited to three metals - arsenic, iron, and manganese. Arsenic and iron concentrations above screening levels only occurred in the sample from well MW-2. Manganese concentrations above screening levels were observed for wells MW-2, well MW-4A (located approximately 175 ft southwest of MW-2), well MW-5A (approximately 125 ft north of well MW-2), and MW-7 (approximately 275 ft northeast of well MW-2). Table 4-1 presents the arsenic, iron, and manganese concentrations for the wells sampled. Laboratory results for groundwater sampling are presented in Appendix K.

In the first RI sampling round, iron and arsenic were detected in all seven groundwater samples, but only exceeded the screening levels in the sample collected from MW-2, while manganese was detected in all seven samples collected, but exceeded the screening levels for the groundwater samples collected from MW-2, MW-4A, MW-5A, and MW-7. Aside from the sample result for iron from well MW-2 (1,490 µg/L), iron concentrations ranged from 100 µg/L to 125 µg/L. Aside from the sample result for arsenic from well MW-2 (16.2 µg/L), arsenic concentrations ranged from 1.06 µg/L to 2.96 µg/L. Aside from the sample results for manganese from wells MW-2 (5,210 µg/L) and MW-4A (421 µg/L), manganese concentrations ranged from 5.34 µg/L to 69.5 µg/L. The groundwater samples from wells MW-5A, MW-7 and MW-9A ranged between 31.5 µg/L and 69.5 µg/L for manganese. Note the manganese screening level (50 µg/L) is a secondary MCL (based on aesthetics) and not a primary MCL.

MW-2 showed the highest first round concentrations of metals by an order of magnitude, and arsenic and iron detected concentrations were limited to the sample from this well. The reduced forms of iron (Fe(II)) and arsenic (As(III)) are more soluble than the oxidized forms and reducing conditions can mobilize both of these metals in groundwater (Delemos et al., 2006).

In the second round of sampling on May 31 – June 1, 2011, Well MW-2 again had sole arsenic and iron detected concentrations above screening levels, consistent with the first round results. There were no other second round arsenic or iron concentrations above

screening levels, these results were consistent with the first round results. Well MW-2 also had a manganese detected concentration above screening levels in the second round, at concentrations that were similar to the first round concentrations. Only two other wells had manganese concentrations above screening levels in the second round of sampling. Well MW-3, with no first round detected concentrations above screening levels had a manganese concentration above screening levels (400 µg/L), compared to the ND first round groundwater sample manganese result. Well MW-12, located upgradient of the other wells and the waste prism, had a manganese concentration of 107 µg/L in the second round (this well was not available during the first round).

Iron is the 4th most abundant element in the earth's crust (Plummer et al., 2005), and mobilization of iron occurring naturally in aquifer solids due to reduced groundwater is the likely reason for the iron concentrations detected above screening levels, rather than a release of iron from the waste. Well MW-2 is located in the waste footprint and is just north of the location of soil-gas sample SG-1-9.5, the only soil-gas sample with detected methane. The SG-1 and SG-2 soil-gas oxygen concentrations are depleted and the carbon dioxide concentrations are elevated, consistent with the presence of organic matter in the vicinity. Since decaying organic matter can act to reduce groundwater, localized reduced groundwater at Well MW-2 is likely to occur, and this is supported by the iron concentrations observed in MW-2.

Native soils at the site are reddish in color. This reddish coloration shows the presence of iron in the +3 oxidation state (e.g., rust), in the soils. Reddish iron staining of exposed rock surfaces is also apparent along the surface water courses, such as the gully on the west side of the site. Such iron staining is common where iron in soils is made soluble by decomposition of organic matter such as leaves or vegetation. The dissolved iron is subsequently immobilized due to contact with oxygen from the air to form a reddish iron stain. This shows the potential for iron (and other redox-sensitive elements such as manganese) to become mobilized from site soils under reduced or anaerobic conditions.

The solubility of iron depends on both the oxidation-reduction potential (Eh) and the pH. Figure 22 shows an Eh-pH diagram for iron at the MCL of 50 µg/L with site wells posted on the plot according to their Eh and pH values. The light blues areas in the figure show conditions where iron is soluble at the MCL. They are labeled with the most stable form of iron under those conditions. The tan areas in the figure show where iron is not soluble at that concentration and are labeled with the mineral form of iron

that is most stable. It can be seen from the plot that site groundwater conditions predict that the iron will precipitate. This shows that metals that are dissolved from mineral sources under reduced conditions like those beneath the waste have a tendency to become re-deposited as minerals after groundwater Eh and/or pH increase. As groundwater containing dissolved iron (or manganese, which also undergoes reductive dissolution – See below) migrates downgradient, the Eh is expected to increase due to infiltration of oxygenated water, contact of the groundwater with soil gas containing O_2, etc. and the iron should precipitate out as Hematite.

Arsenic is known to sorb to iron oxides, and it can be desorbed by reduced groundwater conditions (Delemos, et al, 2006). Because of its common occurrence in geologic media and the potential for release of sorbed arsenic, arsenic detected in groundwater samples is likely from natural materials and not a release from the waste. Arsenic and iron concentrations appear to attenuate naturally downgradient of well MW-2.

Manganese is the 12th most common element in the earth's crust (Emsley, 2001). Mobilization of manganese occurring naturally in aquifer solids due to reduced groundwater is the likely reason for the manganese concentrations detected above screening levels, rather than a release of manganese from the waste. Similar to iron, manganese has a reduced form (Mn (II)) that is more soluble than mineral forms. Kerfoot et al. (2004) observed increased manganese concentrations in groundwater affected by methane from landfill gas. Manganese concentrations appear to attenuate naturally downgradient of Well MW-2.

As with the arsenic and iron data, the first round and second round manganese concentrations appear to decrease downgradient of well MW-2, reaching 69.5 µg/L at well MW-5A and 64.1 µg/L at well MW-7 in the first round and 400 µg/L in well MW-3 and 0.724 to 29.8 µg/L in Wells MW-4, MW-5, and MW-7 in the second round, respectively. This suggests that natural processes could be attenuating the manganese.

Although well MW-12 provided a Site-specific snapshot of the background manganese concentration of 107 µg/L for the Site, other data from the vicinity of the Site also support elevated groundwater manganese concentrations. Variable concentrations of manganese have been measured in samples from all the Site wells, and according to the Camp Pendleton OU 3 Record of Decision "… manganese has been detected in groundwater throughout MCB Pendleton." Camp Pendleton Well 1A1MW-1 had a manganese concentration of 89 µg/L and Building 14133 (Area 14) had manganese

concentrations of 45.2 µg/L to 3520 µg/L. Because the alluvial sediments and weathered bedrock at Camp Pendleton and Site 27 are geochemically similar, these high manganese concentrations at Camp Pendleton suggest that elevated groundwater concentrations of manganese are common in environments like Site 27.

Well MW-1 had a second round nitrate concentration detected above screening level, with a concentration of 64,600 µg/L. This concentration is likely an artifact, since it was not observed in the SI or first round sample results.

Although a detected concentration above screening levels for aluminum was observed for well MW-2 in the SI, it has not been confirmed in two rounds of additional sampling. Because aluminum solubility is controlled by pH (rather than redox potential, as with arsenic, iron, and manganese) that result seems to be an artifact of sampling or sample handling.

In summary, based on the SI data and two additional rounds of sampling, well MW-2 seems to consistently have detected concentrations above screening levels for arsenic, iron, and manganese. The downgradient wells do not indicate arsenic or iron concentrations above screening levels. This is consistent with natural attenuation of these naturally occurring constituents. A background manganese concentration of 107 µg/L was observed in well MW-12 and higher background concentrations have been observed in the same sediment at nearby sites. Manganese concentrations (and detected concentrations above screening levels) seem to show temporal variability in the wells other than MW-2. This variability in manganese concentrations could be due to redox potential changes resulting from fluctuations in the water table elevation. Additional data can show the amount of temporal variability in groundwater manganese concentrations.

8.2 Extent of Landfill

The nature and extent of the landfill waste prism is important in understanding the impact of the landfill on the Site. The RI incorporates the previous data from the SI (MARRS, 2009) and the new data. To evaluate the nature and extent of the waste prism, borehole logs that identified top of trash and/or bottom of waste were used in conjunction with the geophysical data to provide coordinates for the limits of waste. This data was processed using environmental visualization software (EVS) to model a 3D interpretation of the waste prism. Figures 23, 24, 25 and 26 provide 3D images of

the waste prism. These visualizations can help evaluate the potential for groundwater-waste interaction, the trend of the waste prism from south to north within the ravine, and the varying thickness of waste. The 3D model can be used to evaluate the potential quantity of waste.

To develop the 3D visualization of the landfill extent the geophysical survey data was evaluated and coordinates for the location including northing, easting, and depth were taken from the plots. The interpreted geophysical survey values were used and compared with physical data points such as borehole logs. This provided a dense enough data distribution to allow the EVS software to adequately model the 3D extent of waste. Additional data points such as boreholes, soil gas probes, and potholes around the perimeter of the landfill provided additional control on the extent of waste.

Using this 3D model of the waste allows an estimation of the waste volume in the landfill. The capacity within the 3D waste volume is approximately 65,728 yd^3. Because most military landfills are not as efficient as large volume municipal solid waste landfills it is likely that the volume of waste is significantly less than the maximum capacity. For purposes of estimating a removal action the 65,728 yd^3 may be used as a conservative estimate of the waste volume.

8.3 Quality Assurance/Quality Control (QA/QC) Results for RI Sampling

In accordance with the Final SAP, the following field quality control samples were collected: five equipment blanks (EB-110810, EB-110910, EB-053111, EB-060111, EB-100611), three field duplicates (54-0051-FD, 54-002-FD, 54-104 DUP), six trip blanks (TB-110810, TB-110910, TB-053111, TB-060111, TB-100611, Trip Blank), three source blanks (SB-110910, SB-053111, SB-100611), and two matrix spike/matrix spike duplicate (ms/msd) samples (54-001 and 54-050). All QC samples were collected per minimum required frequency detailed in the Final SAP. Equipment blanks were collected for each day of groundwater sampling. Following equipment decontamination, the equipment blanks were collected by pouring laboratory provided distilled water through the sampling pump and collecting the water in the appropriate sample containers. Duplicate samples were collected from monitoring well MW-2 (54-051-FD and 54-052-FD) and from soil gas point SG-3-5 (54-104 DUP). Trip blanks prepared by the laboratory accompanied coolers and SUMMAs containing VOC samples at the Site and during transport to the laboratory each day sampling was conducted. Source blanks were collected directly from distilled water provided by the

laboratory. Additional containers were filled from MW-1 (54-001 and 54-050) for MS/MSD QC analysis.

All trip blanks were analyzed for VOCs by EPA Method 8260B. The equipment blanks and the source blank were analyzed for VOCs, TPH-purgeable and TPH-extractable by EPA Method 8015B, pesticides by EPA Method 8081A, PCBs by EPA Method 8082, SVOCs by EPA Method 8270C, metals by EPA Method 6020A, hydrazine by ASTM D1385, and NDMA by EPA Method 1625C. Duplicate samples and MS/MSD samples were analyzed for VOCs, TPH-purgeable, TPH-extractable, pesticides, PCBs, SVOCs, metals, ammonia/nitrate by EPA Method 350.2/353.3, sulfide by EPA Method 376.1, sulfate/nitrite by EPA Method 300, hydrazine, and NDMA. Analytical results with detected analytes for all field QC samples are provided in Table 8-1. No VOC analyte was detected in any trip blank samples. However, NDMA and various metals were detected in equipment blanks and source blanks. The metals detected in the equipment blank collected on November 8 and 9 of 2010 are likely due to accidental use of drinking water instead of distilled water. Since calcium, magnesium, potassium, and sodium were also detected in the source blanks at similar concentration and these metals are typically added to drinking water. Low levels of metals detected in equipment blanks collected on May 31 and June 1 of 2011 are not from source blanks, since no metals were found in the source blank. However, metals detected in the associated field samples are either non detect or greater than five times the concentration found in the equipment blank, that metals concentrations in the field samples are not affected.

The relative percent difference (RPD) between field parent samples and field duplicates for groundwater are all within the 20 percent limit. Relative percent difference of field duplicate for soil gas matrix was within the 30 percent limit except for carbon disulfide with 51 percent RPD. The RPD for carbon disulfide is high due to relative close concentrations between the parent sample and field duplicate sample, 1.3 and 2.2 $\mu g/m^3$, respectively. The RPD is not applicable when concentrations are low; therefore the high RPD is acceptable for the field duplicate sample. No field duplicates were collected for soil matrix due to non-homogeneity property of soil.

Except for the waste data, all analytical data were validated by LDC, a third-party validator. Level III data validation effort was performed on ninety percent of the analytical data and level IV validation effort was performed on the remaining ten percent. All samples were analyzed within technical holding times for each respective method. Initial calibrations, internal standards, method blanks, mass spectrometer tunes,

laboratory control samples (LCS), and MS/MS were all within QC limits for each analysis. The following table summarizes laboratory QC samples that were not within QC limits which required qualifying data as estimated values.

Compound	Effected Samples	Reason
Freon 113	IRP-SW-1, IRP-SW-2, IRP27-SW-3, TB122110	Percent difference (%D) between initial calibration and second source calibration standard.
Trichlorofluoromethane	EB-110810, 54-051	Percent difference (%D) between initial calibration and second source calibration standard.
Base/neutral compounds	IRP27-SW-3	Low percent recovery (%R) of spiked surrogates.
Chromium	54-050, 54-051, 54-051-FD	Detected low concentration in the equipment blank.

No analytical data were rejected for this project. Any data affected by laboratory or field QC samples being outside of the QC limits were flagged with applicable validation qualifiers and are considered usable. Laboratory reports and validation reports are presented in Appendix L.

8.4 Investigation-Derived Waste

Investigation-derived waste (IDW) was generated as a consequence of field activities and included decontamination water, drilling spoils, used personal protective equipment (PPE), and purged groundwater. IDW was placed into 55-gallon drums. All IDW was stored in a designated and clearly marked IDW management area. All vessels were clearly labeled to indicate the source of the IDW. The IDW storage area was inspected daily during field operations. Laboratory testing was done to determine the proper disposition of these IDWs. The waste was classified as non-hazardous and a manifest was signed for the IDW to be taken off Site on February 11, 2011 (Appendix M). The drums were shipped to US Ecology Nevada in Beatty, Nevada. Fifteen drums containing groundwater from the development activities and decontamination water and 18 drums containing drill cuttings and used PPE were removed from the Site and taken by PSC Environmental Service of Pomona to US Ecology Nevada in Beatty, Nevada.

The IDW was taken off site within 90 days in accordance with Resource Conservation and Recovery Act (RCRA) and disposed of in accordance with applicable federal, state, and local regulations. Manifests are provided in Appendix M.

9.0 RISK ASSESSMENT

As part of the SI, MARRS conducted a human health risk assessment (HHRA) and an ecological risk assessment (ERA) for the chemicals detected at IRP Site 27. A CSM that included the geology and hydrogeology of IRP Site 27 and the exposure pathways for humans and other ecological receptors was developed in the SI. According to the SI (MARRS, 2009), COPCs detected in the soil at IRP Site 27 are unlikely to pose an adverse health risk to an on-site industrial worker, construction worker, hypothetical resident, or off-site adult or child farmer. In addition, the SI concluded that it is unlikely that the COPCs detected pose a significant risk to ecological receptors. However, an RI was recommended at IRP Site 27 to address remaining data gaps.

An updated screening level HHRA and ecological risk assessment (SLERA), using the data collected during the RI and the previous HHRA and ERA as a basis, are provided in the sections below.

9.1 Screening Level Human Health Risk Assessment

The SI (MARRS, 2009) screening level HHRA has thoroughly evaluated soil COPCs. The RI screening level HHRA was developed and scoped as a supplement to the SI HHRA (Appendix B). This screening level HHRA was performed for chemicals detected in soil, soil gas, groundwater, and storm water samples collected at IRP Site 27 during the RI. This screening level HHRA provides an addendum to the HHRA that was performed as part of the SI (MARRS, 2009) incorporating new data that was collected as a part of the RI. This screening level HHRA was performed following guidance presented in U.S. EPA's Risk Assessment Guidance for Superfund (RAGS) (EPA, December 1989, 2009), other EPA guidance (1991; 2011a,b), as well as presented in Cal-EPA guidance documents (Cal-EPA, 1999; 2005; 2010). An updated human health CSM is provided in Figure 27.

Various demarcations of acceptable risk have been established by regulatory agencies. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP; 40 Code of Federal Regulation 300) indicates that lifetime incremental cancer risks posed by a site should not exceed a range of one in one million (1×10^{-6}) to one hundred in one million (1×10^{-4}) and noncarcinogenic chemicals should not be present at levels expected to cause adverse health effects (i.e., a noncancer hazard greater than 1). In addition, other relevant guidance (U.S. EPA, 1991) states that sites posing a cumulative cancer

risk of less than 10^{-4} and hazard indices less than unity (1) for noncancer endpoints are generally not considered to pose a significant risk warranting remediation. The California Hazardous Substances Account Act incorporates the NCP by reference, and thus also incorporates the acceptable risk range set forth in the NCP. The DTSC considers the 1×10^{-6} risk level as the generally accepted point of departure for unrestricted land use.

9.1.1 COPC Detected in Soil

Soil samples were collected from 13 borings at the Site during the SI and analyzed for a total of 21 metals. All metals were detected in one or more soil samples with the exception of molybdenum, selenium, and thallium. As reported in the SI report (MARRS, 2009), twelve metals exceeded background concentrations in one or more samples. These metals were evaluated in the HHRA as part of the SI report (MARRS, 2009). Results of the SI HHRA indicated that the cancer risk estimates were due almost exclusively to arsenic and PCB-1248 and that the cancer risk and noncancer hazard due to the other metals were considered insignificant. During the SI (MARRS, 2009), arsenic was detected in a single soil sample (boring IR27B02) at a concentration (28.4 mg/kg) greater than its U.S. EPA Residential and Industrial Regional Screening Levels (RSL) and greater than the DTSC screening level of 12 mg/kg considered as background for southern California (Cal-EPA DTSC, 2007). The remaining detections of arsenic in soil at IRP Site 27 ranged from 0.97 mg/kg to 2.15 mg/kg for the 0 to 10 ft bgs soil depths. These detected concentrations are most likely attributed to background rather than site-related activities at IRP Site 27.

Because arsenic was the only metal identified as a risk driver in the HHRA (MARRS, 2009), it was the only metal analyzed for during the RI field investigation in October 2010, where boring location IR27B02 was re-occupied by new boring IRP27-SS-1 and sampled and analyzed for arsenic. Arsenic was detected at a concentration (2.79 mg/kg) much lower than the DTSC background screening level. The initial, elevated arsenic concentration (boring IR27B02) was determined to be an anomalous value. As previously stated in the HHRA (MARRS, 2009), cancer risk and non-cancer hazard attributed to arsenic may not be any greater than that posed by background arsenic concentrations.

Results of this screening level HHRA of the soil medium indicated that further human health risk evaluation of arsenic as a soil COPC is not warranted and therefore, no

further action is recommended for soils at IRP Site 27. Final determination for additional assessment and analysis will be made during the FS.

9.1.2 COPCs Detected in Soil Gas

Soil gas samples were collected during the RI in October and November of 2010 at IRP Site 27. Details of the sampling and analytical results were discussed earlier in Section 5.3 of this report.

The Department of Defense Vapor Intrusion Handbook (Tri-Service Environmental Risk Assessment Work Group [Tri-Services], 2009) on vapor intrusion states that Site data should be compared to "conservative health-protective screening concentrations." U.S. EPA presented generic screening levels for chemicals in soil gas in its 2002 draft vapor intrusion guidance; however, many of these were derived using toxicity criteria that have since been updated. Therefore, for this screening level HHRA, maximum soil gas concentrations were compared to the DTSC residential CHHSLs (Cal-EPA, 2005; 2010) as they are the most up-to-date screening concentrations available. Although future residential land use is unlikely since the land is utilized as a weapons station, this receptor had been evaluated in the site-specific HHRA (MARRS, 2009) to address unrestricted land use. Using screening levels based on a hypothetical residential scenario will be protective of the other receptors (e.g., industrial and construction workers) that are at the site far less frequently than what is assumed for a hypothetical resident.

For those VOCs without a published soil gas CHHSL, "CHHSL-equivalents" were derived using the same algorithms and parameters as those in the guidance manual (Cal-EPA, 2005), the most recent version of the Johnson & Ettinger model, as well as the most recent toxicity criteria. No VOCs were detected in soil gas samples at IRP Site 27 at concentrations greater than residential CHHSLs (Table 9-1), except for naphthalene which had a maximum concentration (33 $\mu g/m^3$) only slightly greater than the residential CHHSL of 32 $\mu g/m^3$. This detection would equate to a cancer risk estimate of 1×10^{-6}, which does not exceed the NCP acceptable risk range of 1×10^{-6} to 1×10^{-4} nor the DTSC target risk level for unrestricted land use. Additionally, the maximum naphthalene detection is lower than the industrial soil gas CHHSL of 110 $\mu g/m^3$.

Results of this screening level HHRA of the soil gas medium indicated that VOCs detected in soil gas do not pose a human health risk even for the most conservative receptor, a hypothetical resident. Therefore, further human health risk evaluation of VOCs detected in soil gas is not warranted at IRP Site 27.

9.1.3 COPCs Detected in Groundwater

Groundwater samples were collected during the RI at IRP Site 27. Details of the sampling and analytical results were discussed in earlier sections of this report.

For this screening level HHRA, maximum groundwater concentrations were compared to primary and secondary MCLs, if available, or to U.S. EPA's RSLs based on tap water use (U.S. EPA, November 2011a). Detected concentrations of arsenic, cobalt, iron, manganese, nitrate (as nitrogen) and sulfate exceeded their respective MCLs (Table 9-2). Arsenic concentrations ranged from 1.06 µg/L to 24 µg/L as compared to its primary MCL of 10 µg/L. Iron concentrations ranged from 35 µg/L to 10,400 µg/L as compared to its secondary MCL of 300 µg/L. Manganese concentrations ranged from 0.71 µg/L to 5,680 µg/L as compared to its secondary MCL of 50 µg/L. Nitrate concentrations ranged from 234 µg/L to 64,600 µg/L as compared to its MCL of 10,000 µg/L. Sulfate concentrations ranged from 30,200 µg/L to 205,000 µg/L as compared to its secondary MCL of 250 µg/L.

Cobalt concentrations ranged from 0.63 µg/L to 12 µg/L, with the maximum exceeding the tap water RSL of 4.7 µg/L. However, the 95% upper confidence limit (UCL) of the average concentration for cobalt was less than the RSL. The two highest concentrations of cobalt were detected in MW-02, which is located within the landfill. The perimeter wells, which provide a downgradient evaluation of groundwater quality, had cobalt concentrations that were less than the RSL. Hydrazine concentrations ranged from 1.2 µg/L to 4.5 µg/L, which exceeded the tap water RSL of 0.022 µg/L. No MCLs were available for these chemicals.

Although arsenic, cobalt, iron, hydrazine, manganese, nitrate, and sulfate exceeded a drinking water screening level, groundwater is not used as a public water supply at IRP Site 27. Therefore, ingestion of groundwater is not considered a potentially complete exposure pathway for receptors at this Site. In other words, potential human health risk is absent, since receptors at the Site are unlikely to be exposed to impacted groundwater.

Results of this screening level HHRA of groundwater indicated that chemicals detected in groundwater do not pose a human health risk due to the lack of a complete exposure pathway. Therefore, further human health risk evaluation of chemicals detected in groundwater is not warranted at IRP Site 27.

9.1.4 COPCs Detected in Storm Water

Storm water samples were collected during the RI at IRP Site 27 to identify potential impacts from landfill waste to downgradient areas. Storm water run-off samples were collected from three areas where water temporarily pooled during a significant storm event. These three areas were located upgradient of the landfill, on the surface of the landfill, and downgradient of the landfill. The storm water samples were analyzed for VOCs, metals, pesticides, PCBs, SVOCs, hydrazine, TPH, and general chemistry.

Due to the combination of flat terrain and vegetation present at the Site, residence time of storm water on-site is limited. Therefore, the potential for human receptors to be exposed to COPCs in storm water via direct contact and/or ingestion is unlikely. Despite the limited potential for human exposure to storm water at this Site, maximum storm water concentrations were compared to screening levels in this HHRA.

For this screening level HHRA, maximum storm water concentrations were compared to primary and secondary MCLs, if available, or to U.S. EPA's RSLs based on tap water use (U.S. EPA, November 2011a) to provide a conservative evaluation should someone contact storm water. Of the detected concentrations of chemicals, hydrazine, manganese, and sulfate exceeded their respective screening levels (Table 9-3). Hydrazine concentrations ranged from 38 µg/L to 44 µg/L, which exceeded its tap water RSL of 0.022 µg/L. Manganese concentrations ranged from 4.1 µg/L to 55 µg/L as compared to its secondary MCL of 50 µg/L. Sulfate concentrations ranged from 430 µg/L to 1,120 µg/L as compared to its secondary MCL of 250 µg/L. Although these chemicals exceeded a drinking water screening level, potential human exposures to storm water via direct contact and/or ingestion is unlikely at IRP Site 27 since the average annual precipitation is minimal at the Site (12 in.; MARRS, 2009), residence time of storm water on-site is limited, and workers are seldom at the Site. In other words, potential human health risk is absent since receptors at the Site are unlikely to be exposed to this medium.

Results of this screening level HHRA of storm water indicated that chemicals detected in storm water are unlikely to pose a significant human health risk. Therefore, further human health risk evaluation of chemicals detected in storm water is not warranted at IRP Site 27.

9.2 Screening Level Ecological Risk Assessment

A screening-level ecological risk assessment (previous SLERA) was performed as part of the SI at IRP Site 27. The previous SLERA was conducted to determine whether one or more chemicals or constituents detected in soil at IRP Site 27 cause unacceptable risk and warranted further evaluation with respect to terrestrial ecological receptors (including threatened/endangered species). The previous SLERA was conducted under the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* ([ERAGS] EPA, June 1997).

Based on the previous SLERA, no further action was recommended for IRP Site 27 based on ecological effects. The RI SLERA was developed and scoped as a supplement to the SI SLERA (Appendix B). This revised SLERA provides an addendum to the SLERA that was performed as part of the SI (MARRS, 2009). Key components of the SLERA that formed the basis of this recommendation were reviewed in the context of existing and new RI data, which could potentially affect the SLERA results, conclusion, and/or recommendations. An ecological CSM is provided in Figure 28. Final determination for additional assessment and analysis will be determined in the FS.

9.2.1 Ecological Setting and Assessment Endpoints

IRP Site 27 has an area of approximately 7 acres of permeable surface area, which provides terrestrial ecological habitat and services. The Site consists of open land with coastal sage scrub and dense patches of non-native annual species such as Erodium sp., Brassica sp., and Bromus sp (MARRS, 2009). In addition, several eucalyptus trees and a Peruvian Pepper tree are located along the southern portion of the landfill. IRP Site 27 provides foraging habitat for both birds and mammals. Since IRP Site 27 was closed in 1974, it has been left undisturbed. Upon closure several small eucalyptus trees were planted over the top of the southern portion of the landfill. At the time the previous SLERA was conducted, the eucalyptus trees were mature and appeared to be thriving. Vegetation across the rest of the landfill consisted of coastal sage scrub and

dense patches of non-native annual species such as *Erodium sp*. *Brassica sp.*, and *Bromus sp*. To date, there are no obvious signs of vegetative stress.

The previous SLERA identified three federally listed endangered/threatened animal species that could potentially be present in the vicinity of IRP Site 27: Stephen's kangaroo rat (SKR, *Dipodomys stephensi*), coastal California gnatcatcher (CAGN, *Polioptila californica*), and Least Bell's vireo (LBV, *Vireo bellii pusillus*). A more recent biological survey (BAMP, 2010) confirmed that these are the endangered/threatened animal species that may dwell in the vicinity of IRP Site 27.

No significant changes to the ecological setting that would affect the SLERA CSM have been observed. Thus, the assessment endpoints evaluated in the previous SLERA are also appropriate based on current Site conditions. Terrestrial plants, invertebrates, mammals (including SKR), birds (including CAGN and LBV), and reptiles were identified as potential ecological assessment endpoints. An updated ecological CSM is provided in Figure 28.

9.2.2 Measurement Endpoints and Effects Evaluation

Potential effects to plants and invertebrates were quantified on a community level using media-specific (i.e., soil) benchmarks and the hazard quotient (HQ) approach. Reptiles were not quantitatively evaluated due to a lack of toxicity data. Terrestrial mammals and birds (including endangered/threatened species) were evaluated using food web modeling, dietary toxicity reference values (TRV), and the HQ approach.

The HQ approach is based on the following general equation:

$$HQ = \frac{\text{Exposure Level}}{\text{Effect Level}}$$

For plants and terrestrial invertebrates, the exposure level was assumed to be the maximum detected concentration in environmental media (i.e., soil) and the effects level; the primary source of soil benchmarks values was Oak Ridge National Laboratory's documents titled, *Toxicological Benchmarks for Potential Contaminants of Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Processes* and *Toxicological Benchmarks for Potential Contaminants of Concern for Effects on Terrestrial Plants* (Efroymson et al., November 1997a and 1997b). A second source of soil benchmarks was the ecological soil screening levels derived by EPA (February

2005), as taken from a document title *Guidance for Developing Ecological Soil Screening Levels*.

The exposure level for mammals and birds was calculated using a food web model based on the following general equation:

$$Dose_{oral} = \frac{(C_{soil} \times S_o I) + (C_{soil} \times UF_{plant} \times FI \times FD_{plant}) + (C_{soil} \times UF_{inv} \times FI \times FD_{inv}) + (Dose_{prey} \times UF_{prey} \times FI \times FD_{prey})}{BW}$$

Where:

$Dose_{oral}$	=	Daily dose contaminants ingested (mg/kg-day)
C_{soil}	=	Contaminant concentration in soil (mg/kg)
S_oI	=	Soil ingestion rate (kg/day)
UF	=	Uptake factor (unitless)
FI	=	Food ingestion rate (kg/day)
FD	=	Fraction of dietary intake
$Dose_{prey}$	=	$Dose_{oral}$ calculated for prey item (mg/kg)
BW	=	Body weight (kg)

The contaminant concentration in soil was assumed to be the maximum detected concentration in soil. Exposure assumptions and uptake factors are presented in those described in the *Final Work Plan* (MARRS, September 2005).

The effects level for mammals and birds are No Observable Adverse Effect Level (NOAEL) dietary TRVs, which were developed through a three-step process: 1) literature search; 2) selection of a TRV; and 3) adjustment of the selected TRV for the receptor. As a component of the uncertainty analysis, Lowest Observable Adverse Effect Level (LOAEL) dietary TRVs were also used to evaluate potential risks to populations. Note, however, threatened and endangered species were only evaluated using NOAEL TRVs, which are considered protective of individuals within a population.

No substantial changes in the toxicological profiles of Site COPCs have occurred which would invalidate the soil benchmarks or TRVs utilized in the previous SLERA.

No additional benchmarks or TRVs were identified which could reduce uncertainties associated with the previous SLERA results.

The conclusions of the previous SLERA were based on a weight-of-evidence approach which considered the HQs as well as Site observations, background data (metals only), refined exposure estimates, and uncertainties in the risk assessment process. This approach to evaluating potential eco-toxicity is consistent with current SLERA methodology.

9.2.3 Potentially Complete Exposure Pathways

Section 8 of the previous SLERA (MARRS, 2009) quantitatively evaluated ecological exposure to surface soil (0-2 ft bgs) with the results summarized below.

- Potential risk to the community-level receptors could not be determined due to the lack of screening values for several metals, polybrominated diphenylethers (PBDE), PCBs (soil invertebrates only), pesticides, and hydrazine. Several metals pose a risk to community-level receptors: aluminum, arsenic, chromium, lead, and vanadium exceeded their plant screening values and chromium exceeded its soil invertebrate screening value; however the presence of vegetation belies the risk to plants and all metal concentrations except arsenic and lead maximum concentrations were below background upper tolerance limits (UTLs).
- The only inorganics with NOAEL-based HQs above 1 and concentrations to exceed background UTLs were arsenic and lead, which only exceeded background at their maximum detected locations. Based upon a comparison of maximum concentration NOAEL-based HQs and background NOAEL based HQs, the majority or risk from these metals is attributable to background. Based on the 95% UCL NOAEL-based HQs, arsenic and lead still had NOAEL-based HQs above one, but they were much reduced from the maximum NOAEL-based HQs. Single arsenic and lead maximum locations above background are unlikely to cause substantive ecological risk.
- The only organics with NOAEL-based HQs above one were alpha-chlordane, 4,4’- dichlorodiphenyltrichloroethane (DDT), PCB-1016, and PCB-1260. However, alpha-chlordane had 95% UCL NOAEL-based HQs below one. 4, 4’-DDT, PCB-1016, and PCB-1260 had 95% UCL NOAEL-based HQs

above one, but the risk appears to be minimal since all 95% UCL NOAEL-based HQs are only slightly above one, with all less than 4.0. PCBs and 4, 4'-DDT are not widespread contaminants because exposure is limited to only one out of ten sample locations (IR27B0301). It is unlikely that COPCs detected at only one location would pose a substantive ecological risk to wildlife.

- The SLERA did not take into consideration actual diets (the SLERA assumed a diet composed entirely of the most contaminated dietary item), bioavailability (the SLERA assumed 100% bioavailability), metabolic processes, or area use factors (AUFs), which would reduce the risk calculations.

No additional soil data was collected during the RI; however, soil gas and storm water run-off samples were collected in support of the Site characterization. Although surface soil remains the primary exposure media, ecological receptors also have the potential to be exposed to soil gas and storm water run-off. However, as described in the following two subsections, ecological exposure and, therefore, risk from exposure to these media is likely to be negligible.

9.2.3.1 Soil Gas

Burrowing animals, such as Stephen's kangaroo rat, have the potential to be exposed to soil gas. During the RI, soil gas samples were collected at depths ranging from 3 to 10 ft bgs from locations on and adjacent to the footprint of the landfill. Generally, for ecological exposures, the inhalation pathway is negligible relative to the ingestion pathway. Additionally, quantitative evaluation of this pathway is limited due to a lack of inhalation toxicity and exposure data. However, to ensure that the exclusion of the soil gas pathway from quantitative evaluation in the revised SLERA did not result in a substantial underestimation of risk, maximum detected soil gas concentrations were compared to inhalation-specific ecological screening levels (ESL) obtained from the literature.

Gallegos et al. (2007) conducted a comprehensive literature review to collect inhalation toxicity data. Inhalation TRVs were identified for a limited number of VOCs for various mammalian receptors. Using the equation below, Gallegos et al. calculated inhalation ESLs for Botta's pocket gopher (*Thomomys bottae*).

$$ESL = \left(\frac{BW \times TRV}{IR} \right) \times OF$$

Where:

BW = Body Weight (kg); 0.104

TRV = Chemical-specific inhalation toxicity reference value (mg/kg-day) based on chronic NOAELs

IR = Inhalation rate (cubic meters per day [m^3/day]) = $0.5458 \times BW^{0.80}$ (U.S. EPA, 1997)

OF = Occupancy Factor (unitless), assumes a receptor spends 100% of its time in the burrow

The resultant ESLs calculated by Gallegos et al. (2007) were adjusted based on Stephen's kangaroo rat, which is the most sensitive assessment endpoint likely to burrow at the Site; the assumed body weight and inhalation rate were 0.065 kilograms (kg) and 0.061 m^3/day, respectively.

Table 9-4 presents maximum detected soil gas concentrations and ESLs for those constituents for which a TRV was identified by Gallegos et al. (2007). As indicated in the table, maximum detected concentrations of soil gas were one or more orders of magnitude below the calculated ESLs. Although, TRVs/ESLs were not available for several constituents detected in soil gas, the comparison supports the assumption that risks from the inhalation pathway are likely to be negligible.

Based on the evaluation above, it is unlikely that soil gas represents a significant exposure pathway or risk to ecological receptors. Thus, the results and recommendations of the SLERA are not affected.

9.2.3.2 Storm Water

There are no surface water bodies, such as rivers, streams, or lakes, on or near IRP Site 27. The Site drains to a heavily vegetated ravine to the north; however, this ravine did not contain water during Site visits in 2009 or 2010. Thus, the habitat is not suitable to support benthic or aquatic receptors. An impoundment exists 1,800 feet downstream and across the ravine from the northern site boundary.

Per recommendations of the Final SI Report, storm water sampling was conducted to identify potential impacts from landfill waste to downgradient areas. Although residence time of storm water on-site is limited due to a flat terrain and vegetation, there is a potential for terrestrial ecological receptors to be exposed to COPCs in storm water via direct contact and/or ingestion. Available surface water ESLs are based on benthic or aquatic endpoints and, thus, are inappropriate benchmarks for evaluating potential risks to terrestrial receptors. Moreover, surface water benchmarks are typically based on continuous (i.e., submerged) exposure to dissolved-form COPCs whereas COPCs in overland run-off are likely to be present as suspended particulates and exposures are only likely to occur intermittently.

However, to ensure that the exclusion of the storm water exposure pathway from the revised SLERA did not result in a substantial underestimation of risk, it was assumed upper trophic level receptors would consume storm water as drinking water. The following equations were used to estimate COPC intake and risk from storm water, respectively:

$$ADD = \frac{C_{sw} \times CF \times DWI \times AUF}{BW}$$

$$HQ = \frac{ADD}{TRV}$$

Where:

ADD = Average daily dose (mg/kg-day)

C_{sw} = Concentration in storm water (µg/L)

CF = Conversion factor (0.001 mg/µg)

DWI = Daily water ingestion (L/day)

BW = Body Weight (kg)

AUF = Area use factor (unitless)

HQ = Hazard quotient (unitless)

TRV = Dietary toxicity reference value (mg/kg-day) based on a chronic NOAEL

The receptor-specific daily water ingestion values, body weights, and area use factors are those specified in the *Final Work Plan* (MARRS, 2005). Mammalian and avian TRVs are also those specified in the *Final Work Plan*, with the exception of TRVs for constituents detected in storm water, but not in soil. For these constituents (nitrate, 2,4-dinitrotoluene, 2,6-dinitroltoluene, and 4-methylphenol) mammalian TRVs were obtained from Sample et al. (1996), the U.S. EPA (1999) SLERA Protocol for Hazardous Waste Combustion Facilities, and the U.S. EPA (2011b) Integrated Risk Information System; no avian TRVs were identified for these compounds.

Risks to avian and mammalian receptors from consumption of storm water as drinking water were estimated using the HQ approach described in the previous SLERA. For this evaluation, the California gnatcatcher and Stephen's kangaroo rat were selected as representative avian and mammalian species, respectively, based on their high water consumption rates relative to body weights. The average daily doses, TRVs, and calculated HQs are presented in Table 9-5 for constituents detected in storm water. All HQs are well below one, indicating a limited potential for ecological risk from consumption of storm water. Further, the conservative assumptions of this evaluation (e.g., use of maximum concentrations and AUFs of 1) are likely to overestimate risks.

Based on the evaluation above, it is unlikely that storm water represents a significant exposure pathway or risk to ecological receptors. Thus, the results and recommendations of the previous SLERA are not affected.

9.3 Results

9.3.1 HHRA Results

- During the RI, a soil sample was collected at the location where the maximum arsenic concentration was observed during the SI. Arsenic was detected at this location during the RI at a concentration of 2.79 mg/kg. Arsenic concentrations are considered within regional background for southern California. Therefore, it is unlikely that this COPC presents a human health risk above background. In addition, it is unlikely that this COPC poses a significant risk to ecological receptors.
- VOCs were detected at concentrations at or below residential soil gas CHHSLs. In other words, the cancer risk estimates do not exceed the NCP acceptable risk range of 1×10^{-6} and 1×10^{-4} nor the DTSC target risk level for

unrestricted land use. Therefore, these VOCs are unlikely to present a human health risk for the vapor intrusion pathway.

- Groundwater is not used as a public water supply; therefore, ingestion of groundwater is not considered a complete exposure pathway and the chemicals detected are unlikely to pose a human health risk.
- Ingestion of storm water is not considered a complete exposure pathway since the average annual precipitation is minimal, residence time of storm water is limited, and workers are seldom at the Site; therefore, the chemicals detected are unlikely to pose a significant human health risk.

9.3.2 SLERA Results

Based on a review of the assumptions, data, and methodology utilized in the previous SLERA, no changes to the previous SLERA results or recommendations are warranted. A summary of the updated SLERA results are presented below.

- The inhalation pathway from soil gas for ecological exposures is generally negligible relative to the ingestion pathway. Maximum detected concentrations of soil gas were one or more orders of magnitude below the calculated ESLs.
- There are no surface water bodies, such as rivers, streams, or lakes, on or near IRP Site 27; therefore, the habitat is not suitable to support benthic or aquatic receptors.
- All HQs were estimated well below one, indicating a limited potential for ecological risk from consumption of storm water. Further, the conservative assumptions of this evaluation are likely to overestimate risks.
- No source COPCs has been in place since the 1970s and will not be transported elsewhere due to the lack of surface water and the presence of vegetation cover that reduces the mobility of detected constituents in soil.

9.4 Conclusions

Based on the RI screening level HHRA and the SLERA, there were no identified risks for IRP Site 27 based on human health and ecological effects, respectively. Additional assessment and analysis will be determined in the FS.

10.0 SUMMARY AND CONCLUSIONS

The following section provides a summary of the findings from the RI and an evaluation of these results. As stated in Section 2, the RI was to assess the data gaps from the Final SI Report as well as a letter from the RWQCB dated July 3, 2008 (Appendix A):

1. Clearly define the groundwater gradient at the Site;
2. Evaluate groundwater quality downgradient of the landfill;
3. Evaluate the presence of landfill gas within the waste footprint;
4. Evaluate soil gas around the perimeter of the landfill;
5. Evaluate the extent of the landfill waste prism;
6. Re-sample an anomalous high arsenic detection from soil boring IR27B02;
7. Evaluate the landfill cover thickness, characteristics, and extent; and
8. Evaluate the landfill impact on surface water quality as it crosses the landfill.

The RI field activities addressed these data gaps and developed a 3D assessment of the waste volume from the available data.

During the RI investigation, five new wells were added to the groundwater monitoring well network. These wells, MW-4A, MW-5A, MW-7, MW-9A, and MW-12 in conjunction with the existing well MW-3 provide a six well monitoring well network that provides a point of compliance well network down gradient of the landfill within the first water bearing unit. Within this well network MW-12 and possibly MW-9A provide up gradient water quality results.

1. Groundwater gauging was performed on five occasions, including both dry season and wet season and supported that the groundwater gradient on Site is to the northeast. Groundwater gradient ranges from 0.0038 to 0.0128 during the RI field activities. Water levels increased over most of the RI investigation, indicating a fairly quick response to the wet winter that occurred between November 2010 and March 2011. Water levels over this time increased by approximately two to three ft.

2. Groundwater analytical data show detected concentrations for manganese above secondary MCLs in several of the wells. Only one downgradient

perimeter well, MW-3 exceeded the background (MW-12) manganese detection on one occasion. No other constituents exceeded action levels in the perimeter monitoring well network when reduced by background well MW-12 concentrations. Additional groundwater data needs to be collected to provide statistical evidence that groundwater is not impacted and that manganese impacts are naturally occurring based on the presence of manganese above the secondary MCL in the upgradient well, MW-12. Monitoring wells (MW-1 and MW-2) constructed within the waste prism are recommended for closure and destruction in accordance with Bulletins 74-81 and 74-90, Part 3, of the California Well Standards. The Navy will further evaluate the rationale for and decision to destroy these wells during the FS. The Navy will complete four quarters of groundwater sampling at monitoring wells MW-1 and MW-2. Applicable or relevant and appropriate requirements (ARAR) will be evaluated in the FS report with State regulatory agency input.

3. Six soil gas probes were installed within the waste prism to evaluate conditions within the landfill. None of these six points detected concentrations above the screening levels. The soil gas samples within the waste were identified as SG-1, 2, and 3 with two probe depths for each location, for a total of six points. The data showed that conditions are aerobic within the waste, with evidence of aerobic decomposition of organic matter observed in data for the deeper samples from within the waste. Hydrogen sulfide was not detected within the waste. There is no evidence in the data for the presence of waste at or near the location of samples SG 3-5 and SG 3-8 and those locations seem to be north of the northernmost extent of waste.

4. An additional five soil gas probes were installed around the perimeter of the landfill Site. Soil gas data evaluation showed that no detected concentrations above screening levels were observed for any of the 5 perimeter soil gas probe locations. The data showed that conditions are aerobic outside the waste limits. Hydrogen sulfide was not detected in the perimeter probes. Therefore, soil gas is not a factor at the Site both within the waste prism and along the perimeter of the waste prism.

5. An approximate maximum waste volume has been calculated utilizing historical and current borehole data, potholing, geophysical survey, and topographic differential plot. The potential maximum waste volume range is from 65,728 (RI inferred waste prism) to 93,619 yd^3 (estimated ravine volume

using 1949 U. S. Geological Survey topographic map and new surveyed data). The estimated volume of waste occurs within an approximately 2-acre waste cell as identified in the RI investigation.

6. An arsenic concentration detected above screening levels in soil within the waste prism collected during the SI (MARRS, 2009) could not be duplicated when the location identified from the SI was re-occupied and re-sampled. Therefore, the elevated arsenic hit appeared to be an anomaly and not an issue at the Site. This soil sample location was within the waste material at the Site. To re-occupy the spot the contractor used GPS and identified the original SI stake in the ground.

7. The landfill cover was evaluated using 10 pothole locations over the approximately 4.4 acre identified in the SI. Seven of the 10 potholes encountered waste within 3 feet, 3 potholes did not encounter waste. Soil properties for the cover soil material meet the hydraulic conductivity, Ks, of cover soils of 1.0×10^{-4} cm/sec. The cover efficacy will be further discussed in the FS report in the evaluation of the No Further Action remedial action alternative.

8. There were no screening levels established for surface water (SESTECH, 2010); therefore surface water samples collected during the storm event were compared to the groundwater screening levels defined in the SAP. Surface water does not appear to be a significant issue at the Site. However due to the erosional effects of storm water on the surface of the landfill, physical barriers and pathways can be implemented to divert storm water to drainage gully to the west of the landfill, thereby protecting the landfill cover. Only manganese above groundwater screening level was detected for the on landfill surface water sample. The down gradient and up gradient samples had no detected concentrations above the screening levels.

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11.0 RECOMMENDATIONS

The following recommendations are proposed for the IRP Site 27 Eucalyptus Grove Landfill.

- Recommend no further action for soil gas within and outside of the waste prism.
- No further action prescribed for arsenic in soil.
- Monitoring wells (MW-1 and MW-2) constructed within the waste prism are recommended for closure and destruction in accordance with Bulletins 74-81 and 74-90, Part 3, of the California Well Standards. The Navy will further evaluate the rationale for and decision to destroy these wells during the FS. The Navy will complete four quarters of groundwater sampling at monitoring wells MW-1 and MW-2. ARARs will be evaluated in the FS report with State regulatory agency input.
- Continue groundwater monitoring of six wells at the Site including MW-3, -4A, -5A, -7, -9A, and -12. As part of the groundwater monitoring program statistically evaluate MW-4A, MW-9A, and MW-12 as background points for the other wells.
- Evaluate all closure options in an FS. Use groundwater quality data to support the evaluation of impairment of the groundwater quality due to landfill impacts.
- To achieve a decision document under the CERCLA process, it may be beneficial to complete an FS to gain regulatory acceptance.

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TABLES

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Table 3-1
Depth to Bedrock
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook,
Fallbrook, California

RI Location	Depth to Bedrock (ft bgs)	Notes
MW-4A	5	Intensely weathered bedrock, 50 blows for 5"
MW-5A	5	Weathered bedrock, 50 blows for 5"
MW-6	9	Hit refusal at 9' bgs, rig chattering.
MW-6A	10	Hit refusal at 10' bgs, 50 blows for 1", rig chattering. New location 15 feet north of MW-6
MW-7	23	Hit refusal at 23' bgs, rig chattering/bouncing.
MW-8	15	Hit refusal at 15' bgs, terminated borehole at this depth, rig chattering, 50 blows for 3", SPT sample looks like highly weathered granitic material.
MW-8A	15	Decomposing granite at 15' bgs, terminate borehole at 16' bgs, hit refusal, rig chattering, 50 blows for 4". New location 50' South of MW-8.
MW-9A	20	Weathered bedrock, 50 blows for 4". Same material from 20' to 37' bgs where borehole was terminated.
MW-10A	10	Intensely weathered bedrock first encountered at 10' bgs, hit refusal at 12' bgs, terminate borehole, 50 blows for 5".
MW-10B	15	Intensely weathered bedrock, 50 blows for 6", rig chattering, refusal at 15' bgs.
IRP27-LCE-8/54-707	7	Bedrock, granitic material.
SG-2-10	8.5	Extremely weathered bedrock.
SG-3-8	6	Extremely weathered granitic rock.
SG-4	4	Extremely weathered granitic rock.
SG-5	1.5	Extremely weathered granitic rock.
SI Location	**Depth to Bedrock (ft bgs)**	**Notes**
IR27B09	14	Borehole log indicates at this depth it appears to be decomposed granite.
IR27B10	9	Borehole log indicates at this depth it appears to be decomposed granite.
IR27B11	5	Borehole log indicates that there is no recovery from 5' to termination of borehole at 15'. Blow counts for this interval vary from 50 blows for 2" to 50 blows for 3".
IR27B12	10, 15	At 10' no recovery, blow counts indicate very dense soil. At 15' very difficult to turn augers, boring terminated at this depth.
IR27B13	23, 35	At 23' drill rig chatter, switching to air drilling. At 35' hard rock, driller states some fractures in area of drilling and drilling became easier once drill rig passed the hard rocks.
MW-1	41	Encountered granitic rock, borehole terminated at this depth.
MW-2	31	Encountered granitic rock, borehole terminated at this depth.
MW-3	30	Encountered granitic rock, borehole terminated at this depth.

Notes:

"	inch
ft bgs	feet below ground surface
IR	Installation Restoration
LCE	Landfill Cover Evaluation
MW	Monitoring Well
'	feet
SG	Soil Gas

Table 3-2
Groundwater Elevations
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook,
Fallbrook, California

Well ID	Northing	Easting	Top of Casing Elevation (ft)	Ground Surface Elevation (ft)	Depth to Water (ft btoc) (10/14/10)	Groundwater Elevation (ft) (10/14/10)	Depth to Water (ft btoc) (11/8/10)	Groundwater Elevation (ft) (11/8/10)	Depth to Water (ft btoc) 2/11/11	Groundwater Elevation (ft) 2/11/11	Depth to Water (ft btoc) 5/26/2011	Groundwater Elevation (ft) 5/26/11	Depth to Water (ft btoc) 5/31/11	Groundwater Elevation (ft) 5/31/11	Depth to Water (ft btoc) 10/06/11	Groundwater Elevation (ft) 10/06/11	SI Data			
																	Groundwater Elevation (ft)	Top of Casing Elevation (ft)	Ground Surface Elevation (ft)	Riser Height (ft)
IRP27-MW-1	2072615.42	6248713.01	612.06	608.90	34.90	577.16	35.03	577.03	32.13	579.93	30.95	581.11	30.93	581.13	31.29	580.77	583.590	612.528	609.342	3.186
IRP27-MW-2	2072743.37	6248797.68	602.11	600.07	25.70	576.41	25.81	576.30	22.82	579.29			21.88	580.23	22.48	579.63	581.680	602.649	600.661	1.988
IRP27-MW-3	2072802.00	6248905.41	598.02	594.65	22.92	575.10	22.04	575.98	18.86	579.16			18.14	579.88	18.70	579.32	581.260	598.540	595.254	3.286
IRP27-MW-4A	2072686.67	6248664.14	613.21	610.99			36.39	576.82	33.51	579.70	32.30	580.91	32.29	580.92	32.63	580.58				
IRP27-MW-5A	2072891.67	6248844.14	596.95	594.86			21.20	575.75	18.10	578.85			17.40	579.55	18.00	578.95				
IRP27-MW-7	2072951.47	6248950.74	589.77	587.60			14.87	574.90	11.53	578.24			11.28	578.49	12.20	577.57				
IRP27-MW-9A	2072652.28	6248783.40	608.54	605.99			31.84	576.70	28.90	579.64			27.82	580.72	28.25	580.29				
IRP27-MW-12	2072488.23	6248546.28	624.49	622.76							41.95	582.54	41.89	582.60	40.96	583.53				

Notes:

ft	feet
ft btoc	feet below top of casing
ID	Identification
IRP	Installation Restoration Program
SI	Site Investigation Report

Table 4-1
Groundwater Concentrations Above Screening Level
During SI and RI Sampling Events
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook,
Fallbrook, California

SI Sampling Event			RI First Round Sampling Event				RI Second Round Sampling Event				Screening Criteria	
SI Sample Location	Parameter	Analyte Value (µg/L)	RI Sample Name	RI Sample Location	Parameter	Analyte Value (µg/L)	RI Sample Name	RI Sample Location	Parameter	Analyte Value (µg/L)	Analyte	Screening Threshold Value (µg/L)
MW-1	ALUMINUM	1,380	54-051-FD	IRP27-MW-2	ARSENIC	15.5	54-001	IRP27-MW-1	Nitrate (as N)	64,600	NITRATE (as N)	45,000
MW-1	IRON	1,670	54-051-FD	IRP27-MW-2	IRON	1,450	54-002-FD	IRP27-MW-2	ARSENIC	23.9	ARSENIC	10
MW-1	MANGANESE	77	54-051-FD	IRP27-MW-2	MANGANESE	5,100	54-002-FD	IRP27-MW-2	IRON	10,400	IRON	300
MW-2	ALUMINUM	5,360	54-051	IRP27-MW-2	ARSENIC	16.2	54-002-FD	IRP27-MW-2	MANGANESE	5,680	ALUMINUM	1,000 (SI)
MW-2	IRON	7,900	54-051	IRP27-MW-2	IRON	1,490	54-002	IRP27-MW-2	ARSENIC	24.1		
MW-2	MANGANESE	2,070	54-051	IRP27-MW-2	MANGANESE	5,210	54-002	IRP27-MW-2	IRON	9,890		
MW-3	ALUMINUM	6,250	54-053	IRP27-MW-4A	MANGANESE	421	54-002	IRP27-MW-2	MANGANESE	5,580	MANGANESE	50
MW-3	IRON	6,290	54-054	IRP27-MW-5A	MANGANESE	69.5	54-003	IRP27-MW-3	MANGANESE	400		
MW-3	MANGANESE	718	54-055	IRP-27-MW-7	MANGANESE	64.1	54-012	IRP27-MW-12	MANGANESE	107		

Notes:

µg/L micrograms per liter
FD Field Duplicate
IRP Installation Restoration Program
RI Remedial Investigation (Sealaska/Geosyntec)
SI Site Investigation (MARRS)

Table 4-2
Analytes Evaluated during RI and SI
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook,
Fallbrook, California

RI Analyte	Method
VOCs	EPA 8260B
TPH-P	EPA 8015
TPH-E	EPA 8015
Pesticide/PCBs	EPA 8081/8082
SVOCs	EPA 8270
Dissolved Metals	EPA 6020/7470
Ammonia/Nitrate	EPA 350.2/353.3
Sulfide	EPA 376.1
Sulfate/Nitrite	EPA 300
Hydrazine	ASTM D1385
NDMA	EPA 1625 C
SI Analyte	**Method**
VOCs	EPA 8260B
Perchlorate	EPA 314.0
SVOCs	EPA 8270C and 8270C SIM
Metals	EPA 6020A
Mercury	EPA 7471A
Hexavalent chromium	EPA 7196A
Organics (including diesel and motor oil)	EPA 8015B
Pesticides	EPA 8081A
PCBs	EPA 8082
Inorganics (including nitrate-N and nitrite-N)	EPA 300.0
Ammonia	EPA 350.2
TKN	EPA 351.3
Sulfide	EPA 376.1
pH	EPA 9045C

Notes:

EPA	Environmental Protection Agency
NDMA	N-nitrosodimethylamine
PCBs	Polychlorinated Biphenyls
pH	potential Hydrogen
RI	Remedial Investigation
SI	Site Inspection
SIM	Selected Ion Monitoring
SVOCs	Semi Volatile Organic Compounds
TKN	Total Kjeldahl Nitrogen
TPH-E	Total Petroleum Hydrocarbons - by Extraction
TPH-P	Total Petroleum Hydrocarbons - by Purge and Trap
VOCs	Volatile Organic Compounds

Table 4-3
Well Construction and Development Details
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook,
Fallbrook, California

Well ID	Northing	Easting	Top of Casing Elevation (ft)	Ground Surface Elevation (ft)	Casing Riser Height (ft)	Development Pumping Rate (gpm)	Total Volume of Water Removed/Total Time (Min)	Screened Interval (ft bgs)
IRP27-MW-1	2072615.42	6248713.01	612.06	608.90	3.16	0.37	121.11/217	20.5 - 40.5*
IRP27-MW-2	2072743.37	6248797.68	602.11	600.07	2.04	0.42	41.7/97	20.5 - 30.5*
IRP27-MW-3	2072749.37	6248905.41	598.02	594.65	3.37	0.50	216/215	19.5 - 29.5*
IRP27-MW-4A	2072686.67	6248664.14	613.21	610.99	2.22	0.58	99/137	33.5 - 43.5
IRP27-MW-5A	2072891.67	6248844.14	596.95	594.86	2.09	NE	52/267	13.5 - 23.5
IRP27-MW-7	2072951.47	6248950.74	589.77	587.60	2.17	0.42	88.3/204	12.0 - 22.0
IRP27-MW-9A	2072652.28	6248783.40	608.54	605.99	2.55	NE	92/183	25.5 - 35.5
IRP27-MW-12[1]	2072488.23	6248546.28	624.49	622.76	1.73	NE	9/270	32.0-42.0

Notes:

[1]	IRP27-MW-12 installed on 5/24/2011 and developed on 5/26/2011 (due to low volume of water, development method altered to surging and bailing (using a hand bailer)
*	Screened intervals taken from SI Report
ft	feet
ft bgs	feet below ground surface
ft btoc	feet below top of casing
GPM	Gallons per minute *once well achieved relative constant head
ID	Identification
IRP	Installation Restoration Program
Min	minute
NE	Not established
SI	Site Investigation Report

Table 4-4
Groundwater Field Parameters
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook,
Fallbrook, California

Well Number	Sample ID	Sample Date	Depth to Water Before Sampling (ft btoc)	Depth to Water After Sampling (ft btoc)	Depth of Well (ft btoc)	pH	Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	Temp	ORP (mV)	Turbidity (NTUs)
IRP27-MW-1	54-050	11/8/2010	35.03	35.56	44.16	7.12	0.587	0.23	21.04	76.7	9.6
	54-001	6/1/2011	30.99	31.03	43.72	6.41	1.402	1.99	22.56	130.4	0.04
IRP27-MW-2	54-051/54-051-FD	11/8/2010	25.81	25.85	33.04	6.58	1.166	0.39	21.22	88.9	32.4
	54-002/54-002-FD	6/1/2011	21.9	21.98	33.03	6.45	1.702	0.76	24.6	-83.2	20.6
IRP27-MW-3	54-052	11/9/2010	22.04	22.09	33.37	6.83	0.718	5.06	19.14	196.5	0.38
	54-003	6/1/2011	18.14	18.14	33.15	6.64	0.919	0.93	20.54	104.5	17
IRP27-MW-4A	54-053	11/9/2010	36.37	36.46	45.72	7.15	1.163	2.67	22.03	75	2.06
	54-004	6/1/2011	32.38	32.38	46.81	6.75	0.84	2.2	23.2	99.3	1
IRP27-MW-5A	54-054	11/9/2010	21.21	21.7	26.59	7.13	0.847	3.24	22.01	58.7	3.1
	54-005	5/31/2011	17.47	17.52	26.43	7.18	0.691	2.63	29.49	64.5	0.04
IRP27-MW-7	54-055	11/9/2010	14.9	15.17	25.17	7.39	0.786	4.28	22.09	77.2	3.31
	54-007	5/31/2011	11.28	11.28	25.84	6.9	0.604	2.41	22.85	57.8	3
IRP27-MW-9A	56-056	11/9/2010	31.89	32.96	40.05	7.22	0.678	4.93	21.45	170.1	14.5
	54-009	5/31/2011	27.82	28.78	39.71	7.26	0.051	2.33	23.33	62.2	0.03
IRP27-MW-12	54-012	5/31/2011	41.89	41.89	44.49	6.87	0.754	4.15	24.45	56.6	1

Notes:

btoc	below top of casing
ft	feet
ID	Identification
IRP	Installation Restoration Program
mg/L	micrograms per liter
mS/cm	milliSiemens per centimeter
mV	millivolts
NTUs	Nephelometric Turbidity Units

Table 4-5
NDMA Analytical Results
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook,
Fallbrook, California

Sample Location	Sample ID Nov 8, 2010	Results for Nov. 8, 2010 (ng/L)	EDL (ng/L)	RDL (ng/L)	AL (ng/L)
IRP27-MW-1	**54-050**	0.723 J	0.0148	2.06	10
IRP27-MW-2	**54-051**	0.838 J	0.0558	2.11	10
IRP27-MW-2 (dup)	**54-051-FD**	1.09 J	0.0438	2.13	10
IRP27-MW-3	**54-052**	0.558 J	0.0361	2.06	10
Equipment Blank (EB)	**EB-110910**	0.783 J	0.0541	2.08	10
Source Blank (SB)	**SB-110910**	0.666 J	0.0549	2.06	10

Sample Location	Sample ID June 1, 2011	Results for June 1, 2011 (ng/L)	EDL (ng/L)	RDL (ng/L)	AL (ng/L)
IRP27-MW-1	**54-001**	0.378 J	0.0788	2.15	10
IRP27-MW-2	**54-002**	0.723 J	0.151	2.17	10
IRP27-MW-2 (dup)	**54-002-FD**	0.529 J	0.115	2.15	10
IRP27-MW-3	**54-003**	2.58	0.145	2.17	10
IRP27-MW-4A	**54-004**	0.850 J	0.0535	2.22	10
IRP27-MW-5A	**54-005**	0.580 J	0.112	2.13	10
IRP27-MW-7	**54-007**	0.456 J	0.0835	2.17	10
IRP27-MW-9A	**54-009**	0.665 J	0.156	2.17	10
IRP27-MW-12	**54-012**	2.06 J	0.197	2.17	10
Equipment Blank (EB)	**EB-060111**	0.0175 U	0.0175	2.22	10
Source Blank (SB)	**SB-053111**	0.301 J	0.0886	2.2	10

Notes:

AL	Action Level defined in SAP, which is also the California Notification Limit (Per SAP)
EB	Equipment Blank
EDL	Estimated Detection Limit
FD	Field Duplicate
ID	Identification
IRP	Installation Restoration Program
J	Estimated concentration between the Estimated Detection Limit and Reportable Detection Limit
ng/L	nanograms per liter
RDL	Reportable Detection Limit
SB	Source Blank
U	Undetected at limit of quantitation

Table 5-1
Soil Gas Detections for VOCs
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook,
Fallbrook, California

Sample Name	Sample Location	Analytical Method	Analyte Name	Result	Units	Final Qualifier	Detection Limit
54-101	SG-1-10	TO-15	DICHLORODIFLUOROMETHANE	71	µg/m³		2.8
54-101	SG-1-10	TO-15	TRICHLOROFLUOROMETHANE	8.3	µg/m³		2.6
54-109	SG-7	TO-15	DICHLORODIFLUOROMETHANE	2.4	µg/m³		0.29
54-109	SG-7	TO-15	TRICHLOROFLUOROMETHANE	1.1	µg/m³		0.26
54-109	SG-7	TO-15	FREON 113	0.5	µg/m³	J	0.3
54-109	SG-7	TO-15	CHLOROFORM	0.49	µg/m³	J	0.25
54-109	SG-7	TO-15	BENZENE	0.51	µg/m³	J	0.25
54-109	SG-7	TO-15	TOLUENE	1	µg/m³		0.25
54-109	SG-7	TO-15	CHLOROBENZENE	0.33	µg/m³	J	0.25
54-109	SG-7	TO-15	ETHYLBENZENE	2.3	µg/m³		0.25
54-109	SG-7	TO-15	m-Xylene/P-Xylene	8.3	µg/m³		0.5
54-109	SG-7	TO-15	STYRENE	0.48	µg/m³	J	0.25
54-109	SG-7	TO-15	O-XYLENE	6.1	µg/m³		0.27
54-109	SG-7	TO-15	ISOPROPYLBENZENE	0.27	µg/m³	J	0.25
54-109	SG-7	TO-15	N-PROPYLBENZENE	2	µg/m³		0.25
54-109	SG-7	TO-15	1,3,5-TRIMETHYLBENZENE	5.2	µg/m³		0.26
54-109	SG-7	TO-15	1,2,4-TRIMETHYLBENZENE	23	µg/m³		0.29
54-109	SG-7	TO-15	1,4-DICHLOROBENZENE	3.5	µg/m³		0.3
54-109	SG-7	TO-15	SEC-BUTYLBENZENE	0.26	µg/m³	J	0.23
54-109	SG-7	TO-15	NAPHTHALENE	4.8	µg/m³		0.51
54-109	SG-7	TO-15	N-BUTYLBENZENE	2.3	µg/m³		0.27
54-101	SG-1-10	TO-15	CIS-1,2-DICHLOROETHENE	14	µg/m³		3.1
54-101	SG-1-10	TO-15	BENZENE	7.8	µg/m³		2.4
54-101	SG-1-10	TO-15	TOLUENE	4.2	µg/m³	J	2.4
54-101	SG-1-10	TO-15	ETHYLBENZENE	5	µg/m³	J	2.4
54-101	SG-1-10	TO-15	m-Xylene/P-Xylene	2300	µg/m³		4.9
54-101	SG-1-10	TO-15	O-XYLENE	180	µg/m³		2.7
54-101	SG-1-10	TO-15	ISOPROPYLBENZENE	37	µg/m³		2.4
54-101	SG-1-10	TO-15	N-PROPYLBENZENE	24	µg/m³		2.4
54-101	SG-1-10	TO-15	1,3,5-TRIMETHYLBENZENE	240	µg/m³		2.6
54-101	SG-1-10	TO-15	1,2,4-TRIMETHYLBENZENE	490	µg/m³		2.8
54-101	SG-1-10	TO-15	1,4-DICHLOROBENZENE	26	µg/m³		2.9
54-101	SG-1-10	TO-15	SEC-BUTYLBENZENE	18	µg/m³		2.3
54-101	SG-1-10	TO-15	NAPHTHALENE	33	µg/m³		5
54-100	SG-1-5	TO-15	DICHLORODIFLUOROMETHANE	660	µg/m³		2.8
54-100	SG-1-5	TO-15	TRICHLOROFLUOROMETHANE	170	µg/m³		2.5
54-100	SG-1-5	TO-15	FREON 113	0.49	µg/m³	J	0.29
54-100	SG-1-5	TO-15	CHLOROFORM	1.9	µg/m³		0.24
54-100	SG-1-5	TO-15	1,1,1-TRICHLOROETHANE	0.77	µg/m³		0.24
54-100	SG-1-5	TO-15	BENZENE	2	µg/m³		0.24

Table 5-1
Soil Gas Detections for VOCs
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook,
Fallbrook, California

Sample Name	Sample Location	Analytical Method	Analyte Name	Result	Units	Final Qualifier	Detection Limit
54-100	SG-1-5	TO-15	CARBON TETRACHLORIDE	0.5	µg/m³	J	0.24
54-100	SG-1-5	TO-15	TETRACHLOROETHENE	2.6	µg/m³		0.24
54-100	SG-1-5	TO-15	CHLOROBENZENE	0.91	µg/m³		0.24
54-100	SG-1-5	TO-15	1,2,4-TRIMETHYLBENZENE	0.3	µg/m³	J	0.28
54-108	SG-6	TO-15	DICHLORODIFLUOROMETHANE	2.3	µg/m³		0.3
54-108	SG-6	TO-15	TRICHLOROFLUOROMETHANE	1.2	µg/m³		0.27
54-108	SG-6	TO-15	METHYLENE CHLORIDE	0.54	µg/m³	J	0.27
54-108	SG-6	TO-15	FREON 113	0.51	µg/m³	J	0.31
54-108	SG-6	TO-15	CHLOROFORM	1.9	µg/m³		0.26
54-108	SG-6	TO-15	TETRAHYDROFURAN	0.41	µg/m³	J	0.27
54-108	SG-6	TO-15	BENZENE	1.7	µg/m³		0.26
54-108	SG-6	TO-15	BROMODICHLOROMETHANE	3.3	µg/m³		0.25
54-108	SG-6	TO-15	TOLUENE	39	µg/m³		0.26
54-108	SG-6	TO-15	DIBROMOCHLOROMETHANE	2.5	µg/m³		0.29
54-108	SG-6	TO-15	TETRACHLOROETHENE	0.43	µg/m³	J	0.26
54-108	SG-6	TO-15	CHLOROBENZENE	1.1	µg/m³		0.26
54-108	SG-6	TO-15	ETHYLBENZENE	19	µg/m³		0.26
54-108	SG-6	TO-15	m-Xylene/P-Xylene	84	µg/m³		0.52
54-108	SG-6	TO-15	BROMOFORM	0.43	µg/m³	J	0.29
54-108	SG-6	TO-15	STYRENE	1.9	µg/m³		0.26
54-108	SG-6	TO-15	O-XYLENE	28	µg/m³		0.29
54-108	SG-6	TO-15	ISOPROPYLBENZENE	1.5	µg/m³		0.26
54-108	SG-6	TO-15	N-PROPYLBENZENE	5.9	µg/m³		0.26
54-108	SG-6	TO-15	1,3,5-TRIMETHYLBENZENE	15	µg/m³		0.27
54-108	SG-6	TO-15	1,2,4-TRIMETHYLBENZENE	27	µg/m³		0.3
54-108	SG-6	TO-15	1,4-DICHLOROBENZENE	2.3	µg/m³		0.31
54-108	SG-6	TO-15	SEC-BUTYLBENZENE	0.67	µg/m³	J	0.25
54-108	SG-6	TO-15	N-BUTYLBENZENE	1.9	µg/m³		0.29
54-102	SG-2-5	TO-15	DICHLORODIFLUOROMETHANE	120	µg/m³		0.32
54-102	SG-2-5	TO-15	TRICHLOROFLUOROMETHANE	560	µg/m³		2.9
54-102	SG-2-5	TO-15	METHYLENE CHLORIDE	1	µg/m³		0.29
54-102	SG-2-5	TO-15	FREON 113	0.59	µg/m³	J	0.33
54-102	SG-2-5	TO-15	CHLOROFORM	1.3	µg/m³		0.28
54-102	SG-2-5	TO-15	1,1,1-TRICHLOROETHANE	1.5	µg/m³		0.28
54-102	SG-2-5	TO-15	BENZENE	6.6	µg/m³		0.28
54-102	SG-2-5	TO-15	TOLUENE	31	µg/m³		0.28
54-102	SG-2-5	TO-15	TETRACHLOROETHENE	14	µg/m³		0.28
54-102	SG-2-5	TO-15	CHLOROBENZENE	0.48	µg/m³	J	0.28
54-102	SG-2-5	TO-15	ETHYLBENZENE	11	µg/m³		0.28

Table 5-1
Soil Gas Detections for VOCs
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook,
Fallbrook, California

Sample Name	Sample Location	Analytical Method	Analyte Name	Result	Units	Final Qualifier	Detection Limit
54-102	SG-2-5	TO-15	m-Xylene/P-Xylene	43	µg/m³		0.55
54-102	SG-2-5	TO-15	STYRENE	0.63	µg/m³	J	0.28
54-102	SG-2-5	TO-15	O-XYLENE	15	µg/m³		0.3
54-102	SG-2-5	TO-15	ISOPROPYLBENZENE	1.1	µg/m³		0.28
54-102	SG-2-5	TO-15	N-PROPYLBENZENE	2.4	µg/m³		0.28
54-102	SG-2-5	TO-15	1,3,5-TRIMETHYLBENZENE	1.3	µg/m³		0.29
54-102	SG-2-5	TO-15	1,2,4-TRIMETHYLBENZENE	18	µg/m³		0.32
54-102	SG-2-5	TO-15	1,4-DICHLOROBENZENE	0.91	µg/m³		0.33
54-102	SG-2-5	TO-15	NAPHTHALENE	1	µg/m³		0.57
54-103	SG-2-10	TO-15	DICHLORODIFLUOROMETHANE	13	µg/m³		0.3
54-103	SG-2-10	TO-15	TRICHLOROFLUOROMETHANE	160	µg/m³		1.4
54-103	SG-2-10	TO-15	METHYLENE CHLORIDE	0.28	µg/m³	J	0.27
54-103	SG-2-10	TO-15	FREON 113	0.54	µg/m³	J	0.31
54-103	SG-2-10	TO-15	CHLOROFORM	0.32	µg/m³	J	0.26
54-103	SG-2-10	TO-15	TOLUENE	1.1	µg/m³		0.26
54-103	SG-2-10	TO-15	TETRACHLOROETHENE	1.5	µg/m³		0.26
54-103	SG-2-10	TO-15	ETHYLBENZENE	0.35	µg/m³	J	0.26
54-103	SG-2-10	TO-15	m-Xylene/P-Xylene	2.2	µg/m³		0.52
54-103	SG-2-10	TO-15	O-XYLENE	1.3	µg/m³		0.29
54-103	SG-2-10	TO-15	N-PROPYLBENZENE	0.35	µg/m³	J	0.26
54-103	SG-2-10	TO-15	1,3,5-TRIMETHYLBENZENE	1.8	µg/m³		0.27
54-103	SG-2-10	TO-15	1,2,4-TRIMETHYLBENZENE	9.5	µg/m³		0.3
54-103	SG-2-10	TO-15	1,4-DICHLOROBENZENE	1.2	µg/m³		0.31
54-103	SG-2-10	TO-15	NAPHTHALENE	0.6	µg/m³	J	0.53
54-103	SG-2-10	TO-15	N-BUTYLBENZENE	0.59	µg/m³		0.29
54-104	SG-3-5	EPA TO-15 Modified	2-PROPENAL	1.1	µg/m³	J	
54-104	SG-3-5	EPA TO-15 Modified	PROPENE	1.4	µg/m³		
54-104	SG-3-5	EPA TO-15 Modified	ETHANOL	18	µg/m³		
54-104	SG-3-5	EPA TO-15 Modified	ACETONE	10	µg/m³		
54-104	SG-3-5	EPA TO-15 Modified	METHYLENE CHLORIDE	0.35	µg/m³	J	
54-104	SG-3-5	EPA TO-15 Modified	CARBON DISULFIDE	1.3	µg/m³	J	
54-104	SG-3-5	EPA TO-15 Modified	TRICHLOROFLUOROMETHANE	4.8	µg/m³		
54-104	SG-3-5	EPA TO-15 Modified	DICHLORODIFLUOROMETHANE	3.1	µg/m³		
54-104	SG-3-5	EPA TO-15 Modified	FREON 113	0.66	µg/m³	J	
54-104	SG-3-5	EPA TO-15 Modified	2-BUTANONE	3.9	µg/m³	J	
54-104 DUP	SG-3-5	EPA TO-15 Modified	2-PROPENAL	1.4	µg/m³	J	
54-104 DUP	SG-3-5	EPA TO-15 Modified	VINYL ACETATE	2.1	µg/m³	J	
54-104 DUP	SG-3-5	EPA TO-15 Modified	PROPENE	1.5	µg/m³		
54-104 DUP	SG-3-5	EPA TO-15 Modified	ETHANOL	18	µg/m³		

Table 5-1
Soil Gas Detections for VOCs
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook,
Fallbrook, California

Sample Name	Sample Location	Analytical Method	Analyte Name	Result	Units	Final Qualifier	Detection Limit
54-104 DUP	SG-3-5	EPA TO-15 Modified	ACETONE	10	µg/m³		
54-104 DUP	SG-3-5	EPA TO-15 Modified	CHLOROMETHANE	0.43	µg/m³	J	
54-104 DUP	SG-3-5	EPA TO-15 Modified	CHLOROETHANE	0.41	µg/m³	J	
54-104 DUP	SG-3-5	EPA TO-15 Modified	ACETONITRILE	0.69	µg/m³		
54-104 DUP	SG-3-5	EPA TO-15 Modified	METHYLENE CHLORIDE	0.43	µg/m³	J	
54-104 DUP	SG-3-5	EPA TO-15 Modified	CARBON DISULFIDE	2.2	µg/m³	J	
54-104 DUP	SG-3-5	EPA TO-15 Modified	TRICHLOROFLUOROMETHANE	4.8	µg/m³		
54-104 DUP	SG-3-5	EPA TO-15 Modified	DICHLORODIFLUOROMETHANE	3.1	µg/m³		
54-104 DUP	SG-3-5	EPA TO-15 Modified	FREON 113	0.69	µg/m³		
54-104 DUP	SG-3-5	EPA TO-15 Modified	2-BUTANONE	3.6	µg/m³	J	
54-105	SG-3-10	EPA TO-15 Modified	2-PROPENAL	2	µg/m³	J	
54-105	SG-3-10	EPA TO-15 Modified	ACRYLONITRILE	0.47	µg/m³	J	
54-105	SG-3-10	EPA TO-15 Modified	VINYL ACETATE	3.5	µg/m³	J	
54-105	SG-3-10	EPA TO-15 Modified	PROPENE	2.8	µg/m³		
54-105	SG-3-10	EPA TO-15 Modified	ETHANOL	6.9	µg/m³	J	
54-105	SG-3-10	EPA TO-15 Modified	ISOPROPANOL	1.3	µg/m³	J	
54-105	SG-3-10	EPA TO-15 Modified	ACETONE	22	µg/m³		
54-105	SG-3-10	EPA TO-15 Modified	ACETONITRILE	1.2	µg/m³		
54-105	SG-3-10	EPA TO-15 Modified	METHYLENE CHLORIDE	0.84	µg/m³		
54-105	SG-3-10	EPA TO-15 Modified	CARBON DISULFIDE	12	µg/m³		
54-105	SG-3-10	EPA TO-15 Modified	TRICHLOROFLUOROMETHANE	14	µg/m³		
54-105	SG-3-10	EPA TO-15 Modified	DICHLORODIFLUOROMETHANE	3.5	µg/m³		
54-105	SG-3-10	EPA TO-15 Modified	FREON 113	0.64	µg/m³	J	
54-105	SG-3-10	EPA TO-15 Modified	2-BUTANONE	7.1	µg/m³		
54-106	SG-4	EPA TO-15 Modified	2-PROPENAL	0.62	µg/m³	J	
54-106	SG-4	EPA TO-15 Modified	PROPENE	1.3	µg/m³		
54-106	SG-4	EPA TO-15 Modified	ETHANOL	8.9	µg/m³		
54-106	SG-4	EPA TO-15 Modified	ISOPROPANOL	1	µg/m³	J	
54-106	SG-4	EPA TO-15 Modified	ACETONE	8.7	µg/m³		
54-106	SG-4	EPA TO-15 Modified	ACETONITRILE	0.53	µg/m³	J	
54-106	SG-4	EPA TO-15 Modified	CARBON DISULFIDE	0.61	µg/m³	J	
54-106	SG-4	EPA TO-15 Modified	TRICHLOROFLUOROMETHANE	2	µg/m³		
54-106	SG-4	EPA TO-15 Modified	DICHLORODIFLUOROMETHANE	16	µg/m³		
54-106	SG-4	EPA TO-15 Modified	FREON 113	0.63	µg/m³	J	
54-106	SG-4	EPA TO-15 Modified	1,2-DICHLOROTETRAFLUOROETHANE	0.63	µg/m³	J	
54-106	SG-4	EPA TO-15 Modified	2-BUTANONE	3.7	µg/m³	J	
54-107	SG-5	EPA TO-15 Modified	2-PROPENAL	1.9	µg/m³	J	
54-107	SG-5	EPA TO-15 Modified	VINYL ACETATE	3.4	µg/m³	J	
54-107	SG-5	EPA TO-15 Modified	PROPENE	0.73	µg/m³		

Table 5-1
Soil Gas Detections for VOCs
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook,
Fallbrook, California

Sample Name	Sample Location	Analytical Method	Analyte Name	Result	Units	Final Qualifier	Detection Limit
54-107	SG-5	EPA TO-15 Modified	ETHANOL	35	µg/m³		
54-107	SG-5	EPA TO-15 Modified	ISOPROPANOL	1.3	µg/m³	J	
54-107	SG-5	EPA TO-15 Modified	ACETONE	17	µg/m³		
54-107	SG-5	EPA TO-15 Modified	CARBON DISULFIDE	0.84	µg/m³	J	
54-107	SG-5	EPA TO-15 Modified	TRICHLOROFLUOROMETHANE	1.4	µg/m³		
54-107	SG-5	EPA TO-15 Modified	DICHLORODIFLUOROMETHANE	2.9	µg/m³		
54-107	SG-5	EPA TO-15 Modified	FREON 113	0.62	µg/m³	J	
54-107	SG-5	EPA TO-15 Modified	2-BUTANONE	3.3	µg/m³	J	
54-110	SG-8	EPA TO-15 Modified	2-PROPENAL	0.84	µg/m³	J	
54-110	SG-8	EPA TO-15 Modified	VINYL ACETATE	2	µg/m³	J	
54-110	SG-8	EPA TO-15 Modified	PROPENE	1.5	µg/m³		
54-110	SG-8	EPA TO-15 Modified	ETHANOL	5.1	µg/m³	J	
54-110	SG-8	EPA TO-15 Modified	ISOPROPANOL	0.71	µg/m³	J	
54-110	SG-8	EPA TO-15 Modified	ACETONE	12	µg/m³		
54-110	SG-8	EPA TO-15 Modified	ACETONITRILE	0.83	µg/m³		
54-110	SG-8	EPA TO-15 Modified	CARBON DISULFIDE	1.3	µg/m³	J	
54-110	SG-8	EPA TO-15 Modified	TRICHLOROFLUOROMETHANE	1.6	µg/m³		
54-110	SG-8	EPA TO-15 Modified	DICHLORODIFLUOROMETHANE	9.7	µg/m³		
54-110	SG-8	EPA TO-15 Modified	FREON 113	0.62	µg/m³	J	
54-110	SG-8	EPA TO-15 Modified	1,2-DICHLOROTETRAFLUOROETHANE	2.2	µg/m³		
54-110	SG-8	EPA TO-15 Modified	2-BUTANONE	3.4	µg/m³	J	

Notes:

µg/m³	micrograms per cubic meter
J	indicates an estimated value
SG	soil gas
VOCs	volatile organic compounds

Table 6-1
Soil Sampling Analytical Results
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook,
Fallbrook, California

Sample Name	Sample Location	Sampling Event	Parameter	Analyte Value (mg/kg)	Detection Limit (mg/kg)	Screening Level (mg/kg)
IR27B02	IR27B02	SI	ARSENIC	28.4	0.4	10
54-600	IRP27-SS-1	RI	ARSENIC	2.79	0.4	12

Notes:

IRP	Installation Restoration Program
mg/kg	milligrams per kilogram
RI	Remedial Investigation
S	Soil
SI	Site Inspection

TABLE 7-1

Summary of Potholing Field Test Results
IRP Site 27, Eucalypus Grove Landfill
Fallbrook, California

Pothole Number	Date Excavated	Northing	Easting	Depth to Waste (ft) [a]	In-situ Dry Density [(b)] (pcf)	In-situ Moisture Content [(b)] (%)	Relative Compaction (%)	Hydraulic Conductivity Test
LCE-1	10/21/10	2071881.26	6248584.09	1.75	107.0	15.3	80.5	1.79×10^{-7}
LCE-2	10/21/10	2072138.65	6248587.79	1	134.4	9.3	101.1	7.11×10^{-7}
LCE-3	10/21/10	2072211.70	6248640.16	1.75	150.3	9.2	113.0	4.38×10^{-7}
LCE-4	10/21/10	2072412.82	6248633.32	1.5	145.0	10.1	107.4	1.47×10^{-7}
LCE-5	10/21/10	2072520.87	6248631.48	1.75	151.0	9.6	111.9	8.13×10^{-7}
LCE-6	10/21/10	2072586.53	6248668.51	1.75	118.7	10.6	88.6	7.11×10^{-7}
LCE-7	10/21/10	2072753.39	6248862.32	2.75	115.4	13.5	86.1	3.44×10^{-7}
LCE-8	10/21/10	2072754.31	6248863.14	No Waste	148.8	6.5	116.3	1.96×10^{-7}
LCE-9	10/21/10	2072833.38	6248881.22	No Waste	166.6	7.8	134.4	9.27×10^{-7}
LCE-10	10/21/10	2072911.64	6248946.05	No Waste	107.0	15.3	84.9	7.95×10^{-7}

Notes:
[(a)] Approximate depth to waste as measured in the field from the top of the existing surface.
[(b)] As measured in the field using a nuclear density gauge per ASTM D 6938.
% percent
ft feet
pcf pounds per cubic feet

TABLE 7-2

Summary of Potholing Laboratory Test Results
IRP Site 27, Eucalypus Grove Landfill
Fallbrook,

Pothole Number	Sample Identification	Sample Depth (ft)	USCS (a) Grain Size Gr:Sa:Fi	Atterberg Limits LL:PL:PI	Soil Classification	Max Dry Density (pcf) and Optimum Moisture Content (%) ASTM D 1557		In-Situ Dry Density (pcf) and Moisture Content (%) ASTM D 6938		Remold Compaction (%) and Moisture Content (%)		Saturated Hydraulic Conductivity (cm/sec) ASTM D 5084
LCE-1	IRP27-LCE-1/54-700	1.0	0.0:42.16:26.93	13:NP:NP	SC	8.5	133.0	15.3	107.0	10.6	90%	1.79×10^{-7}
LCE-2	IRP27-LCE-2/54-701	1.0	0.0:35.49:27.15	13.8 :NP:NP	SC	8.5	133.0	9.3	134.4	12.5	90%	7.11×10^{-7}
LCE-3	IRP27-LCE-3/54-702	0.5	0.0:38.15:30.81	21.2:0: :NP:NP	SC	8.5	133.0	9.2	150.3	10.9	90%	4.38×10^{-7}
LCE-4	IRP27-LCE-4/54-703	1.0	0.0:42.44:25.08	18.6:12.3:6.3	SC-SM	8.0	135.0	10.1	145.0	7.5	90%	1.47×10^{-7}
LCE-5	IRP27-LCE-5/54-704	1.5	0.0:43.82:22.90	15.1:11.6:3.5	SM	8.0	135.0	9.6	151.0	9.0	90%	8.13×10^{-7}
LCE-6	IRP27-LCE-6/54-705	1.5	0.0:45.07:23.81	13.7:13.5:0.2	SM	8.0	134.0	10.6	118.7	7.9	90%	7.11×10^{-7}
LCE-7	IRP27-LCE-7/54-706	2.0	0.0:36.17:23.36	16.5:12.5:4.0	SC	8.0	134.0	13.5	115.4	7.8	90%	3.44×10^{-7}
LCE-8	IRP27-LCE-8/54-707	8.0	0.0:49.18:25.20	25.9:15.8:10.1	SM	10.0	128.0	6.5	148.8	7.8	90%	1.96×10^{-7}
LCE-9	IRP27-LCE-9/54-708	5.0	0.0:17.44:44.64	33.7:18.8:14.9	SM	11.5	124.0	7.8	166.6	8.3	90%	9.27×10^{-7}
LCE-10	IRP27-LCE-10/54-709	5.0	0.0:44.86:23.92	23.7:17.3:6.4	SM	11.0	126.0	15.3	107.0	8.0	90%	7.95×10^{-7}

Notes:

% percent
ASTM American Standard Test Method
cm/sec centimeters per second
Fi fines
ft feet
Gr gravel
LL liquid limit
pcf pounds per cubic feet
PI plasticity index
PL plastic limit
Sa sand
USCS unified soil classification system

Table 7-3
Storm Water Exceedance Analytical Results (First Round)
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook,
Fallbrook, California

Sample Name	Parameter	Result (µg/L)	*Exceedance Criteria (µg/L)
IRP27-SW-2	MANGANESE	55.4	50

Notes:
* Stormwater exceedance criteria based on groundwater threshold value for Manganese
µg/L micrograms per liter
IRP Installation Restoration Program
RI Remedial Investigation (Sealaska/Geosyntec)

Table 8-1
QA/QC Results
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook,
Fallbrook, California

Sample Name	Field Quality Control Samples	Analytical Method	Results	Units	Lab Qualifier	Method Detection Limit	Parameter	Matrix
54-002	Parent Sample	300.0	0.24	mg/l	J	0.222	NITRATE (AS N)	GW
54-002	Parent Sample	300.0	195	mg/l		5	SULFATE	GW
54-002	Parent Sample	300.0	15.1	mg/l		0.5	CHLORIDE	GW
54-002	Parent Sample	350.2	0.855	mg/l		0.06	AMMONIA (AS N)	GW
54-002	Parent Sample	6020A	23.1	ug/l		2.5	ARSENIC	GW
54-002	Parent Sample	6020A	99.1	ug/l		2.5	BARIUM	GW
54-002	Parent Sample	6020A	11.4	ug/l		2.5	COBALT	GW
54-002	Parent Sample	6020A	9890	ug/l		100	IRON	GW
54-002	Parent Sample	6020A	5580	ug/l		2.5	MANGANESE	GW
54-002	Parent Sample	6020A	3.64	ug/l	J	2.5	MOLYBDENUM	GW
54-002	Parent Sample	6020A	3.09	ug/l	J	2.5	VANADIUM	GW
54-002	Parent Sample	6020A	213000	ug/l		25	CALCIUM	GW
54-002	Parent Sample	6020A	62600	ug/l		10	MAGNESIUM	GW
54-002	Parent Sample	6020A	4290	ug/l		20	POTASSIUM	GW
54-002	Parent Sample	6020A	44100	ug/l		50	SODIUM	GW
54-002	Parent Sample	6020A	24.1	ug/l		0.5	ARSENIC	GW
54-002	Parent Sample	6020A	99.5	ug/l		0.5	BARIUM	GW
54-002	Parent Sample	6020A	0.627	ug/l	J	0.5	CHROMIUM	GW
54-002	Parent Sample	6020A	10.9	ug/l		0.5	COBALT	GW
54-002	Parent Sample	6020A	9850	ug/l		20	IRON	GW
54-002	Parent Sample	6020A	5310	ug/l	E	0.5	MANGANESE	GW
54-002	Parent Sample	6020A	3.68	ug/l		0.5	MOLYBDENUM	GW
54-002	Parent Sample	6020A	1.5	ug/l		0.5	NICKEL	GW
54-002	Parent Sample	6020A	3.33	ug/l		0.5	VANADIUM	GW
54-002	Parent Sample	8015B	1.9	mg/l		0.05	DIESEL	GW
54-002	Parent Sample	8015B	1.1	mg/l		0.05	MOTOR OIL	GW
54-002	Parent Sample	8260B	0.2	ug/l	J	0.2	1,4-DICHLOROBENZENE	GW
54-002	Parent Sample	8260B	17	ug/l	J	5	ACETONE	GW
54-002	Parent Sample	8260B	0.6	ug/l	J	0.2	CHLOROBENZENE	GW
54-002	Parent Sample	ASTM 1385	4.5	ug/l		0.9	HYDRAZINE	GW
54-002	Parent Sample	EPA 1625C	0.723	ng/l	J	0.151	N-NITROSODIMETHYLAMINE	GW

Table 8-1
QA/QC Results
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook,
Fallbrook, California

Sample Name	Field Quality Control Samples	Analytical Method	Results	Units	Lab Qualifier	Method Detection Limit	Parameter	Matrix
54-002-FD	Field Duplicate	300.0	0.234	mg/l	J	0.222	NITRATE (AS N)	GW
54-002-FD	Field Duplicate	300.0	198	mg/l		5	SULFATE	GW
54-002-FD	Field Duplicate	300.0	14.8	mg/l		0.5	CHLORIDE	GW
54-002-FD	Field Duplicate	350.2	0.85	mg/l		0.06	AMMONIA (AS N)	GW
54-002-FD	Field Duplicate	6020A	96.8	ug/l		0.5	BARIUM	GW
54-002-FD	Field Duplicate	6020A	0.604	ug/l	J	0.5	CHROMIUM	GW
54-002-FD	Field Duplicate	6020A	10.7	ug/l		0.5	COBALT	GW
54-002-FD	Field Duplicate	6020A	9610	ug/l		20	IRON	GW
54-002-FD	Field Duplicate	6020A	5160	ug/l	E	0.5	MANGANESE	GW
54-002-FD	Field Duplicate	6020A	3.48	ug/l		0.5	MOLYBDENUM	GW
54-002-FD	Field Duplicate	6020A	1.33	ug/l		0.5	NICKEL	GW
54-002-FD	Field Duplicate	6020A	3.24	ug/l		0.5	VANADIUM	GW
54-002-FD	Field Duplicate	6020A	23.9	ug/l		2.5	ARSENIC	GW
54-002-FD	Field Duplicate	6020A	102	ug/l		2.5	BARIUM	GW
54-002-FD	Field Duplicate	6020A	11.7	ug/l		2.5	COBALT	GW
54-002-FD	Field Duplicate	6020A	10400	ug/l		100	IRON	GW
54-002-FD	Field Duplicate	6020A	5680	ug/l		2.5	MANGANESE	GW
54-002-FD	Field Duplicate	6020A	3.57	ug/l	J	2.5	MOLYBDENUM	GW
54-002-FD	Field Duplicate	6020A	3.13	ug/l	J	2.5	VANADIUM	GW
54-002-FD	Field Duplicate	6020A	203000	ug/l		25	CALCIUM	GW
54-002-FD	Field Duplicate	6020A	61100	ug/l		10	MAGNESIUM	GW
54-002-FD	Field Duplicate	6020A	4160	ug/l		20	POTASSIUM	GW
54-002-FD	Field Duplicate	6020A	41700	ug/l		50	SODIUM	GW
54-002-FD	Field Duplicate	6020A	23	ug/l		0.5	ARSENIC	GW
54-002-FD	Field Duplicate	8015B	2	mg/l		0.048	DIESEL	GW
54-002-FD	Field Duplicate	8015B	0.97	mg/l		0.048	MOTOR OIL	GW
54-002-FD	Field Duplicate	8260B	0.2	ug/l	J	0.2	1,4-DICHLOROBENZENE	GW
54-002-FD	Field Duplicate	8260B	17	ug/l	J	5	ACETONE	GW
54-002-FD	Field Duplicate	8260B	0.6	ug/l	J	0.2	CHLOROBENZENE	GW
54-002-FD	Field Duplicate	ASTM 1385	4.2	ug/l		0.9	Hydrazine	GW
54-002-FD	Field Duplicate	EPA 1625C	0.529	ng/l	J	0.115	N-NITROSODIMETHYLAMINE	GW

Table 8-1
QA/QC Results
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook,
Fallbrook, California

Sample Name	Field Quality Control Samples	Analytical Method	Results	Units	Lab Qualifier	Method Detection Limit	Parameter	Matrix
54-051	Parent Sample	300.0	15.1	mg/l		0.1	CHLORIDE	GW
54-051	Parent Sample	300.0	0.289	mg/l	J	0.22	NITRATE (AS N)	GW
54-051	Parent Sample	300.0	116	mg/l		2.5	SULFATE	GW
54-051	Parent Sample	350.2	0.0964	mg/l	J	0.06	AMMONIA (AS N)	GW
54-051	Parent Sample	6020A	147000	ug/l		25	CALCIUM	GW
54-051	Parent Sample	6020A	51700	ug/l		10	MAGNESIUM	GW
54-051	Parent Sample	6020A	2970	ug/l		20	POTASSIUM	GW
54-051	Parent Sample	6020A	40700	ug/l		50	SODIUM	GW
54-051	Parent Sample	6020A	16.2	ug/l		0.5	ARSENIC	GW
54-051	Parent Sample	6020A	96.9	ug/l		0.5	BARIUM	GW
54-051	Parent Sample	6020A	6.35	ug/l		0.5	COBALT	GW
54-051	Parent Sample	6020A	1.1	ug/l		0.5	COPPER	GW
54-051	Parent Sample	6020A	1490	ug/l		20	IRON	GW
54-051	Parent Sample	6020A	5210	ug/l		0.5	MANGANESE	GW
54-051	Parent Sample	6020A	7.96	ug/l		0.5	MOLYBDENUM	GW
54-051	Parent Sample	6020A	2.58	ug/l		0.5	NICKEL	GW
54-051	Parent Sample	6020A	5.94	ug/l		0.5	VANADIUM	GW
54-051	Parent Sample	8015B	0.59	mg/l		0.094	DIESEL	GW
54-051	Parent Sample	8015B	0.51	mg/l	J	0.47	MOTOR OIL	GW
54-051-FD	Field Duplicate	300.0	15.1	mg/l		0.1	CHLORIDE	GW
54-051-FD	Field Duplicate	300.0	0.303	mg/l	J	0.22	NITRATE (AS N)	GW
54-051-FD	Field Duplicate	300.0	118	mg/l		2.5	SULFATE	GW
54-051-FD	Field Duplicate	350.2	0.107	mg/l		0.06	AMMONIA (AS N)	GW
54-051-FD	Field Duplicate	6020A	142000	ug/l		25	CALCIUM	GW
54-051-FD	Field Duplicate	6020A	50700	ug/l		10	MAGNESIUM	GW
54-051-FD	Field Duplicate	6020A	2920	ug/l		20	POTASSIUM	GW
54-051-FD	Field Duplicate	6020A	39200	ug/l		50	SODIUM	GW
54-051-FD	Field Duplicate	6020A	15.5	ug/l		0.5	ARSENIC	GW
54-051-FD	Field Duplicate	6020A	93.1	ug/l		0.5	BARIUM	GW
54-051-FD	Field Duplicate	6020A	6.2	ug/l		0.5	COBALT	GW
54-051-FD	Field Duplicate	6020A	0.982	ug/l	J	0.5	COPPER	GW
54-051-FD	Field Duplicate	6020A	1450	ug/l		20	IRON	GW
54-051-FD	Field Duplicate	6020A	5100	ug/l		0.5	MANGANESE	GW
54-051-FD	Field Duplicate	6020A	7.86	ug/l		0.5	MOLYBDENUM	GW
54-051-FD	Field Duplicate	6020A	2.58	ug/l		0.5	NICKEL	GW
54-051-FD	Field Duplicate	6020A	5.46	ug/l		0.5	VANADIUM	GW
54-051-FD	Field Duplicate	8015B	0.66	mg/l		0.094	DIESEL	GW

Table 8-1
QA/QC Results
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook,
Fallbrook, California

Sample Name	Field Quality Control Samples	Analytical Method	Results	Units	Lab Qualifier	Method Detection Limit	Parameter	Matrix
54-104	Parent Sample	TO-15 Modifi	1.1	µg/m³	J		2-PROPENAL	SG
54-104	Parent Sample	TO-15 Modifi	1.4	µg/m³			PROPENE	SG
54-104	Parent Sample	TO-15 Modifi	18	µg/m³			ETHANOL	SG
54-104	Parent Sample	TO-15 Modifi	10	µg/m³			ACETONE	SG
54-104	Parent Sample	TO-15 Modifi	0.35	µg/m³	J		METHYLENE CHLORIDE	SG
54-104	Parent Sample	TO-15 Modifi	1.3	µg/m³	J		CARBON DISULFIDE	SG
54-104	Parent Sample	TO-15 Modifi	4.8	µg/m³			TRICHLOROFLUOROMETHANE	SG
54-104	Parent Sample	TO-15 Modifi	3.1	µg/m³			DICHLORODIFLUOROMETHANE	SG
54-104	Parent Sample	TO-15 Modifi	0.66	µg/m³	J		FREON 113	SG
54-104	Parent Sample	TO-15 Modifi	3.9	µg/m³	J		2-BUTANONE	SG
54-104 DUP	Field Duplicate	TO-15 Modifi	1.4	µg/m³	J		2-PROPENAL	SG
54-104 DUP	Field Duplicate	TO-15 Modifi	2.1	µg/m³	J		VINYL ACETATE	SG
54-104 DUP	Field Duplicate	TO-15 Modifi	1.5	µg/m³			PROPENE	SG
54-104 DUP	Field Duplicate	TO-15 Modifi	18	µg/m³			ETHANOL	SG
54-104 DUP	Field Duplicate	TO-15 Modifi	10	µg/m³			ACETONE	SG
54-104 DUP	Field Duplicate	TO-15 Modifi	0.43	µg/m³	J		CHLOROMETHANE	SG
54-104 DUP	Field Duplicate	TO-15 Modifi	0.41	µg/m³	J		CHLOROETHANE	SG
54-104 DUP	Field Duplicate	TO-15 Modifi	0.69	µg/m³			ACETONITRILE	SG
54-104 DUP	Field Duplicate	TO-15 Modifi	0.43	µg/m³	J		METHYLENE CHLORIDE	SG
54-104 DUP	Field Duplicate	TO-15 Modifi	2.2	µg/m³	J		CARBON DISULFIDE	SG
54-104 DUP	Field Duplicate	TO-15 Modifi	4.8	µg/m³			TRICHLOROFLUOROMETHANE	SG
54-104 DUP	Field Duplicate	TO-15 Modifi	3.1	µg/m³			DICHLORODIFLUOROMETHANE	SG
54-104 DUP	Field Duplicate	TO-15 Modifi	0.69	µg/m³			FREON 113	SG
54-104 DUP	Field Duplicate	TO-15 Modifi	3.6	µg/m³	J		2-BUTANONE	SG
EB-053111	Equipment Blank	6020A	0.943	ug/l	J	0.5	COPPER	GW
EB-053111	Equipment Blank	EPA 1625C	0.433	ng/l	J	0.0445	N-NITROSODIMETHYLAMINE	GW

Table 8-1
QA/QC Results
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook,
Fallbrook, California

Sample Name	Field Quality Control Samples	Analytical Method	Results	Units	Lab Qualifier	Method Detection Limit	Parameter	Matrix
EB-060111	Equipment Blank	6020A	2.16	ug/l		0.5	ARSENIC	GW
EB-060111	Equipment Blank	6020A	36.4	ug/l		0.5	BARIUM	GW
EB-060111	Equipment Blank	6020A	1.14	ug/l		0.5	CHROMIUM	GW
EB-060111	Equipment Blank	6020A	0.927	ug/l	J	0.5	COPPER	GW
EB-060111	Equipment Blank	6020A	0.711	ug/l	J	0.5	MANGANESE	GW
EB-060111	Equipment Blank	6020A	4.07	ug/l		0.5	MOLYBDENUM	GW
EB-060111	Equipment Blank	6020A	0.812	ug/l	J	0.5	NICKEL	GW
EB-060111	Equipment Blank	6020A	0.999	ug/l	J	0.5	SELENIUM	GW
EB-060111	Equipment Blank	6020A	25.2	ug/l		0.5	VANADIUM	GW
EB-060111	Equipment Blank	8260B	0.27	ug/l	J	0.2	TOLUENE	GW
EB-110810	Equipment Blank	6020A	222	ug/l		25	CALCIUM	GW
EB-110810	Equipment Blank	6020A	92.7	ug/l	J	10	MAGNESIUM	GW
EB-110810	Equipment Blank	6020A	57.5	ug/l	J	20	POTASSIUM	GW
EB-110810	Equipment Blank	6020A	1270	ug/l		50	SODIUM	GW
EB-110810	Equipment Blank	6020A	0.777	ug/l	J	0.5	COPPER	GW
EB-110910	Equipment Blank	6020A	214	ug/l		25	CALCIUM	GW
EB-110910	Equipment Blank	6020A	89.8	ug/l	J	10	MAGNESIUM	GW
EB-110910	Equipment Blank	6020A	41.5	ug/l	J	20	POTASSIUM	GW
EB-110910	Equipment Blank	6020A	1100	ug/l		50	SODIUM	GW
SB-053111	Source Blank	EPA 1625C	0.301	ng/l	J	0.0886	N-NITROSODIMETHYLAMINE	GW
SB-110910	Source Blank	6020A	204	ug/l		25	CALCIUM	GW
SB-110910	Source Blank	6020A	96.1	ug/l	J	10	MAGNESIUM	GW
SB-110910	Source Blank	6020A	40.7	ug/l	J	20	POTASSIUM	GW
SB-110910	Source Blank	6020A	1080	ug/l		50	SODIUM	GW

Notes:

FD	field duplicate
GW	groundwater
J	indicates an estimated value
mg/l	milligrams per liter
ng/l	nanograms per liter
QA	quality assurance
QC	quality control
RI	Remedial Investigation
SG	soil gas
ug/l	micrograms per liter
µg/m³	micrograms per cubic meter

Table 9-1
Screening Level HHRA - Soil Gas
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook
Fallbrook, California

CAS Number	Parameter	Number of Detects	Number of Samples	Frequency of Detection	Minimum Reporting Limit ($\mu g/m^3$)	Maximum Reporting Limit ($\mu g/m^3$)	Minimum Detected Concentration ($\mu g/m^3$)	Maximum Detected Concentration ($\mu g/m^3$)	Sample Location of the Maximum Detected	Screening Level		Maximum Detected > Screening Level?
										Soil Gas $CHHSL_c$ ($\mu g/m^3$)	Soil Gas $CHHSL_{nc}$ ($\mu g/m^3$)	
71-55-6	1,1,1-Trichloroethane	2	6	33%	0.24	2.4	0.77	1.5	SG-2-5	--	450,000	no
95-63-6	1,2,4-Trimethylbenzene	6	6	100%	0.28	2.8	0.30 J	490	SG-1-9.5	--	3,200	no
156-59-2	1,2-Dichloroethene, cis-	1	6	17%	0.30	3.1	14	14	SG-1-9.5	--	3,200	no
76-14-2	1,2-Dichlorotetrafluoroethane	2	6	33%	0.28	0.30	0.63 J	2.2	SG-8	--	14,000,000	no
108-67-8	1,3,5-Trimethylbenzene	5	6	83%	0.25	2.6	1.3	240	SG-1-9.5	--	16,000	no
106-46-7	1,4-Dichlorobenzene	5	6	83%	0.29	2.9	0.91	26	SG-1-9.5	97	360,000	no
78-93-3	2-Butanone	6	6	100%	0.29	0.32	3.3 J	7.1	SG-3-8	--	2,300,000	no
107-02-8	2-Propenal	6	6	100%	0.28	0.30	0.62 J	2.0 J	SG-3-8	--	160	no
67-64-1	Acetone	6	6	100%	1.7	1.9	8.7	22	SG-3-8	--	14,000,000	no
75-05-8	Acetonitrile	4	6	67%	0.41	0.44	0.53 J	1.2	SG-3-8	--	26,000	no
107-13-1	Acrylonitrile	1	6	17%	0.29	0.32	0.47 J	0.47 J	SG-3-8	3.6	2,200	no
71-43-2	Benzene	5	6	83%	0.24	2.4	0.51 J	7.8	SG-1-9.5	36	27,000	no
75-27-4	Bromodichloromethane	1	6	17%	0.23	2.3	3.3	3.3	SG-6	31	35,000	no
75-25-2	Bromoform	1	6	17%	0.27	2.7	0.43 J	0.43 J	SG-6	1,200	--	no
104-51-8	Butylbenzene, n-	3	6	50%	0.27	2.7	0.59	2.3	SG-7	--	81,000	no
135-98-8	Butylbenzene, sec-	3	6	50%	0.23	2.3	0.26 J	18	SG-1-9.5	--	81,000	no
75-15-0	Carbon Disulfide	6	6	100%	0.32	0.34	0.61 J	12	SG-3-8	--	360,000	no
56-23-5	Carbon Tetrachloride	1	6	17%	0.24	2.4	0.50 J	0.50 J	SG-1-5	25	18,000	no
108-90-7	Chlorobenzene	4	6	67%	0.24	2.4	0.33 J	1.1	SG-6	--	450,000	no
75-00-3	Chloroethane	1	12	8%	0.33	3.3	0.41 J	0.41 J	SG-3-5	--	13,000,000	no
67-66-3	Chloroform	5	6	83%	0.24	2.4	0.32 J	1.9	SG-1-5; SG-6	200	130,000	no
74-87-3	Chloromethane	1	12	8%	0.24	2.4	0.43 J	0.43 J	SG-3-5	--	40,000	no
124-48-1	Dibromochloromethane	1	6	17%	0.27	2.7	2.5	2.5	SG-6	46	37,000	no
75-71-8	Dichlorodifluoromethane	12	12	100%	0.29	2.8	2.3	660	SG-1-5	--	46,000	no
64-17-5	Ethanol	6	6	100%	2.8	3.0	5.1 J	35	SG-5	--	1,800,000	no
100-41-4	Ethylbenzene	5	6	83%	0.24	2.4	0.35 J	19	SG-6	420	910,000	no
76-13-1	Freon 113	11	12	92%	0.29	2.9	0.49 J	0.69	SG-3-5	--	14,000,000	no
67-63-0	Isopropanol	4	6	67%	0.70	0.76	0.71 J	1.3 J	SG-3-8; SG-5	--	3,200,000	no
98-82-8	Isopropylbenzene	4	6	67%	0.24	2.4	0.27 J	37	SG-1-9.5	--	180,000	no
75-09-2	Methylene Chloride	6	12	50%	0.25	2.6	0.28 J	1.0	SG-2-5	1,000	180,000	no

Table 9-1
Screening Level HHRA - Soil Gas
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook
Fallbrook, California

CAS Number	Parameter	Number of Detects	Number of Samples	Frequency of Detection	Minimum Reporting Limit ($\mu g/m^3$)	Maximum Reporting Limit ($\mu g/m^3$)	Minimum Detected Concentration ($\mu g/m^3$)	Maximum Detected Concentration ($\mu g/m^3$)	Sample Location of the Maximum Detected	Screening Level		Maximum Detected > Screening Level?
										Soil Gas $CHHSL_c$ ($\mu g/m^3$)	Soil Gas $CHHSL_{nc}$ ($\mu g/m^3$)	
91-20-3	Naphthalene	4	6	67%	0.50	5.0	0.60 J	33	SG-1-9.5	32	4,200	Yes
115-07-1	Propene	6	6	100%	0.34	0.37	0.73	2.8	SG-3-8	--	1,900,000	no
103-65-1	Propylbenzene, n-	5	6	83%	0.24	2.4	0.35 J	24	SG-1-9.5	--	460,000	no
100-42-5	Styrene	3	6	50%	0.24	2.4	0.48 J	1.9	SG-6	--	410,000	no
127-18-4	Tetrachloroethene	4	6	67%	0.24	2.4	0.43 J	14	SG-2-5	180	16,000	no
109-99-9	Tetrahydrofuran	1	6	17%	0.25	2.6	0.41 J	0.41 J	SG-6	--	130,000	no
108-88-3	Toluene	5	6	83%	0.24	2.4	1.0	39	SG-6	--	130,000	no
75-69-4	Trichlorofluoromethane	12	12	100%	0.26	2.9	1.1	560	SG-2-5	--	310,000	no
108-05-4	Vinyl Acetate	4	6	67%	1.7	1.9	2.0 J	3.5 J	SG-3-8	--	90,000	no
108-38-3/106-42-3	m-Xylene/p-Xylene	5	6	83%	0.48	4.9	2.2	2,300	SG-1-9.5	--	310,000	no
95-47-6	Xylene, o-	5	6	83%	0.27	2.7	1.3	180	SG-1-9.5	--	310,000	no

Notes:

$\mu g/m^3$: micrograms per cubic meter

%: percent

CHHSL: California Human Health Screening Levels (Cal-EPA, 2005; 2010)

HHRA: Human Health Risk Assessment

nc: CHHSL based on noncancer effects; c: CHHSL based on cancer effects

Note: CHHSL-equivalents were derived using the same algorithms and parameters as those in the guidance manual (Cal-EPA, 2005), and the most recent version of the Johnson & Ettinger model.

References:

Cal-EPA, 2005. *Use of California Human Health Screening Levels (CHHSLs) in Evaluation of Contaiminated Properties* (Cal-EPA, 2005).

Cal-EPA, 2010. *Table 3 - Soil-Gas-Screening Numbers for Volatile Chemicals below Buildings Constructed Without Engineered Fill below Sub-slab Gravel* . www.oehha.ca.gov/risk/chhsltable.html#table2

Table 9-2
Screening Level HHRA - Groundwater
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook
Fallbrook, California

CAS Number	Parameter	Number of Detects	Number of Samples	Frequency of Detection	Minimum Reporting Limit (µg/l)	Maximum Reporting Limit (µg/l)	Minimum Detected Concentration (µg/l)	Maximum Detected Concentration (µg/l)	Sample Location of the Maximum Detected	Screening Level (µg/l)	Source of Screening Level	Maximum Detected > Screening Level
107-06-2	1,2-Dichloroethane	1	28	4%	0.20	0.20	0.26	0.26	MW-3	5	MCL	no
106-46-7	1,4-Dichlorobenzene	2	28	7%	0.20	0.20	0.20	0.20	MW-2	75	MCL	no
67-64-1	Acetone	2	28	7%	5.0	10	17	17	MW-2	22,000	RSL	no
7429-90-5	Aluminum	2	25	8%	20	100	22	100	MW-9A	200	secondary MCL	no
7664-41-7	Ammonia	7	17	41%	60	60	80	855	MW-2	--	--	no
7440-36-0	Antimony	2	25	8%	0.50	2.5	0.55	0.62	MW-3	6	MCL	no
7440-38-2	Arsenic	19	25	76%	0.50	2.5	1.1	24	MW-2	10	MCL	Yes
7440-39-3	Barium	20	25	80%	0.50	2.5	5.0	102	MW-2	2,000	MCL	no
7440-70-2	Calcium	15	15	100%	25	25	204	213,000	MW-2	--	--	no
16887-00-6	Chloride	13	13	100%	100	1,000	14,800	73,300	MW-4A	--	--	no
108-90-7	Chlorobenzene	2	28	7%	0.20	0.20	0.60	0.60	MW-2	100	MCL	no
7440-47-3	Chromium	15	25	60%	0.50	2.5	0.50	3.0	MW-3	100	MCL	no
7440-48-4	Cobalt	11	25	44%	0.50	2.5	0.63	12	MW-2	11	RSL	Yes
7440-50-8	Copper	17	25	68%	0.50	2.5	0.52	1.8	MW-3	1,300	MCL	no
302-01-2	Hydrazine	3	12	25%	0.90	0.90	1.2 J	4.5	MW-2	0.022	RSL	Yes
7439-89-6	Iron	8	25	32%	20	100	35	10,400	MW-2	300	secondary MCL	Yes
7439-92-1	Lead	1	25	4%	0.50	2.5	8.0	8.0	MW-7	15	MCL	no
7439-95-4	Magnesium	15	15	100%	10	10	90	62,600	MW-2	--	--	no
7439-96-5	Manganese	19	25	76%	0.50	2.5	0.71	5,680	MW-2	50	secondary MCL	Yes
7439-98-7	Molybdenum	20	25	80%	0.50	2.5	0.95	12	MW-7	180	RSL	no
7440-02-0	Nickel	15	25	60%	0.50	2.5	0.64	5.5	MW-3	100	MCL	no
14797-55-8	Nitrate	17	17	100%	220	2,220	234	64,600	MW-1	10,000	MCL	Yes
62-75-9	n-Nitrosodimethylamine	11	12	92%	0.00002	0.0002	0.0003	0.003	MW-3	0.01	CDPH 2008	No
7440-09-7	Potassium	15	15	100%	20	20	41	7,850	MW-7	--	--	no
7782-49-2	Selenium	8	25	32%	0.50	2.5	0.77	1.1	MW-7	50	MCL	no
7440-23-5	Sodium	15	15	100%	50	50	1,080	94,500	MW-3	--	--	no
14808-79-8	Sulfate	17	17	100%	1,250	5,000	30,200	205,000	MW-1	250	secondary MCL	Yes
7440-62-2	Vanadium	20	25	80%	0.50	2.5	3.1	60	MW-3	180	RSL	no
7440-66-6	Zinc	3	25	12%	10	50	13	843	MW-7	5,000	secondary MCL	no

Notes:
%: percent
µg/l: micrograms per liter; " -- " indicates not available or not applicable
HHRA: Human Health Risk Assessment
MCL: Maximum Contaminant Level (USEPA, 2011)
RSL: Regional Screening Levels (USEPA, 2011) based on tap water use: ingestion and inhalation of volatiles from household water use

Reference: USEPA, 2011. Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. June
California Department of Public Health (CDPH). 2008. N-nitrosodimethylamine (NDMA) and Other Nitrosamines - Drinking Water Issues. www.cdph.ca.gov/CERTLIC/DRINKINGWATER/Pages/NDMA.aspx

Table 9-3
Screening Level HHRA - Storm Water
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook
Fallbrook, California

CAS Number	Parameter	Number of Detects	Number of Samples	Frequency of Detection	Minimum Reporting Limit (µg/l)	Maximum Reporting Limit (µg/l)	Minimum Detected Concentration (µg/l)	Maximum Detected Concentration (µg/l)	Sample Location of the Maximum Detected	Screening Level (µg/l)	Source of Screening Level	Maximum Detected > Screening Level?
7429-90-5	Aluminum	3	3	100%	20	20	131	181	SW-3	200	secondary MCL	no
7664-41-7	Ammonia	3	3	100%	60	60	91	134	SW-1	--	--	no
7440-39-3	Barium	3	3	100%	0.50	0.50	8.2	33	SW-2	2,000	MCL	no
7440-47-3	Chromium	2	3	67%	0.50	0.50	0.50	0.53	SW-2	100	MCL	no
7440-48-4	Cobalt	3	3	100%	0.50	0.50	0.712 J	0.712 J	SW-2	11	RSL	no
7440-50-8	Copper	3	3	100%	0.50	0.50	2.15	3.65	SW-2	1,300	MCL	no
302-01-2	Hydrazine	3	3	100%	1.8	1.8	38	44	SW-2	0.022	RSL	Yes
7439-89-6	Iron	3	3	100%	20	20	117	172	SW-3	300	secondary MCL	no
7439-92-1	Lead	2	3	67%	0.50	0.50	0.64	1.1	SW-2	15	MCL	no
7439-96-5	Manganese	3	3	100%	0.50	0.50	4.1	55	SW-2	50	secondary MCL	Yes
7440-02-0	Nickel	3	3	100%	0.50	0.50	0.86	1.7	SW-2	100	MCL	no
14797-55-8	Nitrate	2	3	67%	220	220	243	525	SW-1	10,000	MCL	no
14808-79-8	Sulfate	3	3	100%	250	250	430	1,120	SW-1	250	secondary MCL	Yes
7440-62-2	Vanadium	3	3	100%	0.50	0.50	1.2	2.1	SW-3	180	RSL	no
7440-66-6	Zinc	3	3	100%	10	10	15	124	SW-2	5,000	secondary MCL	no

Notes:

>: greater than

µg/l: micrograms per liter; " -- " indicates not available or not applicable

MCL: Maximum Contaminant Level (USEPA, 2011)

RSL: Regional Screening Levels (USEPA, 2011) based on tap water use: ingestion and inhalation of volatiles from household water use

Reference: USEPA, 2011. Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. June

Table 9-4
Screening Level ERA - Soil Gas
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook
Fallbrook, California

Parameter [1]	Units	Maximum Soil Gas Concentration	Ecological Screening Level [2]
1,1,1-Trichloroethane	µg/m³	1.5	220,000
Acetone	µg/m³	22	480,000
Benzene	µg/m³	7.8	23,000
Carbon Tetrachloride	µg/m³	0.50 J	5,200
Chloroform	µg/m³	1.9	18,000
Chloromethane	µg/m³	0.43 J	19,000
cis-1,2-Dichloroethene	µg/m³	14	5,200
Tetrachloroethene	µg/m³	14	66,000
Toluene	µg/m³	39	55,000
Trichlorofluoromethane	µg/m³	560	750,000
m-Xylene/p-Xylene	µg/m³	2,300	79,000
o-Xylene	µg/m³	180	79,000

Notes:

µg/m³ : micrograms per cubic meters

ERA: Ecological Risk Assessment

(1) The table presents volatile organic constituents detected in soil gas for which an ecological inhalation TRV was identified by Gallegos et al. (2007).

(2) Ecological screening levels (ESLs) were calculated by Gallegos et al. for Botta's pocket gopher (*Thomomys bottae*) adjusted based on the body weight (0.065 kg) and inhalation rate (0.061 m^3/day) of Stephen's kangaroo rat, which is the most senstitive assessment endpoint likely to burrow at the Site.

Table 9-5
Screening Level ERA - Storm Water
IRP Site 27, NAVWPNSTA Seal Beach, Detachment Fallbrook
Fallbrook, California

Parameter	Maximum Storm Water Concentration	California Gnatcatcher (1)			Stephen's Kangaroo Rat (1)		
		ADDsw (2)	TRV (3)	HQ_{sw} (4)	ADDsw (2)	TRV (3)	HQ_{sw} (4)
	µg/l	mg/kg-day	mg/kg-day	unitless	mg/kg-day	mg/kg-day	unitless
Aluminum	181	9.6E-02	2.5E+01	3.8E-03	2.4E-02	1.8E+01	1.3E-03
Ammonia	134	7.1E-02	--	--	1.7E-02	--	--
Barium	33	1.8E-02	2.1E+01	8.5E-04	4.3E-03	1.5E+01	2.9E-04
Chromium	0.531	2.8E-04	2.3E-01	1.2E-03	6.9E-05	9.2E+00	7.5E-06
Cobalt	0.712	3.8E-04	5.0E+00	7.6E-05	9.3E-05	1.1E+00	8.4E-05
Copper	3.65	1.9E-03	4.7E+01	4.1E-05	4.8E-04	1.2E+01	4.0E-05
Hydrazine	44	2.4E-02	--	--	5.8E-03	2.0E-01	2.9E-02
Iron	172	9.1E-02	7.0E+01	1.3E-03	2.2E-02	3.8E+01	5.9E-04
Lead	1.1	5.9E-04	1.1E+00	5.2E-04	1.4E-04	8.0E+00	1.8E-05
Manganese	55	2.9E-02	9.8E+02	3.0E-05	7.2E-03	8.8E+01	8.2E-05
Nickel	1.7	9.1E-04	7.7E+01	1.2E-05	2.2E-04	4.5E+00	4.9E-05
Nitrate	525	2.8E-01	--	--	6.8E-02	5.1E+02	1.3E-04
Sulfate	1,120	6.0E-01	--	--	1.5E-01	--	--
Vanadium	2.1	1.1E-03	6.0E-01	1.9E-03	2.8E-04	4.2E-01	6.6E-04
Zinc	124	6.6E-02	1.5E+01	4.5E-03	1.6E-02	6.4E+01	2.5E-04

Notes:

" -- " not applicable or not available; " TRV " toxicity reference value; " HQ " hazard quotient

(1) Potential risk from consumption of storm water as drinking water was evaluated for avian and mammalian species with the highest water ingestion rates relative to body weight.

(2) ADD = (Csw x 0.001 (mg/µg) x DWI / BW) x AUF

ADD = Average daily dose (mg/kg-day)

Csw = Maximum detected concentration in storm water (µg/L)

DWI = Daily water ingestion (L/day) [Avian = 0.00319 L/day; Mammalian = 0.00846 L/day]

BW = Body weight (kg) [Avian = 0.006 kg; Mammalian = 0.065 kg]

AUF = Area use factor (assumes 100 % of a receptor's drinking water is storm water from the Site)

(3) TRVs specified in the Final Work Plan (MARRS, 2005), with the exception of nitrate (Sample et al., 1996) detected in storm water, but not soil.

(4) HQsw = ADDsw / TRV

Additional TRV Source:

Sample BE, Opresko DM, Suter GW. 1996. Toxicological benchmarks for wildlife. ES/ERM-86/R3. Office of Environmental Management, US Department of Energy.

FIGURES

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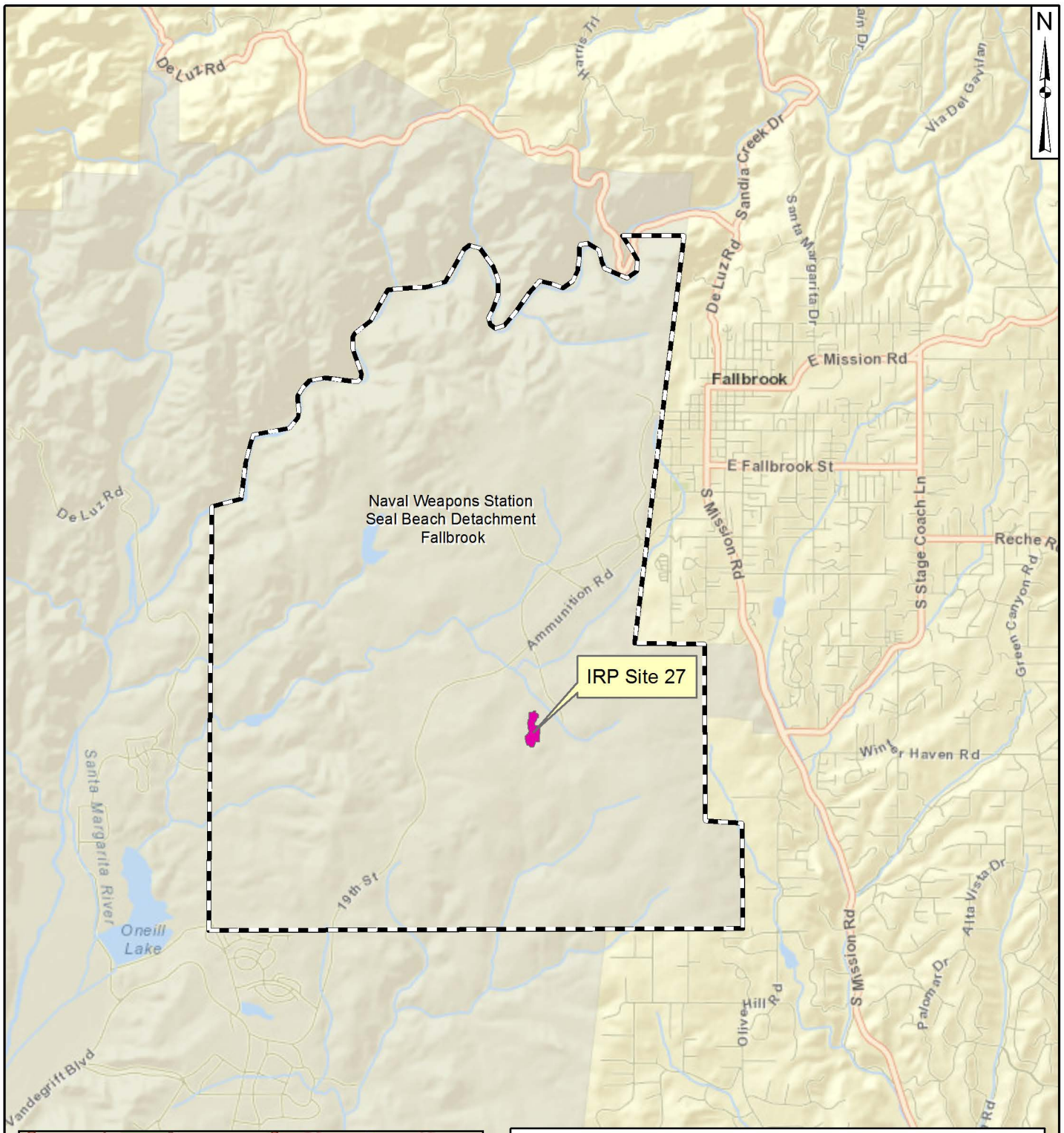

Site Map
Naval Weapons Station
Seal Beach Detachment Fallbrook
Fallbrook, CA.

1 0.5 0 1 2 Miles

Geosyntec consultants

Project No: HY1176 | August 2012

Figure 1

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IRP Site 27
Watershed in Relation to Landfill Extent
Naval Weapons Station
Seal Beach Detachment Fallbrook
Fallbrook, CA.

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Figure 2

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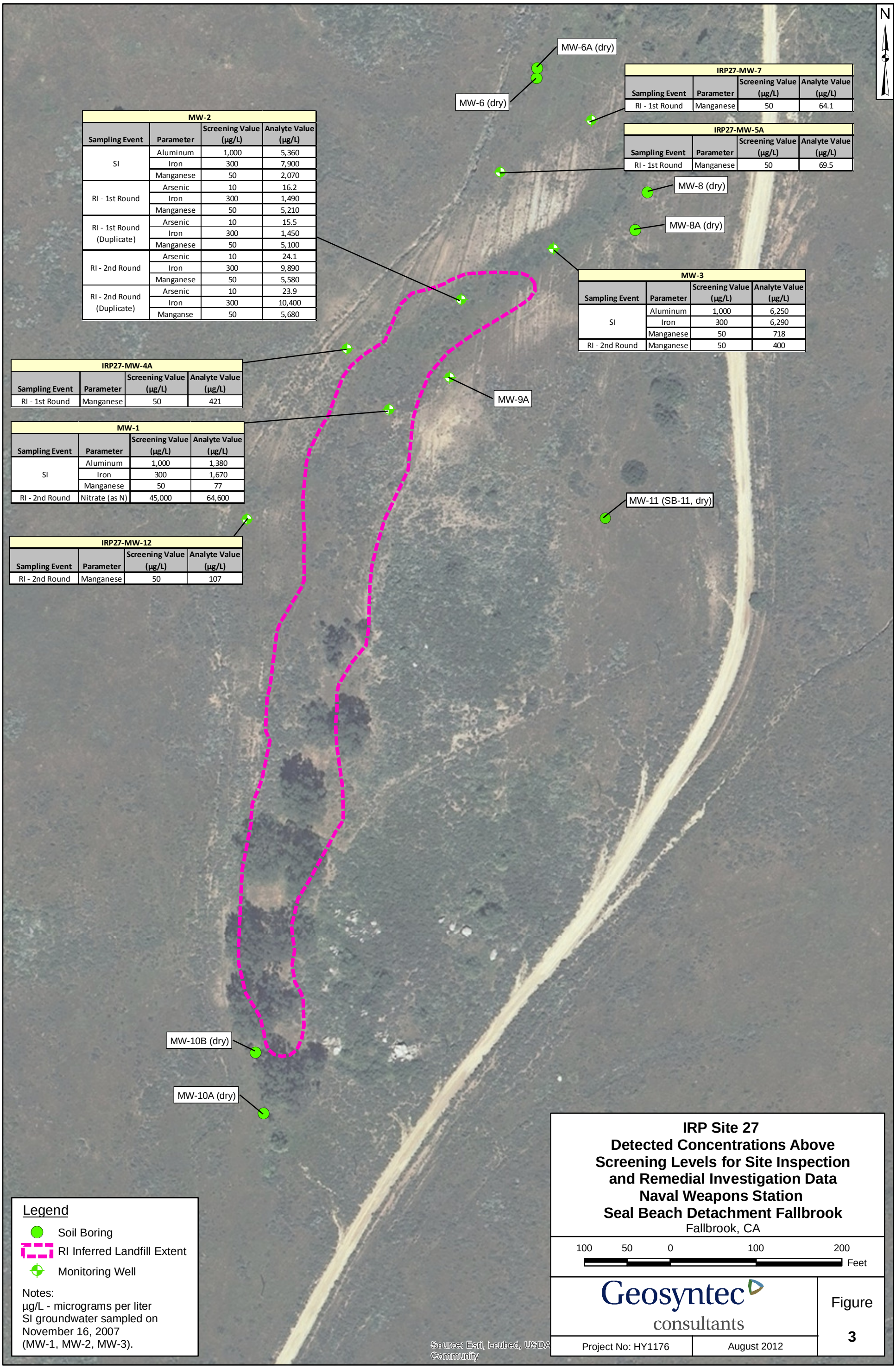


IRP27-MW-7

Sampling Event	Parameter	Screening Value (µg/L)	Analyte Value (µg/L)
RI - 1st Round	Manganese	50	64.1

IRP27-MW-5A

Sampling Event	Parameter	Screening Value (µg/L)	Analyte Value (µg/L)
RI - 1st Round	Manganese	50	69.5

MW-2

Sampling Event	Parameter	Screening Value (µg/L)	Analyte Value (µg/L)
SI	Aluminum	1,000	5,360
	Iron	300	7,900
	Manganese	50	2,070
RI - 1st Round	Arsenic	10	16.2
	Iron	300	1,490
	Manganese	50	5,210
RI - 1st Round (Duplicate)	Arsenic	10	15.5
	Iron	300	1,450
	Manganese	50	5,100
RI - 2nd Round	Arsenic	10	24.1
	Iron	300	9,890
	Manganese	50	5,580
RI - 2nd Round (Duplicate)	Arsenic	10	23.9
	Iron	300	10,400
	Manganse	50	5,680

MW-3

Sampling Event	Parameter	Screening Value (µg/L)	Analyte Value (µg/L)
SI	Aluminum	1,000	6,250
	Iron	300	6,290
	Manganese	50	718
RI - 2nd Round	Manganese	50	400

IRP27-MW-4A

Sampling Event	Parameter	Screening Value (µg/L)	Analyte Value (µg/L)
RI - 1st Round	Manganese	50	421

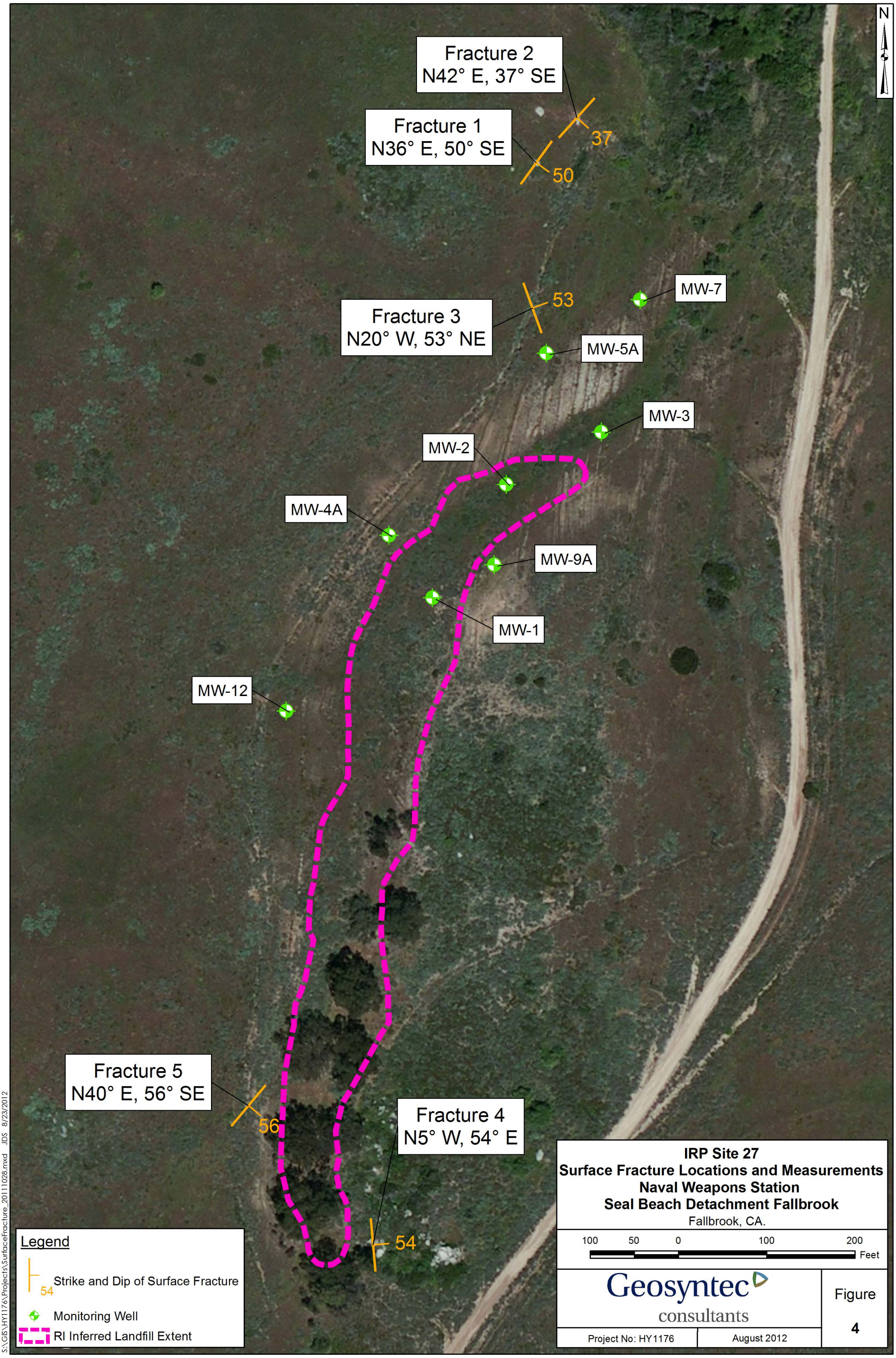
MW-1

Sampling Event	Parameter	Screening Value (µg/L)	Analyte Value (µg/L)
SI	Aluminum	1,000	1,380
	Iron	300	1,670
	Manganese	50	77
RI - 2nd Round	Nitrate (as N)	45,000	64,600

IRP27-MW-12

Sampling Event	Parameter	Screening Value (µg/L)	Analyte Value (µg/L)
RI - 2nd Round	Manganese	50	107

IRP Site 27
Detected Concentrations Above Screening Levels for Site Inspection and Remedial Investigation Data
Naval Weapons Station
Seal Beach Detachment Fallbrook
Fallbrook, CA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Fracture 2
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Fracture 1
N36° E, 50° SE
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53
Fracture 3
N20° W, 53° NE
MW-7
MW-5A
MW-3
MW-2
MW-4A
MW-9A
MW-1
MW-12
Fracture 5
N40° E, 56° SE
56
Fracture 4
N5° W, 54° E
54
Legend
54 Strike and Dip of Surface Fracture
Monitoring Well
RI Inferred Landfill Extent
IRP Site 27
Surface Fracture Locations and Measurements
Naval Weapons Station
Seal Beach Detachment Fallbrook
Fallbrook, CA.
100 50 0 100 200
Feet
Geosyntec consultants
Figure
4
Project No: HY1176
August 2012
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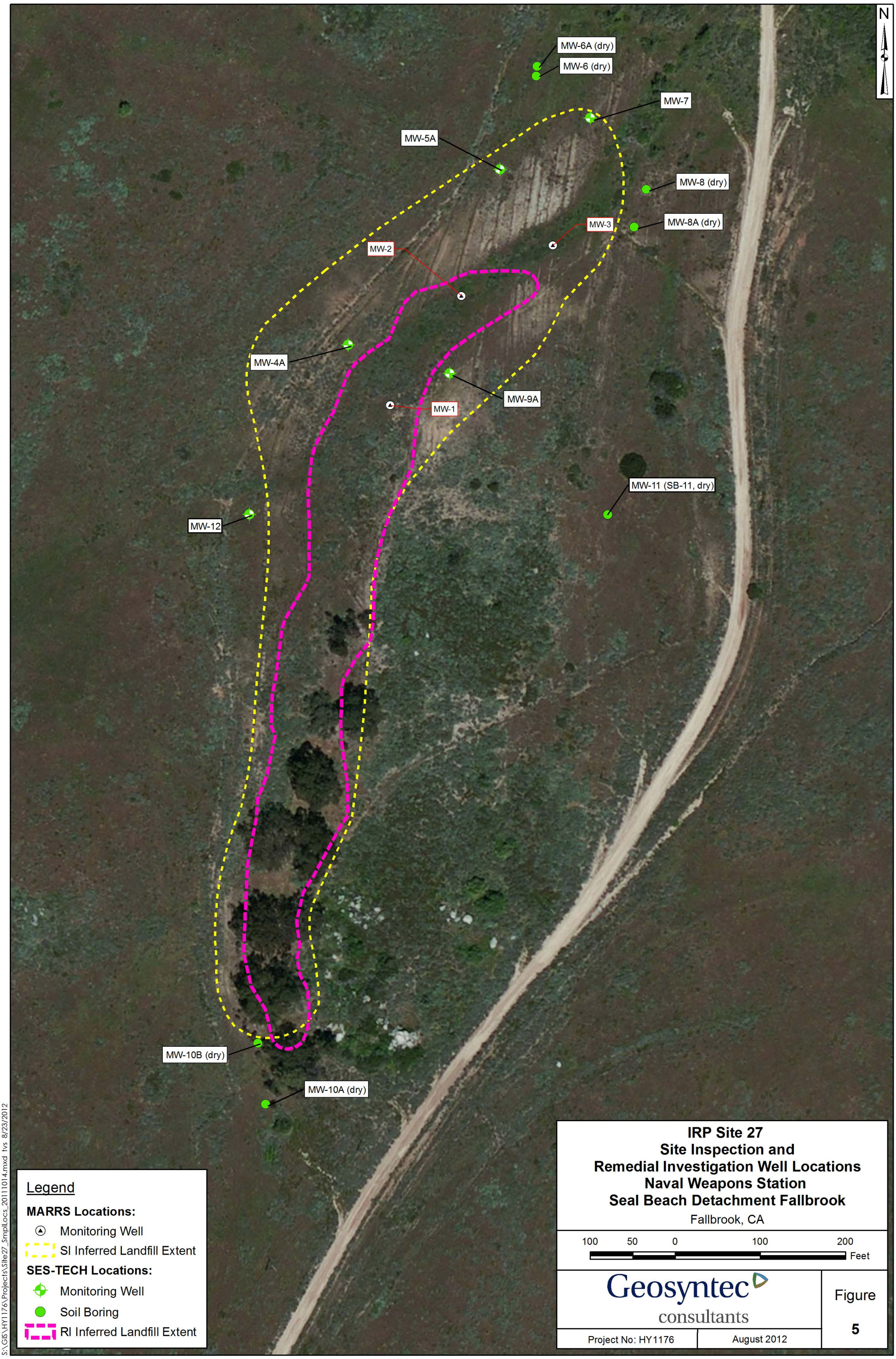

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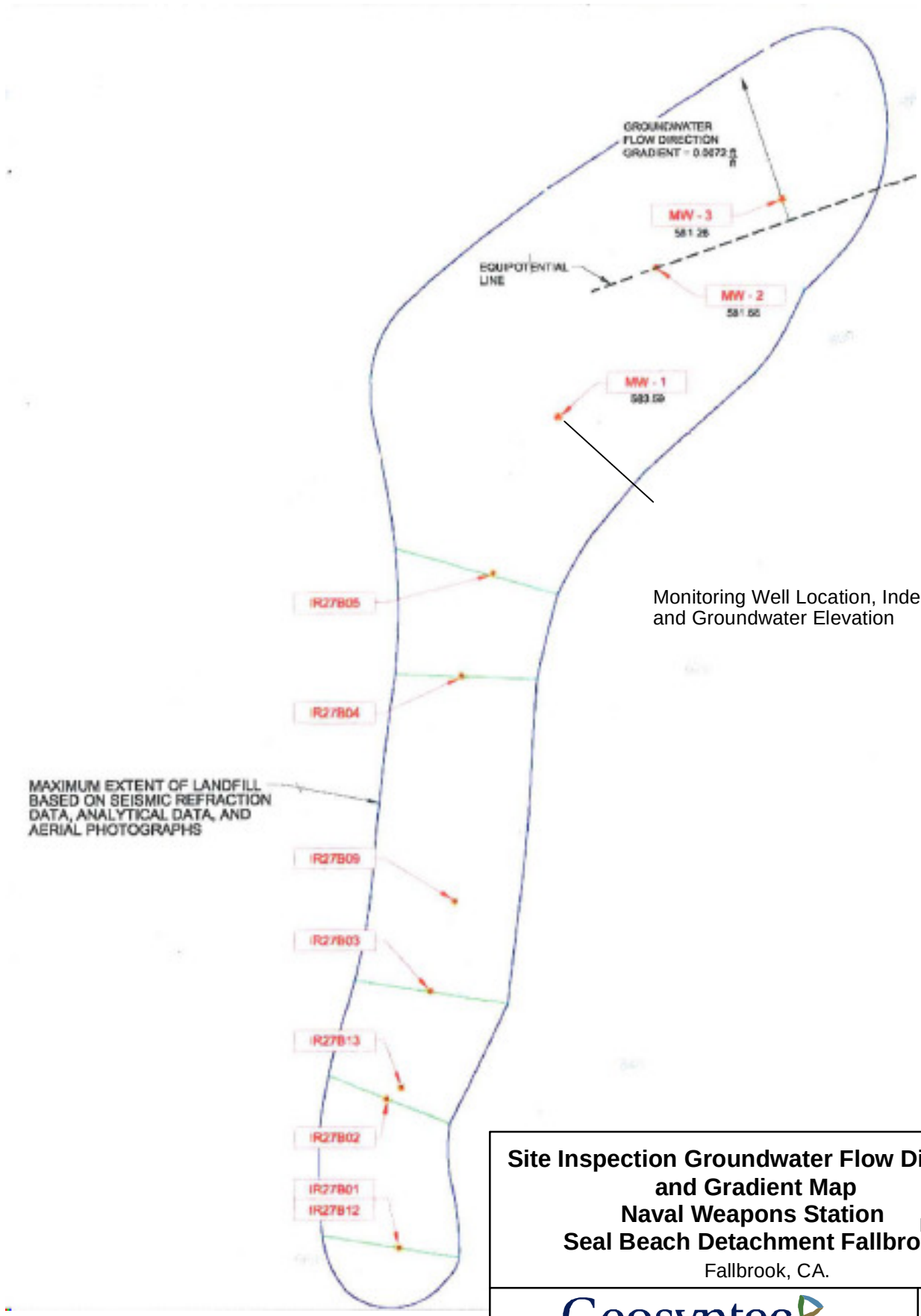

Monitoring Well Location, Indentification and Groundwater Elevation

Site Inspection Groundwater Flow Direction and Gradient Map
Naval Weapons Station
Seal Beach Detachment Fallbrook

Not to Scale

Fallbrook, CA.

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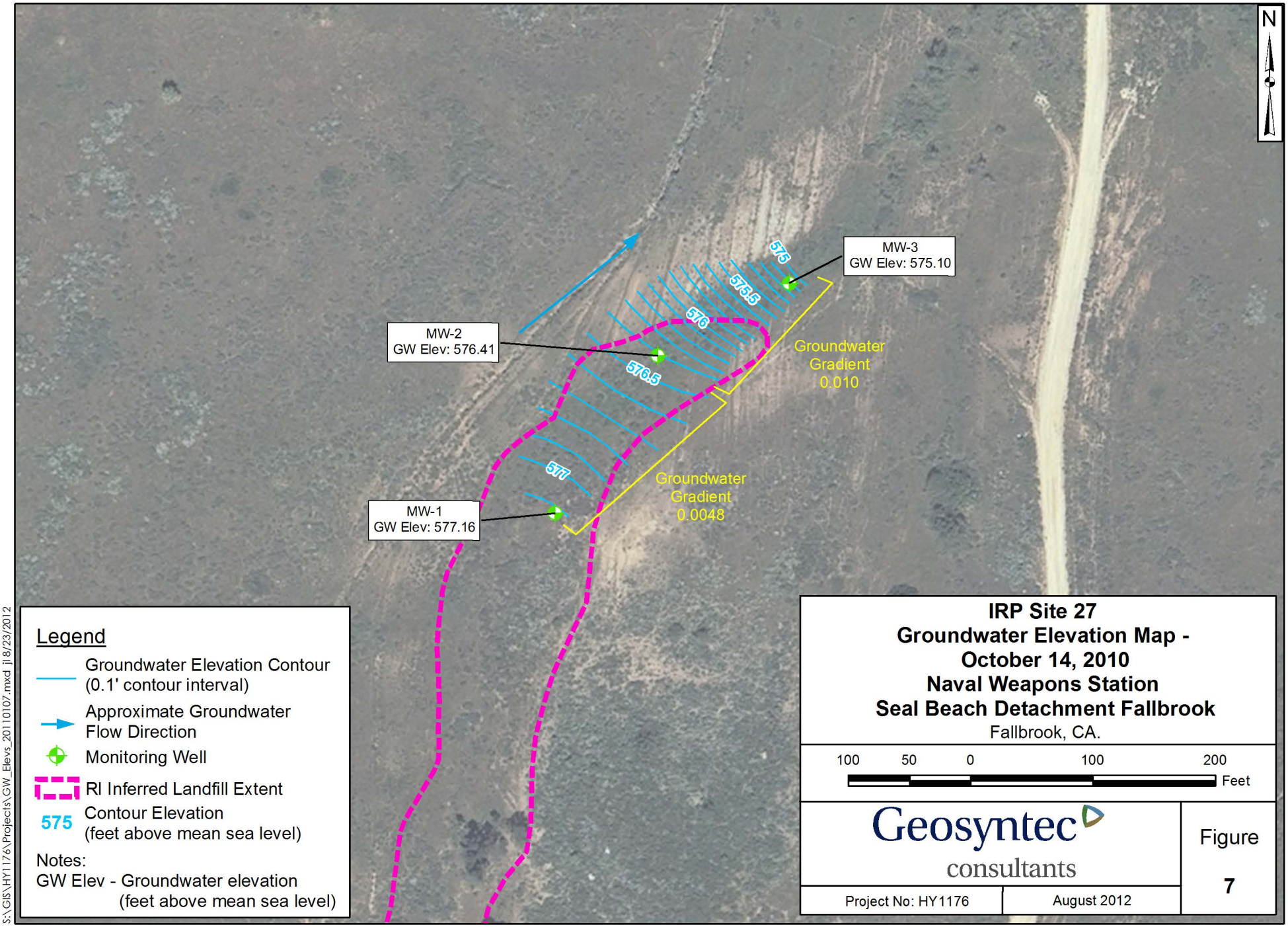
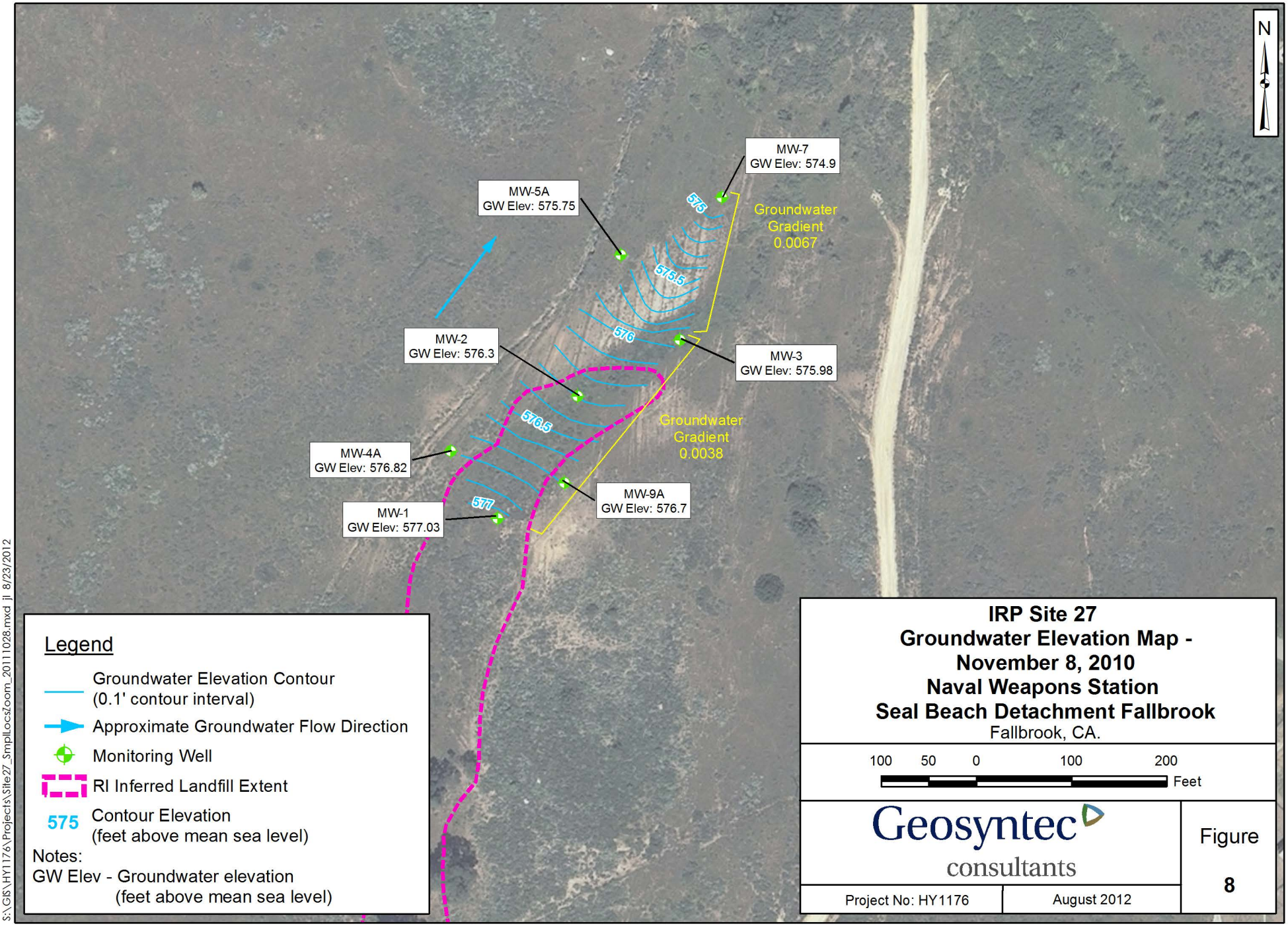
Figure **6**

Project No: HY1176 | August 2012

S:\GIS\HY1176\Projects\SiteMap_20111028.mxd jl

Groundwater Elevations Collected on 11/16/2008:


N
MW-3
GW Elev: 575.10
575
575.5
576
MW-2
GW Elev: 576.41
576.5
Groundwater
Gradient
0.010
577
MW-1
GW Elev: 577.16
Groundwater
Gradient
0.0048
Legend
Groundwater Elevation Contour
(0.1' contour interval)
Approximate Groundwater
Flow Direction
Monitoring Well
RI Inferred Landfill Extent
575 Contour Elevation
(feet above mean sea level)
Notes:
GW Elev - Groundwater elevation
(feet above mean sea level)
IRP Site 27
Groundwater Elevation Map -
October 14, 2010
Naval Weapons Station
Seal Beach Detachment Fallbrook
Fallbrook, CA.
100 50 0 100 200
Feet
Geosyntec
consultants
Figure
7
Project No: HY1176
August 2012
S:\GIS\HY1176\Projects\GW_Elevs_20110107.mxd jl 8/23/2012



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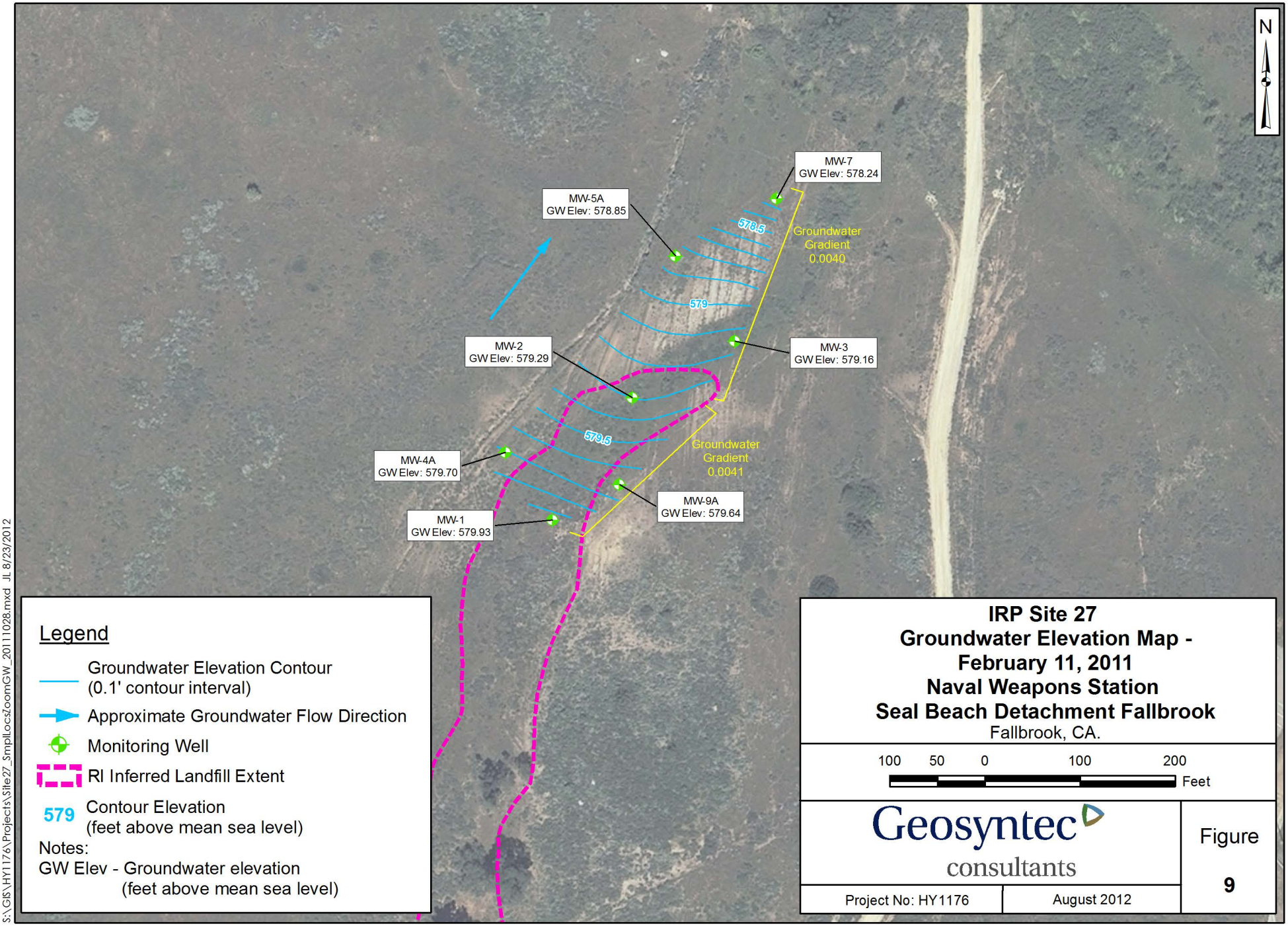
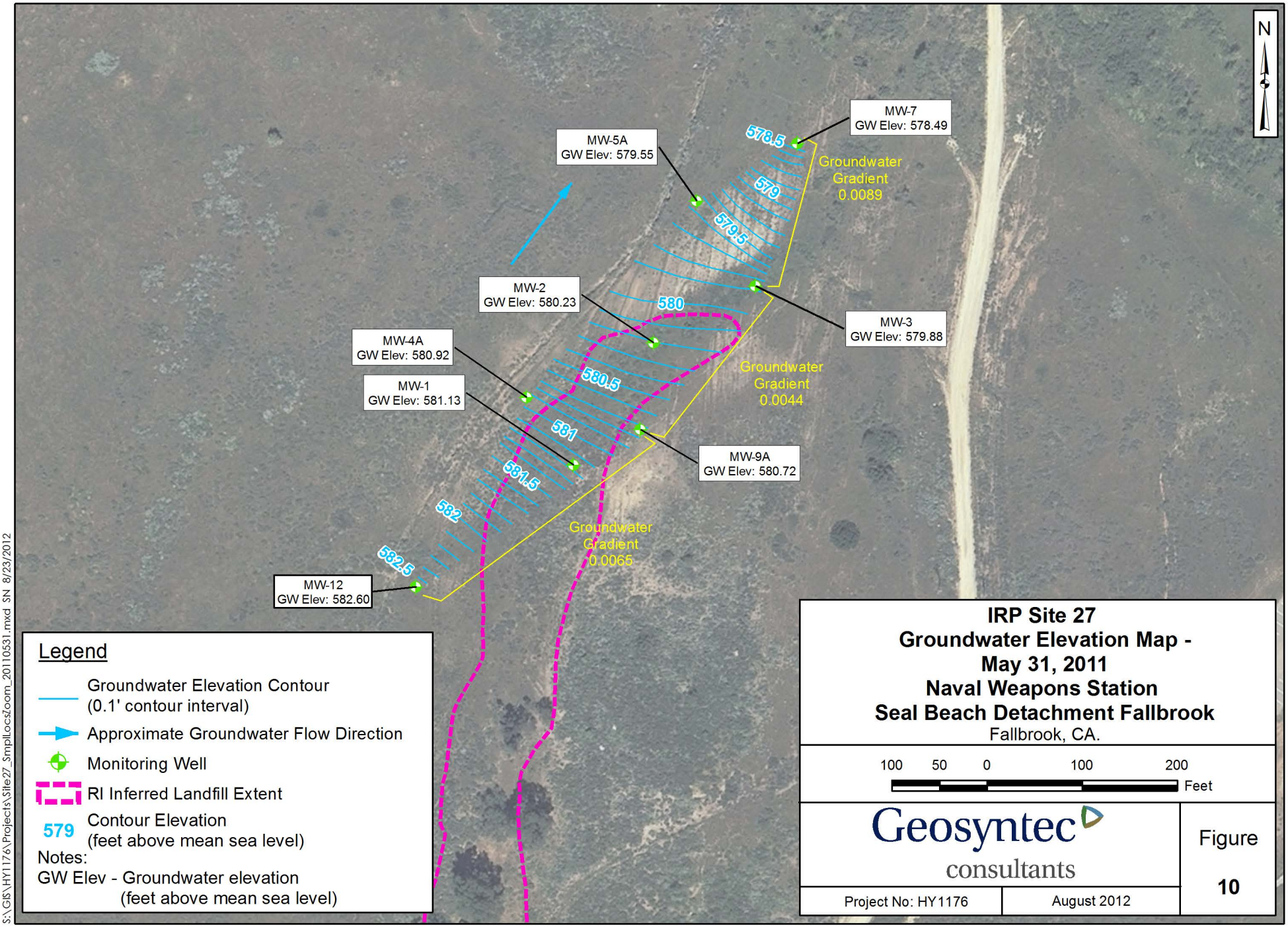
IRP Site 27
Groundwater Elevation Map - November 8, 2010
Naval Weapons Station
Seal Beach Detachment Fallbrook
Fallbrook, CA.

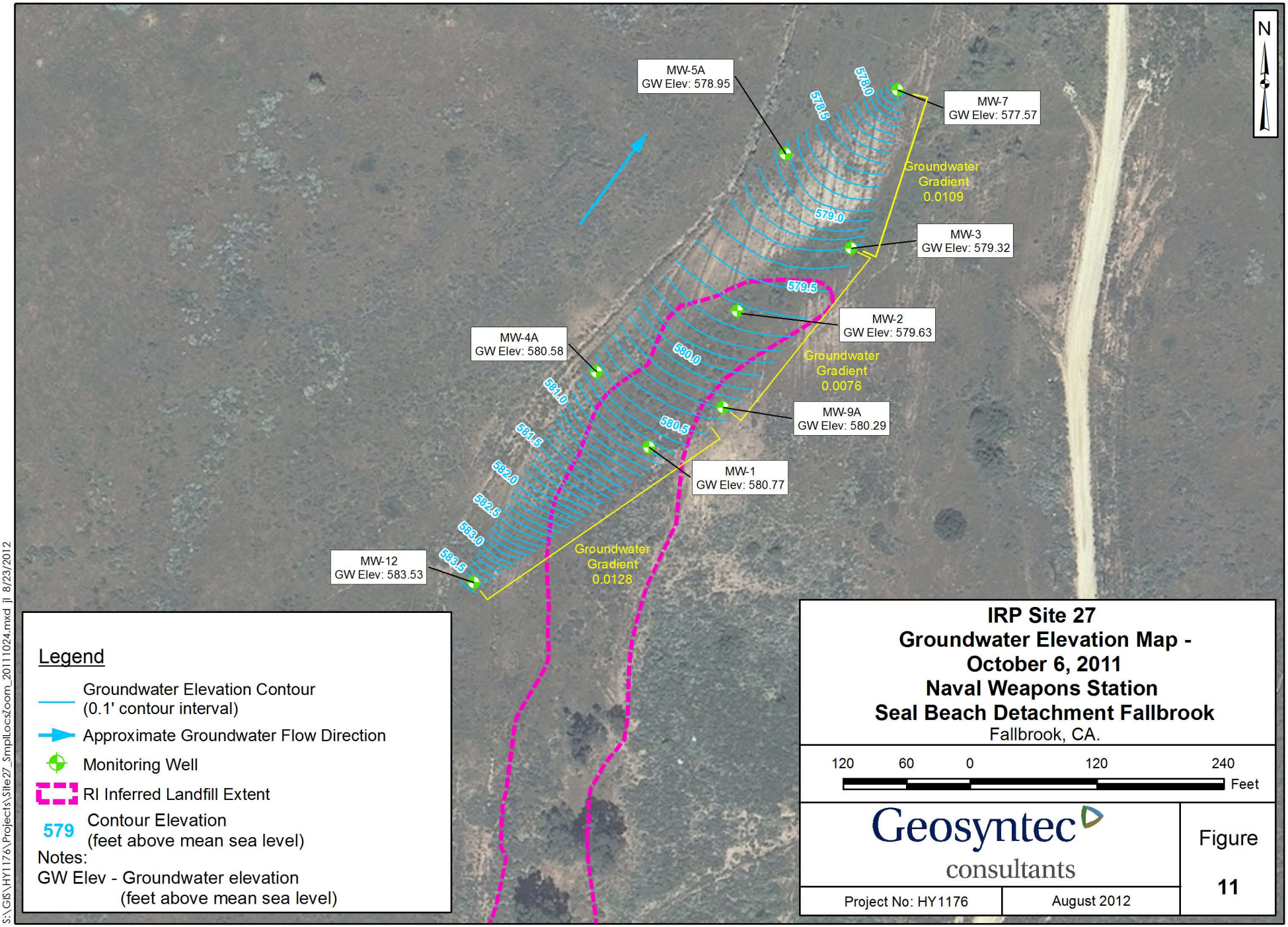


IRP Site 27
Groundwater Elevation Map -
February 11, 2011
Naval Weapons Station
Seal Beach Detachment Fallbrook
Fallbrook, CA.

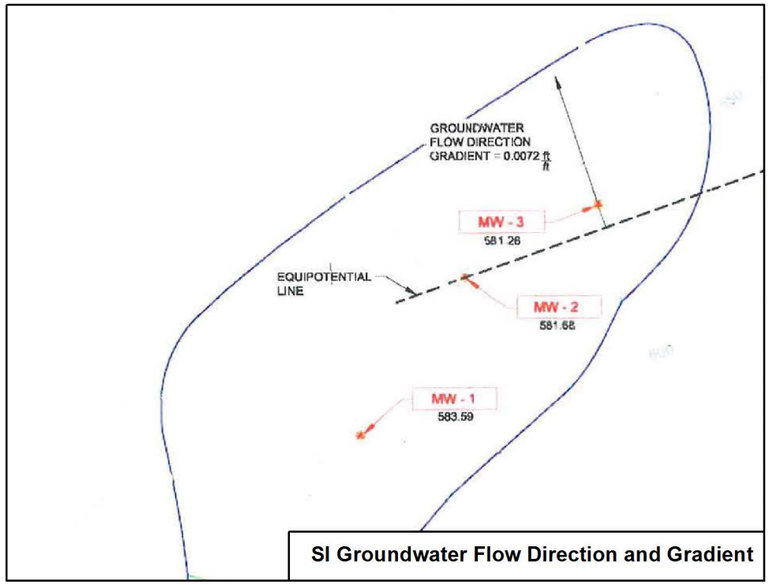
S:\GIS\HY1176\Projects\Site27_SmplLocsZoomGW_20111028.mxd JL 8/23/2012



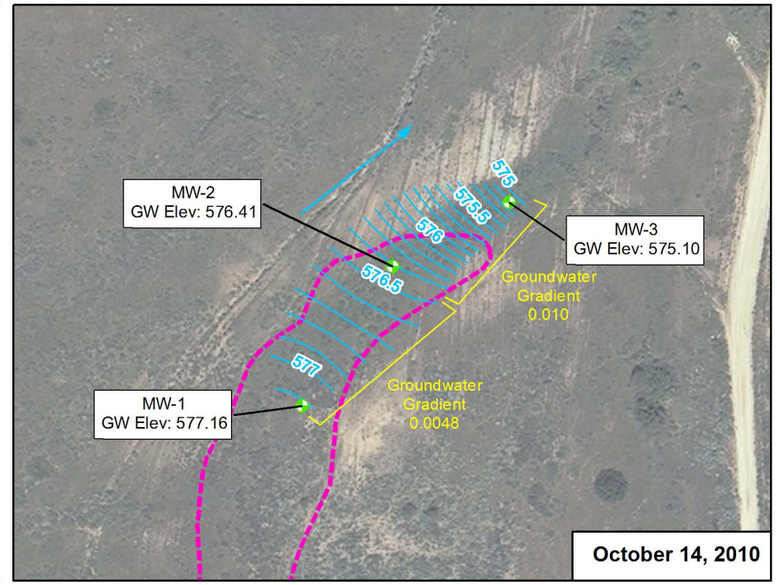
S:\GIS\HY1176\Projects\Site27_SmplLocsZoom_20110531.mxd SN 8/23/2012



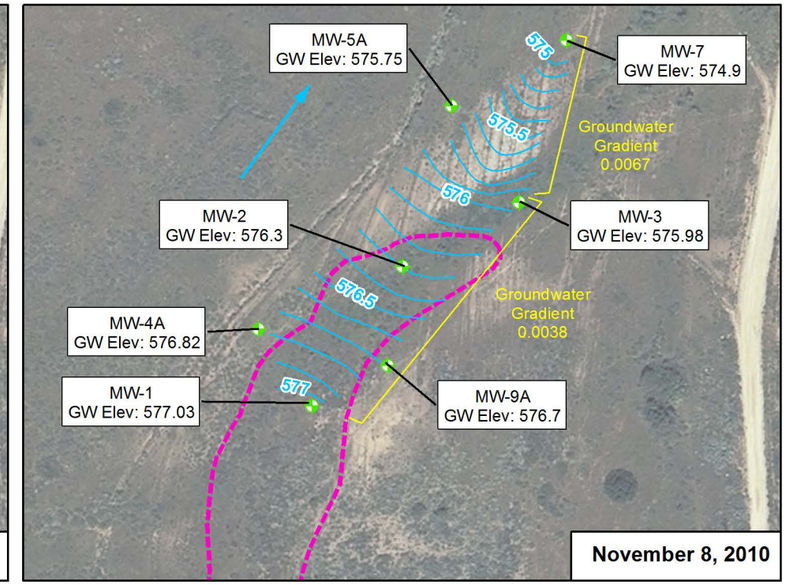
S:\GIS\HY1176\Projects\Site27_SmplLocsZoom_20111024.mxd jl 8/23/2012



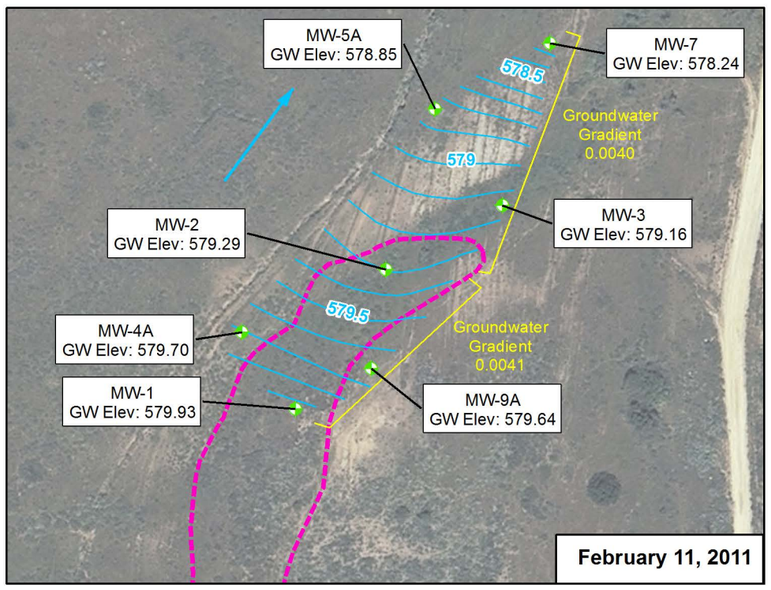
SI Groundwater Flow Direction and Gradient



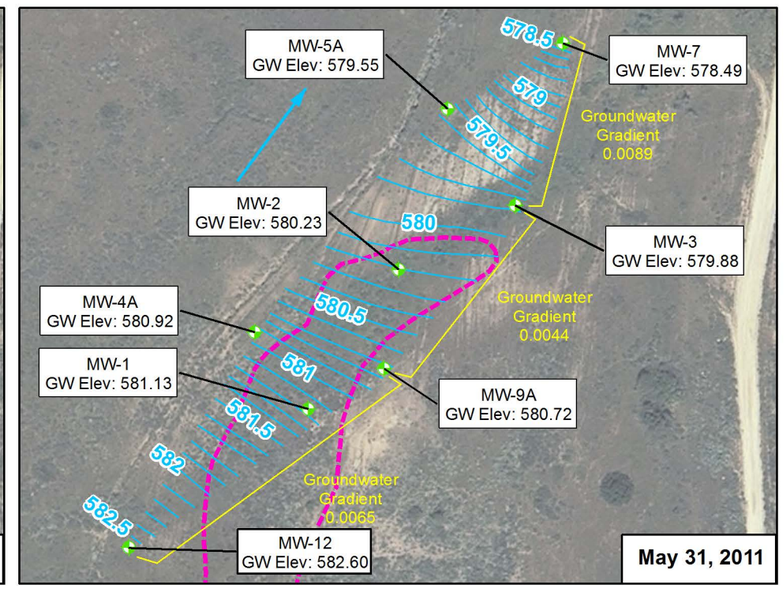
October 14, 2010



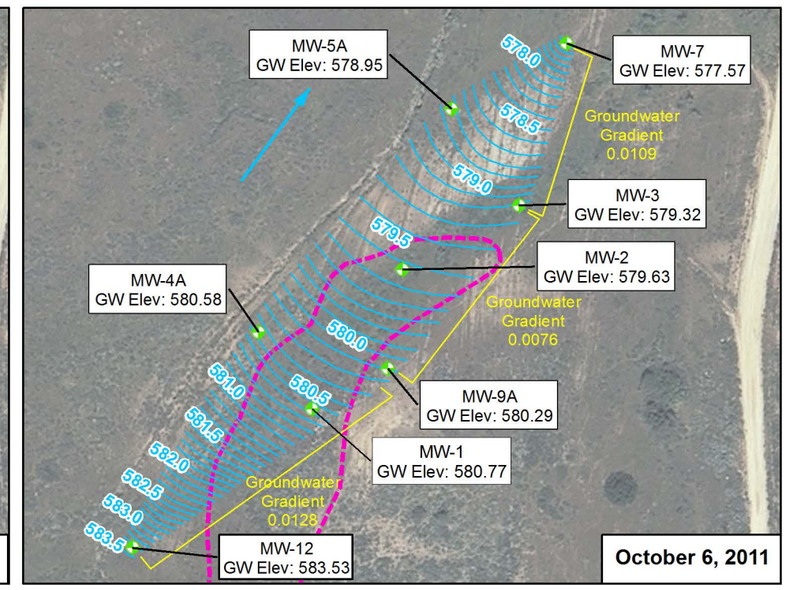
November 8, 2010



February 11, 2011



May 31, 2011



October 6, 2011

Legend

- Monitoring Well
- Groundwater Elevation Contour (0.1' contour interval)
- Approximate Groundwater Flow Direction
- RI Inferred Landfill Extent

N

Groundwater Elevations and Flow Directions - Historical to Present
Naval Weapons Station
Seal Beach Detachment Fallbrook
Fallbrook, CA.

140 70 0 140 280 Feet

Geosyntec consultants

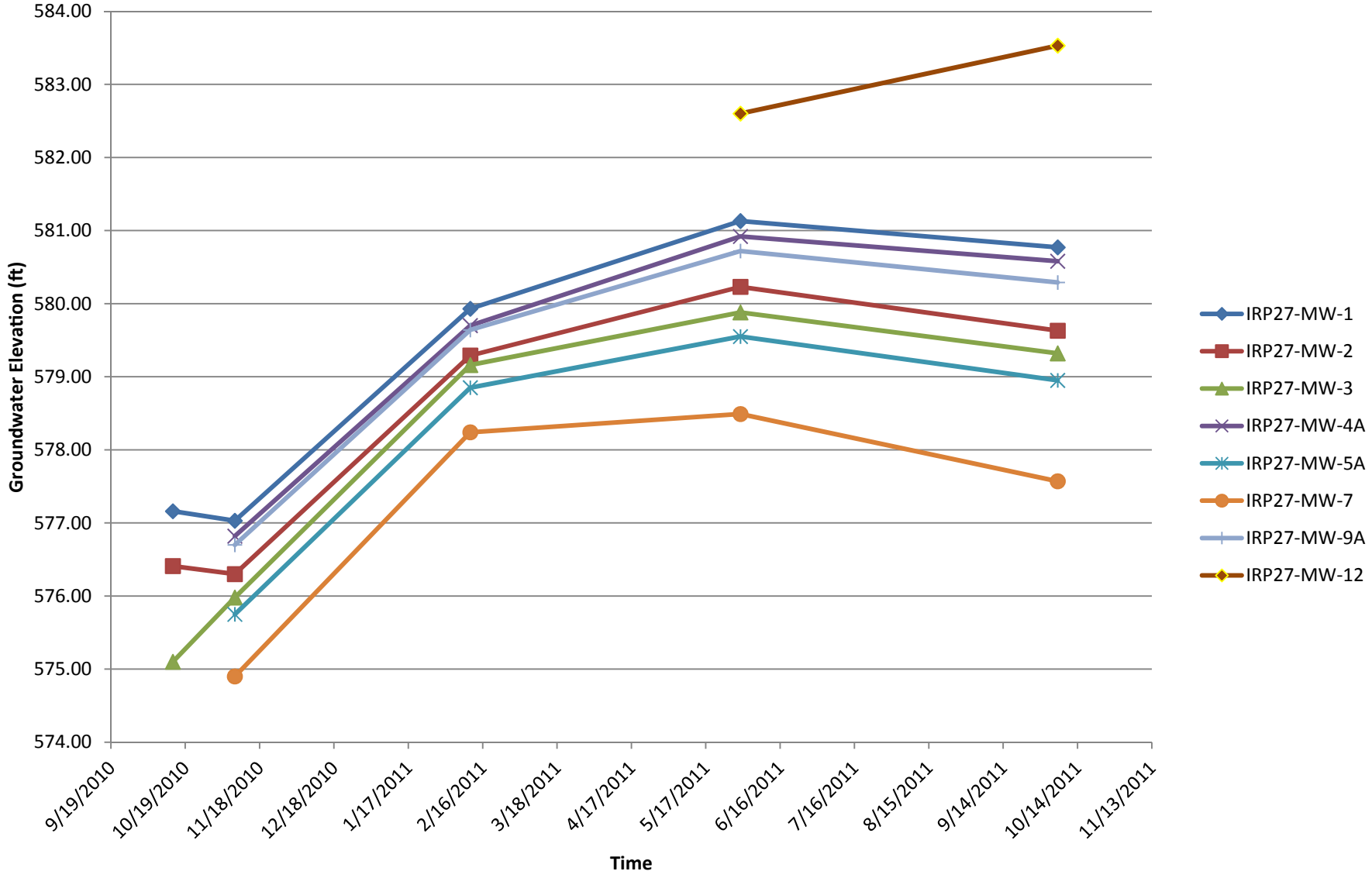
Project No: HY1176 | August 2012

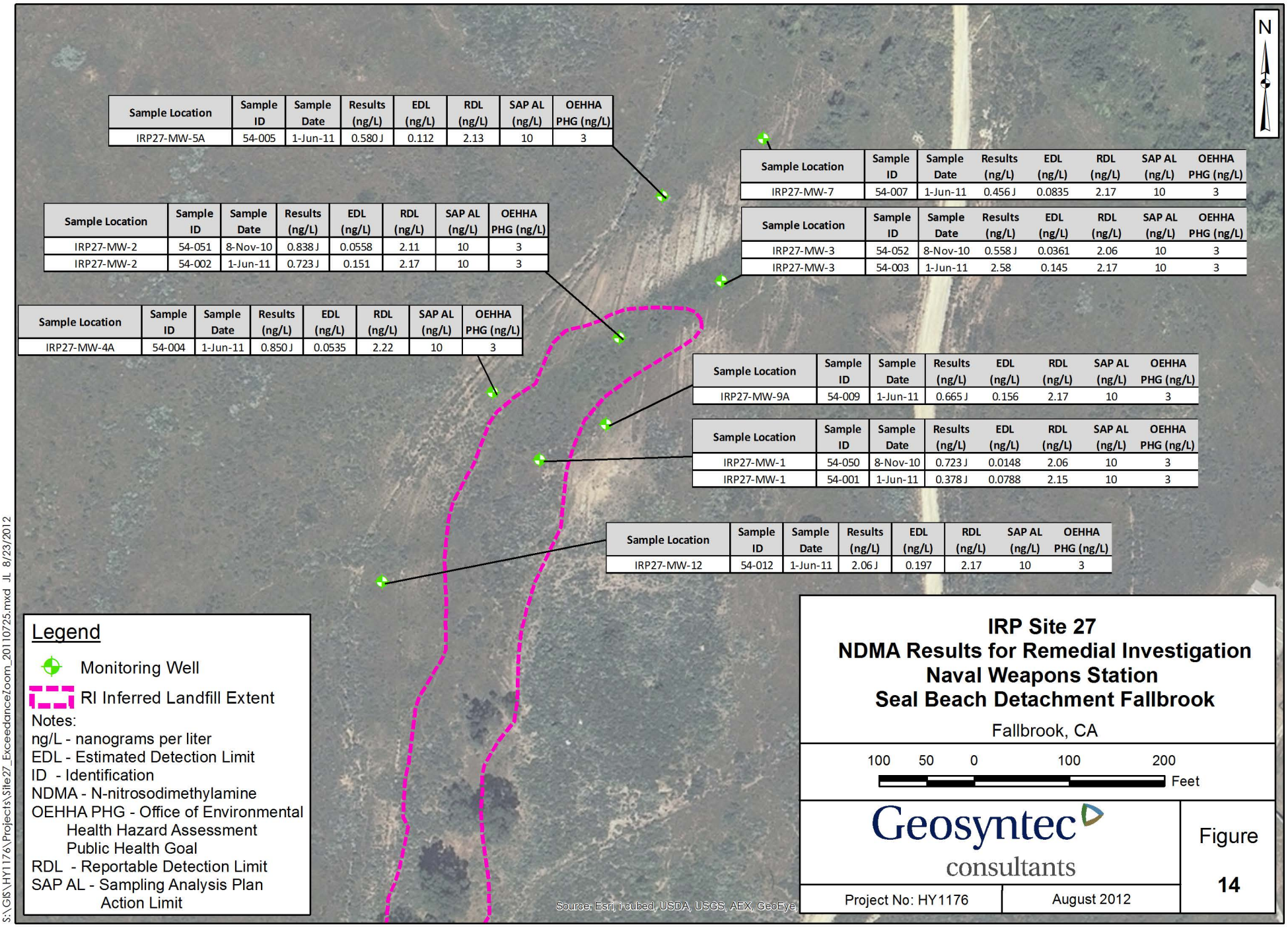
Figure 12

S:\GIS\HY1176\Projects\GW_over_time_20110926.mxd lvs 8/23/2012

Geosyntec consultants

Figure 13
Remedial Investigation Groundwater Elevation Trend





Sample Location	Sample ID	Sample Date	Results (ng/L)	EDL (ng/L)	RDL (ng/L)	SAP AL (ng/L)	OEHHA PHG (ng/L)
IRP27-MW-5A	54-005	1-Jun-11	0.580 J	0.112	2.13	10	3

Sample Location	Sample ID	Sample Date	Results (ng/L)	EDL (ng/L)	RDL (ng/L)	SAP AL (ng/L)	OEHHA PHG (ng/L)
IRP27-MW-7	54-007	1-Jun-11	0.456 J	0.0835	2.17	10	3

Sample Location	Sample ID	Sample Date	Results (ng/L)	EDL (ng/L)	RDL (ng/L)	SAP AL (ng/L)	OEHHA PHG (ng/L)
IRP27-MW-2	54-051	8-Nov-10	0.838 J	0.0558	2.11	10	3
IRP27-MW-2	54-002	1-Jun-11	0.723 J	0.151	2.17	10	3

Sample Location	Sample ID	Sample Date	Results (ng/L)	EDL (ng/L)	RDL (ng/L)	SAP AL (ng/L)	OEHHA PHG (ng/L)
IRP27-MW-3	54-052	8-Nov-10	0.558 J	0.0361	2.06	10	3
IRP27-MW-3	54-003	1-Jun-11	2.58	0.145	2.17	10	3

Sample Location	Sample ID	Sample Date	Results (ng/L)	EDL (ng/L)	RDL (ng/L)	SAP AL (ng/L)	OEHHA PHG (ng/L)
IRP27-MW-4A	54-004	1-Jun-11	0.850 J	0.0535	2.22	10	3

Sample Location	Sample ID	Sample Date	Results (ng/L)	EDL (ng/L)	RDL (ng/L)	SAP AL (ng/L)	OEHHA PHG (ng/L)
IRP27-MW-9A	54-009	1-Jun-11	0.665 J	0.156	2.17	10	3

Sample Location	Sample ID	Sample Date	Results (ng/L)	EDL (ng/L)	RDL (ng/L)	SAP AL (ng/L)	OEHHA PHG (ng/L)
IRP27-MW-1	54-050	8-Nov-10	0.723 J	0.0148	2.06	10	3
IRP27-MW-1	54-001	1-Jun-11	0.378 J	0.0788	2.15	10	3

Sample Location	Sample ID	Sample Date	Results (ng/L)	EDL (ng/L)	RDL (ng/L)	SAP AL (ng/L)	OEHHA PHG (ng/L)
IRP27-MW-12	54-012	1-Jun-11	2.06 J	0.197	2.17	10	3

Legend

Monitoring Well

RI Inferred Landfill Extent

Notes:
ng/L - nanograms per liter
EDL - Estimated Detection Limit
ID - Identification
NDMA - N-nitrosodimethylamine
OEHHA PHG - Office of Environmental Health Hazard Assessment Public Health Goal
RDL - Reportable Detection Limit
SAP AL - Sampling Analysis Plan Action Limit

IRP Site 27
NDMA Results for Remedial Investigation
Naval Weapons Station
Seal Beach Detachment Fallbrook

Fallbrook, CA

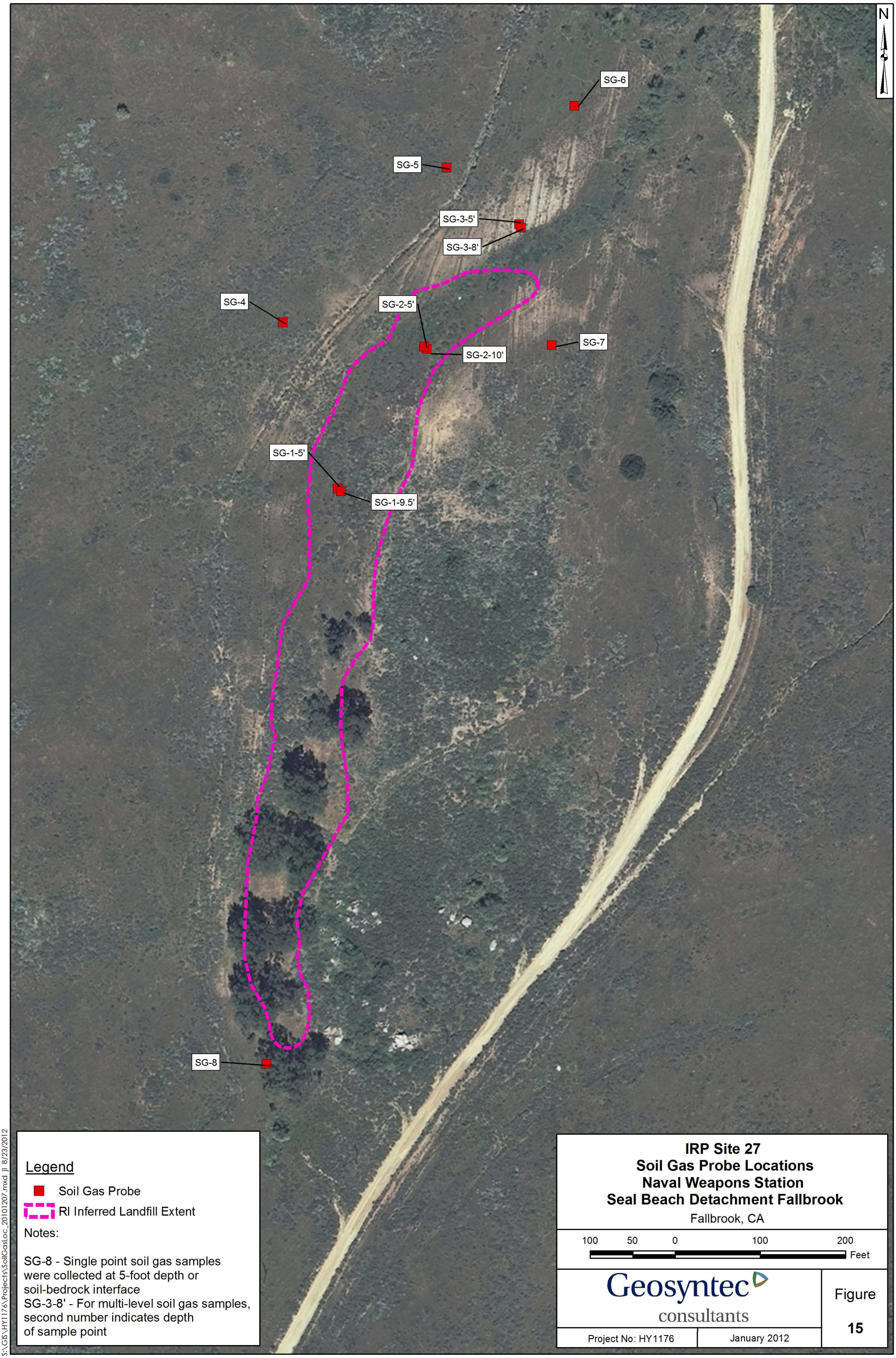
100 50 0 100 200 Feet

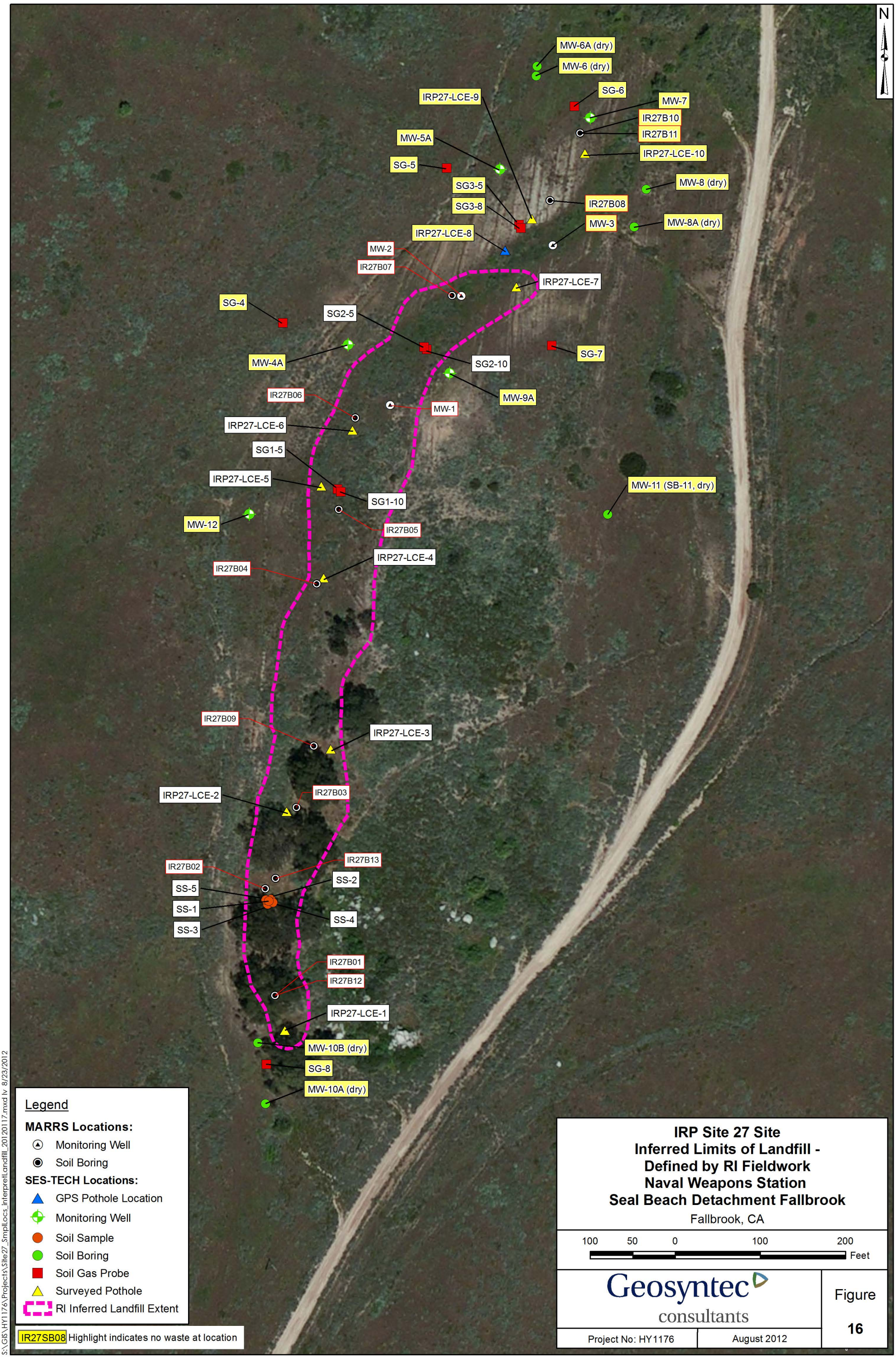
Geosyntec consultants

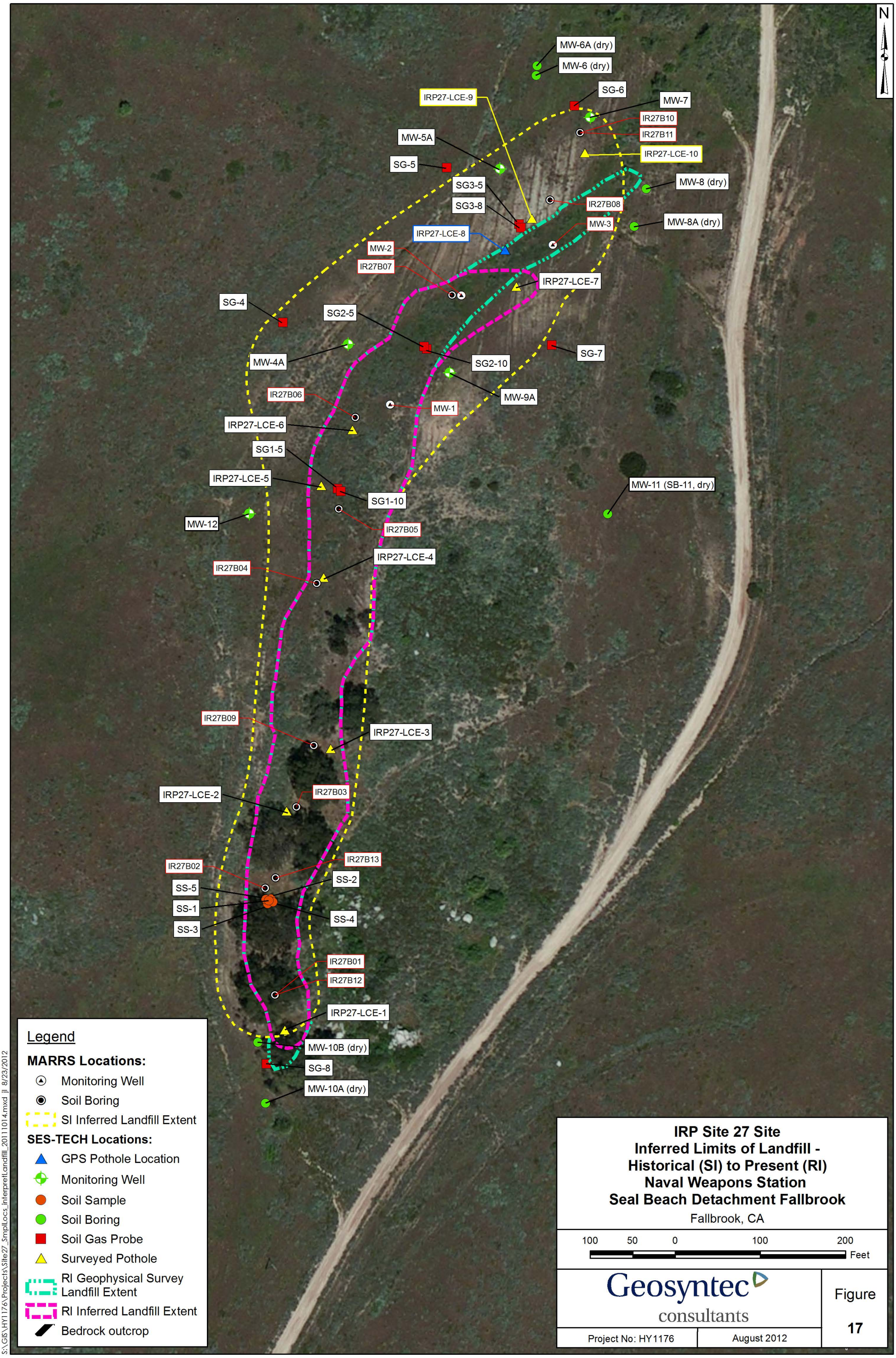
Figure 14

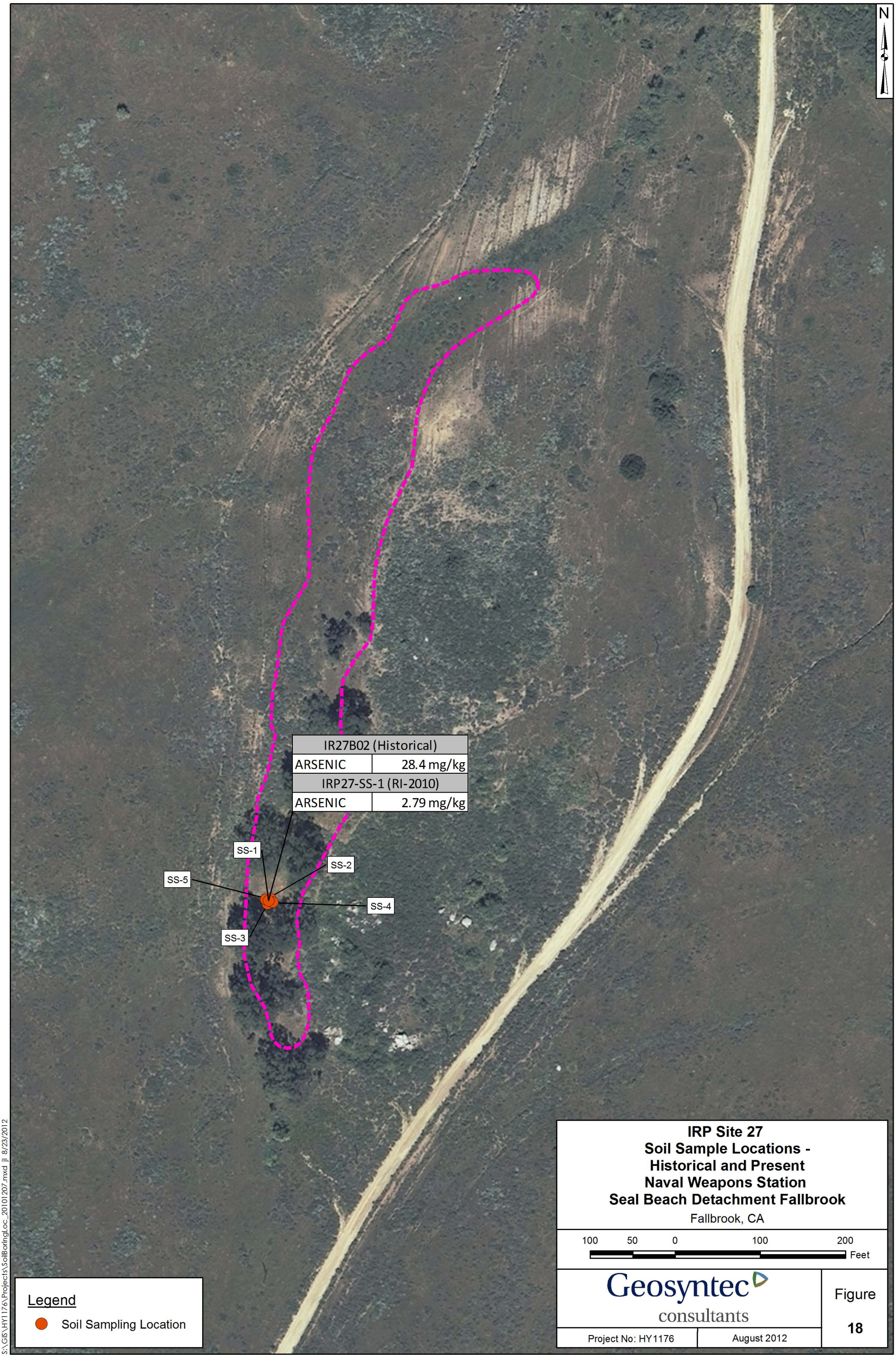
Project No: HY1176 | August 2012

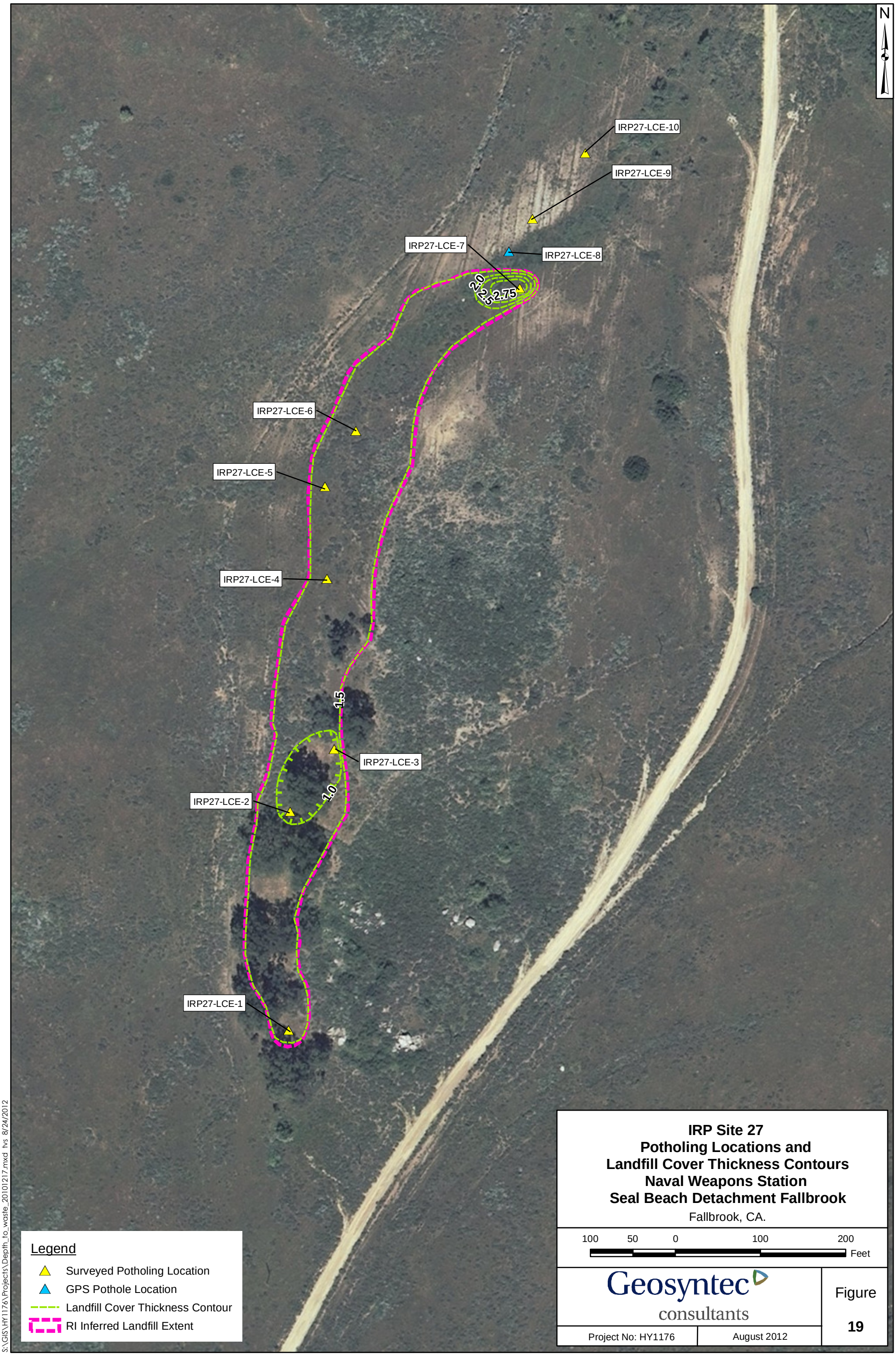
S:\GIS\HY1176\Projects\Site27_ExceedanceZoom_20110725.mxd JL 8/23/2012


N
SG-6
SG-5
SG-3-5'
SG-3-8'
SG-4
SG-2-5'
SG-2-10'
SG-7
SG-1-5'
SG-1-9.5'
SG-8
Legend
Soil Gas Probe
RI Inferred Landfill Extent
Notes:
SG-8 - Single point soil gas samples were collected at 5-foot depth or soil-bedrock interface
SG-3-8' - For multi-level soil gas samples, second number indicates depth of sample point
IRP Site 27
Soil Gas Probe Locations
Naval Weapons Station
Seal Beach Detachment Fallbrook
Fallbrook, CA
100 50 0 100 200
Feet
Geosyntec consultants
Figure
15
Project No: HY1176
January 2012
S:\GIS\HY1176\Projects\SoilGasLoc_20101207.mxd jl 8/23/2012


N
MW-6A (dry)
MW-6 (dry)
SG-6
MW-7
IR27B10
IR27B11
IRP27-LCE-10
IRP27-LCE-9
MW-5A
SG-5
SG3-5
SG3-8
MW-8 (dry)
IR27B08
MW-3
MW-8A (dry)
IRP27-LCE-8
MW-2
IR27B07
IRP27-LCE-7
SG-4
SG2-5
SG-7
MW-4A
SG2-10
MW-9A
IR27B06
MW-1
IRP27-LCE-6
SG1-5
IRP27-LCE-5
SG1-10
MW-11 (SB-11, dry)
MW-12
IR27B05
IRP27-LCE-4
IR27B04
IR27B09
IRP27-LCE-3
IRP27-LCE-2
IR27B03
IR27B02
IR27B13
SS-2
SS-5
SS-1
SS-4
SS-3
IR27B01
IR27B12
IRP27-LCE-1
MW-10B (dry)
SG-8
MW-10A (dry)
Legend
MARRS Locations:
Monitoring Well
Soil Boring
SES-TECH Locations:
GPS Pothole Location
Monitoring Well
Soil Sample
Soil Boring
Soil Gas Probe
Surveyed Pothole
RI Inferred Landfill Extent
IR27SB08 Highlight indicates no waste at location
IRP Site 27 Site
Inferred Limits of Landfill -
Defined by RI Fieldwork
Naval Weapons Station
Seal Beach Detachment Fallbrook
Fallbrook, CA
100 50 0 100 200
Feet
Geosyntec consultants
Figure
16
Project No: HY1176
August 2012
S:\GIS\HY1176\Projects\Site27_SmplLocs_InterpretLandfill_20120117.mxd lv 8/23/2012

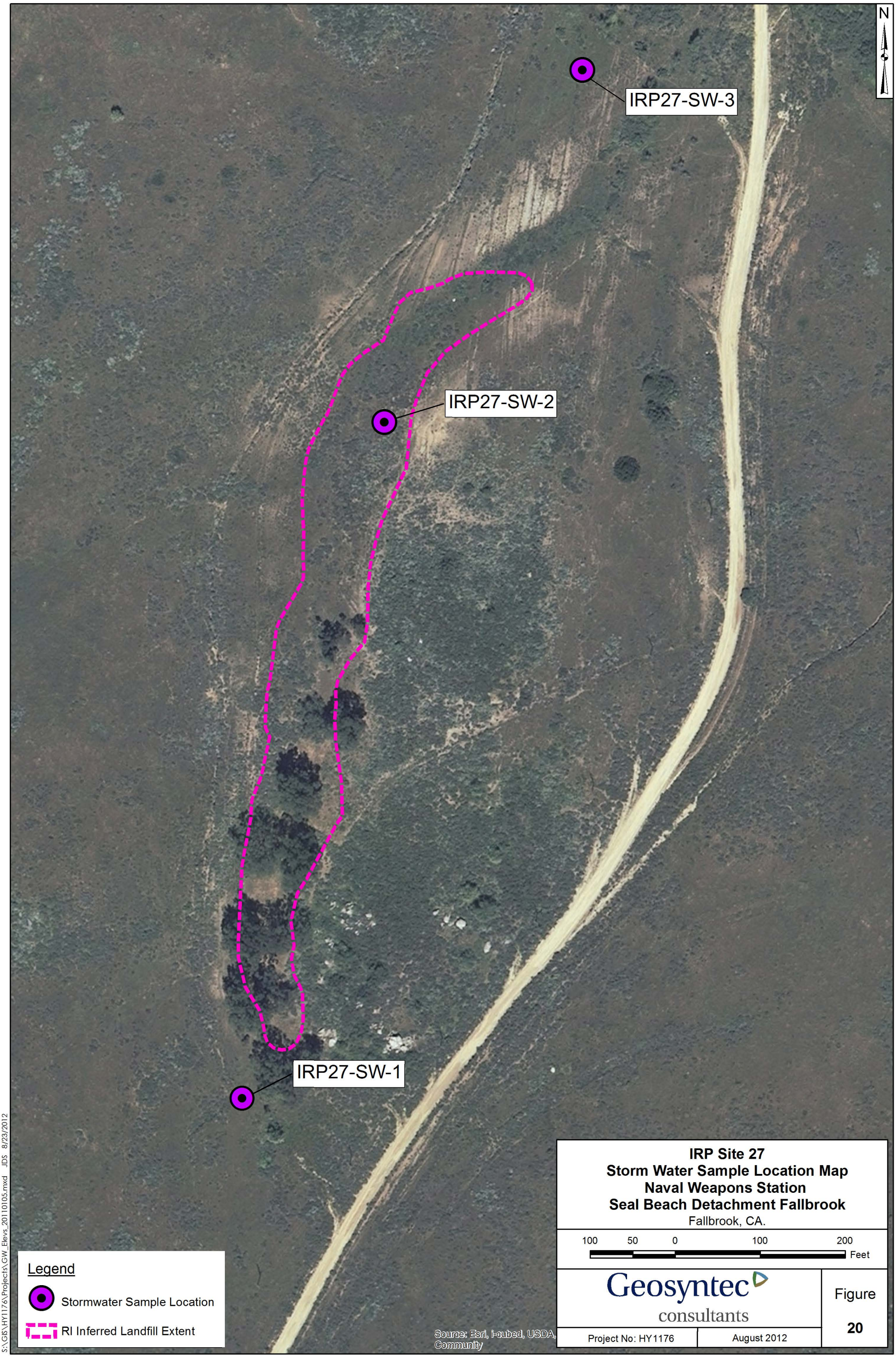

N
MW-6A (dry)
MW-6 (dry)
SG-6
MW-7
IRP27-LCE-9
IR27B10
IR27B11
MW-5A
IRP27-LCE-10
SG-5
MW-8 (dry)
SG3-5
SG3-8
IR27B08
MW-3
MW-8A (dry)
IRP27-LCE-8
MW-2
IR27B07
IRP27-LCE-7
SG-4
SG2-5
SG-7
MW-4A
SG2-10
MW-9A
IR27B06
MW-1
IRP27-LCE-6
SG1-5
IRP27-LCE-5
SG1-10
MW-11 (SB-11, dry)
MW-12
IR27B05
IRP27-LCE-4
IR27B04
IR27B09
IRP27-LCE-3
IRP27-LCE-2
IR27B03
IR27B02
IR27B13
SS-2
SS-5
SS-1
SS-4
SS-3
IR27B01
IR27B12
IRP27-LCE-1
MW-10B (dry)
SG-8
MW-10A (dry)
Legend
MARRS Locations:
Monitoring Well
Soil Boring
SI Inferred Landfill Extent
SES-TECH Locations:
GPS Pothole Location
Monitoring Well
Soil Sample
Soil Boring
Soil Gas Probe
Surveyed Pothole
RI Geophysical Survey Landfill Extent
RI Inferred Landfill Extent
Bedrock outcrop
IRP Site 27 Site
Inferred Limits of Landfill -
Historical (SI) to Present (RI)
Naval Weapons Station
Seal Beach Detachment Fallbrook
Fallbrook, CA
100 50 0 100 200
Feet
Geosyntec consultants
Figure
17
Project No: HY1176
August 2012
S:\GIS\HY1176\Projects\Site27_SmplLocs_InterpretLandfill_20111014.mxd jl 8/23/2012

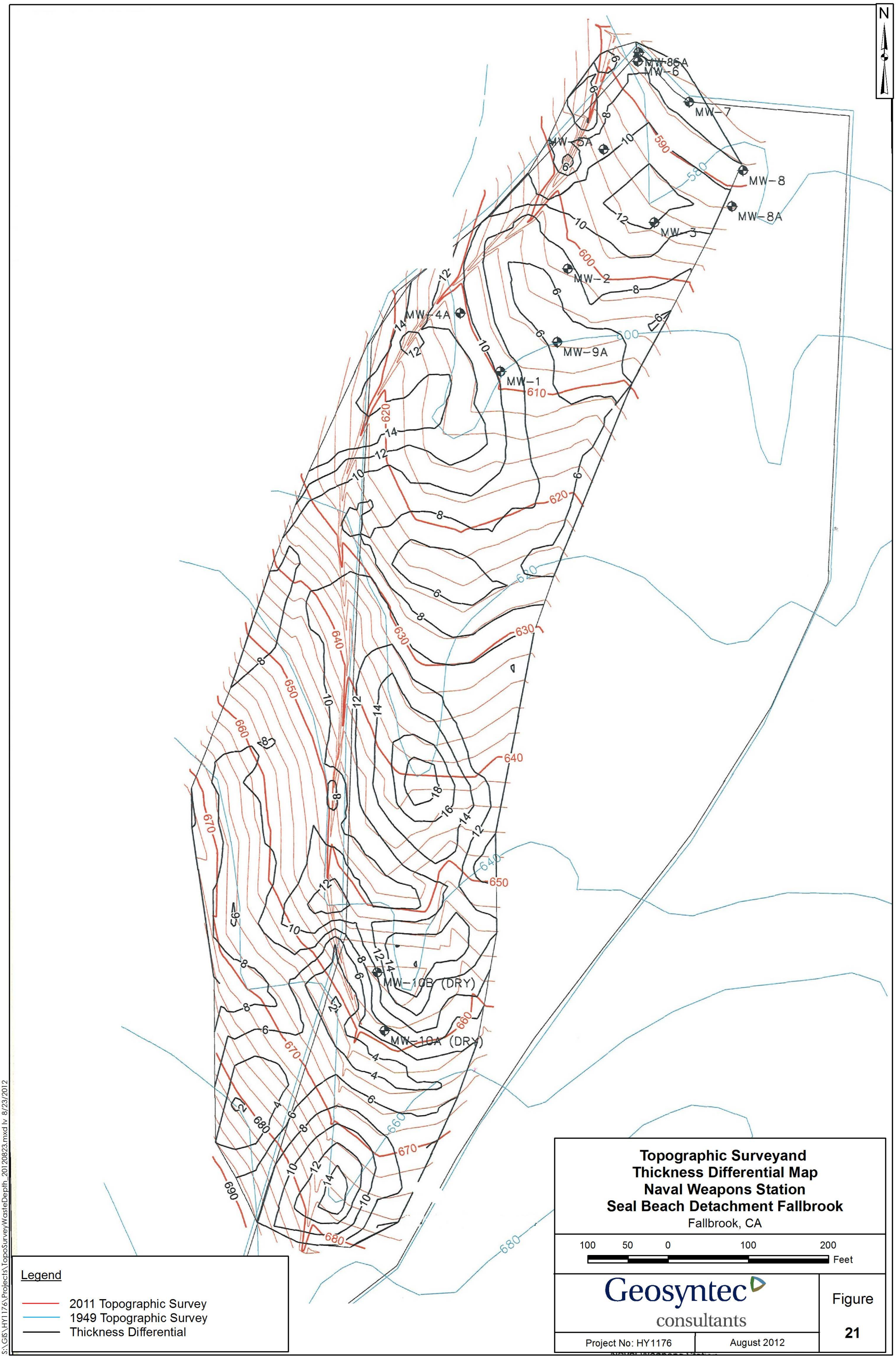

N
IR27B02 (Historical)
ARSENIC 28.4 mg/kg
IRP27-SS-1 (RI-2010)
ARSENIC 2.79 mg/kg
SS-1
SS-2
SS-3
SS-4
SS-5
Legend
Soil Sampling Location
IRP Site 27
Soil Sample Locations -
Historical and Present
Naval Weapons Station
Seal Beach Detachment Fallbrook
Fallbrook, CA
100 50 0 100 200
Feet
Geosyntec consultants
Figure
18
Project No: HY1176
August 2012
S:\GIS\HY1176\Projects\SoilBoringLoc_20101207.mxd jl 8/23/2012

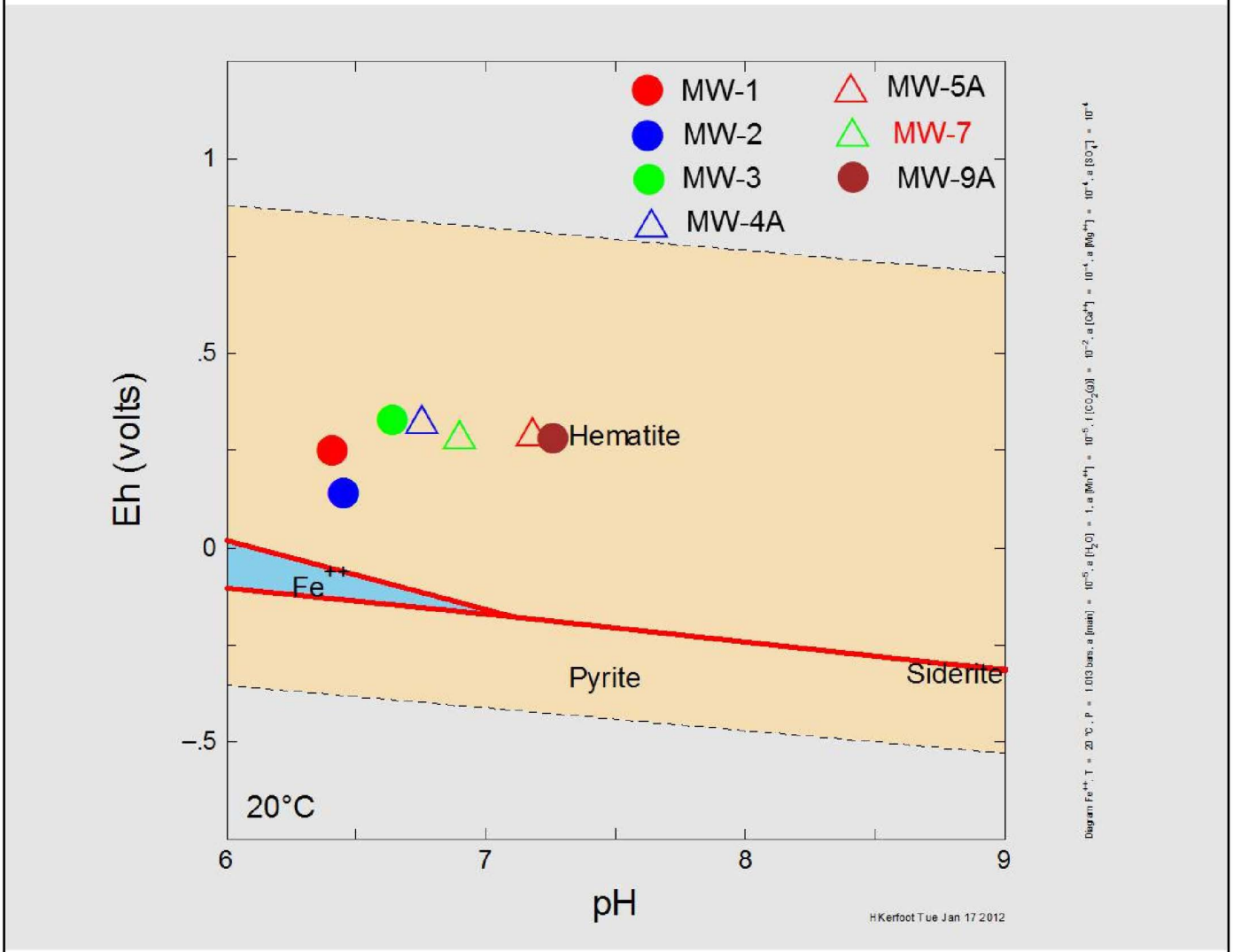


IRP Site 27
Potholing Locations and
Landfill Cover Thickness Contours
Naval Weapons Station
Seal Beach Detachment Fallbrook
Fallbrook, CA.

S:\GIS\HY1176\Projects\Depth_to_waste_20101217.mxd tvs 8/24/2012


N
IRP27-SW-3
IRP27-SW-2
IRP27-SW-1
Legend
Stormwater Sample Location
RI Inferred Landfill Extent
Source: Esri, i-cubed, USDA, Community
IRP Site 27
Storm Water Sample Location Map
Naval Weapons Station
Seal Beach Detachment Fallbrook
Fallbrook, CA.
100 50 0 100 200
Feet
Geosyntec consultants
Figure
20
Project No: HY1176
August 2012
S:\GIS\HY1176\Projects\GW_Elevs_20110105.mxd JDS 8/23/2012


N
MW-6A
MW-6
MW-7
MW-5A
MW-8
MW-8A
MW-3
MW-2
MW-4A
MW-9A
MW-1
MW-10B (DRY)
MW-10A (DRY)
Legend
2011 Topographic Survey
1949 Topographic Survey
Thickness Differential
Topographic Surveyand
Thickness Differential Map
Naval Weapons Station
Seal Beach Detachment Fallbrook
Fallbrook, CA
100 50 0 100 200
Feet
Geosyntec consultants
Figure
21
Project No: HY1176
August 2012
S:\GIS\HY1176\Projects\TopoSurveyWasteDepth_20120823.mxd lv 8/23/2012



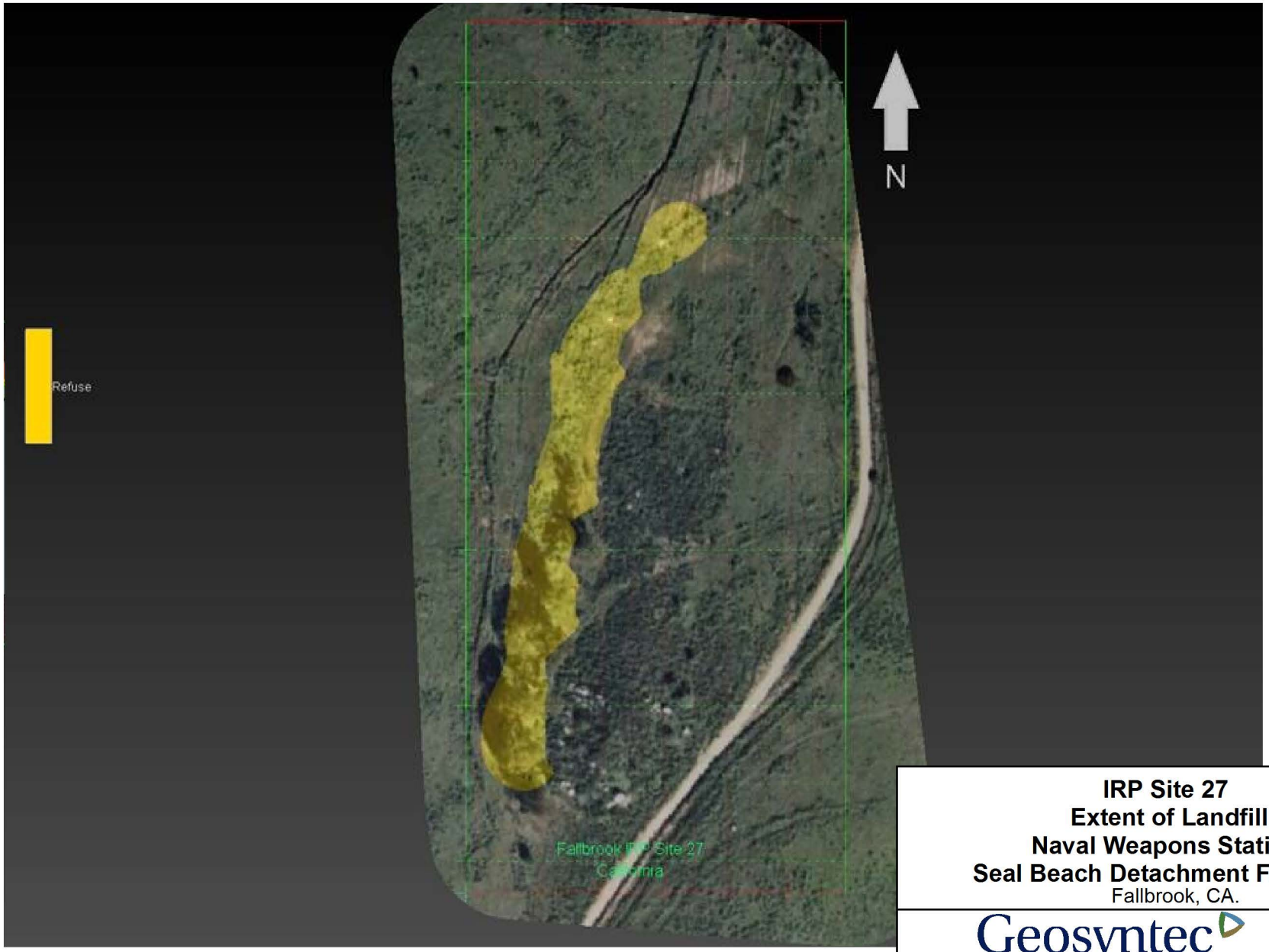
Oxidation-Reduction Potential and pH Diagram for Iron (Fe)
Naval Weapons Station
Seal Beach Detachment Fallbrook
Fallbrook, CA

Geosyntec consultants

Figure **22**

Project No: HY1176 | August 2012

S:\GIS\HY1176\Projects\OxidationReductionFe.mxd tvs 8/23/2012



Not to Scale

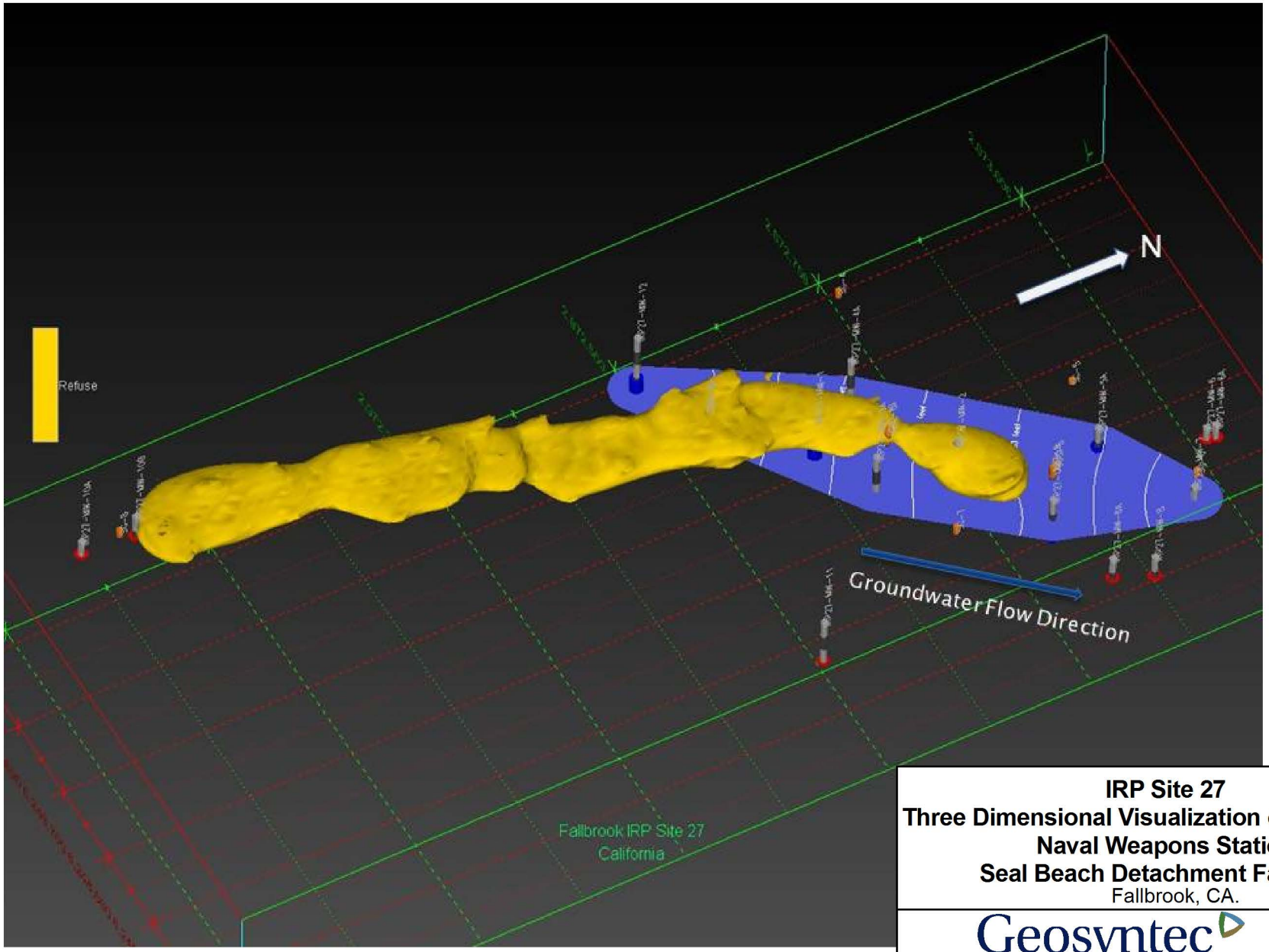
IRP Site 27
Extent of Landfill
Naval Weapons Station
Seal Beach Detachment Fallbrook
Fallbrook, CA.

Geosyntec consultants

Figure **23**

Project No: HY1176 | August 2012

S:\GIS\HY1176\Projects\Extent of Landfill.mxd jl 8/23/2012



Not to Scale

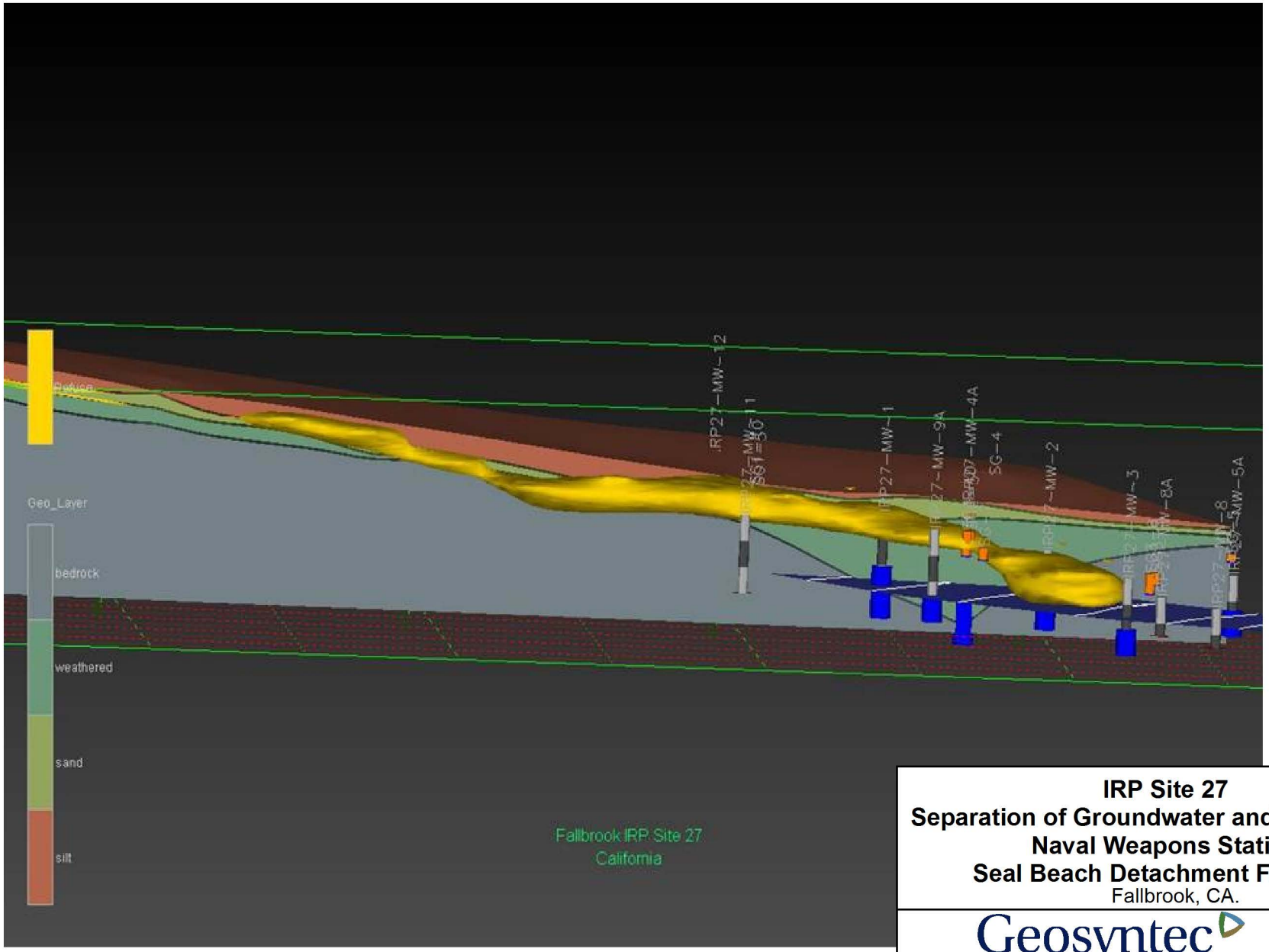
IRP Site 27
Three Dimensional Visualization of Waste Prism
Naval Weapons Station
Seal Beach Detachment Fallbrook
Fallbrook, CA.

Geosyntec consultants

Figure **24**

Project No: HY1176 | August 2012

S:\GIS\HY1176\Projects\3DWastePrism.mxd jl 8/23/2012



Not to Scale

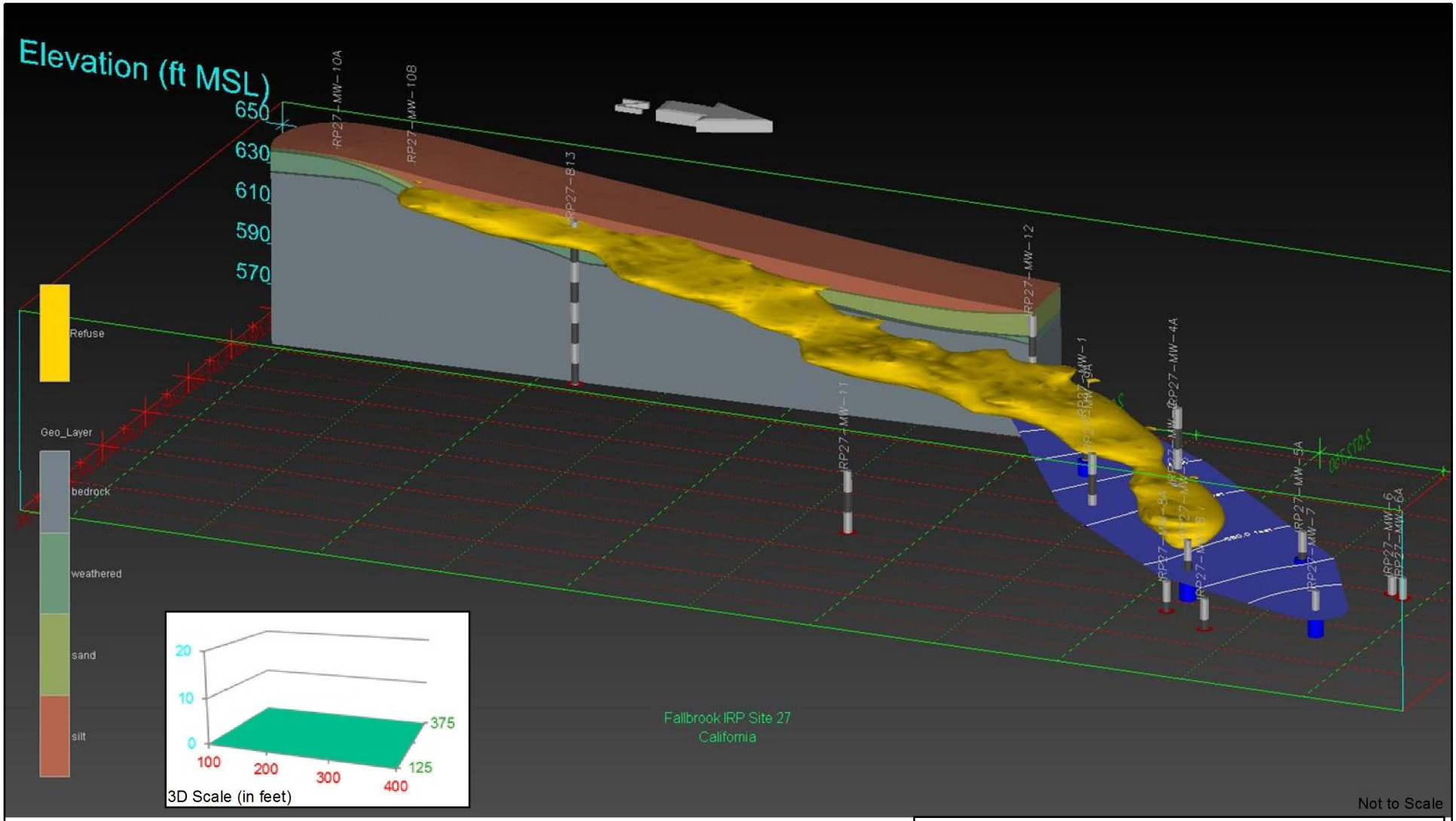
IRP Site 27
Separation of Groundwater and Waste Prism
Naval Weapons Station
Seal Beach Detachment Fallbrook
Fallbrook, CA.

Geosyntec consultants

Project No: HY1176 | August 2012

Figure **25**

S:\GIS\HY1176\Projects\3DWasteSepartaion.mxd jl 8/23/2012



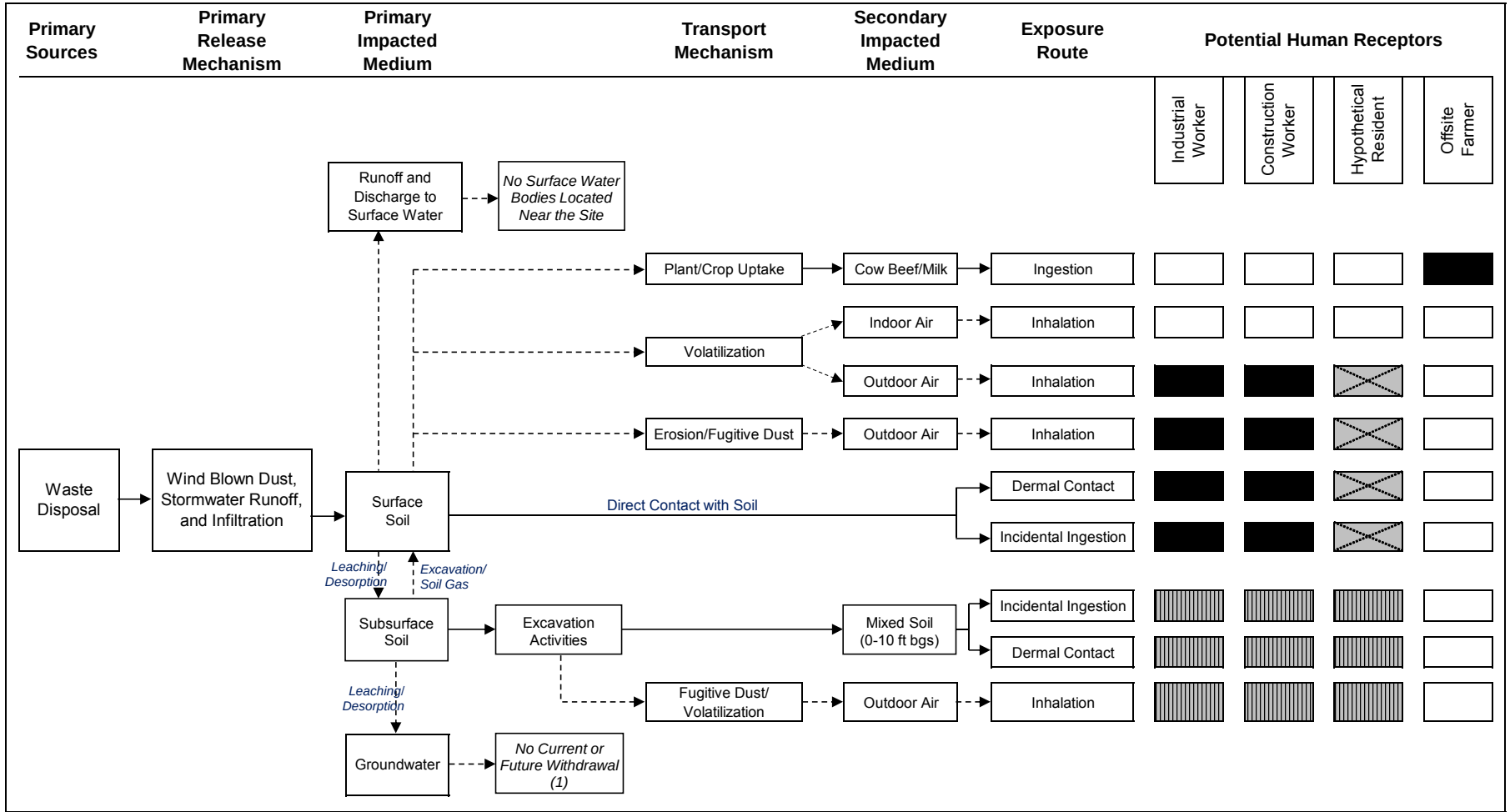
IRP Site 27
Three Dimensional Conceptual Site Model (CSM)
Naval Weapons Station
Seal Beach Detachment Fallbrook
Fallbrook, CA.

Geosyntec consultants

Figure **26**

Project No: HY1176 | August 2012

S:\GIS\HY1176\Projects\3D_CSM.mxd tvs 8/23/2012



NOTES:

(1) Groundwater is approximately 65 feet below ground surface

Potential Migration Pathway

Release/Transport Minimized

Complete or Potentially Complete Exposure Pathway

Complete or Potentially Complete Exposure Pathway only if Current Land Use Changes

Exposure Pathway Evaluated Solely to Address Unrestricted Land Use

Not Complete Exposure Pathway

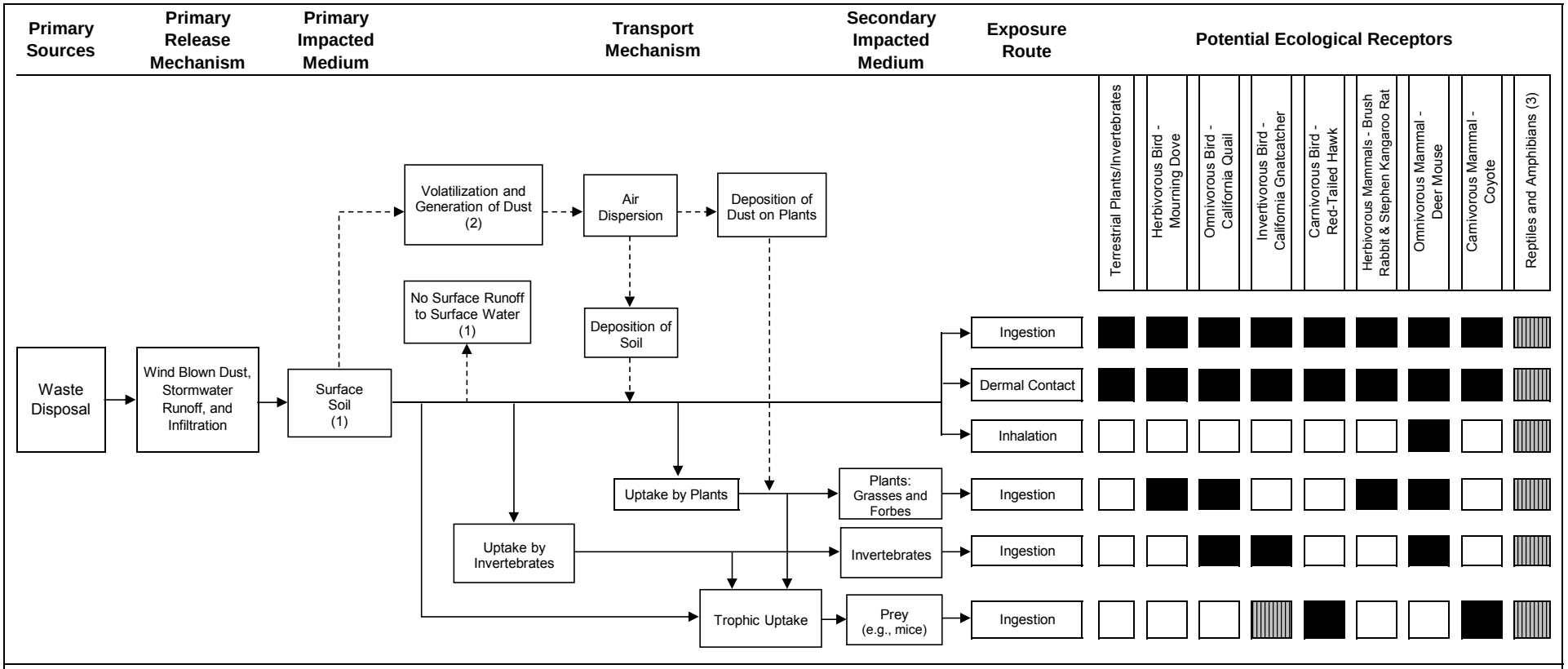
HUMAN HEALTH CONCEPTUAL SITE MODEL

Naval Weapons Station Seal Beach Detachment
Fallbrook, California

Geosyntec consultants

January 2012

Figure 27



NOTES:

→ Potential Migration Pathway

- - - → Release/Transport Minimized

(1) Flat terrain and vegetation minimize surface runoff. Surface water not associated with this Site.

(2) Grass, other vegetation, and impermeable surfaces inhibit dust generation.

(3) Reptiles and amphibians are represented in the food-web; however, toxicological information is unavailable.

■ Complete or Potentially Complete Exposure Pathway

▨ Complete or Potentially Complete Exposure Pathway but is likely to be insignificant

□ Not Complete Exposure Pathway

ECOLOGICAL CONCEPTUAL SITE MODEL
Naval Weapons Station Seal Beach Detachment
Fallbrook, California

Geosyntec consultants

August 2012

Figure 28

APPENDIX A

REGIONAL WATER QUALITY CONTROL BOARD (RWQCB) SAN DIEGO, SI REVIEW LETTER, JULY 3, 2008

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Linda S. Adams
Secretary for Environmental Protection

California Regional Water Quality Control Board

San Diego Region

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July 3, 2008

Ms. Pei-Fen Tamashiro, IR Coordinator
Department of the Navy
Naval Weapons Station Seal Beach
800 Seal Beach Boulevard
Seal Beach, CA 90740-5000

Dear Ms. Tamashiro:

SUBJECT: RESPONSE TO COMMENTS ON DRAFT SITE INSPECTION REPORT INSTALLATION RESTORATION PROGRAM (IRP) SITE 27, NAVAL WEAPONS STATION SEAL BEACH DETACHMENT FALLBROOK, CALIFORNIA (5090 Ser N45W/0014)

The California Regional Water Quality Control Board, San Diego Region (Regional Board) received via email the referenced response to comments letter (RTC) on June 17, 2008. This RTC addresses the Regional Board comments, provided in our letter dated February 14, 2008, concerning the referenced Site Inspection Report (dated November 15, 2007). The Regional Board considered a number of factors in preparing this response to the Navy's RTC:

a. The Site Inspection Report (containing a site investigation) contains an incomplete site conceptual model, with respect to the presence and/or distribution of soil gas in the subsurface and the ground water flow directions/gradients within the fractured bed rock layer underlying the site;
b. Designated beneficial uses of ground water and the critical location of the site; and
c. The significantly elevated concentrations of metals [e.g. aluminum concentrations ranging from 1,380 to 6,250 micrograms per liter (µg/L), iron concentrations from 1,670 to 7,900 µg/L, and manganese concentrations up to 2,070 µg/L; whereas Maximum Contaminant Levels (MCLs) for aluminum, iron, and manganese are 200, 300, and 50 µg/L, respectively[1]] detected in ground water.

CONCLUSIONS

Based upon the concerns and comments expressed in this letter, the Regional Board makes the following conclusions:

[1] CCR Title 22, §64431 and Water Quality Control Plan – San Diego Basin (1994).

1) It is not appropriate to make a determination of no further action (NFA) for the subject site at this time.
2) The Navy should perform a site-specific investigation of soil/landfill gas as soon as practicable.
3) The Navy should investigate of the thickness and integrity of the existing landfill cover. The Navy should develop a Storm Water Pollution Prevention Plan[2] (SWPPP), and implement best management practices (BMPs), to help minimize the effects of erosion upon the landfill cover and protect storm water discharges from pollution by landfill related waste constituents.
4) The Navy should prepare and implement an appropriate post-closure maintenance program for the landfill (pursuant to attached Order 97-11 and addenda 1 to 3)[3] cover at this site, and
5) The Navy should develop and implement an appropriate detection ground water monitoring program (pursuant to either California Code of Regulations Title 27, §20415 – General Water Quality Monitoring and System Requirements, §20420- Detection Monitoring Program, §20425 – Evaluation Monitoring Program, and/or §20430- Corrective Action Program) for Site 27 (Eucalyptus Landfill). The Regional Board requires the Navy to implement water quality monitoring programs at the Eucalyptus landfill (a closed/inactive landfill) under authority of the California Water Code and pursuant to State requirements in CCR Title 27, §20080(g).

As an alternative to above required programs number 3, 4, and 5 above, the Regional Board suggests that the Navy consider implementing "clean-closure" of the site (see State requirements for clean closure in CCR Title 27 §21090(f)). Detailed discussion with respect to the rationale for the Regional Board's above listed decisions/requirements, suggestion, and specific criteria are discussed in the following section:

GENERAL COMMENTS

No further action (NFA) is not appropriate

The Regional Board does not agree with a determination of no further action for Site 27 because of the following:

- **Incomplete Site Conceptual Model**

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[2] SWPPP are required for closed and inactive landfills pursuant to SWRCB Industrial Storm Water General Permit No. 97-03-DWQ, NPDES General Permit No. CAS000001, and WDR Order No. 97-11, Addendum No. 1.

[3] General Waste Discharge Requirements for Post-closure Maintenance of Inactive Landfills Containing Nonhazardous Wastes within the San Diego Region (1997), complete addenda include addendum No. 1 to 5 and are available on line at http://www.waterboards.ca.gov/sandiego/board_decisions/adopted_orders/orders1990s.shtml

- **Remaining uncertainties of site hydrogeology**
  The subject landfill facility is located above fractured bedrock aquifer[4] where ground water flows are likely controlled by the fractures in the bedrock. Groundwater flow in the southern area of Site 27 is not adequately characterized as monitoring wells were not installed and ground water sample were not collected from this portion of the site, data are not available to evaluate the ground water flow directions/gradients, or water quality within the fractured bed rock aquifer. Additionally, an analysis of fracture orientation is required to provide basic information to evaluate the attitude(s) and characteristics of the water-bearing fractures (e.g., orientation, density, etc.) to allow more effective placement/installation of monitoring wells along the ground water flow path downgradient of the landfill facility. The Site Inspection Report does not contain an evaluation of the potential threat from polluted ground water migrating offsite along preferential fracture pathways. In order to adequately characterize the site hydrogeology and evaluate ground water quality, monitoring wells with screened interval open to the water-bearing zone within the fractured bed rock layer should be installed at the site. Detailed requirements for ground water monitoring program will be discussed later.

- **Lack of landfill gas data**
  The Regional Board understands that the Navy has not investigated the nature and extent of soil/landfill gas, including data for typical constituents of concern (COCs) of landfill gas, e.g., methane, carbon dioxide, hydrogen sulfide, as well as volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). As a result, there is a data gap with respect to the existing soil gas conditions at Site 27 (Eucalyptus Landfill).

- **Designated ground water beneficial uses and critical site location**
  Site 27 is located within the Santa Margarita River watershed, where the ground water has been designated beneficial uses for municipal and domestic supply, agricultural supply, industrial service supply, and industrial supply.[5] According to the Site Inspection Report (page 7), two water supply wells, with screened intervals completed within fractured bedrock, are located within 1.0 to 1.25 miles downgradient of Site 27. The site is also located hydrologically upgradient of Marine Corps Base Camp Pendleton (MCB, CP), where the drinking water supplies are pumped from ground water resources of the Santa Margarita basin. Because of the designated beneficial uses of ground water and the uncertainties with respect to the

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[4] Fractured bedrock aquifers generally contain much lower or insignificant capacity for attenuation of water pollutants when compared to the attenuation capacity of alluvial aquifer systems.
[5] Water Quality Control Plan for the San Diego Basin (1994) or "Basin Plan."

ground water flow condition in fractured bedrock aquifer, adequate attention must be given to the effective protection of ground water quality at Site 27.

- **Elevated metal concentrations in ground water**
  Significantly elevated metal concentrations have been found in ground water samples collected from Site 27, including aluminum concentrations ranging from 1,380 to 6,250 micrograms per liter (µg/L), iron concentrations from 1,670 to 7,900 µg/L, and manganese concentrations up to 2,070 µg/L. The observed concentrations far exceeded their respective MCLs (at 200, 300, and 50 µg/L, for aluminum, iron, and manganese, respectively[1]). These concentrations of metals are also above the average concentrations reported to be naturally occurring in ground water supply wells at the Santa Margarita Basin at Camp Pendleton [e.g., the average reported concentrations during 1997 to 1999, were reported at 200 µg/L (iron) and 330 µg/L (manganese)].

  The elevated metal concentrations in ground water at Site 27 indicate that metals have leached from disposed solid waste and/or solid waste-impacted soil to ground water. To prevent surface water from infiltrating through soil/solid waste and causing further leaching of metals, and possibly other pollutants, an appropriate landfill post-closure maintenance program should be implemented. The Navy must develop a groundwater monitoring program[6] to characterize the nature and extent of the metal-impacted ground water plume. The criteria that should be used to develop these programs will be discussed later.

In summary, the Regional Board is not consent with the determination of no further action for Site 27. Furthermore, the Regional Board requires that appropriate post-closure maintenance program and monitoring program be installed at the site. The Regional Board requirements for closed/inactive landfills are pursuant to CCR, Title 27, and Regional Board Order 97-11, which establish landfill maintenance requirements and water quality monitoring for landfills that ceased operation prior to 1984.

Post-closure maintenance program

The post-closure maintenance program should be focused on the adequate protection from any washout, erosion control and surface drainage control. Please refer to 1) CCR, Title 27, Chapter 3, Subchapter 5, Article 2, *Closure and Post-closure maintenance standards for disposal sites and landfills*; and 2) Order 97-11, Addendum 1, for detailed requirements for post-closure maintenance.

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[6] Detection Monitoring Program (see CCR Title 27 §20415, §20420) or Evaluation Monitoring Program (see CCR Title 27 §20415, §20425).

Ground water monitoring programs

The ground water monitoring program must meet the general requirements listed in 1) CCR, Title 27, §20415, §20420, and §20430) and Order 97-11.

Additionally, the Regional Boards requires:

a) Expansion of the current groundwater monitoring well (MW) network, and the installation of new wells to ensure that the applicable groundwater monitoring program[7] meets the water quality monitoring performance standards in CCR Title 27 §20415(b) at Site 27.
b) Ground water monitoring and report of landfill waste constituents (constituents of concern or "COCs") in compliance with CCR Title 27, §20425(d) and (e). Initially, the list of analytes shall include but not be limited to metals, pesticides and all other constituents listed in Code of Federal Regulations, Part 258, Appendix 2.. Detectable concentrations of COCs in groundwater samples shall be reported to the Regional Board on a semiannual frequency.

To assist the determination of new well locations, the Regional Board suggests the following:

a) The Navy perform depth to ground water measurement on existing MWs at the site, to determine/confirm ground water flow directions;
b) The Navy perform an analysis of fracture orientations and attitude(s) using available Colog data (from boring 13) to help determine the optimum locations of additional downgradient MWs; and
c) The Navy examine the current pattern/trend of native plant distribution at the site, and evaluate if this distribution pattern is related to the ground water flow condition, e.g., depth to ground water, flow directions, gradients, etc.

Landfill Soil Gas Survey

To evaluate the soil gas condition, the Regional Board requires a survey for landfill gas[8] and the development of a landfill gas monitoring program in accordance with the requirement listed in CCR, Title 27, Chapter 3, Article 6, *Gas monitoring and control at active and closed disposal sites*. The Regional Board will also consult with the Department of Toxic Substances Control (DTSC) for additional detailed requirements for the soil gas survey and any monitoring program requirements.

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[7] Under CCR Title 27, this may include any one or all of the following: Detection Monitoring Program, Evaluation Monitoring Program or Corrective Action Monitoring Program.

[8] Under authority of CCR Title 27 § 20012(ab): (a) Where necessary to protect water quality, the Regional Water Quality Control Board (RWQCB) can implement, in coordination with the enforcement agency (EA) or, as appropriate, the California Integrated Waste Management Board (CIWMB), appropriate standards promulgated by the CIWMB in this subdivision, provided that the action does not duplicate or conflict with any action taken by the EA..

Clean-closure as an alternative

Because of the relatively small amount of solid waste disposed at the site (estimated to be 24,000 yd^3, page 1 of the referenced report), the Regional Board suggests that the Navy considers the option of clean-closure of the site, i.e, the excavation of solid waste/waste-impacted soil to be disposed at an appropriate waste treatment facility, followed by the restoration of the subject site with clean fill.

The advantage of clean-closure includes: 1) the usually long-term ground water monitoring program and post-closure maintenance program are waived under the condition that the clean-closure requirements, as listed in Title 27, Section 21090 (f), are successfully met; and 2) no restrictions will apply to the future land uses at clean-closed sites. As a matter of fact, the Regional Board has experienced many successful clean-closures of old Navy landfill sites, of which the solid waste volume was comparable to that at the subject site. The Navy has recently completed successful clean closure projects at the Admiral Baker Landfill (under command of Naval Station San Diego) and the Survival Evasion Resistance and Escape (SERE) Camp Landfill located in Warner Springs (see info on-line at http://www.waterboards.ca.gov/sandiego/board_info/agendas/2007/feb/feb.shtml).

The Regional Board suggests that the Navy develop a Record of Decision (ROD) for the future treatment of the subject inactive landfill facility as soon as practicable. During the development of the ROD, please take into consideration the following aspects: 1) site hydrogeology; 2) the volume of disposed waste at site; 3) cost-effectiveness of the long term maintenance and monitoring program, clean closure and other corrective actions; and 4) the funding availability.

SPECIFIC COMMENTS

- The referenced RTC indicates that an incised drainage is located west of the landfill and along the north-south orientation of the landfill.

  Please provide a figure illustrating the location of the referenced drainage. As the solid waste is presumed to be relatively shallow (starting from 2 feet below grade), and currently there may be only a minimal landfill cover, or other type of surface water infiltration and control method, please provide estimation, as well as the rationale, whether the soil/water in drainage has been impacted by infiltrating surface water or polluted groundwater that have been in contact with disposed solid/soil waste.

- It was stated in the RTC that "Observations with respect to the General Storm Water Permit, RWQCB-SD Region Order No 97-11, and the California Toxics Rule requirements were conducted during field activities. With the assessment of data

gathered as part of this SI, it was determined that integrity of the landfill is not compromised and therefore implementation of BMPs is not warranted at this time."

The rationale for the statement cited above is not clear. At a minimum, the Regional Board requires detailed information concerning: 1) the types of observations made on the current integrity and long-term viability of the existing landfill cover; 2) the quality of surface waters flowing in the drainages, 3) the detailed characterization of wastes remaining within Site 27 (Eucalyptus Landfill), and 4) results from an acceptable detection monitoring program implemented at Site 27 in compliance with CCR Title 27.

Should you have any further questions, please contact me at (858) 627-3972 or heyu@waterboards.ca.gov.

Sincerely,

Xueyuan Yu

Xueyuan (Helen) Yu, Ph.D., Water Resources Control Engineer
North Coast Ground Water Unit

XY:jro:xy

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