
2018 ANNUAL RARE PLANT SURVEY
FOR THE
AHTNA MONITORING WELLS
AND
ENHANCED IN SITU BIOREMEDIATION (EISB)
DEPLOYMENT AREA
AT THE
OPERABLE UNIT CARBON TETRACHLORIDE
PLUME (OUCTP)

October 2018

Prepared For
Ahtna Environmental, Inc.
296 12th Street
Marina, CA 93933

Prepared By
Denise Duffy & Associates, Inc.
947 Cass St., Suite 5
Monterey, CA 93940

CONTENTS

1 INTRODUCTION.....1

1.1 Background and Project Initiation.....1

1.2 Site Description3

1.2.1 2015 FONR North OUCTP Monitoring Well Installation3

1.2.2 2016 OUCTP EISB Deployment Area.....3

1.2.3 2018 FONR North OUCTP Monitoring Well Installation and Decommissioning.....4

1.2.4 2018 FONR South Access Route for Well Decommissioning.....4

1.3 Methodology.....5

1.3.1 Plant Surveys5

1.4 Previous Monitoring.....7

1.4.1 2015 Baseline Survey Results – 2015 FONR North Monitoring Wells7

1.4.2 2016 Year 1 Follow-Up Survey – 2015 FONR North Monitoring Wells7

1.4.3 2017 Year 2 Follow-Up Survey – 2015 FONR North Monitoring Wells8

1.4.4 2016 Baseline Survey Results – 2016 EISB Deployment Area8

1.4.5 2017 Year 1 Follow-Up Survey – 2016 EISB Deployment Area.....9

2 Results.....12

2.1 2018 Reference Site Survey Results.....12

2.1.1 Monterey Spineflower12

2.1.2 Monterey Gilia.....12

2.2 2018 Survey Results14

2.2.1 Monterey Spineflower14

2.2.2 Monterey Gilia.....14

2.2.3 Yadon’s Piperia15

2.2.4 2018 Year 3 Follow-Up Survey Results – 2015 FONR North Monitoring Wells.....15

2.2.5 2018 Year 2 Follow-Up Survey Results – 2016 EISB Deployment Area.....16

2.2.6 2018 Baseline Survey Results – 2018 FONR North Monitoring Wells16

2.2.7 2018 Baseline Survey Results – 2018 Dunes SP Monitoring Well.....17

2.2.8 2018 Baseline Survey Results – 2018 FONR South Access Route.....18

3 Discussion19

3.1 Rare Plant Populations.....19

3.1.1 Reference Site.....19

3.1.2 Year 3 Follow-Up Survey 2018 – Monitoring Wells20

3.1.3	Year 2 Follow-Up Survey 2018 – EISB Deployment Area.....	23
4	Conclusion and Recommendation.....	25
5	References.....	27

LIST OF FIGURES

Figure 1.	Complete 2018 Survey Area.....	10
Figure 2.	Ahtna FONR OUCTP Monitoring Well and EISB Survey Areas.....	11
Figure 3.	2018 DD&A Reference Site Survey Results.....	13

LIST OF TABLES

Table 2.1.1	Monterey Spineflower at DD&A Reference Site 2018.....	12
Table 2.1.2	Monterey Gilia at DD&A Reference Site 2018.....	12
Table 2.2.4.1	Monterey Spineflower at OUCTP Monitoring Wells – Year 3 Survey Results 2018.....	15
Table 2.2.4.2	Monterey Gilia at OUCTP Monitoring Wells – Year 3 Survey Results 2018.....	16
Table 2.2.5.1	Monterey Spineflower at EISB Deployment Area – Year 2 Survey Results 2018.....	16
Table 2.2.6.1	Monterey Spineflower at FONR North Monitoring Wells – Baseline Survey Results 2018.....	17
Table 2.2.6.2	Monterey Gilia at FONR North Monitoring Wells – Baseline Survey Results 2018.....	17
Table 2.2.7.1	Monterey Spineflower at the Dunes SP Monitoring Well – Baseline Survey Results 2018.....	18
Table 2.2.8.1	Monterey Spineflower at the FONR South Access Route – Baseline Survey Results 2018.....	18
Table 2.2.8.2	Monterey Gilia at FONR South Access Route – Baseline Survey Results 2018.....	18
Table 3.1.1.1	Monterey Spineflower Population at the DD&A Reference Site 2015 - 2018.....	19
Table 3.1.1.2	Monterey Gilia at DD&A Reference Site 2015 - 2018.....	20
Table 3.1.2.1	Monterey Spineflower within the 2015 Monitoring Wells Survey Area 2015 - 2018.....	21
Table 3.1.2.2	Monterey Gilia within the 2015 Monitoring Well Survey Area 2015 - 2018.....	22
Table 3.1.3.1	Monterey Spineflower within the EISB Deployment Area 2016 - 2018.....	23
Table 3.1.3.2	Monterey Gilia within EISB Deployment Area 2016 - 2018.....	24

ATTACHMENTS

Attachment A: 2018 Rare Plant Survey Results Overview and Detail Maps

1 INTRODUCTION

Denise Duffy and Associates, Inc. (DD&A) was contracted by Ahtna Environmental, Inc. (Ahtna) to conduct baseline surveys and complete annual follow-up surveys within the University of California Fort Ord Natural Reserve (FONR) and the Fort Ord Dunes State Park (Dunes SP) in support of the 2015 monitoring well installation effort, the 2016 Enhanced In Situ Bioremediation (EISB) Deployment Area construction, and the 2018 monitoring well installation and decommissioning effort (Figure 1). Following the installation of wells and support facilities, in accordance with the governing documents, DD&A was scheduled to conduct three annual follow-up surveys for three annual special-status plant species: federally Threatened Monterey spineflower (*Chorizanthe pungens* var. *pungens*), federally Endangered and state Threatened Monterey gilia (*Gilia tenuiflora* ssp. *arenaria*), and federally Endangered Yadon's piperia (*Piperia yadonii*).¹ This report details the results of the Year 3 follow-up survey (annual survey) for the 2015 monitoring well installation within FONR North and provides a comparison to the 2015 baseline survey and the 2016 and 2017 annual surveys. This report also details the results of the 2018 Year 2 annual survey for the 2016 construction of the EISB Deployment Area within FONR North and compares the results to the 2016 baseline survey and the 2017 Year 1 annual survey. Finally, this report details the results of the 2018 baseline surveys for monitoring well installation and decommissioning activities in the FONR and the Dunes SP.

1.1 BACKGROUND AND PROJECT INITIATION

FONR North is located on the former Fort Ord, Marina, California and is adjacent to the Marina Municipal Airport (the former Fritzsche Army Airfield). FONR South is located on the former Fort Ord, Marina, California, east of Imjin Parkway and south of Reservation Road. The Dunes SP is located west of Highway 1 (Figure 1). A portion of the Operable Unit Carbon Tetrachloride Plume (OUCTP) in the A-Aquifer underlies FONR. The chemicals of concern associated with OUCTP in the A-Aquifer are carbon tetrachloride (CT), tetrachloroethene, chloroform, 1,1-dichloroethene, total-1,2-dichloroethene, methylene chloride, vinyl chloride, and trichloroethene. The presence and concentration levels of CT are used to define the extent of OUCTP. The remedy for OUCTP in the A-Aquifer is EISB, which has been implemented at three deployment areas in FONR. In 2014 the U.S. Army Corps of Engineers (USACE) contracted with Ahtna to conduct field work to collect additional site information to further characterize groundwater gradients and chemistry in the north and northeastern portions of the OUCTP to support the design and implementation of additional EISB deployment area(s), if necessary.

Rare plant surveys are required by the Installation-Wide Multispecies Habitat Management Plan (HMP) for Former Fort Ord, California (USACE, 1997) and the Programmatic Biological Opinion for Cleanup and Property Transfer Actions Conducted at the Former Fort Ord, Monterey County, California (PBO; USFWS, USFWS, 2017) in areas that are disturbed during construction activities associated with remediation efforts. Project activities undertaken must protect and maintain the special-status species found within FONR. Efforts are taken to avoid or minimize impacts to all HMP species, with emphasis on three federally listed plant species: Monterey spineflower, Monterey gilia, and Yadon's piperia.

¹ 2015 baseline surveys for the monitoring wells were conducted for only two annual special-status plant species: Monterey spineflower and Monterey gilia. Beginning in 2016, Yadon's piperia was included in the special-status plant species surveys.

Special-status species listed in the HMP and PBOs that occur or may occur on FONR include:

- Monterey gilia (*Gilia tenuiflora* ssp. *arenaria*) – federally endangered, state threatened
- Monterey spineflower (*Chorizanthe pungens* var. *pungens*) – federally threatened
- Seaside bird’s beak (*Cordylanthus rigidus* ssp. *littoralis*) – state endangered
- Sandmat manzanita (*Arctostaphylos pumila*)
- Monterey manzanita (*A. montereyensis*)
- Monterey ceanothus (*Ceanothus rigidus*)
- Eastwood’s goldenbush (*Ericameria fasciculata*)
- Yadon’s piperia (*Piperia yadonii*) – federally endangered
- Coast wallflower (*Erysimum ammophilum*)
- California black legless lizard (*Anniella pulchra nigra*; BLL) – state species of concern
- California tiger salamander (*Ambystoma californiense*; CTS) – federally threatened, state threatened
- Monterey ornate shrew (*Sorex ornatus salarius*) – state species of concern

Monterey gilia, Monterey spineflower, Seaside bird’s beak, and coast wallflower are annual herb species that may occur within maritime chaparral, coastal scrub, grasslands, dune scrub, or disturbed areas. Sandmat manzanita, Monterey manzanita, Monterey ceanothus, and Eastwood’s goldenbush are perennial shrub species that typically occur in maritime chaparral, but individuals can also be found mixed with oak woodland or coastal scrub habitats. Yadon’s piperia is a perennial herb that is typically found in maritime chaparral and Monterey pine habitats.

The BLL is a rare variety of the California legless lizard (*A. pulchra*) that inhabits areas with sandy soils on the former Fort Ord. The Monterey ornate shrew is a rare variety of the ornate shrew (*S. ornatus*) found in riparian forest and oak woodland habitats. The CTS is typically found in vernal or seasonal ponds on the former Fort Ord. The CTS may also be found aestivating in small mammal burrows or under logs in upland areas within 2.2 kilometers of vernal ponds.

As identified in the 2017 PBO success criteria for the contaminated groundwater remediation are as follows:

After the final monitoring period for each of the federally listed species or designated Monterey spineflower critical habitat, species reestablishment will be considered successful when:

1. *densities and acreage of HMP annual species are within a normal range compared with information from reference sites, and;*
2. *the number of wells where HMP annual species are detected in follow up surveys will be the same or greater that the number of wells where these species were found in baseline surveys.*

If the success criteria are not met, then corrective measures will be developed and applied on a case-by-case basis in coordination with the United Fish and Wildlife Service (USFWS), as described in the 2017 PBO.

DD&A met and coordinated with Ahtna, USACE, U.S. Army Base Realignment and Closure (BRAC) Fort Ord Field Office, and FONR staff to finalize the scope and project path, as well as identify project boundaries, project footprint, and site access.

1.2 SITE DESCRIPTION

This report describes activities that have occurred within FONR and the Dunes SP. FONR is approximately 605 acres in size, and the Dunes SP is approximately 981 acres in size. The habitats present within FONR include coast live oak woodland, maritime chaparral, coastal scrub, disturbed/developed land, and annual grassland. The habitats present within the Dunes SP include beach strands and sand dunes. Areas surveyed as part of the 2015 installation of OUCTP monitoring wells (approximately 7 acres), 2016 construction of an EISB Deployment Area (approximately 6 acres)², and 2018 installation and decommissioning of OUCTP monitoring wells and access routes (approximately 5 acres) included portions of each habitat type present on FONR and the Dunes SP.

1.2.1 2015 FONR NORTH OUCTP MONITORING WELL INSTALLATION

The 2015 OUCTP monitoring well installation included eight monitoring wells and corresponding potential access routes within the FONR North survey area. The following monitoring wells were included in the installation³(Figure 2):

- MW-BW-86-A
- MW-BW-87-A
- MW-BW-88-A
- MW-BW-89-A
- MW-BW-90-A
- MW-BW-91-A⁴
- MW-BW-92-A

As required by the HMP and PBO, a habitat checklist was prepared prior to well installation. The habitat checklist identified natural resources present and restrictions to minimize impacts to those resources. These restrictions included, but were not limited to, using existing roads to the greatest extent feasible for potential access routes, using matting to reduce soil disturbance, and pressure washing equipment coming from offsite to minimize the potential of spreading invasive species.

1.2.2 2016 OUCTP EISB DEPLOYMENT AREA

The OUCTP EISB Deployment Area, in the FONR North survey area, included 10 extraction wells, 10 injection wells, pipelines, and corresponding potential access routes. The EISB Deployment Area included the following components (Figure 2):

² This acreage is the survey area for the EISB Deployment Area located on FONR. Please see Section 1.3.1.1.2 below for additional information.

³ Monitoring well MW-BW-85-A was also installed as part of the well installation effort; however, since it is located outside of FONR on a parcel designated as development (S2.1.1) the well location and access route were not included in monitoring efforts.

⁴ A portion of the access route to monitoring well MW-BW-91-A is located on a parcel designated as development (S2.1.1) outside of FONR. Only portions of the access route within FONR were included in monitoring efforts.

Extraction wells

- EW-BW-160-A
- EW-BW-161-A
- EW-BW-162-A
- EW-BW-163-A
- EW-BW-164-A
- EW-BW-165-A
- EW-BW-166-A
- EW-BW-167-A
- EW-BW-168-A
- EW-BW-169-A

Injection wells

- IW-BW-159-A
- IW-BW-160-A
- IW-BW-161-A
- IW-BW-162-A
- IW-BW-163-A
- IW-BW-164-A
- IW-BW-165-A
- IW-BW-166-A
- IW-BW-167-A
- IW-BW-168-A

Pipelines

- Injection
- Extraction

As required by the HMP, and PBO, a habitat checklist was prepared prior to well installation which identified natural resources present and restrictions to minimize impacts to those resources. These restrictions included but were not limited to using existing roads to the greatest extent feasible for potential access routes, and pressure washing equipment coming from offsite to minimize the potential of spreading invasive species.

1.2.3 2018 FONR NORTH OUCTP MONITORING WELL INSTALLATION AND DECOMMISSIONING

Four additional OUCTP monitoring wells and corresponding access route locations were added to the FONR North survey area in 2018. The following monitoring wells were included in the new survey area:

- MW-BW-29-180 (decommission)
- MW-BW-93-A (install)
- MW-BW-94-A (install)
- MW-BW-95-A (install)

As required by the HMP, and PBO, a habitat checklist was prepared prior to well installation which identified natural resources present and restrictions to minimize impacts to those resources. These restrictions included but were not limited to using existing roads to the greatest extent feasible for potential access routes, and pressure washing equipment coming from offsite to minimize the potential of spreading invasive species

1.2.4 2018 DUNES SP SITES 2 AND 12 MONITORING WELL DECOMMISSIONING.

On Sites 2 and 12 (Sites 2/12) monitoring well and the corresponding access route were included the Dunes SP survey area in 2018:

- MW-02-12-180 (decommission)

As required by the HMP, and PBO, a habitat checklist was prepared prior to well installation which identified natural resources present and restrictions to minimize impacts to those resources. These restrictions included but were not limited to using existing roads to the greatest extent feasible for potential access routes, and pressure washing equipment coming from offsite to minimize the potential of spreading invasive species.

1.2.5 2018 FONR SOUTH ACCESS ROUTE FOR WELL DECOMMISSIONING

A baseline survey was conducted for an access route through the FONR South survey area for access to monitoring well MW-OU2-59-A (to be decommissioned).

1.3 METHODOLOGY

1.3.1 PLANT SURVEYS

The Scope of Work (SOW) provided by Ahtna to DD&A was intended to comply with the HMP and the PBOs. The SOW required that annual biological surveys be conducted to determine the effects of well installation and decommissioning, and other groundwater remediation activities on three federally listed HMP species: Monterey spineflower, Monterey gilia, and Yadon's piperia.⁵ Rare plant survey methods were based on methods DD&A used previously for vegetation surveys at FONR on behalf of HydroGeoLogic, Inc. (HGL 2008, 2009a, 2009b, 2011, 2012, 2013a, 2013b, 2014 & 2015). In 2016 Yadon's piperia was added to the species surveyed, at the request of the USFWS and BRAC (HGL 2016).

Monterey spineflower, Monterey gilia, and Yadon's piperia are annual plant species that must be blooming in order to make a positive identification. DD&A conducts a minimum of two survey efforts per year at each site for the required monitoring period. DD&A used several reference sites and conferred with other local experts to ensure that surveys for Monterey spineflower and Monterey gilia were conducted within the appropriate blooming period. Annual plant surveys did not occur at the appropriate blooming period for Yadon's piperia. Of the three special-status plant species included in the survey efforts, the Yadon's piperia blooming period is later, occurring typically May through August. DD&A biologists documented potential piperia basal rosettes and, if observed, relayed the location(s) to the BRAC Biologist so that additional surveys may be conducted by the BRAC Biologist during the appropriate blooming period for Yadon's piperia, if necessary.

Where identified, the locations of the three rare plant species were mapped using a Trimble® Geo 7 Series global positioning system (GPS) with an external Zephyr Model 2 antenna or delineated on an aerial and digitized in office. Large areas of Monterey spineflower, Monterey gilia, and piperia were mapped as polygons, with attributes to identify the number of individuals for Monterey gilia and piperia or percent absolute cover for Monterey spineflower. Smaller groups and individuals were mapped as points with attributes to identify the number of individuals at each location.

Individual counts were made for all Monterey gilia and piperia populations whether they were mapped using points (population ≤ 5) or polygons (population ≥ 6). However, Monterey spineflower were only counted as individuals when groups of five or less were mapped. Monterey spineflower populations consisting of greater than five individuals were mapped as polygons and characterized according to the percent of cover. The density classes used for percent cover were:

- Very Sparse (<3 percent absolute cover),
- Sparse (3-25 percent absolute cover),
- Medium-Low (26-50 percent absolute cover),
- Medium (51-75 percent absolute cover),
- Medium-High (76-97 percent absolute cover), and
- Very High (>97-100 percent absolute cover).

⁵ Prior to 2016, Yadon's piperia was not included in the baseline or annual plant surveys.

GPS data, defining the population boundaries and/or point location(s), were exported to shapefile format. Shapefiles were then imported into the Geographic Information System (GIS) ESRI® ArcGIS 10.6 software platform and overlaid on high-resolution aerial photography/satellite imagery.

1.3.1.1 SURVEY AREA

The entire survey area consisted of the original OUCTP monitoring well and EISB Deployment Area within the FONR North site, the new 2018 monitoring well survey areas within the FONR North, the 2018 well decommissioning survey area within the Dunes SP, and the new 2018 access route survey area within the FONR South site, as shown in Figures 1 and 2. There are approximately 2 acres of overlap between the original 2015 OUCTP monitoring well survey area and the EISB Deployment Area survey area.

1.3.1.1.1 2015 FONR NORTH OUCTP MONITORING WELL SURVEY AREA

The survey area for the 2015 FONR North OUCTP monitoring wells included all monitoring well locations with a 50-foot buffer area. The survey area also included access routes and a 20-foot buffer area on the access routes. The survey area for the monitoring wells installation is shown in Figure 2.⁶

1.3.1.1.2 2016 EISB DEPLOYMENT AREA SURVEY AREA

The survey area for the EISB Deployment Area is the area of impact defined within the baseline survey area.⁷ In general, the survey area was defined using a 50-foot buffer area around the extraction and injection wells and a 20-foot buffer around access routes. The presence of University of California Santa Cruz (UCSC) study plots and transects required that in some instances the typical buffer area around wells and access routes be modified (reduced) to avoid impacts to study areas. Additionally, the buffer along a section of pipeline between wells IW-BW-162-A and IW-BW-160-A was reduced as impacts from installation resulted in less disturbance to ground cover.⁸ The survey area for the EISB Deployment Area is shown in Figure 2.⁹

1.3.1.1.3 2018 FONR NORTH OUCTP MONITORING WELL SURVEY AREA

The survey area for the 2018 FONR North OUCTP monitoring wells included all proposed monitoring well installation and decommissioning locations with a 50-foot buffer area. The survey area also included access routes and a 20-foot buffer area on the access routes. The survey area for the site is shown in Figure 2.

1.3.1.1.4 2018 DUNES OUCTP MONITORING WELL SURVEY AREA

The new 2018 survey area for the Dunes SP OUCTP monitoring well decommissioning included the monitoring well location and a 50-foot buffer area. The survey area also included an access route and a 20-foot buffer area on the access route. The survey area for the site is shown in Figure 2.

⁶ The location of MW-BW-85-A and the associated access route are outside of FONR in adjacent development property.

⁷ The area of impact for the EISB was entirely contained within the area surveyed during the baseline surveys. Please refer to the *2016 Annual Rare Plant Survey & Biological Monitoring Report for the Ahtna Monitoring Well Installation & Development and Enhanced In Situ Bioremediation (EISB) Deployment Area Construction at the Operable Unit Carbon Tetrachloride Plume (OUCTP)* (DD&A, 2017) for additional details.

⁸ No mowing occurred along this section of pipeline. With the exception of the access routes and this area of pipeline mowing of herbaceous ground cover occurred prior to installation of the EISB Deployment Area.

⁹ The location of treatment plant and the associated access route are outside of FONR in adjacent development property.

1.3.1.1.5 2018 FONR SOUTH ACCESS ROUTE SURVEY AREA

The new 2018 survey area for the FONR South access route included the proposed access route and a 20-foot buffer area on the access route. The survey area for the site is shown in Figure 2.

1.4 PREVIOUS MONITORING

A baseline survey for the 2015 FONR North monitoring well installation was conducted in 2015, and the first two annual follow-up surveys were conducted in 2016 and 2017. A baseline survey for the 2016 EISB Deployment Area was conducted in 2016, and the Year 1 follow-up survey was conducted in 2017. A comparison of survey results from previous years for these two survey areas is included in Section 4 (Discussion). No surveys prior to 2018 were conducted for the new 2018 monitoring well and access route survey areas.

1.4.1 2015 BASELINE SURVEY RESULTS – 2015 FONR NORTH MONITORING WELLS

In 2015, DD&A conducted baseline surveys for Monterey spineflower and Monterey gilia within the designated survey area for eight monitoring well installation locations and access routes.¹⁰ In 2015, 150 populations of Monterey spineflower (20,563 square feet [ft²] of polygons and 55 points) were identified. Monterey spineflower was found at four of the eight well locations (MW-BW-86-A, MW-BW-88-A, MW-BW-90-A, and MW-BW-92-A) and along access routes (DD&A 2015).¹¹ In 2015, 14 populations of Monterey gilia (347 individual plants) were identified. All Monterey gilia populations present in 2015 were located along the access route to monitoring well installation location MW-BW-89-A. Additionally, the DD&A reference site was also surveyed in 2015 and is surveyed every year rare plant surveys are conducted.

In 2015, DD&A conducted construction phase biological monitoring for the installation and development of the OUCTP monitoring wells. Please refer to the *Biological Monitoring Completion Report for the Ahtna Well Installation and Development at the Operable Unit Carbon Tetrachloride Plume (OUCTP)* (DD&A, 2015) for additional details.¹²

1.4.2 2016 YEAR 1 FOLLOW-UP SURVEY – 2015 FONR NORTH MONITORING WELLS

DD&A conducted the Year 1 follow-up survey for the original eight OUCTP monitoring wells in 2016. 177 populations (114,818 ft² of polygons and 75 points) of Monterey spineflower were identified. Monterey spineflower was found at six of the eight well locations (MW-BW-86-A, MW-BW-87-A, MW-BW-88-A, MW-BW-89-A MW-BW-90-A, and MW-BW-92-A) and along access routes. 66 populations of Monterey

¹⁰ Please refer to *Biological Monitoring Completion Report for the Ahtna Well Installation and Development at the Operable Unit Carbon Tetrachloride Plume (OUCTP)* (DD&A 2015) for additional details.

¹¹ All 2018 and previous year survey areas included a 50-foot buffer around wells and a 20-foot buffer around access routes.

¹² Results reported in the 2015 report (DD&A 2015) included populations that were located outside of FONR, associated with well MW-BW-85-A. For the purposes of this report the area of rare plants reported as identified in 2015 has been modified to include only the populations that were present within FONR.

gilia (1,591 individuals) were identified. Monterey gilia was found at two of the eight well installation locations (MW-BW-92-A and MW-BW-89-A) and along access routes.

The DD&A reference site was also surveyed in 2016 and is surveyed every year rare plant surveys are conducted. Please refer to the *2016 Annual Rare Plant Survey & Biological Monitoring Report for the Ahtna Monitoring Well Installation & Development and Enhanced In Situ Bioremediation (EISB) Deployment Area Construction at the Operable Unit Carbon Tetrachloride Plume (OUCTP)* (DD&A, 2017a) for additional details.

1.4.3 2017 YEAR 2 FOLLOW-UP SURVEY – 2015 FONR NORTH MONITORING WELLS

DD&A conducted the Year 2 follow-up survey for the original eight OUCTP monitoring wells in 2017. 131 populations (55 points and 76 polygons) of Monterey spineflower were identified. Monterey spineflower was found at five of the eight well locations (MW-BW-86-A, MW-BW-87-A, MW-BW-88-A, MW-BW-90-A, and MW-BW-92-A) and along access routes. 41 populations (28 points and 13 polygons), consisting of a total of 1,539 individual Monterey gilia plants were identified. Monterey gilia was present at one of the eight well installation locations (MW-BW-92-A) and along access routes.

The DD&A reference site was also surveyed in 2017 and is surveyed every year rare plant surveys are conducted. Please refer to the *2017 Annual Rare Plant Survey & Biological Monitoring Report for the Ahtna Monitoring Well Installation & Development and Enhanced In Situ Bioremediation (EISB) Deployment Area Construction at the Operable Unit Carbon Tetrachloride Plume (OUCTP)* (DD&A, 2017b) for additional details.

1.4.4 2016 BASELINE SURVEY RESULTS – 2016 EISB DEPLOYMENT AREA

In 2016, DD&A conducted baseline surveys for Monterey spineflower, Monterey gilia, and Yadon's piperia within the EISB Deployment Area. 76 populations of Monterey spineflower (117,397 ft² of polygons and 22 points) were identified in the EISB Deployment Area. Monterey spineflower was found at fourteen of the twenty well locations (EW-BW-160-A, EW-BW-161-A, EW-BW-162-A, EW-BW-164-A, EW-BW-165-A, EW-BW-166-A, EW-BW-168-A, EW-BW-169-A, IW-BW-159-A, IW-BW-160-A, IW-BW-161-A, IW-BW-162-A, IW-BW-163-A, and IW-BW-165-A) and along access routes. One population of Monterey gilia (36 individual plants) was identified in the EISB Deployment Area. The population of Monterey gilia was located along the access route to well installation location IW-BW-160-A.

In 2016, DD&A conducted construction phase biological monitoring for the EISB Deployment Area. Additionally, the DD&A reference site was also surveyed in 2016 and is surveyed every year rare plant surveys are conducted. Please refer to the *2016 Annual Rare Plant Survey & Biological Monitoring Report for the Ahtna Monitoring Well Installation & Development and Enhanced In Situ Bioremediation (EISB) Deployment Area Construction at the Operable Unit Carbon Tetrachloride Plume (OUCTP)* (DD&A, 2017a) for additional details.

1.4.5 2017 YEAR 1 FOLLOW-UP SURVEY – 2016 EISB DEPLOYMENT AREA

DD&A conducted the Year 1 follow-up survey for the EISB Deployment Area in 2017. 62 populations of Monterey spineflower (89,649 ft² of polygons and 31 points) were identified in the EISB Deployment Area. Monterey spineflower was found at fifteen of the twenty well locations (EW-BW-160-A, EW-BW-161-A, EW-BW-164-A, EW-BW-165-A, EW-BW-166-A, EW-BW-168-A, EW-BW-169-A, IW-BW-159-A, IW-BW-160-A, IW-BW-161-A, IW-BW-162-A, IW-BW-163-A, IW-BW-165-A, IW-BW-166-A, and IW-BW-168-A) and along access routes. One population of Monterey gilia (7 individual plants) was identified in the EISB Deployment Area. The population of Monterey gilia was identified and mapped along the access route to well installation location IW-BW-160-A.

The DD&A reference site was also surveyed in 2017 and is surveyed every year rare plant surveys are conducted. Please refer to the *2017 Annual Rare Plant Survey & Biological Monitoring Report for the Ahtna Monitoring Well Installation & Development and Enhanced In Situ Bioremediation (EISB) Deployment Area Construction at the Operable Unit Carbon Tetrachloride Plume (OUCTP)* (DD&A, 2017b) for additional details.

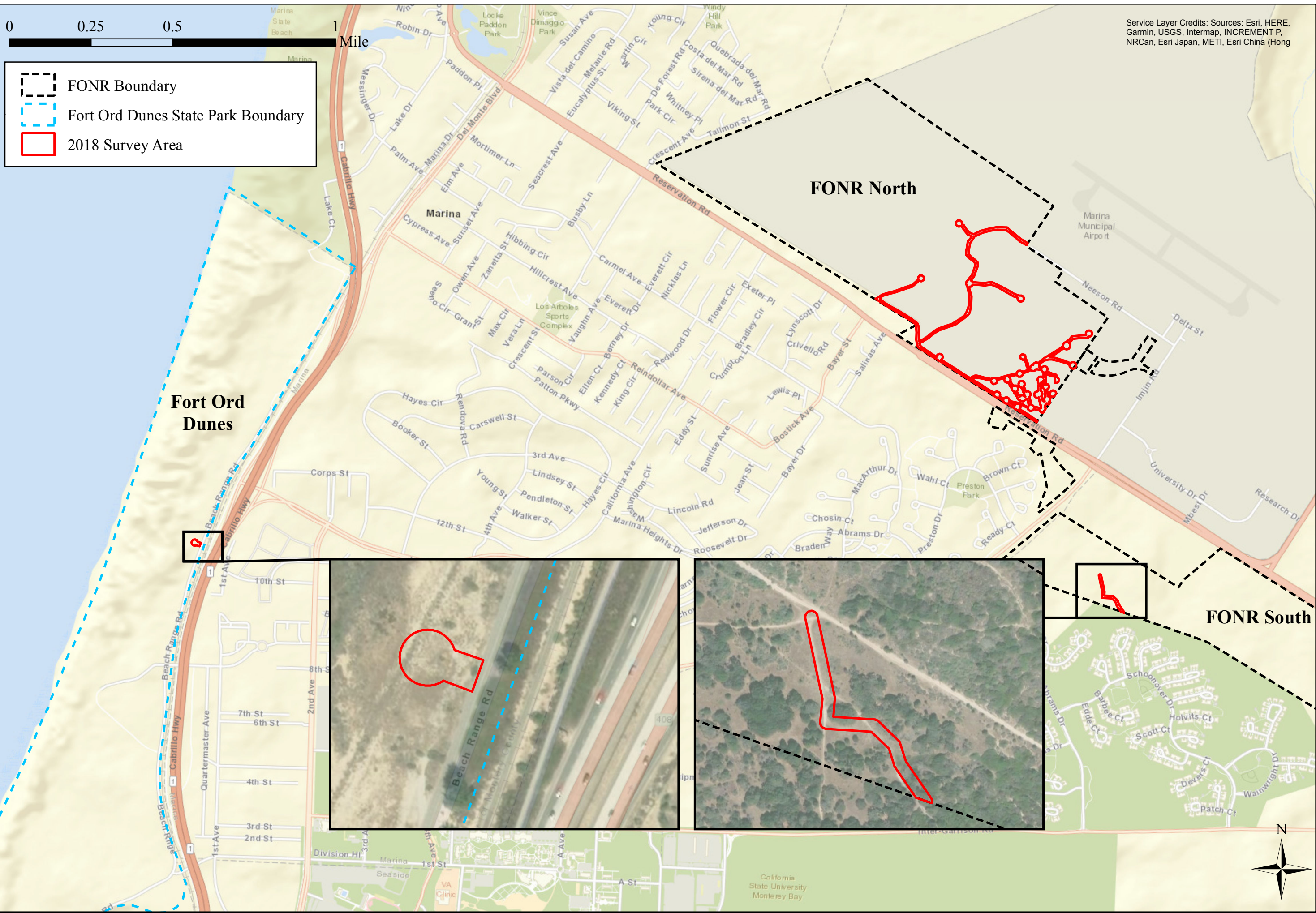
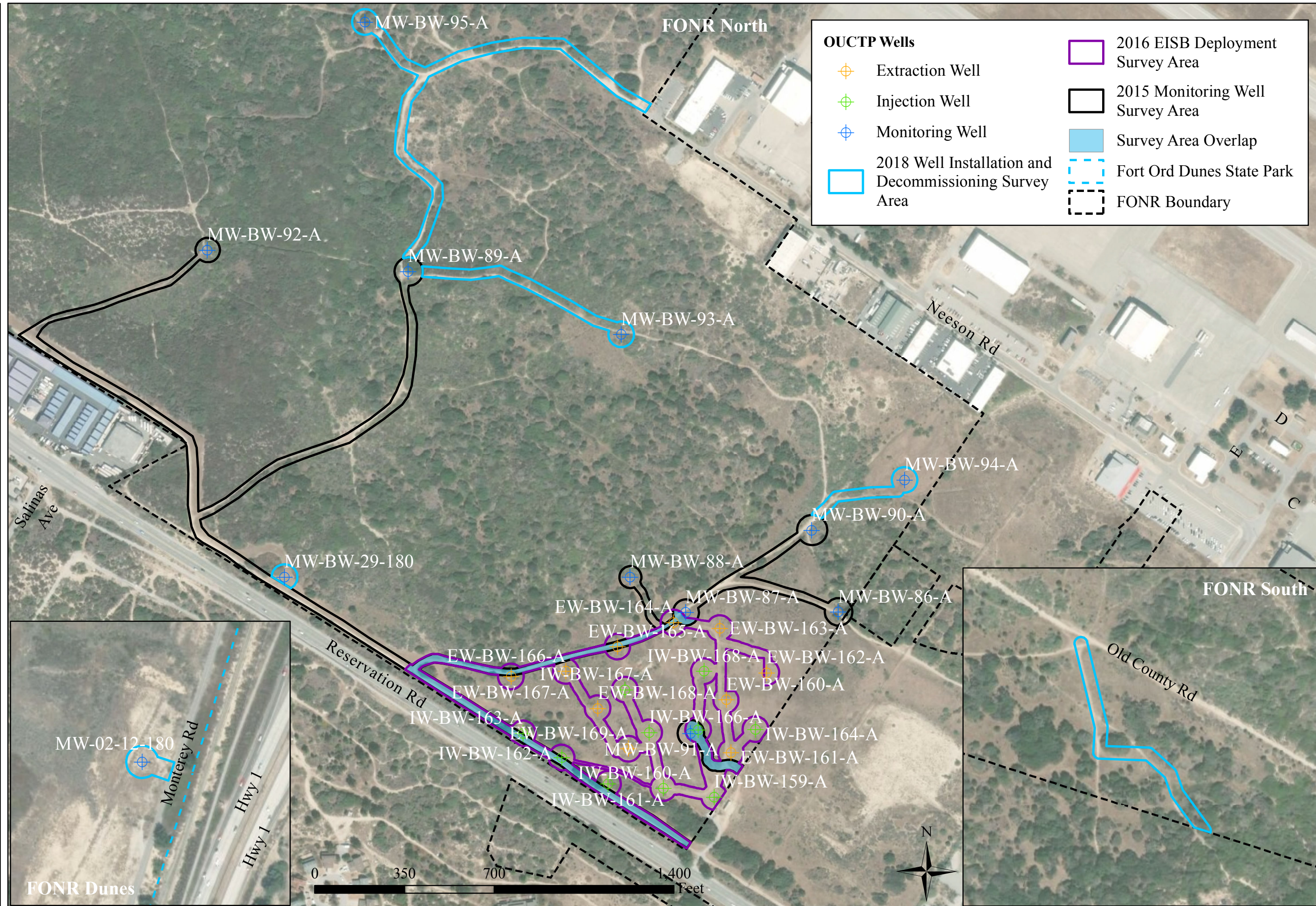


Figure 1. Complete 2018 Survey Area



Figure 2. Ahtha OUCTP Monitoring Well and EISB Deployment Survey Areas



2 RESULTS

A reference site survey, which is conducted every year as part of the survey effort, was conducted in 2018. In addition, the Year 3 follow-up survey was conducted for the original eight OUCTP monitoring wells, the Year 2 follow-up survey was conducted for the EISB Deployment Area, and baseline surveys were conducted for the new monitoring well and access route locations.

2.1 2018 REFERENCE SITE SURVEY RESULTS

The DD&A reference site was surveyed for Monterey gilia on May 2, 2018 and Monterey spineflower on May 14, 2018.

2.1.1 MONTEREY SPINEFLOWER

In 2018, Monterey spineflower occupied approximately 3,078 ft² at the reference site (Table 2.1.1 and Figure 2.1).

Table 2.1.1 Monterey Spineflower at DD&A Reference Site 2018.

Polygon Density Class: Very Sparse (<3 percent cover) and Sparse (3-25 percent cover).

Year	# of Populations	# of Points	# of Polygons	Polygons per Density Class		Total Area of Polygons (ft ²)
				Very Sparse	Sparse	
2018	5	2	3	1	2	3,078

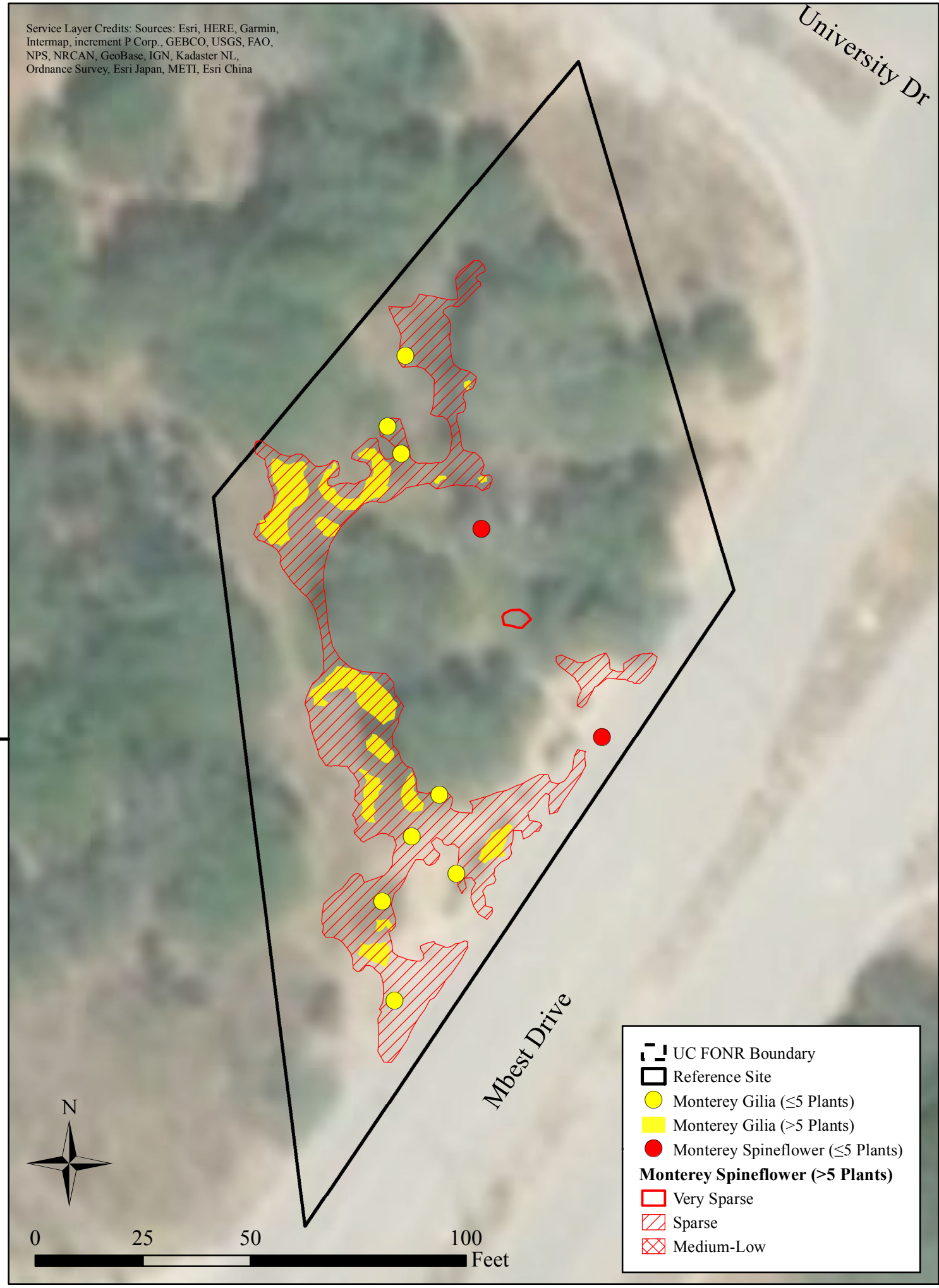
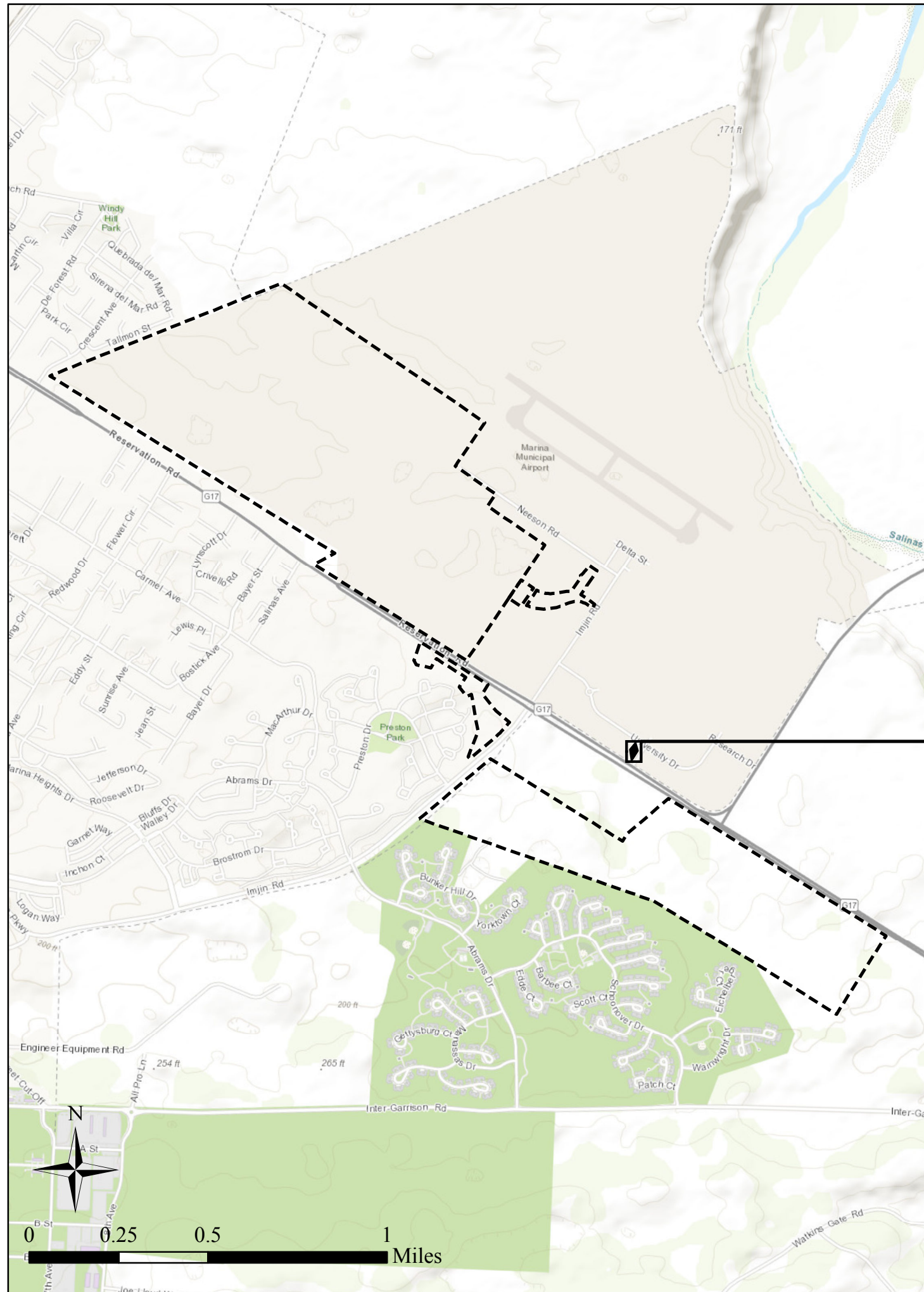
2.1.2 MONTEREY GILIA

In 2018, a total of 352 individual Monterey gilia plants were observed at the reference site (Table 2.1.2 and Figure 2.1).

Table 2.1.2 Monterey Gilia at DD&A Reference Site 2018.

Year	# of Populations	Individual Plants	# of Points	# of Polygons	Total Area of Polygons (ft ²)
2018	21	352	8	13	481

Figure 3. 2018 DD&A Reference Site Survey Results



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China

University Dr

Mbest Drive

2.2 2018 SURVEY RESULTS

The entire survey site was surveyed for Monterey gilia on April 25 and May 2, 2018. DD&A conducted surveys for Monterey spineflower within the entire survey area on May 17, May 23, May 31, and June 13, 2018.

2.2.1 MONTEREY SPINEFLOWER

In 2018, Monterey spineflower occupied approximately 157,021 ft² of the entire survey area (Table 2.2.1-1 and Attachment A). DD&A identified 308 populations of Monterey spineflower (152 points and 156 polygons) within the entire survey area. Of the Monterey spineflower mapped in 2018, 78 populations (39 points and 39 polygons) were located in the approximately 2-acres of overlap of the survey area for the EISB Deployment Area and the monitoring wells survey area (Table 2.2.1-2).

Table 2.2.1-1 Monterey spineflower within the entire survey area.

Polygon Density Class: Very Sparse (<3 percent cover), Sparse (3-25 percent cover), Medium-Low (26-50 percent cover).

Year	# of Populations	# of Points	# of Polygons	Polygons per Density Class			Total Area of Polygons (ft ²)
				Very Sparse	Sparse	Medium-Low	
2018	308	152	156	14	116	26	157,021

Table 2.2.1-2 Monterey spineflower within the 2-acre area of overlap between the monitoring wells and EISB Deployment Area survey areas.

Polygon Density Class: Very Sparse (<3 percent cover), Sparse (3-25 percent cover), Medium-Low (26-50 percent cover).

Year	# of Populations	# of Points	# of Polygons	Polygons per Density Class			Total Area of Polygons(ft ²)
				Very Sparse	Sparse	Medium-Low	
2018	78	39	39	2	31	6	24,707

2.2.2 MONTEREY GILIA

In 2018, a total of 738 individual Monterey gilia plants were observed within the entire survey area (Table 2.2.2 and Attachment A). DD&A identified 80 populations of Monterey gilia (54 points and 26 polygons) within the entire survey area. No Monterey gilia were identified in the 2-acre area of overlap of the survey area for the EISB Deployment Area and the monitoring well survey area.

Table 2.2.2 Monterey gilia within the entire survey area identified in 2018.

Year	# of Populations	Individual Plants	# of Points	# of Polygons	Total Area of Polygons (ft²)
2018	80	738	54	26	2,769

2.2.3 YADON’S PIPERIA

In 2018, DD&A surveyed for piperia within the entire survey area (Figures 1 and 2), which included the monitoring well survey area, the EISB Deployment Area, and the new baseline survey areas. No piperia basal rosettes were found.

2.2.4 2018 YEAR 3 FOLLOW-UP SURVEY RESULTS – 2015 FONR NORTH MONITORING WELLS

In 2018, DD&A performed the Year 3 follow-up survey in the monitoring well survey area (Figure 2), which included eight monitoring well installation locations and their associated access routes. Attachment A includes detailed maps of the survey results for the 2018 monitoring wells Year 3 follow-up survey.

2.2.4.1 MONTEREY SPINEFLOWER

Monterey spineflower was found at six of the eight well locations (MW-BW-86-A, MW-BW-87-A, MW-BW-88-A, MW-BW-90-A, MW-BW-91-A, and MW-BW-92-A) and along access routes at the FONR North survey area (Table 2.2.4.1 and Attachment A).¹³ During the 2018 survey, 198 populations (95 points and 103 polygons) of Monterey spineflower were identified. Of the polygons mapped, the majority (81 polygons) were identified as having a density class of sparse (5-25 percent cover of Monterey spineflower) (Table 2.2.4.1).

Table 2.2.4.1 Monterey Spineflower at OUCTP Monitoring Wells – Year 3 Survey Results 2018.

Polygon Density Class: Very Sparse (<3 percent cover), Sparse (3-25 percent cover), and Medium-Low (26-50 percent cover).

Year	# of Populations	# of Points	# of Polygons	Polygons per Density Class			Total Area of Polygons (ft²)
				Very Sparse	Sparse	Medium-Low	
2018	198	95	103	7	81	15	65,139

2.2.4.2 MONTEREY GILIA

Monterey gilia was present at one of the eight well installation locations (MW-BW-92-A) and along access routes (Table 2.2.4.2 and Attachment A). During the 2018 survey, 60 populations (39 points and 21 polygons)

¹³ This assessment includes the 2-acre overlap between the survey area of the EISB Deployment Area and the monitoring well survey area. This assessment also includes the Monterey spineflower polygon which intersects with both the 2015 monitoring well survey area and the new 2018 monitoring well survey area at monitoring well MW-BW-29-180.

consisting of a total of 638 individual Monterey gilia plants were found within the monitoring well survey area (Table 2.2.4.2).

Table 2.2.4.2 Monterey Gilia at OUCTP Monitoring Wells – Year 3 Survey Results 2018.

Year	# of Populations	Individual Plants	# of Points	# of Polygons	Total Area of Polygons (ft²)
2018	60	638	39	21	2,666

2.2.5 2018 YEAR 2 FOLLOW-UP SURVEY RESULTS – 2016 EISB DEPLOYMENT AREA

In 2018, DD&A conducted the Year 2 survey for Monterey spineflower, Monterey gilia, and Yadon’s piperia within the EISB Deployment Area (Figure 2). Attachment A includes a map of the survey results within the 2018 ESIB Deployment Area.

2.2.5.1 MONTEREY SPINEFLOWER

In 2018, 104 populations of Monterey spineflower (72,816 ft² of polygons and 58 points) were identified in the EISB Deployment Area¹⁴. Monterey spineflower was found at fifteen of the twenty well locations (EW-BW-160-A, EW-BW-161-A, EW-BW-164-A, EW-BW-165-A, EW-BW-166-A, EW-BW-168-A, EW-BW-169-A, IW-BW-159-A, IW-BW-160-A, IW-BW-161-A, IW-BW-162-A, IW-BW-163-A, IW-BW-165-A, IW-BW-166-A, and IW-BW-168-A) and along access routes.

Table 2.2.5.1 Monterey Spineflower at EISB Deployment Area – Year 2 Survey Results 2018.

Polygon Density Class: Very Sparse (<3 percent cover), Sparse (3-25 percent cover), and Medium-Low (26-50 percent cover).

Year	# of Populations	# of Points	# of Polygons	Polygons per Density Class			Total Area of Polygons (ft²)
				Very Sparse	Sparse	Medium-Low	
2018	104	58	46	2	34	10	72,816

2.2.5.2 MONTEREY GILIA

Monterey gilia was not identified in the EISB Deployment Area during the 2018 survey.

2.2.6 2018 BASELINE SURVEY RESULTS – 2018 FONR NORTH MONITORING WELLS

In 2018, DD&A performed a baseline survey for three new monitoring well locations and one monitoring well decommissioning location and their associated access routes in the FONR North survey area (Figure 2). Attachment A includes detailed maps of the survey results.

¹⁴ This assessment includes the 2-acre overlap between the survey area of the EISB Deployment Area and the monitoring well survey area.

2.2.6.1 MONTEREY SPINEFLOWER

Monterey spineflower was found at three of the four well locations (MW-BW-29-180, MW-BW-93-A, and MW-BW-95-A) and along access routes at the new FONR North survey areas¹⁵ (Table 2.2.6.1 and Attachment A). During the 2018 survey, 85 populations (37 points and 48 polygons) of Monterey spineflower were identified. Of the polygons mapped, the majority (34 polygons) were identified as having a density class of sparse (5-25 percent cover of Monterey spineflower) (Table 2.2.6.1).

Table 2.2.6.1 Monterey Spineflower at FONR North Monitoring Wells – Baseline Survey Results 2018.

Polygon Density Class: Very Sparse (<3 percent cover), Sparse (3-25 percent cover), and Medium-Low (26-50 percent cover).

Year	# of Populations	# of Points	# of Polygons	Polygons per Density Class			Total Area of Polygons (ft ²)
				Very Sparse	Sparse	Medium-Low	
2018	69	34	35	7	22	6	31,838

2.2.6.2 MONTEREY GILIA

Monterey gilia was not found within 50 feet of the new monitoring well locations nor MW-BW-29-180 but was found along access routes at the new FONR North monitoring well survey area (Table 2.2.6.2 and Attachment A). During the 2018 baseline survey, 20 populations (15 points and 5 polygons) consisting of a total of 31 individual Monterey gilia plants were found within the new survey area (Table 2.2.6.2).

Table 2.2.6.2 Monterey Gilia at FONR North Monitoring Wells – Baseline Survey Results 2018.

Year	# of Populations	Individual Plants	# of Points	# of Polygons	Area of Polygons (ft ²)
2018	11	75	7	4	79

2.2.7 2018 BASELINE SURVEY RESULTS – 2018 DUNES SP MONITORING WELL

In 2018, DD&A performed a baseline survey for the decommissioning of a monitoring well location and its associated access route in the Dunes SP survey area (Figure 2). Attachment A includes detailed maps of the survey results.

2.2.7.1 MONTEREY SPINEFLOWER

Monterey spineflower was not found within 50 feet of the Dunes SP monitoring well (MW-02-12-180) but was found along its access route (Table 2.2.7.1 and Attachment A). During the 2018 baseline survey, 3 populations (all polygons) of Monterey spineflower were identified. Of the polygons mapped, all were identified as having a density class of sparse (5-25 percent cover of Monterey spineflower) (Table 2.2.7.1).

¹⁵ This assessment includes the Monterey spineflower polygon which intersects with both the 2015 monitoring well survey area and the new 2018 monitoring well survey area at monitoring well MW-BW-29-180.

Table 2.2.7.1 Monterey Spineflower at the Dunes SP Monitoring Well – Baseline Survey Results 2018.

Polygon Density Class: Sparse (3-25 percent cover).

Year	# of Populations	# of Points	# of Polygons	Polygons per Density Class	Total Area of Polygons (ft ²)
				Sparse	
2018	3	0	3	3	309

2.2.7.2 MONTEREY GILIA

Monterey gilia was not identified in the Dunes SP survey area during the 2018 baseline survey.

2.2.8 2018 BASELINE SURVEY RESULTS – 2018 FONR SOUTH ACCESS ROUTE

In 2018, DD&A performed a baseline survey for a new access route location in the FONR South survey area (Figure 2). Attachment A includes detailed maps of the survey results.

2.2.8.1 MONTEREY SPINEFLOWER

Monterey spineflower was found along the access route at the FONR South survey area (Table 2.2.8.1 and Attachment A). During the 2018 survey, 12 populations (3 points and 9 polygons) of Monterey spineflower were identified. Of the polygons mapped, the majority (8 polygons) were identified as having a density class of sparse (5-25 percent cover of Monterey spineflower) (Table 2.2.8.1).

Table 2.2.8.1 Monterey Spineflower at the FONR South Access Route – Baseline Survey Results 2018.

Polygon Density Class: Sparse (3-25 percent cover) and Medium-Low (26-50 percent cover).

Year	# of Populations	# of Points	Polygons per Density Class			Total Area of Polygons (ft ²)
			Very Sparse	Sparse	Medium-Low	
2018	12	3	0	8	1	18,141

2.2.8.2 MONTEREY GILIA

Monterey gilia was found along the access route in the FONR South survey area (Table 2.2.8.2 and Attachment A). During the 2018 baseline survey, 9 populations (8 points and 1 polygon) consisting of a total of 18 individual Monterey gilia plants were found within the new FONR South access route survey area (Table 2.2.8.2).

Table 2.2.8.2 Monterey Gilia at FONR South Access Route – Baseline Survey Results 2018.

Year	# of Populations	Individual Plants	# of Points	# of Polygons	Area of Polygons (ft ²)
2018	9	19	8	1	25

3 DISCUSSION

3.1 RARE PLANT POPULATIONS

As required by the PBO, baseline surveys are conducted prior to a disturbance due to groundwater remediation effort and for three years after. Disturbance is considered activities related to installation or decommissioning of the monitoring wells or related infrastructure.

3.1.1 REFERENCE SITE

DD&A conducted surveys at the reference site in 2018. The DD&A reference site was surveyed in 2015 as part of the monitoring well baseline survey. DD&A again surveyed the reference site in 2016 and 2017 as part of the EISB Deployment Area baseline survey and the first and second annual survey for the monitoring wells.

3.1.1.1 MONTEREY SPINEFLOWER

Several environmental variables can influence the distribution and abundance of Monterey spineflower in a particular year (USFWS, 2002). Table 3.1.1.1 below shows the survey results for Monterey spineflower at the reference site for surveys conducted from 2015 to 2018. Between 2015 and 2016, the total area of Monterey spineflower polygons at the DD&A reference site increased by approximately 53%. Between 2016 and 2017, the total area of Monterey spineflower polygons at the DD&A reference site decreased by approximately 12%. Between 2017 and 2018, the total area of Monterey spineflower polygons at the DD&A reference site increased by approximately 8%. The total area of Monterey spineflower at the reference site was 46% larger in the third year when compared to baseline. While the total area of polygons was in the range of the area observed in previous years, the density class of the polygons in 2018 was on average lower than it had been in the three previous years of surveys. During the 2017 survey effort, DD&A anecdotally observed that non-native invasive grasses were colonizing the reference site more aggressively than previous years. The abundance of non-native invasive grass species resulted in a smaller amount of open space. The reduction in open space lowers the quality of habitat for Monterey spineflower and may have been a contributing factor to the reduction in density observed in the data for 2017. This trend was also confirmed during the 2018 survey effort. Although this trend has continued, it does not necessarily disqualify this site as a compatible reference site for FONR. The majority of FONR survey areas are also dominated by non-native grasses.

Table 3.1.1.1 Monterey Spineflower Population at the DD&A Reference Site 2015 - 2018.

Polygon Density Class: Very Sparse (<3 percent cover), Sparse (3-25 percent cover), Medium-Low (26-50 percent cover), and Medium (51-75 percent cover).

Year	# of Populations	# of Points	Polygons per Density Class				Total Area of Polygons (ft ²)	Area Percent Change
			Very Sparse	Sparse	Medium-Low	Medium		
2015	4	1	0	1	1	1	2,114	N/A
2016	2	0	0	0	1	1	3,241	53%
2017	4	0	0	3	1	0	2,855	-12%
2018	5	2	1	2	0	0	3,078	8%

3.1.1.2 MONTEREY GILIA

Several environmental variables can influence the distribution and abundance of Monterey gilia in a particular year (USFWS, 2008). Table 3.1.1.2 below shows the survey results for Monterey gilia at the reference site for surveys conducted from 2015 to 2018. Between 2015 and 2016 the DD&A reference site showed a decrease in number of individual Monterey gilia plants from 1,078 to 946, and a decrease in total area of Monterey gilia polygons from 1,512 ft² to 1,498 ft². The decrease in individual Monterey gilia plants (132, approximately 12%) was greater than the decrease in total area of Monterey gilia polygons (14 ft², approximately 1%). As with Monterey spineflower there was a reduction in the presence of Monterey gilia at the reference site in 2017. The number of individual plants observed in 2017 was the lowest number observed in the three years of monitoring. Between 2016 and 2017 the number of individual Monterey gilia plants decreased by approximately half (483, approximately 51%); however, the total area of the polygons increased between 2016 and 2017 (452 ft², approximately 30%). Between 2017 and 2018, the number of individual gilia plants once again decreased from 463 to 352 individuals, or approximately 24%, and the total area of gilia polygons decreased substantially from 1,950 ft² to 481 ft², or approximately 75%. As discussed above, it was anecdotally observed in 2017 and 2018 that open space at the reference site was reduced due to an increase in grass cover at the site, which likely contributed to the quality of habitat for this species. Monterey gilia is more dependent on open space than Monterey spineflower. Additionally, a decrease in Monterey gilia area is documented below for populations located on FONR. This trend suggests that conditions during the 2018 growing season were not ideal for Monterey gilia. A new reference site that is more consistent with the habitat on FONR should be delineated for future survey efforts. Where Monterey gilia is found on FONR the habitat is closer to typical Monterey gilia habitat; dominated by bare ground and not annual grasses.

Table 3.1.1.2 Monterey Gilia at DD&A Reference Site 2015 - 2018.

Year	# of Populations	Individual Plants	Indiv. Plant	# of Points	# of Polygons	Area of Polygons	Area
			Percent Change			(ft ²)	Percent Change
2015	11	1,078	0%	4	7	1,512	0
2016	6	946	-12%	3	3	1,498	-1%
2017	8	463	-51%	6	2	1,950	30%
2018	21	352	-24%	8	13	481	-75%

3.1.2 YEAR 3 FOLLOW-UP SURVEY 2018 – MONITORING WELLS

Surveys conducted in 2018 were the third and final of three annual surveys required following the disturbance associated with the well installation and other groundwater remediation efforts of 2015.

3.1.2.1 MONTEREY SPINEFLOWER

As stated in Section 2.2.4, 195 populations (93 points and 102 polygons) of Monterey spineflower were identified in 2018 within the monitoring well survey area. Of the polygons mapped in 2018, the majority (80 polygons) were identified as having a density class of sparse (5-25 percent cover of Monterey spineflower). From 2017 to 2018, the total area of Monterey spineflower decreased substantially from 108,402 ft² to 64,585

ft², or approximately 40%. Similarly, though less severely, the total area of Monterey spineflower polygons decreased by approximately 6% from 2016 to 2017. The only year the area of Monterey spineflower polygons increased within the original 2015 monitoring well survey area was 2016, when the total area of Monterey spineflower polygons increased by approximately 458% from the 2015 baseline. However, the total area observed in 2018 was 214% larger than the total area observed during the 2015 baseline survey.

During the 2015 baseline surveys, Monterey spineflower was found at four well locations (MW-BW-86-A, MW-BW-88-A, MW-BW-90-A, and MW-BW-92-A) and along access routes. In 2016, Monterey spineflower was found at six of the eight well locations (MW-BW-86-A, MW-BW-87-A, MW-BW-88-A, MW-BW-89-A, MW-BW-90-A, and MW-BW-92-A) and along access routes (Table 3.1.2.1). In 2017, Monterey spineflower was found at five of the eight well locations (MW-BW-86-A, MW-BW-87-A, MW-BW-88-A, MW-BW-90-A, and MW-BW-92-A) and along access routes. In 2018, Monterey spineflower was found at six of the eight well locations (MW-BW-86-A, MW-BW-87-A, MW-BW-88-A, MW-BW-90-A, MW-BW-91-A, and MW-BW-92-A) and along access routes.

Table 3.1.2.1 Monterey Spineflower within the 2015 Monitoring Wells Survey Area 2015 - 2018.

Polygon Density Class: Very Sparse (3-25 percent cover), Sparse (5-25 percent cover), Medium-Low (26-50 percent cover), Medium (51-75 percent cover), and Medium-High (76-97 percent cover).

Year	# of Populations	# of Points	Polygons per Density Class					Total Area of Polygons (ft ²)	Area Percent Change
			Very Sparse	Sparse	Medium-Low	Medium	Medium-High		
2015	150	55	3	74	12	5	1	20,563	0%
2016	177	75	0	78	21	3	0	114,818	458%
2017	131	55	0	65	11	0	0	108,402	-6%
2018	195	93	7	80	15	0	0	64,585	-40%

As mentioned above, several environmental variables can influence the distribution and abundance of Monterey spineflower in a particular year. Some combination of the environmental variables is likely responsible for a percentage of the increasing trend in Monterey spineflower populations observed at both the reference site and survey area in 2016. However, while both the survey area and the reference site exhibited an increase in Monterey spineflower in 2016, the percent increase in Monterey spineflower was much greater within the survey area compared to the reference site. In addition to favorable environmental factors, well installation activities within the survey area that required vegetation clearing may have resulted in an increase in suitable habitat for Monterey spineflower (open sandy areas), which may have contributed to the substantial increase of Monterey spineflower observed within the survey area in 2016. The relationship between activities associated with the cleanup of the former Fort Ord and an increase of Monterey spineflower populations has been previously documented (USFWS, 2002). A shift in the density class of polygons (no polygons with a density class above medium-low) and a decrease in total area of polygons was observed in 2017, and again in 2018. The decrease in spineflower observed in 2018 was more than that observed in 2017 and was not consistent with the 8% increase of spineflower at the reference site. In 2017, a large population of spineflower (located within the area of overlap between the EISB Deployment Area and the 2015 monitoring well survey area) was mapped outside of the monitoring well survey area. The same population of spineflower did not intersect the survey area in 2018 and was therefore not included in the 2018 spineflower survey totals, likely contributing to the 40% decrease in total area from 2017. Overall, in Year 3 follow up surveys, the number of

well locations with Monterey spineflower presence increased by two, and the population was three times greater than in baseline year.

3.1.2.2 MONTEREY GILIA

As stated in Section 2.2.4, 60 populations (39 points and 21 polygons) consisting of 2,666 individuals were found within the original 2015 monitoring well survey area in 2018. Between 2015 and 2016, the monitoring well survey area experienced a substantial increase in number of individual Monterey gilia plants, from 347 observed in 2015 to 1,591 observed in 2016, and an increase in total area of Monterey gilia polygons, from 1,217 ft² in 2015 to 4,921 ft² in 2016. Within the monitoring well survey area, the number of individual Monterey gilia plants increased in 2016 by approximately 360% and the total area of Monterey gilia polygons increased by approximately 300%. During the 2015 baseline surveys Monterey gilia was not observed within 50 feet any of the well locations. However, during the 2016 follow-up survey, Monterey gilia was observed within 50 feet of two well locations (MW-BW-89-A and MW-BW-92-A). The number of Monterey gilia populations within the monitoring well survey area more than quadrupled in 2016 compared to the 2015 baseline data (Table 3.1.2.2). The detected increase in Monterey gilia between 2015 and 2016 at the monitoring wells is inconsistent with observations at the reference site. In 2017, Monterey gilia was observed at one well location (MW-BW-92-A). The number of populations and the individual Monterey gilia decreased slightly between 2016 and 2017 (25 fewer populations and 52 fewer plants); however, the total area of Monterey gilia plants increased from 4,921 ft² in 2016 to 8,494 ft² in 2017. In 2018, Monterey gilia was observed at one well location (MW-BW-92-A). Although the number of gilia populations increased from 41 in 2017 to 60 in 2018, the number of individual plants decreased from 1,539 to 638, or approximately 59%, and the total area of gilia polygons decreased from 8,494 to 2,666, or approximately 69%. While this is a substantial decrease, it is consistent with the decrease of Monterey gilia observed at the reference site.

Table 3.1.2.2 Monterey Gilia within the 2015 Monitoring Well Survey Area 2015 - 2018.

Year	# of Populations	Individual Plants	Indiv. Plant		# of Polygons	Area of Polygons (ft ²)	Area Percent Change
			Percent Change	# of Points			
2015	14	347	0%	10	4	1,217	0
2016	66	1591	359%	35	31	4,921	304%
2017	41	1539	-3%	28	13	8,494	73%
2018	60	638	-59%	39	21	2,666	-69%

As mentioned above, several environmental variables can influence the distribution and abundance of Monterey gilia in a particular year. Some combination of factors is likely responsible for the decreasing trend in Monterey gilia populations observed at the reference site. However, the percent variation in Monterey gilia was much greater in the first year following well installation within the survey area compared to the reference site. In addition to favorable environmental factors, well installation activities within the survey area that required vegetation clearing may have resulted in an increase in suitable habitat for Monterey gilia (open sandy areas). Resource competition is generally understood to refer to the negative effects caused by the presence of neighbors, usually by reducing the availability of resources. Competition is an important factor controlling plant communities. Since all plants require a few basic elements, the resources involved are generally light, water, nitrogen, or phosphorus, depending upon the species and the location. The disturbance/clearing

associated with well installation reduces the level of competition for these finite resources by creating voids in otherwise densely competitive communities (grasslands) that are generally dominated by non-native invasive plants. Increased availability of suitable habitat and a reduction in resource competition within the survey area may have contributed to the substantial increase of Monterey gilia observed within this area in 2016. A slight decrease in the number of individual plants was observed in 2017. The decrease was consistent with the trend observed at the reference site in 2017, although the percent decrease in individual plants observed at the reference site was much larger. A substantial decrease in the number of individual gilia was observed in 2018 at both the survey area and the reference site. Although the percent decrease at the survey area was more than double the percent decrease at the reference site. As in 2017, when the opposite was true and the decrease in gilia was greater at the reference site than the survey area, this is likely normal, annual variation within the gilia population. Both the survey area and the reference site had similar decreases in area cover in 2018 from the previous year. Overall, in the Year 3 follow up surveys, the number of well locations with Monterey gilia presence increased by one, and the population was 84% greater than in the baseline year.

3.1.3 YEAR 2 FOLLOW-UP SURVEY 2018 – EISB DEPLOYMENT AREA

Surveys conducted in 2018 were the second of three annual surveys required following the disturbance associated with the EISB Deployment Area where construction activities occurred in 2016.

3.1.3.1 MONTEREY SPINEFLOWER

As stated in Section 2.2.5, 104 populations (58 points and 46 polygons) of Monterey spineflower were identified in 2018 within the survey area of the EISB Deployment Area. Of the polygons mapped in 2018, the majority (34 polygons) were identified as having a density class of sparse (5-25 percent cover of Monterey spineflower). The total area of Monterey spineflower polygons decreased from 117,397 ft² in 2016 to 89,649 ft² in 2017, and from 89,649 ft² in 2017 to 72,816 ft² in 2018 (Table 3.1.3.1). This represents approximately 24% and 19% decreases, respectively.

Table 3.1.3.1 Monterey Spineflower within the EISB Deployment Area 2016 - 2018.

Polygon Density Class: Very Sparse (3-25 percent cover), Sparse (5-25 percent cover), Medium-Low (26-50 percent cover), and Medium (51-75 percent cover).

Year	# of Populations	# of Points	Polygons per Density Class				Total Area of Polygons (ft ²)	Area Percent Change
			Very Sparse	Sparse	Medium-Low	Medium		
2016	76	22	0	39	12	3	117,397	N/A
2017	62	31	0	26	5	0	89,649	-24%
2018	104	58	2	34	10	0	72,816	-19%

As mentioned above, several environmental variables can influence the distribution and abundance of Monterey spineflower in a particular year. Some combination of the environmental variables is likely responsible for a downward trend in Monterey spineflower populations observed at the survey area. A shift in the density class of polygons (no polygons with a density class above medium-low) and a decrease in total area of polygons was observed in 2017 and again in 2018 within the survey area for the EISB Deployment Area. Although the decrease was consistent with the decrease in 2017, it was not consistent with the 8% increase at the reference site in 2018. This decrease is likely due to annual variation within the spineflower population at the survey area.

3.1.3.2 MONTEREY GILIA

As stated in Section 2.2.5, Monterey gilia was not observed within the survey area for the EISB Deployment Area in 2018. Between 2016 and 2017, the number of individual plants observed within the survey area for the EISB Deployment Area decreased from 36 to 7, and the total area of Monterey gilia polygons decreased from 84 ft² to 29 ft² (Table 3.1.3.2). During the 2016 baseline survey and the 2017 and 2018 follow-up surveys, Monterey gilia was not observed within 50 feet any of the well locations, but it was found within the survey area on access roads connecting well locations.

Table 3.1.3.2 Monterey Gilia within EISB Deployment Area 2016 - 2018.

Year	# of Populations	Individual Plants	Indiv. Plant Percent Change	# of Points	# of Polygons	Area of Polygons (ft²)	Area Percent Change
2016	1	36	N/A	0	1	84	N/A
2017	1	7	-81%	0	1	29	-65%
2018	0	0	-100%	0	0	0	-100%

As mentioned above, several environmental variables can influence the distribution and abundance of Monterey gilia in a particular year. Some combination of factors is likely responsible for the decreased Monterey gilia populations observed at the reference site and the survey area for the EISB Deployment Area. Additionally, the sample sizes of gilia observed in the previous two surveys were extremely small, and thus any changes to the populations within them result in large percent changes of the total population.

4 CONCLUSION AND RECOMMENDATION

In 2018, Monterey spineflower was present within the entire survey area, and Monterey gilia was present everywhere but within the EISB Deployment Area and the Dunes SP monitoring well. Within the original 2015 monitoring well survey area, the populations of Monterey gilia and Monterey spineflower were larger in 2018 than those identified in the 2015 baseline survey. The populations of Monterey gilia and Monterey spineflower observed in 2018 within the EISB Deployment Area were less than those observed in the 2016 baseline survey for that area. While a downward trend was also observed at the reference site for gilia, this decrease was not consistent with the increase of spineflower at the reference site. This discrepancy may be explained by a large Monterey spineflower polygon that was mapped previously but did not intersect the survey area, and by the nature of population dynamics, where several environmental variables can influence the distribution and abundance of spineflower in any particular year. No piperia rosettes were identified in 2018.

This survey effort represented the final survey for the original 2015 monitoring well sites. As required by the 2017 PBO, following the third and final monitoring event an evaluation of the success criteria is applied to determine if they have been met or if additional corrective actions are necessary. The success criteria for HMP annual species are identified in the 2017 PBO as:

1. Densities and acreage of HMP annual species are within normal range compared with information from reference sites.
2. The number of wells where HMP annual species are detected in follow up surveys will be the same or greater than the number of wells where these species were found in baseline surveys.

Monterey spineflower and Monterey gilia populations, individual plants, and area have increased since the 2015 baseline survey in the monitoring well site survey area. Although there was a decrease for both species, when compared to 2016 and 2017 survey efforts, that trend is within the normal range when compared to information from the reference site. In 2015, Monterey gilia was not observed within 50 feet any of the well locations, but it was observed on the access route for MW-BW-89-A. In 2018, Monterey gilia was observed at one well location (MW-BW-92-A), as well as the access routes for well sites MW-BW-92-A and MW-BW-89-A. In 2015, Monterey spineflower was found at four well locations (MW-BW-86-A, MW-BW-88-A, MW-BW-90-A, and MW-BW-92-A) and along access routes. In 2018, Monterey spineflower was found at six well locations (MW-BW-86-A, MW-BW-87-A, MW-BW-88-A, MW-BW-90-A, MW-BW-91-A, and MW-BW-92-A) and along access routes. The 2015 monitoring well sites have met the required success criteria and do not require additional survey efforts or corrective actions.

The third and final annual follow-up survey will be conducted at the EISB Deployment Area in 2019. The three annual follow-up surveys for the monitoring well installation and decommissioning, and access route areas will be conducted in 2019, 2020, and 2021. DD&A will communicate with all relevant parties prior to conducting annual surveys.

Well monitoring for the OUCTP involves driving or walking to the monitoring well location and collecting a water level measurement and groundwater samples from the well using passive diffusion bags. To reduce the amount of potential impacts to seedbank of rare annual plants or actual individuals of rare annual plants during the blooming period, walking would be the preferred method to access the monitoring well locations from the main thoroughfares whenever possible. To reduce the potential for impacts to rare annual plant species seed

banks located along the main access roads, it is recommended that vehicle traffic be limited to the minimum necessary to conduct groundwater remediation activities, and vehicle speeds should remain under 15 miles per hour. Four-wheel or all-wheel drive vehicles should be employed to conduct groundwater remediation activities to reduce the likelihood of vehicles becoming stuck and causing excess erosion.

Identification of new well locations, access routes, and staging areas at FONR North, FONR South, and the Dunes SP, if necessary, should be made using baseline and follow up survey data to minimize impacts to HMP plant species by avoiding known populations. Avoidance of UCSC study plots should continue to be coordinated with FONR staff and the BRAC Biologist. Habitat checklists and tailgate meetings with the on-site DD&A biologist and drilling personnel prior to mobilization at each well location will ensure that drilling equipment is placed to avoid HMP species to the greatest extent possible.

5 REFERENCES

Denise Duffy & Associates, Inc. [DD&A]. 2015. Biological Monitoring Completion Report for the Ahtna Well Installation and Development at the Operable Unit Carbon Tetrachloride Plume (OUCTP). Prepared for Ahtna Environmental, Inc. September 2015.¹⁶

_____. 2017a. 2016 Annual Rare Plant Survey & Biological Monitoring Report for the Ahtna Monitoring Well Installation & Development and Enhanced In Situ Bioremediation (EISB) Deployment Construction at the Operable Unit Carbon Tetrachloride Plume (OUCTP). Prepared for Ahtna Environmental, Inc. March 2017.

_____. 2017b. 2017 Annual Rare Plant Survey & Biological Monitoring Report for the Ahtna Monitoring Well Installation & Development and Enhanced In Situ Bioremediation (EISB) Deployment Construction at the Operable Unit Carbon Tetrachloride Plume (OUCTP). Prepared for Ahtna Environmental, Inc. July 2017.

HydroGeoLogic, Inc. [HGL], 2008. 2007 FONR Impact Assessment and Habitat and Rare Plant Survey Results, Fritzsche Army Airfield Fire Drill Area, Former Fort Ord, California. February. Administrative Record Series Number OU1-534.

_____. 2009a. 2008 FONR Impact Assessment and Habitat and Rare Plant Species Survey Results, Fritzsche Army Airfield Fire Drill Area, Former Fort Ord, California. January. Administrative Record Series Number OU1-564.

_____. 2009b. 2009 FONR Impact Assessment and Habitat and Rare Plant Species Survey Results, Fritzsche Army Airfield Fire Drill Area, Former Fort Ord, California. December. Administrative Record Series Number OU1-574.

_____. 2011. 2010 FONR Impact Assessment and Habitat and Rare Plant Species Survey Results, Fritzsche Army Airfield Fire Drill Area, Former Fort Ord, California. January. Administrative Record Series Number OU1-585.

_____. 2012. 2011 FONR Impact Assessment and Habitat and Rare Plant Species Survey Results, Fritzsche Army Airfield Fire Drill Area, Former Fort Ord, California. January. Administrative Record Series Number BW-2614.

_____. 2013a. 2012 FONR Impact Assessment and Habitat and Rare Plant Species Survey Results, Operable Unit 1, Former Fort Ord, California. February. Administrative Record Series Number OU1-600.

_____. 2013b. 2013 FONR Impact Assessment and Habitat and Rare Plant Species Survey Results, Operable Unit 1, Former Fort Ord, California. December. Administrative Record Series Number OU1-605.

_____. 2014. 2014 FONR Impact Assessment and Habitat and Rare Plant Species Survey Results, Operable Unit 1, Former Fort Ord, California. December. Administrative Record Series Number OU1-612.

¹⁶ Attachment F to the Final Operable Unit Carbon Tetrachloride Plume Evaluation Technical Memorandum, A-Aquifer, Former Fort Ord, California. January 2016. OUCTP-0070.

- ____ 2015. 2015 FONR Impact Assessment and Habitat and Rare Plant Species Survey Results, Operable Unit 1, Former Fort Ord, California. December. Administrative Record Series Number OU1-622.
- ____ 2016. 2016 FONR Impact Assessment and Habitat and Rare Plant Species Survey Results, Operable Unit 1, Former Fort Ord, California. January. Administrative Record Series Number OU1-628.
- U.S. Army Corps of Engineers [USACE], 1997. Installation-Wide Multispecies Habitat Management Plan (HMP) for Former Fort Ord, California. April. BW-1787.
- U.S. Fish and Wildlife Service [USFWS]. 2002. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for *Chorizanthe pungens* var. *pungens* (Monterey spineflower). Federal Register 67(103): 37497-3754.
- ____ 2008. Monterey Gilia (*Gilia tenuiflora* ssp. *arenaria*) 5-Year Review: Summary and Evaluation U.S. Fish and Wildlife Service Ventura Fish and Wildlife Office Ventura, California. March 2008.
- ____ 2015. Programmatic Biological Opinion for Cleanup and Property Transfer Actions Conducted at the Former Fort Ord, Monterey County, California (8-8-09-F-74) (2015 Biological Opinion). May 28. AR# BW-2747.
- ____ 2017. Reinitiation of Formal Consultation for Cleanup and property Transfer Actions Conducted at the Former Fort Ord, Monterey County, California (Original Consultation #8-8-09-F-74, 81440-2009-F-0334). June 7. AR# BW-2747A.

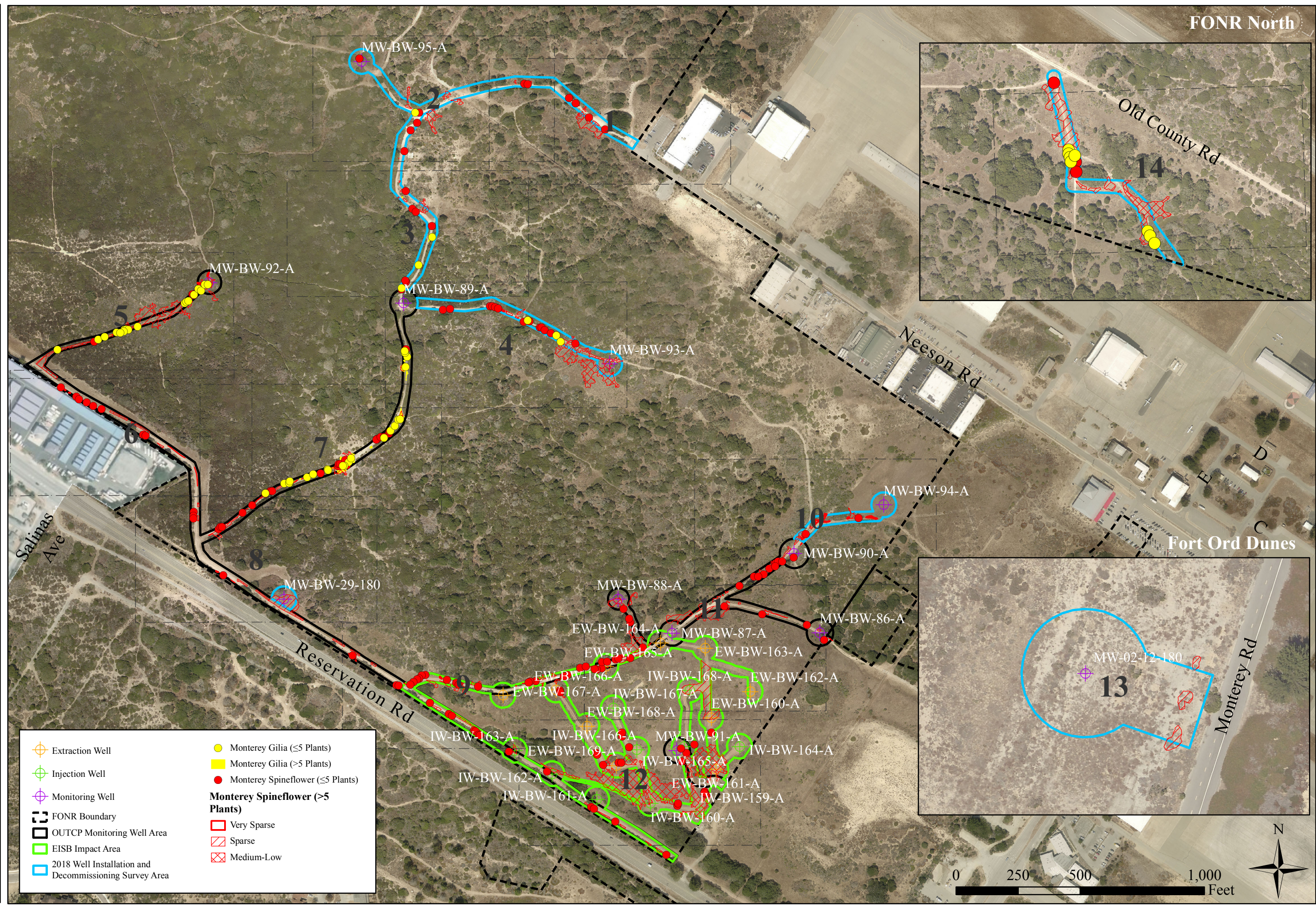
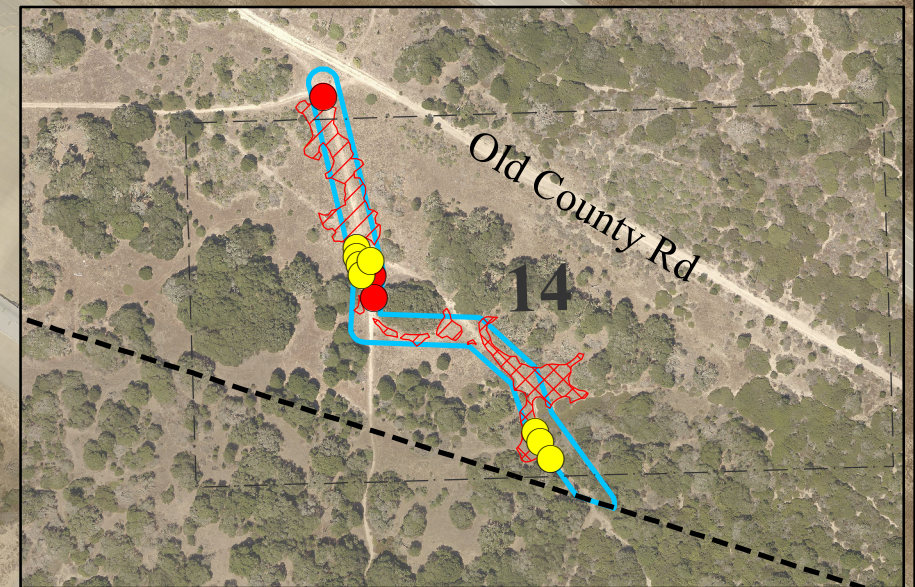
This Page Intentionally Left Blank

ATTACHMENT A

2018 ANNUAL RARE PLANT SURVEY RESULTS
OVERVIEW AND DETAIL MAPS

Attachment A: 2018 Rare Plant Survey Results Overview and Detail Maps

Document Path: F:\GIS\GIS_Progect\2015-09_Altam FONR Map Products\2018 Survey\Attachment A 2018 Rare Plant Survey Results Overview Map.mxd



	Monterey Spineflower (>5 Plants)



Attachment A: 2018 Rare Plant Survey Results Overview and Detail Maps



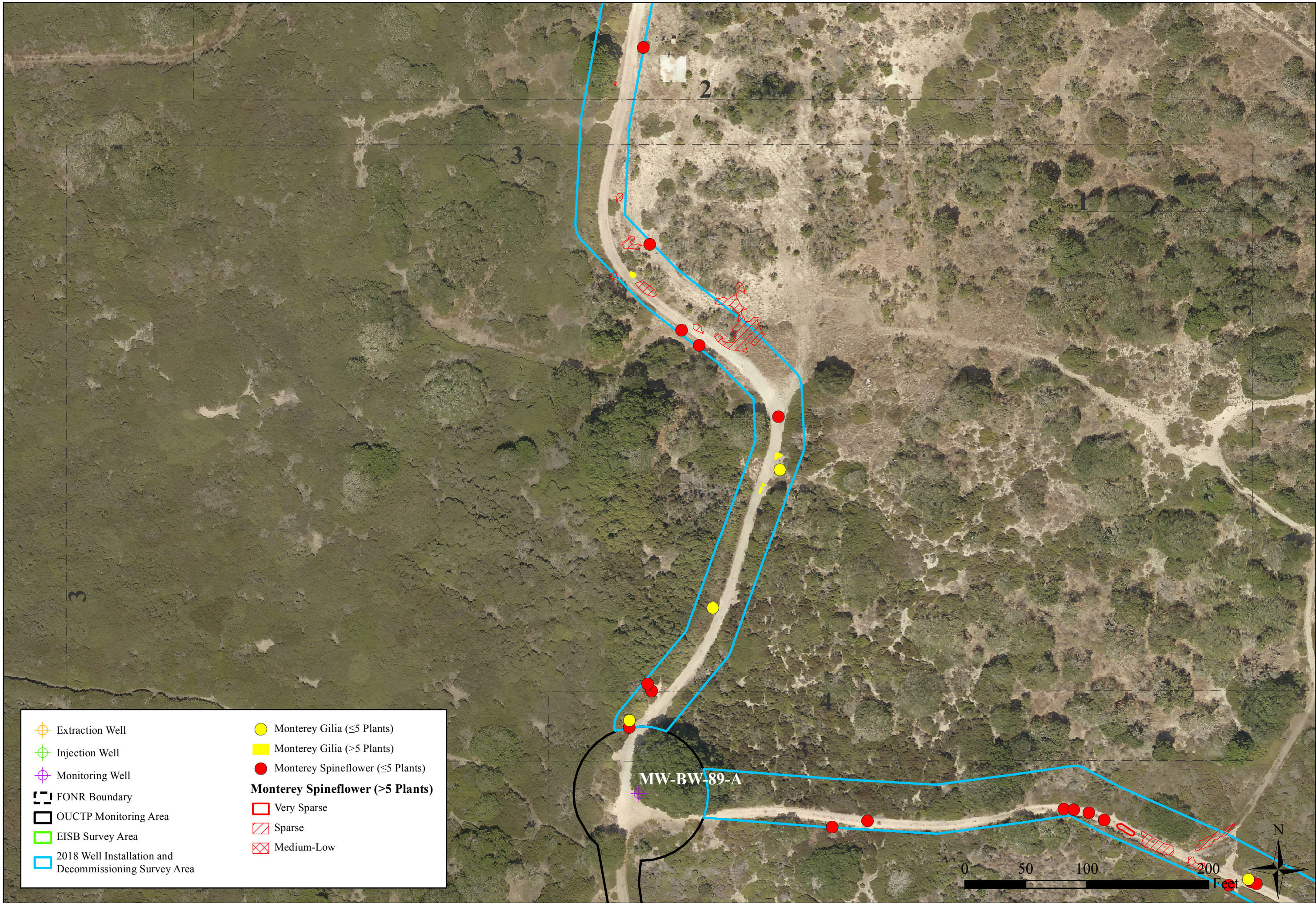
- | | | | |
|--|--|--|-----------------------------------|
| | Extraction Well | | Monterey Gilia (<=5 Plants) |
| | Injection Well | | Monterey Gilia (>5 Plants) |
| | Monitoring Well | | Monterey Spineflower (<=5 Plants) |
| | FONR Boundary | Monterey Spineflower (>5 Plants) | |
| | OUCTP Monitoring Area | | Very Sparse |
| | EISB Survey Area | | Sparse |
| | 2018 Well Installation and Decommissioning Survey Area | | Medium-Low |



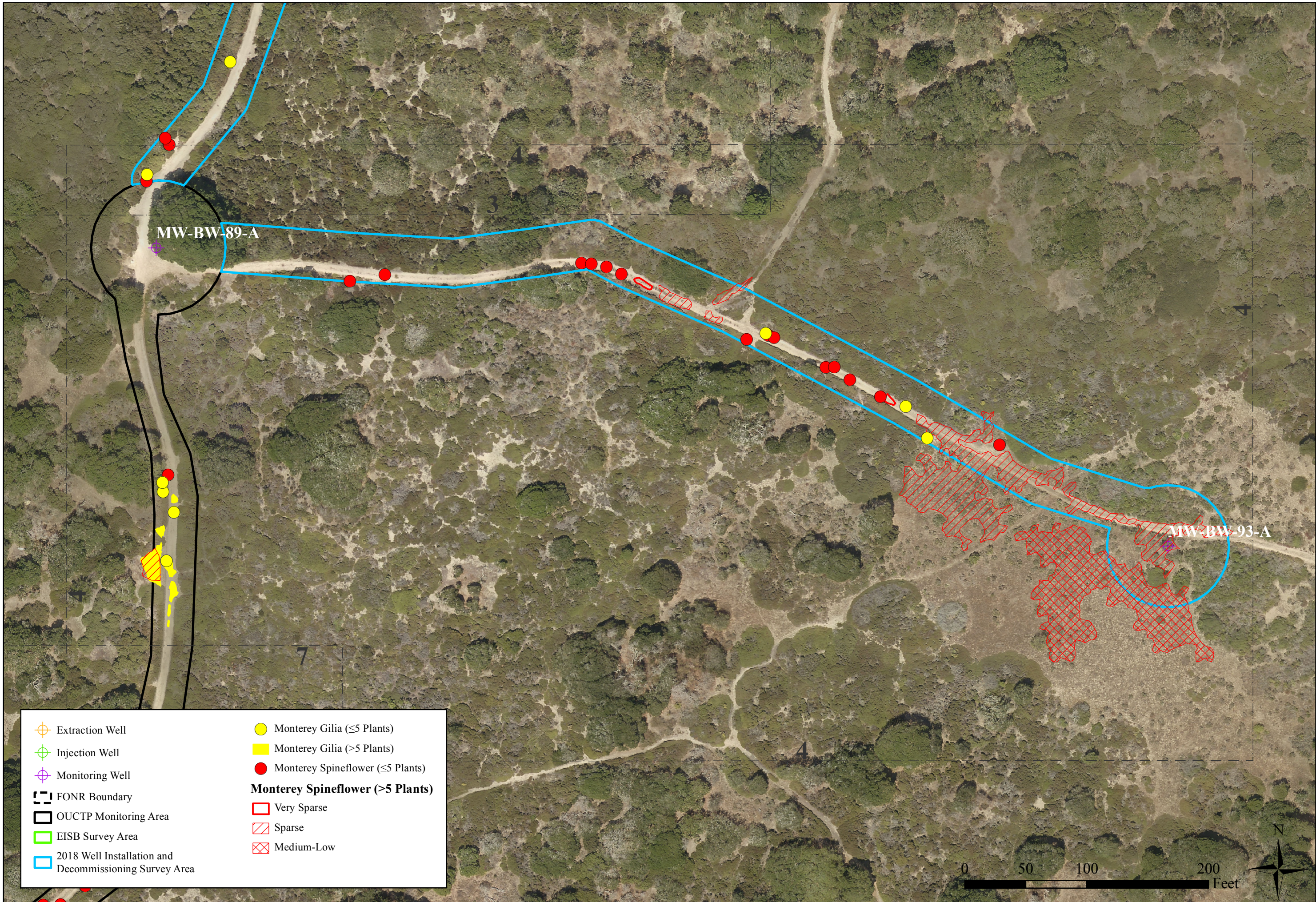
Attachment A: 2018 Rare Plant Survey Results Overview and Detail Maps



Attachment A: 2018 Rare Plant Survey Results Overview and Detail Maps



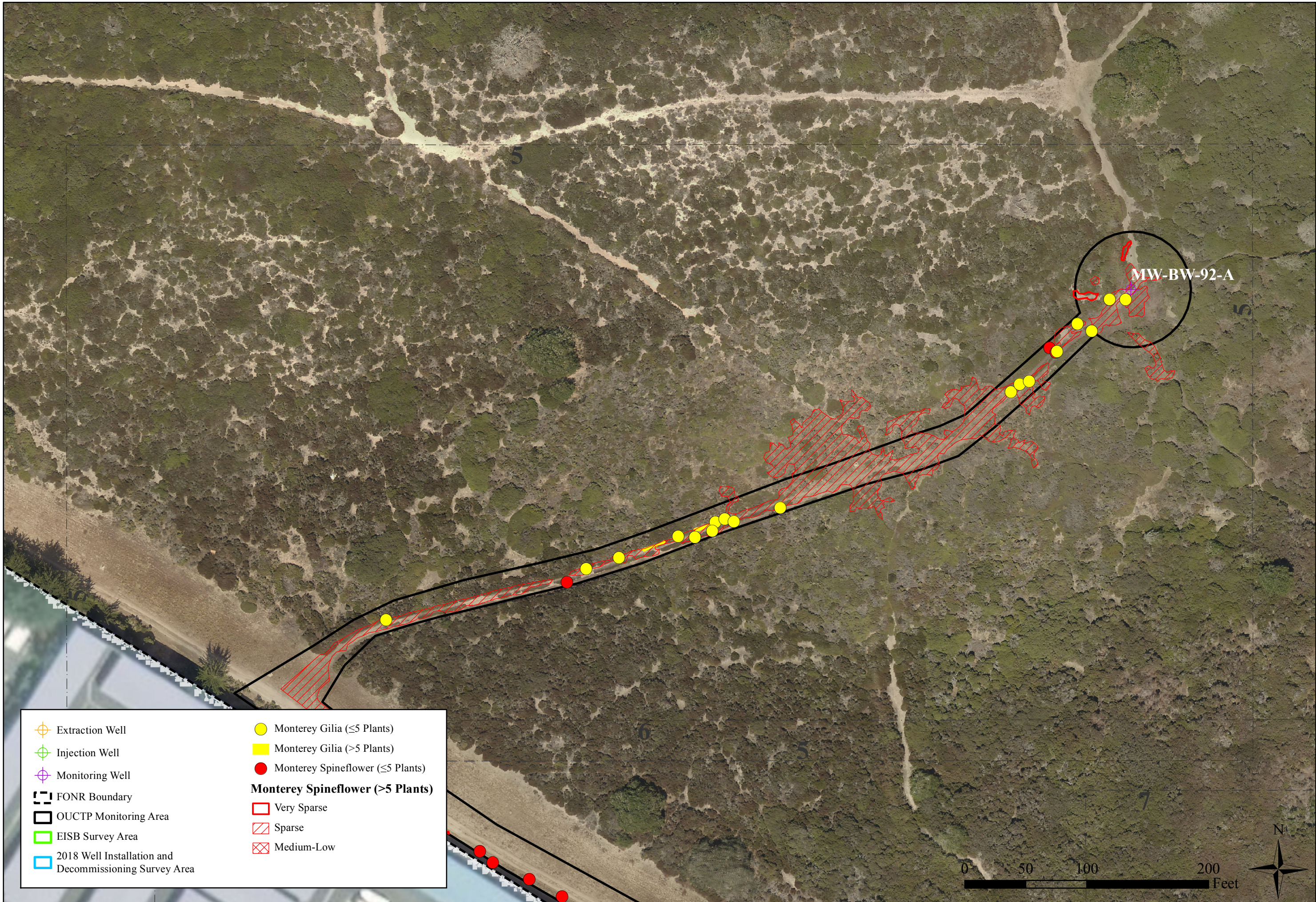
Attachment A: 2018 Rare Plant Survey Results Overview and Detail Maps



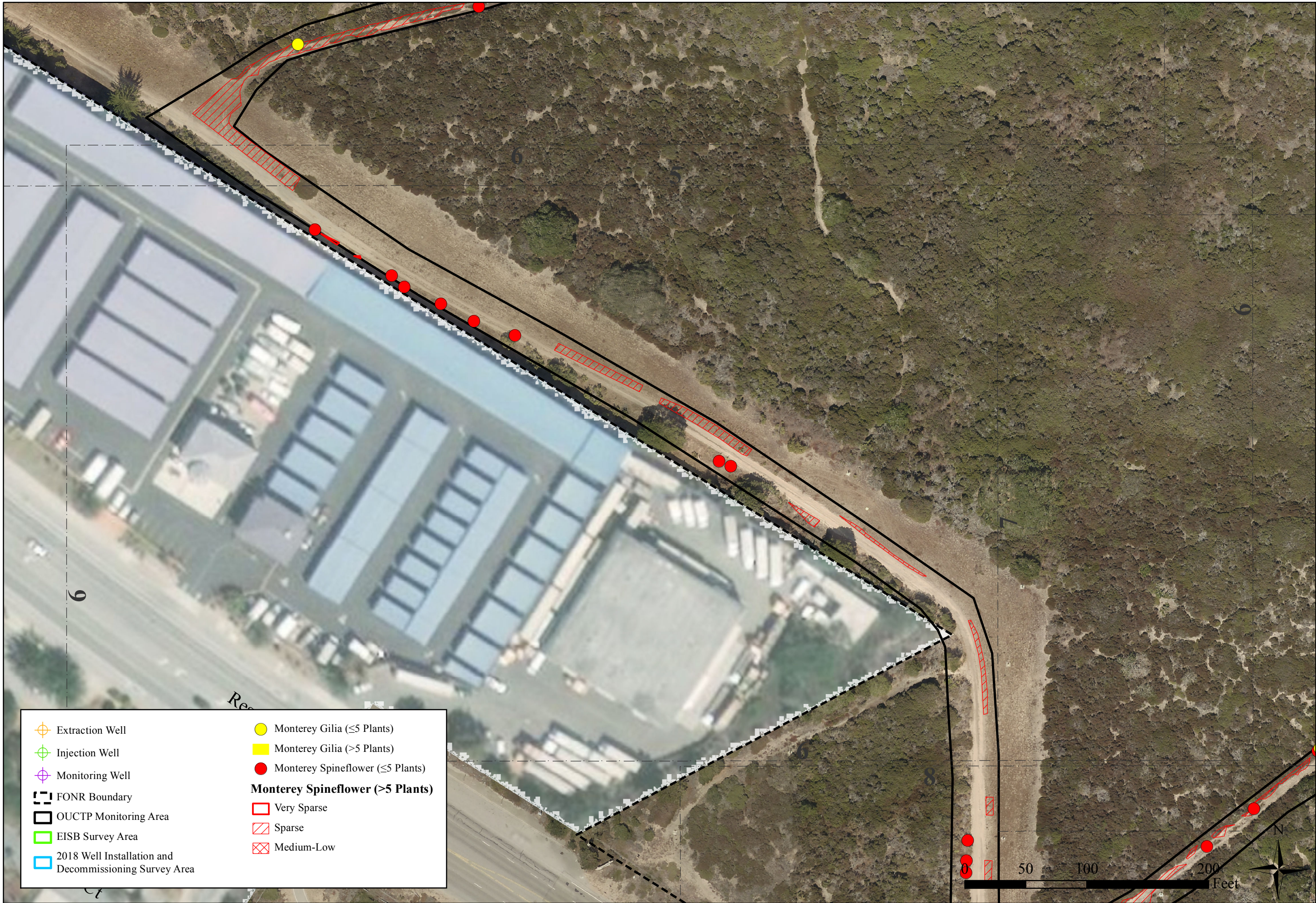
- | | | | |
|--|--|--|---|
| | Extraction Well | | Monterey Gilia (≤ 5 Plants) |
| | Injection Well | | Monterey Gilia (> 5 Plants) |
| | Monitoring Well | | Monterey Spineflower (≤ 5 Plants) |
| | FONR Boundary | Monterey Spineflower (> 5 Plants) | |
| | OUCTP Monitoring Area | | Very Sparse |
| | EISB Survey Area | | Sparse |
| | 2018 Well Installation and Decommissioning Survey Area | | Medium-Low |



Attachment A: 2018 Rare Plant Survey Results Overview and Detail Maps



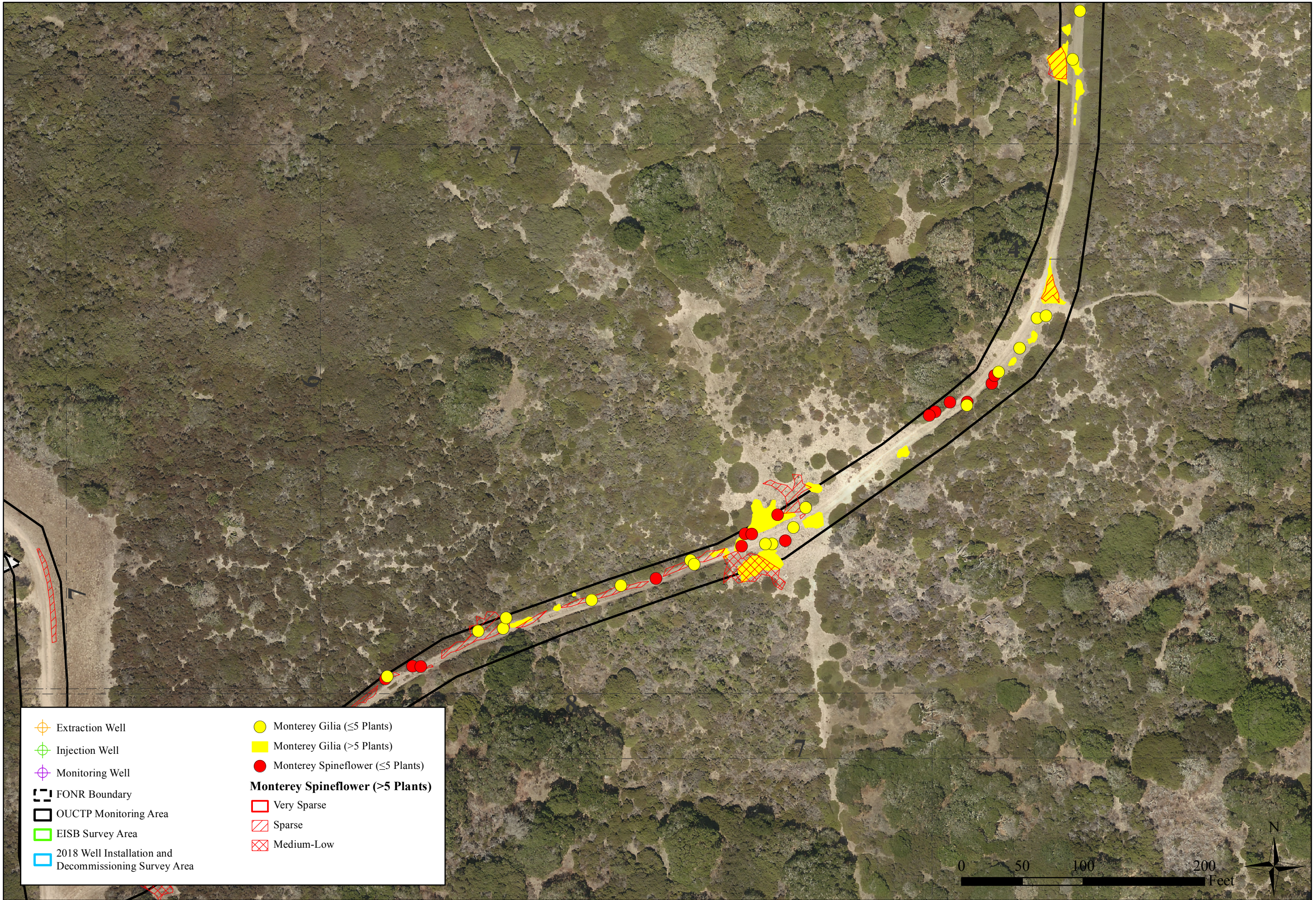
Attachment A: 2018 Rare Plant Survey Results Overview and Detail Maps



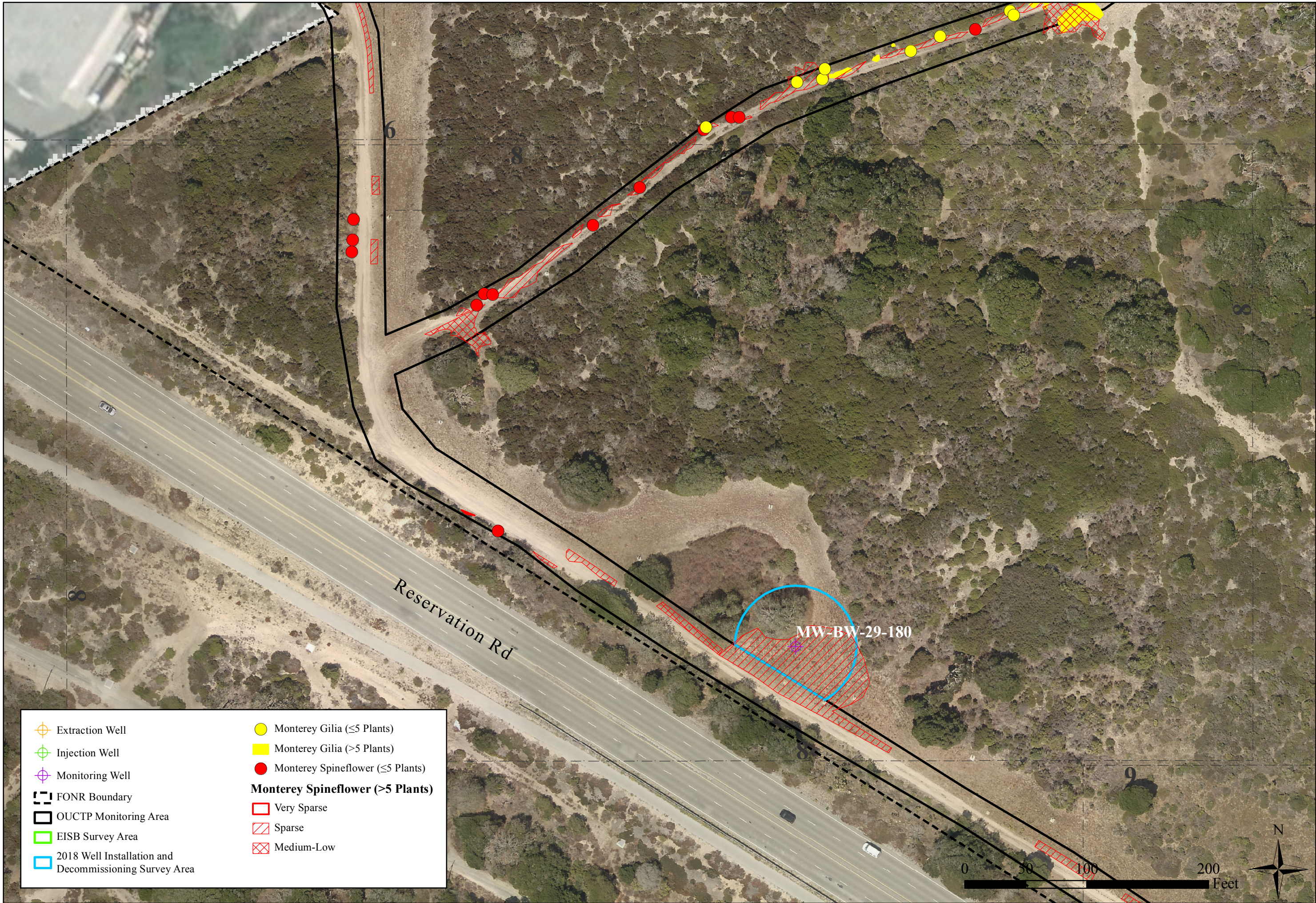
- | | |
|--|--|
| Extraction Well | Monterey Gilia (≤ 5 Plants) |
| Injection Well | Monterey Gilia (> 5 Plants) |
| Monitoring Well | Monterey Spineflower (≤ 5 Plants) |
| FONR Boundary | Monterey Spineflower (> 5 Plants) |
| OUCTP Monitoring Area | Very Sparse |
| EISB Survey Area | Sparse |
| 2018 Well Installation and Decommissioning Survey Area | Medium-Low |



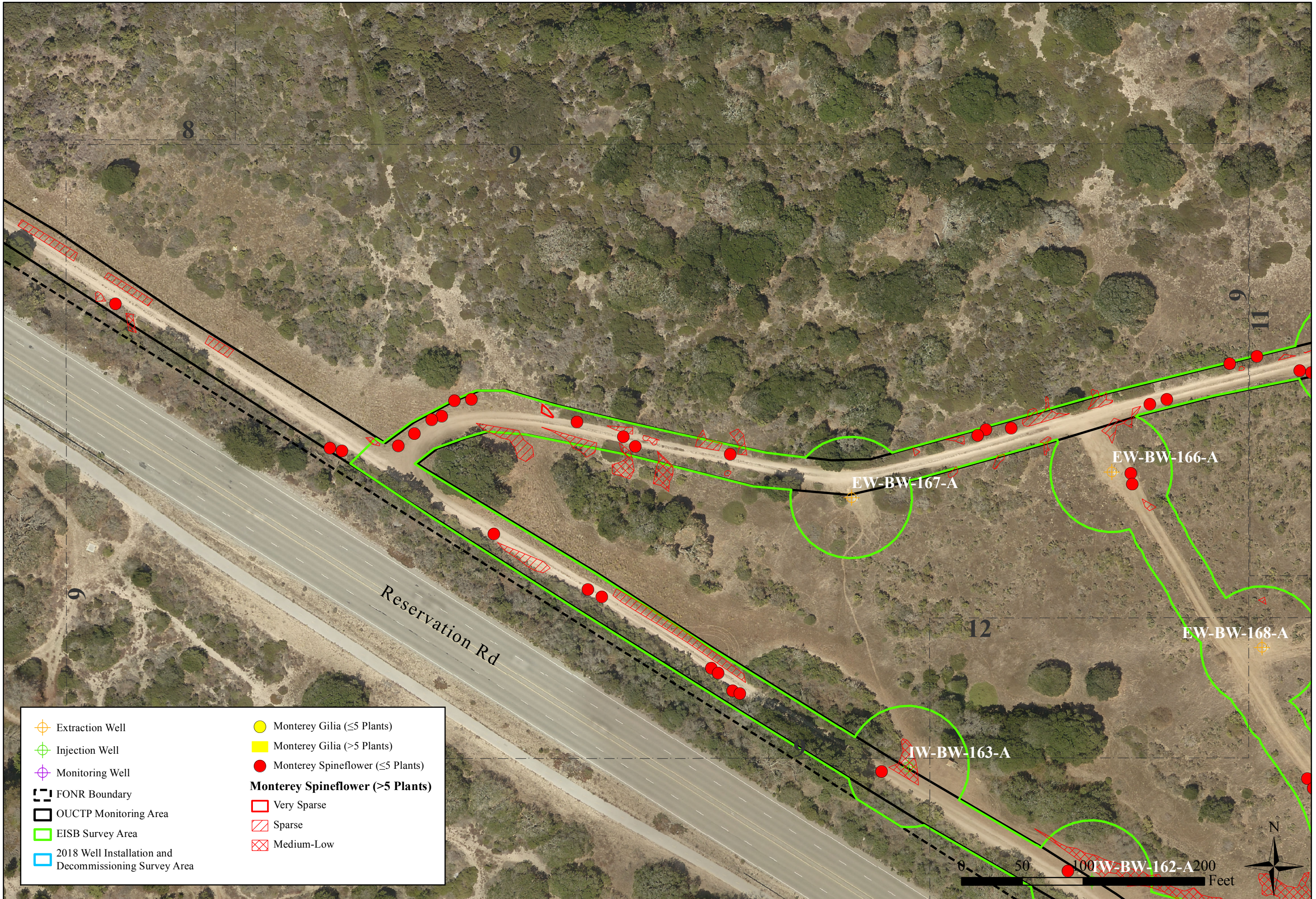
Attachment A: 2018 Rare Plant Survey Results Overview and Detail Maps



Attachment A: 2018 Rare Plant Survey Results Overview and Detail Maps

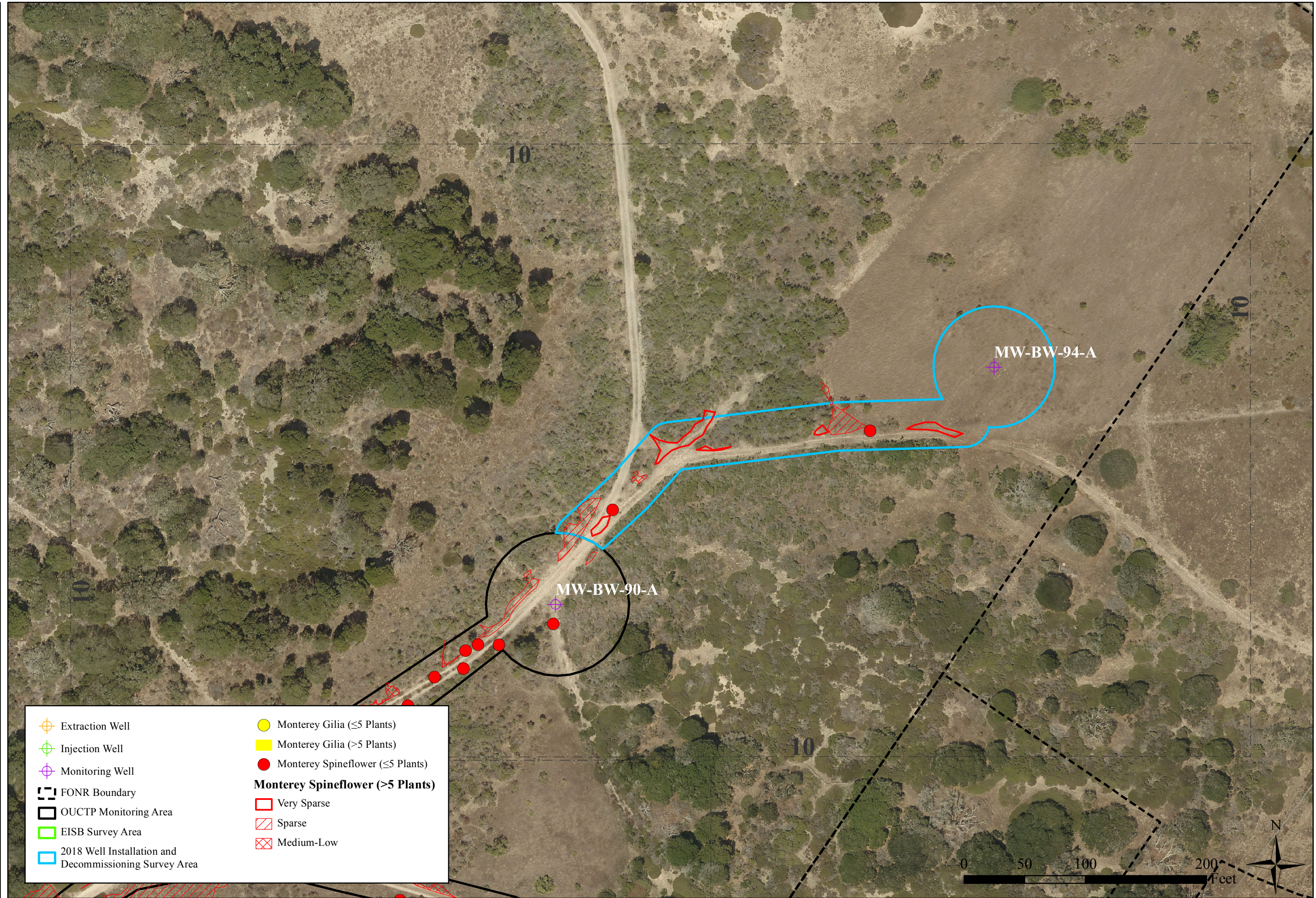


Attachment A: 2018 Rare Plant Survey Results Overview and Detail Maps



	Extraction Well		Monterey Gilia (≤5 Plants)
	Injection Well		Monterey Gilia (>5 Plants)
	Monitoring Well		Monterey Spineflower (≤5 Plants)
	FONR Boundary		Monterey Spineflower (>5 Plants) Very Sparse
	OUCTP Monitoring Area		Sparse
	EISB Survey Area		Medium-Low
	2018 Well Installation and Decommissioning Survey Area		

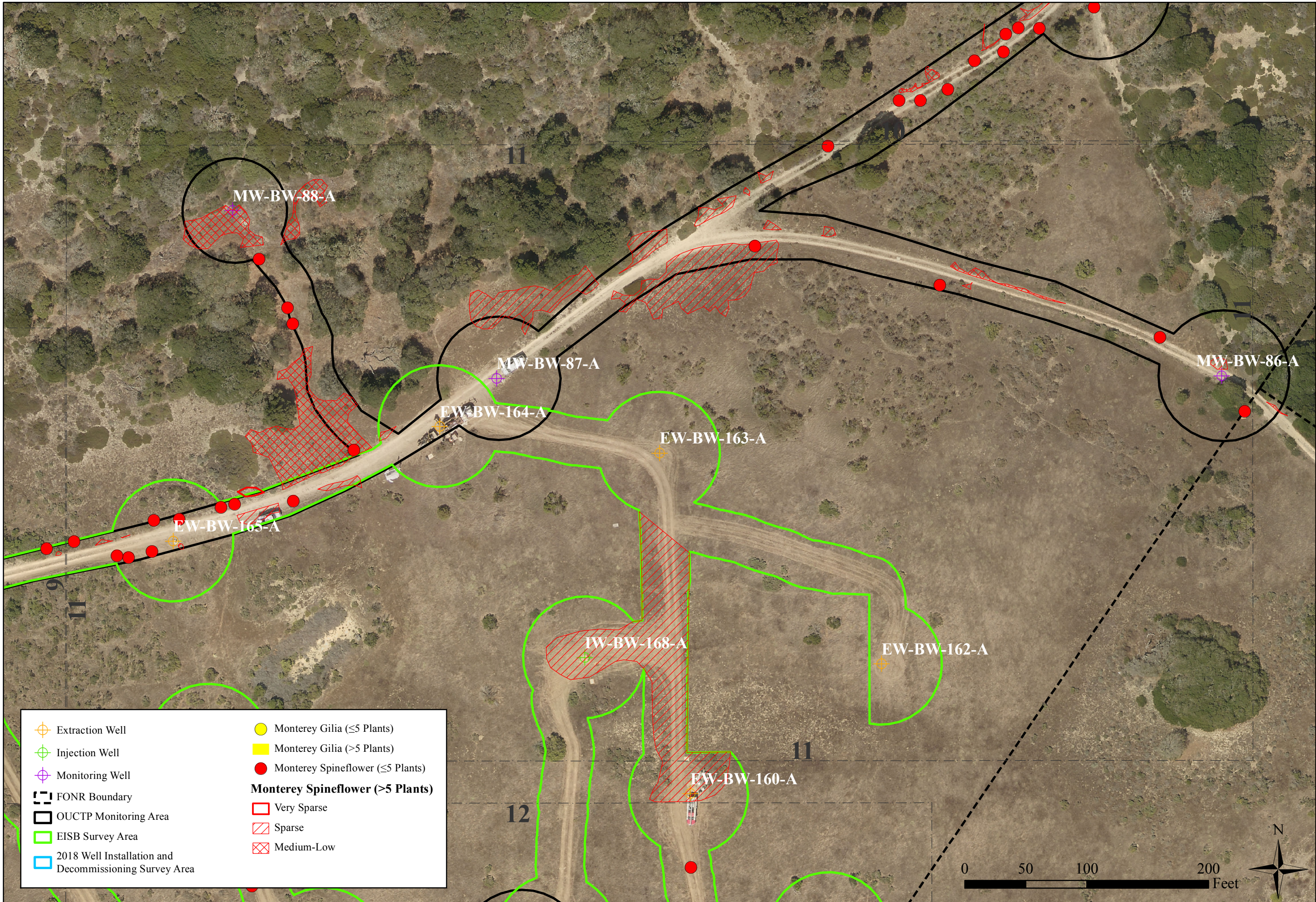
Attachment A: 2018 Rare Plant Survey Results Overview and Detail Maps



	Extraction Well		Monterey Gilia (<=5 Plants)
	Injection Well		Monterey Gilia (>5 Plants)
	Monitoring Well		Monterey Spineflower (<=5 Plants)
	FONR Boundary	Monterey Spineflower (>5 Plants)	
	OUCTP Monitoring Area		Very Sparse
	EISB Survey Area		Sparse
	2018 Well Installation and Decommissioning Survey Area		Medium-Low



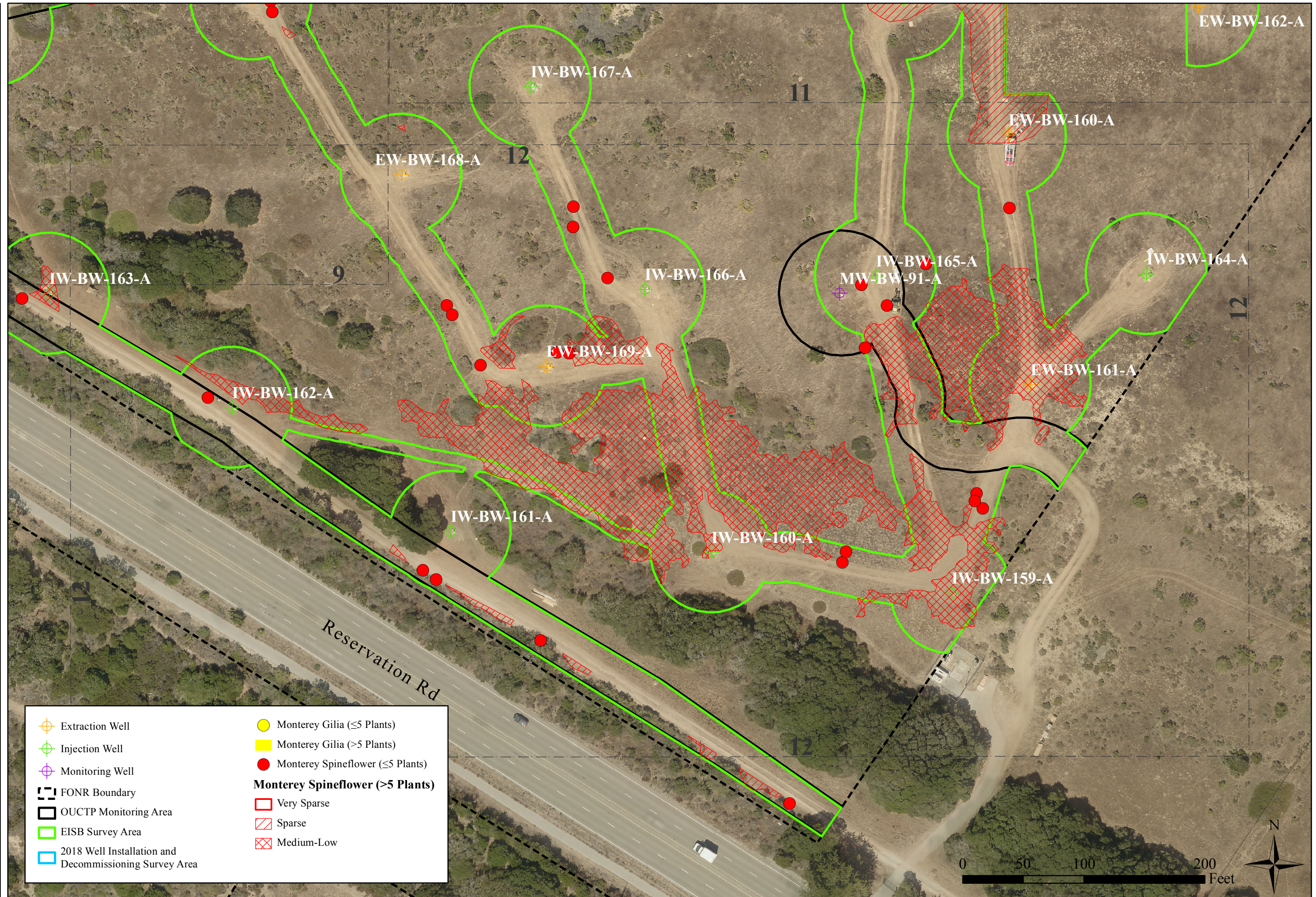
Attachment A: 2018 Rare Plant Survey Results Overview and Detail Maps



	Extraction Well		Monterey Gilia (≤ 5 Plants)
	Injection Well		Monterey Gilia (> 5 Plants)
	Monitoring Well		Monterey Spineflower (≤ 5 Plants)
	FONR Boundary	Monterey Spineflower (> 5 Plants)	
	OUCTP Monitoring Area		Very Sparse
	EISB Survey Area		Sparse
	2018 Well Installation and Decommissioning Survey Area		Medium-Low



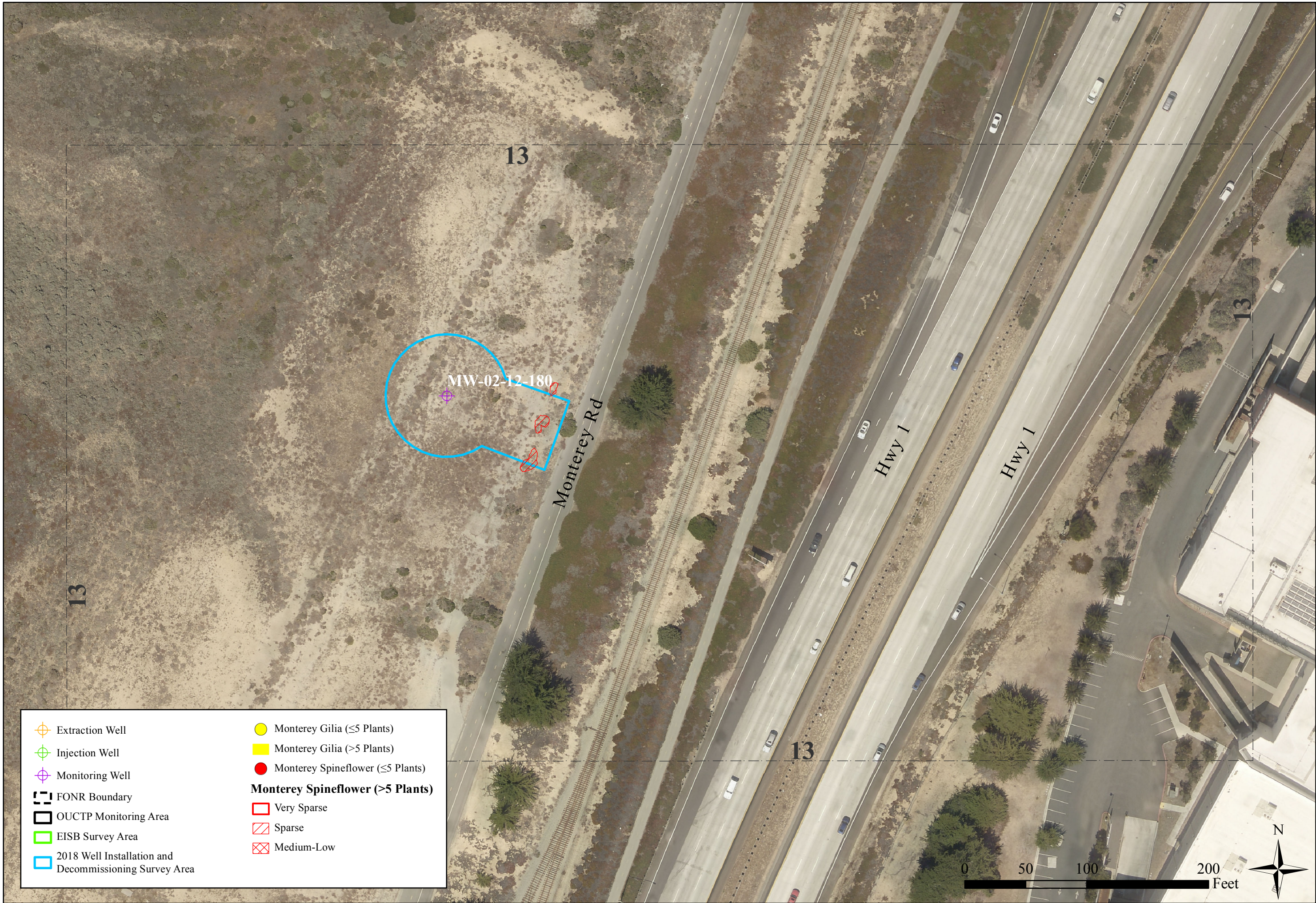
Attachment A: 2018 Rare Plant Survey Results Overview and Detail Maps



	Extraction Well		Monterey Gilia (≤ 5 Plants)
	Injection Well		Monterey Gilia (> 5 Plants)
	Monitoring Well		Monterey Spineflower (≤ 5 Plants)
	FONR Boundary	Monterey Spineflower (> 5 Plants)	
	OUCTP Monitoring Area		Very Sparse
	EISB Survey Area		Sparse
	2018 Well Installation and Decommissioning Survey Area		Medium-Low

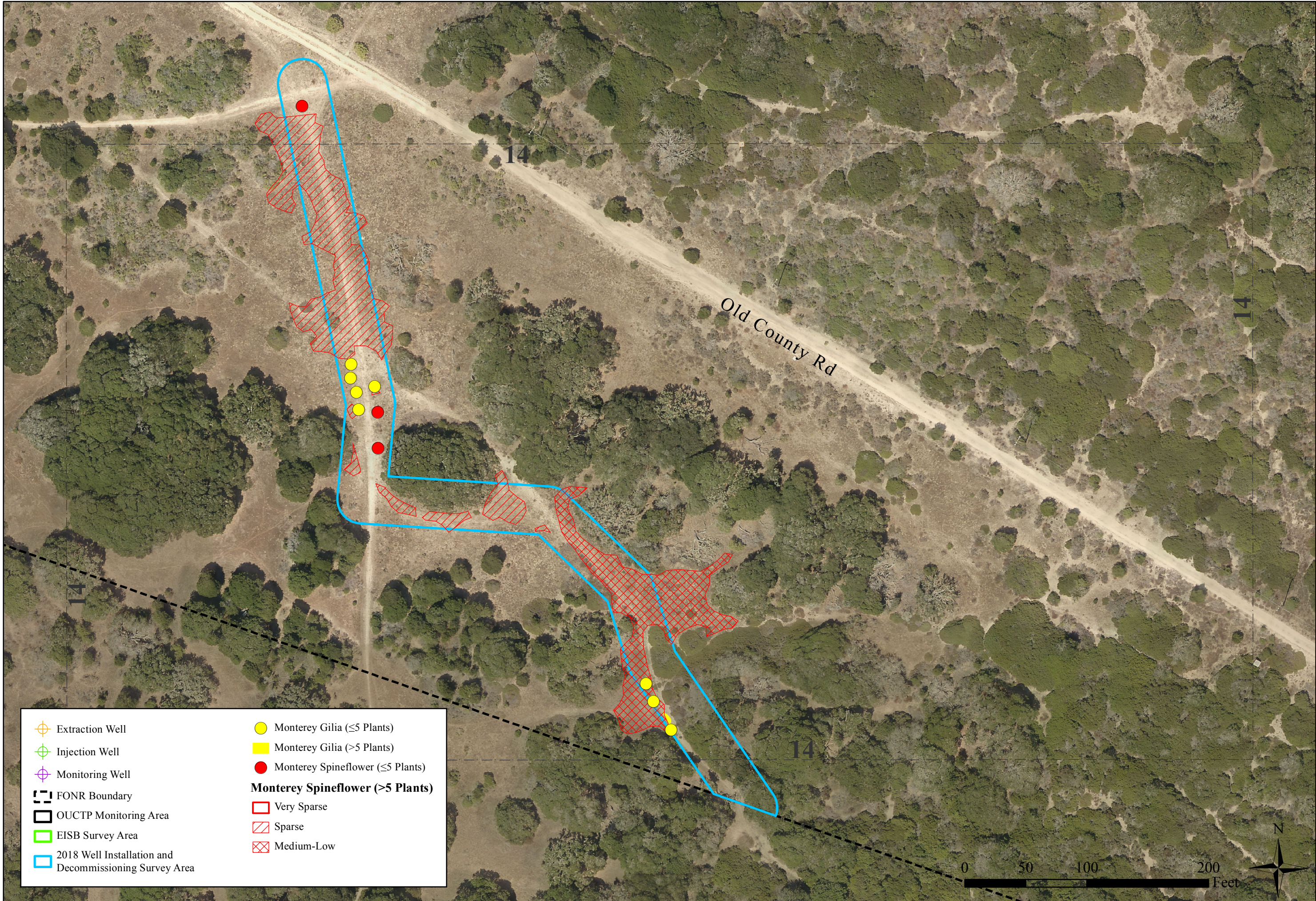


Attachment A: 2018 Rare Plant Survey Results Overview and Detail Maps



	Extraction Well		Monterey Gilia (<=5 Plants)
	Injection Well		Monterey Gilia (>5 Plants)
	Monitoring Well		Monterey Spineflower (<=5 Plants)
	FONR Boundary	Monterey Spineflower (>5 Plants)	
	OUCTP Monitoring Area		Very Sparse
	EISB Survey Area		Sparse
	2018 Well Installation and Decommissioning Survey Area		Medium-Low

Attachment A: 2018 Rare Plant Survey Results Overview and Detail Maps



- | | |
|--|--|
| Extraction Well | Monterey Gilia (≤ 5 Plants) |
| Injection Well | Monterey Gilia (> 5 Plants) |
| Monitoring Well | Monterey Spineflower (≤ 5 Plants) |
| FONR Boundary | Monterey Spineflower (> 5 Plants) |
| OUCTP Monitoring Area | Very Sparse |
| EISB Survey Area | Sparse |
| 2018 Well Installation and Decommissioning Survey Area | Medium-Low |

