Memorandum

Date:	October 9, 2017
To:	Cassandra D. Owens, Los Angeles Regional Water Quality Control Board
Copies to:	Paul Costa, Michael Bower, and Jeff Wokurka, The Boeing Company
From:	SSFL Surface Water Expert Panel and Geosyntec Consultants
Subject:	Area I Former Shooting Range (NPDES Outfall 009 Watershed)

INTRODUCTION

Recent relevant data were reviewed regarding soil and stormwater lead concentrations within and downstream of the Former Shooting Range, in response to a recent site visit by representatives from the Department of Toxic Substances Control (DTSC) and the Los Angeles Regional Water Quality Control Board (RWQCB). The following is a summary of findings with respect to this important subarea within the Outfall 009 watershed. The purpose of this assessment is to evaluate whether existing soils in this area – which are elevated for lead – may be impacting recent downstream lead concentrations in stormwater, including the single lead NPDES permit limit exceedance that occurred at Outfall 009 during the 2016/2017 monitoring season, and whether additional BMPs are needed to further protect downstream stormwater concentrations until final cleanup can be performed.

SOIL CONCENTRATIONS

Background on the former shooting range is summarized in the 2013 report *Former Shooting Range at Sage Ranch Property, Residual Lead Investigation, Santa Susana Field Laboratory* (MWH, 2013):

> Removal actions for lead shot and clay target debris have been conducted at the Former Shooting Range since 1992 on a voluntary basis by Boeing or its predecessor company, Rocketdyne Division – Rockwell International Corporation. Approximately 17 tons of lead shot and clay target debris were reported to be removed during initial lead shot removal activities performed by Rockwell within the Former Shooting Range and the adjacent Overshot Area in 1993 (Rockwell International, 1993). Boeing continued to remove additional lead shot that surfaced after rainfall events and conducted voluntary lead shot removals in 1998 and 2006 (MWH, 2008).
>
> In 2009 Haley & Aldrich, Inc. prepared the Former Shooting Range Debris Removal Action Report (Haley & Aldrich, 2009) on behalf of Boeing. The report documented the soil and debris removal activities conducted in 2008 at the Former Shooting Range (Figure 1). During clay target removal activities in the Former Shooting Range a debris field was identified and investigated. To control the potential release of hazardous substances the debris field was excavated and the material was transported offsite for disposal. A total of 91 confirmation samples were collected and analyzed to evaluate the extent and completeness of debris removal activities.

Though a large amount of lead, clay target, and other debris were removed from the Former Shooting Range during the previous removal actions, the Overshot Area was presumed to contain residual lead concentrations resulting from historic trap/skeet shooting at the Former Shooting Range. In 2013, Boeing initiated the Incremental Sampling Methodology (ISM) program to identify localized areas with elevated lead concentrations in the Overshot Area. ISM sampling covers a larger area than standard RFI sampling, in that composites are used to represent approximately 1-acre grids. DTSC approved the Work Plan to

investigate this area in November of 2016, and Boeing began the ISM investigation in December of 2016. The results of this sampling have identified areas with elevated soil lead concentrations relative to background and risk based screening levels. The full database containing results of the ISM program was provided to the Surface Water Expert Panel in 2017, and soil lead concentration results are shown in Figure 2. These data are being incorporated into the Panel's ongoing Outfall 009 Non-Industrial Sources Special Studies to evaluate these soils in comparison to other sources (e.g., atmospheric deposition and pavement solids) throughout this watershed.

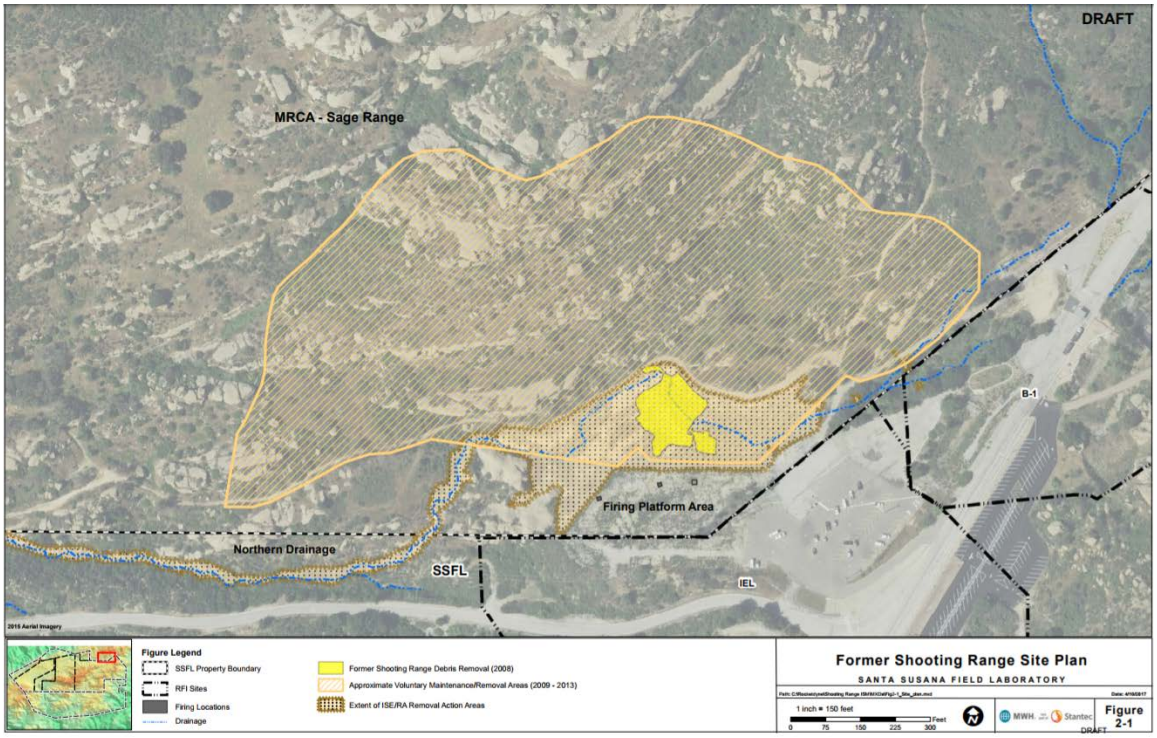


Figure 1. Former Shooting Range Site Plan (MWH, 2017)

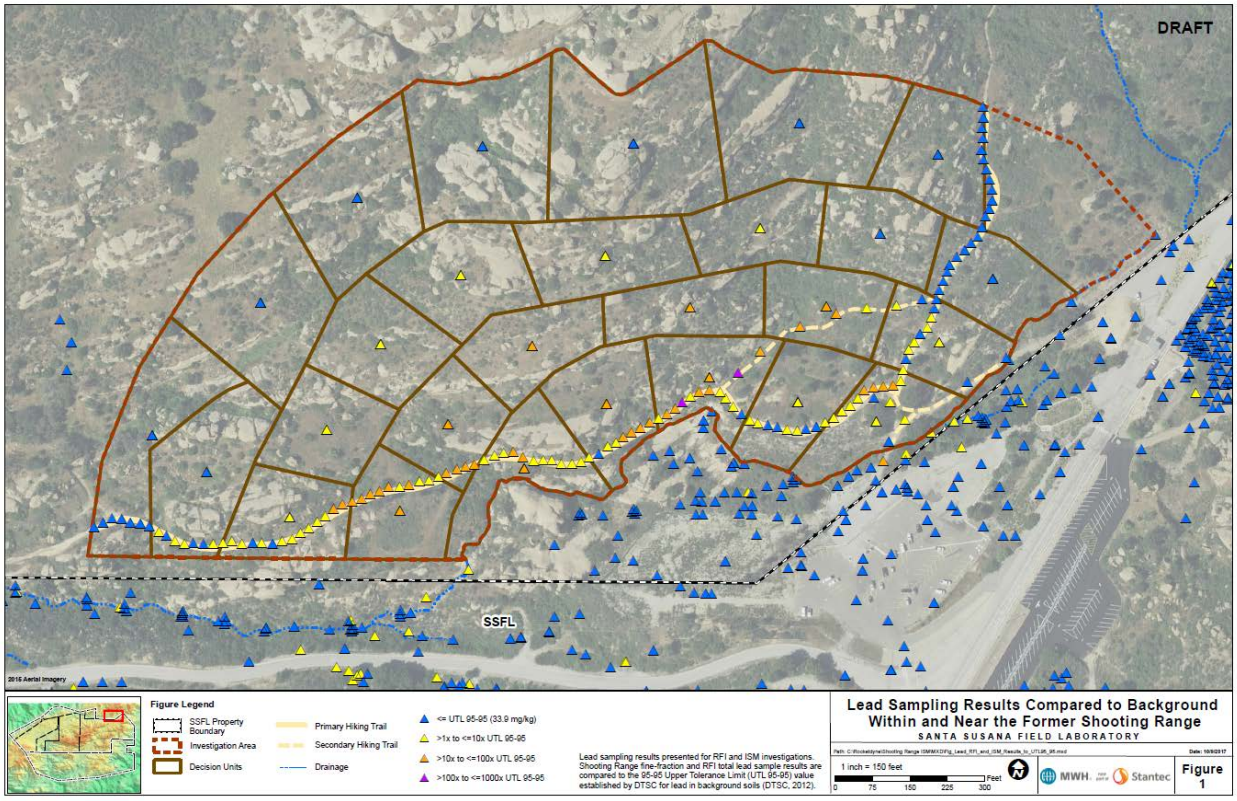


Figure 2. Former Shooting Range Lead Sample Results, ISM and Discrete Trail Samples (Sieved to <250 µm)

BMPS

Existing BMPs in the shooting range area (see photos in Figure 3 below) include bioengineering slope stabilization measures (i.e., vegetation planting areas), rip-rap berms along the Northern Drainage, a culvert maintenance media filter, fiber rolls, and approximately 1,400 feet of silt fencing. Drainage areas to existing treatment BMPs are shown in Figure 4 below. Furthermore, maintenance and inspection of the downstream Northern Drainage BMPs is ongoing, such as the recent cleanout of sediment accumulated behind rip-rap berms during the 2016/2017 rainy season (Figure 5). This recently deposited sediment was analyzed prior to disposal and found to have lead concentrations similar to background soil concentrations.

In addition, based on visual observation, the Former Shooting Range area is well vegetated and naturally undulating, with depressions in the topography that further reduce the transport of lead shot and runoff from this area. This visual observation is confirmed by the fact that in 2017 no appreciable sediment was accumulated or removed from the six rip-rap berms that are most immediately downstream of the Former Shooting Range, indicating that the Former Shooting Range area, like the rest of the upper 009 watershed, is well stabilized from a sediment yield and an erosion/sediment control perspective.

Figure 3. Selection of Existing BMPs at the Former Shooting Range Area (Top row: Silt fence, culvert modification media filter, and fiber rolls; Bottom row: Sand bag berm, rip-rap, and vegetation)

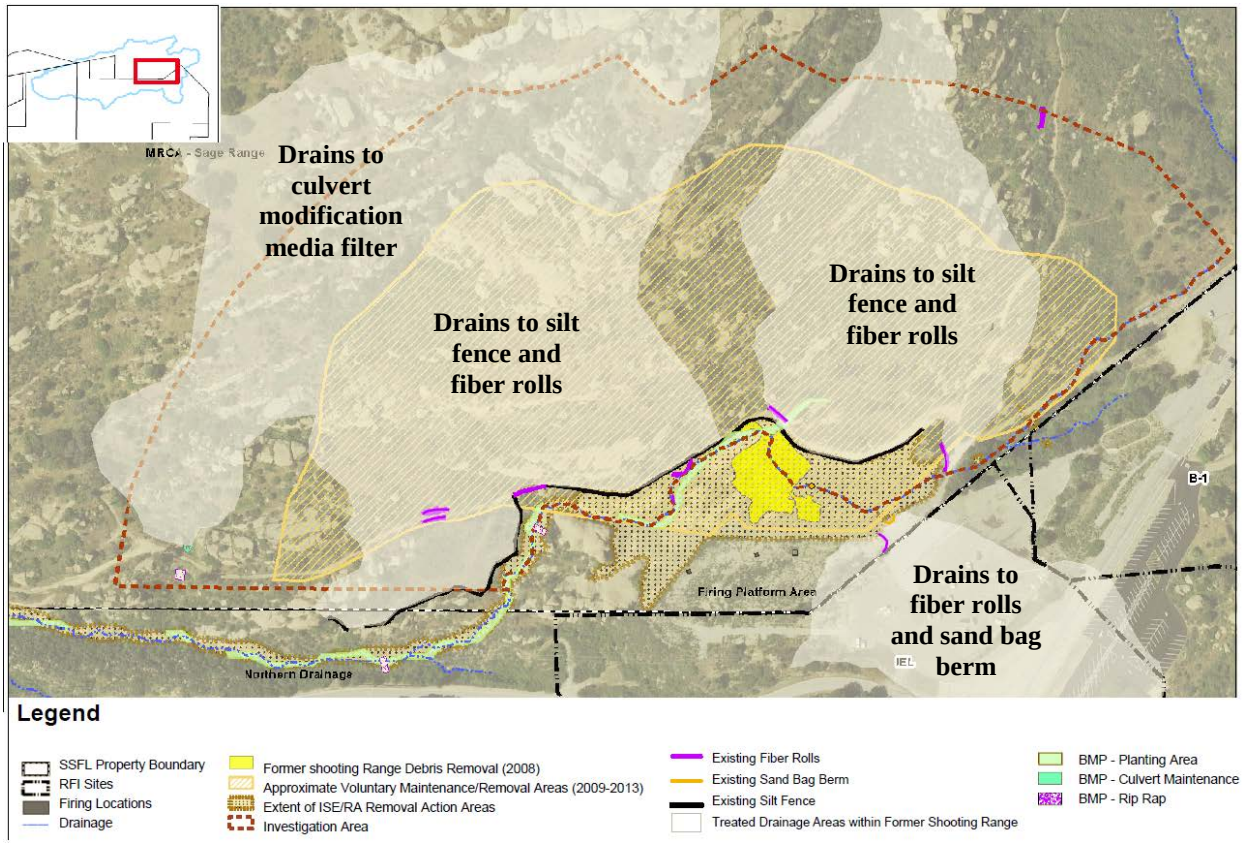


Figure 4. Drainage Areas to Existing Treatment BMPs

Figure 5. Northern Drainage Accumulated Sediment (left) and Sediment Collected in Super Sacks for Removal (right)

STORMWATER LEAD SOURCE INVESTIGATION

An Outfall 009 Non-Industrial Sources Special Studies investigation is ongoing, with results expected in early 2018. There are many potential sources of lead to Outfall 009. As shown in Figure 6, fine and

medium grained soils (<250 um) within the Former Shooting Range area contain relatively high lead concentrations, with the highest results nearest the trail and firing range (Figure 2). Other Outfall 009 watershed surface soils sampled for the RFI program, as well as SSFL atmospheric deposition solids and fine (<75 um) pavement solids from SSFL higher traffic areas (Figure 8), also have elevated lead concentrations relative to other sources in the watershed.

The Figure 7 datasets include two rounds of sediment sampling from the Northern Drainage below the Former Shooting Range area: 1) Bed sediment collected before the 2016/2017 rainy season as part of the Outfall 009 Non-Industrial Sources Special Studies, and 2) sediment accumulated and removed from behind three rip-rap berms downstream of LOX after the 2016/2017 rainy season (Figure 5). As noted above, no appreciable sediment was accumulated or removed from the six rip-rap berms closest to and downstream of the Former Shooting Range area, confirming that the shooting range, like the rest of the upper 009 watershed, is well stabilized. These two sediment datasets indicate low, background level lead concentrations in recently deposited soils from the upper 009 watershed. Sediment sample locations for these datasets are shown in Figure 8.

Solids on pavement surfaces are elevated for lead and have a direct route of conveyance to Outfall 009 through SSFL's curb and gutter drainage system, with storm drains that efficiently route runoff to the drainage. For this reason, the Expert Panel has historically targeted runoff from paved areas for treatment BMP placement. The Panel has also advocated for interim cleanup, such as the Interim Source Removal Action, for surface soils for NPDES-exceeding constituents. And the Expert Panel is again pleased to see constructive dialogue between Boeing, DTSC and the RWQCB regarding remediation of soil areas such as the Former Shooting Range to improve stormwater quality at Outfall 009.

Finally, TSS from all sources (background soils or otherwise), at high enough concentrations, has the potential to cause NPDES exceedances, therefore the Panel has also consistently advocated revegetation and other erosion and sediment controls through SSFL's watersheds wherever needed.

The 009 stormwater source investigation is ongoing and the Expert Panel has recommended additional analyses, including a new round of Northern Drainage sediment sampling (to reflect sediments deposited during the 2016/2017 wet season) and potential lead isotope analysis to compare lead isotope ratios in stormwater at the outfall with ratios of specific sources, including lead shot. All results will be shared when they become final.

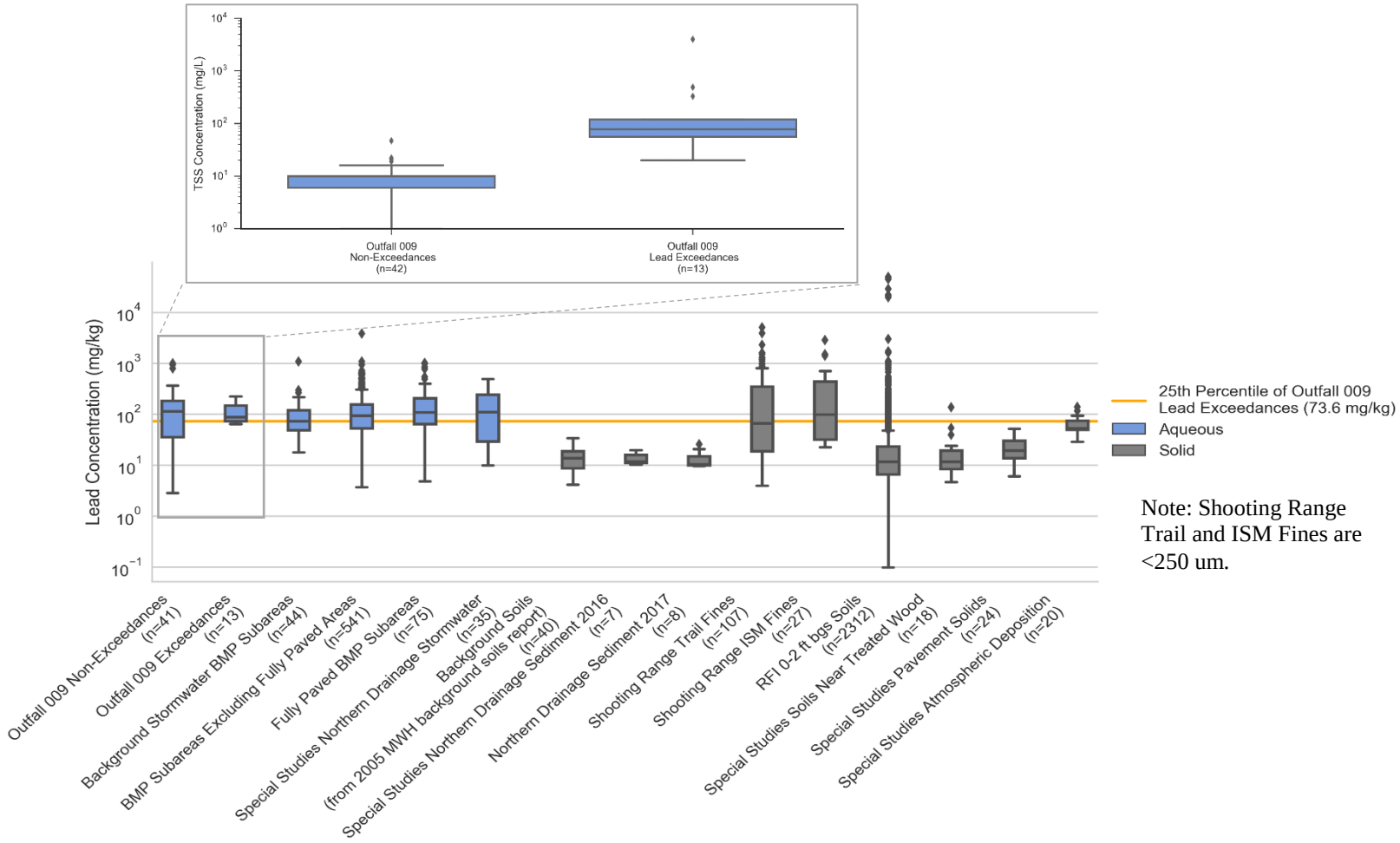


Figure 6. 009 Stormwater Source Investigation Lead Solids Concentrations, with aqueous results representing particulate strengths (i.e., water particulate concentrations [total – dissolved] divided by TSS, to produce a lead mass per mass of suspended solids), and solids results representing soil, stormwater, and other solids samples. Inset box, showing TSS results, indicates that TSS is a primary factor controlling NPDES exceedances at Outfall 009. The point of the solids sampling is to determine the source of stormwater particulate strengths.

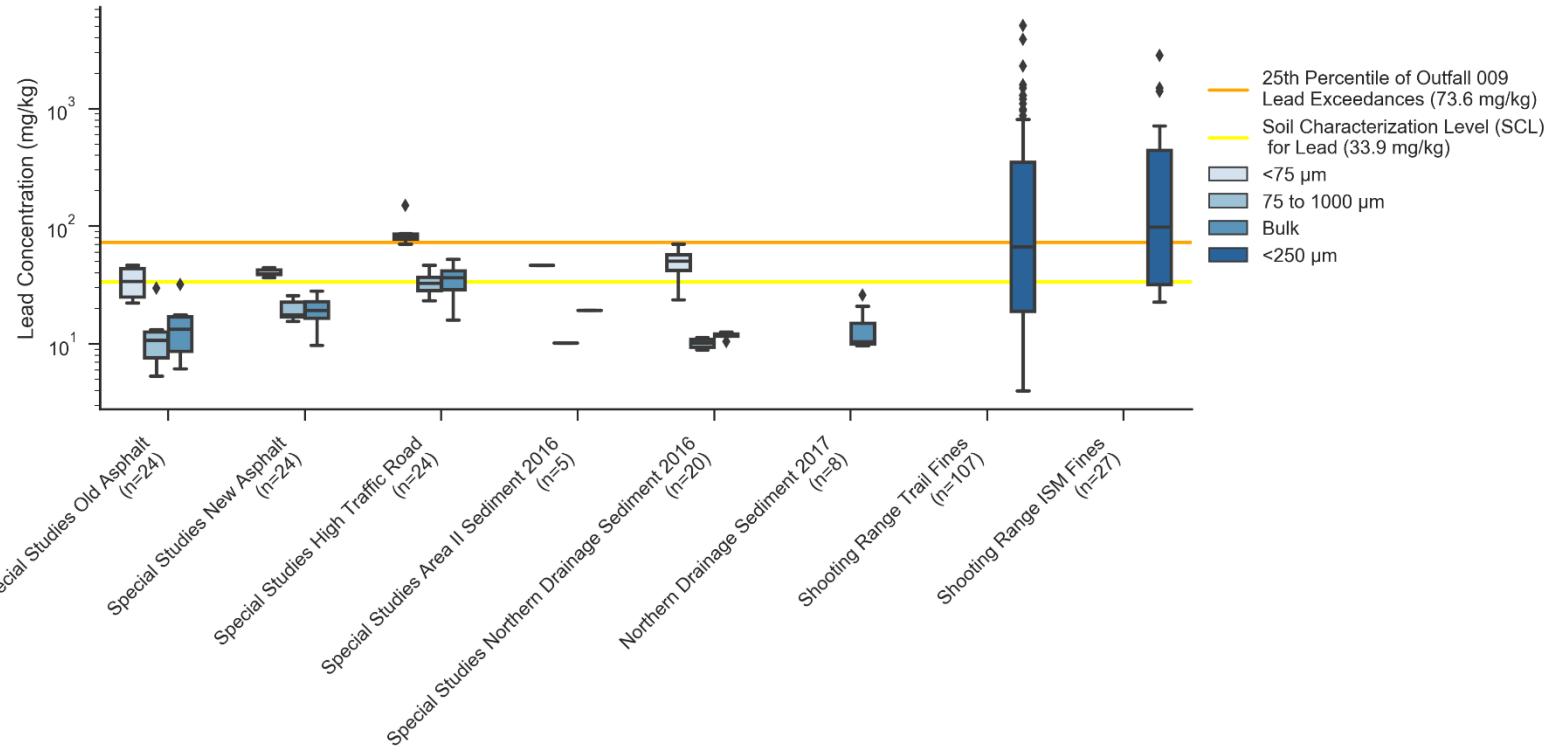


Figure 7. 009 Stormwater Source Investigation Lead Solids Concentrations, by Particle Size. SCL is based on the 95th Upper Tolerance Limit (UTL) of background.

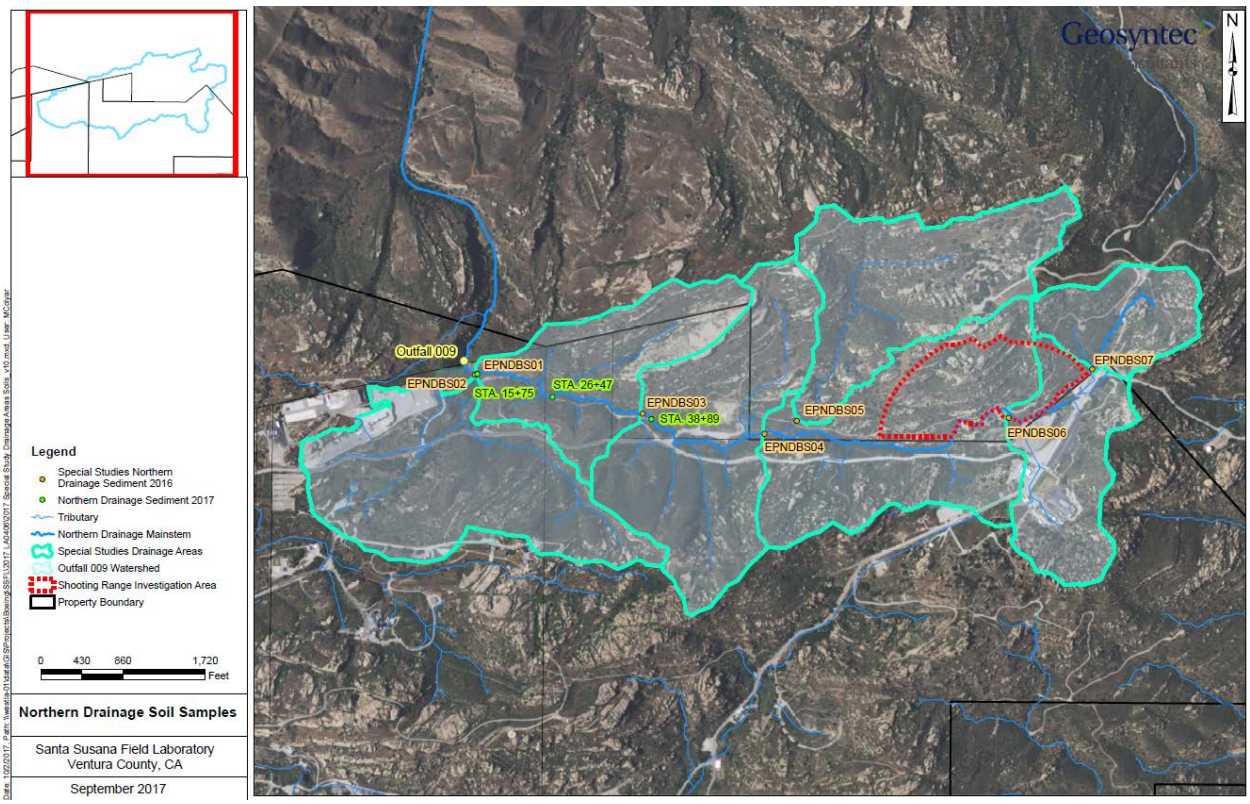


Figure 8. 2016 Special Studies ND Sediment and 2017 ND Sediment Sample Locations

STORMWATER CONCENTRATIONS AT OUTFALL 009

Lead concentrations at Outfall 009 in the 2016/2017 monitoring season were low despite multiple large storm events (out of 8 samples, 1 exceedance [9.5 µg/L] of the Outfall 009 permit limit [5.2 µg/L] was measured). This one exceedance occurred on February 18, 2017 during a 24-hour storm event that equated to approximately a 10-year return frequency, which is well above typical BMP sizing criteria. To put this one exceedance concentration into further perspective, the following considerations are noted:

- With respect to protection of aquatic life, which the lead permit limit is based on, aquatic life toxicity test results for Outfall 009 samples have consistently been low (no exceedances of either acute or chronic toxicity permit limits out of 32 samples over nine years, despite eight of these same samples exceeding the lead permit limit). Therefore, direct measurements of toxicity suggest that aquatic life are protected in this watershed.

  Furthermore, in 1997, USEPA issued a new lead water quality criteria recalculation procedure to more accurately reflect hardness-based lead concentration thresholds at which aquatic life toxicity is observed. This procedure was recently approved by the Los Angeles RWQCB to update the Los Angeles River Metals TMDL[1], becoming effective December 12, 2016. If USEPA's new criteria recalculation procedure were applied to the SSFL NPDES permit for Outfall 009, this would result in a permit limit change from 5.2 µg/L to 35 µg/L, with 35 µg/L being above 100%

[1] California Regional Water Quality Control Board, Los Angeles Region, 2015. Amendment to the Water Quality Control Plan for the Los Angeles Region to Revise the Los Angeles River and Tributaries Metals TMDL. Adopted on April 9, 2015.

of all historic lead concentrations measured at this outfall since 2007. This further indicates that lead stormwater concentrations at Outfall 009 are protective of aquatic life.

- With respect to human health, a Human Health Risk Assessment (HHRA) for stormwater is ongoing, as ordered by the RWQCB on June 24, 2015. The results of this analysis are forthcoming, and are currently under review by RWQCB and OEHHA. Final results will be presented by Boeing and the Expert Panel to the RWQCB at a future hearing, and will be shared with DTSC. The HHRA analysis includes lead at Outfall 009. Non-cancer endpoints are being evaluated based on long-term recreational exposure scenarios, with conservative exposure assumptions, and including both ingestion and dermal contact exposure pathways. These results will be publicly available soon. But given the USEPA drinking water standard of 15 µg/L, all concentrations measured at Outfall 009 this year would be in attainment with even a drinking water-based human health threshold.

- Finally, with respect to natural background stormwater concentrations (i.e., representing stormwater runoff from drainage areas that are without development or historic industrial activity), Outfall 009 historically exceeds the permit limit approximately 23% percent of the time, in contrast to stormwater background sites around SSFL which exceed the permit limit approximately 15% of the time (see probability chart comparing these datasets, shown in Figure 9). Particulate strengths (i.e., stormwater particulate concentrations per mass of suspended solids), which are perhaps a better indicator than water column concentrations of whether highly concentrated soil sources are contributing to stormwater, are also similar between these two datasets. Together, these results indicate that Outfall 009 lead concentrations are low, are minimally or not impacted by anthropogenic sources, and are similar to local natural background levels for stormwater.

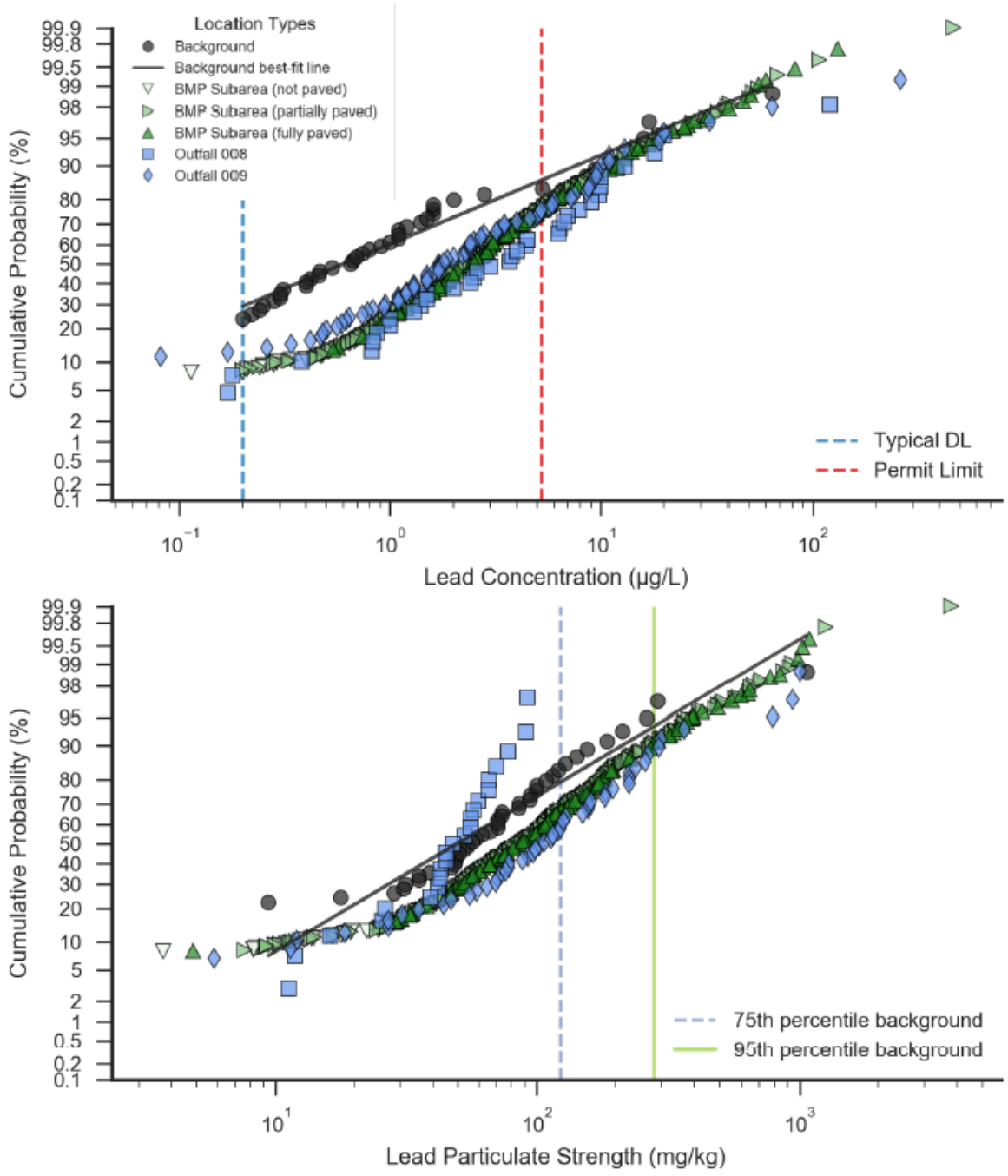


Figure 9. Probability Plots for Lead Concentrations and Particulate Strengths (SSFL Surface Water Expert Panel, 2017)

STORMWATER CONCENTRATIONS BELOW SHOOTING RANGE

Besides stormwater samples collected at Outfall 009, lead concentrations in stormwater and sediment samples along the Northern Drainage during 2016/2017 were also low, including immediately downstream of the Former Shooting Range area (see Figures 10 through 12 below). There is no apparent indication of highly concentrated upstream sources contributing to increasing concentrations below the

Former Shooting Range.

Furthermore, an attempt was made to compare "upstream" (which, relative to the shooting range, represents a blend of runoff locations) versus downstream stormwater concentrations, to further evaluate whether the Former Shooting Range soils and lead shot fragments are impacting stormwater in this watershed. Stormwater samples from subareas that flow into the Former Shooting Range section of the Northern Drainage were compiled, and relative runoff volumes were computed for each location based on drainage area properties. Together, these concentrations and relative runoff volumes were mass balanced to compute an "upstream" weighted average concentration (Figure 12). Based on this comparison, no statistically significant difference[2] was found in lead concentrations in stormwater between the contributing areas upstream of the Former Shooting Range area (consisting of several paved areas, which as noted above are considered to be a potential lead source; measured concentrations used in the weighted average range from 0.50 to 13 µg/L) and the Northern Drainage mainstem sampling location EPNDSW04, downstream of the Former Shooting Range area (measured concentrations at this site range from 0.61 to 6.6 µg/L). This upstream/downstream comparison of lead stormwater concentrations further suggests that lead shot is not being significantly mobilized and transported in stormwater along the Northern Drainage. This comparison is consistent with field observations of 1) topography (the microtopography includes many small areas with mild to flat slopes, despite an overall slope toward the Northern Drainage Channel), 2) well developed shrub and ground vegetation in many areas, and 3) numerous stormwater BMPs and areas of revegetation.

The Panel recommends that this condition continue to be monitored. Therefore, the Panel has recommended that two rounds of stormwater and one round of bed sediment samples be collected again along the Northern Drainage during storms in the 2017/18 wet season. This is reflected in the 2017/18 Sampling and Analysis Plan.

[2] Two-tailed equal variance t-test comparing the eight lead results at EPNDSW04 to the weighted average (based on average annual flow over the long-term) from the upstream areas using event-specific concentrations for each of the same eight events or, when event-specific concentrations were not available at a specific monitoring location, the average result over the same time frame (March 2016 – February 2017). For sites that were not sampled during this time frame (e.g., B1 culvert), the average result over the entire period of record was assumed for each event. The resulting p-value is 0.25; statistical significance requires a p-value <0.05, indicating that a statistically significant difference in these two data sets could not be identified based on the sample size.

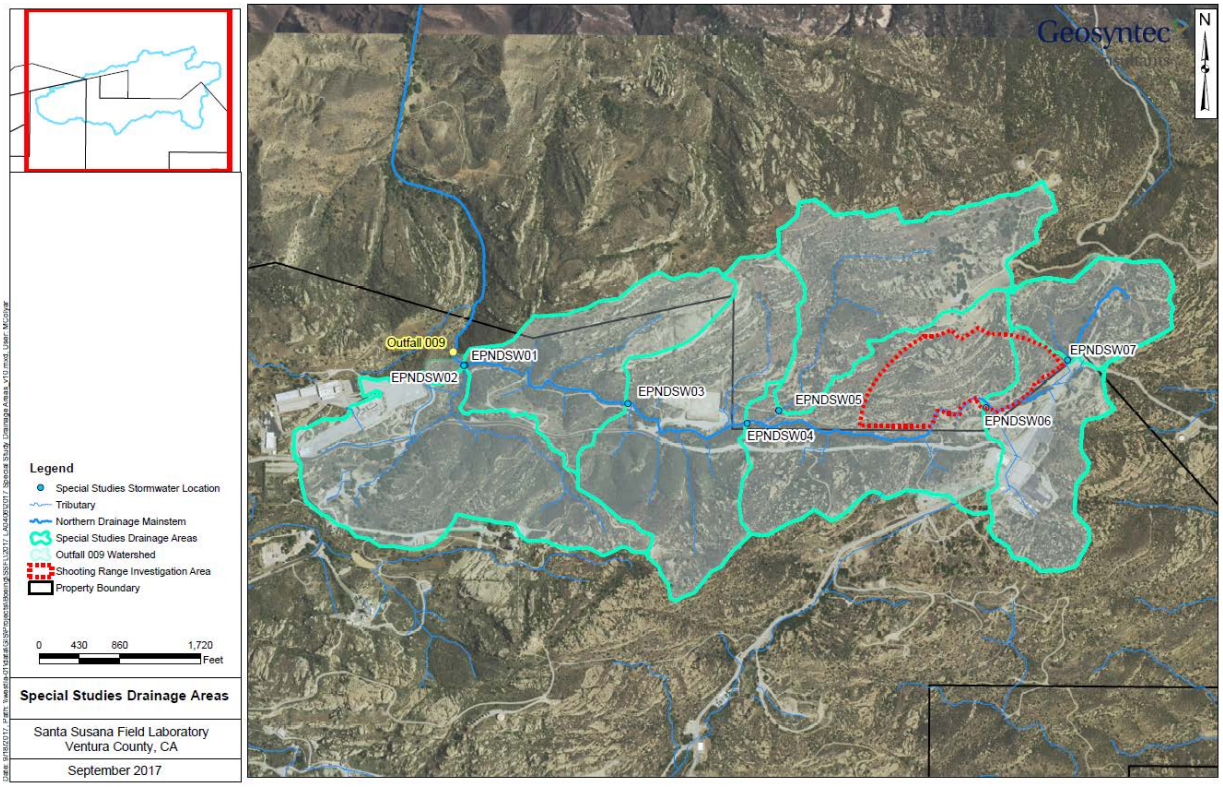


Figure 10. Drainage Areas to Special Studies Northern Drainage Stormwater Sampling Locations

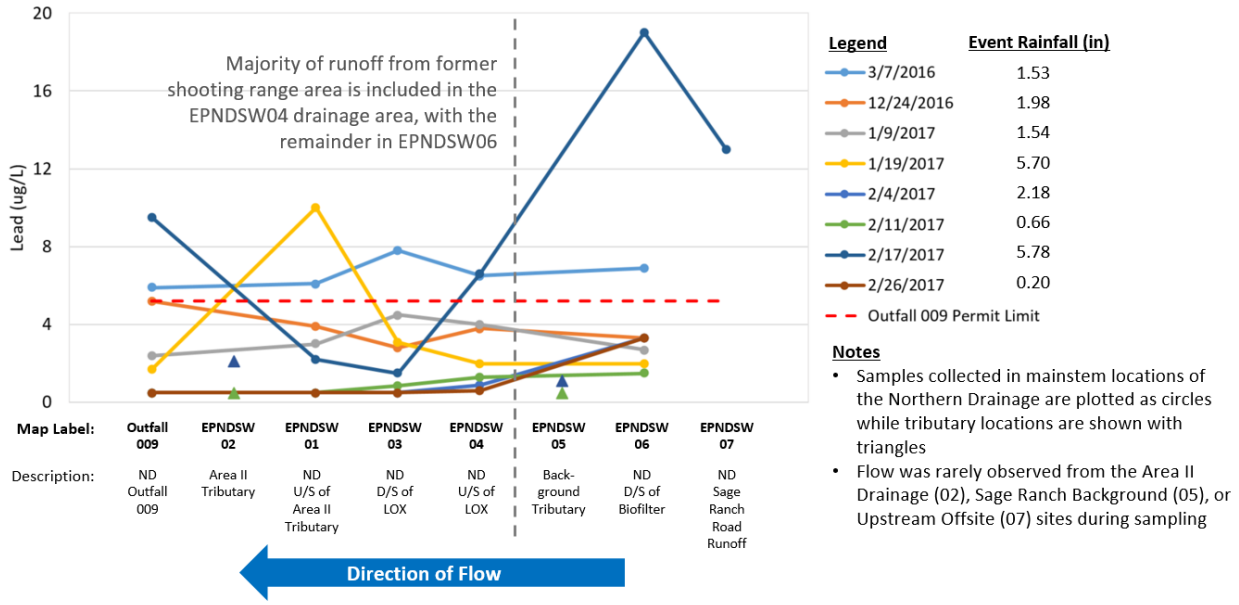
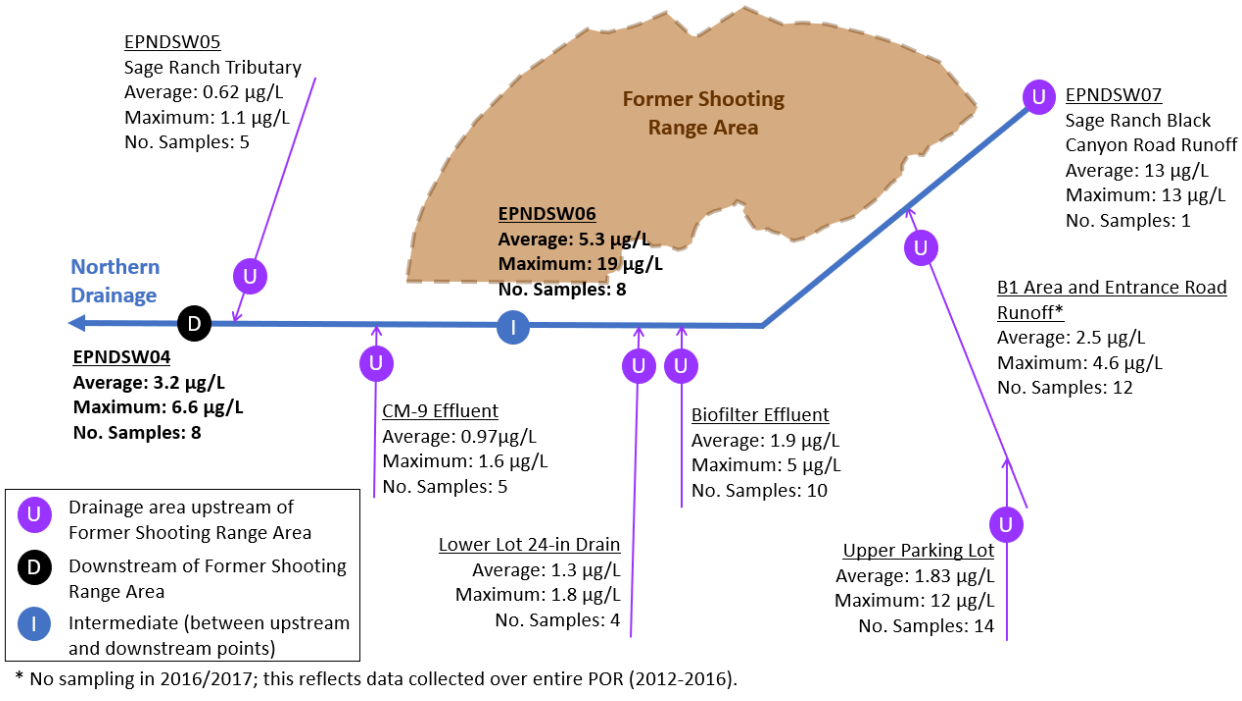


Figure 11. Stormwater Lead Concentrations Along Northern Drainage



* No sampling in 2016/2017; this reflects data collected over entire POR (2012-2016).

Figure 12. Stormwater Lead Concentrations Contributing to Northern Drainage in the Vicinity of the Former Shooting Range Area, March 2016 – February 2017

NEW BMP RECOMMENDATIONS

To inspect the condition of existing BMPs and determine the need for additional BMPs or BMP improvements, an initial site visit was performed on September 22, 2017 and a follow-up visit was performed on October 4, 2017. Figure 13 shows a comprehensive map of all recent and prior BMPs in the Former Shooting Range area. Recent upgrades were made by a professional engineer experienced with stormwater BMP selection based on this recent field inspection. These recommendations include hydroseeding, plantings, placement of additional fiber rolls, diversion of a small drainage area along the hiking trail to the existing culvert modification, and repairing and extending the existing silt fence to prevent downstream migration of the lead shot. It is understood that the recommended BMPs will be installed to the extent feasible, potentially with small modifications, given any potential ground constraints (e.g., boulders, differences in topography, etc.). As shown in Figure 14, with these additions, runoff from the entire Former Shooting Range area will now flow to or through sediment control features. For context, the lead results from four sampling programs are depicted in the shooting range area, including Special Studies Northern Drainage Sediment (2016), Outfall 009 Watershed RFI (0-2 bgs) (1992-2015), shooting range ISM sampling (points representing the mean result over the approximately 1-acre grid) (2016-2017), and the shooting range trail samples (2016-2017).

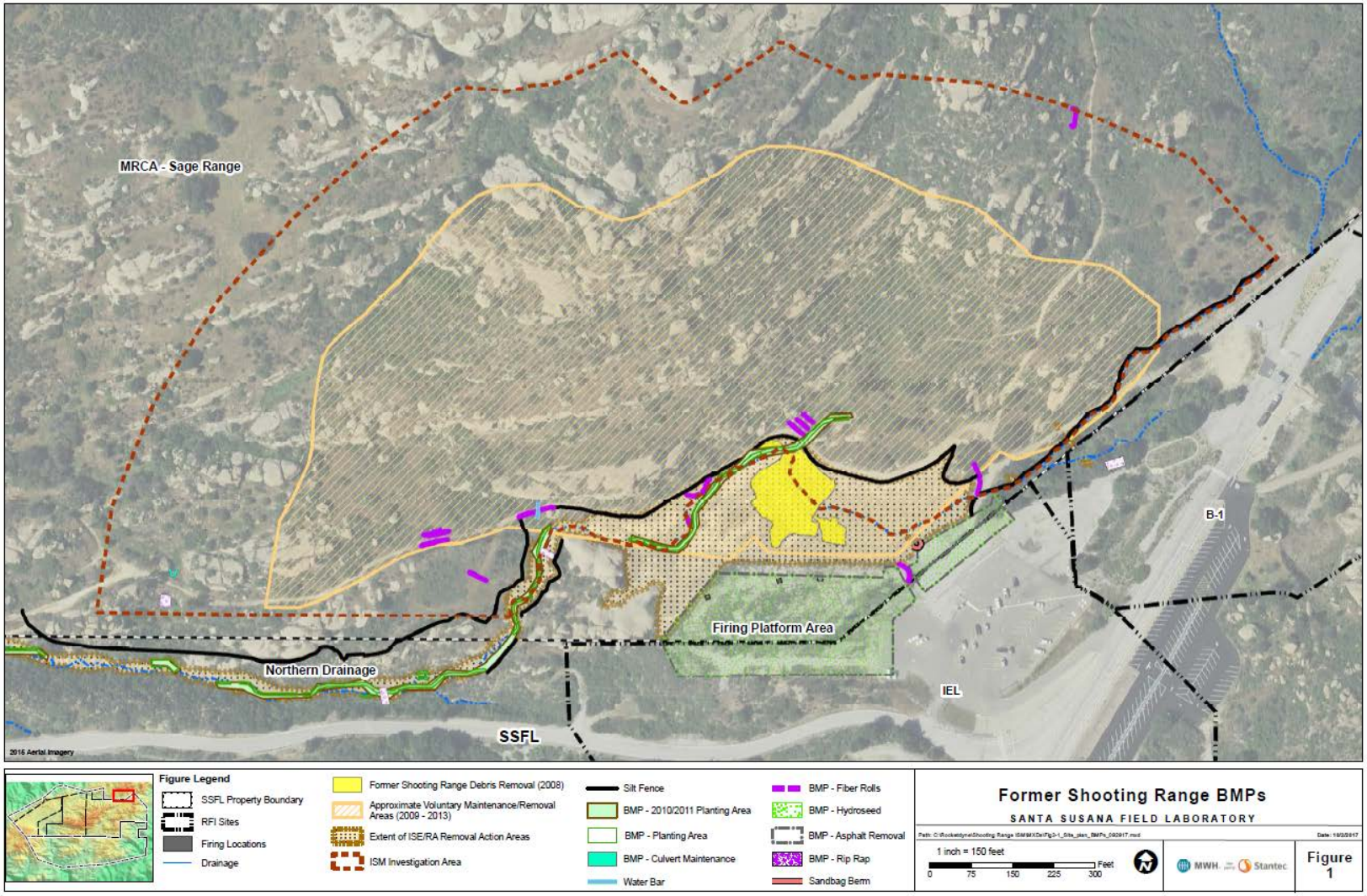


Figure 13. Former Shooting Range Site Plan, Planned BMPs

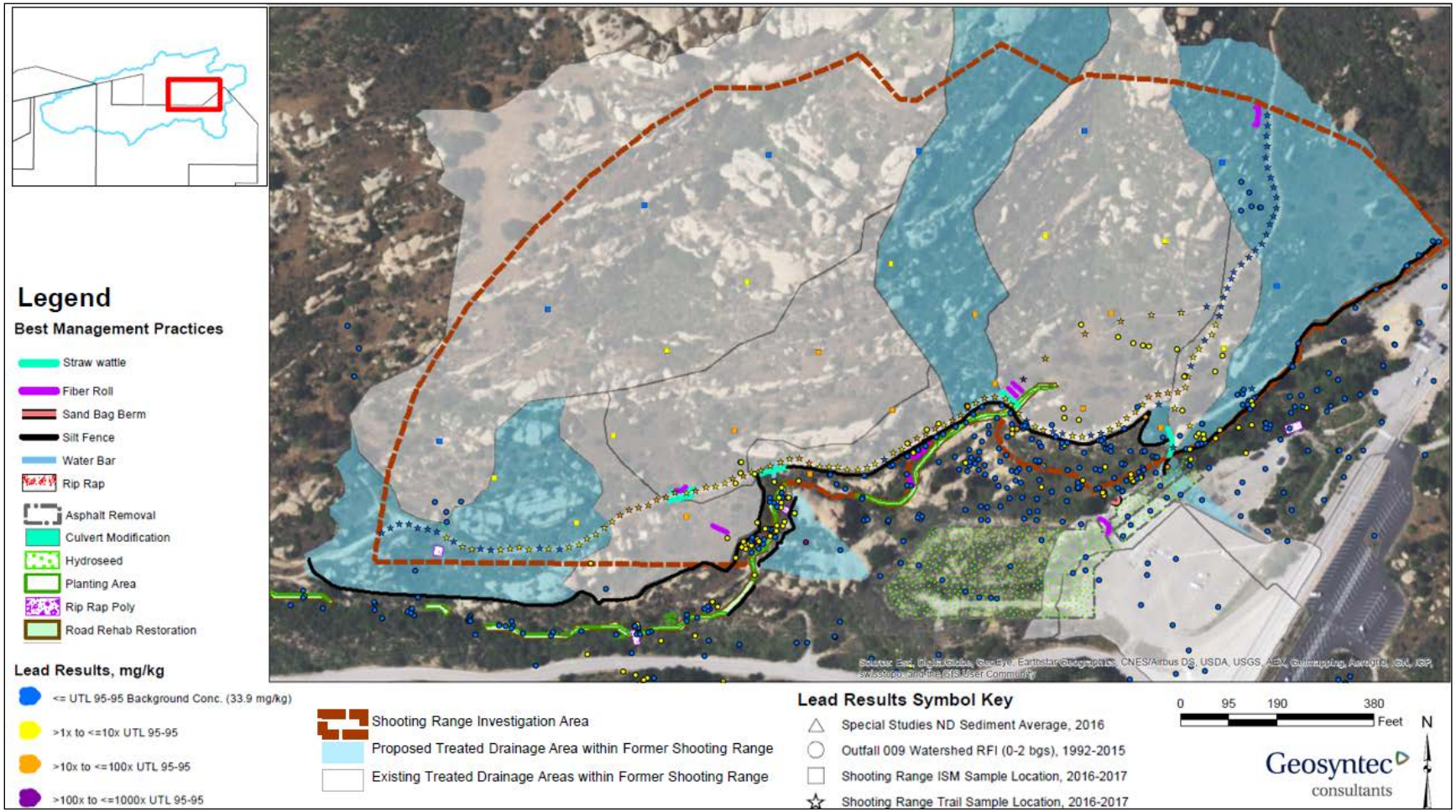


Figure 14. Treated Drainage Areas by Existing and Proposed BMPs

SUMMARY

In conclusion, based on the information and data reviewed to date, the Expert Panel does not presently believe that the lead exceedance measured at Outfall 009 in the 2016/2017 rainy season was caused by soils or shot from the Former Shooting Range for the following reasons:

1. Northern drainage stormwater concentrations do not appear to increase downstream of the shooting range.
   - To confirm this finding, an additional year of stormwater sampling in the Northern Drainage is recommended this year.

2. Northern Drainage sediment concentrations below the Former Shooting Range do not suggest highly concentrated sources from upstream areas.
   - To confirm this finding, an additional round of sediment sampling is recommended this year.

3. Site inspection observations – the area is generally stable from an erosion/sediment control perspective, with several existing BMPs in place, including berms along the Northern Drainage which effectively trapped significant sediment this past year.
   - To further bolster the erosion and sediment controls that are in place and intended to function until cleanup is complete, additional BMP improvements have been recommended and sediment has been removed from the downstream BMPs to increase the sediment capacity for the next rainy season.

To be more conclusive about the source of the lead exceedance, isotope sampling would be required to verify lead sources to downstream stormwater; the Panel is currently exploring this option. However, regardless of the source of the single permit limit exceedance, OF009 lead concentrations in 2016/2017 were very low and are protective of both aquatic life and human health. This finding is supported by comparison with:

1. the USEPA drinking water standard (as well as the results of the pending HHRA);
2. the NPDES permit limit – of the eight samples in 2016/2017, seven were below the permit limit and the sole exceeding result was sampled during a 5 to 10-year 24-hour storm event, which is larger than the SSFL BMP design storm (i.e., untreated BMP overflows are expected during such a large event);
3. USEPA's revised lead criteria;
4. Natural background stormwater concentrations; and
5. NPDES permit limits for toxicity.

And finally, consistent with the model established by the Interim Source Removal Action, the Panel also continues to support cleanup of soils for NPDES exceeding parameters, including for lead at the Former Shooting Range.

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