Response Team members set up air sampling equipment on November 10, 2018, in Area I of the Santa Susana Field Laboratory to measure air contaminants after the Woolsey Fire.

DTSC Final Summary Report of Woolsey Fire

Impacts at SSFL & Surrounding Communities Sampling Results

December 2020

Department of Toxic Substances Control

CalEPA California Environmental Protection Agency

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STATE OF CALIFORNIA

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ACKNOWLEDGMENTS

The Response Team that coordinated the interagency response to evaluate possible releases of radiation and hazardous compounds from the Santa Susana Field Laboratory site due to the Woolsey Fire included:

- California Environmental Protection Agency (CalEPA)
- CalEPA Department of Toxic Substances Control
- CalEPA Office of Environmental Health Hazard Assessment
- California Department of Public Health
- U.S. Department of Energy (DOE) National Nuclear Security Administration Consequence Management Home Team
- DOE Radiologic Assistance Program from Lawrence Livermore National Laboratory
- California National Guard 9th Civil Support Team
- United States Environmental Protection Agency Radiological Emergency Response Team
- Los Angeles County Department of Public Health Radiation Management Program, and other agencies from Los Angeles and Ventura counties

The Response Team also worked closely with the California Office of Emergency Services Incident Command, local law enforcement, and air quality agencies.

The Response Team and its partner agencies express sorrow for the loss of lives and property and the long-term disruption to communities as a result of the Woolsey Fire.

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ACRONYMS AND ABBREVIATIONS

9th CST	9th Civil Support Team (California National Guard)
CalEPA	California Environmental Protection Agency
CDPH	California Department of Public Health
Cs	cesium
DCS	Derived Concentration Standard
DOE	U.S. Department of Energy
DTSC	Department of Toxic Substances Control
ECL	Environmental Chemistry Laboratory
ETEC	Energy Technology Engineering Center
HPGe	high-performance germanium
LACDPH	Los Angeles County Department of Public Health
LARWQCB	Los Angeles Regional Water Quality Control Board
LLNL	Lawrence Livermore National Laboratory
MDA	minimum detectable activity
mg/kg	milligrams per kilogram
NAREL	United States Environmental Protection Agency National Analytical Radiation Environmental Laboratory
NASA	National Aeronautics and Space Administration
NNSA	National Nuclear Security Administration
NORM	Naturally Occurring Radioactive Material
OEHHA	Office of Environmental Health Hazard Assessment (CalEPA)
PAHs	polyaromatic hydrocarbons
PCBs	polychlorinated biphenyls
PM	particulate matter
Pu	plutonium
RAP	U.S. Department of Energy Radiologic Assistance Program
RERT	Radiological Emergency Response Team
RMHF	Radioactive Materials Handling Facility
Rn	radon
SSFL	Santa Susana Field Laboratory
ug/kg	micrograms per kilogram
USEPA	United States Environmental Protection Agency
VOCs	volatile organic compounds

WET	Waste Extraction Test
XRF	X-ray fluorescence (analyzers)
µR/h	microrems per hour

EXECUTIVE SUMMARY

The Woolsey Fire started on November 8, 2018, in the Woolsey Canyon area south of Simi Valley in Ventura County and burned a total of 96,949 acres (approximately 151.5 square miles) in Ventura and Los Angeles counties.[1] Approximately 80 percent of the Santa Susana Field Laboratory (SSFL) was burned in the fire.

Upon learning of the fire on November 8, the Department of Toxic Substances Control (DTSC) mobilized resources to collect and evaluate data to evaluate whether the fire potentially released radiation and hazardous compounds from the SSFL site. Due to the scale and complexity of the activity, DTSC created a Response Team of federal, state, and local agencies. These agencies have scientists, engineers, and technicians with expertise in evaluating releases of radiation and hazardous compounds.

On November 9, DTSC and the Response Team developed a plan to take measurements and sample air, ash, and soil at the SSFL site and surrounding communities for potential contaminants from SSFL. The initial plan included taking measurements and samples at eight locations within the SSFL site and at 10 downwind off-site locations. Measurements are typically observations recorded from a field instrument. Samples are collected in the field and analyzed in a laboratory. Based on a larger burn area than originally considered, the number of offsite sample locations was increased from 10 to 22 and some of the originally planned locations were adjusted.

DTSC collected environmental measurements and samples with other Response Team members on November 11, 12, 13, and 14, 2019. A part of the ongoing SSFL air monitoring program, particulate and radionuclide air data were collected at SSFL's air monitoring stations before, during, and after the fire. Some other Response Team members also continued to collect measurements after the fire.

Taking real-time measurements and sampling air, ash, and soil on the SSFL site and in nearby communities provides DTSC with multiple lines of evidence to determine if the fire caused releases of SSFL contaminants. For example, Response Team members used instruments to take real-time measurements for radiation and heavy metals and collected samples of air, soil, and ash to determine if they contained such contaminants from SSFL. The Response Team used atmospheric air modeling to help identify areas where potential releases from SSFL may have traveled to identify areas to collect data.

On December 18, 2018, DTSC issued an interim report that summarized the fire response activities between November 8 and November 30, 2018. The interim report's purpose was to help us initially determine if monitoring and sampling activities identified SSFL contaminants released by the fire. The interim report presented DTSC's initial conclusions using these multiple lines of evidence: data from sampling and

[1] https://www.fire.ca.gov/incidents/2018/11/8/woolsey-fire/

measurements did not detect the release of chemical or radiological contaminants from SSFL.

This final version of the report incorporates additional data and information not available when the interim report was circulated. This final report reaches the same conclusion as the interim report: data from multiple lines of evidence did not identify a release of contaminants from SSFL. Like the interim report, this final report also finds the risk from exposure to smoke during the Woolsey Fire was not higher than what is normally associated with wildfire.

Some SSFL site features and infrastructure were damaged by the Woolsey Fire, including portions of the stormwater collection and treatment systems. The Los Angeles Regional Water Quality Control Board (LARWQCB), which regulates stormwater discharging from SSFL, verified that The Boeing Company (Boeing) took actions to prevent ash, debris, and contaminated stormwater from leaving the SSFL site. Sampling of surface water discharges in compliance with LARWQCB regulation continued after the fire.

There were exceedances of stormwater Effluent Limits reported in stormwater samples collected after the fire. The constituents exceeding Effluent Limits were almost exclusively from stormwater originating in burned areas and were primarily due to soil erosion and the burning of vegetation, piping, and treated wood. Over the course of the season, post-fire response actions and vegetation recovery resulted in stormwater effluent quality returning to pre-fire levels. The post-fire surface water conditions were generally consistent with published studies[2] that show wildfires in mostly undeveloped areas exhibit increases in many constituents.

Facilities that store hazardous materials were not affected by the fire. With one exception, the fire did not affect SSFL facilities that previously handled radioactive materials. The exception, Building 4029 is within the burn area and was exposed to enough heat or smoke to create scorch marks on the exterior.

The severity of the fire which consumed 80 percent of SSFL and destroyed or damaged almost 2,000 structures in surrounding communities. Fortunately in this case SSFL and the surrounding communities did not experience potentially devastating contaminant releases. However, climate change is increasing the frequency and severity of catastrophic wildfires in California. Climate change is also predicted to increase extreme storm events that, alone and in combination with the projected increase in wildfires, create an increased potential for floods, mudslides, and debris flows in the Los Angeles region.

[2] https://www.dtsc-ssfl.com/files/lib_surface_water/surface_water/ExpertPanelPresentation_LARWQCB_050919.pdf

Reacting to the issues created by such a significant emergency event has provided DTSC with an opportunity to better prepare for future events at SSFL. Ongoing site monitoring will be conducted at SSFL, including a continuation of the air monitoring program, and DTSC will conduct inspections after fire and significant storm events to look for soil movement or erosion. Additionally, DTSC will verify that the Hazardous Materials Release Plans and Spill Prevention and Response Plans submitted by other agencies comply with DTSC's regulatory authority and good practice.

BACKGROUND

Woolsey Fire

The Woolsey Fire started on Thursday, November 8, 2018. It started on the SSFL site at E Street and Alfa Road in the Santa Susana Mountains above the Simi Valley near the boundary between Los Angeles and Ventura counties. E Street and Alfa Road are located with the SSFL property boundary. Santa Ana winds caused the fire to rapidly spread in a southerly direction toward the coast at Malibu.

At 6:11 p.m. November 21, the Woolsey Fire was reported as 100 percent contained, and on January 4, 2019 it was reported as extinguished. The fire burned 96,949 acres, destroyed or damaged almost 2,000 structures, killed three people, and resulted in the evacuation of large areas of western Los Angeles County and eastern Ventura County.[3] The area affected by the fire is shown on Figure 1.

Santa Susana Field Laboratory

SSFL covers approximately 2,850 acres located in Ventura County (Figure 1). The site, also referred to as the Rocketdyne facility, operated from 1948 until 2006, and was used for rocket engine testing and nuclear power research.

Past activities at SSFL have resulted in chemical and radionuclide contamination in the soil and groundwater at the site. The parties responsible for the cleanup of this contamination are Boeing (the owner of the majority of the site), the United States Department of Energy (DOE), and the National Aeronautics and Space Administration (NASA).[4]

DTSC is the lead state agency overseeing the cleanup of SSFL. The majority of radionuclide contamination at SSFL is in a portion of SSFL identified as Area IV. There is no active storage of radioactive or chemical hazardous waste at SSFL.

Air Monitoring Programs at the Santa Susana Field Laboratory

There are two air monitoring programs at SSFL and data were collected during the fire. The two programs include a site-wide Baseline Air Monitoring Program,[5] and air sampling associated with the DOE's Environmental Monitoring Program.[6]

[3] https://www.fire.ca.gov/incidents/2018/11/8/woolsey-fire/
[4] https://www.dtsc-ssfl.com/files/lib_ceqa/ref_draft_peir/Chap2_Intro/67874_DTSC_2007_Consent_Order.pdf
[5] https://www.dtsc-ssfl.com/files/lib_air_monitor/work_plan/2017-09-21_SSFL_BaselineAirMonitoringWorkPlan_Revised_Final.pdf
[6] https://www.etec.energy.gov/Library/Main/ER-AN-0006_Environmental_Monitoring_Plan_Rev_B.pdf

There are 14 air monitoring stations in the Baseline Air Monitoring Program. The locations of the stations were selected based on the areas to be cleaned up, with consideration of winds in the area, topographic features, and accessibility.

The overall goal of the Baseline Air Monitoring Program at SSFL is to characterize levels of particulates (PM10, PM2.5), volatile organic compounds (VOCs), and radionuclides in the air at SSFL prior to cleanup. The Baseline Air Monitoring Program started on April 15, 2018, and called for one year of baseline monitoring, to be followed by a program evaluation to determine a strategy for future routine monitoring. Currently, the air monitoring at SSFL is continuing as designed in the work plan. During future SSFL cleanup activities, air monitoring data will be evaluated against the Baseline Air Monitoring Program database to verify that harmful emissions are not occurring.

Radionuclides in the air are monitored at two locations as part of DOE's Environmental Monitoring Program. One monitoring station is at the Radioactive Materials Handling Facility (RMHF), and the second one is at a site called Building 20.

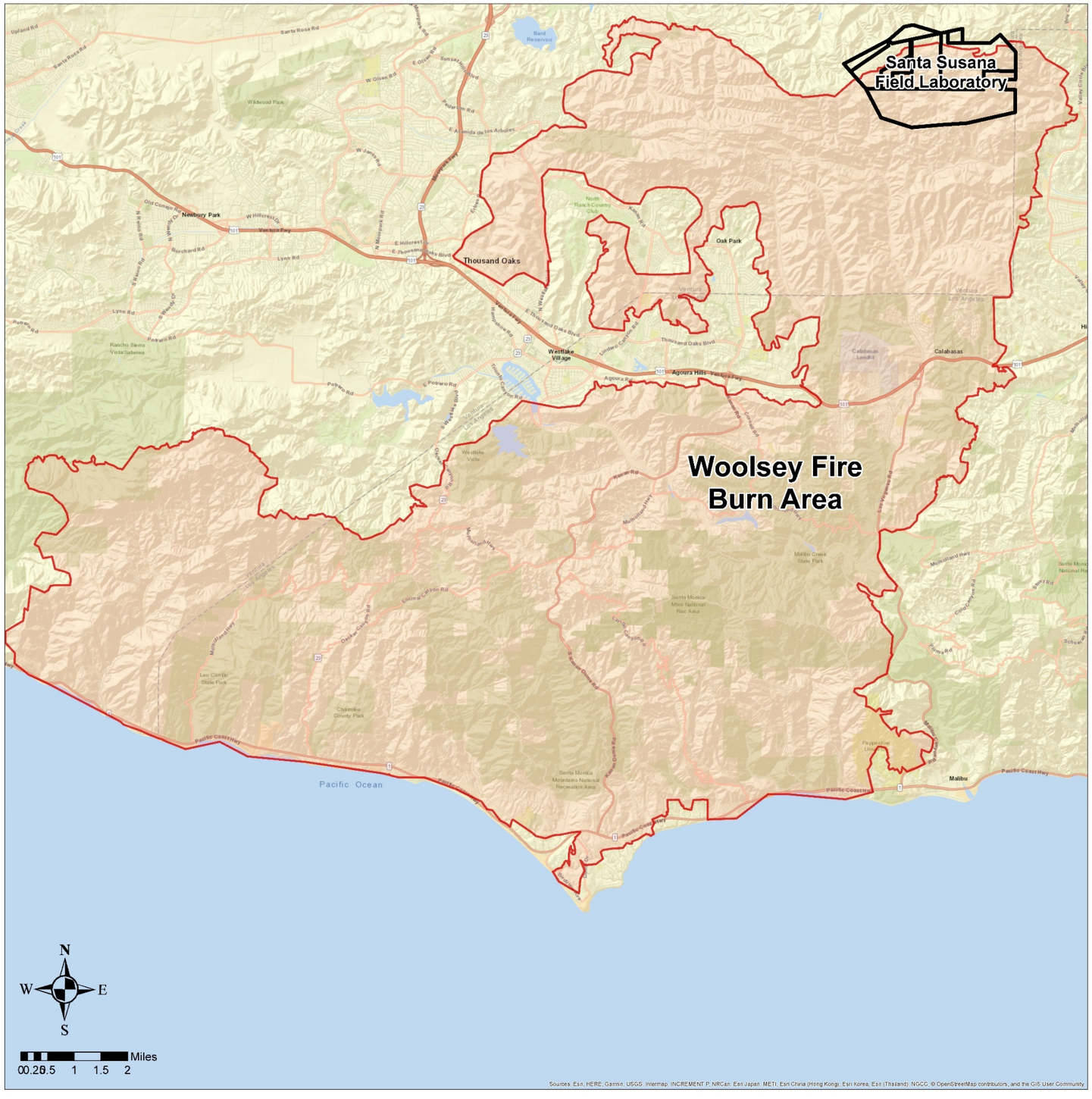
Thirteen of the 14 Baseline Air Monitoring stations collected air monitoring data during the Woolsey Fire. One station was damaged during the fire. The two DOE stations collecting air monitoring data at the RMHF and Building 20 collected air monitoring data during the fire.

Interim Summary Report of Woolsey Fire

On December 18, 2018, DTSC circulated the *Interim Summary Report of Woolsey Fire* that described the Response Team's fire response work conducted between November 8 and 30, 2018. DTSC used multiple lines of evidence from this work to conclude that the Woolsey Fire did not result in detectable concentrations of contaminants released from SSFL. The interim report also found no higher risks than are normally associated with air quality during a wildfire. The interim report provided summaries and conclusions of Response Team member products based on available, validated data. DTSC issued the interim report when validated laboratory data and final reporting were not yet available from several Response Team members.

This *Final Summary Report of Woolsey Fire* incorporates information not available for the interim report, including:

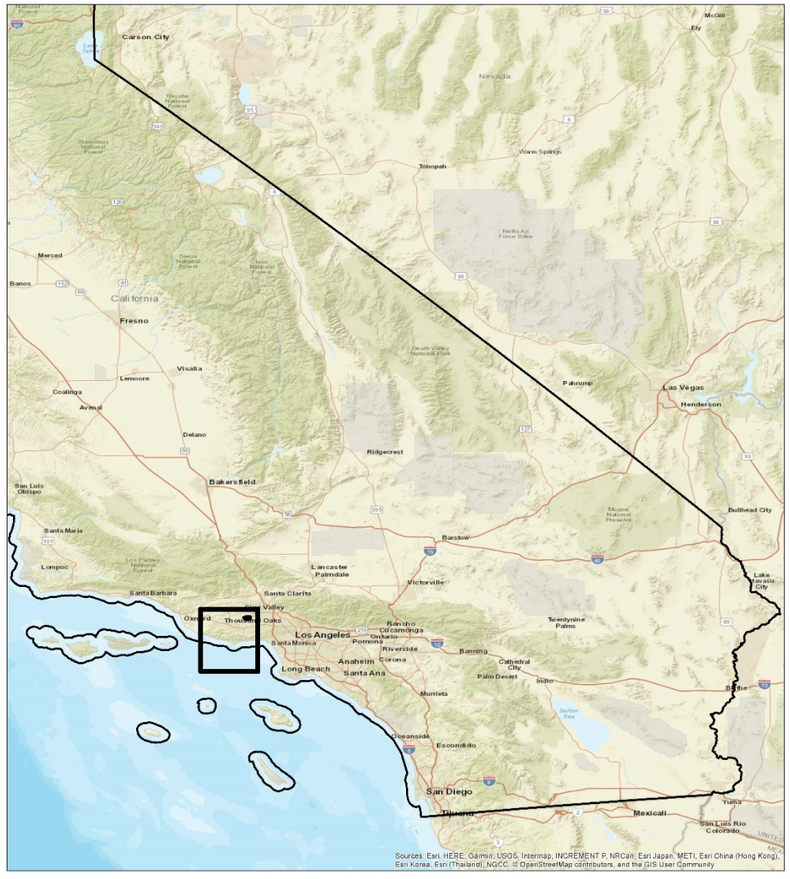
- Final analytical results for dioxins and furans from DTSC's Environmental Chemistry Laboratory;
- The United States Environmental Protection Agency (USEPA) Radiological Emergency Response Team RadNet Monitoring Summary Report;
- Air sample results and a report from DOE's air sampling stations located on SSFL;
- Air sample results and a report from Boeing's air sampling stations located on SSFL;
- Additional stormwater information from the LARWQCB



DTSC

CAL EPA

LOCATION MAP



Miles
0 30 60 120 180 240

Figure 1

Location map

Created by: W. Martinez
Date: 11/30/2018

SUMMARY OF RESPONSE TEAM ACTIVITIES

The Woolsey Fire started on November 8, 2018. and continued to burn across 80 percent of SSFL through November 9, 2018. Shortly after the fire had moved through the site, DTSC emergency responders reached out to local responders who reported that the fire did not burn through facilities that had handled radiological material or hazardous wastes (see photos in Appendix B). However, because the Woolsey Fire burned portions of SSFL, the nearby community was alarmed by the possibility of radionuclides and hazardous chemical waste migrating off site in the fire's smoke and ash. After the fire, the community also expressed concerns about contaminants being washed off SSFL into local drainages in the future.

DTSC assessed the potential chemical and radiological hazards associated with SSFL and developed a list of potential contaminants of concern for sampling based on the historic activities at SSFL. The list included radionuclides, metals, VOCs, polyaromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). In the following days DTSC performed rapid detection for potential releases of radiation and hazardous compounds, and verified the results by collecting soil, ash, and air samples for laboratory analysis.

Beginning Friday, November 9, DTSC requested and coordinated assistance from the Response Team to assess the impacts of the fire on SSFL. In addition to DTSC, the Response Team included the:

- California Environmental Protection Agency (CalEPA)
- CalEPA Office of Environmental Health Hazard Assessment (OEHHA)
- California Department of Public Health (CDPH)
- DOE National Nuclear Security Administration (NNSA) Consequence Management Home Team
- DOE Radiologic Assistance Program (RAP) from Lawrence Livermore National Laboratory
- California National Guard 9th Civil Support Team (9th CST)
- USEPA Radiological Emergency Response Team (RERT)
- Los Angeles County Department of Public Health (LACDPH) Radiation Management Program, and
- Other agencies from the counties of Los Angeles and Ventura

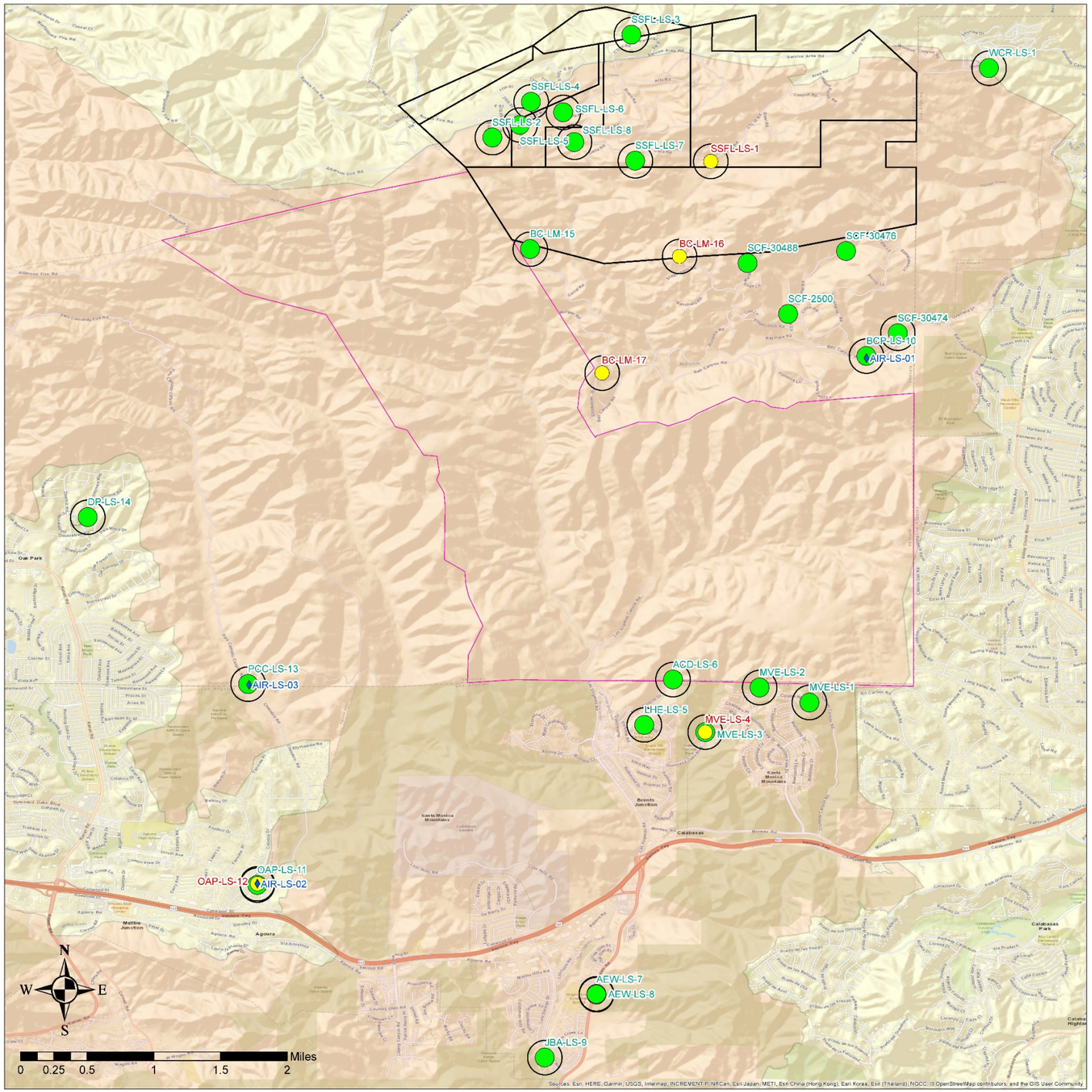
The Response Team also worked closely with the California Office of Emergency Services Incident Command, local law enforcement, and air quality agencies.

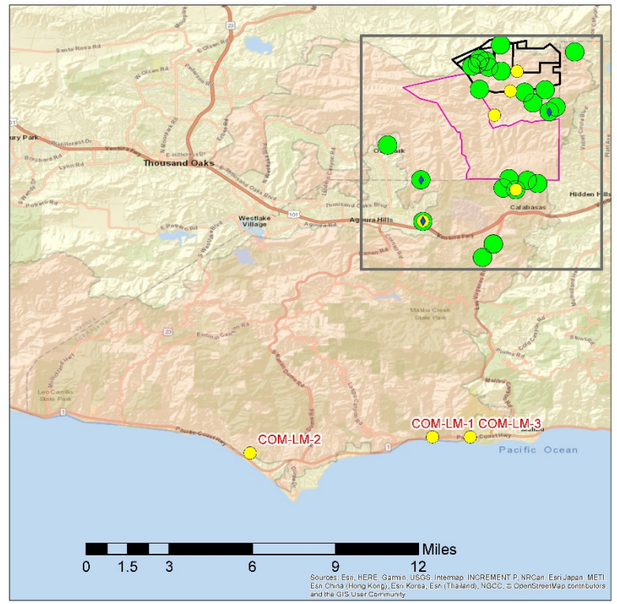
The NNSA Consequence Management Home Team performed a preliminary computer simulation to estimate the total potential inhalation exposure risk from radionuclides found at SSFL. The model assumed that the maximum SSFL soil contamination measurement for each radionuclide was present in the soil in order to calculate the amount released by the fire. The simulation indicated that even when using the maximum observed radionuclide concentration to estimate the amount of radionuclide

being released, the modeled off-site impacts would be over 1 million times lower than USEPA levels of concern. The Response Team considered the simulation when designing the field sampling plan to identify areas where any off-site concentrations would be greatest.

DTSC took samples at SSFL and in other areas off site to ensure wide coverage of nearby residential communities. Sample locations are shown on Figure 2, and sample information is presented in Table A-1 (Appendix A). The DOE RAP team and 9th CST collected field measurements and conducted sampling for radionuclides and chemicals, respectively, at locations co-located with DTSC sampling efforts. Table A-2 (Appendix A) presents a summary of the locations where sampling was conducted by DTSC, DOE RAP, and the 9th CST at the same location.

MEASUREMENT LOCATIONS
DTSC Soil, Ash and Air Sampling





NOTE:
Fire perimeter layer from Los Angeles County GIS Data Portal: Fire Perimeter (updated 11/18/18).

Legend

- Air
- Ash
- Soil
- Field Measurement (Rad Monitor, XRF)
- Santa Susana Field Laboratory
- Fire Perimeter (LA Co, 11/18/2018)
- Upper Las Virgenes Canyon Open Space Preserve

Figure 2

DTSC Map of Woolsey Fire Response Features

Created by: W. Martinez
Date: 11/30/2018

DTSC WOOLSEY FIRE RESPONSE CHRONOLOGY

Upon learning of the active fire on November 8, DTSC began mobilizing resources to assemble information and collect data to evaluate possible releases of hazardous chemicals and radionuclides from the SSFL site. Below is a Chronology of DTSC's response activities.

Day 1, November 8, 2018

- Fire starts approximately 2 p.m.
- DTSC learns of fire and contacts Ventura County and Los Angeles County fire officials regarding fire status
- DTSC develops Community Update for distribution on DTSC's Santa Susana Field Laboratory EList (email is sent early morning November 9, 2018)

Day 2, November 9, 2018

- Fire grows and moves south
- DTSC contacts Boeing, DOE, and NASA site managers, who advised:
    - Fire moved rapidly through site
    - There was extensive burning
    - Former nuclear research areas were not in burned area(s)
        - The exterior of Building 4029 was scorched.
- DTSC assembles a Response Team
- Response Team plans an approach to evaluate potential health threat from SSFL contamination caused by the fire
    - DTSC provides site information to team including:
        - List of target chemicals and radionuclides to evaluate
    - NNSA Consequence Management Home Team conducts atmospheric modeling to assess potential downwind impacts to the public
        - Modeled inhalation dose and deposition (ground contamination) was found to be many times lower than the USEPA's Protective Action Guideline (Doses and Protective Action Guidelines are discussed in the NNSA's report in Appendix C)
    - Program is developed for measurements and sampling
        - The initial plan included taking measurements and samples at eight locations within the SSFL site and at 10 downwind off-site locations
- DTSC circulates Community Update and a press release to provide an update on the status of the fire at SSFL

Day 3, November 10, 2018

- DOE RAP and 9th CST mobilize assets to site in the late afternoon
    - Decision is made to begin sampling on morning of Day 4 because of high winds and active burning
- DTSC visually verifies buildings and sites in Area IV have not been damaged by fire
    - Photographs taken of areas at SSFL including Area IV

Day 4, November 11, 2018

- Measurements and sampling begin
    - DTSC takes measurements and samples at 11 locations
        - 1 location at SSFL, 1 location in Bell Canyon, 9 locations in Calabasas
            - 9 soil samples, 2 ash samples
    - 3 DTSC samples collected at the same locations as DOE RAP sampling (i.e., co-located)
    - 1 sample co-located with 9th CST
- Teams stop work early due to dangerous conditions in field
- DTSC attends Town Hall meeting at Taft Charter High School in Woodland Hills

Day 5, November 12, 2018

- Measurements and sampling continue
    - DTSC takes measurements and samples at 8 locations
        - 2 locations in Bell Canyon, 1 location in Oak Park, 5 locations in Agoura Hills
            - 4 soil samples, 1 ash sample, 3 air samples
    - 3 samples co-located with DOE RAP
    - 3 samples co-located with 9th CST
- Teams stop work early due to dangerous conditions in field
- DTSC circulates a press release describing DTSC's response and sampling activities related to the fire

Day 6, November 13, 2018

- Measurements and sampling continue
    - DTSC takes measurements and samples at 14 locations
        - 7 locations at SSFL, 6 locations in Bell Canyon, 1 location in Woolsey Canyon
            - 12 soil samples, 2 ash samples
    - 6 samples co-located with DOE RAP
    - 2 samples co-located with 9th CST
    - End of DOE RAP and 9th CST sampling activities

Day 7, November 14, 2018

- Measurements and sampling continue
    - DTSC takes measurements and ash samples at 3 locations in Malibu
    - End of DTSC sampling activities
- DTSC circulates Community Update and a press release to provide an update on DTSC's response and sampling activities related to the fire

November 14 through November 30, 2018

- USEPA RERT performs gamma exposure rate monitoring and air sampling using deployable monitors at 5 locations in Ventura and Los Angeles counties
    - 1 background location
    - 4 off-site locations

November 19, 2018

- NNSA submits *Summary of DOE Survey Activities during the Woolsey Fire Response*
- 9th CST submits *Commander's Executive Summary* report (for Woolsey Fire effort)
- The LACDPH Radiation Management staff conducted a radiation survey in Bell Canyon

December 18, 2018

- DTSC circulates *DTSC Interim Summary Report of Woolsey Fire*

December 21, 2018

- USEPA RERT submits *Woolsey Fire Response Summary Report: Gamma Exposure Rate Monitoring and Air Sampling*

January 4, 2019

- Boeing submits *Radiological Air Monitoring Data Associated with the Woolsey Fire, Santa Susana Field Laboratory, Ventura County, California*

January 24, 2019

- DOE submits *Radioactive Particulate Air Sampling Results Associated with the Woolsey Fire*

May 9, 2019

- The Stormwater Expert Panel presented a *Post Wildfire Stormwater Update* to the LARWQCB at a public meeting summarizing the effect of the Woolsey Fire on stormwater discharging from SSFL

DTSC SAMPLING AND MEASUREMENT ACTIVITIES

Overview of Measurement and Sampling Work

Once conditions were safe enough to allow field sampling, DTSC acted promptly to test for potential releases of hazardous constituents using portable instruments that provide results in real time. Radiation can be assessed in real time using handheld instruments called radiologic meters. Similarly, handheld instruments called X-ray fluorescence (XRF) analyzers provide real-time measurements of various metals. Screening samples are often followed up by the collection of samples that are sent to a laboratory for further analysis. DTSC made field measurements using handheld instruments at all locations and collected 36 physical samples of air, soil, and ash. The physical samples were sent to DTSC's Environmental Chemistry Laboratory (ECL) for chemical analysis.

More sophisticated mobile instruments, typically installed in specially equipped vans, can also be used to measure radionuclides, VOCs, and metals. DTSC requested support from members of the Response Team to provide analysis with mobile instruments.

On Saturday, November 10, as soon as access to SSFL was possible, DTSC investigators entered the site and verified the November 8 assessment that the fire had not burned facilities in Area IV where radioactive and hazardous materials were previously managed. Specifically, the fire did not extend to the former RMHF, Hazardous Waste Treatment Facility, Sodium Reactor Experiment area, or other buildings in that area (see pictures in Appendix B). Power lines and poles were down across much of the site. The DTSC investigators used portable instruments to take real-time readings of radiation and did not detect any radiation above background levels during their visit to the site.

DTSC scientists and investigators also took real-time measurements for radiation and hazardous materials, and collected soil, ash, and air samples from November 11 to November 14, 2018. The field measurements and sampling occurred on SSFL and off site in the surrounding and downwind communities of Woolsey Canyon, Bell Canyon, Calabasas, Oak Park, Agoura Hills, and Malibu. Sample locations were selected based on a variety of factors, including modeling, proximity of residential areas to SSFL and the ability to access the areas. The name, location, and type of the 36 samples collected are presented in Table A-1. DTSC, DOE RAP and the 9th CST collected a number of samples at the same locations. Table A-2 presents a list of co-located samples. The sample locations are shown on Figure 2.

Chemical results for soil and ash were compared against USEPA residential screening levels (Table A-3). Arsenic results were compared against the natural background levels found in the surrounding area. The USEPA residential screening levels were used to determine if further investigation was needed and are based on a long-term, 26-year exposure scenario, not on a short-term, single exposure event. This is health-protective for three reasons: First, screening levels for long-term exposures are designed to find contaminants at or above very low levels; in contrast, short-term screening levels are generally designed to find only higher levels of contamination. Second, the use of long-term screening levels is appropriate because any transported soil and ash may remain

in place for years. Third, the long-term screening level fits the pattern of exposure that people may experience.

The chemical results for the three air samples DTSC analyzed were also compared to the USEPA residential screening levels. Again, the screening levels assume a long-term (26-year) exposure to the chemicals in the air. Given the transient nature of fires, use of the USEPA screening levels is extremely protective of human health exposure, because the community is not exposed to that smoke for extended periods of time (multiple years).

Real-Time Measurements – Instruments Used and Results

DTSC took real-time measurements for radioactive contamination or heavy metals at 33 locations. At 27 of the locations, measurements for both radiation and heavy metals were taken. At 31 locations, radiation measurements were taken. At 27 locations, measurements of heavy metals were taken.

DTSC used Ludlum Model 19 portable radiologic meters to look for gamma radiation. These are sensitive instruments that measure gamma levels as low as a few microrems per hour (µR/hr). For fire recovery work, DTSC's industrial hygienists recommend DTSC staff use a safety-based action level of 200 µR/hr.

DTSC screened seven of eight SSFL soil sample locations, and 25 of 26 sampling locations in the communities of Agoura Hills, Bell Canyon, Calabasas, Thousand Oaks, and West Hills, for radiation. The portable radiologic meters were turned on and operating for the full duration of each field inspection, including while driving on the site and in communities around the site where the samples were taken. All readings were within background levels. Discrete measurements of soil and ash were below 40 µR/hr, well below the safety-based action level, with an average between 15 and 20 µR/hr. The results of the DTSC discrete gamma radiation measurements of soil and ash are presented in Table A-4 (Appendix A).

In addition, DTSC used portable XRF analyzers to screen for metals. XRF testing is a nondestructive testing technique typically used during site reconnaissance to rapidly assess site conditions. XRF screening was performed at the eight SSFL locations and 21 of 25 locations in the communities where soil and ash samples were collected for laboratory analysis. A discussion of laboratory sample analysis results is presented later in this report.

The XRF screening results (Table A-5) showed six samples with potential cobalt readings above USEPA residential screening levels (Table A-3), and one sample reading detecting mercury slightly above USEPA residential screening levels. Laboratory analysis for the samples collected from the same locations reported concentrations below the USEPA residential screening levels.

All of the XRF sample results presented in Table A-5 (except the seven samples with cobalt and mercury exceedances described above) did not report concentrations other than what is normally present in the background, or after a fire. Some metals including cobalt, copper, nickel, lead, zinc and mercury may be mobilized in ash from burning

structures or from fire in areas where airborne deposition of metals from urban and industrial sources has occurred.[7,8]

Laboratory Verification – Samples Collected and Results

To verify real-time screening levels measured on and around SSFL following the Woolsey Fire, DTSC collected 36 discrete samples, including air, soil, and ash samples, from 33 locations. Sample locations covered a wide area on site and in the nearby communities. Of the 33 sample locations, eight locations were on SSFL and 25 sample locations were in surrounding communities. The three air sample locations were also soil/ash sample locations.

Table 1 below presents the sample communities and number of air and soil or ash samples collected. The sample locations are shown in Figure 2.

Table 1: Community and Number of DTSC Samples

Community	Air Samples	Soil/Ash Samples	Real-Time Measurements for Heavy Metals or Radiation
SSFL	0	8	8
Ventura County (Bell Canyon)	1	8	8
Los Angeles County (Woolsey Canyon)	0	1	1
Agoura Hills	2	3	3
Ventura County (Oak Park)	0	1	1
Calabasas	0	9	9
Malibu	0	3	3
Total	**3**	**33**	**33**

The sample collection procedures and locations were documented. A chain-of-custody form was used to document sample control from the field to the laboratory. This provides a mechanism for tracking samples through collection, processing, and analysis. The 36 samples DTSC collected were submitted to ECL for analysis. The physical sampling included: air samples in Summa canisters, soil samples in sample jars, and ash samples in sample jars.

DTSC's ECL is nationally recognized and serves as the reference laboratory for the certification of environmental testing laboratories throughout the state. ECL analyzed 33 soil and ash samples for hazardous compounds including metals, PCBs, PAHs, dioxins, and furans. ECL also analyzed the three air samples for VOCs.

[7]https://calepa.ca.gov/wp-content/uploads/sites/6/2019/06/Disaster-Documents-2011yr-GuideRemoval.pdf
[8] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4178038/

ANALYTICAL RESULTS FOR DTSC SAMPLES

Metals Analysis

Normal metals analysis includes 17 metals. This analysis includes the following metals, which are associated with contamination at SSFL:

- antimony
- arsenic
- barium
- beryllium
- cadmium
- chromium
- cobalt
- copper
- lead
- molybdenum
- nickel
- selenium
- silver
- thallium
- vanadium
- zinc
- mercury

Laboratory Results for Metals: All the arsenic sample results were below the local background levels. The remaining metals results were below their respective USEPA residential screening levels (see Table A-3). There was one lead result at 87.2 milligrams per kilogram (mg/kg) – the only value above OEHHA's 80 mg/kg screening value – but below the USEPA residential screening level. Laboratory metals results are presented in Table A-6. DTSC also had ECL run a Waste Extraction Test (WET) to assess whether sampled materials exceeded established hazardous waste levels. None of the material was at hazardous waste levels. The WET results are provided in Table A-7.

PCB Analysis

PCBs are a group of compounds that share a similar chemical structure. Their name describes the chemical similarity, in that they all have polychlorinated biphenyl components. The different members of the group of PCBs are called Aroclors and are referred to by number. The key PCBs found on SSFL are Aroclor 1254 and 1260. The analytical method DTSC used analyzed for seven PCB Aroclors and includes the Aroclors found at SSFL. The PCB Aroclors analyzed include:

- Aroclor 1016
- Aroclor 1221
- Aroclor 1232
- Aroclor 1242
- Aroclor 1248
- Aroclor 1254
- Aroclor 1260

Laboratory Results for PCBs: All the sample results were reported below the minimum detection limit of 1 µg/kg and below USEPA residential screening levels (see Table A-3). The PCB Aroclor laboratory results are presented in Table A-8.

PAH Analysis

PAH's are a group of compounds that share a similar chemical structure. Their name describes the chemical similarity, in that they all have polyaromatic hydrocarbon components. The different members of the group of PAH's have individual chemical names. The analytical method used analyzes for individual PAHs. The analysis includes the PAHs associated with SSFL. The 16 individual PAHs analyzed include:

- acenaphthene
- acenaphthylene
- anthracene
- benzo(a)anthracene
- benzo(a)pyrene
- benzo(b)fluoranthene
- benzo(g,h,l)perylene
- benzo(k)fluoranthene
- chrysene
- dibenzo(a,h)anthracene
- fluoranthene
- fluorene
- indeno(1,2,3-c,d)pyrene
- naphthalene
- phenanthrene
- pyrene

Laboratory Results for PAHs*:* None of the samples were found to have concentrations of any PAH analytes above their respective USEPA residential screening levels. PAH laboratory results are presented in Table A-9.

VOC Analysis of Air Samples

DTSC collected air samples from three locations on November 13 and analyzed them for the presence of 82 individual VOCs. A complete list of the VOCs analyzed can be found in Table A-10. The purpose of the air sampling was to assess the potential for contaminants associated with SSFL to be in the air. The major VOC associated with SSFL is the solvent trichloroethylene.

Laboratory Results for VOCs: The analytical results for 82 individual VOCs in each of three air samples (246 discrete results for 3 samples) are presented in Table A-10. Trichloroethylene was not detected in any sample.

Analytical results for six VOC analytes were reported above screening levels. Benzene and 1,2-dibromethane exceeded DTSC HERO Note 3 residential screening levels[9]. Acrolein, benzyl chloride, 1,2-dichlorobenzene, and 1,2-dichloromoethane exceeded USEPA[10] residential screening levels.

Only acrolein was detected in all samples and it was reported at levels consistent with the mean ambient air value measured in Simi Valley[11] and Burbank[12]. Similarly, benzene levels detected in two locations are consistent with levels that have regularly been measured at Simi Valley and Burbank. The other detected chemicals, are not routinely monitored for air quality, but are at low levels representative of normal variations in VOC concentrations in ambient air resulting from a variety of sources from a nearby urban environment.

[9] https://dtsc.ca.gov/wp-content/uploads/sites/31/2018/01/HHRA-Note-3-June-2018.pdf
[10] https://semspub.epa.gov/work/HQ/199934.pdf
[11] https://www.arb.ca.gov/adam/toxics/sitepages/acrousimi.html
[12] https://www.arb.ca.gov/adam/toxics/sitepages/acroubbnk.html

Comparing transient air samples to USEPA and DTSC HERO Note 3 residential screening levels is very conservative because screening levels are not based on a single exposure, but rather based on the assumption that a person would be breathing air with that concentration of chemical for 26 years. As discussed above, chemicals detected in the samples are at levels consistent with ambient air quality conditions monitored at Simi Valley and Burbank.

Analysis for Dioxins and Furans

Soil and ash samples were also analyzed for dioxins and furans. Dioxins and furans are chemicals that can form when materials that contain common items as plastics and irrigation piping are burned. Natural processes like wildfires can also produce dioxins and furans[13].

Laboratory Results for Dioxins and Furans: Final analytical results for dioxins and furans from DTSC's Environmental Chemistry Laboratory were reevaluated against dioxin toxicity equivalent (TCDD TEQ) concentrations[14]. Two scenarios were evaluated:

- 50 picograms per gram (pg/g, equivalent to parts per trillion) goal for a Residential soil exposure scenario.
- 5 pg/g goal for a soil exposure scenario for a Subsistence Farmer.

The Residential remedial goal of 50 pg/g is typically considered except when farming or raising of food animals is likely to make up the majority of the food supply for residents at the site.

As presented in the laboratory results in Table A-11, none of the 33 samples analyzed for dioxin and furans had laboratory results reported above the 50 pg/g goal for a TCDD TEQ Residential soil exposure scenario.

Five of the 33 samples had laboratory results reported above the goal for a TCDD TEQ subsistence farmer soil exposure scenario. One of the five sample locations was on the SSFL site and the three other locations were in Agoura Hills and Calabasas, several miles from SSFL. Considering the distance from SSFL and the known generation of dioxins and furans from burning plant materials and structures, DTSC does not interpret the data of relatively low-level offsite exceedances to be associated with SSFL.

Analyses and results prepared by other members of the Response Team are summarized below.

[13] https://www.epa.gov/dioxin/learn-about-dioxin
[14] https://dtsc.ca.gov/wp-content/uploads/sites/31/2018/01/HHRA-Note-2-dioxin-2017-04-06.pdf

CONCLUSIONS FOR DTSC SAMPLING AND MEASUREMENT RESULTS

Based on DTSC's sampling results discussed above, none of the measurements and analyses indicate that radiation or hazardous materials associated with SSFL contamination were released by the fire. Soil and ash sample results found no chemical releases from SSFL as a result of the fire. The samples showing dioxin above USEPA risk screening levels suggest a localized source for the dioxins, not directly related to SSFL. The single lead exceedance is located far from SSFL, and the lack of spatial continuity and distribution does not support a conclusion that the single lead result could be tied back to SSFL. The air samples for VOC's are consistent with local ambient air quality results.

Other Agencies' Sampling and Monitoring Activities

In addition to DTSC, other members of the Response Team also took measurements and analyzed samples. The cumulative effort yielded overlapping data sets of measurements and sampling of air, soil and ash. Combined with visual observations and atmospheric modeling, the data provide multiple lines of evidence to help DTSC evaluate whether radiation and hazardous compounds were potentially released from the SSFL site.

The Response Team took measurements and samples for radiation and hazardous compounds from November 11 to November 14, 2018, on the SSFL site and off site, in Bell Canyon, Calabasas, Agoura Hills, Oak Park, and Malibu. The Response Team worked closely with the California Office of Emergency Services Incident Command Post, local law enforcement, and air quality agencies. Although elevated radiation levels were not detected, USEPA RERT mobilized to the area and conducted gamma exposure rate monitoring and air sampling from November 14 through November 30, 2018. The monitoring and air sampling utilized deployable monitors at five locations in Chatsworth, Canoga Park, Agoura Hills, Thousand Oaks, and at the Incident Command Post in Camarillo.

LACDPH's Radiation Management Program staff conducted air monitoring at Fire Station 75 and Fire Station 106 in Box Canyon and conducted surveys and sampling in Bell Canyon and the western San Fernando Valley. Additionally, Boeing and DOE submitted SSFL air monitoring data collected during the fire.

Table 2 presents the number and types of samples collected by each Response Team member.

Table 2: Response Team Samples

Agency	Air Samples (Chemical)	Air Sample Locations (Radiological)	Soil/Ash Samples
DTSC	3	0	33
DOE RAP Team (analysis by Lawrence Livermore National Laboratory)	0	14 (6 locations on SSFL, 8 locations in the communities)	19
9th CST	6	0	6
LA CDPH-RMP	0	2	11
USEPA RERT	0	5 locations	0
Total	9	Multiple samples were taken at the same location	69

The summaries below are based on reports and data provided by the Response Team members. The conclusions in the Response Team members' final reports are consistent with the findings presented in the interim report.

DOE NNSA Radiologic Assistance Program

On November 9, DTSC requested assistance from DOE's Office of Nuclear Incident Response through Region 7 of that office's RAP Team. The team was to assess the

potential for transport of radiological contamination from SSFL to the surrounding community due to the Woolsey Fire. A Response Team led by the Regional Program Manager was dispatched in support of DTSC. Based on an initial assessment of state needs, additional technical support was activated to support the deployed team.

On November 9, support was provided in the form of a predictive model of the potential for off-site transport of materials due to the fire. The modeling results showed that had any migration occurred, the resultant maximum off-site concentrations would have been over 1 million times lower than USEPA levels of concern.

In coordination with CalEPA and DTSC, a sampling plan was developed to support the objective of ensuring the safe return of members of the public who had been previously evacuated due to fire hazards. Therefore, the locations of the measurements, samples, and analyses performed were primarily focused on determining if results were above or below a value that corresponds to a USEPA protective action guideline.

To validate the results predicted by the model, DTSC and the response team identified areas within the SSFL site boundary (on site) and in the surrounding community (off site) at which environmental measurements and samples should be collected for further analysis . By November 13, the RAP team had taken over 50 environmental measurements assessing ambient radiation levels while also collecting samples of soil materials and airborne materials at 12 discrete locations (six on site and six off site). After a review, it was determined that all results were consistent with natural background radiation levels.

In addition, 14 on-site samples (six air and eight soil samples) and 17 off-site samples (eight air and nine soil) were collected.

All samples were analyzed at Lawrence Livermore National Laboratory (LLNL). Sample and measurement results were reviewed and assessed by scientists at LLNL, Sandia National Laboratory, and NNSA’s Remote Sensing Laboratory. Results for all but two of the samples were consistent with naturally occurring radioactive materials. One sample taken on site showed trace quantities of cesium-137 (Cs-137), which has been assessed as consistent with what would be found due to low levels of worldwide fallout from atmospheric weapons testing. The second sample, taken off site in the Bell Canyon area, showed slightly elevated alpha and beta activity relative to other off-site samples. Gamma spectroscopy of this sample showed nothing that could be attributed to residual radioactivity from the Santa Susanna site, but reanalysis of this sample confirmed the slight elevation in gross alpha and beta activity. Follow-up analysis performed at LLNL and additional sampling conducted by the LACDPH Radiation Management Program in this location indicate the presence of elevated levels of naturally occuring radioactive materials.

No radiological measurement or sample collected by DOE RAP has indicated that any protective actions are warranted according to USEPA protective action guidelines. Moreover, all measurements and samples collected beyond the boundaries of SSFL indicate levels of radioactivity that are consistent with those typically found in the environment attributable to global levels of radioactivity from nuclear weapon testing during the 1950s, ’60s, and ’70s.

The NNSA Summary Report is presented in Appendix C.

9th Civil Support Team, California National Guard

CalEPA and DTSC asked the 9th CST to provide support to DTSC to collect air and soil samples in conjunction with DOE's off-site radiation sampling efforts at Bell Canyon. The 9th CST deployed a mobile monitoring unit equipped with instruments that would provide real-time or nearly real-time analytical results for VOCs. Samples were also sent to LLNL for analysis.

Air and soil samples were analyzed using gas chromatography-mass spectrometry and Honeywell MultiRae Pro detectors. The FLIR Instantaneous Biological Analyzer and Collector 1 and Research International's Smart Air Sampler System 3100 were used for filtered air analysis.

The 9th CST took six air and soil samples from six locations. One air sample and one soil sample were collected on November 11, and five samples were collected on November 13. Evacuations due to the fire did not allow for sampling on November 12.

The sampling locations and their latitude and longitude coordinates included:

- Bell Canyon Road, West Hills: 34.20612 / -118.66960
- Saddlebow Road, Bell Canyon: 34.21525 / -118.70973
- Coolwater Road, Bell Canyon: 34.21486 / -118.67586
- Wagon Lane, Bell Canyon: 34.21422 / -118.69343
- Marlboro Lane, Bell Canyon: 34.21363 / -118.68617
- Hackamore Lane, Bell Canyon: 34.20920 / -118.68182

The 9th CST reported that the analysis for the air and soil samples showed no significant findings and concluded that there are no expected current or future health effects relating to the findings provided by the analytical laboratory.

The 9th CST Summary Report is presented in Appendix D.

USEPA Radiological Emergency Response Team

CalEPA and DTSC requested USEPA RERT support to help DTSC collect air samples in conjunction with the Woolsey Fire. On November 14, 2018, USEPA set out five air monitoring stations in Ventura and Los Angeles counties. The array of stations included one background location and four locations downwind of SSFL. The background location was established at the Incident Command Post and the remaining locations were at fire stations selected by the DTSC. The locations of the five stations are presented on the Woolsey Fire RadNet Sampling Stations Map in Appendix E.

Gamma exposure rate monitoring was conducted by USEPA's RERT at the five stations between November 14 and 21, 2018, and November 23 and 28, 2018. Sixty air particulate samples were analyzed for gross alpha and beta radioactivity in the NAREL Mobile Environmental Radiation Laboratory, and by gamma spectrometry in the NAREL fixed laboratory. The average daily exposure rates from the background monitoring location ranged from 10.7 µR/h to 16.4 µR/h. The daily average exposure rates at the

four stations are similar to the background location and ranged from 9.5 µR/h to 13.1 µR/h.

The results of the air samples report detections of naturally occurring radionuclides including daughters of radon-222 (Rn-222) and radon-220. Lead-210 is a long-lived daughter of Rn-222 and is present in these samples at levels similar to those from annual composite analyses of Los Angeles area RadNet fixed air monitoring data. Cs-137 was not detected.

USEPA RERT concluded that the results over the sampling period represent the average concentrations of gross alpha, gross beta, and gamma-emitting radionuclides, consistent with background levels of radiation in the environment.

The USEPA RERT Summary Report is presented in Appendix E.

DOE Energy Technology Engineering Center Air Sampling Results

The DOE Energy Technology Engineering Center (ETEC) monitors and collects air samples for radionuclides at six locations for two programs at SSFL. Four stations are monitored as part of the Baseline Air Monitoring Program, and two stations are monitored as part of the ETEC Environmental Monitoring Program.

Air monitoring results from the Baseline Air Monitoring Program are normally submitted on a quarterly basis, and results from the ETEC Environmental Monitoring Program are submitted annually.

DOE submitted two brief data reports presenting air monitoring data from the two stations in the ETEC Environmental Monitoring Program. The November 10, 2018, data report included gross alpha and beta data from a date range prior to the Woolsey Fire. The November 21, 2018, data report presented isotopic and gross alpha and beta data from samples collected at the RMHF and Building 20 stations during the active burning of the Woolsey Fire. The sample results in the November 21, 2018, data report were less than the minimum detectable concentration for the analysis.

On January 29, 2019, DOE submitted a report, *Radioactive Particulate Air Sampling Results Associated with the Woolsey Fire*. The report indicates that two air samplers located adjacent to DOE buildings in SSFL's Area IV collected data on radionuclide levels during the fire. Filters were analyzed for gross alpha and gross beta. In addition, air filters were sent to an off-site laboratory to be analyzed for 20 individual radionuclides. The DOE report concludes:

> *The results of gross alpha and gross beta radiation from before and after the fire appear to be no different than the gross alpha and gross beta results during the fire. Most sample results before, during, and after the fire are less than their MDA. The one gross beta result from Perimeter station DOE-2 that exceeded the MDA was still within the range of gross beta results before and during the fire.*
>
> *Plutonium-239/249 and strontium-90 were detected above their MDA at stations DOE-3 and Pu-239/240 was detected at Area 20. These were not detected in the composite samples collected before the fire. The detected concentrations were low*

and did not exceed the DOE [Derived Concentration Standard (DCS)]. The DCS is an airborne concentration that would result in an effective dose of 100 mrem for continuous annual occupancy. The detected concentration levels were less than the DOE DCS.

The DOE air sampling report and the two brief data reports are attached in Appendix F.

Boeing Radiological Air Monitoring Data

Boeing operates six air monitoring stations as the site-wide Baseline Air Monitoring Program. Of the six stations, two collect airborne particulates on filters that are processed for counting gross alpha and gross beta radioactivity.

On January 29, 2019, Boeing submitted a technical memorandum (Appendix G) presenting gross alpha and gross beta data through the Woolsey Fire time frame. Additionally, the particulate filters from the Woolsey Fire time frame were submitted for isotopic analysis in a laboratory.

The Boeing technical memorandum concludes that isotopic analysis confirmed that only naturally occurring radioactive materials were reported by the laboratory. Additionally, anthropogenic (man-made), nuclear byproduct radionuclides were not reported in the sample results.

Los Angeles County Department of Public Health Radiation Management

LACDPH Radiation Management staff conducted air monitoring at Fire Station 75 and Fire Station 106 in Box Canyon.

The Los Angeles County Radiation Management program, under the direction and authority of the CDPH Radiologic Health Branch, conducted a radiation survey in Bell Canyon in response to an elevated reading obtained from sampling and concerns about radiation associated with the SSFL decommissioning that may have been affected by the fire.

Sampling was performed between 10:30 a.m. and 1:30 p.m. November 19 at or near the Saddlebow Road location for the RAP Team's initial elevated radiation reading. Sampling consisted of the following:

1. Eight locations were topsoil samples, collected from 0 to 1 inch (3 locations were background samples)
2. Eight locations (same as topsoil locations) subsurface samples, collected from 1 to 6 inches (3 locations were background samples)
3. One ash sample
4. Survey measurements at all sample locations using alpha, beta, and low-energy gamma probes
5. Nuclide identification using a lanthanum bromide detector in each sample location
6. Additional high-performance germanium (HPGe) nuclide identification in the vicinity of sampling locations

Collected samples were placed on the HPGe detector for initial screening and then prepared and shipped for overnight delivery to CDPH's State Drinking Water and Radiation Laboratory Branch for a full analysis. The laboratory results were provided to DTSC (Appendix H), but there is no formal written report with an analysis or conclusions.

In November 2018, the program had indicated that all nuclide identification screening indicates Naturally Occurring Radioactive Material (NORM) (Radium-226, Potassium-40). NORM is not regulated and is related to the natural topography of the land. The radiation levels are low, naturally occurring, and safe for the community. All preliminary data from the Bell Canyon sampling indicates that no radiation has migrated from SSFL to the Bell Canyon area.

Los Angeles County Regional Water Quality Control Board Stormwater Management Actions

The LARWQCB has the authority to oversee the stormwater management and control at SSFL. The stormwater at SSFL is regulated under an LARWQCB Order (No. R4-2015-0033) and a stormwater discharge permit (National Pollutant Discharge Elimination System Permit No. CA0001309).

On November 20, DTSC requested that Boeing, DOE, and NASA ensure the use of all appropriate measures to manage any potential soil and sediment migration from surface runoff water due to rain to ensure the protection of public health. DTSC was also in contact with LARWQCB. LARWQCB staff inspected SSFL on November 20 and determined the Woolsey Fire damaged the piping used to transport collected stormwater around the SSFL site to the detention ponds. In addition, the Woolsey Fire damaged portions of the SSFL stormwater treatment system.

On November 21, LARWQCB issued a letter of concurrence for Boeing to take immediate short-term actions to prevent ash, debris, and stormwater from leaving the SSFL site and to ensure that samples are collected in the event there is a discharge at any of the outfall sampling locations. The immediate response includes short-term actions such as:

- Removal of ash and sediment using a vacuum truck; and
- Installation of best management practices (BMPs) throughout SSFL, such as fiber rolls, hay bales, jute-style erosion control mats, and application of hydromulching to slopes.

On November 29, Boeing reported that it had removed ash from the stormwater outfalls, removed burned pipes, fabricated and replaced the pipes, repaired damaged equipment, and brought temporary generators and pumps on site to manage stormwater. LARWQCB is also working with Boeing to require further long-term actions under their regulatory oversight.

The SSFL Stormwater Expert Panel made a presentation at a May 9, 2019 LARWQCB meeting summarizing SSFL stormwater discharges for the 2018-19 season and effects on stormwater quality related to the Woolsey Fire[15].

They concluded that the 2018-19 season had 150% of normal rainfall and there were more stormwater discharges than normal. Also, because of the burned watershed, there was a large number of exceedances of effluent limits primarily due to soil erosion and burned vegetation, piping, and treated wood.

Another conclusion was that over the course of the season, effluent concentrations returned to pre-fire levels due to the post-fire response actions and to vegetation recovery.

In October 2019, the SSFL Stormwater Expert Panel submitted the Site-Wide Stormwater Annual Report for the 2018/19 Reporting Year to the LARWQCB[16]. The report presents more detail on the year's stormwater effluent monitoring results and BMP performance. The report includes an appendix presenting an investigation on sources of the constituents in post-wildfire effluent limit exceedances.

[15] https://www.dtsc-ssfl.com/files/lib_surface_water/surface_water/ExpertPanelPresentation_ LARWQCB_050919.pdf
[16] https://www.dtsc-ssfl.com/files/lib_surface_water/surface_water/Expert_Panel_Annual_Report_2019.pdf