EXHIBIT C

Post-Cleanup Stormwater Quality Modeling Work Plan

Santa Susana Field Laboratory
Ventura County, CA

Prepared for:

The Boeing Company

Prepared by:

Geosyntec consultants

engineers | scientists | innovators

924 Anacapa Street, Suite 4A
Santa Barbara, California 93101

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Geosyntec consultants

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Geosyntec consultants

1. INTRODUCTION

The Boeing Company (Boeing) is submitting this Post-Cleanup Water Quality Modeling Work Plan (Work Plan) prepared by Geosyntec Consultants, Inc. (Geosyntec) for the Santa Susana Field Laboratory (SSFL or Site) located in Ventura County, California. The Work Plan was prepared in close consultation with and incorporates review, guidance, and recommendations from the Surface Water Expert Panel (Expert Panel). This Work Plan is being prepared to describe the approach that will be used to develop, calibrate, and implement a hydrologic and water quality model to predict post-cleanup stormwater concentrations from SSFL areas where Boeing is responsible for soil cleanup -- i.e., areas draining to National Pollutant Discharge Elimination System (NPDES) Outfalls 001, 002, 008 (which may serve as a background watershed where cleanup is complete), 009, 011, and 018.

The model will be used to predict future stormwater concentrations for pollutants of concern after Boeing has completed soil cleanup under different potential cleanup scenarios. The results of this modeling, and comparisons between predicted concentrations and stormwater background thresholds established in a separate submittal, may be used by the Los Angeles Regional Water Quality Control Board (LA RWQCB) as the basis for future terms in the NPDES Permit No. CA0001309 (2015 NPDES Permit) that regulates surface water discharges from the SSFL and/or for future comparison with post-cleanup stormwater monitoring results from Boeing areas.

This Work Plan provides the technical approach that was used to select the model and is being used to set model input values, compare model predictions against historic measurements of flow and water quality to perform model calibration and validation, and evaluate the results of potential future soil cleanup scenarios to answer the following study questions:

- Will stormwater quality vary significantly between soil cleanup scenarios?
- Will there be exceedances of NPDES permit limits after soil cleanup? If so, are these exceedances due to natural background sources (or exceedances of “background thresholds” established in *Santa Susana Field Laboratory Background Stormwater Thresholds* (Geosyntec 2022))?

1.1 Site Background Information

The SSFL occupies approximately 2,850 acres and is located at the top of Woolsey Canyon Road in the Simi Hills, Ventura County, California. The Site is jointly owned by Boeing and the federal government. The National Aeronautics and Space Administration (NASA) administers the portion of the property owned by the federal government. The

Site is divided into four administrative areas (Areas I, II, III, and IV) and undeveloped land areas to both the north and south. The Site layout is shown in **Figure 1**.

Industrial operations at the SSFL have ceased; current activities at the Site include environmental monitoring and sampling and remediation planning. The SSFL became active in 1948. Site activities have included research, development, and testing of rocket engines, water jet pumps, lasers, liquid metal heat exchanger components, nuclear energy, and related technologies. The principal activity has been large rocket engine testing by Boeing and NASA in Administrative Areas I, II, and III and energy technology research by the United States Department of Energy (DOE) in Area IV. Laboratory research, rocket engine assembly, and rocket engine testing were ongoing activities at the Site, along with site use supporting these activities (maintenance, site engineering, environment, health and safety, and security). Petroleum fuel hydrocarbons and chlorinated solvents have been used at the SSFL in the largest volumes. The periodic burning of off-spec fuels in ponds may have produced polychlorinated dibenzodioxins and dibenzofurans (collectively referred to "dioxins"). Solid propellants, including perchlorate compounds, were used at the SSFL for research and testing operations. Various metals may have been used in machining operations or stored or disposed of as construction debris.

Administrative Areas I and III are operated by Boeing, which owns the majority of Area I and all of Area III. A portion of Area I (40 acres) and all of Area II are owned by the federal government and were formerly administered by NASA and operated by Boeing. The land within Area IV is owned by Boeing and was formerly operated by Boeing for DOE. DOE owns specific facilities located on approximately 90 acres of Area IV.

The SSFL has the potential to discharge stormwater runoff impacted by constituents from the facility. Approximately 60% of the average annual Site discharge volume leaves the property via two southerly discharge points (Outfalls 001 and 002) to Bell Creek, a tributary to the Los Angeles River. Upstream outfalls that contribute to the discharge at Outfalls 001 and 002 include Outfalls 011 and 018. Outfall 019, which has rarely been used, discharges treated groundwater downstream of Outfall 001. Stormwater from the northwestern boundary of the Site is occasionally discharged during large storms via Outfalls 003 through 007 and 010, but is more typically transferred to Silvernale Pond for treatment prior to discharge at Outfall 018. Stormwater from the northern part of the Site flows to Outfall 009 and discharges locally to Arroyo Simi. Stormwater runoff from Happy Valley discharges at Outfall 008 and flows via Dayton Canyon Creek to Chatsworth Creek. Chatsworth Creek flows south to Bell Creek southwest of the intersection of Shoup Avenue and Sherman Way. Bell Creek subsequently flows southeast to the Los Angeles River. In its surface water beneficial use designation tables, the Los Angeles Water Quality Control Plan (Basin Plan) does not explicitly identify the tributary drainages that cross the SSFL boundaries; however, downstream creeks (Bell Creek, Dayton Canyon Creek, and Arroyo Simi) are included, and these are designated as having intermittent recreational uses (water contact and non-contact water recreation), aquatic life uses (e.g., WARM, COLD, MIGR), and other human uses that relate to drinking exposure (e.g., MUN and GWR), many of which dictate the applicable water quality objectives at the Site (LA RWQCB, 1994). **Figure 2** shows the areas surrounding the SSFL.

The SSFL has been regulated under an NPDES permit, as required by Section 402 of the federal Clean Water Act since 1976. A wide range of constituents have been monitored. Constituents vary by outfall, but generally include dioxins, acute and chronic toxicity, metals, radionuclides, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), chloride, cyanide, fluoride, nutrients, oil and grease, perchlorate, pH, sulfate, Total Suspended Solids (TSS), and Total Dissolved Solids (TDS).

At Outfalls 008 and 009, Interim Source Removal Action (ISRA) and Best Management Practices (BMP) programs were implemented beginning in 2009 with oversight and participation of the LA RWQCB to improve compliance with the 2010 Permit limits through the dual approach of remediation of surface soils that are above defined thresholds for NPDES constituents of concern and through distributed control and/or treatment of stormwater runoff from prioritized subareas, respectively. The BMP Plan for the Outfall 008 and 009 Watersheds (MWH et al., 2010) ("2010 BMP Plan") was developed under the oversight of the Surface Water Expert Panel (referred to herein as the "SWEP" or "Expert Panel"). The 2015 Work Plan replaced the 2010 BMP Plan, provides an overall strategy for improving NPDES compliance for stormwater discharges site-wide, and continues the important process of public outreach and engagement on stormwater issues.

The Surface Water Expert Panel – consisting of Dr. Robert Pitt (University of Alabama), Dr. Robert Gearheart (Humboldt State University), Dr. Michael Stenstrom (University of California Los Angeles), Dr. Michael Josselyn (WRA Environmental Consultants), and Jonathan Jones (Wright Water Engineers) – continues to oversee stormwater planning and design work at the SSFL, as well as provide input on monitoring, source removal activities, and other NPDES Permit issues. The SWEP also oversees scientific studies related to SSFL stormwater quality issues and BMP design, reviewed the stormwater Human Health Risk Assessment (HHRA), and interfaces with the public on SSFL stormwater activities and related considerations. Their original mission, to improve stormwater at NPDES Outfalls 008 and 009, was expanded through the 2015 Work Plan to include all NPDES outfalls, as required by the 2015 Permit.

At Outfalls 011 and 018, active treatment systems, including chemical addition and flocculation, bag filters, media filtration, and other advanced treatment elements, have been in place since 2011. The active treatment system at Outfall 018 has been frequently used, however, the Outfall 011 active treatment system is typically not used due to significant pond storage capacity above Outfall 011. Outfalls 001 and 002 are downstream of Outfalls 011 and 018, respectively, and also receive runoff from the undeveloped southern buffer area of the Site.

1.2 Modeling Approach

The objective of this water quality modeling exercise is to project stormwater constituent concentrations and loads in response to various potential Site cleanup scenarios. The following approach will be followed to achieve the objective:

1. A hydrologic and water quality model will be created for each major watershed that has some area under Boeing's jurisdiction – Outfalls 001, 002, 008, 009, 011, and 018. Watersheds solely under NASA or DOE jurisdiction are not included as part of the model domain – Outfalls 003, 004, 005, 006, 007, 010.
2. Administrative boundaries will be included in the model so that different scenarios can be applied to each administrative area within a watershed, including NASA and/or DOE and Boeing administrative areas (e.g., Outfall 009 (NASA and Boeing), Outfall 018/002 (NASA, DOE, and Boeing), and 001 (NASA and Boeing)).
3. The model for each outfall watershed will then be calibrated using hydrology, TSS, and other water quality monitoring data collected at the corresponding outfall prior to the completion of major structural treatment and diversion BMPs and excluding post-wildfire years. This time period was selected to capture water quality conditions at the SSFL without the effects of major BMPs, since such BMPs are anticipated to be removed following soil cleanup, and post-cleanup scenarios are the modeling objective.
4. The calibrated model will then be used to perform continuous simulations of hydrology, TSS, and water quality, based on soil conditions described by each potential cleanup scenario to answer the study questions identified above.

The details of this approach are presented in the following sections.

2. MODEL DEVELOPMENT

This section outlines the model selection process along with the identification and selection of constituents of potential concern (COPC), key model inputs, and the hydrologic and water quality calibration approach.

2.1 Model Selection

The Loading Simulation Program C (LSPC) (Tetra Tech, 2017) model is an open-source, process-based C-coded Hydrological Simulation Program – Fortran (HSPF) watershed modeling system developed by the U.S. Environmental Protection Agency (EPA) to simulate watershed hydrology, sediment erosion and transport, and water quality processes from both upland contributing areas and receiving streams. Long-term, hourly rainfall data and average monthly evapotranspiration values are used along with land use-linked catchment imperviousness, soil properties, and land use-specific pollutant buildup/wash-off rates to estimate wet weather runoff volumes and pollutant loading. Additional modeling programs were evaluated, but the LSPC model was selected for this modeling effort because it:

- Includes continuous long-term simulation of hydrology, TSS, and water quality in one package (i.e., additional models/calculations not necessary);
- Is widely used and accepted in the watershed modeling industry (i.e., its watershed hydrologic and water quality prediction capabilities have been proven);
- Includes model parameters ("potency factors") that allow the prediction of stormwater runoff concentrations in response to input soil concentrations;
- Is familiar to LA RWQCB model reviewers (for example, LSPC was used in the most recent municipal stormwater Watershed Management Program Reasonable Assurance Analyses in the Los Angeles region); and
- Can easily incorporate existing SSFL model inputs (e.g., rainfall, watershed boundaries, subbasins, ponds, topography, soil types, vegetative coverage, imperviousness) from the Site hydrologic model developed by Geosyntec in its support of the Surface Water Expert Panel using the EPA Stormwater Management Model (SWMM).

2.2 Selection of Constituents of Potential Concern with Data Available

The process for identifying COPCs to include in the model began with evaluating Site outfall stormwater data for the full monitoring period available (1997-2020) and then focusing on the period prior to major BMPs as defined below (consistent with **Table 5)**.

- Outfalls 001 and 011: Up through May 2005, prior to when media-filled sandbags were placed upstream of Outfall 011;
- Outfalls 002 and 018: Up through December 2006, prior to when the media filter was added to the R-2A pond spillway;
- Outfall 008: Up through May 2009, prior to ISRA activities; and
- Outfall 009: Up through July 2009, prior to filter media installation at culvert modifications.

The LA RWQCB staff provided a list of constituents for consideration that is included in Attachment A: Constituents of Potential Concern by Watershed. The COPCs identified for inclusion in the model are:

- Those with concentrations detected above the method detection limits one or more times in outfall samples collected prior to the implementation of stormwater BMPs; and
- Those with Risk-Based Soil Characterization Level (RBSLs) or other soil cleanup thresholds that will be applied to the COPC by the Department of Toxic Substances Control (DTSC) for purposes of soil cleanup.

Table 1 summarizes the COPC selection criteria for the constituents listed in Attachment A.

Table 1. COPC Selection Criteria

Constituent	Sample Count (Note 1)	Detected Count (Note 1)	Detected in at least one pre-BMP Sample	Has Soil Clean-Up Risk-Based Screening Level	Evaluate Post-Cleanup Modeling Scenarios
Total Suspended Solids	162	73	Yes	No	No
Barium	23	23	Yes	Yes	Yes
Boron	29	22	Yes	Yes	Yes
Fluoride	33	16	Yes	Yes	Yes
Ammonia as Nitrogen (N)	64	14	Yes	No	No
Nitrate as Nitrogen (N)	10	10	Yes	No	No
Nitrite as Nitrogen (N)	10	1	Yes	No	No
Nitrate + Nitrite as Nitrogen (N)	118	102	Yes	No	No
Perchlorate	173	6	Yes	Yes	Yes
Sulfate	122	122	Yes	No	No
Gross Alpha	106	96	Yes	Only individual radionuclides have RBSLs (Note 2)	Empirical analysis will be provided and will include evaluation of individual radionuclides (Note 3)
Gross Beta	114	106	Yes	Only individual radionuclides have RBSLs (Note 2)	Empirical analysis will be provided and will include evaluation of individual radionuclides (Note 3)
Combined Radium-226 and Radium-228	39	39	Yes	Yes	Yes
Tritium	109	73	Yes	Yes	Yes
Strontium-90	112	76	Yes	Yes	Yes
Antimony	123	31	Yes	Yes	Yes
Arsenic	89	37	Yes	Yes	Yes
Beryllium	89	7	Yes	Yes	Yes
Cadmium	128	49	Yes	Yes	Yes
Chromium VI	18	1	Yes	Yes	Yes
Copper	179	143	Yes	Yes	Yes
Lead	184	113	Yes	Yes	Yes
Mercury	191	45	Yes	Yes	Yes
Nickel	89	35	Yes	Yes	Yes
Selenium	106	16	Yes	Yes	Yes
Silver	90	4	Yes	Yes	Yes
Thallium	109	10	Yes	Yes	Yes
Zinc	101	64	Yes	Yes	Yes
Cyanide	141	6	Yes	Yes	Yes

Constituent	Sample Count (Note 1)	Detected Count (Note 1)	Detected in at least one pre-BMP Sample	Has Soil Clean-Up Risk-Based Screening Level	Evaluate Post-Cleanup Modeling Scenarios
TCDD TEQ (No DNQ)	130	51	Yes	Yes	Yes
1,2-Dichloroethane	146	0	No	Yes	No
1,1-Dichloroethene	146	0	No	Yes	No
Trichloroethene	146	13	Yes	Yes	Yes
Pentachlorophenol	100	0	No	Yes	No
2,4,6-Trichlorophenol	100	0	No	Yes	No
bis (2-ethylhexyl) Phthalate	100	12	Yes	Yes	Yes
2,4-Dinitrotoluene	100	0	No	No	No
N-Nitrosodimethylamine	99	0	No	Yes	No
alpha-BHC	100	0	No	Yes	No

Notes:
Note 1. Data inventory includes Outfalls 001, 002, 008, 009, 011, and 018 during the period prior to major treatment BMPs described in Section 2.2 and excluding any post-fire years. Post-fire years are the first wet season immediately following a wildfire.
Note 2. Individual alpha and beta-emitting radionuclides will be evaluated as shown in this table. Furthermore, if additional radionuclides (not shown in this table) are included in the final soil cleanup levels and have been detected in stormwater, they will be added to this COPC table at that time.
Note 3. Empirical analysis for gross alpha and gross beta will also look at individual radionuclides as described in the Attachment E of the NPDES Permit.

Based on these criteria, the COPCs for stormwater post-cleanup evaluation were identified as:

- Barium
- Boron
- Fluoride
- Perchlorate
- Total Antimony
- Total Arsenic
- Total Beryllium
- Total Cadmium
- Total Chromium
- Hexavalent Chromium
- Total Copper
- Total Lead
- Total Mercury
- Total Nickel

- Total Selenium
- Total Silver
- Total Thallium
- Total Zinc
- Cyanide
- Dioxins (will consider TCDD TEQ both with and without DNQ)
- Gross Alpha
- Gross Beta
- Strontium-90
- Tritium
- Combined Radium 226 and 228
- Trichloroethene
- bis (2-ethylhexyl) Phthalate

Additional constituents included as COPCs in order to calibrate the model and better predict stormwater concentrations may include:

- Filterable metals from the list above
- TSS
- Iron
- Manganese
- Mass of solids size fractions

The COPCs included here serve as a starting point for the model and others may be added if there are sufficient soil and stormwater data to allow calibration and modeling. With this said, Geosyntec and the SWEP believe that this list of COPCs is comprehensive and will be adequate to accomplish modelling objectives.

2.3 Key Model Inputs

2.3.1 Precipitation and Evapotranspiration

The LSPC model requires the input of hourly climate data as boundary conditions to execute the hydrology, TSS, and water quality modules. **Figure 3** shows the locations of meteorological stations that will provide precipitation and evapotranspiration data for the modeled areas, across which the average elevation is approximately 1,800 ft above sea level (ASL). The climate data sources are described below:

- Hourly precipitation data collected at the SSFL Area 4 rain gage (January 1, 2001 to December 31, 2012, located at approximately 1,874 ft ASL, and hourly precipitation data collected at the SSFL Area 1 rain gage near the Site entrance (January 1, 2013 to present), located at 1,922 ft ASL.

- Chatsworth rain gage hourly precipitation data, located at 910 ft ASL, which represents the closest off-site rain gage with hourly data prior to the SSFL gages, will be scaled using a ratio developed between SSFL and Chatsworth data during periods of overlap. The scaled record may be used to fill in missing time periods.
- Daily average Potential Evapotranspiration (PET) rates from the closest weather grid in the Watershed Management Modeling System (WMMS) 2.0 database[1].

2.3.2 Subbasin delineation

LSPC subbasins will be developed by combining the existing topography-based drainage areas (using in the Site SWMM model where available) with the Site administrative boundaries. The resultant subbasins will provide the flexibility to set model variables and produce LSPC output at various scales (e.g., watershed, subbasin, or administrative areas within a watershed).

2.3.3 Hydrologic Response Unit

The hydrologic response unit (HRU) is the core modeling component used to predict hydrologic and water quality responses to precipitation received within the modeled watersheds. Each HRU represents areas of similar physical characteristics driving the modeling processes. The HRU development process in each drainage area will incorporate land use and land cover (LULC), hydrologic soils group (HSG), slope, and soil cleanup areas (e.g., post-cleanup soil conditions) to develop HRUs that represent unique combinations of these four layers. Hydrology, TSS, and water quality modeling input parameters will be assigned based on the four layers and then transferred to the HRUs accordingly. Table 2 provides an overview of the input layers and associated key modeling parameters. The initial values for these parameters will be obtained from the WMMS 2.0 database, which shares many of the same input layers for HRU definition. A detailed description of the HRU layer development is provided in the following sections.

[1] WMMS 2.0 is a watershed modeling framework developed by the Los Angeles County Flood Control District. Publicly released in May 2020, WMMS 2.0 includes a data repository that reflects the latest available California Irrigation Management Information System ET data up to December 2018. The closest WMMS 2.0 ET grid is approximately 2 miles from the SSFL Site.

Table 2. Key parameter summary and relationship to HRU layers

Key Parameters	Description	LULC	HSG	Slope	Cleanup Area
lzsn	Lower zone nominal soil moisture storage	Yes			
infilt	Soil Infiltration capacity	Yes	Yes		
agwrc	Base groundwater recession	Yes			
bastp	Fraction of remaining potential PET that can be satisfied from baseflow	Yes			
agwetp	Fraction of remaining PET that can be satisfied from active groundwater	Yes			
cepsc	Interception storage	Yes		Yes	
uzsn	Upper zone nominal storage	Yes		Yes	
nsur	Manning's n for the assumed overland flow plan	Yes			
intfw	interflow inflow parameter	Yes			
lzetp	lower zone e-t parameter	Yes			
krer	coefficient in the soil detachment equation	Yes	Yes		
cover	fraction of land surface which is shielded from rainfall erosion	Yes	Yes		
kger	coefficient in the matrix soil scour equation, which simulates gully erosion	Yes			
jger	Exponent in the matrix soil scour equation, which simulates gully erosion	Yes			
accsdp	rate at which solids accumulate on the land surface (used in impervious land)	Yes			
kser	coefficient in the detached sediment washoff equation	Yes		Yes	
sed_i	Fraction of clay, sand and silt	Yes	Yes		
potfs	Constituent potency factor	Yes			Yes
acqop	Pollutant accumulation rate on surface	Yes			
sqolim	Maximum storage of pollutant on surface	Yes			
wsqop	rate of surface runoff that removes 90% of stored pollutant	Yes			

2.3.3.1 Land Use and Land Cover

LULC represents a characterization of the physical nature of the land surface. For the SSFL LSPC model, LULC classifications are created by spatially aggregating the following layers:

- National Land Cover Dataset: this 30-meter grid resolution raster will be used to classify pervious land cover based on existing vegetation coverage. Future simulations will use either existing vegetation coverage or may set cleanup areas to no- or low-density vegetation.

- Existing SSFL BMP geodatabase: this database will be used to estimate existing and historical impervious surfaces at the Site. Over time, due to remediation and demolition activities, the impervious surfaces have changed at the Site. Therefore, this database will be used to provide a temporal-specific assumption for impervious areas depending on the year being modeled.
- Satellite imagery: high-resolution satellite imagery provided by Boeing will be used to classify impervious surface types (road, roof, or bedrock). Soil cleanup areas that are currently paved will be modeled as unpaved with low-density vegetation in the post-cleanup condition.

Table 3 summarizes the resultant LULC classification for the SSFL LSPC model.

Table 3. Land Use Land Cover Descriptions

Imperviousness Class	LULC Description
Impervious	Bedrock
Impervious	Paved Surface
Impervious	Roof
Pervious	Non-vegetated Open Space
Pervious	Low-Density Vegetated Open Space (grasses)
Pervious	Medium-Density Vegetated Open Space (shrub/scrub)
Pervious	High-Density Vegetated Open Space (dense chaparral)

Each LULC class is the result of a unique combination of the aggregated layers mentioned above. Specific modeling parameters will be determined for each LULC class to predict hydrologic, TSS, and water quality response. Key modeling parameters associated with the LULC category are summarized in **Table 2**.

While the impervious LULC dataset is derived from the available spatial data, it is anticipated that a fraction of the mapped impervious area will drain to the surrounding pervious area and is, therefore, disconnected from the conveyance network within the LSPC model. The difference between the mapped impervious area and the Disconnected Impervious Area (DIA) is classified as Directly Connected Impervious Area (DCIA). To account for these different classifications, only the DCIA will be modeled as an impervious surface in the LSPC model, and the DIA will be modeled as a pervious surface with limited subsurface conveyance and storage capacity. The DCIA will be estimated by a spatial analysis of impervious areas adjacent to drainages.

2.3.3.2 Slope

A Light Detection and Ranging (Lidar) survey was completed for the SSFL in 2018. The result of this survey includes a two-foot contour topographical map, which will be converted into a slope raster file. This slope raster file will then be further grouped into three bins including: low (<=10%); medium (> 10% and <= 30%); and high (>30%), following the classification used in the WMMS 2 model. The slope component of each HRU will either be low, medium, or high, based on these groupings.

Slope classifications will be used as a basis for setting hydrologic parameters, as summarized in **Table 2**. Initial hydrology and TSS parameter values will be adopted from the WMMS 2.0 database and then adjusted through model calibration.

2.3.3.3 Hydrologic Soil Group (HSG)

HSGs characterize the propensity for precipitation to saturate and percolate through the subsurface or contribute to runoff. Soils with similar hydrologic and physical properties are grouped by HSGs. Consistent with the conventional HSG definition, four HSGs will be assigned to different soil properties at the Site. HSG-A generally has the highest infiltration and lowest runoff potential; whereas, HSG-D has the lowest infiltration and highest runoff potential. HSG designations for the region will be obtained from the Natural Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO, 2020). If a HSG designation is not specified in the source data, HSG-D will be applied, as it is the most prevalent HSG at the Site.

HSG classifications will be used as a basis for setting hydrologic parameters, as summarized in **Table 2**. Initial hydrology and TSS parameter values will be adopted from the WMMS 2.0 database and then adjusted through model calibration. For all soil cleanup areas, even where excavation to bedrock occurs, the post-cleanup condition will be assumed to have the same earthen coverage (i.e., assume there will be soil backfill meeting the cleanup criteria), and will not change to an exposed bedrock condition.

2.3.3.4 Soil Cleanup Areas

The extent of each specific cleanup area will be provided based on the various cleanup scenarios chosen for modeling. Including these areas in the HRU definition will allow various cleanup scenarios to be compared to one another by changing the soil concentrations, or soil “potency factor,” according to each cleanup scenario.

2.3.4 Hydraulic Networks

Most subbasins drain to streams/channels before being conveyed into ponds or the outfall for discharge. The streams, channels, and ponds will be incorporated into the model as described below.

2.3.4.1 Stream/Channels

The length, cross section, and slope of the stream and channels will be created using the two-foot contour data from the 2018 Lidar survey and incorporated into the LSPC model. Channel roughness will be estimated based on the overlaying land cover description according to the WMMS 2.0 channel roughness assumptions. Based on Geosyntec's geomorphic observations from the field, it will be assumed that these streams and channels do not include any hydrologic, sediment, or water quality processes (e.g., infiltration, sediment deposition and resuspension, scour) – i.e., that they are at a relatively geomorphically stable state, and that there is minimal groundwater-surface water interaction (i.e., in-channel gains and losses) that affects their wet weather-driven hydrologic responses.

2.3.4.2 Ponds

Ponds within the Site will be represented as F-tables in the LSPC model. An F-table is a piecewise function used to represent a feature's surface area, volume, and discharge relationship in the model environment. The F-table will be created using the stage-storage and stage-discharge curves from the existing SSFL SWMM model. Evapotranspiration (ET) and infiltration within the ponds will also be modeled based respectively on the closest ET station from the WMMS 2 precipitation data repository and assumed subsurface infiltration rates based on HSG. It is assumed that the current pond geometry across the Site, regardless of administrative area, will remain unchanged after soil cleanup.

3. MODEL CALIBRATION

3.1 Model Calibration Metrics

Model calibration performance statistics will be compared with calibration acceptance criteria in the LA RWQCB Reasonable Assurance Analysis (RAA) Guidelines (LA RWQCB, 2014), which are summarized in **Table 4**.

Table 4. RAA Calibration Metrics and Percent Bias(PBIAS)

Category	Evaluation Metric	Very Good PBIAS (Note 1)	Good PBIAS (Note 1)	Fair PBIAS (Note 1)
Hydrology / Flow	Daily Average Flowrate	±0 – 10%	≥ ±10% - 15%	≥ ±15% - 25%
Sediment	EMC (Note 2)	±0 – 20%	≥ ±20% - 30%	≥ ±30% - 40%
Water Quality - Metals	EMC (Note 2)	±0 – 15%	≥ ±15% - 25%	≥ ±25% - 35%
Water Quality - Pesticides / Toxics	EMC (Note 2)	±0 – 20%	≥ ±20% - 30%	≥ ±30% - 40%

Notes:
Note 1. PBIAS = Percent Bias Between Model-Predicated and Observed Data
Note 2. MC = Event Mean Concentration for composite samples, or single concentration for grab samples

PBIAS will be a key statistic used to evaluate agreement between modeled-predicted and observed data. PBIAS quantifies systematic over- or under-prediction. Low values of PBIAS indicate better fit and predictive capability of the model. The calibration metrics will target the lowest possible PBIAS. The lower bound of the “Fair” threshold is considered the minimum acceptable criteria for the model calibration process. If a “Fair” threshold is not achieved during the model validation process, additional model adjustments will be made to attain the threshold at the validation site. If a “Fair” model calibration cannot be achieved and/or if a COPC has an inadequate number of detected sample results, an empirical approach will be used. The empirical approach will evaluate historical, pre-BMP stormwater data for the COPC for data robustness (number of samples, detections, and detection limits) and for exceedances of applicable effluent limits or background thresholds.

The water quality calibration metrics from the LA RAA Guidelines may also be used evaluate the model’s predictions of stormwater particulate strength, where monitoring data are available for comparison. Stormwater particulate strength is the constituent concentration on suspended solids in stormwater.

Additional metrics to evaluate the calibration may include visual observations of measured vs modeled results, seasonal analysis of residuals, probability distributions, and/or other standard calibration performance metrics.

3.2 Calibration and Validation Locations and Periods

Model calibration will be performed using hydrology and water quality monitoring data collected prior to the completion of major treatment and diversion BMPs, which is different for each watershed. The hydrology time periods for each watershed are based on when flow records began and prior to any major BMPs that altered the watershed hydrology (e.g., biofilter, diversion pumping, stormwater treatment systems). TSS and water quality time periods are based on when water quality monitoring began at each particular outfall and prior to any major BMPs in the watershed (e.g., the Outfall 009 culvert modifications and the Outfall 011 and 018 flow through media filter systems), so that the water quality effects of treatment controls are not reflected in the data (since the modeling objective is to accurately predict stormwater quality without treatment control improvement). If restricting the water quality data to these time periods does not result in an acceptable model calibration, Outfall 009 samples prior to the biofilter and Outfalls 011 and 018 samples prior to the active treatment systems may be included if the outfall results before and after the earlier media-based systems were installed are not statistically different. One exception is Outfall 008, which is unique in that extensive surface soil cleanup for the ISRA was completed here in 2009; therefore, the post-ISRA time period will be used for the Outfall 008 TSS and water quality calibration to confirm the model's ability to accurately predict post-cleanup stormwater concentrations. For all watersheds, the wet season immediately following a wildfire (i.e., 2005/2006 rainy season for the Topanga Fire and 2018/2019 rainy season for the Woolsey Fire) will be excluded from calibration due to the significant effects of wildfires on hydrology and water quality. **Table 5** summarizes the proposed calibration and validation period for each watershed. Details of the calibration and validation approach are presented in the following subsections. The decision-making process surrounding some calibration and validation details is ongoing, and working meetings will be held with the SWEP and LA RWQCB staff during model calibration, sensitivity analysis, and scenario simulation steps to allow LA RWQCB input during the project.

The calibration and validation periods will be segregated by selecting years representative of the whole record available for each watershed. For instance, the Outfall 008 hydrology calibration and validation period is October 2007 to June 2020 (excluding 2018/19). The annual rainfall depth of each year will be evaluated, and representative water years may be selected as the validation period; for instance, 2011/12 (50th percentile), 2012/13 (25th percentile), 2014/15 (56th percentile), and 2019/20 (75th percentile). The remaining years will be used as the calibration period. The same process will be applied to each of the other watersheds. Due to the hydrological connectivity and short period available in some watersheds, Outfalls 001 & 011 and Outfalls 002 & 018 may be modeled together to increase the number of observed data points available for calibration and validation.

Table 5. Calibration and Validation Periods

Watershed	Hydrology Calibration & Validation Period (Note 3)	TSS and Water Quality Calibration & Validation Period (Note 1 and 4)
Outfall 001	October 2007 - December 2009 (Note 2) (OF011 pumping associated with treatment system began 2010 Q1)	June 1997 - May 2005 (Note 2) (OF011 media filter added in May 2005, pilot active treatment system became operational 2010 Q1)
Outfall 002	October 2007 - December 2010 (Note 2) (diversion from northern outfalls to OF018 completed 2011 Q1)	June 1997 - December 2006 (Note 2) (media filter added in December 2006, OF018 pilot active treatment system became operational 2010 Q1)
Outfall 008	October 2007 - June 2020 (no major changes to watershed hydrology)	June 2010 – 2020 (post-ISRA, as a "background" calibration watershed)
Outfall 009	October 2007 - June 2012 (pumping from helipad to Silvernale began in 2012)	June 2004 – July 2009 (culvert modifications installed starting Q3 2009, biofilter completed March 2013)
Outfall 011	October 2007 - December 2009 (pumping associated with treatment system began 2010 Q1)	June 2004 – May 2005 (media filter added in May 2005, pilot active treatment system became operational 2010 Q1)
Outfall 018	October 2007 - December 2010 (diversion from northern outfalls completed 2011 Q1)	June 2004 – December 2006 (media filter added in December 2006, pilot active treatment system became operational 2010 Q1)

Notes:
Note 1. 70% of the available data will be used for calibration, and 30% of the available data will be used for validation for periods that have sufficient data.
Note 2. Outfall 011 and Outfall 018 discharge to Outfall 001 and Outfall 002, respectively, so these watershed models may be considered together as one larger watershed. Outfalls 001 and 002 may be modeled as standalone watersheds up to present for the storms where the upstream outfalls did not flow.
Note 3. Daily flow records are available prior to 2009, while sub hourly flow records are available from 2009 and later.
Note 4. The Expert Panel is still determining which locations to include for water quality calibration.

In addition to outfall data, other non-outfall stormwater datasets may be used for calibrating certain land cover as needed, including:

- Background and subarea water quality;
- Pavement runoff water quality; and
- Particle size distribution in subarea stormwater samples.

3.3 Hydrology

Flow data measured at the outfalls will be used for the hydrology calibration of each watershed. The hydrology calibration for each watershed will be performed as follows:

- Default modeling parameters from the WMMS 2.0 database will be used as the initial parameter values;
- Sensitivity analyses will be performed to identify the ranges and combinations input parameters that have the most impact on predicted results, to help guide the calibration and provide information on model uncertainty; and
- The most sensitive inputs will be iteratively adjusted until the performance goals outlined below are met.

The first goal in the hydrology calibration includes comparing an average annual water balance (i.e., water lost to evapotranspiration, water infiltrated/recharged, and water discharged as stormwater runoff) with the published literature distribution of these volumes for the Site (Manna et al., 2016). The second goal includes computing and evaluating the PBIAS in accordance with the acceptance thresholds summarized in **Table 4** and metrics described in Section 3.1. The modeling parameters will be adjusted until both these goals are achieved.

3.4 Total Suspended Solids

TSS calibration will be performed using TSS concentrations measured in SSFL watersheds following the hydrology calibration. The TSS calibration for each watershed will be performed as follows:

- Default modeling parameters from the WMMS 2.0 database will be used as the initial values for sediment-associated parameters;
- Sensitivity analyses will be performed to identify the input parameters that have the most impact on predicted results, to help guide the calibration and provide information on model uncertainty; and
- The most sensitive inputs will be iteratively adjusted until the performance goals outlined below are met.

The performance goal for TSS calibration includes meeting the acceptance thresholds summarized in Section 3.1 by comparing the model-predicted and measured concentrations of TSS.

The above TSS calibration approach will also be applied to paved HRU areas within the Outfall 009 watershed using subarea monitoring results in paved areas. These calibrated TSS model parameters will then be applied to paved area HRUs across all watersheds.

3.5 Water Quality

Water quality calibration will be performed similar to the TSS calibration approach, using COPC concentrations measured in SSFL watersheds. The water quality calibration will be performed as follows:

- Default modeling parameters from the WMMS 2.0 database will be used as the initial values for sediment-associated pollutant loading parameters;
- Measured bulk soil concentrations of each COPC will be used to establish the initial values for the model soil potency factor;
- Sensitivity analyses will be performed to identify the input parameters that have the most impact on predicted results, to help guide the calibration and provide information on model uncertainty;
- The soil potency factor and other most sensitive inputs will be iteratively adjusted until the performance goals are met; and
- Dissolved constituents may be modeled empirically or using processes in the LSPC.

The performance goal for water quality calibration includes meeting the acceptance thresholds summarized in Section 3.1 by comparing the model-predicted and measured concentrations for the COPCs.

The soil potency factor used in the model represents the product of bulk soil concentrations and a multiplier that accounts for the higher pollutant concentrations in the fine, stormwater-mobilized portion of soils. Multipliers specific to each COPC will be calculated by dividing the calibrated soil potency factor by the measured bulk soil concentration. The soil potency factor is the key parameter the model uses to predict stormwater particulate strengths, so when transitioning from modeling calibration scenarios to post-cleanup scenarios, this will be the parameter that is adjusted according to potential soil cleanup criteria, which are bulk soil concentrations. For example, if a COPC average stormwater particulate strength for a calibration scenario is 10 and the average bulk surface soil concentration of that COPC is 5, then the "calibrated" multiplier is 2 and the "calibrated" potency factor used in the model will be 10. Then when a future cleanup scenario for that COPC is modeled and the soil cleanup criteria is 4, the multiplier of 2 is applied to get a potency factor of 8 that is entered in the model in the cleanup area.

4. POST-CLEANUP SCENARIO MODELING APPROACH

The cleanup scenarios for modeling will be provided at a later date. An additional future scenario will also evaluate the effects of climate change (i.e., increased variability in rainfall and temperature effects on ET).

Once calibrated, the model will be used to predict SSFL stormwater concentrations under each of the various potential surface soil cleanup scenarios that is being evaluated. If the cleanup scenarios change after the initial agreement, the modeling scenarios will be updated accordingly within a reasonable amount of time. The extent of the proposed soil excavation area for each scenario will be reflected in the model and the applicable potency factors will be assigned based on the soil cleanup criteria in each scenario multiplied by bulk soil-to-stormwater particulate strength multipliers computed during the calibration, as described above. The following assumptions will be made for cleanup areas:

- Backfill with soil meeting the cleanup criteria (including if bedrock is exposed);
- Grade to match pre-cleanup grade with appropriate erosion controls installed; and
- Revegetation with native species to the same level as current conditions will be achieved; however, lower vegetation density will be modeled as a conservative estimate.

Final areas and depths will not be known until after cleanup, but if cleanup scenarios result in less impervious area, no vegetation, or lower-density vegetation, these changes can be reflected in the modeling scenarios. In the areas of soil cleanup at SSFL that are the responsibility of NASA and DOE, the model will assume soils will be cleaned up to background. An additional post-soil cleanup model scenario will be included based on existing soil concentrations in the areas of soil cleanup that are the responsibility of NASA and DOE, since Boeing anticipates that it may complete its soil cleanup prior to NASA and DOE completing theirs, with the caveat that Boeing is not responsible for characterizing impacts in NASA and DOE areas of responsibility. The data and assumptions covering existing conditions in those areas will be to the best of Boeing, Geosyntec, and the Expert Panel's knowledge. Existing condition modeling for DOE and NASA will be based on data available to Boeing and may not be entirely up to date, complete, or accurate. The locations of these areas are detailed in previous reports. Detailed approaches and assumptions for the modeling scenarios are subject to ongoing discussions and, as previously noted, working meetings will be held with the SWEP and LA RWQCB staff to allow LA RWQCB input during the project.

Soil concentrations in portions of the watershed outside of cleanup areas will remain unchanged from conditions established during model calibration. For these areas, the topography, land use, and vegetation will also be assumed constant between existing conditions and potential post-cleanup scenarios.

The potential cleanup scenarios will then be modeled for a 10-year simulation period based on a recent 10-year precipitation period with similar average annual rainfall depth and variability as the 55-year long-term record and having maximum data completeness (i.e., minimum gaps in the data).

For each storm event over the 10-year period, modeled COPC concentrations will be compared between cleanup scenarios and against the existing 2015 NPDES permit limits and background thresholds developed in *Santa Susana Field Laboratory Background Stormwater Thresholds* (Geosyntec 2022) to evaluate how potential cleanup scenarios may impact stormwater quality from SSFL.

5. POST-CLEANUP CONFIRMATION STORMWATER MONITORING

The model will be developed in such a way that predicted water quality output will be extractable from internal locations in the SSFL watersheds that best reflect Boeing-only runoff, and any final post-cleanup stormwater sampling locations should similarly reflect this, to minimize effects from ongoing or future/incomplete cleanup by the federal agencies at the SSFL. Stormwater monitoring data collected following completion of Boeing's soil remediation may be compared to model predictions and Expert Panel stormwater background thresholds (Geosyntec 2022). The results of this comparison may be considered by the LA RWQCB to help evaluate stormwater quality from Boeing's remediated areas of the SSFL. In response to a request by the LA RWQCB staff, the SWEP offers the following recommended "guiding elements" of a post-cleanup stormwater quality monitoring program. A more detailed post-cleanup stormwater monitoring plan following the framework outlined here will be submitted to the LA RWQCB for review and approval after the modeling is complete.

- **Locations**
  - Locations will be representative of Boeing-only cleanup areas, excluding contribution from DOE and NASA areas (which are expected to be completed over a longer cleanup schedule);
  - Representative post-cleanup Boeing stormwater monitoring locations will be identified based on model results and will cover all outfall watersheds that contain Boeing RFI areas; and
  - These locations may be a blend of comingled runoff downstream of multiple cleanup areas or runoff directly adjacent to and downgradient of single cleanup areas.
- **Analytes**
  - The analytical suite will match the modeled COPC list (**Table 1**), additional filtered COPCs, TSS, Chronic Toxicity, plus any other site-specific constituents with cleanup thresholds
- **Frequency**
  - Monitor subareas during at least 12 rain events, with at least two of the sample events representing storms equal to or greater than the 2-year recurrence interval rain event with a duration greater than the time required for runoff from the entire drainage subarea to reach the sampling point, within 5 years of post-cleanup stormwater monitoring. If the required number of 2-year events does not occur within 5 years of the start

of post-cleanup confirmation stormwater monitoring, then any 12 rain events can be relied upon.

- Upon approval by the LA RWQCB, results for individual constituents may be combined from different locations that were cleaned up for that same constituent in order to satisfy the 12 sample minimum.

- **Sample collection procedures**
  - Automated composite sampling is preferred, consistent with existing NPDES outfall sampling procedures; however, if that is not feasible at a location, then grab samples are acceptable (although automated grabs are preferred over manual grabs to avoid runoff being missed).

6. UNCERTAINTIES

The results of the post-cleanup modeling are estimates only and include some uncertainty. Where possible, a sensitivity analysis will be performed to evaluate output uncertainty, and conservative assumptions will be used to set inputs during model development. Major sources of uncertainty in the LSPC model may include the following:

1) Limitations of existing available datasets, including data used for the hydrology and water quality calibrations (in particular, data to support the calibration of COPC potency factors for various types of soil areas and HRUs);
2) Actual, final surface soil concentrations post-cleanup (these average values are expected to be less than the cleanup criteria used by the model);
3) The operation and geometry of the ponds post-cleanup, as these are expected to affect hydrology and water quality at Outfalls 011 and 018;
4) Geomorphic restoration of the drainages post-cleanup, as these can potentially serve as future sources or sinks of TSS and COPCs depending on the effectiveness of their restoration;
5) Plans for post-cleanup backfill, stabilization, and erosion control of upland areas; and
6) Natural variability that is inherent to stormwater quality datasets (especially grab samples).

7. SCHEDULE

A Draft Work Plan was provided to the LA RWQCB on September 15, 2021. The LA RWQCB provided comments, and the Draft Work Plan was revised and resubmitted on October 18, 2021. The LA RWQCB issued a conditional approval letter on November 1, 2021, and the Final Work Plan was submitted on April 8, 2022, following several discussions with LA RWQCB staff and a pause in progress during the NPDES permit renewal. Model calibration is expected to be complete approximately three months after the acceptance of the Final Work Plan and the Memorandum of Understanding[2] is executed by all parties, whichever occurs later. A Draft Calibration Report is tentatively scheduled for submittal to the LA RWQCB for review and approval one month after completing model calibration, prior to proceeding with soil cleanup scenario modeling. Following LA RWQCB approval of the Calibration Report and subsequent soil cleanup scenario modeling, a Draft Modeling Report will be submitted to the LA RWQCB for review and approval (approximately four months from Calibration Report approval). As noted before, if the cleanup scenarios change after the initial agreement, the modeling scenarios will be updated accordingly within a reasonable amount of time. In addition, a draft Confirmation Stormwater Monitoring Plan is tentatively scheduled for submittal to the LA RWQCB for review and approval one month after receiving approval of the Modeling Report.

[2] MEMORANDUM OF UNDERSTANDING BETWEEN THE LOS ANGELES REGIONAL WATER QUALITY CONTROL BOARD AND THE BOEING COMPANY ESTABLISHING THE PROCESSES, METHODOLOGIES, AND STANDARDS FOR ASSESSING STORMWATER DISCHARGES AND APPLICABLE REQUIREMENTS FOLLOWING THE BOEING COMPANY SOIL CLEANUP AT THE SANTA SUSANA FIELD LABORATORY SITE

8. REFERENCES

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Manna, Cherry, McWhorter, Parker. 2016. Groundwater recharge assessment in an upland sandstone aquifer of southern California. *Journal of Hydrology*, Volume 541, Part B.

Tetra Tech. 2017. *Loading Simulation Program in C++ (LSPC) Version 5.0.*

FIGURES

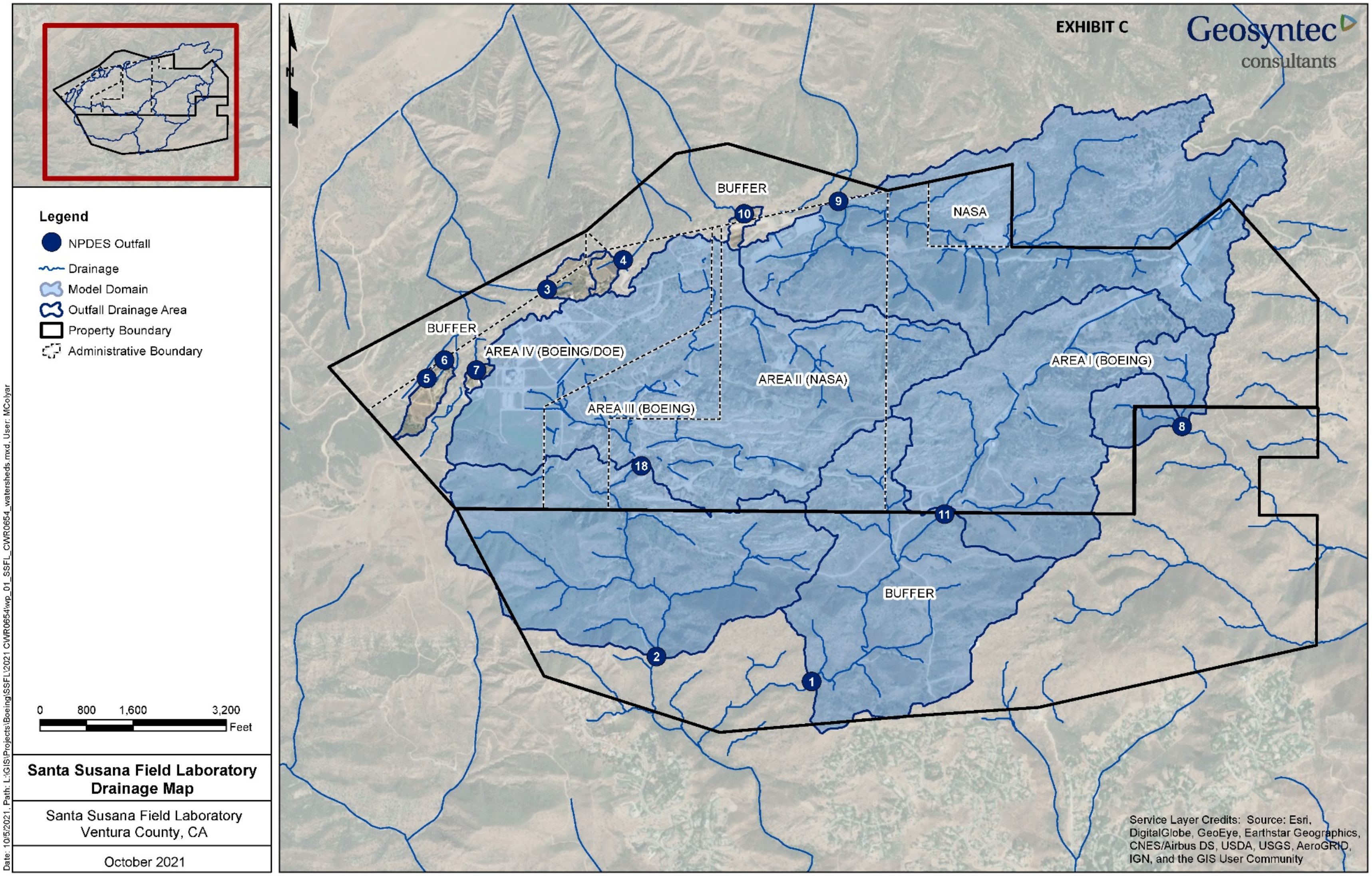

Figure 1. Site Map

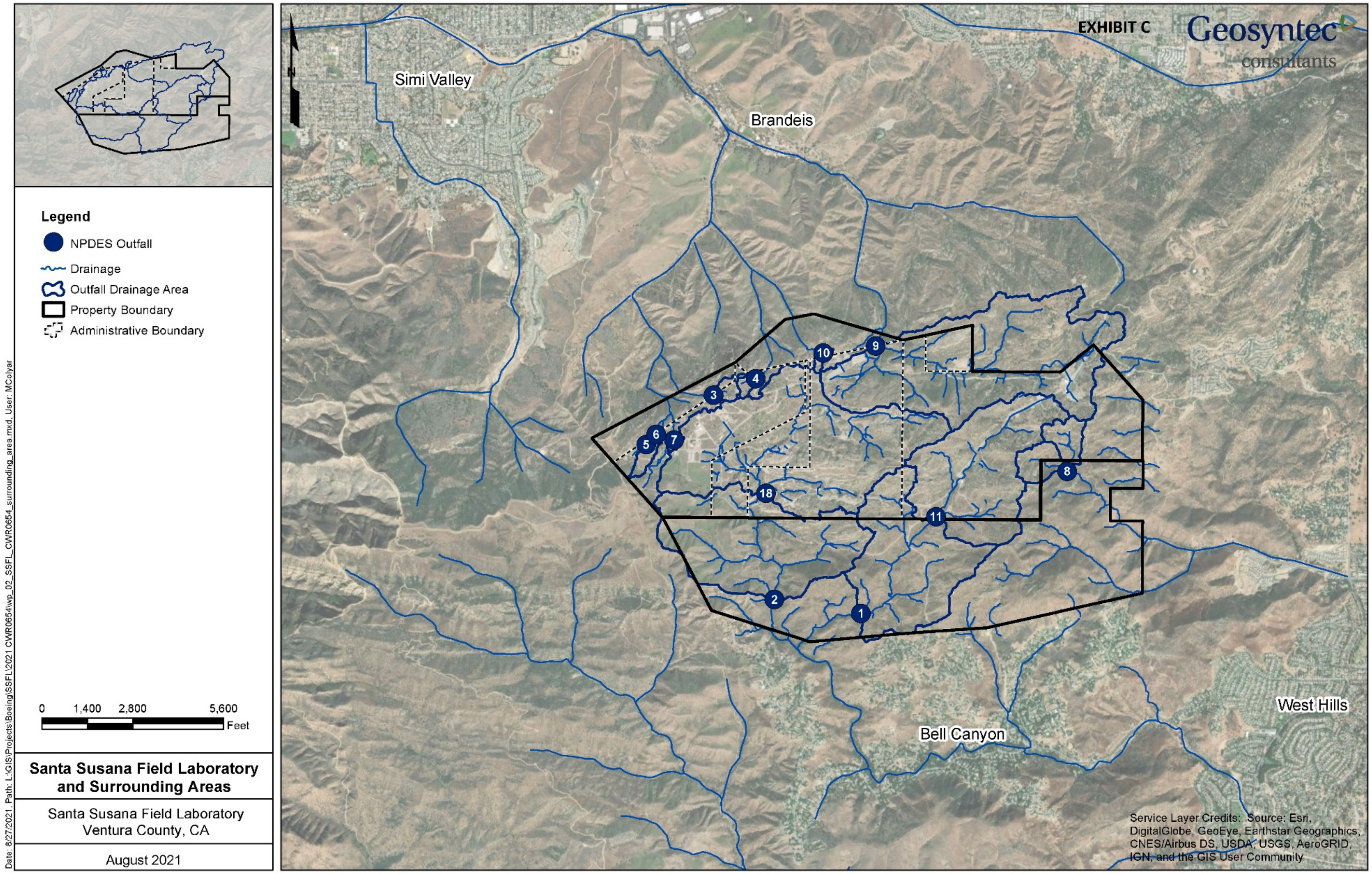

Figure 2. Site Layout and Surrounding Communities

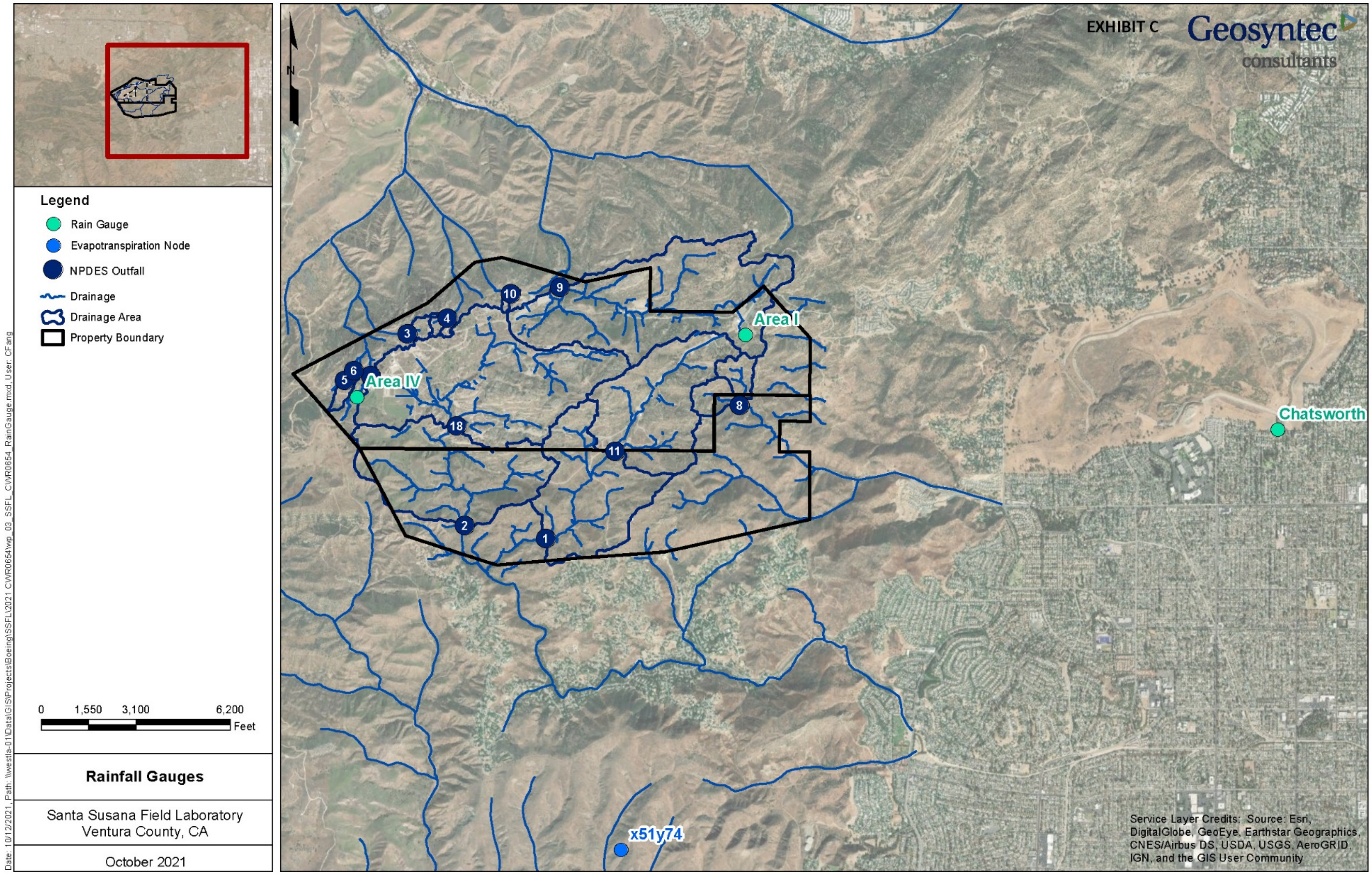

Figure 3. Rain Gauges

ATTACHMENT A

Constituents of Potential Concern by Watershed

Constituent	Constituents of Potential Concern in Outfall 001, 002,011, & 018	Constituents of Potential Concern in Outfall 003, 004, 005, 006, 007, 009, & 010 (Note 1)	Constituents of Potential Concern in Outfall 008	Outfall 001 (Note 2)	Outfall 002 (Note 2)	Outfall 008 (Note 2)	Outfall 009 (Note 2)	Outfall 011 (Note 2)	Outfall 018 (Note 2)	TOTAL (Note 2)
Biochemical Oxygen Demand (BOD) (5- day @ 20°C)	YES			20	30	0	0	8	12	70
Oil and Grease	YES	YES	YES	20	30	19	24	6	12	111
Total Suspended Solids (TSS)	YES			40	82	9	11	8	12	162
Barium, Total Recoverable (TR)	YES			5	7	0	0	10	1	23
Boron		YES	YES	4	6	4	4	10	1	29
Chloride	YES	YES	YES	21	34	19	24	13	12	123
Chlorine	YES			5	10	0	0	3	1	19
Chronic Toxicity	YES	YES	YES	0	0	0	0	0	0	0
Fluoride	YES	YES	YES	5	10	3	3	11	1	33
Detergents (as MBAS)	YES			20	30	0	0	5	12	67
Ammonia – N	YES		YES	16	22	9	0	5	12	64
Nitrate – N	YES		YES	0	1	9	0	0	0	10
Nitrite – N	YES		YES	0	1	9	0	0	0	10
Nitrate + Nitrite – N	YES	YES	YES	20	30	19	24	13	12	118
Perchlorate	YES		YES	43	78	19	7	14	12	173
Settleable Solids	YES			23	33	0	0	10	12	78
Sulfate	YES		YES	20	34	19	24	13	12	122
Total Dissolved Solids	YES	YES	YES	20	30	19	24	6	12	111
Radioactivity – Gross Alpha	YES	YES	YES	31	59	6	3	6	1	106
Radioactivity – Gross Beta	YES	YES	YES	27	59	10	11	6	1	114

Constituent	Constituents of Potential Concern in Outfall 001, 002,011, & 018	Constituents of Potential Concern in Outfall 003, 004, 005, 006, 007, 009, & 010 (Note 1)	Constituents of Potential Concern in Outfall 008	Outfall 001 (Note 2)	Outfall 002 (Note 2)	Outfall 008 (Note 2)	Outfall 009 (Note 2)	Outfall 011 (Note 2)	Outfall 018 (Note 2)	TOTAL (Note 2)
Combined Radium-226 & Radium-228	YES	YES	YES	13	25	0	0	1	0	39
Tritium	YES	YES	YES	26	58	9	9	6	1	109
Strontium-90	YES	YES	YES	27	59	10	10	5	1	112
Antimony, TR	YES	YES		22	49	18	23	10	1	123
Arsenic, TR	YES			22	49	4	4	9	1	89
Beryllium, TR	YES			22	49	4	4	9	1	89
Cadmium, TR	YES	YES		22	53	18	24	10	1	128
Chromium (VI)	YES			5	4	1	0	8	0	18
Copper, TR	YES		YES	40	70	19	24	14	12	179
Lead, TR	YES	YES	YES	42	73	19	24	14	12	184
Mercury, TR	YES	YES		41	82	19	24	13	12	191
Nickel, TR	YES	YES		22	49	3	4	10	1	89
Selenium, TR	YES		YES	25	56	10	4	10	1	106
Silver, TR	YES			22	49	4	4	10	1	90
Thallium, TR	YES	YES		22	52	10	14	10	1	109
Zinc, TR	YES	YES	YES	27	49	10	4	10	1	101
Cyanide	YES	YES	YES	38	76	4	4	7	12	141
TCDD Equivalents	YES	YES	YES	29	42	19	24	4	12	130
1,2-Dichloroethane	YES			38	74	4	4	14	12	146
1,1-Dichlorethylene	YES			38	74	4	4	14	12	146
Trichloroethylene	YES			38	74	4	4	14	12	146
Pentachlorophenol	YES			26	41	4	4	13	12	100

Constituent	Constituents of Potential Concern in Outfall 001, 002,011, & 018	Constituents of Potential Concern in Outfall 003, 004, 005, 006, 007, 009, & 010 (Note 1)	Constituents of Potential Concern in Outfall 008	Outfall 001 (Note 2)	Outfall 002 (Note 2)	Outfall 008 (Note 2)	Outfall 009 (Note 2)	Outfall 011 (Note 2)	Outfall 018 (Note 2)	TOTAL (Note 2)
2,4,6-Trichlorophenol	YES			26	41	4	4	13	12	100
Bis(2-ethylhexyl)Phthalate	YES			26	41	4	4	13	12	100
2,4-Dinitrotoluene	YES			26	41	4	4	13	12	100
N-Nitrosodimethylamine	YES			26	41	4	4	13	11	99
alpha-BHC	YES			26	40	4	4	14	12	100

Notes:
Note 1. Outfalls 003, 004, 005, 006, 007, and 010 are not proposed for post-cleanup stormwater modeling as these drainage areas are outside of Boeing's cleanup responsibility
Note 2. Count of sample results in non-wildfire years, before major treatment BMPs

Constituent	Constituents of Potential Concern in Outfall 001, 002,011, & 018	Constituents of Potential Concern in Outfall 003, 004, 005, 006, 007, 009, & 010 (Note 1)	Constituents of Potential Concern in Outfall 008	Outfall 001 (Note 2)	Outfall 002 (Note 2)	Outfall 008 (Note 2)	Outfall 009 (Note 2)	Outfall 011 (Note 2)	Outfall 018 (Note 2)	TOTAL (Note 2)
Biochemical Oxygen Demand (BOD) (5- day @ 20°C)	YES			14	21	0	0	8	12	55
Oil and Grease	YES	YES	YES	7	6	4	8	1	4	30
Total Suspended Solids (TSS)	YES			15	35	8	5	4	6	73
Barium, Total Recoverable (TR)	YES			5	7	0	0	10	1	23
Boron		YES	YES	3	6	3	4	5	1	22
Chloride	YES	YES	YES	21	34	19	24	13	12	123
Chlorine	YES			0	0	0	0	0	0	0
Chronic Toxicity	YES	YES	YES	0	0	0	0	0	0	0
Fluoride	YES	YES	YES	1	3	3	3	5	1	16
Detergents (as MBAS)	YES			7	12	0	0	3	6	28
Ammonia – N	YES		YES	4	5	1	0	1	3	14
Nitrate – N	YES		YES	0	1	9	0	0	0	10
Nitrite – N	YES		YES	0	1	0	0	0	0	1
Nitrate + Nitrite – N	YES	YES	YES	16	24	19	24	10	9	102
Perchlorate	YES		YES	0	0	5	0	0	1	6
Settleable Solids	YES			1	4	0	0	1	1	7
Sulfate	YES		YES	20	34	19	24	13	12	122
Total Dissolved Solids	YES	YES	YES	20	30	19	24	6	12	111
Radioactivity – Gross Alpha	YES	YES	YES	29	58	5	2	1	1	96
Radioactivity – Gross Beta	YES	YES	YES	26	55	10	9	5	1	106

Constituent	Constituents of Potential Concern in Outfall 001, 002,011, & 018	Constituents of Potential Concern in Outfall 003, 004, 005, 006, 007, 009, & 010 (Note 1)	Constituents of Potential Concern in Outfall 008	Outfall 001 (Note 2)	Outfall 002 (Note 2)	Outfall 008 (Note 2)	Outfall 009 (Note 2)	Outfall 011 (Note 2)	Outfall 018 (Note 2)	TOTAL (Note 2)
Combined Radium-226 & Radium-228	YES	YES	YES	13	25	0	0	1	0	39
Tritium	YES	YES	YES	23	50	0	0	0	0	73
Strontium-90	YES	YES	YES	24	52	0	0	0	0	76
Antimony, TR	YES	YES		5	6	8	12	0	0	31
Arsenic, TR	YES			8	21	0	0	8	0	37
Beryllium, TR	YES			1	2	0	0	4	0	7
Cadmium, TR	YES	YES		6	6	10	17	9	1	49
Chromium (VI)	YES			0	0	0	0	1	0	1
Copper, TR	YES		YES	32	43	18	24	14	12	143
Lead, TR	YES	YES	YES	21	25	19	22	14	12	113
Mercury, TR	YES	YES		8	14	6	9	2	6	45
Nickel, TR	YES	YES		7	13	3	3	8	1	35
Selenium, TR	YES		YES	1	8	5	0	2	0	16
Silver, TR	YES			1	2	0	0	0	1	4
Thallium, TR	YES	YES		1	7	0	0	2	0	10
Zinc, TR	YES	YES	YES	15	26	8	4	10	1	64
Cyanide	YES	YES	YES	1	2	1	1	0	1	6
TCDD Equivalents	YES	YES	YES	6	9	7	18	1	10	51
1,2-Dichloroethane	YES			0	0	0	0	0	0	0
1,1-Dichlorethylene	YES			0	0	0	0	0	0	0
Trichloroethylene	YES			0	7	0	0	1	5	13
Pentachlorophenol	YES			0	0	0	0	0	0	0

Constituent	Constituents of Potential Concern in Outfall 001, 002,011, & 018	Constituents of Potential Concern in Outfall 003, 004, 005, 006, 007, 009, & 010 (Note 1)	Constituents of Potential Concern in Outfall 008	Outfall 001 (Note 2)	Outfall 002 (Note 2)	Outfall 008 (Note 2)	Outfall 009 (Note 2)	Outfall 011 (Note 2)	Outfall 018 (Note 2)	TOTAL (Note 2)
2,4,6-Trichlorophenol	YES			0	0	0	0	0	0	0
Bis(2-ethylhexyl)Phthalate	YES			5	5	0	0	0	2	12
2,4-Dinitrotoluene	YES			0	0	0	0	0	0	0
N-Nitrosodimethylamine	YES			0	0	0	0	0	0	0
alpha-BHC	YES			0	0	0	0	0	0	0

Notes:
Note 1. Outfalls 003, 004, 005, 006, 007, and 010 are not proposed for post-cleanup stormwater modeling as these drainage areas are outside of Boeing's cleanup responsibility
Note 2. Count of detected sample results in non-wildfire years, before major treatment BMPs

Constituent	Constituents of Potential Concern in Outfall 001, 002,011, & 018	Constituents of Potential Concern in Outfall 003, 004, 005, 006, 007, 009, & 010 (Note 1)	Constituents of Potential Concern in Outfall 008	Outfall 001 (Note 2)	Outfall 002 (Note 2)	Outfall 008 (Note 2)	Outfall 009 (Note 2)	Outfall 011 (Note 2)	Outfall 018 (Note 2)	TOTAL (Note 2)
Biochemical Oxygen Demand (BOD) (5- day @ 20°C)	YES			0	0	0	0	0	0	0
Oil and Grease	YES	YES	YES	0	0	0	1	0	1	2
Total Suspended Solids (TSS)	YES			0	0	0	0	0	0	0
Barium, Total Recoverable (TR)	YES			0	1	0	0	0	0	1
Boron		YES	YES	0	0	0	0	0	0	0
Chloride	YES	YES	YES	0	0	0	0	0	0	0
Chlorine	YES			0	0	0	0	0	0	0
Chronic Toxicity	YES	YES	YES	0	0	0	0	0	0	0
Fluoride	YES	YES	YES	0	0	0	0	0	0	0
Detergents (as MBAS)	YES			0	0	0	0	0	0	0
Ammonia – N	YES		YES	0	0	0	0	0	0	0
Nitrate – N	YES		YES	0	0	0	0	0	0	0
Nitrite – N	YES		YES	0	0	0	0	0	0	0
Nitrate + Nitrite – N	YES	YES	YES	0	0	0	0	0	0	0
Perchlorate	YES		YES	0	0	0	0	0	0	0
Settleable Solids	YES			0	0	0	0	0	0	0
Sulfate	YES		YES	0	9	0	0	0	0	9
Total Dissolved Solids	YES	YES	YES	0	1	0	0	0	0	1
Radioactivity – Gross Alpha	YES	YES	YES	1	1	2	0	0	0	4
Radioactivity – Gross Beta	YES	YES	YES	0	1	0	0	0	0	1
Combined Radium-226 & Radium-228	YES	YES	YES	0	1	0	0	0	0	1

Constituent	Constituents of Potential Concern in Outfall 001, 002,011, & 018	Constituents of Potential Concern in Outfall 003, 004, 005, 006, 007, 009, & 010 (Note 1)	Constituents of Potential Concern in Outfall 008	Outfall 001 (Note 2)	Outfall 002 (Note 2)	Outfall 008 (Note 2)	Outfall 009 (Note 2)	Outfall 011 (Note 2)	Outfall 018 (Note 2)	TOTAL (Note 2)
Tritium	YES	YES	YES	0	0	0	0	0	0	0
Strontium-90	YES	YES	YES	0	0	0	0	0	0	0
Antimony, TR	YES	YES		0	0	0	0	0	0	0
Arsenic, TR	YES			0	2	0	0	0	0	2
Beryllium, TR	YES			0	1	0	0	0	0	1
Cadmium, TR	YES	YES		0	1	0	0	0	0	1
Chromium (VI)	YES			0	0	0	0	0	0	0
Copper, TR	YES		YES	0	2	1	0	0	0	3
Lead, TR	YES	YES	YES	1	2	8	7	0	1	19
Mercury, TR	YES	YES		8	12	3	3	2	5	33
Nickel, TR	YES	YES		0	1	0	0	0	0	1
Selenium, TR	YES		YES	0	0	0	0	0	0	0
Silver, TR	YES			0	0	0	0	0	0	0
Thallium, TR	YES	YES		0	1	0	0	0	0	1
Zinc, TR	YES	YES	YES	0	1	0	0	0	0	1
Cyanide	YES	YES	YES	0	1	0	0	0	0	1
TCDD Equivalents	YES	YES	YES	1	2	1	6	0	4	14
1,2-Dichloroethane	YES			0	0	0	0	0	0	0
1,1-Dichlorethylene	YES			0	0	0	0	0	0	0
Trichloroethylene	YES			0	0	0	0	0	0	0
Pentachlorophenol	YES			0	0	0	0	0	0	0
2,4,6-Trichlorophenol	YES			0	0	0	0	0	0	0
Bis(2-ethylhexyl)Phthalate	YES			0	0	0	0	0	0	0

Constituent	Constituents of Potential Concern in Outfall 001, 002,011, & 018	Constituents of Potential Concern in Outfall 003, 004, 005, 006, 007, 009, & 010 (Note 1)	Constituents of Potential Concern in Outfall 008	Outfall 001 (Note 2)	Outfall 002 (Note 2)	Outfall 008 (Note 2)	Outfall 009 (Note 2)	Outfall 011 (Note 2)	Outfall 018 (Note 2)	TOTAL (Note 2)
2,4-Dinitrotoluene	YES			0	0	0	0	0	0	0
N-Nitrosodimethylamine	YES			0	0	0	0	0	0	0
alpha-BHC	YES			0	0	0	0	0	0	0

Notes:
Note 1. Outfalls 003, 004, 005, 006, 007, and 010 are not proposed for post-cleanup stormwater modeling as these drainage areas are outside of Boeing's cleanup responsibility
Note 2. Count of sample results above 2015 Permit Limit or Benchmark in non-wildfire years, before major treatment BMPs, not necessarily an exceedance count since the 2015 Permit was not in effect for the time period covered

Constituent	Constituents of Potential Concern in Outfall 001, 002,011, & 018	Constituents of Potential Concern in Outfall 003, 004, 005, 006, 007, 009, & 010 (Note 1)	Constituents of Potential Concern in Outfall 008	Proposed for Consideration in Draft Work Plan	Has Soil Clean-Up Risk-Based Screening Level	Detected in at least one pre-BMP Sample	Evaluate Post-Cleanup Modeling Scenarios (Note 2)
Biochemical Oxygen Demand (BOD) (5- day @ 20°C)	YES			NO	NO	YES	NO
Oil and Grease	YES	YES	YES	NO	NO	YES	NO
Total Suspended Solids (TSS)	YES			YES (but not a COC)	NO	YES	NO
Barium, Total Recoverable (TR)	YES			YES	YES	YES	YES
Boron		YES	YES	YES	YES	YES	YES
Chloride	YES	YES	YES	NO	NO	YES	NO
Chlorine	YES			NO	NO	NO	NO
Chronic Toxicity	YES	YES	YES	NO	NO	NO	NO
Fluoride	YES	YES	YES	YES	YES	YES	YES
Detergents (as MBAS)	YES			NO	NO	YES	NO
Ammonia – N	YES		YES	YES	NO	YES	NO
Nitrate – N	YES		YES	YES	NO	YES	NO
Nitrite – N	YES		YES	YES	NO	YES	NO
Nitrate + Nitrite – N	YES	YES	YES	YES	NO	YES	NO
Perchlorate	YES		YES	YES	YES	YES	YES
Settleable Solids	YES			NO	NO	YES	NO
Sulfate	YES		YES	YES	NO	YES	NO
Total Dissolved Solids	YES	YES	YES	NO (per 10/8 call)	NO	YES	NO
Radioactivity – Gross Alpha	YES	YES	YES	YES	YES (indiv. rads)	YES	YES
Radioactivity – Gross Beta	YES	YES	YES	YES	YES (indiv. rads)	YES	YES

Constituent	Constituents of Potential Concern in Outfall 001, 002,011, & 018	Constituents of Potential Concern in Outfall 003, 004, 005, 006, 007, 009, & 010 (Note 1)	Constituents of Potential Concern in Outfall 008	Proposed for Consideration in Draft Work Plan	Has Soil Clean-Up Risk-Based Screening Level	Detected in at least one pre-BMP Sample	Evaluate Post-Cleanup Modeling Scenarios (Note 2)
Combined Radium-226 & Radium-228	YES	YES	YES	YES	YES	YES	YES
Tritium	YES	YES	YES	YES	YES	YES	YES
Strontium-90	YES	YES	YES	YES	YES	YES	YES
Antimony, TR	YES	YES		YES	YES	YES	YES
Arsenic, TR	YES			YES	YES	YES	YES
Beryllium, TR	YES			YES	YES	YES	YES
Cadmium, TR	YES	YES		YES	YES	YES	YES
Chromium (VI)	YES			YES	YES	YES	YES
Copper, TR	YES		YES	YES	YES	YES	YES
Lead, TR	YES	YES	YES	YES	YES	YES	YES
Mercury, TR	YES	YES		YES	YES	YES	YES
Nickel, TR	YES	YES		YES	YES	YES	YES
Selenium, TR	YES		YES	YES	YES	YES	YES
Silver, TR	YES			YES	YES	YES	YES
Thallium, TR	YES	YES		YES	YES	YES	YES
Zinc, TR	YES	YES	YES	YES	YES	YES	YES
Cyanide	YES	YES	YES	YES	YES	YES	YES
TCDD Equivalents	YES	YES	YES	YES	YES	YES	YES
1,2-Dichloroethane	YES			YES	YES	NO	NO
1,1-Dichlorethylene	YES			YES	YES	NO	NO
Trichloroethylene	YES			YES	YES	YES	YES
Pentachlorophenol	YES			YES	YES	NO	NO

Constituent	Constituents of Potential Concern in Outfall 001, 002,011, & 018	Constituents of Potential Concern in Outfall 003, 004, 005, 006, 007, 009, & 010 (Note 1)	Constituents of Potential Concern in Outfall 008	Proposed for Consideration in Draft Work Plan	Has Soil Clean-Up Risk-Based Screening Level	Detected in at least one pre-BMP Sample	Evaluate Post-Cleanup Modeling Scenarios (Note 2)
2,4,6-Trichlorophenol	YES			YES	YES	NO	NO
Bis(2-ethylhexyl)Phthalate	YES			YES	YES	YES	YES
2,4-Dinitrotoluene	YES			YES	NO	NO	NO
N-Nitrosodimethylamine	YES			YES	YES	NO	NO
alpha-BHC	YES			YES	YES	NO	NO

Notes:

Note 1. Outfalls 003, 004, 005, 006, 007, and 010 are not proposed for post-cleanup stormwater modeling as these drainage areas are outside of Boeing's cleanup responsibility

Note 2. Proposed for consideration if detected at least once and has soil clean-up risk-based screening level