NORTHERN DRAINAGE RESTORATION, MITIGATION AND MONITORING PLAN
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

by

Haley & Aldrich, Inc.
San Diego, California

for

The Boeing Company
Canoga Park, California

and

National Aeronautics and Space Administration

File No. 20090-486
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HALEY & ALDRICH

Haley & Aldrich, Inc.
9040 Friars Road
Suite 220
San Diego, CA 92108-5860

Tel: 619.280.9210
Fax: 619.280.9415
HaleyAldrich.com

HALEY & ALDRICH

5 October 2011
File No. 20090-486

The Boeing Company
5800 Woolsey Canyon Road, MC: 033-T436
Canoga Park, California 91304-1148

Attention: Ms. Debbie Taege

Subject: Northern Drainage Restoration, Mitigation, and Monitoring Plan
Santa Susana Field Laboratory
Ventura County, California

Ms. Taege:

The team of Haley & Aldrich, Inc., Padre Associates, Inc., MWH Americas, Inc., Geosyntec Consultants, and the Surface Water Expert Panel members is pleased to present this plan for restoration, mitigation, and monitoring of the Northern Drainage following successful completion and close out of the California Environmental Protection Agency Department of Toxic Substances Control Imminent and Substantial Endangerment Determination and Order and Remedial Action Order, Santa Susana Field Laboratory, Ventura County, California (CAD 093365435 and CA 1800090010) dated April 29, 2011.

This document fulfills the requirements specified in the California Regional Water Quality Control Board, Los Angeles Region, Cleanup and Abatement Order No. R4-2007-0054 to develop a site-specific plan to restore, mitigate, and monitor the site following "complete abatement of contamination to the satisfaction of the workplans approved by DTSC." The elements of this plan also satisfy the requirements specified in the California Department of Fish and Game Streambed Alteration Agreement 1600-2003-5052-R5.

We appreciate this opportunity to work with Boeing on this project. Please contact us if you have any questions or wish to discuss this report further.

Sincerely yours,
HALEY & ALDRICH, INC.

Richard M. Farson, P.E. No. 47269
Vice President

Lissa Miller
Project Manager

James K. Barrett, P.E., LSP
Senior Engineer

Enclosures

cc: The Boeing Company; Attn: Mr. A. Lenox
NASA; Attn: Mr. P. Zorba

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EXECUTIVE SUMMARY

This Restoration, Mitigation, and Monitoring Plan (RMMP) was prepared by the team of Haley & Aldrich, Inc., Padre Associates, Inc., MWH Americas, Inc., Geosyntec Consultants, and the Surface Water Expert Panel members, on behalf of The Boeing Company (Boeing) and the National Aeronautics and Space Administration (NASA) to satisfy the requirement for a mitigation plan specified in paragraph A.x. of the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB) Cleanup and Abatement Order (CAO) No. R4-2007-0054 (LARWQCB, 2007). The requirements of paragraph 38 of the California Department of Fish and Game (CDFG) - issued Lake or Streambed Alteration Agreement #1600-2003-5052-R5 (CDFG, 2003) and extensions and amendments are also incorporated.

The CAO requires Boeing to develop a site-specific plan to restore, mitigate, and monitor the site following "complete abatement of contamination to the satisfaction of the workplans approved by DTSC." The California Environmental Protection Agency Department of Toxic Substances Control (DTSC) issued a Certification of Completion on April 29, 2011, stating that the response actions required under the Imminent and Substantial Endangerment Determination and Order and Remedial Action Order, Santa Susana Field Laboratory, Ventura County, California (CAD 093365435 and CA 1800090010) were successfully performed, the contaminants of concern had been removed, and remaining concentrations no longer posed an immediate risk to humans or environmental receptors (DTSC, 2011).

This RMMP is specific to the areas of the Northern Drainage at the Santa Susana Field Laboratory (Santa Susana site) that were subject to removal of clay targets, construction and other debris, and soil via vacuum truck and excavator. This RMMP also is applicable to areas where several trees and vegetation were removed, and an increase in erosion potential and loss of bank stability resulted from the removal actions. These areas of the Northern Drainage include the Rocketdyne–Atomics International Rifle and Pistol Club, Inc. trap and skeet shooting range (the former shooting range), the former shooting range debris removal area, the NASA former Liquid Oxygen debris removal area, and the reach of the drainage from the former shooting area west to a few hundred feet past Outfall 009, and are collectively referred to as "the Northern Drainage". The portion of Northern Drainage work performed on American Jewish University, Brandeis Bardin Campus property was non-invasive, vegetation was not impacted, and the channel was not altered in any way; therefore, it is excluded from this RMMP.

The primary elements of the RMMP include description and definition of the project site; discussion of the types of habitat to be established, restored, enhanced, and/or preserved; an implementation plan for both in-stream stabilization measures (check structures, bank protection, and culvert outlet energy dissipation) and planting, seeding, and irrigating; review of short-term, in-channel erosion and sediment controls for use during construction; operation and maintenance activities; and monitoring and reporting activities.

The proposed in-stream stabilization measures consist of 13 check structures, up to 45 locations of bank protection, and two energy dissipation aprons. It is estimated that approximately 450 tons of riprap, up to 1,550 square yards of erosion control blanket, and up to 450 square yards of turf reinforcement mat will be needed to construct the proposed in-stream stabilization measures.

Recommended mitigation activities to re-establish native vegetation and provide habitat value equivalent to pre-project conditions or better includes planting 502 cuttings and container plants of native shrubs and trees, planting a native seed mix, hydromulching, irrigation, and weeding. Placement of native species will be conducted to mimic the transition from ephemeral streambed/riparian habitat to adjacent upland scrubby or woodland habitats.

TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

TABLE OF CONTENTS
(continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

BBC	American Jewish University, Brandeis-Bardin Campus
BMPs	best management practices
Boeing	The Boeing Company
CAO	Cleanup and Abatement Order
CASQA	California Stormwater Quality Association
CDFG	California Department of Fish and Game
CMP	corrugated metal pipe
CWA	Clear Water Act
DTSC	California Environmental Protection Agency Department of Toxic Substances Control
ECB	erosion control blanket
Geosyntec	Geosyntec Consultants
Haley & Aldrich	Haley & Aldrich, Inc
HEC-RAS	Hydraulic Engineering Centers River Analysis System
HP-FGM	High Performance-Flexible Growth Medium
ISE/RA Order	Imminent and Substantial Endangerment Determination and Order and Remedial Action Order
LACDPW	Los Angeles County Department of Public Work
LARWQCB	California Regional Water Quality Control Board, Los Angeles Region
LOX	Liquid Oxygen
MRCA	Mountains Recreation and Conservation Authority
MWH	MWH Americas, Inc.
NASA	National Aeronautics and Space Administration
NPDES	National Pollution Discharge and Elimination System

Padre	Padre Associates, Inc.
RMMP	Restoration, Mitigation, and Monitoring Plan
SAA	Streambed Alteration Agreement
SMMC	Santa Monica Mountains Conservancy
SWMM	Storm Water Management Model
SWPPP	storm water pollution prevention plan
TRM	turf reinforcement mat
USACE	United States Army Corps of Engineers

1. PROJECT DESCRIPTION

This Restoration, Mitigation, and Monitoring Plan (RMMP) was prepared by the team of Haley & Aldrich, Inc., (Haley & Aldrich), Padre Associates, Inc., (Padre), MWH Americas, Inc., (MWH), Geosyntec Consultants, (Geosyntec), and the Surface Water Expert Panel members on behalf of The Boeing Company (Boeing) and the National Aeronautics and Space Administration (NASA) to satisfy the requirement for a mitigation plan specified in paragraph A.x. of the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB) Cleanup and Abatement Order (CAO) No. R4-2007-0054 (LARWQCB, 2007). The requirements of paragraph 38 of the California Department of Fish and Game (CDFG) - issued Lake or Streambed Alteration Agreement (SAA) #1600-2003-5052-R5 (CDFG, 2003) and extensions and amendments are also incorporated.

The California Environmental Protection Agency Department of Toxic Substances Control (DTSC) issued an Imminent and Substantial Endangerment Determination and Order and Remedial Action Order (ISE/RA Order), Santa Susana Field Laboratory, Ventura County, California in November 2007 (CAD 093365435 and CA 1800090010; DTSC, 2007). On April 29, 2011, DTSC issued a Certification of Completion stating that the response actions required under the ISE/RA Order were successfully performed, the contaminants of concern had been removed, and remaining concentrations no longer posed an immediate risk to humans or environmental receptors (DTSC, 2011). Overall, implementation of the ISE/RA Order resulted in the removal of approximately 14,949 tons of clay target, debris and soil.

This RMMP is specific to the areas of the Northern Drainage at the Santa Susana Field Laboratory (Santa Susana site) that were subject to removal of clay targets, construction and other debris, and soil via vacuum truck and excavator. This RMMP also is applicable to areas where several trees and vegetation were removed, and an increase in erosion potential and loss of bank stability resulted from the removal actions. These areas of the Northern Drainage include the Rocketdyne–Atomics International Rifle and Pistol Club, Inc. trap and skeet shooting range (the former shooting range), the former shooting range debris removal area, the NASA former Liquid Oxygen (LOX) debris removal area, and the reach of the drainage from the former shooting area west to a few hundred feet past Outfall 009, and are collectively referred to as "the Northern Drainage". The portion of Northern Drainage work performed on American Jewish University, Brandeis Bardin Campus (BBC) property was non-invasive, vegetation was not impacted, and the channel was not altered in any way; therefore, it is excluded from this RMMP.

1.1 Scope and Objectives

This RMMP provides a description and conceptual designs for restoration and stabilization of the banks and bottom of the Northern Drainage channel as well as mitigation for riparian plants removed during remediation. The primary objective of work described in this RMMP is to mitigate for alterations to stream morphology and for removal of riparian vegetation caused by the debris removal associated with implementation of the ISE/RA Order by:

- Restoring remediation areas in the Northern Drainage to approximate pre-project conditions (i.e., natural and self-sustainable conditions) through contouring, slope stabilization and planting of native plant species; and
- Installing stabilization measures in and along the banks and bottom of the Northern Drainage where needed to minimize erosion.

These measures are intended to function pending the completion of the final site cleanup that will be performed under the oversight of DTSC.

1.2 Summary of Mitigation Activities, To Date

As part of interim best management practices (BMPs) for erosion control and slope stabilization subsequent to excavation activities, a total of 1,797 native container plants were installed throughout the Northern Drainage in spring and summer 2010, according to the following breakdown:

- 210 Coyote brush (*Baccharis pilularis*);
- 1,253 Mulefat (*Baccharis salicifolia*);
- 293 Mexican elderberry (*Sambucus mexicana*);
- 11 Mugwort (*Artemisia douglasiana*); and
- 30 Creeping wildrye (*Leymus triticoides*).

Irrigation and maintenance has been underway since the plant installation and periodic visual inspections indicate that approximately 60 percent of these plants are currently alive. Installation of these plants was done voluntarily by Boeing and was not specifically part of the subject RMMP, but successful establishment of these plants will assist in the overall mitigation objectives and long-term goals of the RMMP (See Appendix A).

1.3 Responsible Parties

Project Proponent:

Ms. Debbie Taege
The Boeing Company
P.O. Box 7922
Canoga Park, California 91309-7922
Tel: 818.446.8849

Mitigation Plan Preparer:

Mr. Richard M. Farson, P.E.
Haley & Aldrich, Inc.
9040 Friars Road, Suite 220
San Diego, California 92108-5860
Tel: 619.285.7112

The following Boeing contractors assisted in the development of this RMMP: Padre, Geosyntec, MWH, and the Storm Water Expert Panel. Additional information about the roles and responsibilities for each contractor is provided in Appendix B.

1.4 Location of Project / Impact Site

Work performed under the DTSC ISE/RA Order extended from the east boundary of the former shooting range to approximately 3,800 feet onto the southern portion of the BBC property. Since the work performed on the BBC property was conducted entirely by manual methods and was non-invasive and did not disturb or alter the channel or surrounding flora, the work described in this RMMP is limited to the project area defined as the Northern Drainage channel which begins at the eastern edge of the former shooting range and ends several hundred feet beyond Outfall 009 (Figure 1).

1.5 Current Regulatory Framework

In accordance with DTSC and LARWQCB orders, as summarized below, field activities were undertaken to remove debris from and adjacent to the drainage; minimize sediment erosion and transport; and aid in achieving surface water quality objectives. This section summarizes these orders and discusses permits obtained to perform work adjacent to and within the ephemeral drainage. Mitigation, monitoring, and restoration of the Northern Drainage will be performed in accordance with applicable requirements[1].

1.5.1 DTSC ISE/RA Order

The ISE/RA Order required removal actions from two specific project areas in the Northern Drainage: a debris field east of the former LOX Plant (a facility located in a federally owned portion of the site in Area I and administered by NASA), and the former shooting range located on Mountains Recreation and Conservation Authority (MRCA) Sage Ranch property and Boeing property.

The work was performed from 2007 through 2010, and the required removal action report documenting the field activities was submitted in December 2010. DTSC approved the documented removal and issued a certification of completion for actions conducted pursuant to the ISE/RA Order April 29, 2011 (DTSC, 2011).

1.5.2 LARWQCB CAO

The LARWQCB-issued CAO required Boeing to implement measures to cleanup and abate wastes discharged to waters of the State; minimize impacts to habitat adjacent to the streambed during the cleanup; protect water quality during and after the cleanup; and restore the streambed and surrounding habitat following the cleanup. The CAO was issued for the Northern Drainage, the LOX debris field, and the former shooting range area.

The LARWQCB CAO provides guidance on stabilization requirements, reporting requirements, coordination with other agencies, monitoring requirements, and the requirement to deploy BMPs to minimize impacts to water quality. Boeing has complied with CAO requirements and continues to comply with CAO requirements. As part of these requirements, Boeing and NASA have prepared this RMMP.

The following three subsections discuss evaluation of necessary permits and their acquisition or determination that the permits were not required.

1.5.3 CDFG SAA

In 2003, Boeing applied for and was issued a SAA for the *Interim Measures for Remediation and Removal of Perchlorate at Happy Valley (HVIM)* which is a different watershed from the Northern Drainage. The SAA authorized Boeing to perform proposed field activities in the Happy Valley Drainage (an unnamed tributary to Dayton Creek) to remove soil, rock, and sediment containing perchlorate, and to replace the removed soil. In addition, the SAA allowed

[1] As previously noted, DTSC has oversight of the cleanup of the Santa Susana site and future activities under DTSC's direction could lead to re-evaluation of this RMMP.

for the installation of surface water sampling stations and the installation of retention structures to contain surface water. The SAA was effective through December 1, 2004; however, Boeing submitted appropriate notifications to CDFG to extend the effective date of the SAA through December 1, 2007. Using the HVIM SAA as a basis, Boeing submitted a Request to Amend a Lake or Streambed Alteration to CDFG for the field activities in the Northern Drainage (CDFG, 2007). Since 2007, Boeing has submitted notifications to CDFG to extend the effective date of the SAA and the current extension is valid through December 1, 2011. Boeing anticipates extending the SAA again this year through 2012. Boeing has conducted and continues to conduct field activities in accordance with requirements established in the HVIM SAA, including storm water best management practices (MWH, 2007b).

As part of the former LOX Plant debris removal in 2007 and the clay target debris removal actions in 2008, 2009, and 2010, sections of the Northern Drainage and upland areas were consequently disturbed. In accordance with paragraph 33 in the SAA, storm water BMPs were deployed as erosion and sediment control measures in the streambed work areas prior to commencement of removal activities, and upon completion of each removal action prior to the rainy seasons. The following BMPs were placed in the former shooting range prior to non-sensitive vegetation removal:

- Shaker plates (to control sediment migration to/from the construction site) installed at the point of vehicle entry and exit in the work areas (a tracking control BMP);
- Type-3 (gravel bag barrier) storm drain inlet protection devices (a sediment control BMP) at the storm drain inlet in the vicinity of the eastern end of the Northern Drainage;
- Silt fencing (a sediment control BMP) along the north and south sides of the drainage, near the top of the banks, in the former shooting range and in the "plateau" area to the west.

Prior to work in the drainage channel in 2008, both within and downstream of the former shooting range area, a row of straw bales (a sediment control BMP) was placed across the channel at select locations. The straw bales were placed immediately downstream of the drainage channel work areas and removed or replaced upon completion of work.

After debris removal activities in 2008 and 2009, and prior to the winter rainy season, the following temporary BMPs/site mitigation measures were installed to reduce downstream sediment migration:

- Seed-free straw bales were placed within the drainage channel;
- Straw wattles, jute mats/nets, and silt fencing were placed along the banks of the drainage;
- Hydroseed/hydromulch was sprayed along the banks to stimulate growth of new vegetation and stabilize soil;
- Localized planting of container plants to establish shrubs and trees; and
- The proliferation of non-native invasive plant species, such as mustard and thistles, was removed from the work areas by MP Environmental Services, Inc. using a weed trimmer.

In summary, the HVIM SAA and Northern Drainage SAA Amendment provides guidance for working within and adjacent to drainages, vegetation restoration, replacement ratios for specific plant species and other native vegetation, bank stabilization methods, metrics for measuring success of plantings, and reporting requirements. Reporting requirements are similar to those provided in the LARWQCB CAO; therefore, Boeing will provide a copy of this RMMP, as well as annual reports as required in the CAO and SAA, to CDFG.

1.5.4 USACE and LARWQCB 401/404 Permits

Clean Water Act (CWA) Sections 401 and 404 provide standards/regulations for achieving state water quality objectives for work in wetlands and regulating the discharge of dredged and fill material into waters of the United States, respectively. The 401 and 404 programs are "concurrent" and permitting/certification are performed simultaneously. As part of Boeing's pre-project evaluation, proposed project activities were discussed and permit needs determined.

Based upon the anticipated project activities, work scope, project location, and project goals for the work performed from 2007 to 2010, it was determined a CWA Section 404 permit would not be required because the project would not include or result in the discharge of dredged and/or fill material into waters of the United States. This determination was discussed with the United States Army Corps of Engineers (USACE) and they concurred. Because a CWA Section 404 permit was not required, LARWQCB water quality certification through CWA Section 401 was not necessary. However, the LARWQCB did require surface water sampling in the CAO.

1.5.5 LARWQCB NPDES Permit

Boeing has an active National Pollution Discharge and Elimination System (NPDES) Permit (LARWQCB, 2010) for stormwater discharged from the site. The Northern Drainage, Outfall 009 (located in the Northern Drainage approximately 460 feet south of the Area II/Northern Undeveloped Land boundary) has specific numeric effluent limits that are listed in the NPDES Permit. Boeing conducts surface water sampling to confirm these permit limits are achieved. In addition to the NPDES Permit, the LARWQCB CAO required surface water sampling be performed in conjunction with project field activities. Specific NPDES Permit and CAO requirements related to surface water sampling are described in those documents.

1.6 Project Setting and History

This section presents information pertaining to site location, history of the former shooting range, detailed physical and geologic form and structure, topography, and climate associated with the Northern Drainage. Following the discussion of project setting is a summary of previous work conducted in the Northern Drainage.

1.6.1 Project Setting

The Santa Susana site is located in the southeast corner of Ventura County, approximately 29 miles northwest of Los Angeles, California. The facility occupies approximately 2,850 acres of hilly terrain with about 1,100 feet of topographic relief near the crest of the Simi Hills. The Santa Susana site is divided into four administrative areas (Areas I, II, III, and IV) and has undeveloped land along the northern and southern boundaries. The source of the clay target

debris was an approximately 3.5-acre former shooting range located on the MRCA Sage Ranch property adjacent to the northeastern portion of the Santa Susana site, near the Main Gate. The source of the asphalt, concrete, and insulation debris was likely from the demolition of the former LOX Plant.

No buildings or other structures exist within the former shooting range. The Northern Drainage roughly bisects the former shooting range area in an east to west direction. An unpaved, actively used hiking trail (Loop Trail) originating on Sage Ranch generally parallels the north side of the drainage on Sage Ranch property from the former shooting range to the eastern boundary of the former LOX Plant. The area north of the former shooting range is characterized by relatively steep outcrops of Chatsworth formation bedrock.

1.6.2 Geomorphic Setting

By definition, the morphology of any stream is composed of channel geometry (in plan, cross-section, and profile) and the material making up the channel bed and banks. The dominant aspects typically controlling channel form, however, are discharge and sediment supply since a stream's most basic function is to convey water and sediment. With this in mind, Geosyntec prepared the summary of the geomorphic setting of the Northern Drainage below describing its channel geometry, bed/bank material, and the watershed characteristics (topography, climate, geology, and land cover) which contribute most to the hydrology and sediment flux of the drainage's fluvial system.

1.6.2.1 Channel Geometry

The 1.5-mile long project reach drains east to west across the northern portion of the Santa Susana site, starting upstream at the former shooting range and ending downstream at NPDES Outfall 009. In plan view (Figure 1) the Northern Drainage generally lacks sinuosity because its geometry is dictated by geologic controls more so than any meandering pattern typically associated with alluvial streams. The channel is altered by historic site development including dirt and paved roads and the former LOX Plant pad which constrain the width of the natural channel.

Cross section geometry is highly variable. Bank slopes range from flat to nearly vertical, and generally deepen with distance downstream. Bankfull[2] widths, based on 39 measurements, range between 9 feet and 60 feet with an approximate average of 21 feet. Bankfull depths range from 1.5 feet to 12 feet, with an average of approximately 5 feet.

The longitudinal profile (Appendix C) is governed by nickpoints[3] of exposed sandstone bedrock (Appendix C, photograph numbers 115 and 390) and large boulders (Appendix C, photograph number 409), which serve as natural grade control. The profile is also controlled to an extent by two large instream culverts, one located southwest of the former LOX Plant and the other 1,500 feet upstream of there. This results in steps in

[2] The water level, or stage, at which a stream is at the top of its banks and any further rise would result in water moving into the flood plain.

[3] A nickpoint, in surface hydrology, is the location along the profile of a stream at which a sudden gradient change occurs.

the profile with flat depositional zones between the geologic hard points (Appendix C, photograph number 131). These steps are generally more frequent in the steeper upstream reaches of the Northern Drainage, closest to the former shooting range. The longest stretch of steep channel is located a few hundred feet upstream of Outfall 009.

1.6.2.2 Bed/Bank Material

Bank material consists primarily of consolidated sandy silt with some brief stretches of bedrock lined banks (Appendix C, photograph number 86). The softer banks are mostly vegetated with grasses or brush (Appendix C, photograph numbers 143 and 382), but bare erosive sections exist as well.

Bed material is highly variable and includes sand, gravel, cobble, boulder, and bedrock. While the geologic nickpoints consist of permanent sandstone bedrock and boulders, the bed of the low gradient depositional sections, in between the hard points, consists primarily of easily mobilized fine sand (Appendix C, photograph number 131).

1.6.2.3 Watershed Topography

The watershed area tributary to Outfall 009 is 536 acres (0.84 square miles), which includes portions of the Sage Ranch, NASA, Boeing, and BBC properties. Elevations in the watershed range from 1,608 feet above mean sea level, at Outfall 009, to 2,158 feet above mean sea level, on the highest ridge. Locally higher gradients of approximately 19 and 13 percent exist in short reaches approximately 250 feet upstream of the former shooting range and 220 feet upstream of Outfall 009, respectively and longer, low gradient (1.0 to 2.4 percent) reaches exist between these areas. The average gradient of the project reach is approximately 5.1 percent between points located approximately 900 feet upstream of the former shooting range and Outfall 009 (Geosyntec, 2008).

In relation to the regional watershed, the Northern Drainage is at the eastern headwaters of the Calleguas Creek watershed (Appendix D). As shown in the regional longitudinal profile (Appendix D), the project reach is situated on top of a plateau in the Simi Hills, which flows through an unnamed intermittent drainage tributary to Meier Canyon and subsequently to the Arroyo Simi, Arroyo Las Posas, and Calleguas Creek, which eventually discharges into the Pacific Ocean at Point Mugu Lagoon. Although the profile is dictated by geologic controls, the steep terrain of the Simi Hills situates the Northern Drainage in the general geomorphic zone of sediment production and high transport. Therefore, the natural function of the Northern Drainage, a steep first or second order canyon drainage, is to supply and transport sediment to downstream reaches of the watershed.

1.6.2.4 Climate

The drainage is typically dry throughout the year, with the exception of the months of November through March during the rainy season. Winter storms provide a large enough quantity of precipitation to produce surface water flow in the Northern Drainage. Typically, storm and watershed hydrologic characteristics do not allow for long-term surface water flow; however, the Northern Drainage may flow for several

days before flow diminishes and dries up. Little rainfall occurs during the April through September dry season. The average annual rainfall in the project area is about 18 inches, though cyclical periods of above average and below average rainfall are common.

1.6.2.5 Geology

The Cretaceous-age Chatsworth formation underlies the Northern Drainage watershed as well as the majority of the Santa Susana site (Appendix D). The Chatsworth formation is identified as a deep-sea turbidite deposit and is predominantly composed of resistant, thickly bedded, medium to coarse grained sandstone with lesser amounts of interbedded fine sandstone, siltstone and conglomerate (MWH, 2007b). Several geologic structures have been identified across the Santa Susana site by previous studies (MWH, 2007b) defined as either faults, with hundreds of feet of inferred displacement or as deformation bands, with apparent displacements of less than a foot. The identified structures at the site typically exhibit an east-west or northeast-southwest orientation.

Soils are generally comprised of fine-grained silty sands, clayey sandy silts, and lean clay, interpreted to be weathered products of the Chatsworth formation Canyon member interbedded sandstone, siltstone and shale bedrock (MWH, 2007a). In addition, the soils can be predominately classified as being in hydrologic soil group D, which has the highest runoff potential of the four hydrologic soil groups categorized by the National Resources Conservation Service.

1.6.2.6 Land Cover

The 536 acres encompassing the project watershed are primarily (over 90 percent) open space. The watershed is characterized by chaparral and grassland vegetation, bedrock outcrops, developed areas (i.e., buildings, asphalted roads, or other paved surfaces), and dirt roadways (for fire, monitoring well, construction, and security access), with steep to moderate slopes.

1.6.3 Previous Work Conducted in the Northern Drainage

The former shooting range, which was operated by the Rocketydyne-Atomics International Rifle and Pistol Club, Inc., is located on property owned by the MRCA, who acquired it in 1990. Although the Rocketydyne-Atomics International Rifle and Pistol Club, Inc. was responsible under the terms of the lease agreements with the previous property owners to remove lead shot and clay target debris on the property at lease termination, Rockwell International participated in voluntary cleanup activities in 1992 and 1993 to remove visible lead shot and clay targets from the former shooting range. This work was performed pursuant to agreements with the MRCA and the California Conservation Corps. In subsequent years, Boeing identified additional lead shot in the vicinity of the former shooting range and implemented voluntary maintenance/removal actions in 1998 and 2006.

In 2007, DTSC issued an ISE/RA Order to cleanup clay target debris in the Northern Drainage downstream from the former shooting range and demolition-related debris just east of the former LOX Plant. During late 2007, Boeing removed construction/demolition-derived debris

potentially containing asbestos and antimony from the Northern Drainage east of the former LOX Plant. Approximately 2,112 tons of impacted soil, sediment and debris were removed from this area and disposed of off-site. This portion of the work was documented in the Boeing submittal, "*Northern Drainage Former Liquid Oxygen (LOX) Plant, Debris/Asbestos Removal Action Report, Santa Susana Field Laboratory, Ventura County, California*" (MWH, 2008).

In 2008, clay target debris removal was conducted along the channel. Vacuum trucks were used between the former shooting range and Outfall 009 to remove clay target pieces from the streambed and banks. During clay target removal activities, debris was discovered within the former shooting range area of the Northern Drainage on Sage Ranch property. Sediment, soil, debris, and igniters were removed, characterized, and transported off-site for disposal. This effort was documented in the Boeing submittal "*Former Shooting Range Debris Removal Action, Santa Susana Field Laboratory, Ventura, California*," dated 28 May 2009 (Haley & Aldrich, 2009). Clay target removal activities were suspended during the 2008-2009 rainy season and resumed June 2009.

In 2009, as in previous years, clay target removal began in the former shooting range area and proceeded west toward Outfall 009, re-visiting locations where 2008 confirmation samples exceeded soil clean up criteria or where visual evidence of clay targets was present. Boeing's contractors traversed the full length of the drainage twice from the shooting range to beyond Outfall 009 and removed visible clay target debris, soil, and sediment. Vacuum trucks removed clay target debris as far as 500 feet downstream of Outfall 009 and manual clay target debris removal was completed on BBC property downstream of the areas designated as "Environmentally Sensitive Areas" per the requirements in the DTSC ISE/RA Order. Between 2007 and 2011, approximately 14,949 tons of clay target debris, general debris, soil, sediment, and incidental lead shot were removed from the Northern Drainage as documented in the Boeing submittal "*Northern Drainage Clay Target Debris Removal Action Report, Santa Susana Field Laboratory, Ventura County, California*" (Haley & Aldrich, 2010).

1.7 Existing Conditions

The banks and bed of the channel and nearby vegetation from the former shooting range area to Outfall 009 (Appendix C, photograph number 70), including the concentrated debris area at the former LOX Plant, have been impacted as a result of implementing the removal actions. Impacts are a result of:

- Placement and movement of long lengths of vacuum piping on the banks and the bottom of the channel;
- Excavation and sediment removal of the finer materials encountered on the banks and bottom of the channel by hand, vacuum truck, and excavator; and
- Repeated foot traffic between access points and removal locations during multiple removal actions and confirmation sampling.

It is likely that in-stream erosion and suspended solids concentrations/loads have increased following strong flow events in the channel. Vegetation planting in specific locations within the Northern Drainage and its watershed described in Section 1.2 above (with figures provided in Appendix C including an as-built containerized planting map), in addition to natural vegetative and geomorphic recovery, has contributed to some amount of stabilization in the project reaches that have been affected by removal activities. Natural sediment loading rates have replenished depositional areas, which in

some cases were excavated down to bedrock, with new sediments. A comparison of photographs taken by Geosyntec of the bed at the same location (Appendix C, Sheet 6a) shows this sediment recovery. While the photograph dated November 2009 was taken following excavation activities, as seen by the exposed bedrock on the bed, the photograph dated August 2010 was taken nine months later and indicates that sand has deposited on the bed over that time period. Most important to the recovery of the stream system, however, is the naturally resilient stepped morphology of the Northern Drainage which is governed by shallow or exposed bedrock (Appendix C, photograph number 115) and large boulders (Appendix C, photograph numbers 86 and 409), as well as culverts, that act as in-stream grade controls (see Section 1.6.2.1). Head cut damage initiated by the debris removal activities has been relatively limited because any propagation has or will stop at the nearest upstream location of natural grade control.

Despite the system's natural resiliency to disturbance, instabilities, primarily in the form of bank erosion, are present throughout the Northern Drainage. The most pronounced in-stream erosion area is located between the box culvert outlet (Appendix C, photograph number 433) and the east end of the former LOX Plant. An initial, and very limited, Phase 1 stabilization action was implemented in December 2010 under the USACE Nationwide Permit (13) Bank Stabilization and the Individual 401 Water Quality Certification issued by the LARWQCB. The Phase I action included hydromulch placement on banks and one approximately 35-foot long section of riprap for bank protection (Appendix C, photograph number 443). Portions of the Northern Drainage's southern bank, between the LOX culvert outlet and Outfall 009, are also considered high priority areas for channel preservation and protection because of the infrastructure (i.e., access road and utilities) situated adjacent to the channel (Appendix C, photograph number 105).

1.7.1 Summary of Hydraulic Analyses

Geosyntec estimated design velocities and shear stresses within the Northern Drainage channel, for both the existing and proposed conditions using the USACE Hydraulic Engineering Centers River Analysis System (HEC-RAS) software program, a one- dimensional hydraulics model under steady state flow conditions. HEC-RAS inputs included channel geometry, hydraulic roughness, slope and discharge. Estimates for discharge were obtained from from a calibrated Storm Water Management Model ([SWMM]; Geosyntec, 2011), which estimates peak flow rates at 14 locations along the drainage based on the 24-hour theoretical precipitation events and watershed characteristics (drainage area, overland flow length, slope, percent imperviousness and soil infiltration rate) of each location. SWMM provided estimates of peak flow rates at 14 locations along the drainage based on the 24-hour theoretical precipitation events and watershed characteristics (drainage area, overland flow length, slope, percent imperviousness and soil infiltration rate) of each location. The modeling analysis was performed to support the design of channel stabilization measures including bank stabilization, check structures, and culvert outlet energy dissipation. The proposed bank stabilization measures include turf reinforcement mat (TRM) and erosion control blanket (ECB), and are used to protect channel banks from erosion.

1.7.1.1 Geometric Input

A total of 65 cross section transects were surveyed by Haley & Aldrich to characterize the channel geometry between Outfall 009 (downstream limit) and the former shooting range (upstream limit) in August 2010 using an auto-level and survey rod. The longitudinal profile geometry was based on aerial light detection and ranging survey

data from Ventura County (however more recent and more accurate aerial survey data from Sage Survey were used for all GIS maps and design drawings). Cross section geometry was modified by Geosyntec for modeling of the proposed conditions by including check structures modeled as broad-crested weirs with low flow points at the center of their respective cross sections. The elevation difference between the top of the weir at the banks and the center point ranges between 1 foot to 1.5 feet. Check structure locations were selected based on the criteria listed in Section 4.1.2. Appendix E includes cross section geometries and modeled check structures that were used in the HEC-RAS hydraulic analysis.

1.7.1.2 Hydraulic Roughness Input

Due to the highly variable morphology of the channel and presence of large boulders, a Manning's *n* value of 0.07 was used based on guidance and analysis provided by Wright Water Engineers, Inc., 2010.

1.7.1.3 Hydrologic Input

The SWMM model (Geosyntec, 2011) was used to simulate runoff generated for the 5-year 24-hour hyetograph, consistent with the Los Angeles County Department of Public Work's (LACDPW) Hydrology Manual (LACDPW, 2006), for design purposes. Per the Hydrology Manual, conservatively high discharge estimates were developed at 14 computation points in the Northern Drainage assuming saturated antecedent soil conditions. Results from the hydrologic simulation are provided in Table I, which are organized by SWMM nodes and HEC-RAS stations. Refer to Section 4.1.2.1 for a full explanation of the basis for selection of the 5-year design discharge. Figure 2 illustrates the catchment delineations associated with each SWMM node computation point. The 2, 5, 10, 25, 50, and 100-year exceedance interval discharge rates are provided in Appendix F.

Table I - Hydrologic Inputs

SWMM Node	HEC-RAS Station	5- Year Design Discharge (cfs)
J15	51	48
J14	44.1764*	51
J13	41.5384*	64
J12A	37	74
J12	32.3333*	88
J11	29.64*	104
J10	28.25*	107
J8	23.1212*	129
J7	21	131
J6	18.5142*	140

SWMM Node	HEC-RAS Station	5- Year Design Discharge (cfs)
J5	13	142
J4	11	148
J2	9.34*	151
J1	2	184

Notes:
* HEC-RAS stations were interpolated between surveyed cross sections in field.
SWMM = Storm Water Management Model
cfs = cubic feet per second

1.7.1.4 Hydraulic Results

Geosyntec's simulated water surface elevations, channel velocities, and shear stresses for the existing and proposed conditions at the 5-year peak discharge rate are plotted in Appendix E. The highest velocities and shear stresses occur within the steepest channel segments and the outlets of the two in-stream culverts (Appendix C, photograph numbers 144 and 433). Although the steep sections have the greatest erosive energy, they tend to be stable because they are armored with large boulders and bedrock (see Appendix C, photograph number 82). Appendix F provides a summary of the existing and proposed condition hydraulic results at the locations where stabilization measures (e.g., bank stabilization measures, check structures, and culvert outlet energy dissipation) are proposed based on field observations and the criteria described in Section 4.1.2. HEC-RAS velocity and shear results were compared to the stability thresholds summarized in section 1.7.2 and are provided in Appendix F.

1.7.2 Restoration Method Stability Thresholds

Permissible flow velocity and shear stress thresholds of various stabilization measures were evaluated by Geosyntec to select the stabilization measures that would be able to withstand the velocities and shear stresses estimated by HEC-RAS. Velocity and shear stress stability thresholds are provided in Table II for the following substrates/measures: (1) native material, (2) ECB, (3) TRM, (4) riprap, and (5) hardened surfaces. Table II is based on a comprehensive literature search and best professional judgment (Geosyntec, 2011).

Table II - Stability Thresholds

Material	Shear Threshold (lb/ft^2)	Velocity Threshold (ft/s)	Side Slope (XH:1V)	Source
firm loam	0.075	2.5		Fischenich 2001
alluvial silts (non-colloidal)	0.048	2		Chow 1959
alluvial silts (non-colloidal) - water transporting colloidal silts	0.15	3.5		Chow 1959
alluvial silts (colloidal)	0.26	3.75		Fischenich 2001, Chow 1959
alluvial silts (colloidal) – water transporting colloidal silts	0.46	5		Chow 1959

Material	Shear Threshold (lb/ft^2)	Velocity Threshold (ft/s)	Side Slope (XH:1V)	Source
short native grass	0.7 to 0.95	3 to 4		Fischenich 2001
long native grass	1.2 to 1.7	4 to 6		Fischenich 2001
Erosion Control Mat*	3	8	1:1	WWE 2011
Turf Reiniforcement Mat*	8	14	1:1	WWE 2011
Class 1/4 T - 500 lb (~21.5-inch D50)	10	16.6		Caltrans 2002, Shield's eqn, FHWA 1989
Class Light - 200 lb (~15.9-inch D50)	7.3	14.3		Caltrans 2002, Shield's eqn, FHWA 1989
Class Facing - 75 lb (~11.4-inch D50)	5.3	12.1		Caltrans 2002, Shield's eqn, FHWA 1989
grouted riprap	>12	>20	2:1	WWE 2011

* Threshold values for Erosion Control Mat and Turf Reinforcement Mat are for higher end products.
lb/ft^2 = pounds per square foot
ft/s = feet per second

2. GOAL OF MITIGATION

As discussed in Section 1.1, the primary objective is to mitigate the existing conditions in the drainage caused by debris removal associated with implementing DTSC's ISE/RA Order. The information presented in this section was provided by Padre and contains additional information for the habitat restoration portion of the work.

2.1 Types of Habitat to be Established, Restored, Enhanced, and/or Preserved

Habitats within the former shooting range and the Northern Drainage include coastal sage scrub, chamise (*Adenostoma fasciculatum*) chaparral, coast live oak (*Quercus agrifolia*) and willow (*Salix* sp.) riparian woodland, and annual grassland. Native plant species observed within the Northern Drainage included, but are not limited to (in general descending order of occurrence), yerba santa (*Eriodictyon crassifolium*), chamise, laurel sumac (*Malosma laurina*), coyote brush (*Baccharis pilularis*), mulefat (*Baccharis salicifolia*), deerweed (*Lotus scoparius*), poison oak (*Toxicodendron diversilobum*), holly-leaved cherry (*Prunus ilicifolia ssp. ilicifolia*), Mexican elderberry (*Sambucus mexicana*), mountain-mahogany (*Cercocarpus betuloides*), canyon sunflower (*Venegasia carpesioides*), toyon (*Heteromeles arbutifolia*), coast live oak, narrow-leaved willow (*Salix exigua*), arroyo willow (*Salix lasiolepis*), red willow (*Salix laevigata*), Fremont cottonwood (*Populus fremontii*), California bay (*Umbellularia californica*), and southern California black walnut (*Juglans californica*). Scattered patches of Santa Susana tarplant (*Deinandra minthornii*, a State rare species) are also present at the former shooting range, and on adjacent rock outcrops. Non-native blue gum (*Eucalyptus globulus*) was previously present at the former shooting range, but was removed at the request of Sage Ranch management at the outset of the project.

Impacted areas that support vegetation will be re-vegetated to provide habitat value equivalent to pre-project conditions or better through slope stabilization and planting of native plant species. Re-vegetated areas will include portions of both banks of the drainage bottom, and adjacent slopes that were impacted by past project activities, or will be impacted in the restoration of the channel. Placement of native species will be conducted to mimic the transition from ephemeral streambed/riparian habitat to adjacent upland scrubby or woodland habitats.

The goal of the mitigation will be achieved by the following actions:

- Planting of cuttings of native shrubs and trees;
- Planting of container plants of native shrubs and trees;
- Planting of a native seed mix;
- Hydromulching;
- Irrigation; and,
- Weeding.

These actions will provide riparian and upland habitat, reduce erosion, and reduce soil temperature and evaporation through shading. The end result should be a mixed riparian scrub and/or woodland in the channel bottom, with native shrubs and herbs on the slopes to control erosion.

2.2 Specific Functions and Values of Habitat to be Created / Enhanced

The goal of this RMMP is to restore pre-project functions and values of the subject reach of the Northern Drainage, including:

- Groundwater recharge;
- Flood flow alteration;
- Sediment stabilization;
- Nutrient removal; and
- Wildlife habitat.

The area of riparian habitat (mulefat scrub, willow thicket, and other mixed riparian woodlands) will be increased due to the commitment to plant replacements at the ratios described in Section 4.2.3.

2.3 Time Lapse

It is expected that a minimum of three years will be required for mulefat and other shrubs to reach appropriate size and maturity to provide substantial wildlife functions, and tree species may require between five to eight years. However, seeded areas may provide increased wildlife foraging value in less than one year.

2.4 Special Aquatic Habitat

Based on a 2003 field meeting with USACE staff in Happy Valley wherein it was determined that wetlands were absent from Happy Valley, and a similar ephemeral streambed characterization of the subject reach of the Northern Drainage, where it is expected that the period of inundation is too brief and infrequent to support wetlands, no wetlands occur within or adjacent to the project site. Other special aquatic habitats, such as riffle and pool complexes, are also absent based on the ephemeral nature of the Northern Drainage. Therefore, the primary goal of this RMMP is not to create wetlands or other special aquatic sites, including riffle and pool complexes.

3. DESCRIPTION OF PROPOSED MITIGATION PLANTING AREAS AND RESTORATION PLANTING AREAS

As discussed in Section 1.4 above, the proposed project site is defined as the area in the Northern Drainage where vacuum truck field activities were performed. Boeing proposes to perform habitat restoration measures within affected project areas so habitat does not experience long-term significant impacts, erosion and sediment transport are minimized, and the mitigation is successful. Although the goals of the habitat restoration activities are consistent throughout the entire project site, activities at specific locations are categorized as either:

- Mitigation Planting areas (or "Mitigation Areas"), wherein activities are designed to compensate for vegetation impacts resulting from the project, and are subject to success criteria set forth in the CDFG SAA and other regulatory permits; or,
- Restoration Planting areas, wherein activities are designed to be part of the engineered bank stabilization activities and will assist in enhancing bank erosion control, but are not subject to regulatory success criteria.

Both categories of planting activities are provided and quantified in Figures 3 through 7.

3.1 Location and Size of Mitigation Areas

The proposed Mitigation Areas are located within selected areas of the Northern Drainage, and will encompass approximately 0.51 acres (22,234 square feet).

Additionally, although not subject to specific success criteria, the Restoration Planting areas will encompass approximately 0.07 acres (approximately 3,000 square feet). As discussed below, a native hydroseed application will also be completed throughout all bare soil areas of the project site (both within and outside of the Mitigation Areas and the Restoration Planting areas).

3.2 Ownership Status

- The entire project site measures approximately 5.36 acres, and includes portions of the Santa Susana site and Sage Ranch Park. As noted above, NASA administers the federally-owned portions of the Santa Susana site. The Santa Monica Mountains Conservancy (SMMC) administers Sage Ranch Park.

Boeing will be taking the lead on implementing all of the proposed activities in this RMMP with the cooperation of and in coordination with NASA and SMMC.

3.3 Existing Functions and Values of the Mitigation Areas

According to information provided by Padre, the Mitigation Areas support coastal sage scrub, chamise chaparral, coast live oak and willow riparian woodlands, and annual grassland. These areas support the functions and values listed in Section 2.2 above.

3.4 Present and Proposed Uses of the Mitigation Areas

The Mitigation Areas are within or downstream of a former shooting range; however, a majority of the Mitigation Areas (and likewise, much of the project site) are mostly undeveloped. Following completion of remediation and mitigation activities, the Mitigation Areas (and encompassing project site) will likely continue to be open space.

3.5 USACE Jurisdictional Delineation

The USACE completed a jurisdictional determination for the Northern Drainage and concluded that the Northern Drainage is within their jurisdiction. A delineation of the waters of the United States potentially affected by the proposed mitigation project site is provided below.

Based on an average width of 16 feet (75 percent of the average bankfull width of 21 feet described above in Section 1.6.2.1) and length of 1.5 miles (or 7,920 feet), the total potential area of non-wetland waters of the United States within the project site is approximately 2.91 acres, 0.07 acres of which will be permanently impacted by the restoration and stabilization measures. The total potential area for restoration, stabilization, and mitigation activities for the Northern Drainage project is equal to the limits of the project site (i.e., 5.36 acres). Based on the nature of the project (bank stabilization) with minimal permanent impacts on the Northern Drainage, actual mitigation activities would, according to this RMMP, be limited to 0.38 acres of potential USACE jurisdictional area (75 percent of the sum total of the Mitigation Areas described above in Section 3.1 and exhibited in Figures 3 through 7). As described above in Section 2.4, no USACE-defined wetlands are present within the subject reach of the Northern Drainage.

3.6 CDFG Jurisdictional Delineation

CDFG asserts jurisdiction over state water bodies and watercourses that exhibit a defined bed and bank. The upward limit of CDFG jurisdiction is generally the top of the bank, typically extending further out from non-wetland USACE jurisdictional areas.

As stated in Section 1.6.2.1, the average bankfull width of the subject reach of the Northern Drainage is 21 feet. Multiplied by a reach length of 1.5 miles (7,920 linear feet), approximately 3.82 acres of the entire 5.36-acre project site is potentially within the jurisdiction of CDFG. However, based on the nature of the project (bank stabilization) with minimal permanent impacts on the Northern Drainage, actual mitigation activities would, according to this RMMP, be limited to 0.51 acres of potential CDFG jurisdictional area (100 percent of the sum total of the Mitigation Areas described above in Section 3.1 and exhibited in Figures 3 through 7). Additional habitat restoration activities consistent with, but not subject to the same success criteria, will be conducted throughout the remainder of potential CDFG jurisdictional areas located within the project site.

3.7 Present and Proposed Uses of All Adjacent Areas

Adjacent areas include the Santa Susana site, Sage Ranch, and BBC. The Santa Susana site is a decommissioned testing laboratory. Boeing is discussing possible future uses of its property. NASA has not decided on the future use of its property. The lands owned by MRCA and BBC are currently used for recreation (i.e., hiking, camping). No change in land use of any of these areas is expected in the foreseeable future.

3.8 Reference Site

The reference used to determine target functions and values for habitat restoration is the pre-project conditions of the project site, based on site photographs and botanical data collected during preconstruction biological surveys.

In regards to erosion control and stabilization, and as described in Section 7.1.1 below, a reference reach with similar geology and slope will be located in the Outfall 008 drainage approximately 1,500 feet downstream of Outfall 008 (Figure 8). This reference reach will allow comparison to conditions in an undisturbed drainage to help assess whether in-stream geomorphic changes are likely associated with management actions in the Northern Drainage or natural processes.

4. IMPLEMENTATION PLAN

This section discusses the technical approach for implementing restoration/stabilization measures (Section 4.1) followed by the technical approach to mitigation/planting efforts (Section 4.2). Restoration/stabilization is discussed first because it will be implemented first to avoid disrupting, disturbing, or destroying mitigation/planting efforts.

The restoration methods selected for implementation will not significantly alter or increase physical safety hazards beyond those already present to site visitors (e.g., hikers) or workers within the Northern Drainage channel (i.e., slips, trips, or falls). Other restoration methods that may be selected in the future will also be evaluated for potential physical safety hazards beyond those present at that time to site visitors or workers within the Northern Drainage channel.

4.1 Restoration / Stabilization

Implementation of in-channel stabilization measures involves their installation per the eventual final design drawing planset. The draft 60 percent level design planset is provided in Appendix G. In-channel restoration/stabilization measures described in this section are intended to be left in place permanently. The check structures will be filled in with sediment over time but will continue to provide grade control function over the long term (i.e., >10 years). Similarly, the energy dissipation measures will continue to provide culvert outlet protection erosion control over the long term. The bank stabilization measures (ECB and TRM) will degrade over time or be filled in or covered by vegetation so that they provide a shorter term benefit (on the order of several years) while natural channel restoration proceeds.

4.1.1 Rationale for Expecting Implementation Success

Selection of the proposed in-channel stabilization measures is based on the evaluation of the design criteria (discharge, velocity, shear stress), review of on-site available materials and commercial materials to be used that are capable of meeting and exceeding the design criteria, and the ability to construct the measures at the designated locations in the Northern Drainage channel without undue environmental impacts.

4.1.2 Design Criteria

This section, provided by Geosyntec, describes the criteria used to design the in-channel stabilization measures developed to achieve the objectives discussed in Section 1.1 above.

4.1.2.1 Design Discharge

The 2-, 5-, and 10-year return period, 24-hour duration design storms were considered for the interim stabilization design based on discussions and correspondence with the Expert Panel and design team. For perspective, the probability associated with a 2-year, 5-year, and 10-year return period 24-hour duration storm event of interest occurring within a 10-year period is provided below:

$$P_{(2\text{-yr})} = 1-(0.5)^{10} = 0.999\ (99.9\%)$$
$$P_{(5\text{-yr})} = 1-(0.8)^{10} = 0.893\ (89.3\%)$$

$$P_{(10\text{-yr})} = 1-(0.9)^{10} = 0.651\ (65.1\%)$$

The 2-year peak flowrate was assumed to be too frequent and not large enough of an event even for interim channel stabilization because it is highly likely that the 2-year event will occur in a 10-year period. Thus, the 2-year event is interpreted as not sufficiently protective for the interim condition. In order to compare the 5-year and 10-year design events, the HEC-RAS model of the Northern Drainage was run for the existing channel geometry and calibrated flow inputs from SWMM. Modeling results indicate that the 5-year peak channel velocities and shear stresses are slightly (12 to 17 percent) lower than the 10-year results at most cross-sections. However, the shear and velocity values directly upstream of in-stream culverts decrease significantly with increased flowrate, due to temporary backwater effects associated with the higher flows (see profile plots in Appendix C). Considering that the 5-year flowrates result in relatively comparable shear and velocity to the 10-year for most of the drainage and have markedly higher results upstream of culverts, the 5-year event was selected as the appropriate design event.

Application of a bulking factor to the design flowrates was considered due to the occasional high sediment discharges in the Northern Drainage watershed. The bulking factor is used to increase the design flow rate to account for the increased unit weight of the sediment and water mixture and the resulting forces exerted on the channel (LACDPW, 2006). Review of the available total suspended solids data for the Northern Drainage sub-basin, including immediately after the 2005 Topanga fire, indicated that a bulking factor is not required.

4.1.2.2 Targeted Sources of Sediment to Stabilize

The stabilization design addresses in-stream sediment sources from the Northern Drainage's bed and banks and provides sediment control at the mouths of erosive tributaries (for example, Appendix C, photograph number 437). The design does not address erosion control of side tributaries above the confluence with the main channel, nor does it attempt to stabilize rilling and gullying outside of the main channel caused by concentrated runoff via roads, dirt paths, and side culverts. These out-of-stream sources are not covered because the ISE/RA Order and CAO did not result in direct impact to these areas. However, other activities within the watershed do address excess erosion and sedimentation from sources outside of the Northern Drainage. These include culvert modifications on side tributaries to detain and filter sediment, stabilization of unpaved roads and the north channel bank stabilization that is planned for the former LOX Plant area.

4.1.2.3 Location of Stabilization Measures

The proposed Northern Drainage in-stream stabilization measures include check structures, bank protection (including toe protection), and culvert outlet energy dissipation. Additionally, demolition or removal of existing check structures (for example, Appendix C, photograph number 143) and in-stream boulders, which direct flow into susceptible banks (for example, Appendix C, photograph number 97), are identified; however, installation of these measures is a lower priority because they are not related to debris removal activities. Check structures are installed to create

localized backwater conditions that reduce in-channel velocities and bank shear stresses and to settle out suspended sediment. Bank stabilization is used to reduce erosion of susceptible channel banks by installation of various bank stabilization measures. Energy dissipation reduces velocities and shear stresses to reduce erosion of susceptible bed material. Potential locations for these stabilization measures were identified during a field assessment conducted by Geosyntec on May 17, 2011 and are described below.

Proposed check structures were preferentially located: (1) at the downstream limit of depositional reaches to maximize backwater effects and increase deposited sediment (for example, Appendix C, photograph number 131); (2) downstream of major sediment inputs, including erosive banks (Appendix C, photograph number 23) and side tributaries (for example, Appendix C, photograph number 437); (3) at locations that are reasonably accessible from roads; and (4) where minimal materials are needed to construct a check structure. The fourth criterion means that placement is preferred at locations with confined pinch points (for example, Appendix C, photograph number 86), existing check structures in place (for example, Appendix C, photograph number 14), and hardened bed and bank materials (for example, Appendix C, photograph number 390). Check structures may be constructed in locations with and without exposed bedrock. The benefits of preferentially locating check structures at natural hard points include: (1) more reliable structures that are less likely to have undermining or side bank erosion than if constructed in soft soil (for example, Appendix C, photograph number 143); (2) dissipation aprons downstream of the drop structures do not need to be as large due to naturally resilient bedrock and boulders; and (3) location of check structures at the top of bedrock hardpoints allows for the maximum backwater possible in the flat depositional reaches, increased sedimentation, and reduced shear stresses on soft banks.

Proposed bank stabilization is preferentially located on banks with: (1) steep side slopes; (2) soft soil material; (3) lack of existing vegetation; (4) observed erosion/scour; and (5) observed toe erosion (where the banks meet the channel bottom).

Proposed energy dissipation is located at the outlets of two in-stream culverts, a large corrugated metal pipe (CMP) culvert and a concrete box culvert where concentrated flow has created unstable bed and bank conditions (Appendix C, photograph numbers 144 and 433, respectively). The CMP culvert is located beneath the access road to the former LOX Plant (Appendix C, Sheet 5a, ~STA 41+00), and the concrete box culvert is located beneath a dirt road crossing approximately 1,500 feet upstream of the CMP culvert (Appendix C, Sheet 6a, ~STA 54+00).

4.1.2.4 Selection of Stabilization Measures

All in-stream check structures will be constructed of riprap. Riprap check dams are considered to be well-suited for soft erodible channels because the riprap can be placed into scoured areas to provide armor to protect vulnerable points in a ductile manner. Riprap check structures can also be placed on hardened bed and banks. In areas where boulders and cobbles are present, abundant riprap can be added to enhance the natural check structure by filling void spaces and thus increasing backwater (for example, Appendix C, photograph number 90).

Bank stabilization measures are only situated where the banks are relatively soft and erosive, and along the toe of the channel. The selection of the type of measure for a specific location is thus dictated by the anticipated shear stress, flow velocity and local scour calculated from the HEC-RAS hydraulic analysis for the nearest cross-section. The selected bank stabilization is re-vegetation which can be done by reinforcing with the following materials, ranked from lowest to highest strength: (1) ECB; (2) TRM; and (3) vegetated riprap protection with live staking. For both ECB and TRM, toe protection will be provided by fiberschine coconut fiber rolls installed along the toe of the bank. In cases where installation of ECB or TRM on the bank slope would cause more disturbance than if the bank were left alone, then the fiberschine toe protection should be provided without ECB or TRM. Hard solutions are not preferred given the temporary nature of the stabilization, the vegetation management goals for the Northern Drainage, and cost considerations. Grouted riprap is an appropriate hardened solution to use when design shear stresses and flow velocities exceed the stability thresholds for the previously mentioned materials. However, grouting will interfere with vegetated stabilization.

Energy dissipation structures will be constructed of grouted riprap aprons with vegetated riprap used to stabilize the bank side slopes above the toe. The selection of grouted riprap material type is dictated by the anticipated shear stress and flow velocity for the design event.

Factsheets summarizing general information on site suitability, design considerations, construction considerations, and operations and maintenance related to each stabilization measure type are provided in Appendix H.

4.1.2.5 Sizing of Stabilization Measures

The methodology described in *Stability Thresholds for Stream Restoration Materials* (Fischenich, 2001; Appendix I) was used as a basis for iteratively evaluating the appropriate sizing and design of stabilization measures. Additional references used in evaluating stability thresholds for native bed and bank materials, check structures, and bank stabilization materials include *Open Channel Hydraulics* (Chow, 1959), *Manual of Engineering Practice No 77,* (American Society of Civil Engineers, 1992), *Design of Riprap Revetment, HEC-11* (United States Department of Transportation Federal Highway Administration, 1989), California Stormwater Quality Association (*CASQA) BMP Handbook* (CASQA, 2009), *Environmentally-Sensitive Streambank Stabilization Techniques* (Salix, 2004), information from the International Erosion Control Association, 2011, and manufacturers product information.

The following sizing and design criteria apply specifically for check structures within the Northern Drainage:

- The maximum check structure height will be 3 feet in order to: (1) avoid large structures which require more material, heavier equipment to install, and greater disturbance of terrain; and (2) allow for reasonable walking access.
- The check structures and their materials (i.e., riprap) will be designed to resist the shear stresses and velocities associated with the design event as calculated in the HEC- RAS modeling.

- Each riprap check dam will be constructed of a specific common class of riprap (either California Department of Transportation Class Facing or Class Light) that is available at local quarries. Natural in-stream cobble and boulders can also be used if they are sized appropriately and their disturbance does not create additional scour issues. If native large rounded boulders are used (Appendix C, photograph number 90), they should be fractured to improve interlocking for use as riprap.
- Locations must be selected to avoid scouring and resuspension of sediment at the downstream side of the check structures.
- Check structures will be sufficiently anchored (i.e., not placed directly on the channel bottom but in a trench) into the native bed and banks (as possible) to avoid scour from bypassing flows. Minimum anchoring depths for riprap structures are will be equal to twice the median rock size.
- All check structures will have a low flow point at the center of the structure to prevent blowout (erosion) along the banks.

Although ponding is anticipated upstream of the check structures, it is assumed that the increased depth of the ponded water will not be a concern to ecological functions or vector control because ponding is a natural occurrence within the Northern Drainage. Riprap check structures are porous and ponded water conditions will be temporary. Site-specific circumstances requiring grouting of stabilized riprap or portions of some check dams will also create ponding but this is not likely to differ substantially from natural conditions

The following sizing and design criteria apply specifically for bank stabilization measures:

- The bank stabilization measures will be designed to resist the shear stresses and velocities associated with the design event, as calculated in the hydraulic model.
- Bank stabilization measures will be sufficiently anchored beneath the toe of the bank per manufacturer's and engineer's recommendations.

The following sizing and design criteria apply specifically to energy dissipation structures:

- The dissipation structures will be designed to resist the shear stresses and velocities associated with the design event, as calculated in the hydraulic model.
- Energy dissipation aprons will be sufficiently anchored down to bedrock or 1-ft below the calculated toe-down scour associated with the 5-year design event.
- Minimum width and length dimensions associated with riprap or grouted riprap aprons will be evaluated from design nomographs such as the one presented in Appendix F. If the minimum width is greater than the channel width, then the entire channel width will be protected.

4.1.3 Site Preparation

Site preparation will be based on the specific in-channel stabilization measures selected to be installed and will be specifically addressed in a project-specific construction storm water pollution prevention plan (SWPPP), if necessary.

4.2 Mitigation / Planting

Implementation for mitigation/planting involves planting, seeding, and irrigation. The information presented in this section was provided by Padre.

4.2.1 Rationale for Expecting Implementation Success

Plants selected are currently present adjacent to the project site, or were present within the project site prior to vacuum truck soil and debris removal operations. Planting methods have been selected to minimize erosion, plant mortality, and weed infestation. Therefore, it is expected that native cuttings, container plants, and seeds of native plants will survive and prosper in the project site. In addition, plantings will be irrigated as needed to ensure they become established.

4.2.2 Site Preparation

Any non-native plants establishing within the project site prior to planting will be removed by hand or hand-held equipment to the extent feasible. Dead plant material will be removed to minimize dispersal of seeds of non-native plants. Weeding will be conducted in the spring, prior to plants' setting seed. Prior to entry of weed removal crews, all Santa Susana tarplants located within the project site by a qualified biologist will be flagged to ensure their protection throughout implementation of the RMMP.

4.2.3 Planting Plan

Planting along the Northern Drainage channel will primarily be focused on enhancing and expanding previously planted areas, which were selected by the project biologist for having the highest likelihood of successful plant establishment. In addition, live cuttings of selected species (including, but not limited to, *Baccharis* spp., *Salix*, *Sambucus,* and *Artemisia douglasiana*) may be incorporated into selected bioengineered bank treatments (see Figures 3 through 7). All areas disturbed by project activities will be seeded with a native erosion control seed mix described in Section 4.2.4 below. Condition 48 of the CDFG SAA requires that plant material for revegetation be derived from cuttings and/or seeds obtained from randomly selected native trees and shrubs occurring within the Northern Drainage. Any replacement tree/shrub stock which cannot be grown from cuttings or seeds shall be obtained from a native plant nursery, be ant-free, and be grown without the use of pesticides or fertilizers.

Plantings will, at a minimum, require the replacements of the following project-related removals, as shown in Table III:

Table III - Project Related Planting Removals and Replacements (Mitigation Plantings)

Species	Common Name	Removed	Ratio	Replacement
Baccharis salicifolia	Mulefat	15	3:1	45 shrubs
Juglans californica	Southern California black walnut	1	10:1	10 trees
Salix laevigata	Red willow	2	5:1	10 trees
Quercus agrifolia	Coast live oak	2	10:1*	20 trees
* - SAA replacement ratio			**Total:**	**85 plantings**

In addition, Table IV presents the following additional species that may be planted on a voluntary basis to further enhance the restoration of the Northern Drainage channel, especially at the engineered treatment sites:

Table IV - Restoration Plantings

Species	Common Name
Artemisia douglasiana	Mugwort
Baccharis pilularis	Coyote brush
Baccharis salicifolia	Mulefat
Leymus triticoides	Creeping wildrye
Sambucus mexicana	Mexican elderberry
Total	**417 plantings**

4.2.4 Seeding Plan

An initial hydroseed application is proposed immediately following installation of slope stabilization measures and container plants. This hydroseed application would include the use of Flexterra® High Performance-Flexible Growth Medium™ (HP-FGM), mixed with 50 percent of the proposed native seed mix. This seed mix is made up of 14 species native to the region, combining rapid growth species (grasses) for initial erosion control, and long-term shrubby and small tree cover species. Many of species were also chosen for their ability to support a variety pollinating insects, which Boeing has begun to voluntarily include as part of their restoration efforts. Note, however, that the application rates for the annual grasses have been decreased compared to typical seeding rates to ensure these plants do not out-compete the slower growing species, while still providing adequate erosion control. Please refer to Table V for a list of species included in the seed mix.

Table V - Species Included in the Native Seed Mix

Species	Application Rate (lbs/acre)	Notes
Black sage (Salvia mellifera)	1	Supports pollinator habitat
Bush mallow (Malacothamnus fasciculatus)	0.5	Supports pollinator habitat
California brome (Bromus carinatus)	2	Rapid germinator
California bush sunflower (Encelia californica)	2	Highly successful colonizer, supports pollinator habitat
Chamise (Adenostoma fasciculatum)	0.5	Common SSFL chaparral species
Climbing penstemon (Keckiella cordifolia)	0.2	Supports pollinator habitat
Cucamonga brome (Bromus arizonicus)	3	Rapid germinator
Deerweed (Lotus scoparius)	3	Leguminous nitrogen fixer
California buckwheat (Eriogonum fasciculatum)	1	Supports pollinator habitat
California sagebrush (Artemisia californica)	0.5	Sage scrub species
Island false bindweed (Calystegia macrostegia)	0.3	Supports pollinator habitat
Purple sage (Salvia leucophylla)	2	Common SSFL sage-scrub species, supports pollinator habitat
Small fescue (Vulpia microstachys)	4	Rapid germinator
Toyon (Heteromeles arbutifolia)	0.4	Supports pollinator habitat

lbs/acre = pounds per acre

Prior to the onset of the winter rains, a secondary hydroseed application would then be applied, with the remaining 50 percent of the seed mix combined with additional HP-FGM. To ensure that no inadvertent germination of ornamental or otherwise non-native species occurs within the Restoration Area, the hydroseeding contractor will ensure that their equipment is properly cleaned and rinsed prior to use at the restoration area.

4.2.5 Irrigation Plan

New tree and shrub plantings will be irrigated by a temporary irrigation system during the establishment period for up to three years following planting. This irrigation system will either be a drip or spray system connected to the existing irrigation of the site, or will utilize DriWater® time release water capsules or their equivalent, or will be manually watered with a truck or hose.

The final decision on the type of irrigation system to be used will be determined during the detailed design phases of the project, and will take into account the need to protect the entire system from rabbits and rodents to the greatest extent possible. If drip irrigation is used, possible protection techniques may include the burial, hanging, or sheathing of drip lines,

treatment of drip lines with repellants, or fencing / caging the planting areas to exclude rabbits and rodents.

If used, DriWater® watering packages will be spaced evenly on the uphill side of the root ball, installed per the manufacturer's recommendations, and replaced at a minimum of every 90 days during the dry season. Plants will also be manually watered at the time of the initial planting and with every subsequent reapplication of DriWater®. Reapplication of watering packages will either be conducted by a qualified biologist during annual monitoring activities, or by on-site staff.

Irrigation will be applied during the dry summer months or as determined necessary by the project biologist. Irrigation will also be applied during dry winters to supplement any deficiency in rainfall that may occur for up to two years following planting. The need for supplemental irrigation will be determined by the project biologist, and may be discontinued as appropriate.

4.3 Need for Additional Permits

As discussed above, various activities will be performed to restore project areas and mitigate previous project impacts. Based on the described actions, additional permitting may be required. If fill material is proposed to be placed in the drainage, it is likely a CWA Section 404 general permit will be required (nationwide basis) by the USACE. In addition, a CWA Section 401 water quality certification will be required by the State Water Resources Control Board (through the LARWQCB). Ventura County-specific permits (for example, Oak tree, etc.) may also be required. Boeing will obtain required permits prior to commencing permit-required activities.

5. SHORT-TERM, IN-CHANNEL EROSION AND SEDIMENT CONTROLS FOR USE DURING CONSTRUCTION

This section describes the approach developed by Geosyntec and Haley & Aldrich and the resulting criteria that will be implemented for the short-term, in-channel erosion and sediment controls (controls) associated with constructing the stabilization measures described in Section 4.1. For the purposes of this RMMP, it is assumed that the construction project area, in total, is greater than one acre, thus triggering the need for a project-specific SWPPP (this will be confirmed prior to construction). If necessary, the project-specific SWPPP will be developed for and implemented during the construction phase of the project. It will specify the temporary erosion and sediment control measures that will be implemented throughout the project area during the construction period to mitigate potential water quality and erosion impacts. The following erosion and sediment control alternatives that will be considered in the SWPPP are included in this section as examples.

The primary reference document supporting this approach and criteria is the BMP Plan for Outfalls 008 and 009 (MWH, 2010). Another general source is the CASQA Construction BMP Handbook (CASQA, 2009). For the purposes of this discussion, the short-term controls are grouped into one of three categories: source controls, erosion controls, and sediment controls.

5.1 Source, Erosion, and Sediment Controls

Although source, erosion and sediment controls have been and are being implemented in the Northern Drainage watershed, these will be used specifically to address concerns during the construction phase of the project. The following are brief definitions for source, erosion and sediment controls, taken directly from the Outfall 008 and 009 BMP Plan.

Source controls are practices that aim to reduce the quantity and improve the quality of stormwater runoff at or near the source of the constituents of concern. This may include schedules of activities to minimize exposure to potential runoff, structural devices (either constructed or natural), maintenance procedures, and managerial or operational practices such as removing the sources of contamination.

Erosion controls (a subset of source controls) are practices that protect soil and/or sediment from eroding under rainfall, flowing water and/or wind conditions. Effective erosion controls are techniques in preventing water pollution and soil loss through minimization of soil or vegetation disturbance; the use of physical barriers, such as vegetation, rock, and runoff diversions to reduce the energy of the water that is causing the erosion; and stabilization measures of disturbed areas. These measures are often implemented in conjunction with sediment controls.

Sediment controls are practices designed to keep already eroded soil from discharging and causing water pollution to receiving waters. Sediment control measures are usually passive systems that rely on filtering or settling of particles from the stormwater runoff.

5.2 Selection Approach

The approach for identifying source, erosion and sediment controls to be implemented within the Northern Drainage during the construction phase will be based on the type of area and control needed, because there is no “one size fits all” suite of controls or selection methodology. Source, erosion and sediment controls will be selected based on design storm flow characteristics, coverage/use, observed

effectiveness of the existing controls, results of subarea runoff monitoring, and recommendations from the Expert Panel. The following is a list of potential short-term, in-channel source, erosion, and sediment controls, all or some of which will be implemented during construction of the stabilization measures:

- Schedule construction to take place during dry weather (source control);
- Provide a trained erosion and sedimentation control professional to inspect and monitor construction controls per construction permit requirements (source control);
- Include a BMP maintenance plan in the project-specific SWPPP that addresses the inspection/monitoring report comments/action items (source control);
- Provide rumble grates for vehicles exiting the site (source control);
- Provide proper containment of fuel, portable toilets, trash debris and other contaminant sources associated with construction supplies and equipment (source control);
- Provide concrete wash-out area(s) if concrete will be used in stabilization measures (source control);
- Prohibit vehicles from driving on the channel bed or banks (erosion control);
- Install temporary fencing between the immediate work area and surrounding vegetation in order to limit disturbance of vegetation (erosion control);
- Properly install perimeter protection around all potentially disturbed areas and stock pile areas (sediment control);
- Upon completion of construction activities, install appropriate erosion controls (e.g., vegetation planting, wattles, hydroseed/mulch, and/or erosion control blanket) in areas disturbed by construction activities (erosion control);
- Install dirt road stabilization measures (e.g., water bars) for any access roads (existing or new) that are used for construction purposes and limit traffic to essential vehicles only (source control);
- Properly install temporary rock bag check structures, or equivalent, to span the channel width just down gradient of in-stream disturbances (sediment control); and
- Schedule construction with the following considerations:
  - Construction should begin at the downstream end of the channel and progress upstream so that check dams may be utilized as sediment controls; and
  - Construction should progress towards access points to the Northern Drainage to avoid repeated traffic between access points and construction areas (see Section 1.7).

If a control is not providing satisfactory erosion and sediment control at targeted locations, an "upgrade" of the control will be evaluated and implemented as soon as possible. Selection criteria to be used for source, erosion, and sediment controls includes: effectiveness, sustainability, applicability, fate of captured pollutants, environmental constraints, permitting requirements, and costs. Proper maintenance of controls is crucial to their effectiveness. All controls will be monitored and maintained, repaired and/or replaced immediately upon observation that they are not functioning properly or adequately.

Site preparation during construction will be based on the specific short-term, in-channel sediment controls and will be specifically addressed in a project-specific construction SWPPP, if that is determined to be necessary.

6. OPERATION AND MAINTENANCE DURING THE MONITORING PERIOD

This section briefly describes the proposed operation and maintenance requirements for the categories of proposed in-channel stabilization measures and planting efforts described in Section 4.

6.1 Operation and Maintenance Activities for In-channel Restoration / Stabilization Measures

Operation and maintenance requirements are summarized in the following tables for Riprap Check Structures, ECBs, TRMs, Vegetated Riprap, and Energy Dissipation Aprons. In the tables below, "routine maintenance" includes activities appropriate to avoid major maintenance but the measure is still functioning as intended, such as removal of limbs or brush, repositioning a few stones, adding or replacing anchor pins, etc. "Major maintenance", on the other hand, is required when a measure is no longer functioning as intended (e.g., major maintenance would be performed to correct erosion, settlement or failure of riprap, other bank protection measures and check dams).

Riprap Check Structures

Maintenance requirements for check structures are included in Table VI below. See section 7.1.6 for the planned schedule.

Table VI - Riprap Check Structures Maintenance Activities

Frequency	Activity or Maintenance Issue	Description
Routine Maintenance	Visual inspections	Check functionality and structural integrity of check structures during or following storm events (in excess of 1.5 inches of precipitation based on daily SSFL gauge results at LARWQCB-approved weather station AREA4), at least once every quarter during the rainy season, and once during the dry season.
	Missing or dislodged rocks, causing voids in check structures	Replace or reposition riprap such that voids are filled.
Major Maintenance	Sediment accumulation	None (leave sediment in place)
	Damaged or deformed check structure	Replace missing rocks and rebuild check structure to initial geometry, if needed.

Erosion Control Blankets

Maintenance requirements for ECBs are included in Table VII below. Also refer to manufacturer instructions for specific operations related to different ECB materials.

Table VII - Erosion Control Blanket Maintenance Activities

Frequency	Activity or Maintenance Issue	Description
Routine Maintenance	Visual inspections	Check function of ECB during or following storm events (in excess of 1.5 inches of precipitation based on daily SSFL gauge results at LARWQCB-approved weather station AREA4), at least once every quarter during the rainy season, and once during the dry season.
Major Maintenance	Evidence of blanket defects; rilling; washout or breakage; evident erosion; loss or dislodging of staples or stakes; decomposition of material	Repair ECB by providing additional staking and trenching; replace ECB only if vegetation is not yet established; add additional layer(s) of ECB if vegetation is established, but not consistent.

Turf Reinforcement Mats

Maintenance requirements for TRMs are included in Table VIII below. Also refer to manufacturer instructions for specific operations related to different TRM materials.

Table VIII - Turf Reinforcement Mat Maintenance Activities

Frequency	Activity or Maintenance Issue	Description
Routine Maintenance	Visual inspections	Check function of TRMs during or following storm events (in excess of 1.5 inches of precipitation based on daily SSFL gauge results at LARWQCB-approved weather station AREA4), at least once every quarter during the rainy season, and once during the dry season.
Major Maintenance	Evidence of blanket defects; rilling; washout or breakage; evident erosion; loss or dislodging of staples or stakes	Repair TRMs by providing additional staking and trenching; replace TRMs only if vegetation is not yet established; add additional layer(s) of TRM if vegetation is established, but not consistent.

Vegetated Riprap

Typically, maintenance of vegetated riprap is not intensive, unless large storms and high flows wash away rock and leave the area susceptible to erosion. Riprap should be repaired immediately after such events to ensure that it is operating properly. Maintenance requirements for vegetated riprap are included in Table IX.

Table IX - Vegetated Riprap Maintenance Activities

Frequency	Activity or Maintenance Issue	Description
Routine Maintenance	Visual inspections	Check function of vegetated riprap during or following storm events (in excess of 1.5 inches of precipitation based on daily SSFL gauge results at LARWQCB-approved weather station AREA4), at least once every quarter during the rainy season, and once during the dry season.

Frequency	Activity or Maintenance Issue	Description
Major Maintenance	Rock displacement	Replace rocks and revegetate, as needed, where rocks are displaced.
	Vegetation establishment	If vegetation is not properly established in places or if there are weak points in the riprap, revegetate using the live stake method, as needed.
	Displacement of soil or filter fabric	If soil or filter fabric is displaced around or under vegetated riprap, restabilize area and/or reinstall, as needed.

Energy Dissipation Aprons

Typically, maintenance of energy dissipation aprons is not intensive, unless large storms and high flows wash away rock and leave the area susceptible to erosion. The aprons should be repaired immediately after such events to ensure that it is operating properly. Refer to Table X below for other maintenance activities.

Table X - Energy Dissipation Apron Maintenance Activities

Frequency	Activity or Maintenance Issue	Description
Routine Maintenance	Visual inspections	Check function of energy dissipation aprons during or following storm events (in excess of 1.5 inches of precipitation based on daily SSFL gauge results at LARWQCB-approved weather station AREA4), at least once every quarter during the rainy season, and once during the dry season.
	Minor rock displacement	Replace missing rocks such that underlying soil is not exposed.
Major Maintenance	Major rock displacement or cracking of grout	Replace and rebuild riprap structure, replace grout.
	Displacement of filter fabric	Secure filter fabric into place by keying fabric into slope and ensure that fabric is completely covered by riprap.
	Scour around edges of riprap	Extend and rebuild riprap structure, as needed, to eliminate scour. Consider larger rocks, as necessary.

6.2 Operation and Maintenance Activities for Mitigation / Planting Efforts

The following maintenance activities will be implemented as needed throughout the planting areas during the first five years unless successful establishment is reached earlier:

- General hand weeding;
- Irrigation system maintenance and adjustment;
- Inspection and replacement of DriWater® watering packages at a minimum of every 90 days, if used. It is expected that irrigation will only be required for the initial two years unless successful establishment is reached earlier. The decision on the length of

supplemental water will be made by the qualified botanist assigned to the project by Boeing; and

- Inspection, maintenance (or replacement), and eventual removal of wire cages, if used.

A qualified botanist will train landscape workers in the identification of native plants to ensure only non-native plants are removed during weeding. Maintenance will occur at least twice annually (January and June) or more often as needed to meet the goals of the RMMP. If a traditional drip irrigation system is used, inspections and maintenance may occur to ensure that rabbit and rodent damage does not adversely affect system performance.

Replacement cuttings of mulefat, willow, Mexican elderberry, and mugwort may be installed in areas where low success is occurring or to meet mitigation requirements as specified in Table III. Cuttings will be taken from donor plants existing within the Northern Drainage or, if required, other areas within the Santa Susana site.

7. MONITORING PLAN FOR RESTORATION AND MITIGATION

7.1 Restoration

As important as proper design, construction, and maintenance of the stabilization measures are to mitigating the in-stream disturbances caused by debris removal activities, post construction monitoring is crucial to ensure the measures are serving their intended functions. The purpose of this section is to describe the applicant's proposed performance standards and monitoring methods for the proposed restoration portion of the work.

7.1.1 Performance Standards

The primary objectives of the monitoring plan for the Northern Drainage in-stream stabilization measures are to: (1) assess whether stabilization measures are effectively mitigating in-stream erosion caused by debris removal activities; (2) assess the function and structural integrity of stabilization measures over time so that maintenance needs are identified; and (3) assess whether stabilization measures are creating unintentional geomorphic impacts, such as sediment starved conditions downstream of check structures. Performance of the stabilization as it relates to these three objectives will be monitored as follows:

1. In order to assess whether stabilization measures are effectively mitigating in-stream erosion caused by debris removal activities (monitoring objective #1), monitoring reaches will be located in the Northern Drainage where in-stream erosion control is of highest priority, as mentioned in Section 1.7. These reaches are shown in Figure 9 and include: (1) between the outlet of the rectangular culvert and just east of the former LOX Plant; and (2) where the access road and utility line are directly adjacent to the Northern Drainage's southern bank. Additionally, a reference reach will be located in the Outfall 008 drainage approximately 1,500 feet downstream of Outfall 008 (Figure 8). This reference reach will allow comparison to conditions in an undisturbed drainage to help assess whether in-stream geomorphic changes are likely associated with management actions in the Northern Drainage or natural processes. This reference reach was selected based on it being a relatively undisturbed reach and having comparable geomorphic features to the Northern Drainage restoration reaches (e.g., roughly comparable longitudinal profile/slope, drainage area, bed/bank materials, geological formation [Chatsworth]), and accessibility (i.e., located on Boeing property). Within these three monitoring reaches, repeated physical surveys, facies mapping (i.e., plan view map of bed and bank form), and photographic surveys will be conducted, as described in Sections 7.1.5 and 7.1.6.

2. In order to assess the function and structural integrity of stabilization measures so that maintenance needs are identified (monitoring objective #2), regular inspections and annual photograph surveys will be conducted of each measure, per Sections 7.1.5 and 7.1.6.

3. In order to assess whether stabilization measures are creating unintentional geomorphic impacts (monitoring objective #3), an annual stream walk that extends from the former shooting range at the upstream limit to the property line with the BBC at the downstream limit will be conducted following the rainy season. This downstream limit

is set beyond the limit of major debris removal activities so that the potential impacts of reducing sediment will be observed if they occur. The impacts of sediment supply reduction will also be assessed by locating a monitoring reach just downstream of the limit of debris removal. Within this monitoring reach repeated physical surveys, facies mapping, and photographic surveys will be conducted, as described in Sections 7.1.5 and 7.1.6.

7.1.2 Target Functions and Values

An adaptive approach will be used to assess and manage morphological changes and stabilization measure effectiveness in the Northern Drainage per the objectives stated in Section 7.1.1. Adaptive management allows "…a management decision to be made, based on best available information, but also allows the decision to be revisited as new information is collected and more is learned about the functions and responses of natural systems" (Wieringa and Morton, 1996). The appropriate steps to adaptive management as they pertain to the Northern Drainage are to: (1) periodically monitor the channel for geomorphic changes; (2) review monitoring data and evaluate what management actions are needed; (3) implement management actions, as appropriate, based on available data; and (4) document monitoring data and management actions to establish a continuous record of the channel conditions, which will be used to inform future management actions.

7.1.3 Target Hydrological Regime

The magnitude, frequency, and timing of runoff are not anticipated to change due to the proposed stabilization measures.

7.1.4 Target Jurisdictional Acreage to be Created / Enhanced

There is no target jurisdictional acreage to be created by the proposed stabilization measures although it is anticipated that in-stream vegetation growth will increase behind check structures. Examples of such in-stream vegetation growth is shown on photograph number 419 in Appendix C.

7.1.5 Monitoring Methods

Proposed monitoring methods include stabilization measure inspections, physical surveying, facies mapping, photographic surveying, and an annual stream walk. A description of each method is provided below.

7.1.5.1 Inspection of Stabilization Measures

Stabilization measures will be inspected in order to identify whether routine or major maintenance is required, per Tables VI to X in Section 6.1. Standardized observation forms will be created prior to the first set of inspections such that the inspections can be done efficiently and in a standardized way.

7.1.5.2 Physical Survey

Morphologic changes will be measured by surveying established cross sections and longitudinal thalweg profiles and comparing them over time. This provides a record of channel geometry such that in-stream erosional (deepening and/or widening) or depositional changes can be quantified. As a rule of thumb, the length of each longitudinal profile will extend at least 10 channel widths (approximately 500-foot subsections of the study reach) and a minimum of three cross-sections will be established per monitoring reach. The physical surveys will be conducted with an automatic level, plumb rod, and cloth tape. A baseline survey will be conducted prior to construction of the stabilization measures for three selected reaches in the Northern Drainage and the reference reach. During the baseline survey of the selected reaches, labeled stakes (i.e., surveyed and photographed at installation) will be installed at the extents of each cross-section survey so that the same cross-sections and thalweg profile can be resurveyed in the future. The stakes will act as a datum and be situated such that they will not be disturbed during construction of the stabilization measures. See section 7.1.6 for the planned schedule.

7.1.5.3 Facies Mapping

A facies map is a plan view of a channel which illustrates distinct bed and bank forms. Creating facies maps over time is helpful in noting changes in bed and bank material. Facies mapping will take place within the same reaches defined by the physical surveys, which are approximately 500-foot subsections of the study reach. Grain size distribution data will be obtained for each distinct bed form (such as a bar or pool) for the initial facies map, and will be repeated if significant changes to the bed and bank material occurs. If the bed material consists of gravel and cobble, a Wolman pebble count will be conducted to characterize the grain size distribution. Wolman pebble counts consist of measuring 100 rocks at random within the unit of interest and measuring the thickness of their secondary axis. If the bed material is sand or finer, a sample will be collected so that a sieve analysis can be performed. See section 7.1.6 for the planned schedule.

7.1.5.4 Photographic Survey

At minimum, a pair of geo-referenced photographs, one looking upstream and another looking downstream, will be taken annually for each point of interest (i.e., physical survey cross-section or stabilization measure). These photographs will be taken from a defined location so that a consistent image record is obtained throughout time. Additional photographs may be taken as well, but the two geo-referenced photographs per point of interest are required. See section 7.1.6 for the planned schedule.

7.1.5.5 Stream Walk

A stream walk covering the entire study reach (i.e., from Outfall 009 to the shooting range, or a length of approximately 1.5 miles) will be conducted by a qualified engineer or scientist to identify geomorphic changes in locations that are not otherwise monitored. If, during the stream walk, a segment of the channel is observed to be particularly sensitive to erosion or deposition, then the location will be photographed,

geo-referenced, and consideration will be given to adding a physical survey location there so that the need for management actions can be better assessed. See section 7.1.6 for the planned schedule.

7.1.6 Monitoring Schedule

Stabilization measures will be inspected: (1) following storm events that are in excess of 1.5 inches of precipitation over a daily period as recorded by the onsite LARWQCB-approved "AREA4" rain gauge; (2) at least once every quarter during the rainy season (October to December and January to March); and (3) at least once during the dry season. Reference photographs of the stabilization measures should be taken once a year during the dry weather inspection. Designated monitoring reaches will have a repeat physical survey and photographic survey performed once every dry season. Facies mapping will occur only if there is significant observed changes to the bed and bank material. The stream walk shall also be done annually during the dry season. After two years of monitoring, the monitoring schedule can be reassessed. For instance, if stable conditions are consistently observed, frequency of monitoring can be decreased.

7.1.7 Annual Monitoring Reports

An annual monitoring report will be completed during the dry season to document the maintenance and monitoring efforts conducted during the previous year, summarize monitoring data collected during the previous year, review trends in the monitoring data to date, evaluate the efficacy of previous management actions, and assess what management actions should be implemented prior to the next rainy season, if any. The report should be completed early enough in the dry season that proposed management actions that require construction can be implemented prior to the following rainy season. Monitoring and reporting will occur for a duration of five years.

7.2 Mitigation/Planting

The CDFG SAA contains monitoring requirements and performance standards which must be documented on a regular, periodic basis and which must be met prior to closure of the permit. The purpose of this section is to describe the proposed monitoring methods and schedule for the mitigation and planting portion of this plan.

7.2.1 Performance Standards

The performance standards specified in the CDFG SAA for mitigation plantings to replace plants removed during remediation pertain to percent plant cover and percent survival as described below. These standards will not apply to volunteer plantings for restoration measures; however they can provide a guide to monitoring the success of those volunteer plantings.

7.2.1.1 Percent Plant Cover

Condition 44 of the CDFG SAA requires plantings to attain 75 percent cover within the designated Mitigation Areas after three years and 90 percent cover after five years. Replacement planting may be conducted if these criteria are not met.

7.2.1.2 Percent Survival

Condition 44 of the CDFG SAA requires plantings to attain 80 percent survival after the first year and 100 percent survival thereafter including natural recruitment. Replacement planting may be conducted if these criteria are not met. The percent survival criterion applies only to the required Mitigation Plantings for project-related removals (and not the Restoration Plantings) described in Section 4.2.

7.2.2 Target Functions and Values

Functions and values of the Mitigation Areas described above in Section 3.3 are assumed to be enhanced upon compliance with the above success criteria.

7.2.3 Target Hydrological Regime

No significant changes in hydrologic regime will occur in the designated planting areas, including any substantial permanent changes in landforms or vegetation characteristics, except those hydrological changes associated with any stream channel measures specifically installed to meet restoration goals.

7.2.4 Target Potential Jurisdictional Acreage to be Created / Enhanced

There is no target potential jurisdictional area to be created, but according to acreage calculations in Sections 3.5 and 3.6, restoration and planting activities will enhance a minimum of approximately 0.38 acres of potential USACE jurisdictional area and 0.51 acres of potential CDFG jurisdictional area.

7.2.5 Monitoring Methods

Monitoring activities will include establishment of photo-documentation stations in selected planting areas, survival surveys, botanical surveys, and line intercept surveys. Photographs will be taken during each monitoring visit at established stations to document overall progress. Survival surveys will be conducted to determine percent mortality of each planted species in each Mitigation Area. Botanical surveys will be conducted to document the increase in the number and proportion of native species over time. Line intercept surveys will be conducted to determine the percent cover of planted species.

7.2.5.1 Methods

Color photographs will be taken at established, permanent monitoring stations in each Mitigation Area. The compass direction, time, date, exposure number and location will be documented on data sheets.

Survival surveys will be conducted by counting the number of live cuttings and container plants in randomly selected locations in each Mitigation Area. Newly recruited native plants will also be counted. This task will also include an evaluation of the adequacy of irrigation, extent of weed infestation and herbivory losses. These surveys will be conducted in summer to document increase in cover associated with spring growth.

Botanical surveys will be conducted by identifying each plant species within each Mitigation Area and preparing a list of native and non-native species found. The intent is to document the success of native plants in excluding non-native plants.

Line transects will be established parallel to the streambed at randomly selected locations within each Mitigation Area. Plant species' identity and length of intercept will be determined for each entire transect. The development of a native plant community and eradication of non-native plant species will be documented by the percent cover and percent native species in the planting area as it changes over time and approaches that of undisturbed adjacent vegetation. Transect data will be collected at the time of the survival surveys.

7.2.5.2 Personnel

Qualified biologists and/or technicians supervised by qualified biologists contracted by Boeing will be used to conduct all monitoring activities.

7.2.6 Monitoring Schedule

In accordance with Condition 45 of the CDFG SAA, the permittee (Boeing) will conduct monitoring of the Mitigation Areas for a minimum of 5 years.

7.2.7 Annual Monitoring Reports

In accordance with Condition 45 of the CDFG SAA, annual reports will be submitted by January 1 of each year for a period of five years after planting. To enhance the transfer of information and to reduce the burden on the regulatory agencies, this annual report will be an appendix or attachment to the annual report discussed in Section 8.

The annual report will include the following (as a minimum):

- Names and qualifications of all monitoring personnel and report preparers;
- Reporting forms and photographs;
- Discussion of monitoring methods and dates activities were completed;
- Comparison of collected data to the success criteria;
- Discussion of problems encountered and probable reasons success criteria were or were not attained;
- Discussion of all activities conducted to remediate planting areas which failed to meet the success criteria;
- Recommendations to modify the success criteria based on past performance;
- Recommendations to minimize future mortality, excessive weeds, herbivory losses, slow growth and human impacts; and
- Discussion of storm-related or other natural damage (if any), activities conducted to repair damage, and recommendations to minimize future damage.

8. REPORTING AND COMPLETION OF MITIGATION

8.1 Reporting Activities

In accordance with Paragraph A.xi. of the LARWQCB CAO and Condition 45 of the CDFG SAA, an annual report will be submitted by January 1 of each year that one is required. The CAO requires that the first submittal of an annual report occur "following completion of mitigation activities" while the SAA requires the first submittal occur "after planting." Since planting is included in the mitigation activities discussed in this RMMP and will generally follow completion of the restoration/stabilization portion of the work described herein, the first annual report is anticipated to be due January 1, 2014 (refer to Section 10 for schedule information). Both the CAO and the SAA require annual reports for a minimum of 5 years; however, it is possible that annual reporting will extend beyond the five year period for the following reasons: a) the SAA requires five years of annual reporting for any replacement plants that are needed, and b) the CAO requires annual reports to be submitted until "mitigation success has been achieved and documented."

The annual report will include the following information, at a minimum, per the requirements specified in Paragraph A.xi. of the LARWQCB CAO and Condition 45 of the CDFG SAA:

- Survival, percent cover, height by species of replacement trees and shrubs, the method used to assess these parameters, and the number of plants replaced by species;
- Color photo documentation of pre- and post-project and mitigation site conditions and photos from designated photo stations;
- Activities performed during the year including revegetation efforts, exotic plant control, project activities, and restoration and mitigation efforts, monitoring activities;
- Status of other agreements (and active permits, as applicable);
- Overall project status, schedule, and project delays;
- Geographical positioning system coordinates in decimal-degree format outlining the boundary of the project and mitigation areas;
- Water quality monitoring results, as necessary;
- A certified statement of "no net loss" of wetlands associated with this project; and
- Operation and maintenance reports and monitoring reports generated during the reporting period.

8.2 Notification of Completion

Boeing will notify in writing, as appropriate, LARWQCB, CDFG, and USACE personnel in writing when restoration/stabilization is complete, when mitigation/planting is complete, and when mitigation monitoring is complete.

8.3 Agency Confirmation

Boeing will provide, as appropriate, LARWQCB, CDFG, and USACE personnel opportunity to inspect the Northern Drainage to confirm that the restoration and mitigation effort is complete. After said inspection, Boeing will submit, in writing, its request to terminate the CAO.

9. CONTINGENCY MEASURES

If restoration/stabilization measures show signs of failure or mitigation/planting measures do not meet the survival and percent cover requirements specified in the SAA, then contingency measures may be necessary. This section provides the pertinent information about such measures.

9.1 Initiating Procedures

Based on annual reports, visual observation, or maintenance records, a professional engineer will recommend appropriate contingency measures to ensure the engineered structure(s) meet their performance criteria. Similarly, a qualified biologist, botanist, or restoration specialist will develop recommendations should the plantings fail to meet their survival or percent cover requirements. If deemed reasonable and feasible by Boeing, these contingency measures will be submitted to LARWQCB, CDFG, and USACE, as appropriate, for approval. Upon approval, these measures will be implemented and documented in the annual reports.

9.2 Alternative Locations

Reaches of the Northern Drainage not identified as restoration/stabilization or mitigation/planting areas could be considered for alternative locations.

10. SCHEDULE

The implementation schedule provided in this section is designed to be an overview of the activities scheduled to take place between the submittal of this RMMP to the LARWQCB and CDFG for review and the submittal of the first Annual Report. More detailed implementation schedules will be provided in the subsequent work plans to be submitted in conjunction with the proposed work discussed in this RMMP. Overall, the implementation philosophy is to maximize the potential for success, i.e., restoration/stabilization measures will be implemented during the dry season and mitigation/planting activities will occur during the rainy season. In general, the work is expected to occur per the following timeline:

Table XI - Implementation Schedule

Task	Anticipated Timeline
Submit RMMP to the Regulatory Agencies (LARWQCB, CDFG, USACE)	Early October 2011
Evaluate Need For, Prepare, and Submit Permit Packages to the Regulatory Agencies (LARWQCB, CDFG, and USACE)	Mid October 2011
Implement Non-permit Required Restoration/Stabilization and/or Mitigation/Planting Activities	October – December 2011
Finalize Design Documents and Prepare All Required Construction-specific Work Plans, Health and Safety Plans, SWPPPs, and Transportation Plans.	January – March 2012
Implement Restoration/Stabilization Measures	April – October 2012
Finalize Planting, Seeding, and Irrigation-specific Work Plans Based on Expected As-built Restoration/Stabilization Measures	September – October 2012
Begin Restoration/Stabilization Monitoring Regime per Sections 7.1.5 and 7.1.6	October 2012
Implement Mitigation/Planting Measures	November 2012 – February 2013
Begin Mitigation/Planting Monitoring Regime per Sections 7.2.5 and 7.2.6	March / April 2013
Submit First Annual Report	December 2013 (due on or before January 1, 2014)

It should be noted that the Final Report required by paragraph B.xvi. of the LARWQCB CAO will be submitted October 2012. The Final Report will include a description and analysis of restoration/stabilization and mitigation/planting activities implemented to date (per paragraph B.xvi.c.) and a description of additional activities planned but not yet implemented (per paragraph B.xvi.d.).

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AMERICAN-JEWISH UNIVERSITY,
BRANDEIS-BARDIN CAMPUS

NPDES
OUTFALL 009

NASA
AREA I

MOUNTAINS RECREATION AND
CONSERVATION AUTHORITY
(SAGE RANCH PROPERTY)

AREA II
LANDFILL

FORMER
LOX
PLANT

"PLATEAU"
AREA

LOOP TRAIL

FORMER
SHOOTING
RANGE

LOWER PARKING
LOT STAGING
AREA

SSFL MAIN GATE

LOX DEBRIS AREA

BOX CULVERT

BOEING
AREA I

AREA I
LANDFILL

LEGEND

- SSFL PROPERTY BOUNDARY
- SSFL ADMINISTRATIVE BOUNDARY LINE
- DRAINAGE CHANNEL
- FORMER SHOOTING RANGE DEBRIS REMOVAL (2008)
- LOX DEBRIS REMOVAL(2007)
- TOPOGRAPHIC CONTOUR INTERVALS (FEET ABOVE MEAN SEA LEVEL)
- INACCESSIBLE NORTHERN DRAINAGE REACH
- MANUAL REMOVAL ONLY
- MECHANICAL AND MANUAL SOIL REMOVAL AND VEGETATION REMOVAL AREA

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SCALE IN FEET

HALEY & ALDRICH

THE BOEING COMPANY
NORTHERN DRAINAGE AREA
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALFIORNIA

PLAN VIEW

SCALE: AS SHOWN
OCOTBER 2011

FIGURE 1

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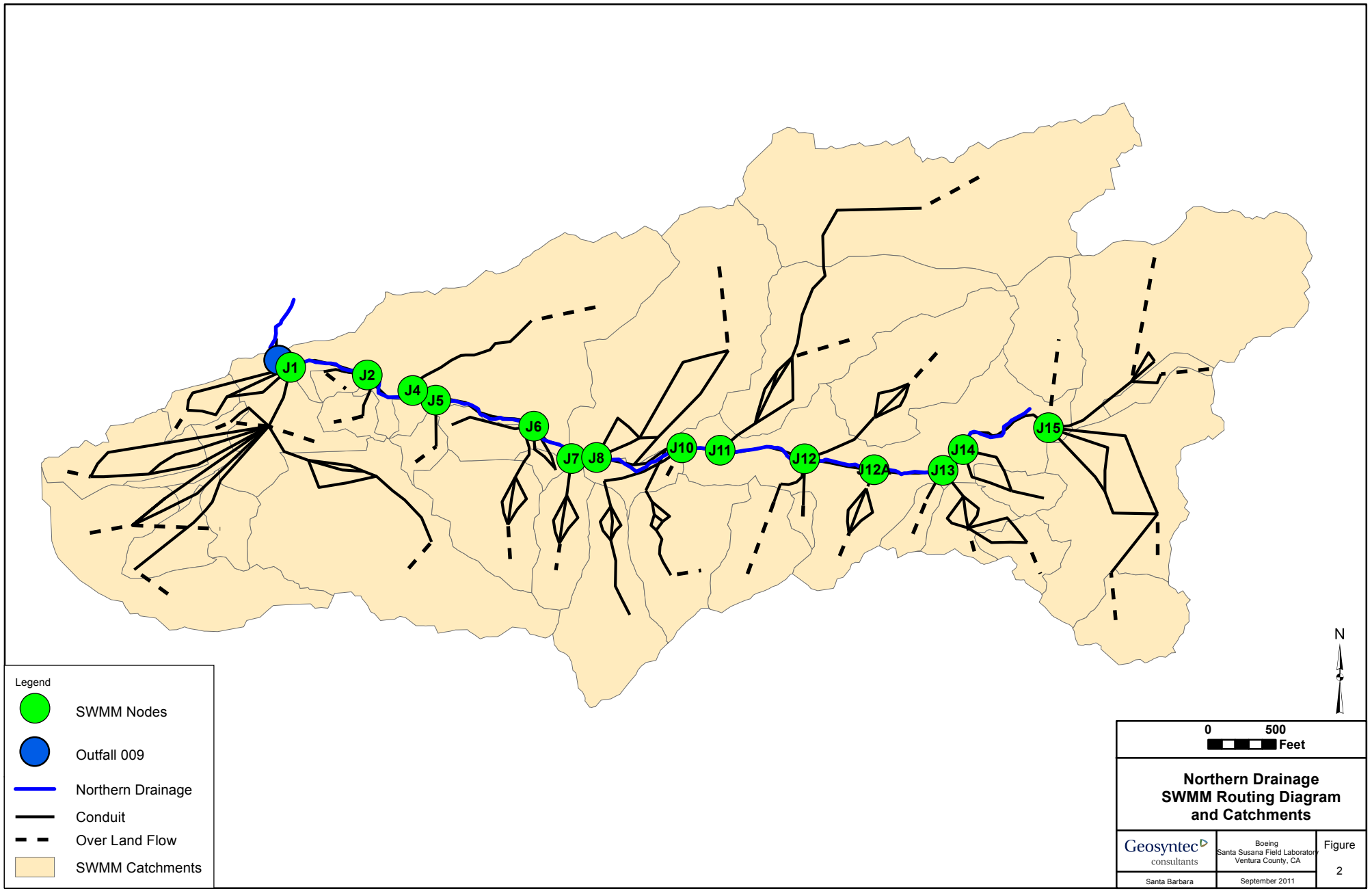
J1
J2
J4
J5
J6
J7
J8
J10
J11
J12
J12A
J13
J14
J15
N
Legend
SWMM Nodes
Outfall 009
Northern Drainage
Conduit
Over Land Flow
SWMM Catchments
0
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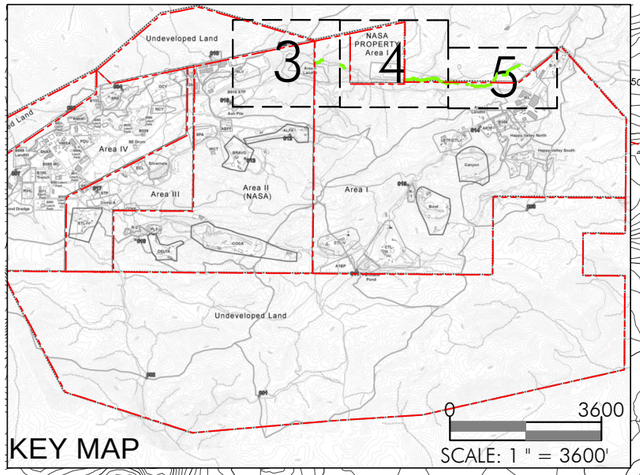
Feet
Northern Drainage
SWMM Routing Diagram
and Catchments
Geosyntec consultants
Santa Barbara
Boeing
Santa Susana Field Laboratory
Ventura County, CA
September 2011
Figure
2



OUTFALL 009

NORTHERN DRAINAGE (ND)

14+00 15+00 16+00 17+00 18+00 19+00 20+00 21+00 22+00 23+00 24+00 25+00 26+00 27+00 28+00 29+00 30+00 31+00 32+00 33+

ND-PLANT24

WATERSHED 009 - SEE FIGURE 3

WATERSHED 009 - SEE FIGURE 4

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2169-G East Francisco Blvd.
San Rafael, CA 94901
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(415) 454-0129 Fax

Boeing SSFL

60% DRAWINGS: NOT FOR CONSTRUCTION

NORTHERN DRAINAGE RESTORATION PLANTING

Figure 3
Western Reach Planting Plan

N

0 200

SCALE: 1 " = 200 '

LEGEND

- PLANTING AREA
- WATERSHED
- THALWEG
- PROPERTY LINE
- STABILIZATION SITE W/ CUTTINGS OR PLANTS
- STABILIZATION SITE W/OUT CUTTINGS OR PLANTS

Date: July 2011
Map By: MCB
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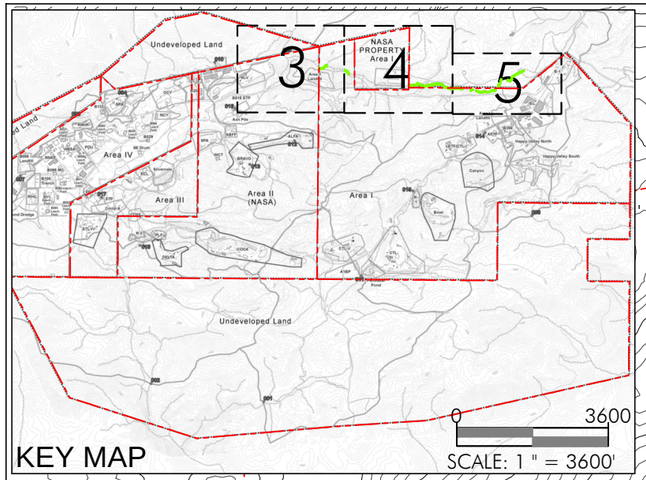

LOX

ND-PLANT23

32+00 33+00 34+00 35+00 36+00 37+00 38+00 39+00 40+00 41+00 42+00 43+00 44+00 45+00 46+00 47+00 48+00 49+00 50+00

ND-PLANT16-19A

51+00 52+00 53+00 54+00 55+00 56+00 57+00 58+00 59+00 60+00 61+00 62+00

ND-PLANT16-19B

ND-PLANT1-15A, CONT'D ON FIGURE 5

NORTHERN DRAINAGE (ND)

WATERSHED 009 - SEE FIGURE 3

WATERSHED 009 - SEE FIGURE 4

WATERSHED 009 - SEE FIGURE 4

WATERSHED 009 - SEE FIGURE 5

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NORTHERN DRAINAGE RESTORATION PLANTING

Figure 4
Middle Reach Planting Plan

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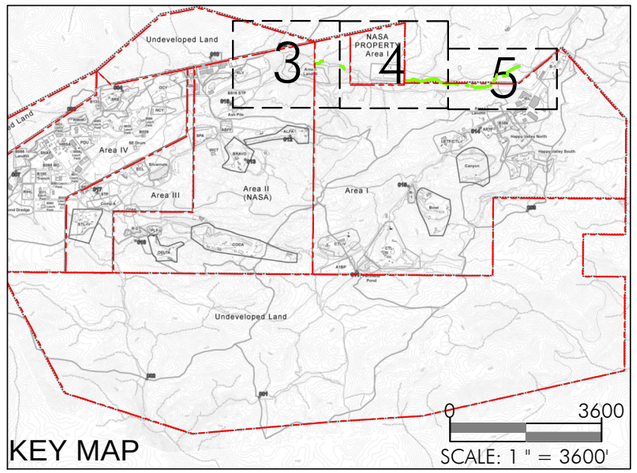
SCALE: 1 " = 200 '

LEGEND

- PLANTING AREA
- WATERSHED
- THALWEG
- PROPERTY LINE
- STABILIZATION SITE W/ CUTTINGS OR PLANTS
- STABILIZATION SITE W/OUT CUTTINGS OR PLANTS

Date: July 2011
Map By: MCB
Filepath: L:\Acad 2000 Files\17000\17166\dwg\Northern Drainage\Planting Plan - Northern Drainage RMMP.dwg



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NORTHERN DRAINAGE RESTORATION PLANTING

Figure 5
Eastern Reach Planting Plan

NORTHERN DRAINAGE (ND)

ND-PLANT1-15A, CONT'D ON FIGURE 4

ND-PLANT1-15B

ND-PLANT1-15C

ND-PLANT25-32A

ND-PLANT25-32B

ND-PLANT25-32C

WATERSHED 009 - SEE FIGURE 4

WATERSHED 009 - SEE FIGURE 5

N

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SCALE: 1 " = 200 '

LEGEND

- PLANTING AREA
- WATERSHED
- THALWEG
- PROPERTY LINE
- STABILIZATION SITE W/ CUTTINGS OR PLANTS
- STABILIZATION SITE W/OUT CUTTINGS OR PLANTS

Date: July 2011
Map By: MCB
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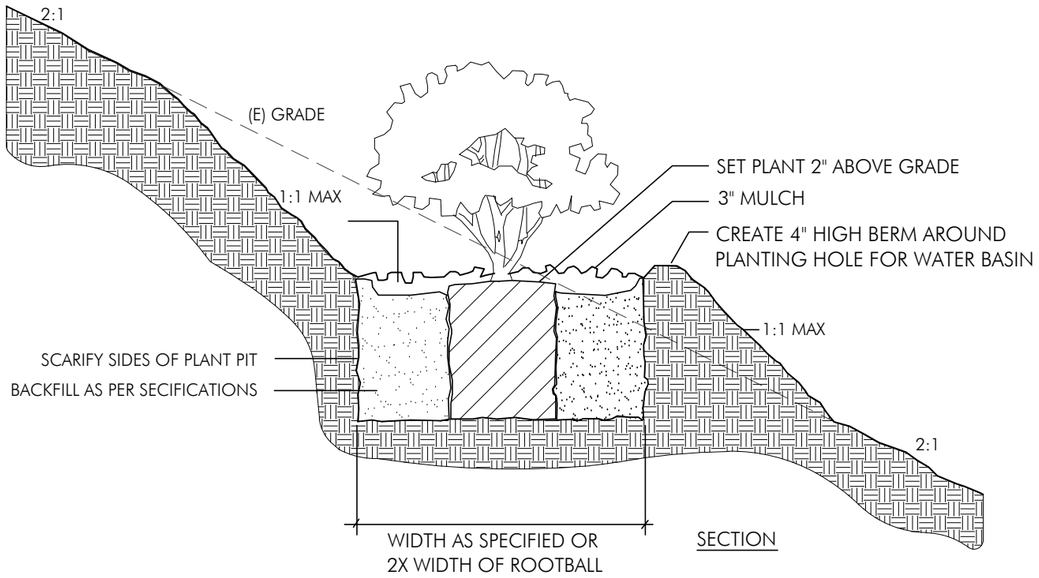


NOTE: IN THE EVENT THAT EXCAVATED SOIL FROM THE PLANTING HOLE IS INSUFFICIENT TO FORM THE WATER BASIN BERMS AROUND EACH PLANT DURING PLANT INSTALLATION, THE CONTRACTOR SHALL PROVIDE AND MAINTAIN A SMALL STOCKPILE OF CLEAN SOIL FOR THIS PURPOSE. CLEAN SOIL MUST BE APPROVED FOR USE PRIOR TO PLANTING, IF REQUIRED.

TREE & SHRUB PLANTING ON SLOPE DETAIL

NOT TO SCALE

PLANTING NOTES:

1. PLANTING ALONG THE NORTHERN DRAINAGE WILL BE LIMITED TO THE FOLLOWING CATEGORIES:

   i) MITIGATION PLANTING: AT THE PLANTING AREAS DESIGNATED ON THE PLANS, FOR VEGETATION IMPACTS ASSOCIATED WITH THE PROJECT.

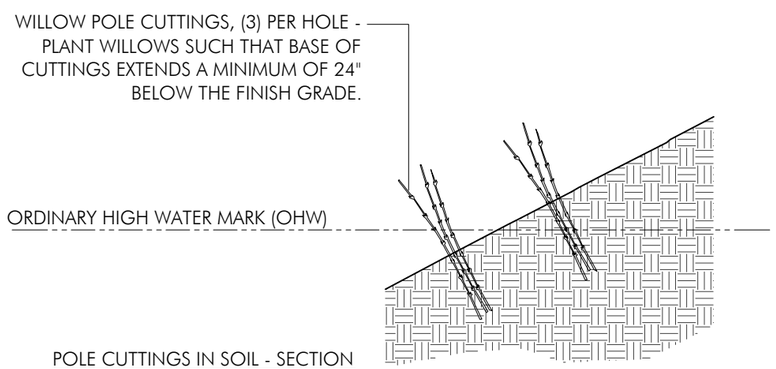
   ii) RESTORATION PLANTING: AT THE STABILIZATION SITES DESIGNATED ON THE PLANS, FOR ENHANCED BANK EROSION CONTROL.

2. MITIGATION PLANTINGS WITHIN PLANTING AREAS DESIGNATED ON THE PLANS ARE TO BE FIELD-FIT BY THE PROJECT BIOLOGISTS. FINAL LOCATIONS WILL BE SELECTED BASED UPON OBSERVED MORTALITY OF EXISTING CONTAINERIZED PLANTS, EASE OF ACCESS, AND LIKELIHOOD OF SUCCESSFUL ESTABLISHMENT.

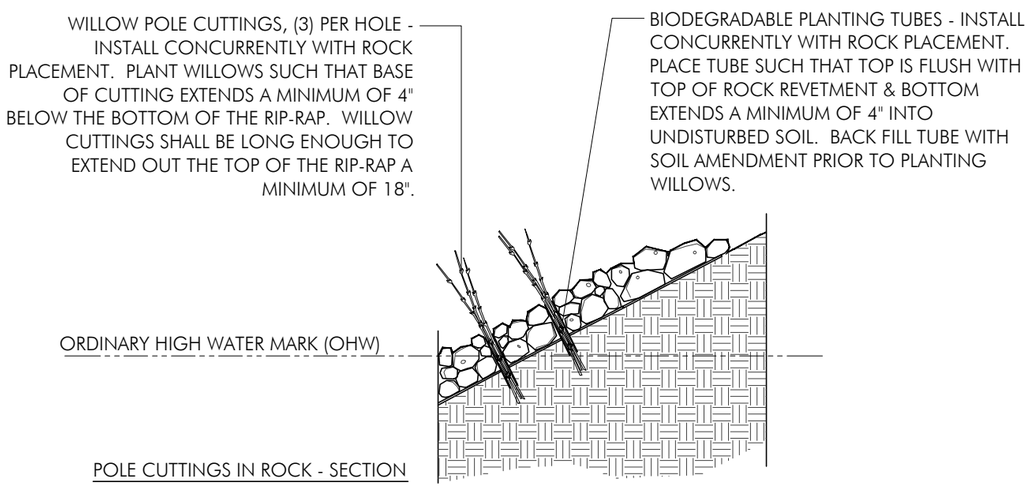
3. RESTORATION PLANTINGS ARE TO BE FIELD-FIT BY THE PROJECT ENGINEERS AND BIOLOGISTS, AND ARE TO BE LIMITED TO STABILIZATION SITES ON THE SOUTH (NORTH-FACING) BANK OF THE NORTHERN DRAINAGE AND IN-CHANNEL CHECK STRUCTURES, WHERE LIVE CUTTINGS OR CONTAINERIZED PLANTS MAY BE INCORPORATED NEAR THE ORDINARY HIGH WATER MARK (OHWM) OF THE CHANNEL.

4. NATIVE HYDROSEED MIX TO BE INSTALLED AT A PORTION OF THE STABILIZATION SITES DESIGNATED ON THE PLANS. FINAL SEED MIX AND LOCATIONS TO BE DETERMINED BY THE PROJECT ENGINEER AND BIOLOGISTS.

5. THE FINAL METHODOLOGY AND NEED FOR IRRIGATION FOR ALL NEW PLANTINGS IS TO BE DETERMINED BY THE PROJECT BIOLOGISTS.



POLE CUTTINGS IN SOIL - SECTION



POLE CUTTINGS IN ROCK - SECTION

LIVE POLE CUTTINGS

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NORTHERN DRAINAGE RESTORATION PLANTING

Figure 6

Planting Details and Notes

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