FINAL REPORT

NASA Ames Research Center

Moffett Field Storm Water Retention Pond Tidal Restoration Feasibility Study

May 2005

BROWN AND CALDWELL

In association with
Philip Williams & Associates, LTD. ❖ HT Harvey & Associates ❖ GAIA Consulting Inc.

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ACRONYMS AND ABBREVIATONS

ACSCE	Annual Comprehensive Site Compliance Evaluation
BAT	Best Available Technology
BC	Brown and Caldwell
BCT	Best Control Technology
BMP	Best Management Practices
Cal-IPC	California Invasive Plant Council
CDFG	California Department of Fish and Game
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
CNDDB	CDFG Natural Diversity Data Base
CNPS	California Native Plant Society
Corps	U.S. Army Corps of Engineers
CWA	Clean Water Act
cy	cubic yard(s)
DDT	dichloro-diphenyl-trichloroethane
EDS	Environmental Data Solutions
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FESA	Federal Endangered Species Act
FRP	Facility Response Plan
ft	foot (feet)
GAIA	GAIA Consulting, Inc.
GIS	Geographic Information Systems

ACRONYMS AND ABBREVIATONS (continued)

HSPF	Hydrologic Simulation Program – Fortran
HTH	H.T. Harvey & Associates
MEP	maximum extent practicable
mg/L	milligrams per liter
MHHW	mean higher high water
MHW	mean high water
MLLW	mean lower low water
MROSD	Mid-peninsula Regional Open Space District
MS4	Municipal Separate Storm Sewer System
MSL	Mean Sea Level
MTL	Mean Tide Level
NASA	National Aeronautics and Space Administration
NAVD	North American Vertical Datum of 1988
NE Basin	Northeast Basin
NGVD	National Geodetic Vertical Datum of 1988
NOAA-COOPS	National Oceanic and Atmospheric Administration – Center for Operational Oceanographic Products and Services
NPDES	National Pollutant Discharge Elimination System
NWS	National Weather Service
O&M	Operations and Maintenance
PCB	polychlorinated biphenyls
PET	potential evapotranspiration
PMT	Project Management Team
ppt	parts per thousand
PWA	Philip Williams & Associates, Ltd.
RWQCB	Regional Water Quality Control Board
San Jose	San Jose International Airport
SBSPRP	South Bay Salt Pond Restoration Project
SCVWD	Santa Clara Valley Water District
SFO	San Francisco International Airport
Site 25	Superfund Site 25
South Bay	South San Francisco Bay
SPCC	Spill Prevention, Control, and Countermeasures
SSC	suspended sediment concentrations
SWMP	Storm Water Management Plan/Program
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
SWRP	Storm Water Retention Pond
SWSB	Storm Water Settling Basin
TA	Tucker & Associates
USFWS	U. S. Fish and Wildlife Service
USGS	United States Geological Survey

Table E-1. Alternatives Evaluation Matrix

	Alternative Rating				
	1a	**1b**	**2a**	**2b**	**3**
Primary Objectives	**No Action (Existing Conditions)**	**No Action (Removal of MROSD parcel)**	**Stevens Creek Expansion**	**NE Basin Restoration**	**Full Tidal Restoration**
Storm Water Management	High (3)	Medium (2)	Medium (2)	Low (1)	Not Achievable (0)
Biological Habitat					
Balanced Biological Habitat	Low (1)	Low (1)	Medium (2)	High (3)	Medium (2)
Salt Marsh Habitat	Low (1)	Medium (2)	Medium (2)	Medium (2)	High (3)
Nuisance Species Management	Low (1)	Low (1)	High (3)	High (3)	Medium (2)
Public Access – Bay Trail	High (3)	High (3)	High (3)	Medium (2)	Low (1)
Cost Effectiveness	Not Achievable (0)	Low (1)	High (3)	Medium (2)	Low (1)
Total Score[a]	8	8-9	13	10-11	6-7

[a] Total scores are shown as a range to reflect the two different biological habitat scores, based on the two slightly different habitat objectives.

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SECTION 1

INTRODUCTION AND OVERVIEW

1.1 Project Objective

The overall purpose of this study is to assess the technical and fiscal feasibility of restoring the NASA Ames Research Center (Moffett Field) Storm Water Retention Pond (SWRP), Figure 1-1, to tidal marsh. Over the last several years, various proposals have been made to restore portions or all of the approximately 213-acre SWRP to tidal salt marsh. These proposals include one by the Mid-peninsula Regional Open Space District (MROSD) and another by Save the Bay. The SWRP is adjacent to Pond A2E, which is part of the South Bay Salt Pond Restoration Project (SBSPRP), and to Stevens Creek, which is managed for flood control by the Santa Clara Valley Water District (SCVWD).

The feasibility assessment of restoring the Moffett Field SWRP will be integrated into the larger planning and decision-making process of the SBSPRP, as Moffett Field is considered a "related project." Planning for the restoration of the SWRP must be integrated with the SBSPRP long-term plan for Pond A2E and plans for a future flood control levee. An integrated assessment will also allow for a broader context to make decisions about the appropriate habitat mix for the site.

1.2 Description of Project Site

Moffett Field is located in South San Francisco Bay (South Bay), California, and is bordered by the towns of Mountain View on the western side and Sunnyvale on the eastern side and by U.S. Highway 101 on the southern side. The SWRP is the northern portion of Moffett Field (Figure 1-1). It is bordered to the west by Stevens Creek Shoreline Nature Study Area and to the north by inactive salt pond A2E, which is currently part of the Don Edwards National Wildlife Refuge and included within the SBSPRP boundary. The SWRP is enclosed by levees separating the site from Stevens Creek, Pond A2E, the Moffett Field airstrip, and the Eastern and Western Diked Marshes. The airstrip and the diked marshes border the SWRP to the south.

The Moffett Field watershed consists of about 1,690 acres and is divided into two drainage areas – the Eastern and Western Drainage Systems (Figure 1-2). The Western Drainage System, which discharges into the SWRP, is the focus of this analysis. The majority of storm water from the Western Drainage System is discharged at the Moffett Field site boundary into two 42-inch pipes, which flow north toward a settling basin to the south of the Eastern Diked Marsh. From the settling basin, storm water is discharged into the Eastern Diked Marsh. From there, the storm water is drained by three 48-inch culverts under North Perimeter Road to the SWRP.

Exec. Summary

EXECUTIVE SUMMARY

The overall purpose of this study is to assess the technical and fiscal feasibility of restoring the Moffett Field Storm Water Retention Pond (SWRP) to tidal salt marsh. As part of the restoration feasibility study, Brown and Caldwell, Philip Williams & Associates, H.T. Harvey & Associates, and GAIA Consulting, Inc., (Project Team) evaluated existing conditions, identified opportunities and constraints, developed alternatives, and evaluated the alternatives against a set of project objectives.

Existing Conditions

Existing SWRP conditions were evaluated with respect to topography, groundwater, storm water hydrology, physical processes, and biological functions and values. The NASA Ames Research Center (Moffett Field) watershed consists of 1,690 acres, divided into Eastern and Western Drainage Basins. The majority of the storm water runoff from the Western Drainage Basin currently discharges to the SWRP, via a settling basin and the Eastern Diked Marsh. A small portion of the Western Drainage Basin runoff flows to the Western Diked Marsh and into the SWRP. The SWRP has no outlet and generally fills up with storm water runoff over the wet season (winter and early spring) and then empties, primarily through evaporation, during the dry season (summer and fall). During very wet years in the past, storm water runoff from the site has occasionally exceeded the capacity of the SWRP and, to avoid overflows, NASA has had to install temporary pumps to remove water from the SWRP and pump it directly to Stevens Creek.

Topography. Topographic data collected by NASA in 1992 were supplemented by a ground survey performed by PWA in July 2004 to provide spot checks on the NASA data, particularly for key locations. Some relatively significant discrepancies between the 1992 and 2004 data sets exist which could indicate subsidence over time. However, the amount of SWRP subsidence cannot be accurately deduced, as the lowest points in the SWRP (borrow ditches) were not surveyed during the 1992 survey. The typical bed elevation of the SWRP is presently -1 to -2 feet and the low points in the perimeter levees around the SWRP are 4 feet (NAVD 1988 vertical datum).

Groundwater. The water table at the Moffett Field site is relatively high, on the order of -2 to -3 feet NAVD. Therefore, groundwater levels are anticipated to be within 1 to 2 feet of the bed of the SWRP.

Storm Water Storage. The entire SWRP encompasses 213 acres, including a 54-acre parcel owned by the Mid-Peninsula Regional Open Space District (MROSD), a 56-acre NE Basin, and a 103-acre Central Basin. The three components of the SWRP are hydraulically connected with one another, but the NE and Central Basin are separated by a low-lying levee. Altogether, the SWRP currently provides approximately 900 acre-ft of storage volume for storm water, with a water surface elevation of 4 ft NAVD, or the height of the low points in the levees. The three components of the SWRP provide storage volume as follows: MROSD - 200 acre-ft, NE Basin - 249 acre-ft, and Central Basin - 454 acre-ft. The Eastern and Western Diked Marshes provide additional storm water storage volume, above and beyond the SWRP, totaling approximately 57 acre-ft.

Storm Water Runoff. A hydrologic model (Hydrologic Simulation Program – Fortran or HSPF) was applied to the Moffett Field site using a 56-year period of record (1948 – 2003) to simulate historic storm water flows from the site. Rainfall data from the Moffett Field and San Jose stations were used, along with estimates of impervious area on the site, to predict storm water runoff volumes. Evapotranspiration data from sources near the Moffett Field site were used to estimate losses from the SWRP. No site-specific data were available to calibrate the model. Uncertainties associated with the input data, particularly for evapotranspiration and impervious area, were quantified and model results have been presented as ranges. The range of model predictions associated with evapotranspiration data and impervious surface area variability were plus or minus 40% and 12%, respectively. Under existing SWRP conditions, the model predicts a range of zero to 11 overflow events over the 56-year period of record, depending on the evapotranspiration range of data.

Physical Processes. Tide data from the vicinity of the Moffett Field site indicate that if tidal circulation were re-introduced to the SWRP, tidal elevations (e.g., Mean Higher High Water level of 7.6 feet) would be high enough to inundate much of the Moffett Field site, unless levees were created to separate the SWRP from upland areas. The far South Bay is typically a depositional environment with easily resuspended sediments and relatively high suspended sediment concentrations (e.g., as high as 1,000 mg/L or more), due to the strong influence of wind-wave driven sediment resuspension.

Biological Functions and Values. Historic biological surveys for the Moffett Field site and surrounding area were augmented by a reconnaissance-level biotic survey performed by HT Harvey in June, 2004. An existing habitat map for the project area was updated and expanded to include Stevens Creek, based on site surveys performed in July 2004. The project site currently includes a diverse mosaic of biotic habitats, including non-tidal open water, diked salt marsh, salt marsh/freshwater seasonal wetland transition, freshwater marsh, salt pan, peripheral halophyte, coyote brush scrub, non-native herbaceous vegetation, and developed areas. Existing wildlife and vegetation were described for each of the habitat types. Based on the existing habitat, several special-status plant and animal species could potentially occur at the project site.

Opportunities and Constraints

A number of opportunities and constraints were identified for the Moffett Field site related to storm water hydrology, physical processes, and biological functions and values. Several possible opportunities to address storm water capture and storage needs were identified, but the Moffett Field site is also quite constrained by a relatively high ground water level, limited undeveloped area in the watershed for storm water storage, and high potential for upland flooding with relatively flat, low topography of the site. Some sort of storm water management facility, either the existing SWRP or a comparable facility, is needed to capture and store storm water runoff from the Moffett Field site, and NASA has set an objective to limit pumping of the SWRP to no more frequently than one year in five.

A few opportunities for tidal connection to the SWRP were identified, via Stevens Creek and via Pond A2E of the South Bay Salt Pond Restoration Project (SBSPRP). Natural sedimentation over time or on-site fill could be used to raise ground elevations on the site to support a tidal marsh environment. However, because the site has subsided seven to nine feet below the typical natural marshplain elevation of MHHW (7.6 ft NAVD), a considerable amount of sediment would be required to restore the entire area to tidal marsh. The SWRP site provides biological opportunities for shorebirds and waterfowl, potential recovery of the salt marsh harvest mouse, restored habitat for the California Clapper Rail, restored transitional upland habitat, and restored riparian habitat.

Invasion of perennial pepperweed and/or *Spartina alterniflora* (smooth cordgrass) were identified as significant potential constraints.

Restoration Alternatives

Opportunities and constraints were applied by the Project Team to help frame three restoration alternatives, including no action, partial tidal restoration, and full tidal restoration. Variations of the no action and partial tidal restoration alternatives were also assessed. Brief summaries of each of the alternatives follow.

Alternative 1 – No Action

Alternative 1a - Existing Conditions. This alternative represents no change in the current site condition, and was considered as a baseline only for comparison to other actions.

Alternative 1b - Removal of the MROSD Parcel from Storm Water Storage. NASA has agreed to discontinue use of the MROSD parcel for storm water retention in the future, if a levee were to be constructed by MROSD or the U.S. Army Corps of Engineers (Corps) as part of the SBSPRP, to isolate the MROSD parcel from the SWRP. Tidal salt marsh/upland transition habitat would be provided by constructing a gently sloped fill area along the outboard side of the new flood control levee going from MHHW to the levee crest. Alternative 1b would result in a reduction of the available storage volume of the SWRP, together with the Western and Eastern Diked Marshes, from approximately 960 acre-ft to 760 acre-ft.

If tidal action were introduced at the existing grades, the site would be under approximately 5 ft of sea water on average during a normal tidal cycle and the vast majority of the site would be under water even during low tide. In addition, preliminary sedimentation modeling results indicate that natural sedimentation would take approximately 6-12 years to raise site elevations by 5 to 7 ft to a level suitable for salt marsh vegetation establishment. Additional sediment could be imported to increase the rate of tidal salt marsh habitat establishment, but this would be very difficult logistically and could be prohibitively expensive.

Alternative 2 – Partial Restoration

Alternative 2a - Stevens Creek Expansion. The eastern levee between Stevens Creek and the SWRP (MROSD parcel) would be removed to allow flows into the MROSD parcel and development of tidal marsh. Stevens Creek would be widened by removing the eastern levee beginning slightly south of Moffett Field's perimeter road. It is assumed that as part of SBSPRP a new levee, to be constructed by the Corps or others, would be angled to the north-northeast across the northwest corner of the Western Diked Marsh. This alternative would result in restoration of tidal salt marsh at the current NASA Ames Plant Engineering yard in the northwest corner of the Moffett Field property. Tidal salt marsh/upland transition habitat, as defined under Alternative 1b, would be provided along the outboard side of the flood control levee that borders Stevens Creek. Alternative 2a would treat storm water runoff in the same way as Alternative 1b and would result in the same reduction of available storm water storage volume, from approximately 960 acre-ft to 760 acre-ft. As described in Alternative 1b, natural sedimentation would take approximately 6-12 years to raise site elevations to a level suitable for salt marsh vegetation establishment.

Alternative 2b - NE Basin Restoration. Alternative 2b would build on Alternative 2a, restoring the NE Basin to tidal salt marsh habitat by breaching the Pond A2E levee. Alternative 2b would result in a reduction of the available storage volume of the SWRP, together with the Western and Eastern Diked Marshes, from approximately 960 acre-ft to 511 acre-ft.

As described in Alternatives 1b and 2a, preliminary sedimentation modeling results indicate that natural sedimentation would take approximately 6-12 years to raise site elevations to a level suitable for salt marsh vegetation establishment.

Alternative 3 – Full Tidal Restoration

Restoration of the entire SWRP (MROSD parcel, Central Basin, and NE Basin) to tidal salt marsh is considered in the "full tidal restoration" alternative. Tidal connectivity would be achieved by removing the Stevens Creek levee and/or the Pond A2E levee, assuming that the SBSPRP provides sufficient tidal connection to Stevens Creek and/or that Pond A2E is restored to tidal salt marsh. A levee, to be constructed by others as part of the SBSPRP, would separate the Western and Eastern Diked Marshes and the remainder of the Moffett Field site from the restored SWRP. Storm water retention volume would essentially be eliminated under this alternative, with only 57 acre-ft of storage volume available in the Western and Eastern Diked Marshes. Storm water runoff from Moffett Field would be pumped to the San Francisco Bay regularly. The Western and Eastern Diked Marshes would be frequently flooded and would hold standing water for much of the winter and upland flooding would be very likely. A loss of existing pond and seasonal brackish marsh habitat functions and values would occur under the full tidal alternative. The biotic habitat would become tidal salt marsh only.

As with the other tidal restoration alternatives, preliminary sedimentation modeling results indicate that natural sedimentation would take approximately 6-12 years to raise site elevations to a level suitable for salt marsh vegetation establishment.

Evaluation of Restoration Alternatives

The feasibility assessment of restoring the Moffett Field SWRP will be integrated into the larger planning and decision-making process of the SBSPRP, as Moffett Field is considered a "related project." Planning for the restoration of the SWRP must be integrated with the SBSPRP long-term plan for Pond A2E and plans for a future flood control levee. An integrated assessment will also allow for a broader context to make decisions about the appropriate habitat mix for the site.

Moffett Field restoration alternatives were evaluated relative to five project objectives, which were based on five SBSPRP objectives that were particularly relevant for the Moffett Field project, including storm water management (aka flood management), biological habitat, nuisance species management, public access (Bay Trail), and cost effectiveness. Several other objectives for the SBSPRP project (i.e., flood management, water and sediment quality, infrastructure, and environmental impact) were less relevant for the Moffett Field project or had insufficient information to assess at this point in the process, and were therefore not evaluated in any detail for this Feasibility Study. Each of the alternatives was evaluated against the five project objectives and rated low (1 point), medium (2 points), or high (3 points) relative to the ability of the alternative to meet the objective. Alternatives not capable of meeting a given objective were rated as not achievable (0). Storm water management is a critical success factor for any alternative. No weightings have been applied to differentiate the relative importance of the various objectives.

Storm Water Management. The hydrologic model developed for the Moffett Field site was used to predict a range of frequency of overflow events associated with each alternative, based on the 56-year period of historical record. In order to provide some freeboard, pumping would likely be required even more frequently than the predicted overflow events. A summary of the model predictions for overflow events follows.

- Alternative 1a: Existing Conditions - overflows during one in every 32 to 56 years
- Alternative 1b: Removal of the MROSD parcel from storm water storage – overflows one in every 5 to 56 years
- Alternative 2a: Stevens Creek expansion - overflows one in every 5 to 56 years
- Alternative 2b: NE Basin restoration – overflows one in every 2 to 4 years
- Alternative 3: Full Tidal Restoration – overflows every year

As noted in the Opportunities and Constraints section, NASA has established an objective to limit pumping events to once every five years. Based on the modeling results, Alternative 1a would meet the NASA pumping objective. Alternatives 1b and 2a would likely meet the objective. Alternatives 2b and 3 would not meet the objective. Alternative 3 would require pumping every year and would lead to significant flooding of the Moffett Field site.

Biological Habitat. The area for each of nine different types of biological habitat was predicted for each of the alternatives. The main difference in biological habitat between the alternatives is that the tidal salt marsh and tidal salt marsh/upland transition habitat increases going from Alternative 1b to 3, while the non-tidal, open water habitat decreases. In addition to considering the broad biological habitat objective as described in Section 5.1, two more specific biological selection criteria were evaluated, as follows.

> ***Balanced Biological Habitat.*** Restore and enhance a balance of both salt marsh habitat and open water/mudflat habitat to improve conditions for salt marsh endemic species as well as for shorebirds and waterfowl. This objective would improve habitat for the federally-listed endangered salt marsh harvest mouse and California clapper rail, the salt marsh wandering shrew (a California species of special concern), and the state-threatened California black rail.
>
> ***Salt Marsh Habitat.*** Restore and enhance salt marsh habitat to improve habitat for endemic salt marsh species including the federally-listed endangered salt marsh harvest mouse and California clapper rail, the salt marsh wandering shrew, and the California black rail.
>
> Depending on the objective, the preferred alternative from a biological perspective would be either Alternative 2b or 3. Alternative 2b would be the preferred alternative to

restore/enhance a balance of both salt marsh and open water habitat. Tidal salt marsh/upland transition habitat has been identified as a critical habitat type for restoration to support the recovery of the salt marsh harvest mouse, salt marsh wandering shrew and California black rail in the San Francisco Bay. Alternative 3 would be the preferred alternative if the primary biological objective were solely to restore salt marsh habitat for the salt marsh harvest mouse and California clapper rail. Alternative 3 provides for a large, continuous band of tidal salt marsh/upland transition habitat. In addition, this alternative would restore the largest surface area of contiguous tidal salt marsh among the alternatives.

Nuisance Species Management. Alternatives 2a and 2b offer the greatest opportunities for cost-effective design and management tools for control of nuisance species, particularly mosquitoes and invasive plants. Alternative 3, full tidal restoration, provides fewer management tools for control of nuisance species since water management is not an option. Finally, Alternatives 1a and 1b do not allow for water level management as a tool, while still retaining the storm water ponds and Western Diked Marsh as havens for mosquitoes and pepperweed.

Public Access (Bay Trail). The most potential for public access (linkage of the Bay Trail adjacent to NASA Ames) is provided by Alternatives 1a, 1b, and 2a. Alternative 2b offers limited public access, as the levee alignment next to the Moffett Field airstrip presents security and public safety issues. Because the levee closely surrounds NASA Ames for Alternative 3, this alternative offers the least potential for public access.

Cost Effectiveness. A comprehensive planning level cost evaluation was conducted (Section 4.5). Capital improvement costs ranged from zero for Alternative 1a to $21.0 million for Alternative 3. Incremental costs of restoration ranged from $31,000 to $98,000 per acre, with Alternative 2a being the most cost-effective.

Recommended Alternative

A summary of ratings for each of the alternatives is presented in the table below. Alternative 2a was rated the highest and is the restoration alternative recommended by the Project Team. This alternative represents a cost-effective approach to restoring tidal salt marsh, creating beneficial biological habitat, and managing for nuisance species while continuing to effectively manage storm water flows.

Legend

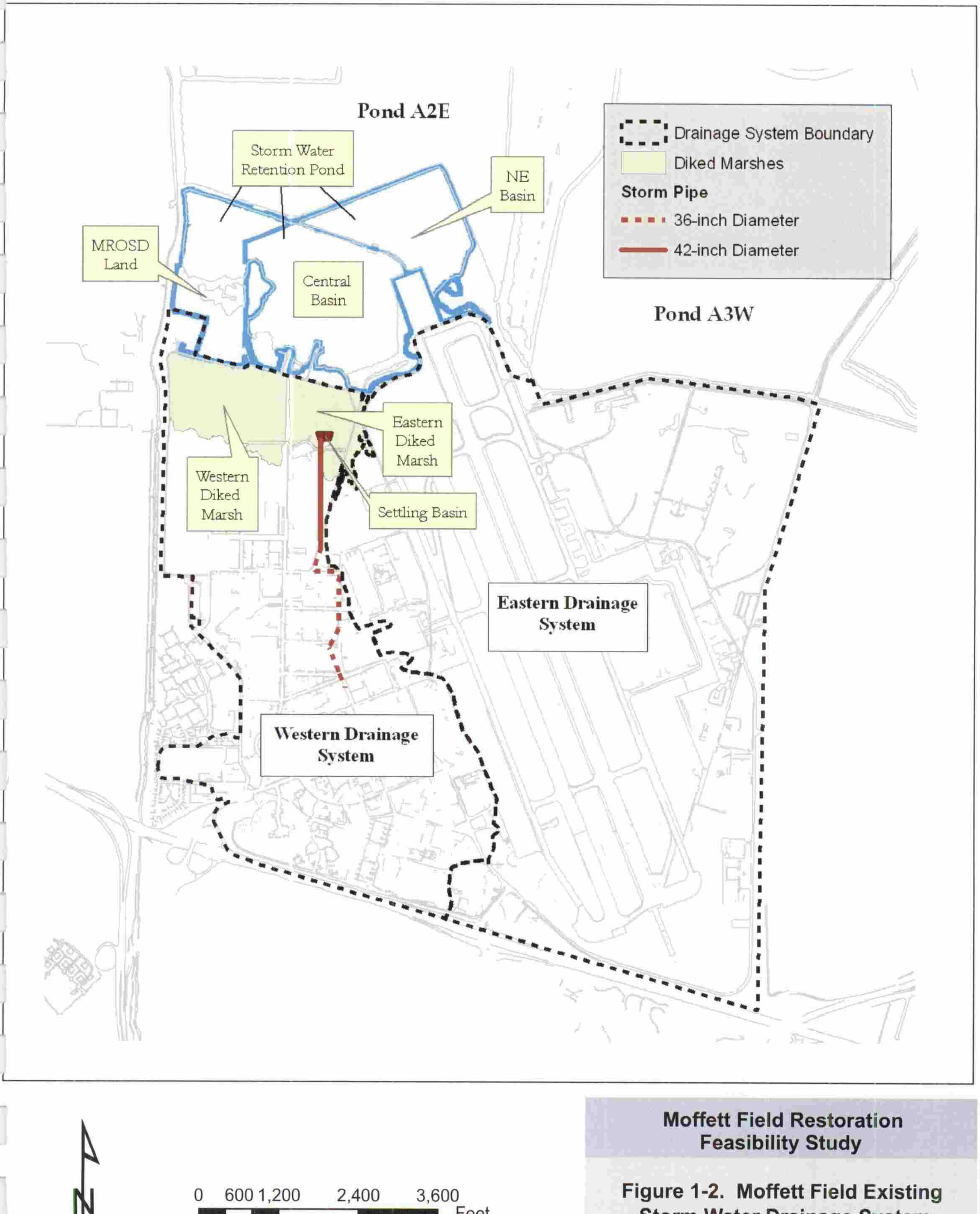
- - - - - - MROSD-Owned portion of SWRP

——— NASA-Owned portion of SWRP

——— NASA Ames Research Center Boundaries

Moffett Field Restoration Feasibility Study

Figure 1-1
NASA Ames Research Center Boundaries



Moffett Field Restoration Feasibility Study

Figure 1-2. Moffett Field Existing Storm Water Drainage System

Project No. 25486

Storm water runoff from a 179-acre area south of the Western Diked Marsh is collected in a separate, smaller storm drainage system. Storm water from this area drains into the Western Diked Marsh and flows into the SWRP through a 10-inch culvert under the North Perimeter Road.

The SWRP has no outfall and during most of the year, water is removed by evaporation and/or percolation only. During the wet season of some years, when flow into the SWRP exceeds the storage capacity, NASA would obtain permission from MROSD to pump water directly into Stevens Creek. A portable emergency discharge pump would be deployed at the northwest corner of the site during high runoff to prevent overtopping of the levees. The pumped water would be discharged into Stevens Creek. In the past, portions of the facility have experienced general flooding due to a combination of inadequate culvert pipe capacity and ground elevations that are low relative to the water level of the SWRP, while the remainder of the Western Drainage System has experienced localized flooding due to inadequate system capacity. Multiple storm drain studies (e.g., (Nolte and Associates Inc. 1998) have been completed within the past 20 years. All agree that major renovation and rehabilitation of the Western Drainage System should occur (National Aeronautics and Space Administration 2002).

A parcel of approximately 54 acres on the western side of the retention pond is owned by the MROSD; the National Aeronautics and Space Administration (NASA) owns the remaining 159 acres[1]. The MROSD portion of the site is partially separated from the rest of the site by a raised peninsula that extends northward from the southern levee approximately two-thirds of the way across the retention pond. There is also a levee separating the western half of the retention pond from the northeast corner of the site to the north of the airstrip, dividing the site into two hydrologically distinct areas. Only a small (~8 ft wide and ~2 ft deep) break in the levee forms the hydraulic connection between these two portions of the retention pond.

The SWRP is a designated Superfund Site (Navy Site 25) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (NASA Ames Research Center 2003). The site is contaminated with chemicals including polychlorinated biphenyls (PCBs), lead, zinc, and dichloro-diphenyl-trichloroethane (DDT). The Navy, who formerly occupied the site for 75 years, is primarily responsible for the Site 25 clean-up. The potential restoration of the SWRP would occur after the Navy clean-up is conducted. Therefore, for the purposes of this feasibility study, it is assumed that the site is uncontaminated.

1.3 Scope of Work

The approach to assessing restoration feasibility was phased, starting with a preliminary assessment that coincided closely with the 9-month effort (completed in October 2004) to develop initial restoration concepts for the SBSPRP. Work on the Moffett Field feasibility study project built directly on SBSPRP efforts, leveraging data collection/information gathering efforts, and overall coordination. Restoration feasibility for the Moffett Field SWRP was considered in the context of the SBSPRP (e.g., decisions about future restoration of Pond A2E directly affect the SWRP). The assessment of feasibility was also tied into the larger decision-making process of the SBSPRP, as the SBSPRP Project Management Team (PMT) integrated the Moffett Field feasibility study alternatives

[1] For the purposes of this feasibility study, land areas owned by MROSD and NASA were approximated using GIS data. A more detailed review of property boundaries is recommended for subsequent phases of this project.

into the SBSPRP initial restoration concepts. Close coordination with the SBSPRP effort was facilitated by the make-up of the Project Team, which includes the same firms and key individuals that make up the SBSPRP Consultant Team: Brown and Caldwell (BC), Philip Williams & Associates, Ltd. (PWA), H.T. Harvey & Associates (HTH), and GAIA Consulting, Inc. (GAIA).

For the Moffett Field feasibility study, the Project Team evaluated three main alternatives – a no action alternative, full tidal restoration, and partial tidal restoration. Partial tidal restoration represents an alternative with less tidally restored area than the full tidal alternative (e.g., restoring half of the SWRP and retaining the other half for storm water retention). The primary focus of the feasibility study was on full tidal restoration, but the analysis and tools developed for the study also enabled some consideration of the partial tidal restoration alternative.

1.4 Report Organization

This report is divided into seven sections, including this introduction. Existing conditions of the site are presented in Section 2. Opportunities and constraints related to the SWRP restoration are discussed in Section 3, which segues into the description of restoration alternatives in Section 4. Section 5 includes the evaluation of alternatives. Sections 6 and 7 provide report references and preparers, respectively.

2

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SECTION 2

EXISTING CONDITIONS

This section contains existing site conditions details with respect to topography, groundwater, storm water hydrology, physical processes, and biological functions and values. The information provided in this section serves as baseline conditions for the feasibility study.

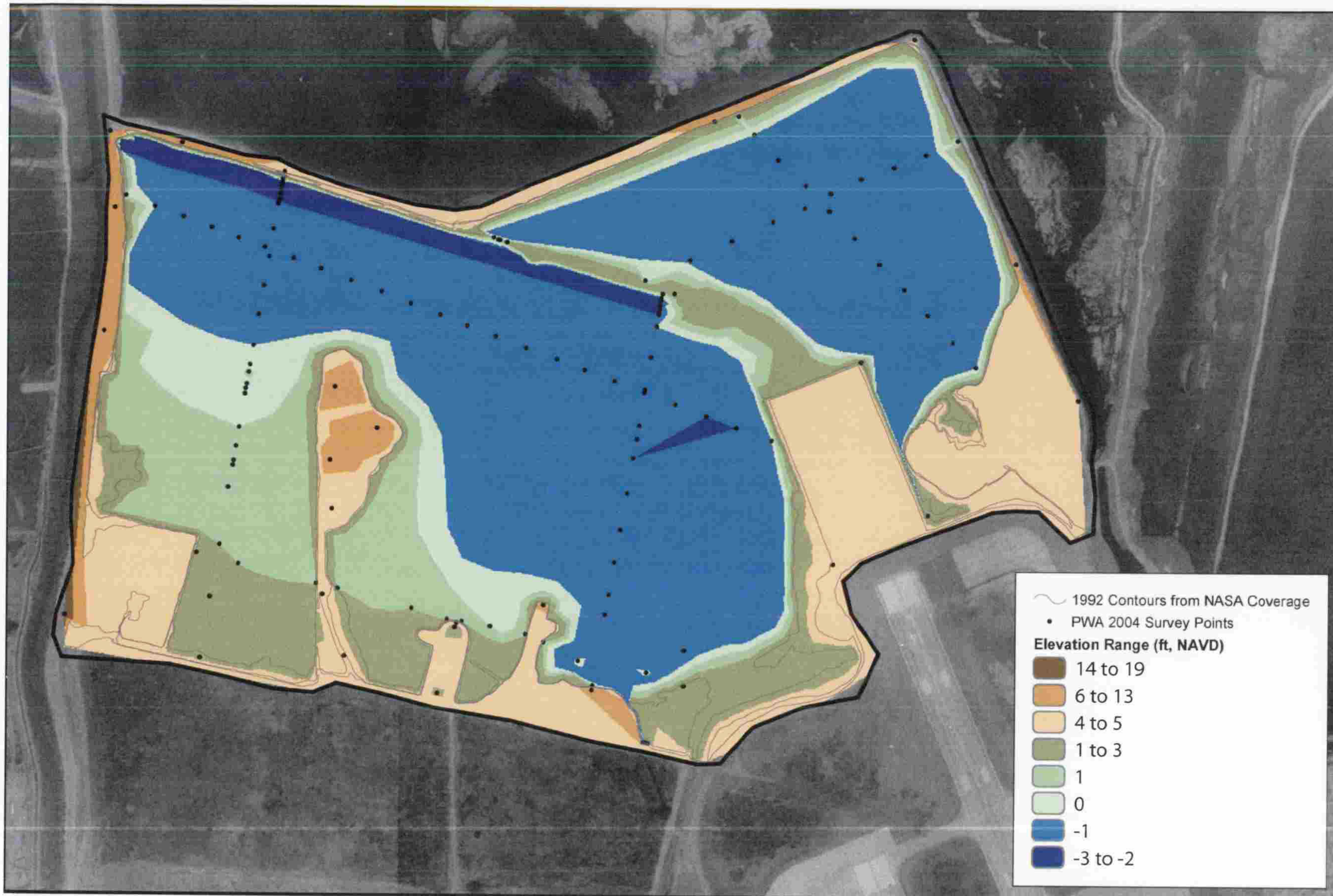
2.1 Topography

Accurate site topographic coverage is fundamental for the development of storm water and hydrodynamic models, as well as for the analysis of marshplain evolution. Two sets of site topographic data were merged for this study – (1) Geographic Information Systems (GIS) topographic data (circa 1992, based on the North American Vertical Datum of 1988 [NAVD]), which were supplied by NASA staff, and (2) ground survey elevation data collected by PWA during July 2004 (Figure 2-1).

Tidal monitoring data were collected from two locations in Stevens Creek during January to April 2004 and used in the study to assess the tidal signal in areas adjacent to the SWRP. To optimize consistency, the 2004 topographic ground survey referenced the same datum (National Geodetic Vertical Datum of 1929 [NGVD]) as the tidal monitoring data.

PWA surveys were made using reference benchmarks established by Tucker & Associates (TA). TA established benchmarks using SCVWD survey data (Moffatt & Nichol Engineers 2004; Tucker & Associates 2004). SCVWD periodically runs "cross valley loops" to establish control in the South Bay and correct for the effects of subsidence. SCVWD reports control points and benchmarks in the South Bay in NGVD and NAVD. The 2004 tidal monitoring data in Stevens Creek were collected using TA benchmarks in NGVD (Moffatt & Nichol Engineers 2004; Tucker & Associates 2004). To remain consistent with the tidal datum, PWA surveyed in NGVD benchmarks at the SWRP, and then uniformly corrected elevations to NAVD using a conversion factor of 2.75 feet (ft). PWA obtained benchmark data, as well as the correction from NGVD to NAVD, from Tom Tucker (Professional Land Surveyor) of TA (Tucker 2004).

The average elevation for the levee separating the site from Pond A2E, the airstrip, and the diked marshes is approximately 5 ft NAVD with low points (overflow elevation) at 4 ft NAVD. The surveyed cross-sections from the SCVWD and the spot elevations collected in 2004 show that the average elevation of the levee separating the SWRP from Stevens Creek is approximately 13 ft NAVD. However, toward the southwestern corner of the SWRP, a grade break occurs in the levee where the levee top elevation increases to 19 ft NAVD.



Source: NASA (1992 contours, Image).

Moffett Field Restoration Feasibility Study

Figure 2-1. SWRP Topographic Data Used for Moffett Field Restoration Feasiblity Study

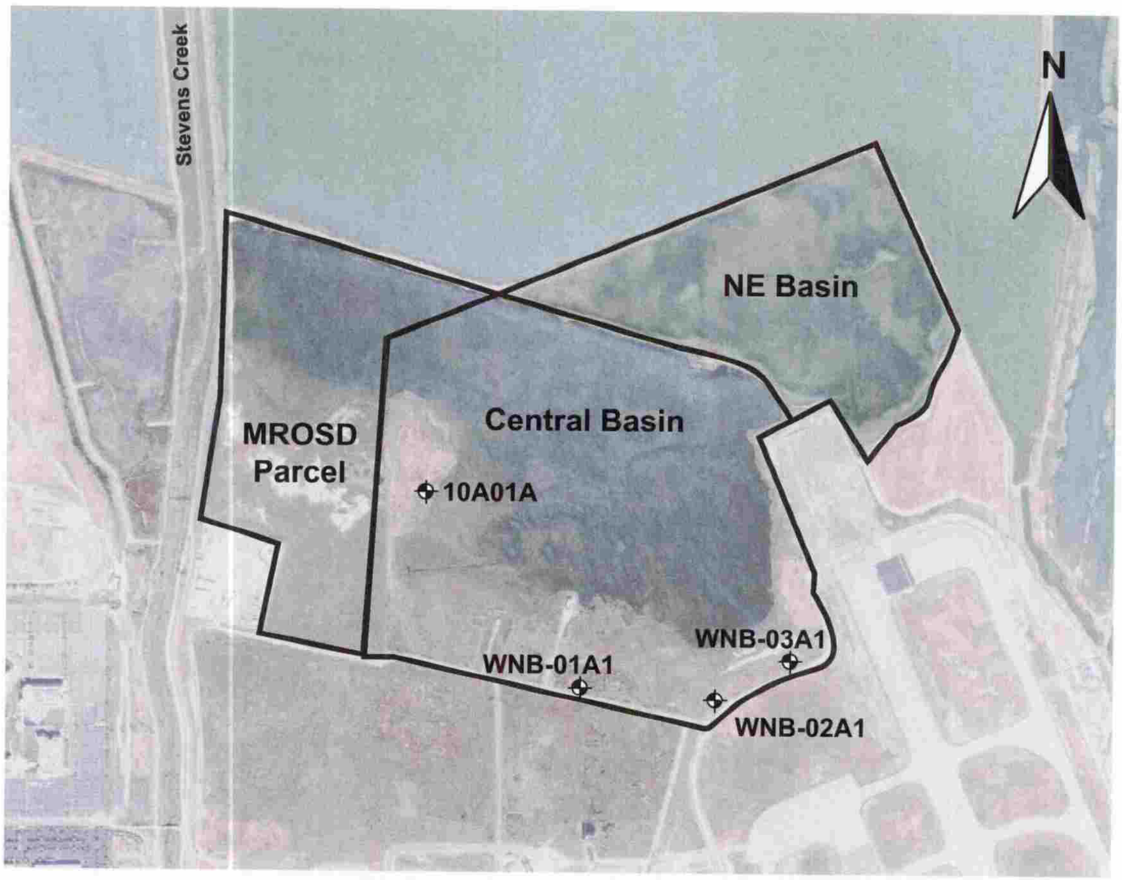
For the purpose of this study, the SWRP is considered an area that can be divided into three sub-areas (Figure 2-2), including: (1) approximately 54 acres of land owned by MROSD (MROSD parcel), (2) approximately 56 acres of land in the northeast corner of the SWRP (NE Basin), and (3) approximately 103 acres in the center of the SWRP (Central Basin). The bed of the MROSD parcel and Central Basin lies at an average elevation of -1 to -2 ft NAVD, sloping gently upward from the northern to the southernmost portion of the SWRP where a small area rests at an elevation of 2 to 3 ft NAVD (Table 2-1, Figure 2-1). The NE Basin, separated by an internal levee (~2 ft NAVD), also lies at an elevation of -1 to -2 ft. The results from the 2004 ground survey show that the MROSD parcel, Central Basin, and NE Basin are below the elevation of mean lower low water (MLLW), which is 0.05 ft NAVD (Table 2-1). The amount of site subsidence cannot accurately be deduced based on the comparison of the 1992 NASA topographic data to the 2004 PWA survey, as borrow ditch elevations were not collected in 1992.

As previously mentioned, the use of accurate topographic data is important for determining the current site elevations for storm water and hydrodynamic models and for the analysis of marshplain evolution. Lack of complete site topographic data could have significant implications for the assessment of existing conditions and the prediction of potential future restoration scenarios. Though the merged topographic data are sufficient for this feasibility study, it is recommended that a detailed topographic survey is conducted during any potential restoration planning/design to guarantee full accuracy.

Table 2-1. Key Site Elevations at Moffett Field

	1992 Elevation (ft NAVD)	2004 Elevation (ft NAVD)
Typical Bed Elevation in Central Basin and MROSD parcel	2	-1 to -2
Typical Bed Elevation in NE Basin	NA	-1 to -2
Average Perimeter Levee Elevation (N, S, E border)	5	5
Low Perimeter Levee Elevation (N, S, E border)	4	4
Average Internal Levee Elevation (between Central and NE Basins)	2	2
Average Perimeter Levee Elevation (Stevens Creek border)	10 to 12	13
Average Elevation at Eastern and Western Diked Marshes	3	NA

Source: NASA topographic coverage of Moffett Air Strip (1992), PWA Field Survey (2004).
Note: NASA 1992 coverage did not include areas lower than 2 ft NAVD (e.g., borrow ditches).



Moffett Field Restoration Feasibility Study

Figure 2-2
SWRP Sub-areas and Groundwater Well Locations

Project No. 25846

2.2 Groundwater

The groundwater table at Moffett Field is relatively high. Groundwater elevations were evaluated for four wells in the SWRP (Figure 2-2) through groundwater level hydrographs (Figure 2-3). The hydrographs show that groundwater levels tend to fluctuate seasonally typically from -2 to 3 ft mean sea level (MSL) (NAVD). Seasonal variations would be dampened and unidentifiable if groundwater levels were tidally influenced; thus, no apparent tidal influence is evident in the hydrographs. The average bed elevation of the SWRP is -1 to -2 ft NAVD. Therefore, the current groundwater table is in close proximity to the existing elevation of the SWRP bed. If the water levels for a given sampling event are considered spatially, they show a northerly gradient that would result in groundwater flow toward the Bay. This is consistent with the general trend that groundwater in the region flows toward the Bay.

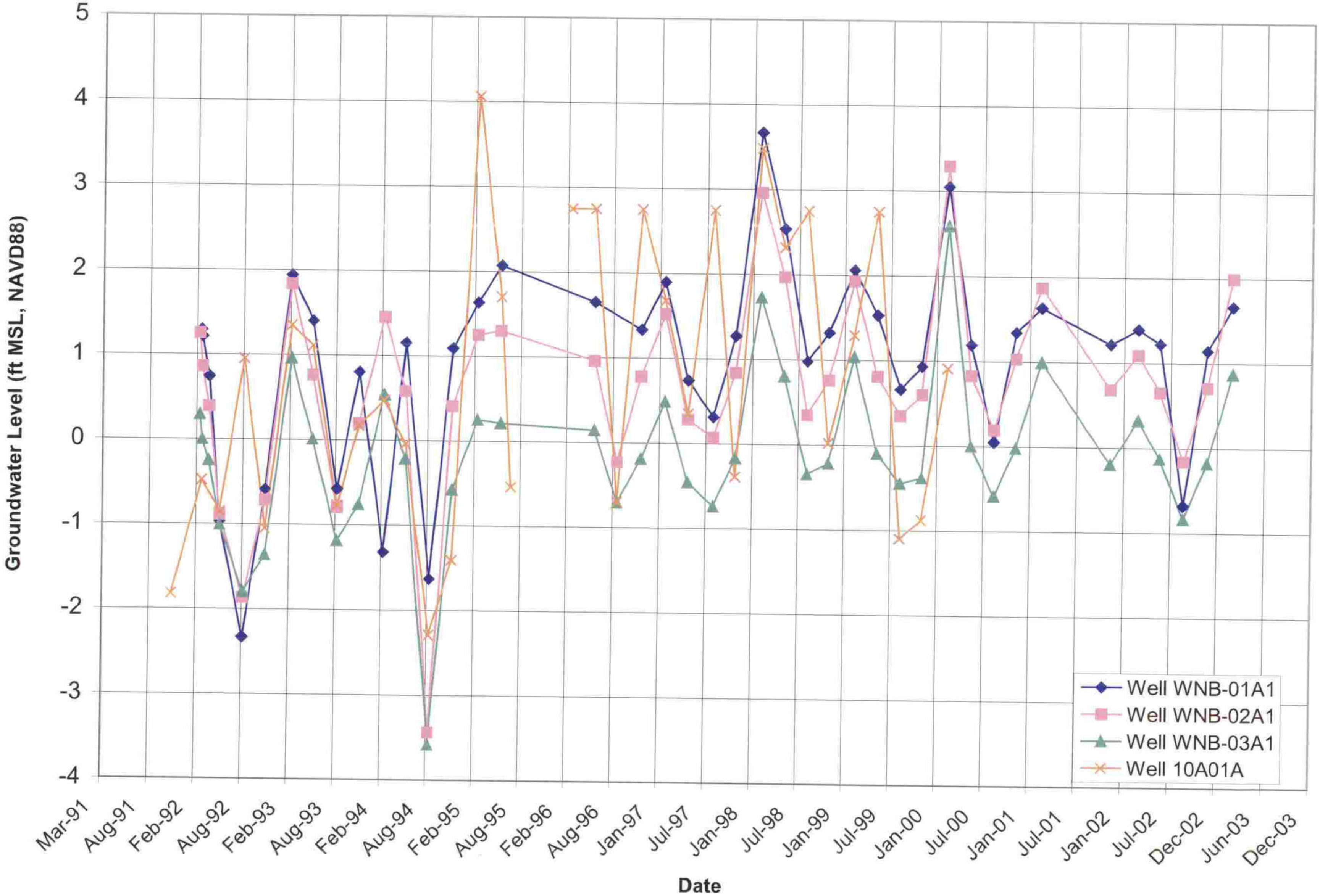
2.3 Storm Water Hydrology

2.3.1 Storm Water System Description

The Moffett Field watershed consists of approximately 1,690 acres. Storm water from the site drains via two separate systems - the Western Drainage System and the Eastern Drainage System. The areas drained by these systems are shown in Figure 1-2.

The Eastern Drainage System, consisting of approximately 1,105 acres, discharges to the Northern Channel and ultimately flows into the San Francisco Bay. The storm water runoff from this area does not contribute any runoff to the Moffett Field SWRP; thus, the Eastern Drainage System is not evaluated within this analysis.

The Western Drainage System, which includes approximately 585 acres of the site, discharges to the 213-acre SWRP. Storm water flows generally follow a south to north pathway as they are conveyed from the Western Drainage System to the SWRP. The flow discharges into a 36-inch diameter main trunk located near the center of the Western Drainage System. Storm water continues to flow north in this main trunk collecting flows from other smaller storm water pipes along the route. Further north, the 36-inch diameter trunk discharges to two 42-inch diameter main trunks. These trunks flow north (also collecting additional flow from smaller storm water pipes along the route) and discharge to a settling basin. Storm water discharges from the settling basin to the Eastern Diked Marsh, from which the storm water flows by gravity to the SWRP. A portion of the site along the western boundary drains to the Western Diked Marsh, where it flows by gravity to the SWRP. The SWRP has no outfall, but water exits the facility through evaporation. In addition, water can be pumped under permit from MROSD from the western edge of the SWRP to Stevens Creek during particularly wet conditions when the amount of storm water nearly reaches the pond storage capacity. Over the last 20 years, water has been pumped infrequently, approximately two times (Olliges 2004).



Moffett Field Restoration Feasibility Study

Figure 2-3
SWRP Existing Groundwater Levels

2.3.2 Storm Water Storage Volume

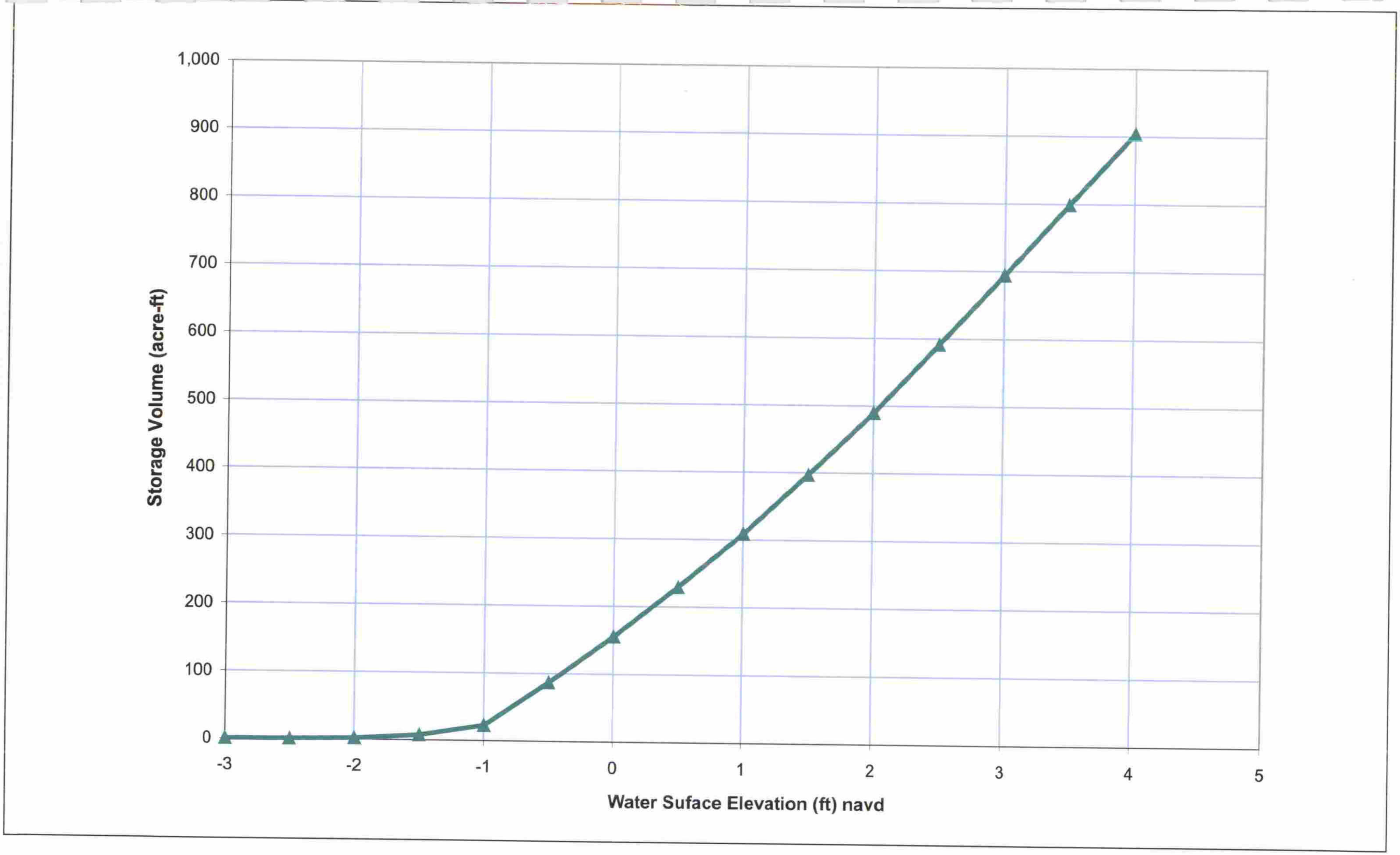
The entire SWRP (213 acres) provides approximately 900 acre-ft of storage volume for storm water, based on the stage/storage relationship described below and a water surface elevation of 4 ft NAVD. The SWRP includes approximately 54 acres of land owned by MROSD (200 acre-ft of storage at a water surface elevation of 4 ft NAVD), a 56-acre NE Basin (249 acre-ft of storage), and a 103-acre Central Basin (454 acre-ft of storage). The Eastern and Western Diked Marshes provide additional storm water storage volume, above and beyond the SWRP, totaling approximately 57 acre-ft.

The Moffett Field topographic data, augmented by PWA surveys, were used to create the stage/storage relationship used in the storm water hydrology model (Table 2-2 and Figure 2-4). As shown in Figure 2-4, the maximum storage volume estimated for the entire SWRP is approximately 900 acre-ft. Flooding is anticipated to occur above this level of storage (at an elevation of 4 ft NAVD).

The only discharge simulated from the SWRP is the evaporation occurring from the water surface of the pond. Infiltration from the bottom of the pond was not simulated due to high groundwater levels (Section 2.2) and low permeability of soils (Jones and Stokes 1999).

Table 2-2. Moffett Field SWRP Stage/Storage Relationship

SWRP STAGE (ft)	WATER SURFACE ELEVATION (ft-NAVD)	AREA (acres)	CUMULATIVE VOLUME (acre-ft)
0.0	-3.0	0	0
0.5	-2.5	2	0
1.0	-2.0	6	2
1.5	-1.5	18	7
2.0	-1.0	124	22
2.5	-0.5	133	87
3.0	0.0	144	155
3.5	0.5	153	229
4.0	1.0	173	308
4.5	1.5	181	397
5.0	2.0	201	489
5.5	2.5	205	591
6.0	3.0	207	694
6.5	3.5	210	798
7.0	4.0	213	903



Moffett Field Restoration Feasibility Study

Figure 2-4. SWRP Stage/Storage Relationship

The Western Drainage System of the Moffett Field site was divided into five distinct modeling basins for simulation of the storm water hydrology (Figure 2-5). The division of the basins was based on the storm water drainage network and topography. Basin 5 is the Eastern Diked Marsh. Simulated storm water flow is estimated at the outlet of each basin. The flow estimates allow for an incremental assessment of each basin's contribution to the total Western Drainage System runoff. Additionally, the five basins allow for storm water pipe capacity to be checked at the outlet of each basin.

All basins are simulated to drain to the SWRP (Figure 2-5). Basins 1, 2, and 3 first combine at the settling basin (located in the upstream area of Basin 5) before discharging to the Eastern Diked Marsh, and subsequently to the SWRP via three 48-inch culverts. Storm runoff from Basin 4 drains to the Western Diked Marsh before discharging to the SWRP via one 12-inch culvert.

Meteorological data required for running the hydrologic model include rainfall and evapotranspiration time series. Data from National Weather Service (NWS) monitoring stations at Moffett Field, San Jose International Airport (San Jose), Alamitos, and San Francisco International Airport (SFO) were used to run the model. Rainfall data used in the model were from the San Jose and Moffett Field stations. The Moffett Field data were daily and were supplemented with hourly San Jose data. The time series data sets have periods of record that are sufficient to allow for continuous hydrologic simulations of extended time periods. The periods of record range from March 1945 to January 2004 for both rainfall data sets. These long-term data sets allow for hydrologic conditions at the Moffett Field site (including the SWRP) to be analyzed for a wide range of meterological conditions, as experienced over the period of record. Detailed descriptions of the meteorological time series and their role in the HSPF model are available in Appendix B.

Four evaporation data sets were available for the area from: (1) California Irrigation Management Information System (evapotranspiration), (2) SFO, calculated using the Jensen method (potential evapotranspiration, PET), (3) SFO, calculated using the Penman method (pan evaporation with a pan coefficient of 0.7), and (4) Alamitos (pan evaporation with coefficient of 0.6 to 0.8). The storm water hydrology model included the two most extreme evapotranspiration data sets to produce a range of results. The Alamitos data was used for a representative low evapotranspiration, while the SFO data, calculated using the Penman method, was used for a representative high evapotranspiration. The uncertainty of the storm water model results related to the evapotranspiration was quantified (Figure 2-6).

The amount of impervious area included in the storm water model is another source of uncertainty. As a rough estimation of the uncertainty contributed by impervious area, sensitivity of the model results to variations in impervious surface area was tested by adding and removing 5% of the total impervious area. Relative to error contributed by the variable evapotranspiration, impervious area error is insignificant (Figure 2-7). The range of model predictions associated with evapotranspiration data and impervious surface area variability were plus or minus 40% and 12%, respectively.

2.3.3 Storm Water Runoff

The Project Team developed a hydrologic model of the Moffett Field Western Drainage System to use as a tool to help understand the feasibility of restoring the SWRP. Investigating whether storm water management could be maintained at current levels with implementation of proposed restoration alternatives was of particular concern. The hydrologic model was created using the Hydrologic Simulation Program – Fortran (HSPF), which is a widely applied model for assessing wet weather runoff in developed areas. In addition to modeling the runoff from land surfaces using the hydrologic equations, HSPF also simulates the operation of the SWRP as a storm water retention facility.

HSPF uses a large array of hydrologic equations to model the movement of moisture in an area. These hydrologic equations contain numerical constants *(parameters)*, the values of which are specific to the characteristics of the area being modeled. Meteorological time series data are required as input to the model for solution of the hydrologic equations. The standard method for model construction involves setting parameters' values based on well-known information or physically measured data wherever possible and obtaining meteorological data from nearby monitoring stations.

The Project Team defined the model parameters based on two available sources: EPA Basins Technical Note 6[1] and the model parameter values contained in the HSPFParm database[2] (Appendix A). These sources provided reasonable parameter values for an initial assessment. Parameter values were refined using applicable GIS data detailing land surface, topography, and storm drainage provided by NASA staff. Typically, parameter values are further refined through model calibration, whereby simulated results are compared to measured storm flow or pond stage data. Depending on the results of this comparison, model parameters are adjusted to produce simulated results close to the measured data. There are no available storm flow or pond stage data for the Moffett Field project site; thus, calibration to measured data is not possible.

Model parameters are applied to the different land surfaces within the project site for simulation of storm water runoff. For the Moffett Field storm water modeling, the Project Team chose to use two broad land surface types for simulation of runoff – impervious and pervious. Areas considered to be impervious surfaces are assumed to allow minimal infiltration and contribute to storm water runoff. Estimation of land surface types within the project site was completed by using planimetric GIS data of building outlines, pavement outlines, and landscaped surfaces provided by NASA staff. Orthophotographs, provided by Moffett Field, were available for limited areas and allowed for a more detailed analysis of some Western Drainage System areas. The orthophotographs were used to supplement the planimetric GIS land surface type estimation. Based on this analysis, approximately 384 acres of impervious and 201 acres of pervious land surfaces were simulated for the Western Drainage System.

[1] EPA Basin Technical Note 6 is titled, "Estimating Hydrology and Hydraulic Parameters for HSPF." It contains tables listing the typical range and limits of parameter values.
[2] HSPFParm is a database of HSPF parameters from previously completed analyses throughout the United States. For this work, parameters were taken from a study completed for Calabazas Creek, which is near Moffett Field.

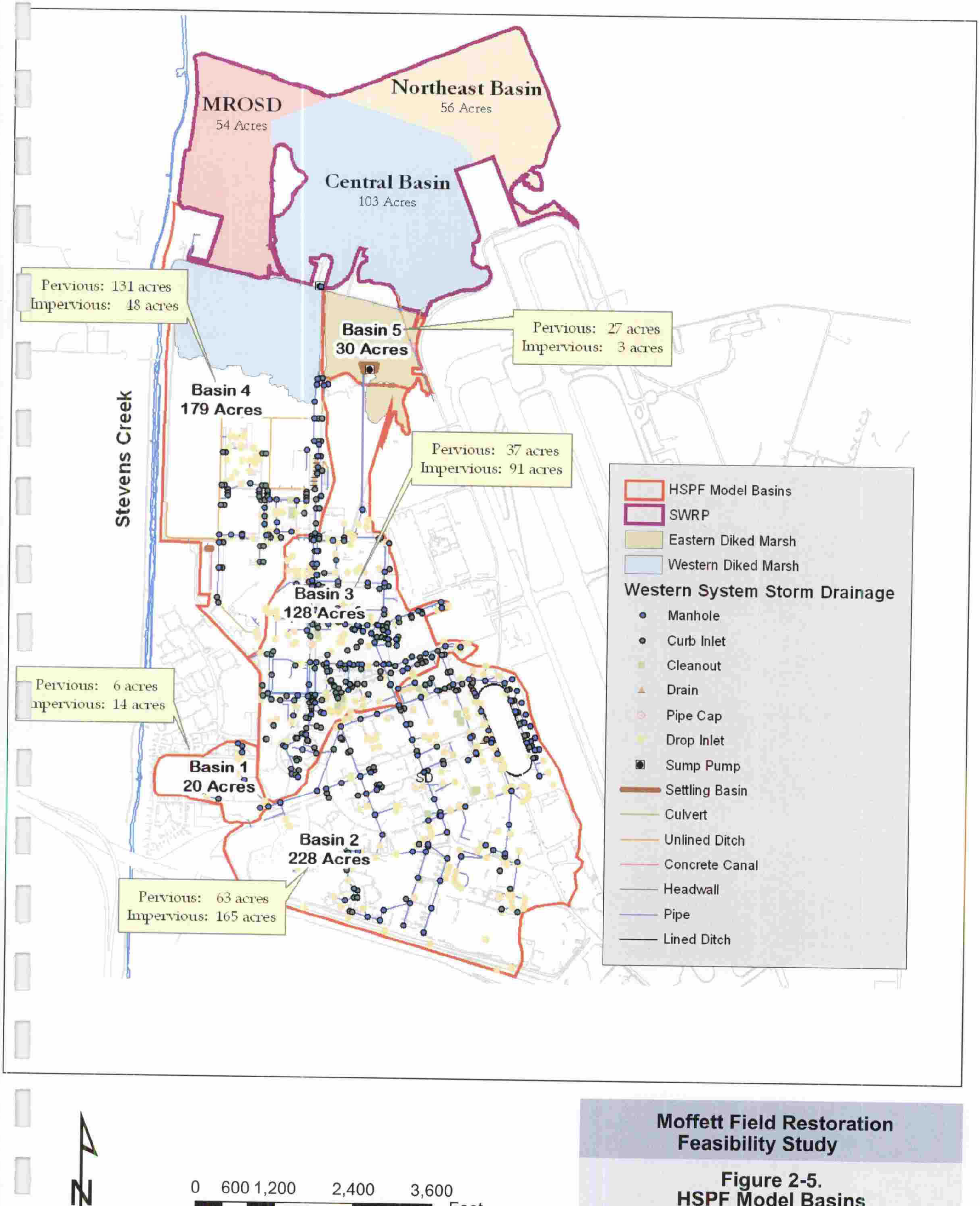


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Figure 2-5. HSPF Model Basins for the Western Drainage System

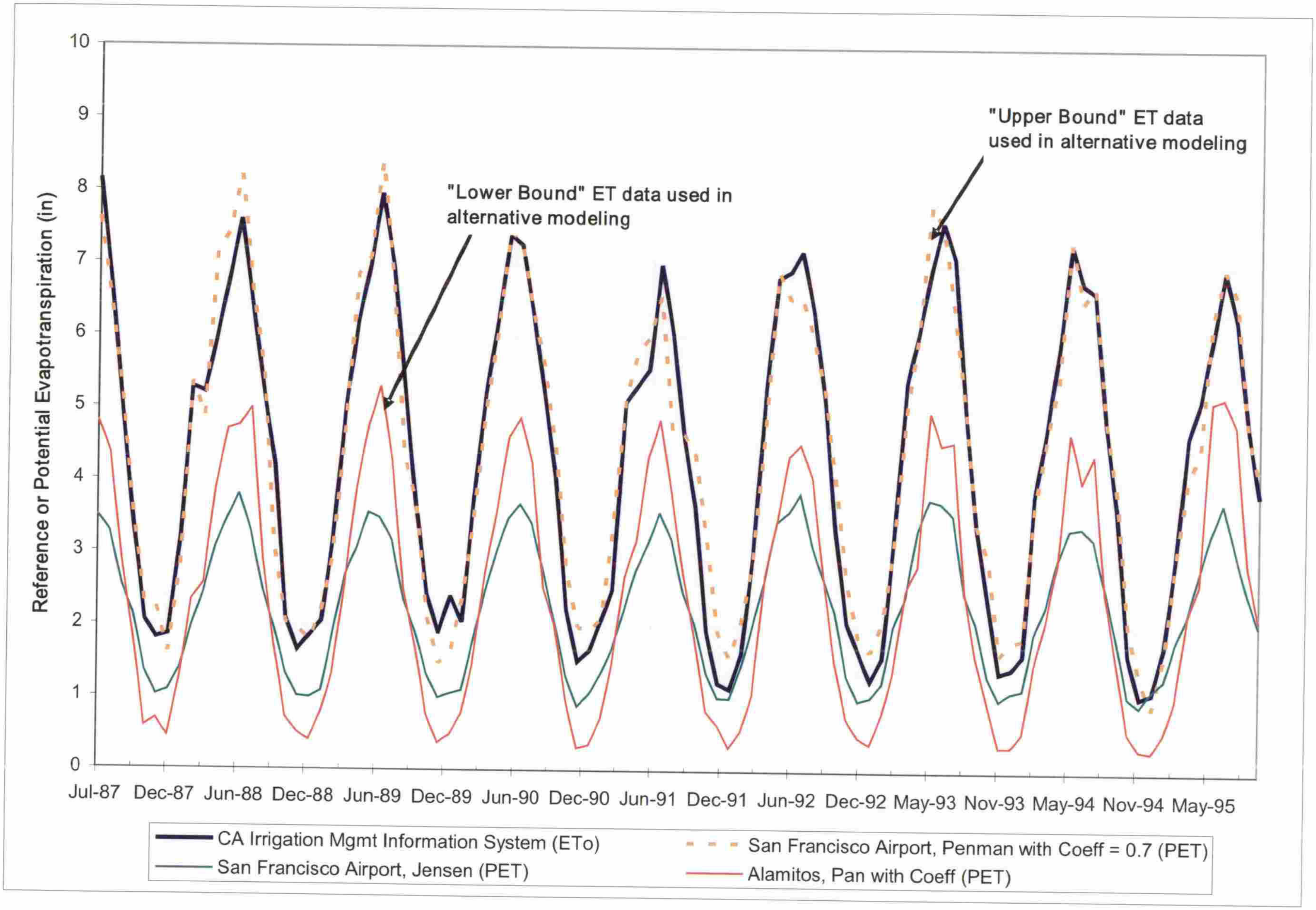

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Figure 2-6
Storm Water Hydrology Model Evapotranspiration Data Variation

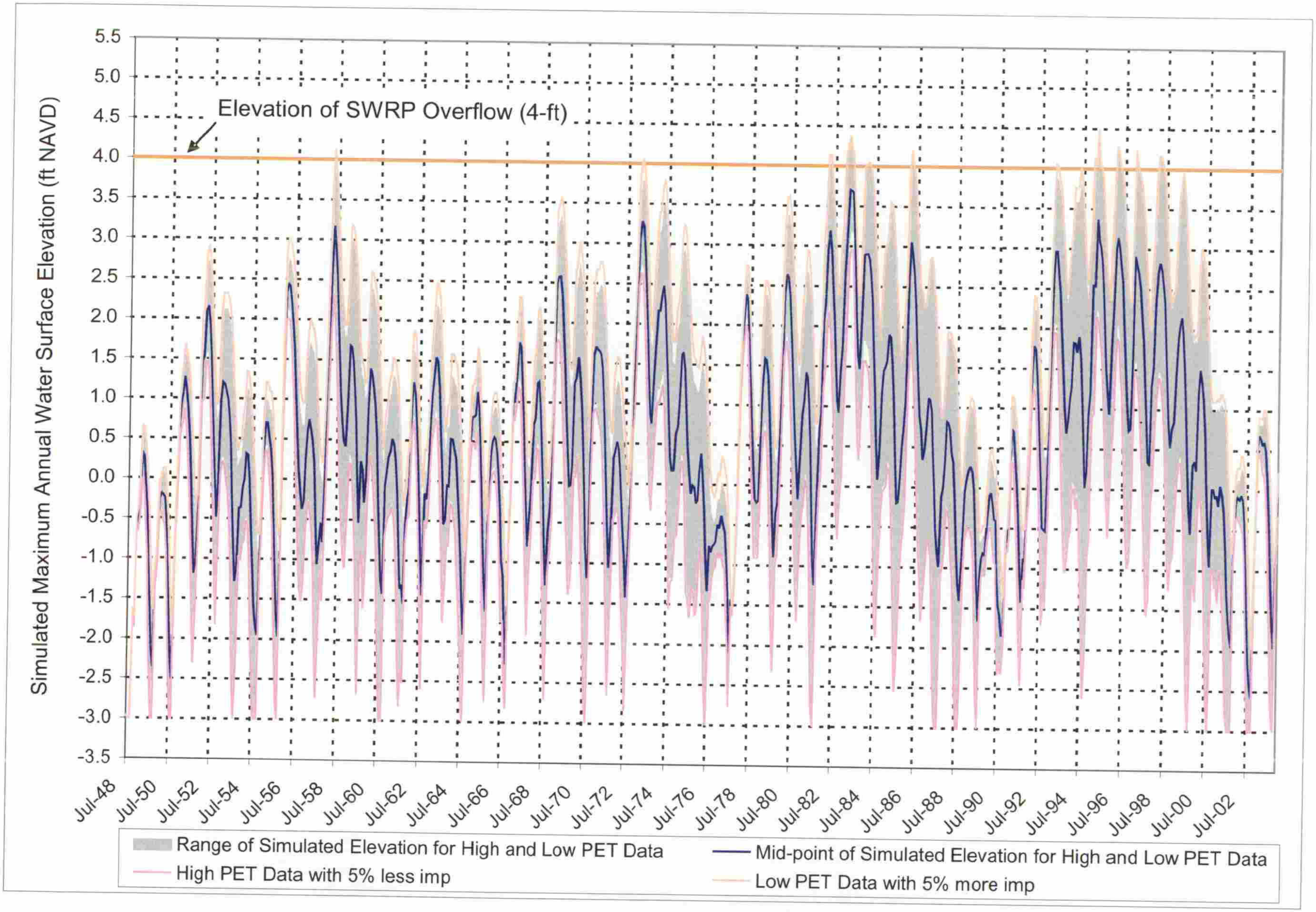

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Figure 2-7
Storm Water Hydrology Model Existing Conditions
Simulated Water Surface Elevation

Additional model input potentially contributing to the uncertainty of storm water model results includes precipitation and pervious land surfaces. It is often difficult to quantify the error in precipitation data sets because rainfall gauges where the data are collected rarely have published calibration information from which to discern error. In addition, error is typically contained in precipitation data because measured data collected at one point is assumed to represent rainfall over a basin for modeling purposes, and sometimes this basin is located at some distance from the rainfall gauge. The error associated with the rainfall gauge being remote to the model basin was addressed in this study by comparing coincident rainfall data from San Jose and Moffett Field. This comparison indicated the two sets of precipitation data were similar (Appendix B). Therefore, it was assumed that the spatial variability of the measured rainfall was acceptable for this application. The error associated with measurement of rainfall was not quantified nor was the error related to applying point rainfall measurements over an area. In the presence of model calibration data, the impact of these errors could be more fully understood by investigating the source of differences between measured and simulated storm water flows. At present, based on professional judgment, these precipitation errors are believed to be minimal.

Uncertainty of model results due to pervious land surfaces are from either an inaccurate accounting of pervious land area or misrepresentation of the hydrologic behavior of pervious land within the model. The latter uncertainty is not readily quantified in the absence of calibration data detailing the runoff of water from pervious surfaces. Uncertainty associated with estimating an inaccurate amount of pervious land is quite possible for this project as both impervious and pervious land surfaces were derived from GIS data, which were not subjected to quality checks. Thus, it is recognized that there may be uncertainty based on usage of the land surface data. However, based on professional judgment, this uncertainty is minimal. The volume of storm water runoff simulated by the model is relatively insensitive to the area of pervious land surface. In particular, the model has less sensitivity to pervious land surface than impervious land surface. Because the amount of error contributed by impervious area is relatively insignificant (Figure 2-7), variation in pervious land surface areas is assumed to be of minimal consequence to model results.

Initial long-term simulations of the Moffett Field HSPF model result in SWRP stages as shown in Figure 2-7. The figure also shows error ranges for variable evapotranspiration and impervious area used in the model. The Moffett Field Western Drainage System was simulated for the periods of 1948 to 2003. Considering the mid-range of the evapotranspiration data sets, the SWRP does not overflow for the simulated period of record. However, maximum annual water surface elevations in the SWRP reach approximately 3 ft six times during the simulated time. These two high water events support anecdotal evidence provided by NASA staff that temporary pumps transferring water from the SWRP to Stevens Creek for flood control were operated twice during approximately the past 20 years (Olliges 2004). This agreement between the simulated results and anecdotal evidence assumes the temporary pumps are operated when the SWRP water surface reaches a relatively high elevation (approximately 3 ft NAVD), but not necessarily the overflow level (4 ft NAVD).

The elevation of the water surface in the SWRP was further analyzed for specific years in the simulated period of record. In particular, specific years were chosen based on a statistical analysis of the annual rainfall totals (based on water years, October to September) for the data used in simulating the Moffett Field storm water system (Appendix B). Based on the statistical analysis, three years representing wet, dry, and average rainfall conditions were selected. The results of the statistical analysis are presented in Figure 2-8.

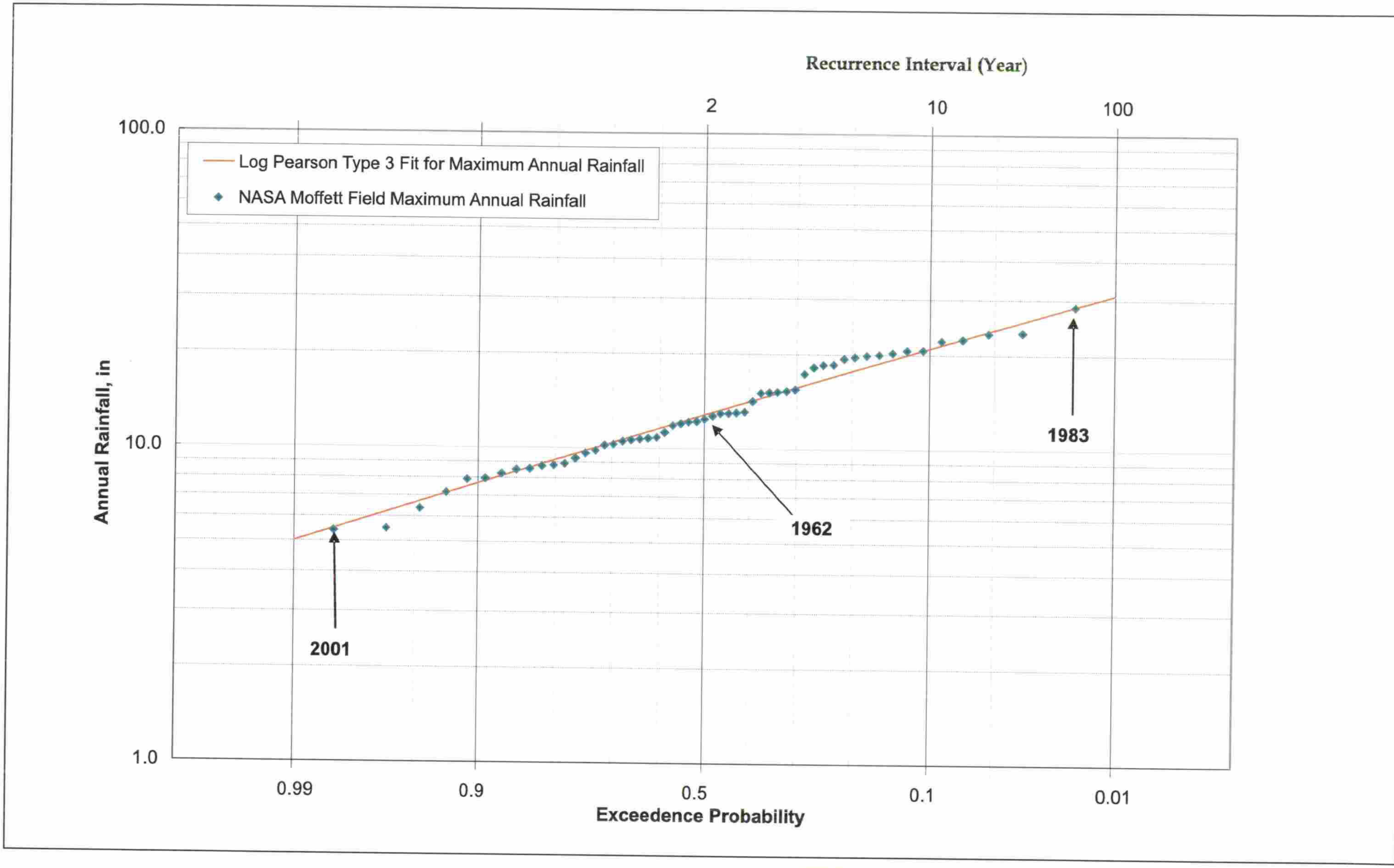

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Figure 2-8. Frequency of Maximum Annual Rainfall Used in Storm Water Hydrology Model

As shown in the figure, the annual rainfall totals were also fit to a Log Pearson Type III distribution to present the probability rainfall exceedance for any given year in comparison to wet, dry, and average rainfall years.

The purpose of selecting the specific years for analysis was to examine how the SWRP water surface changes throughout the year given certain conditions. The resulting SWRP water surface elevation for dry, average, and wet conditions is presented in Figures 2-9, 2-10, and 2-11 respectively.

2.4 Physical Processes

Physical processes addressed in this section include site drainage and tidal hydrology of Stevens Creek. This information is required to determine the existing potential for natural sedimentation to increase the SWRP elevation to marshplain elevation in a potential restoration scenario.

The Project Team collected numerous studies for use in evaluating existing conditions at the site, including a previous PWA study of Stevens Creek tidal hydrology for the Stevens Creek Tidal Marsh Enhancement Project, the most recent topographic information for the Research Center (National Aeronautics and Space Administration 1992; Philip Williams & Associates 1997), and cross-sections for Stevens Creek (National Aeronautics and Space Administration 1992; Philip Williams & Associates 1997), Figure 2-12, (http://www.valleywater.org/).

PWA obtained 2004 tidal monitoring data for this project from Environmental Data Solutions (EDS) (Kulpa 2004). Tidal datums and heights for the nearby Palo Alto Yacht Harbor station were collected from the National Oceanic and Atmospheric Administration-Center for Operational Oceanographic Products and Services (NOAA-COOPS) website (http://www.co-ops.nos.noaa.gov/). United States Geological Survey (USGS) Open-File Report #03-312 (Buchanan and Ganju 2001) provided information for suspended sediment concentrations (SSC) in the South Bay. Figure 2-13 displays the existing tides in Stevens Creek.

2.4.1 Site Drainage

The levees surrounding the Moffett Field SWRP site isolate the retention pond from incoming surface flow from Stevens Creek and Pond A2E. The site is seasonally inundated primarily by freshwater storm runoff from the Eastern and Western Diked Marshes that drain Moffett Field. Levee seepage from the A2E salt pond and from Stevens Creek may also be a factor during the winter months. The pond dries through evaporation and minimal infiltration in the summer months except for the flow from the Navy's Westside Aquifer Treatment System. The northwestern corner of the site stores water for longer time periods due to lower elevations in this portion of the site. The levee elevations were confirmed during site reconnaissance.

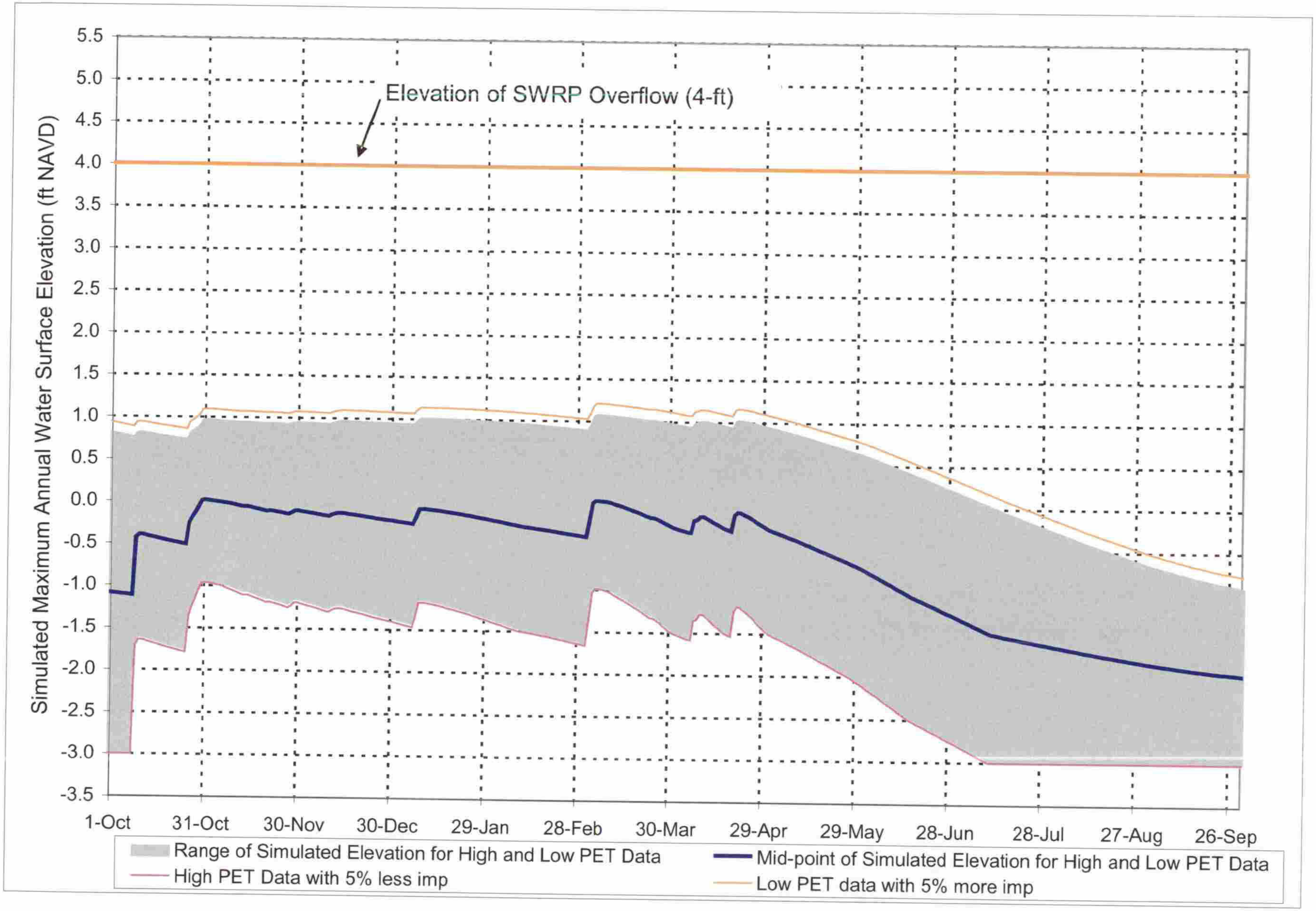

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Figure 2-9
Storm Water Hydrology Model Existing Conditions
Simulated Water Surface Elevation during a Dry Year (Water Year 2001)

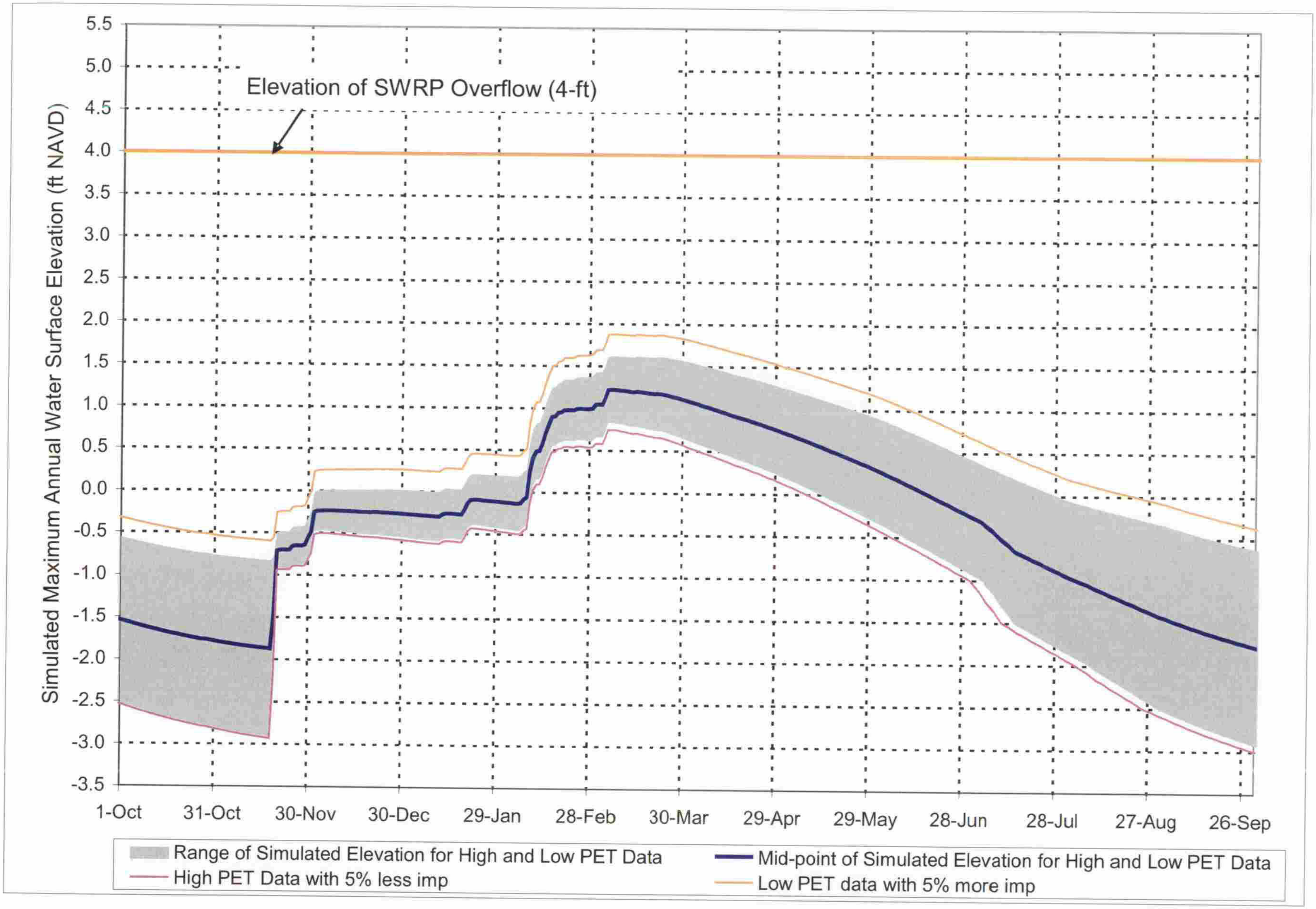

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Figure 2-10
Storm Water Hydrology Model Existing Conditions
Simulated Water Surface Elevation During an Average Year (Water Year 1962)

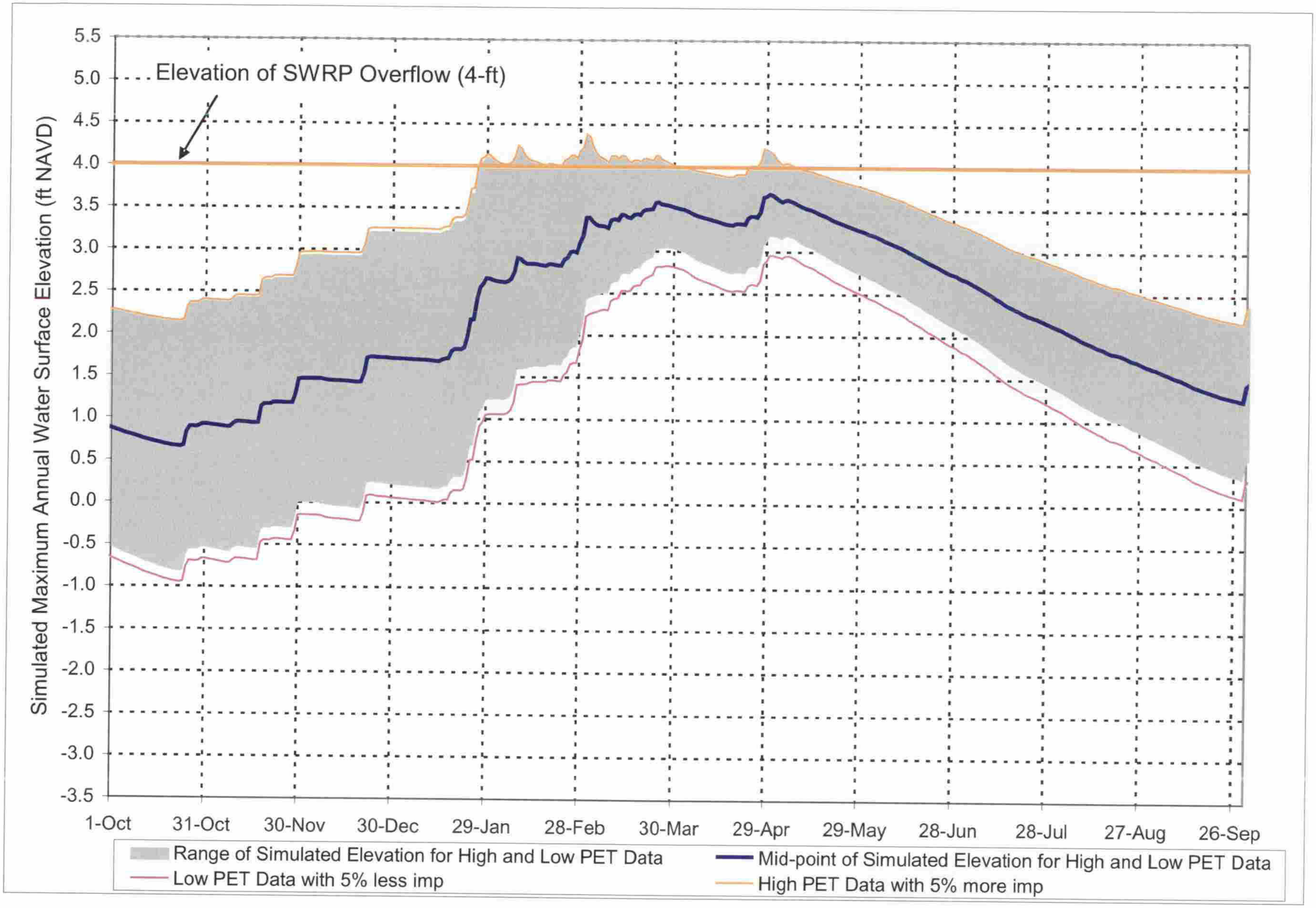

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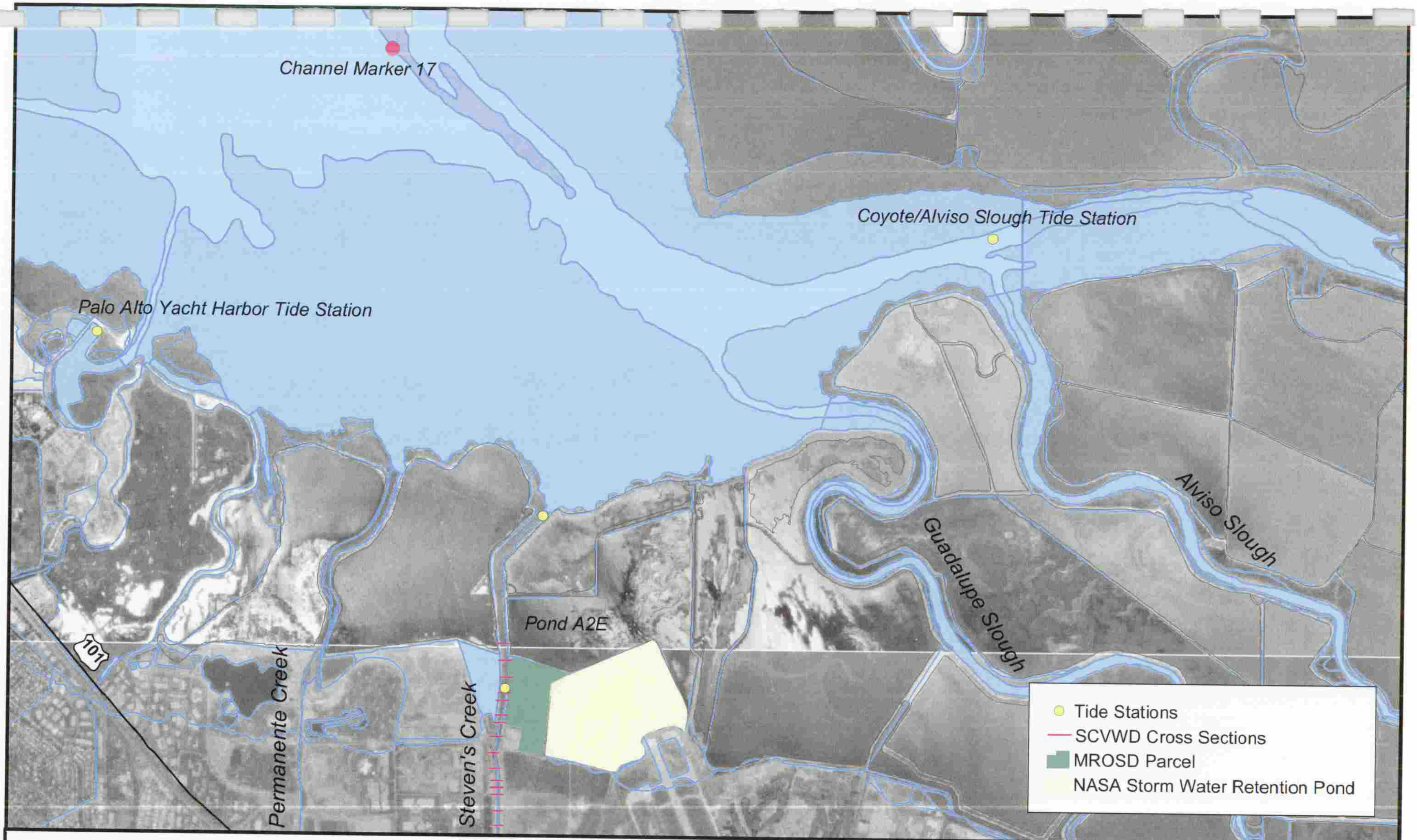
Figure 2-11
Storm Water Hydrology Model Existing Conditions
Simulated Water Surface Elevation During a Wet Year (Water Year 1983)



Source: Cargill (salt ponds), EDAW (highways), SFEI (baylands, modern rivers), NOAA COOPS (Palo Alto and Coyote/Alviso tide stations), SCVWD (cross sections) PWA (topography), Environmental Data Solutions (Stevens Creek tide gages).

Note: Stevens Creek, Palo Alto, and Coyote/Alviso Slough tide stations are no longer in operation.

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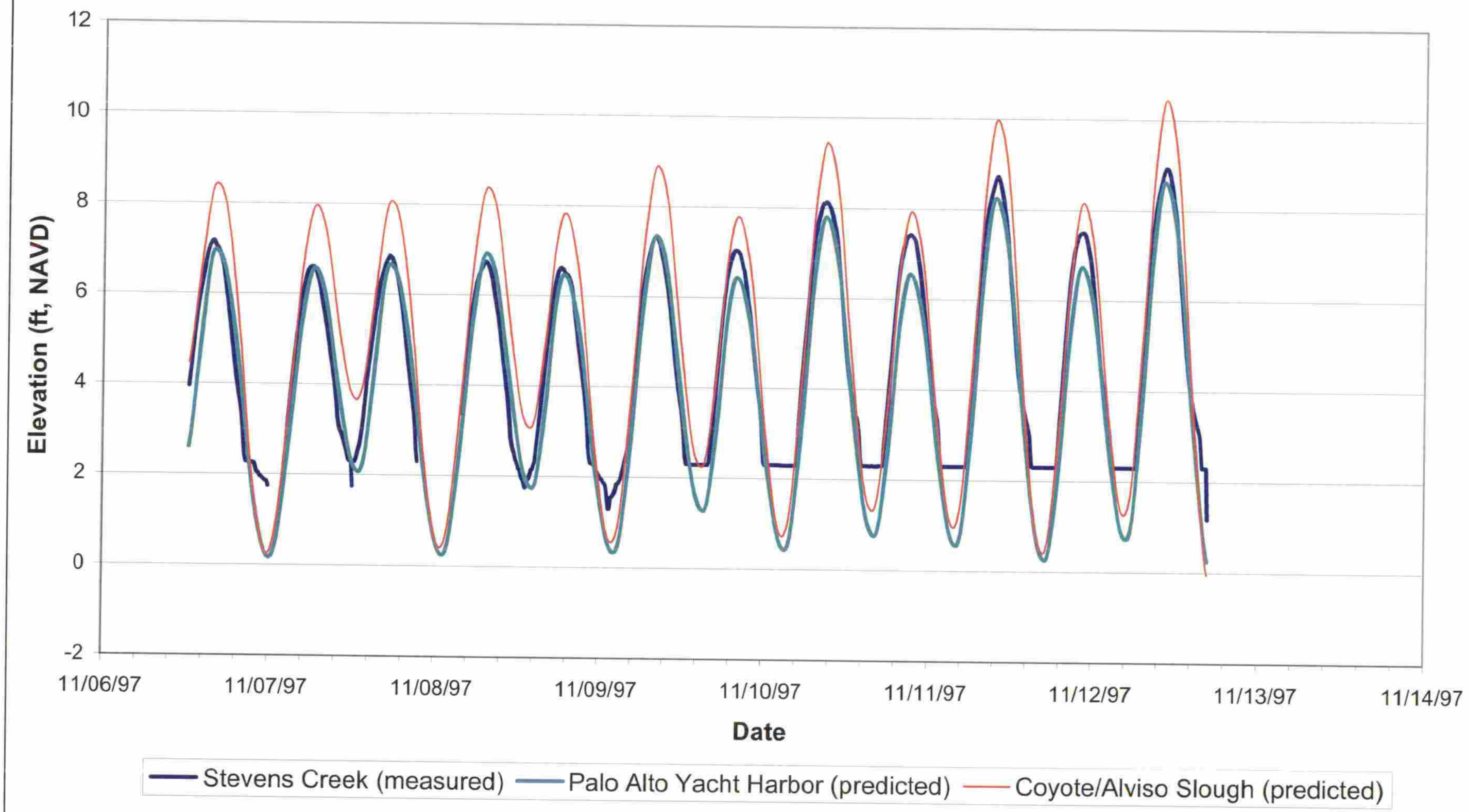
Figure 2-12 Existing Hydrology



Source: Stevens Creek tide data from Stevens Creek Marsh Tidal Enhancement Project (PWA, 1997); Predicted tides from Tides & Currents Pro 2.5 which references NOAA-COOPs Golden Gate tidal station.

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Figure 2-13 Local Tides

2.4.2 Stevens Creek Tidal Hydrology

Stevens Creek drains an 18-mi^2 area (U.S. Geological Survey 2004). The volume of freshwater and sediment from the watershed supplied to Stevens Creek near the Moffett Field site are diminished by the SCVWD Stevens Creek Reservoir (3,138 acre-ft), which is approximately 10 miles upstream of the site. Adjacent to the site, Stevens Creek is a relatively shallow and narrow tidal slough, which contributes seasonal freshwater flow to the South Bay (U.S. Fish and Wildlife Service and California Department of Fish and Game 2003). It is managed as a flood control channel by the SCVWD, which also maintains the levee. Hydraulic modeling performed by SCVWD indicates that the levee along Stevens Creek can contain design flows of approximately 7,500 ft^3/s. The highest peak flow from 1930-1959 (the available period of record) was 1420 ft^3/s (U.S. Geological Survey 2004), so the levee effectively separates Stevens Creek from the retention pond up to very extreme flood conditions.

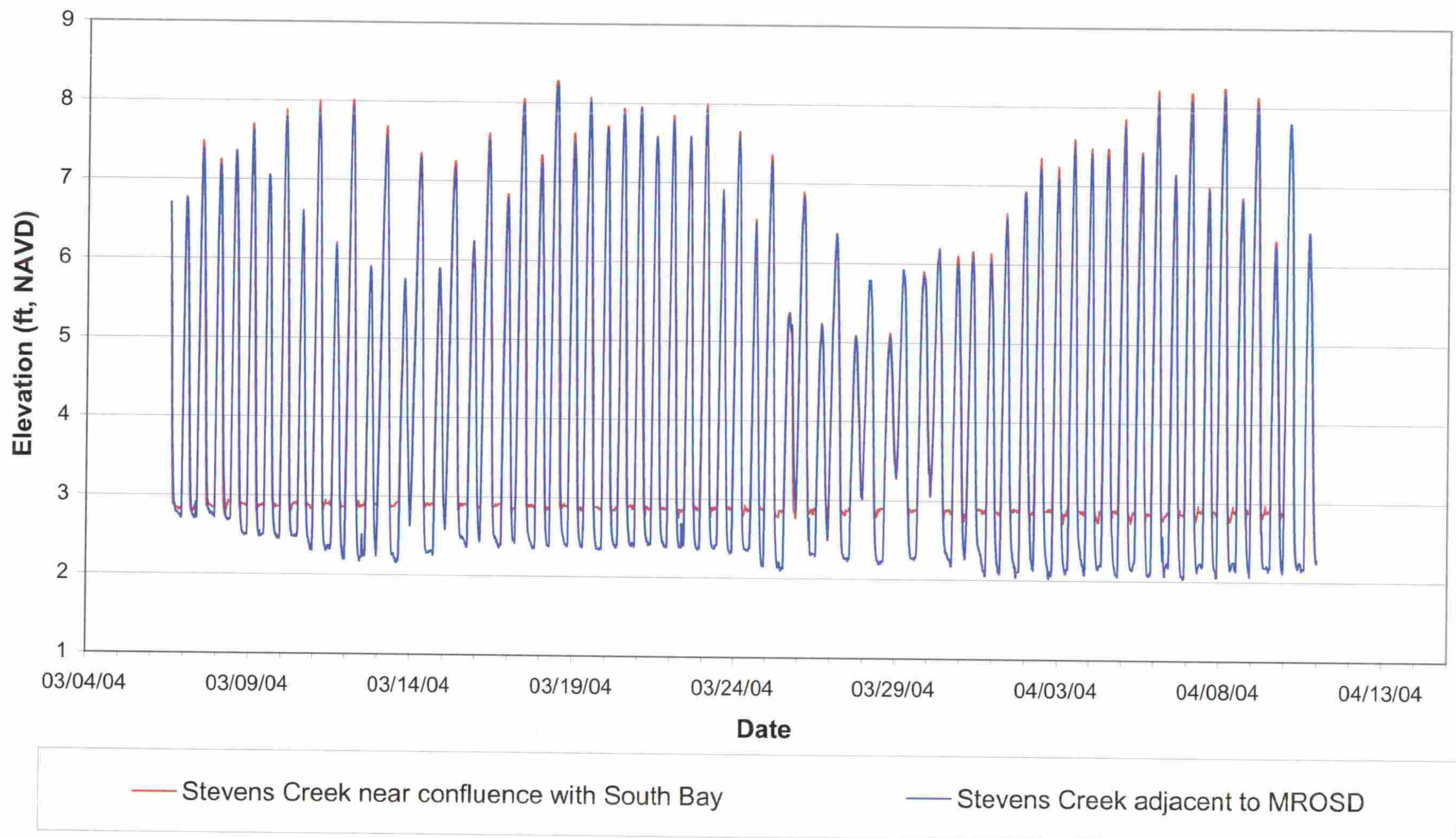
Tidal Hydrology. The nearest stations for which tidal benchmarks and predictions are available from NOAA-COOPs are the Palo Alto Yacht Harbor and Coyote/Alviso Slough stations. A comparison of predicted tides for these two stations with tides in Stevens Creek, measured in November of 1997 (Philip Williams & Associates 1997) shows that tides in Stevens Creek are most similar to Palo Alto Yacht Harbor (Figure 2-13). The Palo Alto benchmark data are included here for a comparison to Stevens Creek.

Updated tide data at Stevens Creek were collected by EDS from January to April 2004. A spring-neap tide cycle from the 2004 tidal monitoring is shown in Figure 2-14. Tides in Stevens Creek are truncated adjacent to the SWRP. A comparison of the tide data with site elevations shows that tidal elevations (Table 2-1) are high enough to inundate the SWRP if tidal circulation were re-introduced to the SWRP (Table 2-3, Figure 2-14).

Table 2-3. Tide Characteristics at Palo Alto Yacht Harbor

	Elevation	
	ft, above MLLW	**ft NAVD**
Mean Higher High Water (MHHW)	7.61	7.66
Mean High Water (MHW)	6.99	7.04
Mean Sea Level (MSL)	3.88	3.93
Mean Tide Level (MTL)	3.77	3.82
Mean Low Water (MLW)	0.77	0.82
Mean Lower Low Water (MLLW)	0.00	0.05

Source: NOAA-COOPs. Conversion to NAVD was made using tidal benchmark data from NOAA-COOPs.



Source: Environmental Data Solutions.
Note: Low tides at Stevens Creek are truncated at the local mudflat elevation. Low tides are expected to be similar to those at Palo Alto once the site is restored. Tides near the confluence with the South Bay are truncated higher than adjacent to the MROSD because the mooring was positioned in a shallower portion of the channel.

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Figure 2-14 Stevens Creek Tides

Sediment Dynamics and Availability. SSCs in the South Bay exhibit highly dynamic short-term variability, primarily in response to riverine input from tributaries and sloughs, variations in tidally driven resuspension, and wind driven resuspension (Cloern and others 1989; Powell and others 1989; Schoellhamer 1996). In shallow areas, such as those found in the far South Bay, south of the Dumbarton Bridge, tidal forcing is generally weak and insufficient to resuspend sediment. However, because the far South Bay is typically a depositional environment with easily resuspended sediments (Foxgrover and others 2004), the strong influence of wind-wave driven sediment resuspension leads to high SSC. Because SSC data were not available for Stevens Creek, it is assumed that Stevens Creek SSCs are comparable to those in the South Bay.

At channel marker 17 in the middle of the far South Bay (Figure 2-12), mid-depth SSCs are on the order of 150 mg/L and near-bed SSCs are on the order of 200 mg/L (Buchanan and Ganju 2001). Large daily variations exist due to the semidiurnal tidal cycle and the diurnal nature of the wind. Strong seasonal and event scale variations also exist, and SSCs can exceed 1000 mg/L during storm events with high tributary inflows and/or high winds.

Salinity. The South Bay is generally well mixed vertically (i.e., there is little tidally-averaged vertical salinity variation) with near oceanic salinities (33 ppt) due to low fresh water inputs in the far South Bay. In summer months and dry years, the wastewater inflows exceed natural stream flows (Cheng and Gartner 1985). High tributary inflows typically occur in the winter and early spring in wet years, and can set up density stratification in the main South Bay channel, as well as stratification on tidal time scales in the tributaries and sloughs.

2.5 Biological Functions and Values

The purpose of the current work is to describe existing biological conditions of the SWRP area and assess whether the conditions have changed since the time of the previous biological surveys conducted by others. The current study provides baseline information used to develop management and restoration objectives, to evaluate tidal marsh restoration opportunities and constraints, and to generate and assess alternatives for restoring tidal marsh habitat.

The SWRP area is within a former tidal salt marsh located to the south of the San Francisco Bay. Due to considerable anthropogenic changes, this area is currently a mosaic of open water, mudflat, and vegetated habitats characterized within this section. The habitats along Stevens Creek bordering the SWRP area are also described in the section.

2.5.1 Biotic Surveys

The *Moffett Field Development Plan Final Programmatic Environmental Impact Statement* (Design Community and Environment 2002) described biological resources on the project site. Other biological surveys that have been conducted at the project site include bird surveys (Alderete 2004; U.S. Fish and Wildlife Service San Francisco Bay National Wildlife Refuge 1992), surveys that identify sensitive species (Layne and Harding-Smith 1994), research on the salt marsh harvest mouse (Pomeroy 1991), and vegetation surveys (Science Applications International Corporation 1999; Zippin and Engels 1997). This background information was reviewed before the current biotic survey was conducted. According to background information, minimum cordgrass colonization elevations range from 4 to 5 ft NAVD at Bair Island, approximately 10 miles north of the site in the South Bay (Philip Williams & Associates 2002). Natural pickleweed marshplain elevations typically range between mean high water (MHW) and mean higher high water (MHHW) (Philip Williams & Associates 2002). The pickleweed marshplain elevation ranges from approximately 7.04 to 7.66 ft NAVD at the Moffett Field site. Approximately 7 to 8 ft of sedimentation at the Moffett Field site would have to occur to raise the site to natural pickleweed marshplain elevation at approximately MHW to MHHW (~7.04- 7.66 ft NAVD; Table 2-3). These vegetation colonization characterizations assume that the site drains well. There is little existing information on the extent of remnant drainage channels at the site, so how well the site would drain under tidal conditions is unknown.

HTH conducted a reconnaissance-level field survey on June 9, 2004, to characterize existing biotic habitats and the occurrence of suitable habitat for special-status species. The survey was conducted by restoration ecologists Max Busnardo and Helen Dijkstra, wildlife ecologist Laird Henkel, and botanist Andrew Dilworth. Stevens Creek was briefly assessed during the site visit because one of the tidal marsh restoration options would involve establishing a tidal connection between the project site and Stevens Creek.

Upon reviewing the Environmental Impact Statement (EIS) habitat map "Distribution of Vegetation Areas" in the field (Design Community and Environment 2002), the team determined that there were substantial differences between the existing habitat distributions and the habitats described on the map. Therefore, the habitat map for the project area has been updated. Habitats along Stevens Creek were also mapped. HTH's restoration ecologist Helen Dijkstra remapped habitat types in the project area on July 15 and 16, 2004. Figures 2-15a and 2-15b show the updated habitat boundaries.

2.5.2 Biotic Habitats On-site

A diverse mosaic of biotic habitats was observed at the project site. Nine habitat types were identified and are described below. These included: non-tidal open water, diked salt marsh, salt marsh/freshwater seasonal wetland transition, freshwater marsh, salt pan, peripheral halophyte, coyote brush scrub, non-native herbaceous vegetation, and developed areas (Figures 2-15a, 2-15b). Some of the habitats described in the EIS (Design Community and Environment 2002) were renamed in this report for biological accuracy. When renaming occurred, the name used in the EIS document is indicated in parentheses.

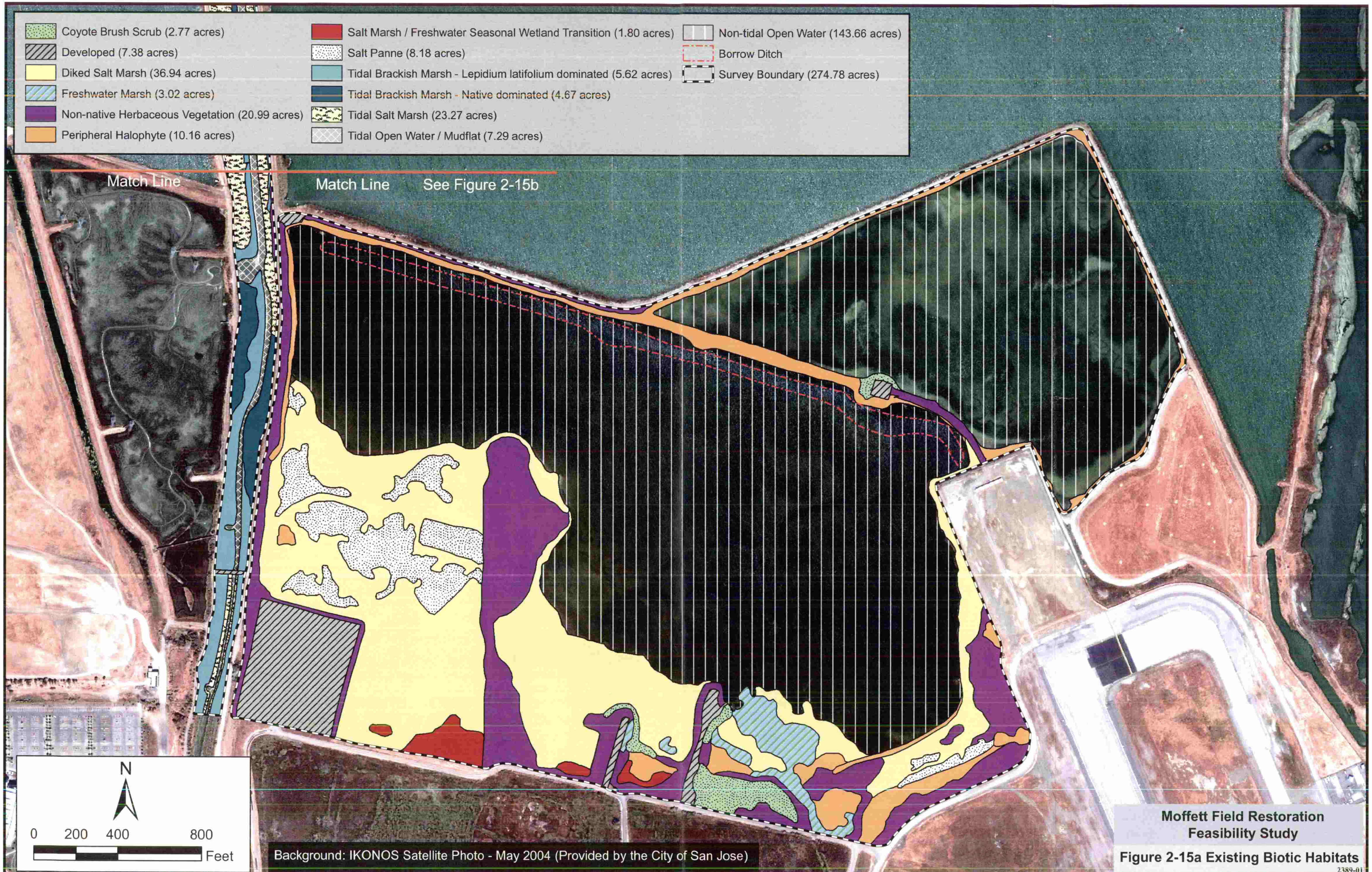


Figure 2-15a Existing Biotic Habitats

Moffett Field Restoration
Feasibility Study

Figure 2-15b Existing Biotic Habitats

2389-01

2.5.3 Non-Tidal Open Water (Open Water)

Open Water exists within the northern section of the SWRP. The acreage of the Open Water within the levee fluctuates seasonally, covering more of diked salt marsh area in winter than in summer. Based on the simulated maximum annual water surface elevations, water ponds to a maximum depth of approximately 2-3 ft during most winters. A bathymetric gradient from south to north results in a spatial gradient in ponding depth from shallow in the south end to deeper in the north end. The water depth and surface area gradually decrease from the wet to the dry season due to evaporation, with the majority of the pond drying out during summer. Shallow ponding depths of approximately 0.5 ft were observed during a site reconnaissance in June 2004. A borrow ditch parallels the northern edge of the Open Water. Because the NE Basin has little to no existing habitat (no vegetation or wildlife species were observed), the following descriptions of vegetation and wildlife are primarily for the Central Basin and MROSD parcel.

Vegetation. A macroalgae, of the genus *Cladophora* or *Oedogonium*, is abundant in the shallow areas of the Open Water. No macroalgae or vascular plants were observed in the deep-water habitat of the borrow ditch.

Wildlife. Although the salinity of these sites was not measured during the site visit, the presence of reticulate water boatmen (*Trichocorixa reticulata*) indicated that the water in the SWRP was at least brackish. Water boatmen provide prey for a variety of waterbirds, including Ruddy Duck (*Oxyura jamaicensis*), and several species of shorebird (Maffei 2000). The non-tidal open water/mudflat habitat that dominates the site provides foraging habitat for a variety of waterbirds. During winter and early spring, when open water is present, ducks such as the Northern Shoveler (*Anas clypeata*), American Wigeon (*Anas americana*), Mallard (*Anas platyrhynchos*), Cinnamon Teal (*Anas cyanoptera*), and Ruddy Duck (*Oxyura jamaicensis*) forage on invertebrates and aquatic vegetation in the Central Basin, occasionally in large numbers. American Coots (*Fulica americana*) are usually present in large numbers as well. Piscivorous birds such as the Pied-billed Grebe (*Podilymbus podiceps*), Great Egret (*Ardea alba*), Snowy Egret (*Egretta thula*), and Forster's Tern (*Sterna forsteri*) forage on small fish in the Central Basin. As water is drawn down through evaporation in spring, the shallows and exposed flats provide important foraging habitat for shorebirds. Species such as the Black-bellied Plover (*Pluvialis squatarola*), Semipalmated Plover (*Charadrius semipalmatus*), Dunlin (*Calidris alpina*), Willet (*Catoptrophorus semipalmatus*), Least Sandpiper (*Calidris minutilla*), and Western Sandpiper (*Calidris mauri*) may forage or roost in the shallow open water/mudflat habitat on-site during high tide, flying to the mudflats around the edge of the bay to forage on the receding tide. Other shorebirds, such as the Greater Yellowlegs (*Tringa melanoleuca*), Black-necked Stilt (*Himantopus mexicanus*), and American Avocet (*Recurvirostra americana*), forage primarily in the shallow open water/mudflat habitat on-site regardless of tide height on the bay, and the Black-necked Stilt nests in the pickleweed-dominated habitat of the diked salt marsh. Numerous migratory shorebirds also forage on brine flies (*Ephydra* spp.) on the exposed flats during late summer and fall, and when moist-soil areas are present during fall migration in some years, a high diversity of shorebird species, including the federally threatened Western Snowy Plover (*Charadrius alexandrinus nivosus*), have been recorded here. The NE Basin typically has less bird use than the Central Basin.

Other birds observed in Open Water at the SWRP included American Coots (*Fulica americana*), and Mallards (*Anas platyrhynhos*). During winter, the SWRP is used extensively by wintering waterfowl. The presence of foraging Forster's Terns (*Sterna forsteri*) indicates that small fish are present in this habitat and that Black-crowned Night-Herons (*Nycticorax nycticorax*) also forage in this habitat.

The NE Basin is occasionally used for foraging and roosting by shorebirds and waterfowl.

2.5.4 Diked Salt Marsh (Coastal Salt Marsh)

The diked salt marsh community occurs along the southern extent of the SWRP, to the south of the Open Water, where surrounding levees have eliminated tidal influence. As the Open Water area fills with winter precipitation, the diked salt marsh becomes partially flooded. During the dry summer season the Open Water subsides, and the salt marsh becomes more exposed. The diked salt marsh is similar to a coastal salt marsh community but without tidal influence.

Vegetation. Salt marsh plant species tolerate high concentrations of salt, and salt excludes non-halophytic competitors, although the area is diked and thus no longer tidal. Pickleweed (*Salicornia virginica*) is the dominant plant species in the diked marsh and forms extensive monotypic patches. The pickleweed at the project site is taller along the northern and southern extents and is shorter in the middle of the diked salt marsh. Other common plant species found in the diked salt marsh are alkali heath (*Frankenia salina*), salt marsh dodder (*Cuscuta salina*), jaumea (*Jaumea carnosa*), and saltgrass (*Distichlis spicata*).

Wildlife. The pickleweed-dominated marsh provides habitat for the federally-listed salt marsh harvest mouse (*Reithrodontomys raviventris*), although trapping efforts in 1991 and 1994 resulted in only one salt marsh harvest mouse caught each year (Layne and Harding-Smith 1994; Pomeroy 1991). Other small mammals caught during these studies in this habitat included California voles (*Microtus californicus*) and house mice (*Mus musculus*). H.T. Harvey & Associates wildlife ecologists observed young Black-necked Stilts (*Himantopus mexicanus*) on-site in June 2004, indicating that this species nested successfully in the SWRP. When migratory shorebirds are present in the Bay Area (August-May), this habitat may be used by foraging and roosting shorebirds, such as the Willet (*Catoptrophorus semipalmatus*) and the Marbled Godwit (*Limosa fedoa*). The federally-listed California Clapper Rail (*Rallus longirostris obsoletus*) has also been recorded in this habitat at the project site (Orton-Palmer and Takekawa 1992).

2.5.5 Salt Marsh/Freshwater Seasonal Wetland Transition (Seasonal Salt Marsh and Transition)

The salt marsh/freshwater seasonal wetland transition area occurs in the southern part of the MROSD area. The salt marsh transition area contains plant species common to salt marsh and to freshwater seasonal wetland habitat. The transition zone is at a higher elevation and contains plant species that are less salt tolerant, such as Mexican rush (*Juncus mexicanus*), growing beside salt tolerant species, such as pickleweed.

Vegetation. The primary species found in the seasonal salt marsh/freshwater wetland seasonal transition include: Mexican rush, pickleweed, heliotrope (*Heliotropium* sp.), western goldenrod (*Euthamia occidentalis*), and the non-native, invasive perennial pepperweed (*Lepidium latifolium*).

Wildlife. The pickleweed was notably tall and lush in this area, potentially providing good habitat for the salt marsh harvest mouse. In general, wildlife use of this habitat is likely to be similar to that of the diked salt marsh.

2.5.6 Freshwater Marsh (Fresh and Brackish Water Marsh)

Freshwater marsh occurs to the south of the SWRP, midway along the southern boundary of the project site. A culvert connects the Eastern Diked Marsh to the project site, providing freshwater inputs (surface water in the winter and treated groundwater in the summer) that maintain the freshwater marsh.

Vegetation. The dominant species in the freshwater marsh include: cattail (*Typha angustifolia*), brass buttons (*Cotula coronopifolia*), California bulrush (*Scirpus californicus*), and western goldenrod. There are some native grasses in the project site; the slope above the freshwater marsh is dominated by creeping wild rye (*Leymus triticoides*).

Wildlife. Cattails provide nesting habitat for Marsh Wrens (*Cistothorus palustris*) and potentially for Salt Marsh Common Yellowthroats (*Geothlypis trichas sinuosa*). Although they were not observed during the June 2004 visit, Red-winged Blackbirds (*Agelaius phoeniceus*) could also nest here. This freshwater marsh provides foraging habitat for a number of other bird species.

2.5.7 Salt Pan

Patches of salt pan habitat exist within the diked salt marsh. These are depressed areas where salt water ponds and then evaporates, creating high salinity soils and salt crusts where no plants grow. Some stunted vegetation occurs along the edges of the salt pan.

Vegetation. The vegetation around the edge of the salt pan includes: iceplant (*Mesembryanthemum* sp.), rush (*Juncus* sp.), sickle grass (*Parapholis incurva*), and goldfields (*Lasthenia platycarpa*).

Wildlife. Killdeer (*Charadrius vociferus*) could potentially nest in or adjacent to this habitat. In addition, several other shorebird species are likely to use this habitat for foraging and roosting. These include: Western and Least Sandpipers (*Calidris mauri* and *C. minutila*), Dunlin (*C. alpina*), and dowitchers (*Limnodromus* spp.). Federally-listed Western Snowy Plovers (*Charadrius alexandrinus nivosus*) could forage and potentially nest in this habitat.

2.5.8 Peripheral Halophyte

Peripheral halophytic habitat occurs along the slopes of the levees that encircle the Open Water areas and in the ecotone between diked salt marsh and upland habitats (coyote brush scrub and non-native herbaceous). This habitat was not separated out in the EIS (Design Community and Environment 2002). Peripheral halophytic vegetation provides habitat to salt marsh species. During high tide, therefore, peripheral halophytic habitats provide important refugial habitat.

Vegetation. The dominant plant species in the peripheral halophytic habitat include pickleweed, salt grass, and alkali heath. Other species include: saltbush (*Atriplex triangularis*), stinkwort (*Dittrichia graveolens*), heliotrope, perennial pepperweed, and western goldenrod

Wildlife. This habitat is of greatest importance as refugial habitat for the salt marsh harvest mouse. During periods of high water in winter, harvest mice and other terrestrial animals are forced to retreat to this adjacent habitat. More substantial vegetation (greater structural complexity) in this habitat also provides potential nesting habitat for terrestrial birds, such as the Song Sparrow (*Melospiza melodia*).

2.5.9 Coyote Brush Scrub

Coyote brush scrub, which is one of the first native shrub species to colonize disturbed upland areas, is found in upland areas along the southern boundary of the project site.

Vegetation. The overstory of coyote brush scrub is dominated by coyote brush (*Baccharis pilularis*). The species composition of the herbaceous plants in the understory is similar to that of the adjacent non-native herbaceous area described below.

Wildlife. Coyote brush scrub provides the greatest structural complexity within the project site and supports some larger fauna. Black-tailed hares (*Lepus californicus*) were observed in this habitat. Other smaller mammals, such as California voles, house mice, and Botta's pocket gophers (*Thomomys bottae*) likely occur here as well. Coyote brush provides potential nesting habitat for Song Sparrows, Western Scrub-jays (*Aphelocoma californica*), Loggerhead Shrikes (*Lanius lucovicianus*), and even White-tailed Kites (*Elanus leucurus*). The drier habitat here is also suitable for reptiles such as western fence lizards (*Sceloporus occidentalis*) and garter snakes (*Thamnophis* spp.).

2.5.10 Non-native Herbaceous Vegetation (Weed Dominated Area)

Non-native herbaceous vegetation grows in areas that are regularly disturbed, either naturally or by humans. In the San Francisco Bay area, weedy, annual, non-native plants are typically the first species to colonize these sites following a disturbance. Non-native herbaceous vegetation is found in upland areas along the levee that separates the SWRP Central Basin and MROSD areas and in the southeastern portion of the SWRP.

Vegetation. The predominant ruderal species (species that initially colonize a disturbed site) identified in the project site include: Italian ryegrass (*Lolium multiflorum*), ripgut brome (*Bromus diandrus*), black mustard (*Brassica nigra*), wild radish (*Raphanus sativus*), Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*), wild oats (*Avena fatua*), yellow star-thistle (*Centaurea solstitialis*), common sow thistle (*Sonchus oleraceus*), bull thistle (*Cirsium vulgare*), bristly ox-tongue (*Picris echioides*), wild fennel (*Foeniculum vulgare*), rabbitsfoot grass (*Polypogon monspeliensis*), and coyote brush.

Wildlife. Ruderal habitats generally provide poor habitat for wildlife. A few bird species, such as the Lesser Goldfinch (*Carduelis psaltria*) may occasionally forage in this habitat, and small reptiles like the western fence lizard may occur here. House mice and California voles may also occur in this habitat.

2.5.11 Developed (Developed and Levee Areas)

Developed habitat refers to the unvegetated gravel and paved tops of the levees that are present around the perimeter of the project site. The NASA buildings and storage lot area adjacent to the southwestern corner of the MROSD and other structures also constitute developed area.

Vegetation. These areas contain sporadic vegetation consisting of non-native herbaceous species.

Wildlife. Developed habitats provide limited foraging and nesting opportunities for wildlife. Open levees do provide habitat for nesting Killdeer and in less disturbed areas, for Black-necked Stilts and American Avocets (*Recurvirostra americana*). Structures provide potential nesting habitat for birds, such as Cliff Swallows (*Petrochelidon pyrrhonota*), Black Phoebes (*Sayornis nigricans*), and House Finches (*Carpodacus mexicanus*). Non-native European Starlings (*Sturnus vulgaris*) were observed nesting in one of the structures on the south side of the SWRP. Abandoned structures on the south side of the SWRP also provide potential roosting habitat for bats.

2.5.12 Biotic Habitats within Adjacent Areas

Stevens Creek

Stevens Creek runs along the western boundary of the project site. Due to its proximity, plant communities and wildlife habitat found along Stevens Creek may greatly influence the development of any restoration design within the SWRP Central Basin and MROSD area. HTH briefly assessed the vegetation and wildlife habitat along this reach of Stevens Creek, beginning at the south-western corner of the project site to the confluence of Stevens Creek and the Bay. Five habitat types were identified and mapped (Figure 2-15b) within Stevens Creek adjacent and downstream of the project site. These included: tidal brackish marsh dominated by native plant species, tidal brackish marsh dominated by perennial pepperweed (*Lepidium latifolium*), tidal salt marsh, tidal open water/mudflat, and non-native herbaceous vegetation.

Tidal Brackish Marsh (Native and non-native dominated). Tidal brackish marsh habitat occurs in Stevens Creek along the reach directly adjacent to the SWRP Central Basin and MROSD area (Figure 2-15b). The brackish marsh is dominated by the native species alkali bulrush (*Scirpus maritimus*) in some areas and by the non-native perennial pepperweed in other areas. The brackish environment has promoted the recent spread of perennial pepperweed along Stevens Creek, particularly directly adjacent to the project site as indicated in Figure 2-15b. Perennial pepperweed is a highly invasive plant rated by the State of California with a 'B' pest rating (eradication, containment, control, or other holding action at the discretion of the Commissioner) and by the California Invasive Plant Council (Cal-IPC) as an 'A-1' weed (a widespread pest that is invasive in more than three Jepson regions). Perennial pepperweed is a dominant plant species and has significantly degraded the quality of the habitat in the brackish tidal marsh directly adjacent to the project site.

Tidal Salt Marsh. The tidal salt marsh along Stevens Creek is dominated by pickleweed, Pacific cordgrass (*Spartina foliosa*), gumplant (*Grindelia hirsutula*), alkali bulrush (*Scirpus robustus*), bulrush (*Scirpus robustus*), jaumea, alkali heath, and saltgrass. Smooth cordgrass (*Spartina alterniflora*) and its hybrids with *Spartina foliosa* (hybrids), is another highly invasive species (Cal-IPC A-2, invasive in three or more Jepson regions) that was identified at the mouth of Stevens Creek during the field survey. The Invasive Spartina Project is in initial phases of a San Francisco Bay-wide control of invasive *Spartina alterniflora* and hybrids.

Wildlife. Wildlife communities occurring along Stevens Creek are likely to be fairly similar to those described under Diked Salt Marsh (above). Special-status wildlife species potentially occurring in Stevens Creek (discussed below), include: steelhead (*Oncorhynchus mykiss*), salt marsh harvest mice (*Reithrodontomys raviventris*), and California Clapper Rails (*Rallus longirostris obsoletus*).

Summary. The presence of the perennial pepperweed and smooth cordgrass along Stevens Creek present substantial constraints to restoration planning in the project site. The survey team briefly visited Stevens Creek and confirmed the importance of considering this adjacent habitat during the development and evaluation of tidal marsh restoration alternatives at the project site.

2.5.13 Eastern and Western Diked Marshes

Two diked marshes occur inland (south) of the project site. The Eastern Diked Marsh appears to be primarily a freshwater marsh. This marsh is a result of the freshwater outfall into the area. Though the Eastern Diked Marsh is primarily freshwater marsh, it appears to contain riparian habitat as well. The Western Diked Marsh consists of a 'Salt Marsh Transition' habitat. The Western Diked Marsh contains some native species, such as Mexican rush and cattail (*Typha* sp.). An invasive perennial pepperweed is a dominant species in the Western Diked Marsh, as well as poison hemlock (*Conium maculatum*). The Eastern and Western Diked Marshes offer potential for restoration by removal of the invasive plant species, if this were coordinated with control of invasive plant species along Stevens Creek.

The Eastern and Western Diked Marshes are likely to support more terrestrial wildlife species, including a variety of small mammals and migratory songbirds. White-tailed Kites (*Elanus leucurus*) and Salt Marsh Common Yellowthroats (*Geothlypis trichas sinuosa*) are likely to occur here, and Northern Harriers (*Circus cyaneus*) could potentially nest here as well. The Western Diked Marsh likely provides transitional habitat for salt marsh harvest mice.

2.5.14 Special-Status Plant and Animal Species Regulatory Overview

Federal and state endangered species legislation gives special status to several plant and animal species known to occur in the vicinity of the project site. In addition, state resource agencies and professional organizations, whose lists are recognized by federal agencies when reviewing environmental documents, have identified as sensitive some species occurring in the vicinity of the project site. Such species are referred to collectively as "species of special-status" and include: plants and animals listed, proposed for listing, or candidates for listing as threatened or endangered under the Federal Endangered Species Act (FESA) or the California Endangered Species Act (CESA), animals listed as "fully protected" under the California Fish and Game Code, animals designated as "Species of Special Concern" by the California Department of Fish and Game (CDFG), and plants listed as rare or endangered in the *Inventory of Rare and Endangered Vascular Plants of California* (California Native Plant Society 2001).

FESA provisions protect federally-listed threatened and endangered species and their habitats from unlawful take. "Take" under FESA includes activities such as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any of the specifically enumerated conduct." The U.S. Fish and Wildlife Service (USFWS) regulations define harm to mean "an act which actually kills or injures wildlife." Such an act "may" include "significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering" (50 Code of Federal Regulations [CFR] § 17.3). Activities that may result in "take" of individuals are regulated by the USFWS. Candidate species are not afforded any legal protection under FESA; however, candidate species typically receive special attention from federal and state agencies during the environmental review process. Provisions of

CESA protect state-listed threatened and endangered species. CDFG regulates activities that may result in "take" of individuals (i.e., "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill"). Habitat degradation or modification is not expressly included in the definition of "take" under the CDFG Code. The CDFG, however, has interpreted "take" to include the "killing of a member of a species which is the proximate result of habitat modification."

The CDFG has also produced three lists (amphibians and reptiles, birds, and mammals) of "species of special concern" that serve as "watch lists." Species on these lists either are of limited distribution or the extent of their habitats has been reduced substantially, such that threat to their populations may be imminent. Thus, their populations should be monitored. They may receive special attention during environmental review but do not have statutory protection.

Vascular plants listed as rare or endangered by the California Native Plant Society (CNPS) (California Native Plant Society 2001) but which have no designated status under state endangered species legislation, are defined as follows:

- List 1A. Plants considered by the CNPS to be extinct in California.
- List 1B. Plants rare, threatened, or endangered in California and elsewhere.
- List 2. Plants rare, threatened, or endangered in California but more numerous elsewhere.
- List 3. Plants about which we need more information - a review list.
- List 4. Plants of limited distribution - a watch list.

2.5.15 Assessment Methodology

HTH's biologists collected and reviewed information concerning the distribution of threatened, endangered, or other special-status plant and animal species that may occur at the project site. The sources included the CDFG Natural Diversity Data Base (CNDDB 2004), and miscellaneous information available through the USFWS, CDFG, and technical publications. The CNPS *Inventory of Rare and Endangered Vascular Plants of California* (California Native Plant Society 2001) and *The Jepson Manual* (Hickman 1993) supplied information regarding the distribution and habitats of vascular plants in the vicinity. The *NASA Ames Development Plan Final Programmatic EIS* (Design Community and Environment 2002) and supporting documents (e.g., (Layne and Harding-Smith 1994) also provided information on the distribution of special-status species at the project site.

2.5.16 Special-Status Plant Species

The following factors were considered to assess the site's habitat suitability for special-status plant species: 1) the proximity and date of known occurrences; 2) the presence and ecological condition of habitats on-site; 3) past and current land use practices; 4) the existence of known associate species; and 5) direct observation of plants as a result of optimally timed, species-specific surveys. HTH botanist Andrew Dilworth assessed the project site for special-status plant species during the reconnaissance-level survey on June 9, 2004.

A query of the CNDDB (CNDDB 2004) was performed to identify special-status plant species potentially occurring in the project vicinity. All habitats were specified in the CNDDB query, but only those species occurring in coastal scrub, vernal pool, valley and foothill grassland, and marsh habitats were assessed for potential occurrence on site. These general habitat types were chosen for their similarity to those existing on site. In addition, the CNPS Inventory (California Native Plant Society 2001) was used to identify additional species occurring in a similar habitat throughout Santa Clara County.

A total of 59 special-status plant species were identified in these queries. Based on the above-listed factors considered to assess suitability for special-status plants, only 10 of the 59 species identified could potentially occur at the project site. Seven of these species were previously addressed in the EIS (Design Community and Environment 2002) and include: California seablite (*Suaeda californica),* alkali milk-vetch (*Astragalus tener* var. *tener*), San Joaquin saltbush (*Atriplex joaquiniana*), Congdon's tarplant (*Centromadia parryi* ssp. *congdonii*), Point Reyes bird's-beak (*Cordylanthus maritimus* ssp. *palustris*), Contra Costa goldfields (*Lasthenia conjugens*), and delta tule pea (*Lathyrus jepsonii* var. *jepsonii*). The Contra Costa goldfields is federally listed as endangered, and all are listed by the CNPS as rare or endangered in California (California Native Plant Society 2001). Four additional potentially occurring species not identified in the EIS include: Hoover's button-celery (*Eryngium aristulatum* var. *hooveri*), prostrate navarretia (*Navarretia prostrate*), delta woolly-marbles (*Psilocarphus brevissimus* var. *multiflorus*), and saline clover (*Trifolium depauperatum* var. *hydrophilum*); of these, only the delta wooly marbles and the saline clover are listed as CNPS 1B, while the others are considered plants of limited distribution (California Native Plant Society 2001). None of these species were observed on site during the reconnaissance-level survey conducted on June 9. However, protocol-level surveys are warranted during their respective blooming periods for all 10 potentially occurring species. It is recommended that these surveys are conducted during the conceptual restoration design phase to determine presence or absence of these special-status plant species, better define restoration opportunities, and assess project impacts, with respect to special-status plant species. Four protocol-level surveys should be conducted to coincide with the blooming periods of the 10 potentially-occurring species; two surveys in spring (April-May and May-June), one survey in mid-summer (mid-July), and one survey in fall (September-October). Expanded descriptions of these species are presented below and in Appendix C.

Five other special-status plant species identified in the EIS that are not likely to occur at the project site include: San Francisco Bay spineflower (*Chorizanthe cuspidata* var. *cuspidata*), robust spineflower (*Chorizanthe robusta* var. *robusta*), hairless popcorn-flower (*Plagiobothrys glaber*), California seablite (*Suaeda californica*), and caper-fruited tropidocarpum (*Tropidocarpum capparideum*). The spineflower species were rejected since there is no native sandy habitat on site, and the popcorn-flower and tropidocarpum were rejected since they are now considered extinct (California Native Plant Society 2001). The remaining 44 special-status plant species were considered but rejected because most of the species are endemic to serpentine substrates, the site lies below the known elevation range for many species, and/or known plant associates and microhabitats do not occur on site. In addition, some of the rejected species are considered to have been extirpated from Santa Clara County, or their only known occurrences are historic, or they are considered extinct. Appendix D lists all the special-status plant species (48 total) considered but rejected in this assessment. No further surveys are warranted for these species.

Finally, three sensitive habitats were identified in the CNDDB query including: serpentine bunchgrass, valley oak woodland, and northern coastal salt marsh. Of all the habitats within the project site, only the reach of Stevens Creek adjacent to the project site contains elements of northern coastal salt marsh; the other habitats are not present in the project site. While constituent species of the northern coastal salt marsh habitat type are found in the ponds on site, the ponds are too highly disturbed and altered hydrologically to be characterized as such.

2.5.17 Federal Endangered Plant Species

Two Federally-listed endangered plant species, Contra Costa Goldfields and California Seablite, have the potential to occur at the site. These two species are discussed in detail below.

Contra Costa Goldfields (Lasthenia conjugens). Federal Listing Status: Endangered; State Listing Status: None; CNPS List 1B. This annual herb occurs in mesic valley and foothill grasslands and vernal pools. The blooming period is from March to June. This species is reported to have been significantly reduced and extirpated from several counties forming its historic range, including Santa Clara County (California Native Plant Society 2001). Four occurrences of this species have been documented within the nine quadrangle area surrounding the project site, particularly in the vicinity of San Jose, Fremont, and Newark (CNDDB 2004). Of these, only one population is known to be extant, at the San Francisco National Wildlife Refuge in Fremont. None of the occurrences are located within a five mile radius of the project site. Suitable habitat and associate plant species are present on site, and this species could therefore occur on site, given existing habitat and the existing populations in adjacent counties.

California Seablite (Suaeda californica). Federal Listing Status: Endangered; State Listing Status: None; CNPS List 1B. This evergreen shrub occurs in coastal salt marshes. The blooming period is from July to October. The range of this species once included Alameda and Santa Clara counties, but extant populations are now believed to be limited to San Luis Obispo County (California Native Plant Society 2001). Two occurrences of this species have been documented within the nine quadrangle area surrounding the project site, at the Palo Alto yacht harbor, and across the Bay in the vicinity of Mud Slough. Both of these occurrences are likely extirpated since the plant is now believed to be restricted to Morro Bay. The Palo Alto occurrence is located within a five mile radius of the project site. While suitable habitat and associate plant species are present on site, this species is presumed absent since it is highly conspicuous but was not observed during the reconnaissance-level surveys.

2.5.18 State Protected or CNPS Plant Species

Nine State protected and/or California Native Plant Society plant species, including Alkali Milk-vetch, San Joaquin Spearscale, Congdon's Tarplant, Point Reyes Bird's-beak, Hoover's Button-celery, Delta Tule Pea, Prostrate Navarretia, Delta Woolly-marbles, and Saline Clover, have the potential to occur at the site. These nine species are discussed in detail below.

Alkali Milk-vetch (Astragalus tener var. tener). Federal Listing Status: None; State Listing Status: None; CNPS List 1B. This annual herb occurs in alkaline soils in playas, vernal pools, and adobe clay areas in valley and foothill grasslands. The blooming period extends from March to June. The range of this species currently includes: Alameda, Merced, Solano, and Yolo counties, but it has been extirpated from 10 other counties including Santa Clara County. Six occurrences of this species have been documented within the nine quadrangle area surrounding the project site, particularly in the vicinity of Alviso, Newark, Union City, Milpitas, Palo Alto, and Albrae (CNDDB 2004). Of these, only one population is known to be extant, at the Pacific Commons Reserve, west of Fremont (in the area formerly known as Albrae); some of the occurrences are located within a five mile radius of the project site. Suitable habitat and associate plant species (*Lasthenia platycarpha*) are present on site; and therefore, this species could occur on site, given existing habitat and the existing populations in adjacent counties.

San Joaquin Spearscale (Atriplex joaquiniana). Federal Listing Status: None; State Listing Status: None; CNPS List 1B. This annual herb occurs in chenopod scrub, meadows, playas, and valley and foothill grasslands, particularly those with alkaline substrates. The blooming period extends from April through October. The range of this species includes: Alameda, Contra Costa, Colusa, Glenn, Merced, Monterey, Napa, Sacramento, San Benito, Santa Clara, San Joaquin, Solano, Tulare, and Yolo counties. Two occurrences of this species have been documented within the nine quadrangle area surrounding the project site, particularly in the Warm Springs and Albrae areas of Alameda county (CNDDB 2004). Of these, only one population is expected to be extant, at the Pacific Commons Reserve, west of Fremont (in the area formerly known as Albrae). Neither of the occurrences is located within a five mile radius of the project site. Suitable habitat and associate plant species are present on site; and therefore, this species could occur on site.

Congdon's Tarplant (Centromadia parryi ssp. congdonii). Federal Listing Status: None; State Listing Status: None; CNPS List: 1B. This annual herb occurs in valley and foothill grasslands, particularly those with alkaline substrates, and in sumps or disturbed areas where water collects. The blooming period extends from June through November. The range of this species has been reduced to Monterey, San Luis Obispo, Santa Clara, and Alameda counties. Eleven occurrences of this species have been documented within the nine quadrangle area surrounding the project site, particularly in the vicinity of Alviso, Newark, Menlo Park, Milpitas, East Palo Alto, and Albrae (CNDDB 2004). Of these, six populations are expected to be extant, some of which occur within a five mile radius of the project site. Suitable habitat and associate plant species are present on site; and therefore, this species could occur on site.

Point Reyes Bird's-beak (Cordylanthus maritimus ssp. palustris). Federal Listing Status: None; State Listing Status: None; CNPS List 1B. This annual hemi-parasitic herb occurs in coastal salt marsh. The blooming period extends from June to October. The range of this species includes San Mateo and five other counties in California and in Oregon, though it is believed to be extirpated from the South Bay area (California Native Plant Society 2001). Five occurrences of this species have been documented within the nine quadrangle area surrounding the project site, particularly in the vicinity of Alviso, Palo Alto, Redwood City, and Belmont (CNDDB 2004). All of these occurrences are believed to be extirpated; some of these occurred within a five mile radius of the project site. Nevertheless, suitable habitat and associate plant species are present on site; and therefore, this species could occur on site.

Hoover's Button-celery (Eryngium aristulatum var. hooveri). Federal Listing Status: None; State Listing Status: None; CNPS List 1B. This perennial herb occurs in vernal pools and blooms in July. The range of this species includes Alameda, San Benito, Santa Clara, and San Luis Obispo counties (California Native Plant Society 2001). No occurrences of this species have been documented in the CNDDB for the nine quadrangle query area (CNDDB 2004). Nevertheless, suitable habitat and associate plant species are present on site and therefore this species could occur on site.

Delta Tule Pea (Lathyrus jepsonii var. jepsonii). Federal Listing Status: None; State Listing Status: None; CNPS List 1B. This perennial herb occurs in brackish and freshwater marshes between sea level and 5 meters. The blooming period extends from May to September. The range of this species includes: Alameda, Contra Costa, Napa, Sacramento, San Joaquin, and Solano counties. No occurrences of this species have been documented in the CNDDB for the nine quadrangle query area (CNDDB

2004). Nevertheless, suitable habitat and associate plant species are present on site; and therefore, this species could occur on site.

Prostrate Navarretia (Navarretia prostrata). Federal Listing Status: None; State Listing Status: None; CNPS List 1B. This annual herb occurs in mesic areas in coastal scrub, vernal pool, and alkaline valley and foothill grassland habitats. The blooming period is April to July. The historic range of this species included Alameda County, but it is now believed to exist only in Los Angeles, Merced, Monterey, Orange, Riverside, San Diego, and possibly San Bernardino counties (California Native Plant Society 2001). However, two recent occurrences of this species have been documented within the nine quadrangle area surrounding the project site, in the vicinity of the Pacific Commons Preserve and Albrae areas of Alameda County (CNDDB 2004). These occurrences are located just outside the five mile radius of the project site. Suitable habitat and associate plant species are present on site; and therefore, this species could occur on site.

Delta Woolly-marbles (Psilocarphus brevissimus var. multiflorus). Federal Listing Status: None; State Listing Status: None; CNPS List 4. This annual herb occurs in vernal pools. The blooming period extends from May to June. The range of this species includes: Alameda, Napa, Santa Clara, San Joaquin, Solano, Stanislaus, and Yolo counties. No occurrences of this species have been documented in the CNDDB for the nine quadrangle query area (CNDDB 2004). Nevertheless, suitable habitat and associate plant species are present on site; and therefore, this species could occur on site.

Saline Clover (Trifolium depauperatum var. hydrophilum). Federal Listing Status: None; State Listing Status: None; CNPS List 1B. This annual herb occurs in marshes and swamps, mesic and/or alkaline valley and foothill grasslands, and vernal pools. Populations have been reported at elevations up to 300 meters. The blooming period is April to June. The geographic range of this species includes Alameda, Monterey, Napa, San Benito, Santa Clara, San Luis Obispo, San Mateo, Solano, Sonoma, and possibly Colusa counties. Only one historic occurrence of this species has been documented within the nine quadrangle area surrounding the project site, in the vicinity of Belmont (CNDDB 2004), located well outside the five mile radius of the project site. Nevertheless, suitable habitat and associate plant species are present on site; and therefore, this species could occur on site.

2.5.19 Special-Status Animal Species

The special-status animal species that occur in the vicinity in habitats similar to those found on the project site are described below. The legal status and likelihood of occurrence of these species on-site are given in Appendix C. Expanded descriptions are included of species for which potentially suitable habitat occurs on the project site, for which specific surveys were conducted, or for which the resource agencies have expressed particular concern.

Other special-status species may occur on the project site only as visitors, migrants, or common foragers but are not expected to breed on the site. Species that could occasionally occur on the project site include: the California Brown Pelican (*Pelecanus occidentalis californicus*), California Black Rail (*Laterallus jamaicensis coturniculus*), Short-eared Owl (*Asio flammeus*), Bald Eagle (*Haliaeetus leucocephalus*), Golden Eagle (*Aquila chrysaetos*), Cooper's Hawk (*Accipiter cooperii*), Sharp-shinned Hawk (*Accipiter striatus*), Merlin (*Falco columbarius*), American Peregrine Falcon (*Falco peregrinus anatum*), Vaux's Swift (*Chaetura vauxi*), California Yellow Warbler (*Dendroica petechia brewsteri*), Bank Swallow (*Paria riparia*), California Horned Lark (*Eremophila alpestris actia*), Tricolored Blackbird (*Agelaius tricolor*), and pallid bat (*Antrozus pallidus*). Species that are likely to occur on-site regularly as foragers but have special-status only at nesting sites elsewhere (off-site) include: the American White Pelican (*Pelecanus erythrorhynchos*), Double-crested Cormorant (*Phalacrocorax auratus*), California Gull (*Larus californicus*), Black Skimmer (*Rynchops niger*), Elegant Tern (*Sterna elegans*), and White-faced Ibis (*Plegadis chihi*).

The Northern Harrier (*Circus cyaneus*) is likely to occur on the project site only as an occasional forager, but this species could potentially nest in the Eastern or Western Diked Marshes. Suitable habitat for the salt marsh wandering shrew (*Sorex vagrans halicoetes*) does not occur on site, and trapping efforts have failed to detect this species. This species could, however, occur in salt marsh habitat near the mouth of Stevens Creek.

2.5.20 Federal or State Endangered or Threatened Animal Species

Steelhead (Oncorhynchus mykiss). Federal Listing status: Threatened; State listing status: Species of Special Concern. The steelhead is an anadromous form of rainbow trout that migrates upstream from the ocean and Bay to spawn. Steelhead usually migrate upstream to spawning areas in late fall or early winter, when flows are sufficient to allow them to reach suitable habitat in far upstream areas that may have little water at other times of the year. Spawning occurs between December and June. Steelhead eggs remain in gravel depressions that are known as redds for one and one-half to four months before hatching. After hatching, young steelhead using the deeper reaches of streams as rearing areas will remain in freshwater streams for a year or two (the range is 1 to 4 years) before migrating to the ocean. After migration, they typically grow rapidly for two to three years before returning to freshwater streams to spawn. Unlike other salmonids, steelhead do not necessarily die after spawning. Many adults survive and return to the ocean after spawning, only to come back and spawn another season or two. Steelhead run in only a few South Bay streams, including: Coyote Creek, the Guadalupe River, Stevens Creek, and San Francisquito Creek (Smith 2004). The species does not occur in the project area, which is fully diked but is known to occur in Stevens Creek, adjacent to the project site.

Chinook Salmon (Oncorhynchus tshawytscha). Federal Listing Status: Endangered (Winter-run), Threatened (Spring-run), Candidate (Central Valley fall/ late-fall run); State Listing Status: Endangered (Winter-run), Threatened (Spring-run), Species of Special Concern (Central Valley fall/ late-fall run). The chinook salmon is an anadromous fish, spawning in freshwater rivers and streams but spending most of its adult life at sea. Chinook salmon populations have suffered the effects of over-fishing by commercial fisheries, degradation of spawning habitat, added barriers to upstream migration, and reductions in winter flows due to damming. Almost all chinook salmon occurring in the San Francisco Bay are from the Sacramento-San Joaquin watershed. There are four races of Sacramento-San Joaquin chinook: winter, spring, fall, and late-fall, as defined by the timing of adult migration upstream to spawning areas. Spring-run chinook are state and federally listed as Threatened, and winter-run chinook are listed as Endangered by both agencies. Fall/late-fall chinook are listed as a California Species of Special Concern.

Chinook salmon have not historically spawned in streams flowing into South Bay. Since the mid-1980s, however, small numbers of fall-run chinook salmon have been found in several such streams including: Coyote Creek, Los Gatos Creek, and the Guadalupe River (Smith 1998). These fish are probably strays from Central Valley runs (Smith 2004). These fall-run chinook salmon typically arrive in South Bay streams in October or later, although on rare occasions, adult chinook salmon have been detected in these streams in summer. No run of chinook salmon is known to spawn in

Stevens Creek, however, juvenile fish of all runs could potentially forage in tidal habitats throughout San Francisco Bay, including those near the mouth of Stevens Creek.

California Clapper Rail (Rallus longirostris obsoletus). Federal listing status: Endangered; State listing status: Endangered. The California Clapper Rail is a locally permanent resident of coastal salt and brackish marshes around San Francisco Bay. Since the mid-1800s, about 80% of San Francisco Bay's marshlands have been eliminated through filling, diking, or conversion to salt evaporation ponds. As a result, the California Clapper Rail lost most of its former habitat, the population declined severely, and the species was listed as endangered in 1970.

Clapper Rails along the Pacific Coast prefer salt marshes and brackish marshes dominated by cordgrass (*Spartina foliosa*) and marsh gumplant (*Grindelia stricta*); in brackish marshes they also frequent areas supporting bulrushes (*Scirpus* sp.). These birds also require shallow areas or mudflats for foraging, particularly dendritic channels with overhanging banks and vegetation. In coastal situations, Clapper Rails forage on crabs, mussels, clams, snails, insects, spiders, worms, and occasionally mice and dead fish (Zembal and Massey 1983). As a refuge from extreme high tides and as a supplementary foraging area, rails move to the upper marsh vegetation where it intergrades with peripheral halophytic vegetation. California Clapper Rails nest from early March through August in the tallest vegetation along tidal sloughs, particularly in California cordgrass and marsh gumplant. They are non-migratory, although juveniles disperse during late summer and autumn.

Surveys were conducted in the SWRP for Clapper Rails during the breeding season (March-April) in 1992 (Orton-Palmer and Takekawa 1992). These surveys resulted in detections of one pair, and one individual rail in the western portion of the SWRP. Although Clapper Rails typically breed in tidal habitats with dendritic channels, the SWRP may provide an alternate foraging and breeding habitat. Orton-Palmer and Takekewa (1992) proposed that the SWRP may provide habitat for rails when adjacent tidal habitat on Stevens Creek is unavailable due to tidal flooding. Thus, although the SWRP provides habitat that would typically be considered sub-optimal for Clapper Rail breeding, Rails have been observed on-site during the breeding season and may forage and breed on-site.

Salt Marsh Harvest Mouse (Reithrodontomys raviventris). Federal Listing Status: Endangered; State Listing Status: Endangered. The salt marsh harvest mouse is endemic to pickleweed marshes of the San Francisco Bay. This species is most abundant in deep, dense pickleweed in marshes providing non-submerged refugia during high winter tides (Shellhammer and others 1982). Although this species makes some use of grasses and salt-tolerant forbs at the upper margins of salt and brackish marshes, it is closely tied to the cover of dense pickleweed, and it makes little use of pure alkali bulrush or cordgrass stands (Shellhammer and others 1982; Wondolleck and others 1976). These mice inhabit both marshes that are open to tidal action and diked marshes, provided that suitable pickleweed habitat is present.

Although the dense pickleweed on the south side of the SWRP appears to provide salt marsh harvest mouse habitat, trapping efforts conducted on the project site in 1991 and 1994 resulted in only one salt marsh harvest mouse caught each year (Layne and Harding-Smith 1994; Pomeroy 1991). Surprisingly, one of these mice (in 1991) was apparently caught on the levee between the SWRP and the NE Basin, on the NE Basin side of the levee. The low density of mice in the SWRP may be a result of extended periods of winter flooding. Salt marsh harvest mice use higher-elevation refugia habitat during short-term flooding events (e.g., high tides), but extended winter flooding of the SWRP may preclude the establishment of a population at the project site. Higher densities have been found in pickleweed habitat adjacent to Stevens Creek in 2004, near the project site

(Shellhammer unpublished data). The Western Diked Marsh, south of the project site, may also provide transitional habitat suitable for salt marsh harvest mice.

Western Snowy Plover (Charadrius alexandrinus nivosus). Federal Listing Status: Threatened; State Listing Status: Species of Special Concern. Western Snowy Plovers are small shorebirds that nest on beaches and similar habitats throughout western North America. Western Snowy Plovers historically nested primarily on sandy coastal beaches and on the margins of alkali lakes and playas in inland areas. Currently, about 10% of the California population of Snowy Plovers breeds within San Francisco Bay salt ponds, mostly in the southern part of the Bay (Page and Stenzel 1981; Page and others 1991). Here, the species nests on flat, bare or sparsely vegetated substrates, particularly light-colored substrates such as salt flats. Nests may be placed on salt pond levees, islands, or dry salt flats. Adults nesting in these ponds and their chicks, forage almost entirely within the salt ponds or on surrounding levees.

No Snowy Plovers were observed on the project site during our site visit in June 2004 or during directed surveys for the species during the 1994 breeding season (Layne and Harding-Smith 1994). Individual Snowy Plovers have been recorded in salt ponds in the vicinity, and there is at least one incidental record from the SWRP (Layne and Harding-Smith 1994). Although the project area provides suitable foraging habitat for Snowy Plovers, breeding habitat in the SWRP is probably not suitable for the species. Snowy Plovers typically nest where there are larger expanses of unvegetated salt pan. Snowy Plovers could potentially forage on-site, but are unlikely to breed on-site.

California Least Tern (Sterna antillarum browni). Federal Listing Status: Endangered; State Listing Status: Endangered. Least Terns are small fish-eating birds that nest primarily on beaches. Currently, the breeding colony at Alameda is one of the most important breeding colonies in the State and is currently the only nesting colony in San Francisco Bay. The main post-breeding (late summer/fall) staging area of the Least Tern in the South Bay is in the complex of salt ponds immediately north of Moffett Field and, to a lesser extent, in the vicinity of Shoreline Park in Mountain View.

California Least Terns do not currently nest anywhere in the South Bay, but foraging birds frequently occur in South Bay salt ponds. Although there area no records from the project site, Least Terns have been observed foraging and roosting at salt ponds B1 and B2, just north of the project site (Layne and Harding-Smith 1994). These ponds may be an important habitat for post-fledging foraging in late summer. Least Terns are unlikely to nest on the project site but could forage or roost on the site.

2.5.21 California Species of Special Concern, State Protected, or Federal Candidate Species

Burrowing Owl (Athene cunicularia). Federal listing status: None; State listing status: Species of Special Concern. The burrowing owl is a small, terrestrial owl of open country. Burrowing owls favor flat, open grassland or gentle slopes and sparse shrubland ecosystems. In California, Burrowing Owls are found in close association with California ground squirrels (*Spermophilus beecheyi*). Owls use the abandoned burrows of ground squirrels for shelter and nesting. Ground squirrels provide nesting and refuge burrows and maintain short vegetation height, which provides visual protection from avian predators and foraging habitat.

Burrowing Owls nest at various sites around Moffett Field and have been studied for a number of years (Trulio 2001). Most occupied burrows are in grassland habitats elsewhere at Moffett Field, but a few burrows have been found in the Eastern and Western Diked Marshes. In 2000, there was an active burrow near the service yard just south of the SWRP (Trulio 2001). Most habitat within the

SWRP is marginal for Burrowing Owl nesting, but there are areas of grassland, especially on the central peninsula, that could be used for foraging and potentially for nesting by Burrowing Owls.

Loggerhead Shrike (Lanius ludovicianus). Federal listing status: None; State listing status; Species of Special Concern. Loggerhead Shrikes prefer open habitats interspersed with shrubs, trees, poles, fences, or other perches from which they can hunt. Although Loggerhead Shrike populations have declined over the past 20 years, they are still considered a fairly common species in California. Loggerhead Shrikes are primarily monogamous and are very territorial throughout the year. Nests are built in densely-vegetated shrubs or trees, often containing thorns, which offer protection from predators and upon which prey items are impaled. They typically breed February and June. Loggerhead Shrikes have been observed regularly in the vicinity of the project site and have nested within the SWRP (Layne and Harding-Smith 1994). Suitable nesting habitat exists along the south side of the SWRP and at other smaller areas with shrubs.

Salt Marsh Common Yellowthroat (Geothlypis trichas sinuosa). Federal listing status: None; State listing status: Species of Special Concern. The Salt Marsh Common Yellowthroat inhabits emergent vegetation and breeds in fresh and brackish marshes and associated upland areas in the San Francisco Bay Area. This subspecies (one of the approximately 12 subspecies of Common Yellowthroat recognized in North America) breeds from mid-March through early August and pairs frequently raise two clutches per year (Terrill 2000). Because subspecies cannot be reliably distinguished in the field, determination of the presence of Salt Marsh Common Yellowthroat can be achieved only by locating a nest in the breeding range known for this subspecies or by observing them during the summer months when only the Salt Marsh Common Yellowthroat is present. Although little is known regarding the movements of this taxon, the wintering areas have been described as coastal salt marshes from the San Francisco Bay region to San Diego County (Grinnell and Miller 1944). The Salt Marsh Common Yellowthroats have been observed during the breeding season at the Eastern and Western Diked Marshes (Layne and Harding-Smith 1994) and likely breed there. They are also likely to breed within the freshwater marsh habitat in the SWRP.

Alameda Song Sparrow (Melospiza melodia pusillula). Federal listing status: None; State Listing Status: Species of Special Concern. The Alameda Song Sparrow is one of three subspecies of Song Sparrow breeding only in salt marsh habitats in the San Francisco Bay area. Locally, it is most abundant in the taller vegetation found along tidal sloughs, including salt marsh cordgrass and marsh gumplant. Although it is occasionally found in bulrushes in brackish marshes, the Alameda Song Sparrow is very sedentary and is not known to disperse upstream into freshwater habitats. Populations of the Alameda Song Sparrow have declined due to the loss of salt marshes around the bay, although within a suitable habitat it is still fairly common. The location of the interface between populations of the Alameda Song Sparrow and those of the race breeding in freshwater riparian habitats (*M. m. santaecrucis*) along most creeks is not known due to difficulties in distinguishing individuals of these two races in the field. Song Sparrows were observed on the project site during the June 2004 site visit, and Alameda Song Sparrows likely nest and forage within the SWRP.

White-tailed Kite (Elanus caeruleus). Federal Listing Status: None; State Listing Status: Fully Protected. White-tailed Kites are raptors that forage for small rodents and other prey primarily in open grassy or scrubby areas. They nest in large shrubs or trees adjacent to this habitat. This species is fairly common in San Francisco Bay marshes. White-tailed Kites were observed in the diked marshes south of the SWRP engaged in courtship behavior (Layne and Harding-Smith 1994). This species likely forages regularly over the SWRP and could nest in coyote brush within the project site.

2.5.22 Existing Biotic Functions and Values Summary

The project area provides a variety of habitats for wildlife species, as well as suitable habitat for numerous special-status plant and animal species. In total, nine habitat types were identified on site, seven of which are vegetated with native plant species and provide valuable habitat for native wildlife. Ten special-status plant species could occur in the project area including the federally-endangered Contra Costa goldfields and California seablite. None were observed during the initial site reconnaissance. Protocol-level surveys for the special-status species are recommended to determine presence or absence and to better assess tidal marsh restoration opportunities and constraints.

The diked salt marsh provides habitat for two federally-listed animal species, the salt marsh harvest mouse and the California Clapper Rail, while the peripheral halophyte area provides refugial habitat for the salt marsh harvest mouse during high water. Existing habitat for these species on-site is likely marginal due to the lack of tidal flushing and prolonged storm water inundation during the winter and spring. Steelhead (federally-listed threatened) are known to occur in Stevens Creek adjacent to the site. The project site also affords suitable foraging habitat (not breeding habitat) for two other federally-listed species, the Western Snowy Plover and the California Least Tern. In addition, suitable foraging and breeding habitat is present on-site for various special-status wildlife species including: Burrowing Owl, Loggerhead Shrike, Salt Marsh Common Yellowthroat, Alameda Song Sparrow, and White-tailed Kite.

Of primary concern with respect to the biotic functions and values of the SWRP is the potential for perennial pepperweed to invade and degrade the valuable habitat areas as a result of breaching the Stevens Creek levee. This highly competitive non-native plant is well established in adjacent areas. Currently, high soil salinity and/or prolonged flooding likely preclude the expansion of the few perennial pepperweed colonies that have established in the project area. A decrease in salinity (a shift to more brackish conditions) could promote the spread of perennial pepperweed at the project site.

3

BROWN AND CALDWELL

SECTION 3

OPPORTUNITIES AND CONSTRAINTS

Opportunities and constraints related to storm water hydrology, physical processes, and biological functions and values will influence the formulation of Moffett Field restoration alternatives. Opportunities and constraints identified as part of the restoration feasibility study have been compiled into several categories and are presented in this section.

3.1 Storm Water Hydrology

3.1.1 Storm Water Hydrology Opportunities

- *Upstream storage in diked marshes.* The Eastern and Western Diked Marshes could potentially be used for some storm water detention. The amount of storage, however, would be significantly less than the SWRP because the diked marshes are at higher elevations.

- *Levee modifications for increased storage.* Based on Moffett Field topographic data, some low spots exist in the levees currently surrounding SWRP. The low spots at elevation 4.0 ft NAVD could be raised to allow for greater storage capacity.

- *Upstream detention facility.* If storm water flows could possibly be detained in multiple small upstream detention facilities, then peak storm water flows into the SWRP could be decreased.

3.1.2 Storm Water Hydrology Constraints

- *Need to capture site drainage.* A storm water management facility, either the existing SWRP or another facility, is needed to capture and treat site runoff.

- *Upland flooding due to increased water surface elevations.* Increasing water surface elevations above 4 ft NAVD by raising SWRP levee elevations could potentially cause upland flooding. Storm water is collected through the drainage system, flows to the settling basin, and is gravity-fed to the Eastern Diked Marsh. Because the settling basin is at approximately 4 ft NAVD, increasing water surface elevations above 4 ft NAVD in the SWRP and Eastern Diked Marsh would potentially cause upland flooding and would render the settling basin inoperable. Additionally, recent reports have stated that the northern portion of the site (near the diked marshes and settling basin) is prone to flooding caused by storm flows that exceed the current site drainage system capacity (National Aeronautics and Space Administration 2002). Therefore, increasing the water surface elevations in the SWRP would further contribute to the existing site flooding.

- *Water quality from storm water.* If storm water is discharged to Stevens Creek, receiving water bodies (i.e., Stevens Creek, Pond A2E, and the Bay) could be adversely affected unless upstream treatment occurs. Regulatory issues could potentially be associated with any such discharge.

- *Groundwater table.* The high groundwater table within the project area eliminates the possibility of excavating the SWRP for additional storage. Groundwater levels within the project area are shallow, typically ranging from approximately -2 ft MSL (NAVD) in the dry season to approximately 3 ft MSL (NAVD) in the wet season, as described in Section 2.2. Excavation would not likely result in additional storage, since the excavated area would fill with groundwater.

- *Lack of undeveloped upstream area and sufficient replacement SWRP area.* An approximate total of 385 acres of pervious land exists upstream of the project area; however, the pervious land is scattered throughout the Moffett Field Western Drainage Basin. The lack of undeveloped upstream areas means that construction of a replacement SWRP is unlikely to be feasible.

- *Long-term operational costs.* High, long-term operational costs (pumping) may limit the storm water outlet to Stevens Creek. Due to associated operational and maintenance costs, NASA has established an objective to limit pumping events (overflow events) to no more than once every five years.

3.2 Physical Processes

3.2.1 Physical Processes Opportunities

- *Tidal circulation via Stevens Creek.* Stevens Creek monitoring data show a strong tidal signal adjacent to the site, indicating that the creek could supply tidal circulation to the SWRP if the creek levee were breached or removed (Figure 2-13). The connection to Stevens Creek could be designed to allow either muted or full tidal action in the SWRP site.

- *Tidal circulation via Pond A2E.* USGS bathymetric data for Pond A2E adjacent to the site suggest that a tidal connection could be achieved if the levee separating the two sites were breached or removed. However, no information is available regarding the potential tidal range that Pond A2E might provide under various restoration scenarios.

- *SWRP elevation increase by natural sedimentation.* Natural sedimentation could raise ground elevations on the site to desired levels over time if a tidal connection to Stevens Creek were created.

- *SWRP elevation increase by on-site fill.* On-site fill material could potentially be used to raise ground elevations in some portions of the site for habitat creation/restoration. Alternatively, on-site fill material could potentially be used to enhance the SWRP containment levees and increase the level of flood protection they provide.

- *Remnant drainage channels.* Recent aerial photographs show remnant drainage channels in the SWRP. These channels could be used to optimize site drainage if tidal circulation were re-introduced.

3.2.2 Physical Processes Constraints

- *Low site elevation for tidal restoration.* If tidal action were introduced at the existing grades, the majority of the site would be under approximately 5 ft of sea water on average during a normal tidal cycle and the vast majority of the site would be under water even during low tide. The average SWRP bed elevation is approximately –2 to –1 ft NAVD, indicating that the site has subsided 7 to 9 ft below the typical natural marshplain elevation of MHHW (7.7 ft NAVD at Palo Alto Yacht Harbor) (Tables 2-1 and 2-3).

- *Time period for natural sedimentation.* Natural sedimentation may take a significant period of time and will be slower than raising site elevations by grading the surface of the site. Sedimentation rates would be slower if tidal exchange to the site is muted rather than full tidal.

- *Levee top elevations.* Typical levee top elevations along the northern, eastern, and southern portions of the SWRP (~4 ft NAVD) are approximately 2 to 3 ft below the MHW level (7.0 ft NAVD). Therefore, if tidal action were introduced to the SWRP with existing levee elevations, the risk of tidal flooding around the site would likely increase.

- *Levee erosion.* The introduction of tidal circulation could increase the potential for erosion of the levees surrounding the SWRP. Similarly, increased tidal circulation could put additional stress on the Stevens Creek levee downstream of the site.

- *Other Infrastructure.* Other existing infrastructure on and around the site such as culverts, drainage channels, fences, and roads will need to be protected against any adverse impacts caused by the introduction of tidal circulation.

3.3 Biological Functions and Values

3.3.1 Biological Functions and Values Opportunities

- *SWRP and MROSD parcel managed specifically for waterbirds.* Salt ponds are used extensively by many waterbird species in the South Bay, and the existing storm water retention pond provides breeding and foraging habitat for a variety of waterbird species. Pond management for waterbirds could complement the regional SBSPRP where the potential impact on shorebirds and waterbirds of decreasing the number of salt ponds is a primary concern. There is a tremendous opportunity to manage the site more effectively for waterbird use (e.g., breeding, roosting, foraging). For example, maintenance of extensive shallow water areas throughout the year could enhance the existing function of the site as a high-tide foraging habitat for shorebirds. Construction of island complexes like those designed in San Joaquin Valley experiments (Gordus and others 1996; Terrill and others 1996; Terrill and Seay 2001), could greatly increase the area available for shorebird breeding. In addition, different portions of the site could be separated via levees/berms and managed for a variety of salinities to benefit different waterbird species (moderate or low salinity for most waterfowl species, higher salinity for salt pond specialists e.g., Wilson's Phalaropes and potentially snowy plover).

- *Increase in surface area of tidal saltwater habitats including tidal mudflat and tidal salt marsh over the long term.* The restoration of tidal saltwater habitats would have a net benefit to invertebrates, birds, fishes, small mammals, seals, and native plants.

- *Potential for recovery of the South Bay subspecies of the salt marsh harvest mouse.* By restoring pickleweed-dominated tidal salt marsh for the salt marsh harvest mouse, the opportunity exists to substantially contribute to the recovery of this endangered subspecies. Restored tidal salt marshes should be complete, meaning the restored marshes contain: 1) upper-elevation, pickleweed zones, 2) broad bands of peripheral halophytes, 3) broad transitional zones into upland vegetation, as well as 4) the cordgrass and lower pickleweed zones that currently exist.

- *Restored habitat for the California Clapper Rail.* The endangered California Clapper Rail is found only in San Francisco Bay wetlands. Restoration of tidal salt marsh habitat at the site would benefit the California Clapper Rail by increasing the available nesting/foraging habitat in the region. Restoration of habitat for this species would also benefit other special-status bird species, such as Alameda Song Sparrow and Salt Marsh Common Yellowthroat.

- *Restored transitional ecotone between tidal salt marsh and upland habitats.* Restoration of the tidal salt marsh/upland ecotone would be an essential component of a tidal marsh restoration design to provide high tide refugia for tidal-marsh species and shorebirds. It could also benefit rare-plant species including Contra Costa goldfields (*Lasthenia conjugens*) and Pt. Reyes birds beak (*Cordylanthus maritimus* ssp. *palustris*).

- *Restored riparian habitat.* Additional riparian habitat (i.e. willow groves), a valuable habitat type, could be established by active revegetation in appropriate locations.

- *Storm water discharge could control the invasive perennial pepperweed (Lepidium latifolium) in the Western Diked Marsh.* The invasive exotic plant perennial pepperweed, dominates the plant community of the Western Diked Marsh. If the Western Diked Marsh were needed and utilized for storm water retention, the hydroperiod could be designed to eradicate perennial pepperweed from this area. The storm water would be used on a temporary basis to remove pepperweed, and the Western Diked Marsh returned to seasonal tidal marsh with the objective of establishing salt marsh harvest mouse habitat.

3.3.2 Biological Functions and Values Constraints

- *Invasion of restored tidal marshes by perennial pepperweed.* Perennial pepperweed has colonized the tidal marshplain in brackish areas of the South Bay including Stevens Creek adjacent to the site, as well as the upstream Western Diked Marsh.

- *Invasion of restored tidal marshes by smooth cordgrass (Spartina alterniflora* [hybrids]). Smooth cordgrass and its hybrids have colonized previously unvegetated, tidal mudflats, degrading shorebird foraging habitat. Hybrids between S. *alterniflora* and the native cordgrass, S. *foliosa*, threaten to eradicate native cordgrass through pollen swamping. Cordgrass hybrids are also able to invade higher elevations, impacting salt marsh harvest mouse and California Clapper Rail habitat, as well as damaging native-plant communities. S. *alterniflora* [hybrids] can also invade into lower elevations than the native, threatening mudflats and smaller order channels and thus shorebird and California Clapper Rail foraging habitat. Restoration work should be coordinated with the Invasive Spartina Project to assess constraints associated with S. *alterniflora* [hybrids].

- *Loss of pond as habitat for shorebirds and waterfowl.* The loss of pond as habitat for shorebirds and waterfowl. The conversion of the SWRP to tidal salt marsh would benefit special-status species such as the California Clapper Rail and the salt marsh harvest mouse but would be detrimental to wildlife species that use the existing pond, such as shorebirds (including the Western Snowy Plover), waterfowl, and possibly terns (including the California Least Tern) on a site-specific level. However, in the context of the SBSPRP, the loss of shorebird and waterfowl habitat at the SWRP is not a major consideration.

- *Nuisance algae/algal blooms.* Nuisance algae can occur in ponds with elevated nitrogen and phosphorus concentrations and salinity levels below a range of approximately 30 to 50 ppt. Macroalgal mats and heavy algal blooms lead to anoxia and the accumulation of biomass along the shoreline. The decomposition of the biomass causes odor problems caused by releases of hydrogen sulfide.

4

BROWN AND CALDWELL

SECTION 4

DESCRIPTION OF RESTORATION ALTERNATIVES

Alternatives for restoration of the Moffett Field SWRP were developed based on the existing conditions (Section 2) and identified opportunities and constraints (Section 3), and are described in this section.

Assumptions integral to each of the alternatives include the following:

1. Contaminated sediments in the Central and NE Basins and the MROSD Parcel will be completely removed and/or capped with a layer of "clean" clay sediment suitable to support the habitats identified in each alternative (i.e., Navy Site 25 will be fully remediated to wildlife-compatible standards, not just to address human health risks).

2. The current basin floor elevation of the Central and NE Basins will be maintained.

3. Present day storm water input contaminant loads to the SWRP are below biotic effects thresholds.

4.1 Alternative 1 – No Action

4.1.1 Overview

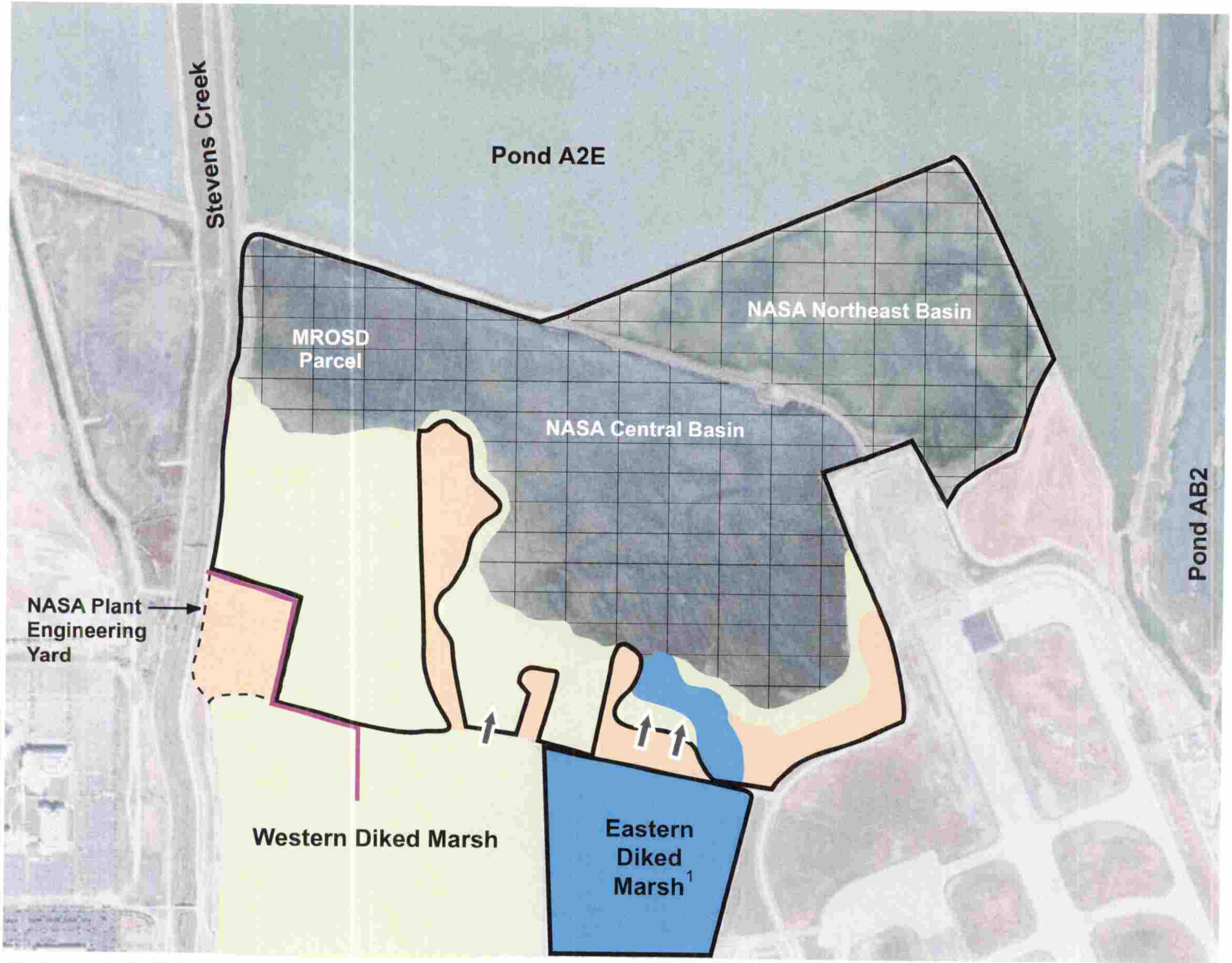
The "no action" alternative represents no changes to the existing SWRP. Two variations of no action are as follows:

a. *Alternative 1a - Existing conditions.* This alternative represents no change in the current site condition, and was considered only for comparison to other actions (Figure 4-1).

b. *Alternative 1b - Removal of the MROSD parcel from storm water storage.* NASA has agreed to discontinue use of the MROSD parcel for storm water retention in the future, if a levee were to be constructed by MROSD or the U.S. Army Corps of Engineers (Corps) as part of the SBSPRP, to isolate the MROSD parcel from the SWRP (Figure 4-2)[1]. This would result in a reduction of the available storage volume of the SWRP.

Tidal salt marsh/upland transition habitat would be provided by constructing a gently sloped fill area along the outboard side of the new flood control levee going from MHHW to the levee crest. Such transitional habitat is essential for the recovery of the salt marsh harvest mouse.

[1] The proposed levee alignment does not follow property boundaries. The actual levee location would be determined by MROSD, NASA, and the Corps in future planning. A small portion (~2 acres) in the northwest corner of the area depicted as the NASA Central Basin in Figure 4-2 is actually owned by MROSD. Refer to Figure 1-1 for MROSD and NASA property boundaries.



Background: IKONOS Satellite Photo - May 2004 (Provided by the City of San Jose)

[1] The Eastern Diked Marsh was not surveyed during the exisiting conditions field work, but appears to be primarily freshwater marsh with some pockets of riparian habitat (Jones and Stokes, 1999).

Legend

Target Biotic Habitats

- Diked Salt Marsh (includes salt panne)
- Freshwater Marsh
- Non-Tidal Open Water (not actually managed for shorebirds)
- Other (upland, peripheral halophyte, developed, coyote brush scrub, non-native herbaceous)
- Storm Water Retention Pond Boundary
- Storm Water Flow
- NASA Sewer Connection to Mountain View Line

Moffett Field Restoration Feasibility Study

Figure 4-1
Alternative 1a: No Action (Existing Conditions)

0 425' 850'
Scale in feet

N

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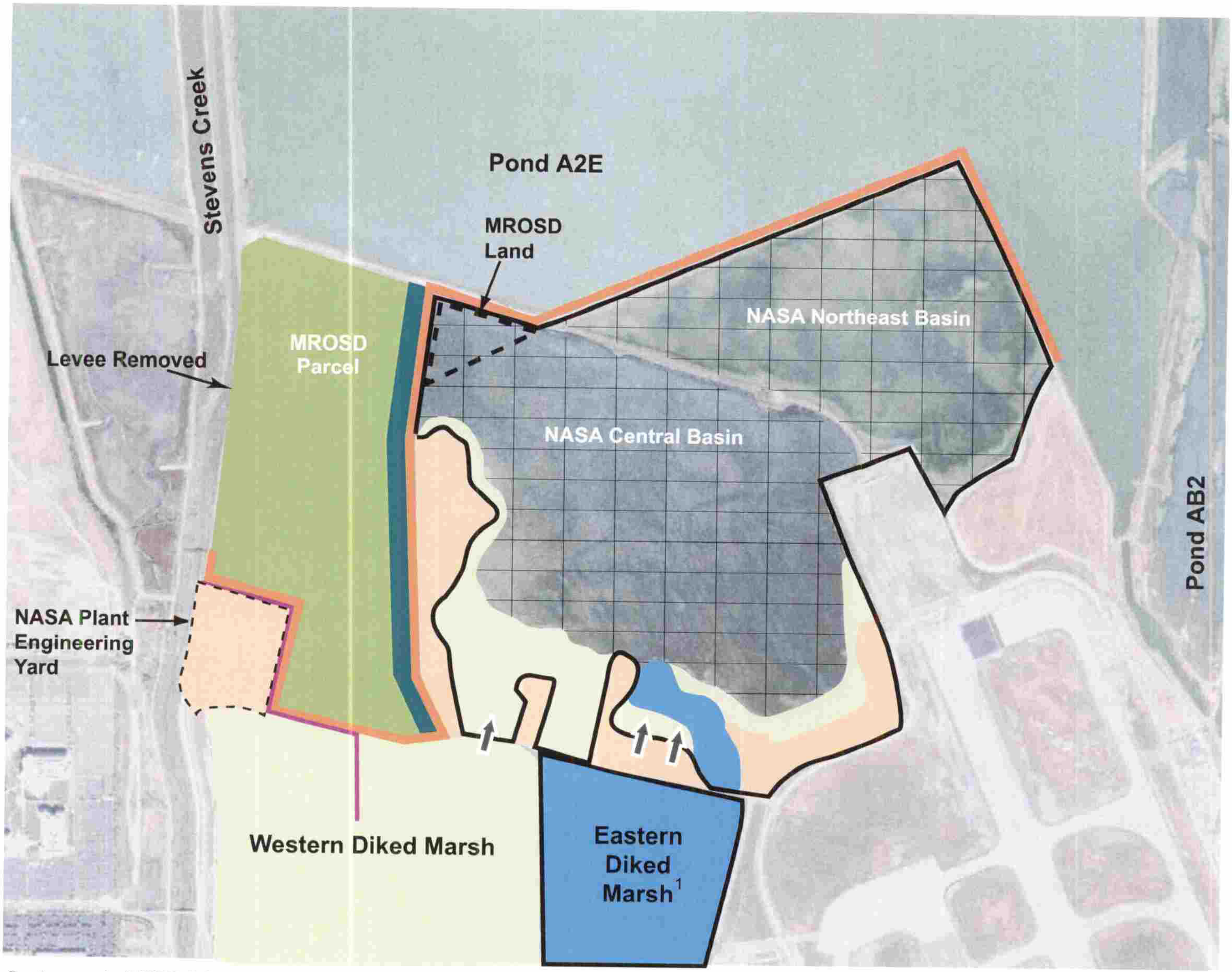

Background: IKONOS Satellite Photo - May 2004 (Provided by the City of San Jose)

[1] The Eastern Diked Marsh was not surveyed during the exisiting conditions field work, but appears to be primarily freshwater marsh with some pockets of riparian habitat (Jones and Stokes, 1999).

Legend

Target Biotic Habitats

- Diked Salt Marsh (includes salt panne)
- Freshwater Marsh
- Non-Tidal Open Water (not actually managed for shorebirds)
- Tidal Salt Marsh
- Tidal Salt Marsh-Upland Transition (gentle slope ≥100 feet wide from MHHW to levee crest)
- Other (upland, peripheral halophyte, developed, coyote brush scrub, non-native herbaceous)

- Proposed Levee
- Storm Water Retention Pond Boundary
- Storm Water Flow
- NASA Sewer Connection to Mountain View Line

Moffett Field Restoration Feasibility Study

Figure 4-2
Alternative 1b: No Action
(Removal of MROSD Parcel)

0 425' 850'
Scale in feet

N

Project No. 25846

4.1.2 Assumptions

Alternative 1b

- NASA would not take any action under this alternative. MROSD, SBSPRP, and/or the Corps would be responsible for restoration actions and levee modifications.
- The Stevens Creek levee would be fully removed along the western edge of the site to allow for tidal action in the MROSD parcel.
- The SBSPRP would increase the tidal prism between the MROSD parcel and the Bay by implementing tidal restoration in adjacent salt ponds (e.g., Ponds AB1, A2W, and/or A2E) to result in a salinity regime sufficiently high to be suitable for salt marsh vegetation establishment.

4.1.3 Key Design Features

Alternative 1b

As part of this alternative, levee modifications and key design features would include the following:

- As part of the SBSPRP, a levee would be constructed separating the MROSD parcel from the Moffett Field SWRP. This levee would have a broad, outboard side approximately 200 ft wide extending from the levee crest (8.5 ft NAVD) to MHHW (7.6 ft NAVD). This outboard levee would extend from MHHW to existing ground elevations at a side slope of 8:1. The inboard side of this levee would be a 3:1 side slope consistent with existing side slopes along this levee. The broad, outboard slope would provide refuge habitat for the salt marsh harvest mouse, in keeping with the SBSPRP Goals and Objectives. This slope would also reduce wave propagation by dissipating wave energy over a broader area, reducing the risk of levee erosion.
- Approximately 8,500 linear ft of perimeter flood levees separating the SWRP from the MROSD parcel and Pond A2E would be raised to 8.5 ft NAVD with 3:1 side slopes.
- Under this alternative, approximately 2,900 linear ft of the existing levees separating the SWRP from Stevens Creek would be "removed" (i.e., lowered to 4.0 ft to 6.0 ft NAVD).

Specific details regarding levee construction, volumes of material needed for design features, and associated costs are provided in Appendix E.

4.2 Alternative 2 – Partial Tidal Restoration

4.2.1 Overview

Partial restoration of the SWRP to tidal marsh, and continued use of the remaining portion of the SWRP (the Central Basin and possibly the Northeast Basin) for storm water retention is considered under this alternative. Some enhancements or management features may also be incorporated. Two variations of Alternative 2 are as follows:

a. *Alternative 2a - Stevens Creek expansion* (Figure 4-3). The eastern levee between Stevens Creek and the SWRP (MROSD parcel) would be removed to allow flows into the MROSD parcel and the northwest corner of the NASA property and development of tidal marsh. Stevens Creek would be widened by removing the eastern levee beginning slightly south of the NASA Ames perimeter road. It is assumed that as part of SBSPRP, a new levee would be constructed by the Corps and would be angled to the north-northeast across the northwest corner of the Western Diked Marsh. The levee would continue at a consistent angle through the NASA Western Diked Marsh, the NASA Plant Engineering Yard, and the MROSD parcel until connecting to the new flood control levee that would be constructed across Pond A2E as part of the SBSPRP[2]. This alternative would result in restoration of tidal salt marsh at the current NASA Ames Plant Engineering yard in the northwest corner of the NASA Ames property. Tidal salt marsh/upland transition habitat, as defined under Alternative 1b, would be provided along the outboard side of the flood control levee that borders Stevens Creek.

Three tide gates would be installed – one between Stevens Creek and the Western Diked Marsh to create a seasonal tidal salt marsh, one between the tidally restored MROSD parcel and the seasonal tidal marsh MROSD parcel, and another between the tidally restored MROSD parcel and the Central Basin to manage the pond for shorebirds as well as storm water retention. The Western Diked Marsh tide gate would be operated during the dry season (April-October) to manage the hydroperiod and soil salinity to decrease perennial pepperweed abundance and increase pickleweed abundance.

b. *Alternative 2b - NE Basin restoration* (Figure 4-4). Under this alternative, Alternative 2a would be implemented with the addition of restoring the NE Basin to tidal salt marsh habitat by breaching the Pond A2E levee and importing approximately 5 to 7 ft of sediment[3]. If tidal action were introduced at the existing grades, the site would be under approximately 5 ft of sea water on average during a normal tidal cycle and the vast majority of the site would be under water even during low tide. In addition, preliminary sedimentation modeling results indicate that natural sedimentation would take approximately 6-12 years to raise site elevations to a level suitable for salt marsh vegetation establishment. Therefore, sediment import may be warranted to increase the rate of tidal salt marsh habitat establishment. Tidal salt marsh/upland transition habitat, as defined under Alternative 1b, would be provided along the outboard side of the flood control levees that border Stevens Creek and Pond A2E.

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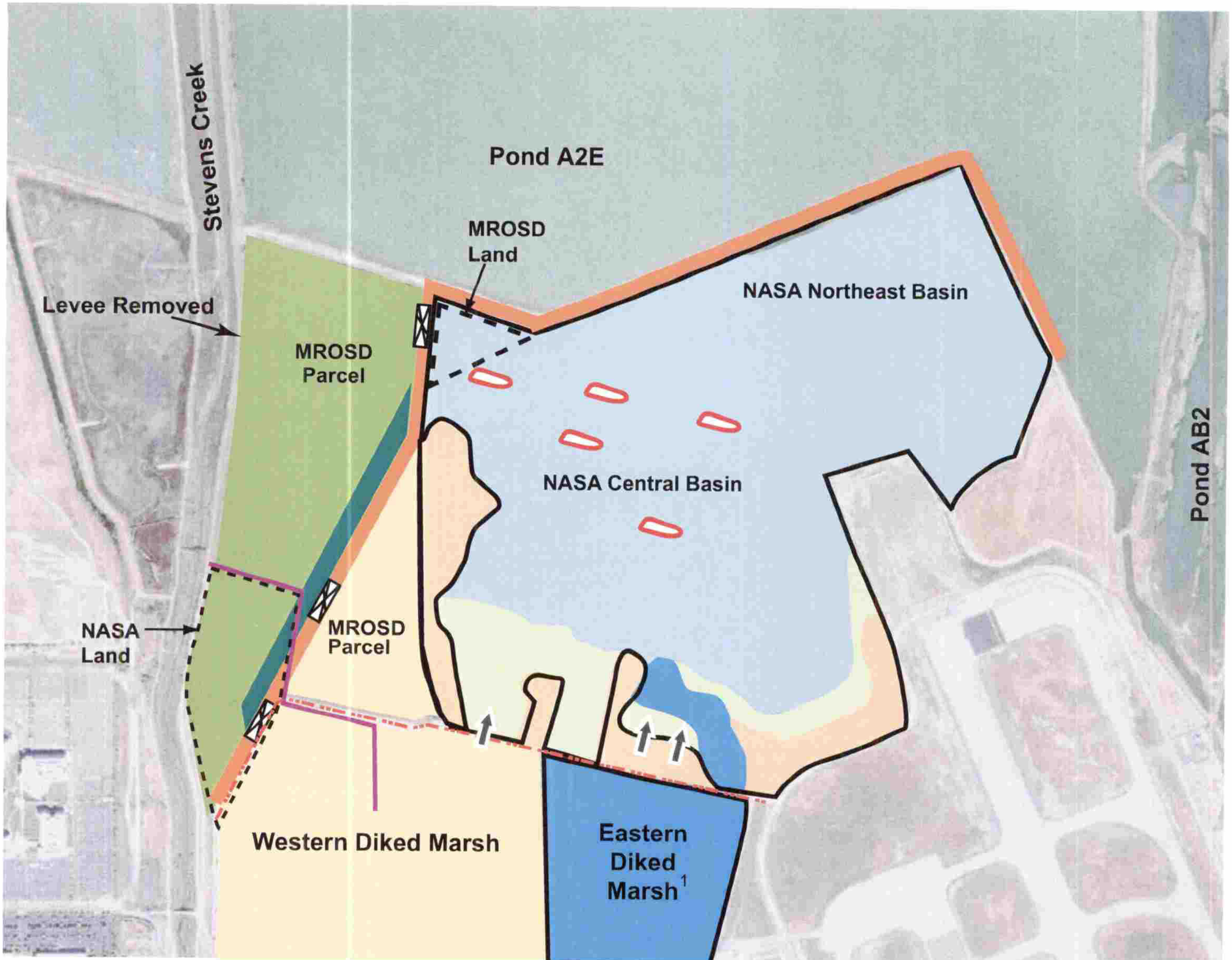
[2] The proposed levee alignment does not follow property boundaries. The actual levee location would be determined by MROSD, NASA, and the Corps in future planning. A small portion (~2 acres) in the northwest corner of the area depicted as the NASA Central Basin in Figure 4-3 is actually owned by MROSD. Refer to Figure 1-1 for MROSD and NASA property boundaries.

[3] The proposed levee alignment does not follow property boundaries. The actual levee location would be determined by MROSD, NASA, and the Corps in future planning. A small portion (~2 acres) in the northwest corner of the area depicted as the NASA Central Basin in Figure 4-4 is actually owned by MROSD. Refer to Figure 1-1 for MROSD and NASA property boundaries.



Background: IKONOS Satellite Photo - May 2004 (Provided by the City of San Jose)

[1] The Eastern Diked Marsh was not surveyed during the exisiting conditions field work, but appears to be primarily freshwater marsh with some pockets of riparian habitat (Jones and Stokes, 1999).

Legend

Target Biotic Habitats

- Diked Salt Marsh (includes salt panne)
- Freshwater Marsh
- Managed Pond for Shorebirds and Storm Water Retention
- Seasonal Tidal Salt Marsh
- Tidal Salt Marsh
- Tidal Salt Marsh-Upland Transition (gentle slope ≥100 feet wide from MHHW to levee crest)
- Other (upland, peripheral halophyte, developed, coyote brush scrub, non-native herbaceous)
- Shorebird Breeding / Roosting Island (~10ft x 40ft above maximum design water level)

- Proposed Levee
- Storm Water Retention Pond Boundary
- Storm Water Flow
- Tide Gate
- NASA Sewer Connection to Mountain View Line
- Proposed NASA Perimeter Road

Moffett Field Restoration Feasibility Study

Figure 4-3
Alternative 2a: Partial Restoration Stevens Creek Expansion

0 425' 850'
Scale in feet

N

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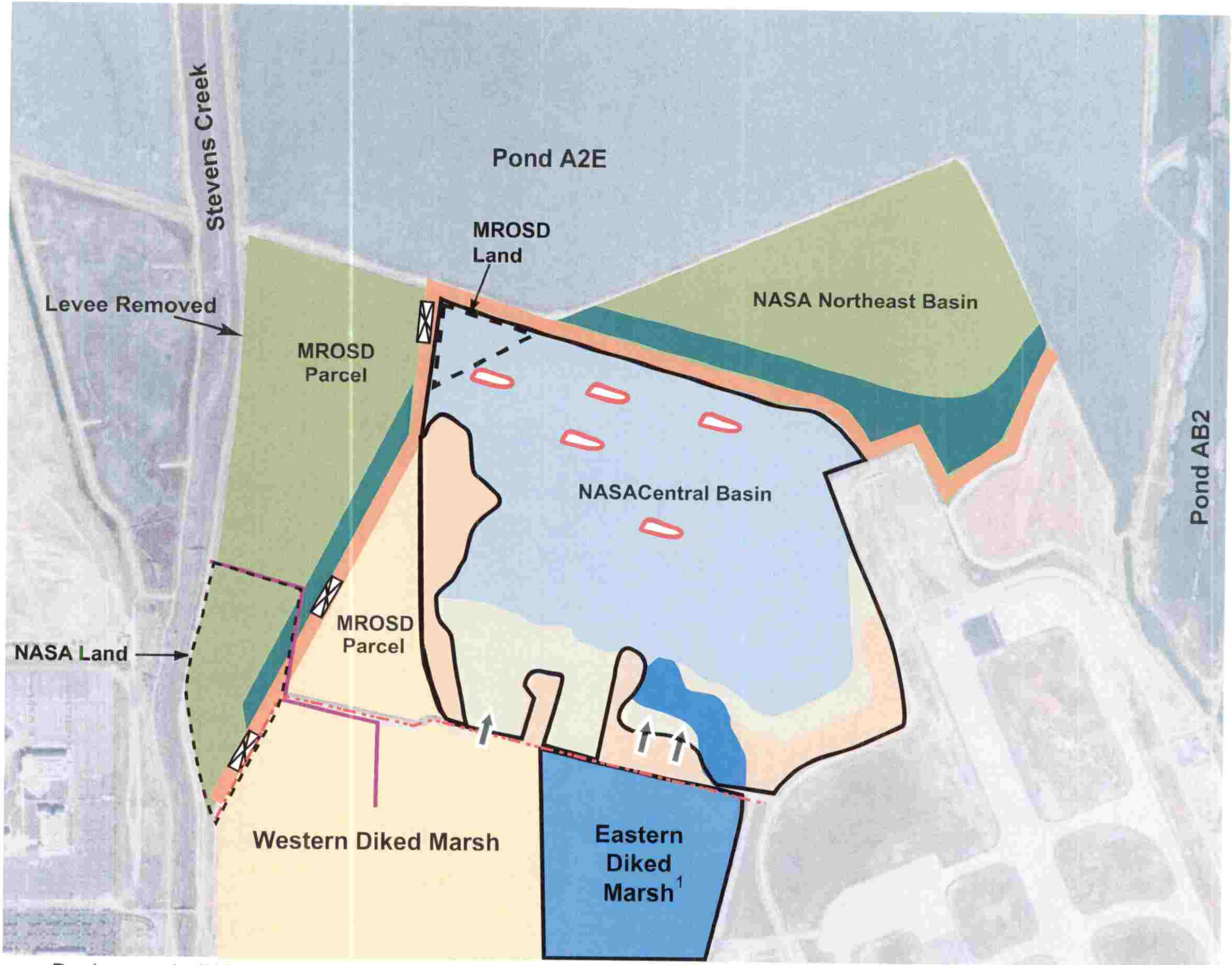


Background: IKONOS Satellite Photo - May 2004 (Provided by the City of San Jose)

[1] The Eastern Diked Marsh was not surveyed during the exisiting conditions field work, but appears to be primarily freshwater marsh with some pockets of riparian habitat (Jones and Stokes, 1999).

Legend

Target Biotic Habitats

- Diked Salt Marsh (includes salt panne)
- Freshwater Marsh
- Managed Pond for Shorebirds and Storm Water Retention
- Seasonal Tidal Salt Marsh
- Tidal Salt Marsh
- Tidal Salt Marsh-Upland Transition (gentle slope ≥100 feet wide from MHHW to levee crest)
- Other (upland, peripheral halophyte, developed, coyote brush scrub, non-native herbaceous)
- Shorebird Breeding / Roosting Island (~10ft x 40ft above maximum design water level)

- Proposed Levee
- Storm Water Retention Pond Boundary
- Storm Water Flow
- Tide Gate
- NASA Sewer Connection to Mountain View Line
- Proposed NASA Perimeter Road

Moffett Field Restoration Feasibility Study

Figure 4-4
Alternative 2b: Partial Restoration Northeast Basin Restoration

0 425' 850'
Scale in feet

N

Project No. 25846

4.2.2 Assumptions

Alternative 2a

- The Stevens Creek levee would be fully removed along the western edge of the site to allow for tidal action in the MROSD parcel.
- The SBSPRP would increase the tidal prism between the MROSD parcel and the Bay by implementing tidal restoration in adjacent salt ponds (e.g., Ponds AB1, A2W, and/or A2E) to result in a salinity regime sufficiently high to be suitable for salt marsh vegetation establishment.
- The Corps would construct a levee between the MROSD parcel and the Moffett Field storm water retention pond, as part of the SBSPRP.
- Preliminary sedimentation modeling results indicate that natural sedimentation could take 6-12 years to raise site grades enough to allow salt marsh vegetation establishment.
- The acreage of diked salt marsh vegetation along the southern boundary of the Central Basin would not increase and may decrease, depending on the water management regime.
- NASA Ames personnel would be available for operating NASA tide gates as needed, and MROSD personnel would be available for operating MROSD tide gates as needed.

Alternative 2b

All assumptions listed for Alternative 2a would apply with the addition of the following:

- The SBSPRP implements either Option 2 (mix of tidal and managed ponds) or Option 3 (tidal emphasis), as detailed in the South Bay Salt Ponds Preliminary Program Alternatives Memorandum (January 2005) (South Bay Salt Pond Restoration Project 2005), which would result in tidal restoration of Pond A2E.

4.2.3 Key Design Features

Alternative 2a

As part of this alternative, levee modifications and key design features would include the following:

- As part of the SBSPRP, a levee would be constructed separating the MROSD from the Moffett Field SWRP. Under Alternative 2a, this levee includes an expansion of the tidal marsh to the south with continued storm water storage to the north of the Western Diked Marsh. This levee would have a broad, outboard side approximately 200 ft wide extending from the levee crest (8.5 ft NAVD) to MHHW (7.6 ft NAVD). This outboard levee would extend from MHHW to existing ground elevations at a side slope of 8:1.
- The inboard side of this levee would be a 3:1 side slope consistent with existing side slopes along this levee. The broad, flat, outboard slope would provide refuge habitat for the salt marsh harvest mouse, in keeping with the SBSPRP Goals and Objectives. This slope also would reduce wave propagation by dissipating wave energy over a broader area, reducing the risk of levee erosion.

- Five islands would be constructed in the Central Basin to enhance breeding and roosting habitat for waterbirds. Each island would have an area of ±400 ft^2 above the maximum winter storm water elevation. Volume estimates were made on a per island basis for 8:1 side slopes, which is recommended to minimize the risk of erosion of the islands.
- Approximately 7,100 linear ft of levees separating the SWRP and MROSD parcel from Pond A2E would be raised to 8.5 ft NAVD with 3:1 side slopes.
- Under this alternative, approximately 3,500 linear ft of the existing levees separating the SWRP from Stevens Creek would be "removed" (i.e., lowered to 4.0 ft to 6.0 ft NAVD).

Alternative 2b
As part of this alternative, levee modifications and key design features would be the same as Alternative 2a with the exception of the following:

- A levee would be constructed on the outboard side of the Central Basin and Moffett Field airstrip, and the levee separating NE Basin from Pond A3E would be removed, opening the NE Basin to full tidal exchange. This levee would have a broad, outboard side approximately 200 ft. wide extending from the levee crest (8.5 ft NAVD) to MHHW (7.6 ft NAVD). This outboard levee would extend from MHHW to existing ground elevations at a side slope of 8:1. The inboard side of this levee was modeled at a 3:1 side slope consistent with existing side slopes along this levee. The broad, flat, outboard slope would provide refuge habitat for the salt marsh harvest mouse, in keeping with the SBSBRP Goals and Objectives. This slope also would reduce wave propagation by dissipating wave energy over a broader area, reducing levee erosion.
- Approximately 7,200 linear ft of levees separating the Central Basin and the MROSD parcel from Pond A2E and the restored Northeast Basin would be constructed to 8.5 ft NAVD with 3:1 side slopes.
- Under this alternative, approximately 7,100 linear ft of the existing levees separating the MROSD parcel from Stevens Creek and Pond A2E and the NE Basin from Pond A2E would be "removed" (i.e., lowered to 4.0 ft to 6.0 ft NAVD).

Specific details regarding levee construction, volumes of material needed for design features, and associated costs are provided in Appendix E.

Alternative 2 (Partial Tidal Restoration) Optional Components
Depending on which areas are restored, it may be necessary to expand the available storage volume of the remaining SWRP to offset losses associated with restoration. Two optional components that could be implemented as part of the partial tidal restoration alternative to increase available storage volume as follows:

- Raise levee elevations to create additional storm water storage in the Central Basin. (Constraints associated with this option are discussed in Section 3.1.2.)
- Use part of Pond A2E for storm water management when the new flood control levee is constructed, if Pond A2E (or a portion of the pond) becomes a managed pond under

the SBSPRP. (Acceptance of this option would be dependent upon management strategies and decisions made as part of the SBSPRP.)

4.3 Alternative 3 – Full Tidal Restoration

4.3.1 Overview

Restoration of the entire SWRP (MROSD parcel, Central Basin, and NE Basin) to tidal salt marsh is considered in the "full tidal restoration" alternative (Figure 4-5). Tidal connectivity would be achieved by removing the Stevens Creek levee and/or the Pond A2E levee, assuming that the SBSPRP provides sufficient tidal connection to Stevens Creek and/or that Pond A2E is restored to tidal salt marsh. A levee, to be constructed by others as part of the SBSPRP, would separate the Western and Eastern Diked Marshes and the remainder of the Moffett Field site from the restored SWRP. Storm water retention volume would essentially be eliminated under this alternative, and storm water runoff from Moffett Field would be pumped to the San Francisco Bay regularly. The Western and Eastern Diked Marshes would be frequently flooded and would hold standing water for much of the winter.

A loss of existing pond and seasonal brackish marsh habitat functions and values would occur under the full tidal alternative. The biotic habitat would become tidal salt marsh only.

4.3.2 Assumptions

- The SBSPRP implements either Option 2 (mix of tidal and managed ponds) or Option 3 (tidal emphasis), as detailed in the South Bay Salt Ponds Preliminary Program Alternatives Memorandum (January 2005) (South Bay Salt Pond Restoration Project 2005), which would include tidal restoration of Pond A2E.

4.3.3 Key Design Features

As part of this alternative, key design features would include the following:

- One levee would be constructed separating Moffett Field from a restored full tidal salt marsh, including the MROSD parcel, the Central Basin, and the NE Basin. This levee would have a broad, outboard side approximately 200 ft. wide extending from the levee crest (8.5 ft NAVD) to MHHW (7.6 ft NAVD). This outboard levee would extend from MHHW to existing ground elevations at a side slope of 8:1. The inboard side of this levee was modeled at a 3:1 side slope consistent with existing side slopes along this levee. The broad, flat, outboard slope would provide refuge habitat for the salt marsh harvest mouse, in keeping with the SBSPRP Goals and Objectives. This slope also would reduce wave propagation by dissipating wave energy over a broader area, reducing levee erosion.
- Under this alternative, 7,200 linear ft of the existing levees separating the SWRP from Stevens Creek and Pond A2E would be "removed" (i.e., lowered to 4.0 ft to 6.0 ft NAVD).

Background: IKONOS Satellite Photo - May 2004 (Provided by the City of San Jose)

[1] The Eastern Diked Marsh was not surveyed during the exisiting conditions field work, but appears to be primarily freshwater marsh with some pockets of riparian habitat (Jones and Stokes, 1999).

Legend

Target Biotic Habitats

- Diked Salt Marsh (includes salt panne)
- Tidal Salt Marsh
- Tidal Salt Marsh-Upland Transition (gentle slope ≥100 feet wide from MHHW to levee crest)
- Freshwater Marsh
- Other (upland, peripheral halophyte, developed, coyote brush scrub, non-native herbaceous)
- Proposed Levee
- NASA Sewer Connection to Mountain View Line

Moffett Field Restoration Feasibility Study

Figure 4-5
Alternative 3: Full Tidal Restoration

0 425' 850'
Scale in feet

N

Project No. 25846

Specific details regarding levee construction, volumes of material needed for design features, and associated costs are provided in Appendix E.

4.4 Sedimentation Evaluation

Since much of the site is significantly subsided, the timeframe for achieving restored tidal salt marsh under the alternatives being considered depends greatly on rates of sedimentation. Expected sedimentation was evaluated for all the alternatives using MARSH98, a one-dimensional, mass-balance model that accounts for non-linear marsh sediment accumulation rates assuming a full tidal connection (Appendix F). This section describes the field data collected to parameterize the model, as well as the model results.

The MARSH98 model was calibrated to the average sedimentation rate in the Stevens Creek Tidal Marsh. Six sediment cores were collected from the Stevens Creek Tidal Marsh (Figure 4-6). Core C was collected at a point not too proximal or distal from the northern culvert in Stevens Creek Tidal Marsh, and was, therefore, used as a representative average sedimentation location for calibration of the model. Local tidal conditions were also used for model calibration (Appendix F).

The six collected sediment cores contained a soil horizon, interpreted to be the pre-restoration horizon, which was overlain by estuarine mud (Figure 4-6). Sedimentation in Stevens Creek Tidal Marsh increased with proximity to the northern culvert, which is closer to the San Francisco Bay (Table 4-1). The higher sedimentation rates closer to the Bay and the type of sediment deposited (fine mud) suggest that the Bay is the primary source of sediments.

Table 4-1. Sedimentation Rates in Stevens Creek Tidal Marsh

Core ID (Figure 4-6)	Top Elevation (ft NAVD)	Bottom Elevation (ft NAVD)	Net Dep. (ft)	Sed. Rate (ft/yr)
A	6.2	2.3	3.9	0.19
B	6.5	1.8	4.7	0.22
C	6.6	-0.3	6.9	0.33
D	6.5	-1.4	7.9	0.37
E	6.5	-2.7	9.2	0.44
F	6.5	-1.3	7.8	0.37

Post Restoration-Estuarine Muds

*Pre-restoration Soil Horizon**

*Shows total core depth

Note: Core pictures taken from cores C & D to demonstrate representative sediment sequence.

N

0 375 750 1,500 Feet

Moffett Field Retention Basin Restoration Feasibility Study

Figure 4-6. Sediment Core Locations

Project No. 25486

PWA

Based on data from other locations in the South Bay, it is predicted that vegetation would colonize the Moffett Field site within an elevation range of 4.5 to 5 ft NAVD. Cordgrass generally grows between the colonization elevation and MHW (7.0 ft NAVD), at which point pickleweed begins to colonize higher in the tideframe. Pickleweed tends to grow between MHW and MHHW (7.7 ft NAVD).

The MARSH98 results predict that natural sedimentation would raise existing grades in the MROSD parcel and the NASA SWRP to colonization elevations in approximately 6-12 years (Figure 4-7). It is estimated that early successional tidal salt marsh habitat will require approximately 12-17 years to establish via natural sedimentation and vegetation establishment processes. A mature marshplain is at an elevation of approximately MHW to MHHW (Williams and Orr 2002). In the case of the MROSD parcel and the SWRP, the MARSH98 results indicate that a mature marshplain would form in approximately 30 years (assuming that there is no decrease in SSC as a result of SBSPRP implementation).

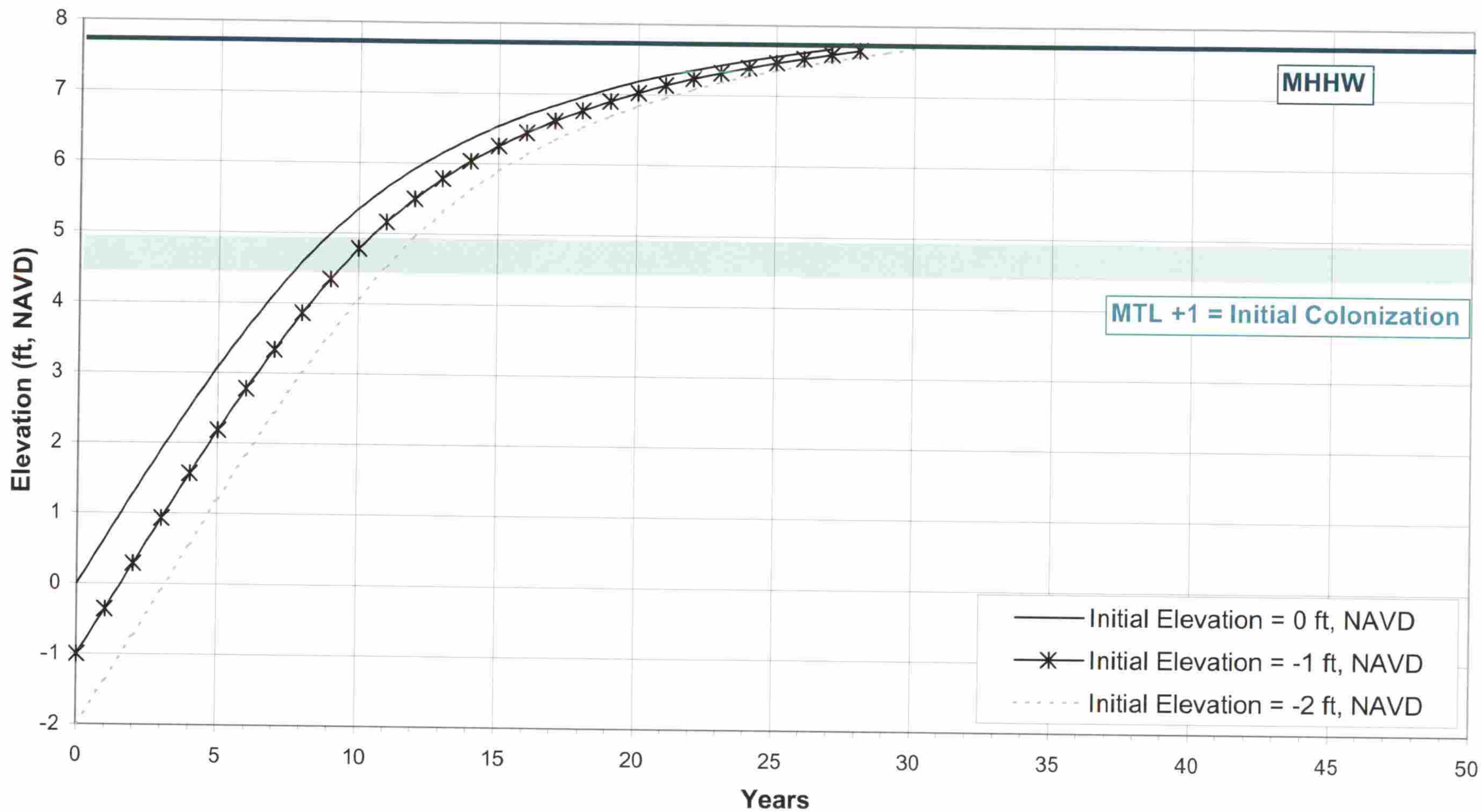
Actual sedimentation will depend on a number of variables that could increase or decrease the time required to achieve colonization, such as initial ground elevation, proximity to sediment supply with greater deposition nearest to the breach, annual variations in sediment supply, consolidation of newly deposited sediment, soil conditions, and proximity to colonizing plants. The SWRP and MROSD parcel are larger than Stevens Creek Tidal Marsh, so some portions of the project site may accumulate sediment more slowly than the modeled rates.

4.5 Earthworks Evaluation

A surface model of the Moffett Field Restoration Alternatives was developed to evaluate construction and cost feasibility. The surface model was built in AutoCAD2004 using the available topography (Section 2). Volume of fill required for key design features was compared to the volume of existing or available fill on-site for each alternative (Appendix E).

The following assumptions were made for all of the volume calculations:

- Stability berms are not included in the volume analysis. It is assumed that any material, either borrowed from the existing site or imported, will be tested for constructability and suitability for levee stability. Also, the broad side slope of the new levee separating the tidal and managed pond parcels will increase levee stability on the outboard side, eliminating the need for stability berms.
- All levees outside the SWRP on the tidal side will be lowered as part of the SBSPRP to an elevation conducive to rapid colonization by marsh vegetation. This elevation is estimated to be approximately 1.0 ft above Mean Tide Level (MTL) or 4.0 ft NAVD.
- The boundary of the surface model is the levee surrounding the existing SWRP, including the road separating the Eastern and Western Diked Marshes from the SWRP on the southern side. Along this side, we assumed that the inboard sides of the levee will be lowered to 2 ft NAVD. These elevations may be higher at the final stage of design but are not considered to represent a significant amount of the volume needed to complete the restoration alternatives.



Note: Sediment curve calibrated using dry density of inorganic material = 550 kg/m^3, representative for south bay marshes; suspended sediment concentraton = 275 mg/l; sea level rise = 1.5 mm/year (historic rate); Mean monthly tide from Palo Alto Yacht Harbor tide station.

Source: PWA analysis (MARSH98 modeling, Beeman & Krone, 1992). Colonization elevations from H.T. Harvey, and Williams & Orr, 2002.

Moffett Field Retention Basin Restoration Feasibility Study

Figure 4-7. Expected Sedimentation in SWRP

Project No. 25486

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4.6 Estimated Costs

4.6.1 Capital Costs

An opinion of probable cost for each restoration alternative was developed using a unit cost approach. This information is presented in Table 4-2. Unit costs were derived for earthwork quantities involved in building levees, clearing and grubbing in preparation for earthwork, and construction of water control structures. No costs were calculated for import fill to raise bed elevations in tidal marshes. As discussed previously, this will occur through natural sedimentation over time. While it is possible to accelerate this process by importing sediment, it was felt that this would be prohibitively expensive. Each of these unit costs is discussed further below. All construction costs (except where noted) are in 2005 dollars, using the State Prevailing Wage scale for the San Francisco area.

Earthwork. Volumes of earthwork required for each alternative are based on work done by PWA. This work is presented in detail in Appendix E. A summary table of fill requirements for new levee construction and levee alterations for the various alternatives is presented in Table 4-3. Total fill requirements for building new levees, repairing/expanding existing levees, and building nesting islands were calculated. The volume requirement presented is the difference between the finish grade and the starting surface elevation, referred to as the in-place fill. The project team then looked at the fill available on-site from material in existing levees that could be lowered. This volume was adjusted to account for 10% losses in transportation and handling. The difference between the total in-place fill and on-site fill is the net amount required to be imported from off-site. In order to derive the total imported fill requirement, the net fill was increased by 30%. This is a typical adjustment used by contractors to account for losses in transportation, handling and compaction.

The following assumptions went into the calculation of a unit cost for borrow and placement of on-site material:

- Average haul distance is ½ mile.
- Haul is accomplished using scrapers, or a combination of excavator, dump truck, and dozer.
- Compaction is provided with 6-inch lifts and four passes of a vibratory roller.
- Haul distance for a water truck is three miles.

The following assumptions went into the calculation of a unit cost for borrow and placement of imported material:

- There is currently a glut of clean fill material in the South Bay. This "free" fill material of proper quality is available from other projects in the South Bay sufficient to meet the fill requirements of this project, provided that fill material can be stockpiled starting several years in advance of the project .
- Sufficient lead time is available to stockpile "free" fill as it becomes available.
- Nominal cost for "free" fill is $1.70 per cubic yard for testing, paperwork, etc.
- Fill material can be stockpiled in advance within one mile of the project site.
- Imported fill is moved from the stockpile to the construction area with combination of front end loader, dump truck, and dozer.

- Compaction is provided with 6-inch lifts and four passes of a vibratory roller.
- Haul distance for a water truck is three miles.

The unit cost for imported fill dirt, if bought from the closest quarry (Stevens Creek Quarry in Cupertino) will be $15.00 per cubic yard higher than the unit cost shown in Table 4-3. This cost option was not calculated.

Water Control Structures. The Project Team performed a preliminary hydraulic analysis of the water control structure requirements for a tidal connection between Stevens Creek and the Western Diked Marsh, Stevens Creek and the diked MROSD pond, and Stevens Creek and the Central and NE Basins. This tidal connection is presumed for Alternatives 2a and 2b. Three 48-inch diameter pipes will allow drawdown or fill of the MROSD parcel, the Central Basin, and the NE Basin in 19 days based on a volume of 700 acre-feet equaling a water surface elevation of 4 ft. One 24-inch diameter pipe will allow drawdown or fill of the Western Diked Marsh in 11 days, based on a volume of 33 acre-feet equaling a water surface elevation of 4 ft. The assumption in each case is that due to tidal action, fill or drain takes place for four hours per day with no back water effects. Though this approach is simplified, it provides a conservative result. The proposed configuration of the pipes is to mount a combination flap/slide gate on each end of each pipe. This configuration has been installed on the Eden Landing Preserve as a part of the SBSPRP Interim Stewardship Plan for enabling a tidal connection to diked ponds. The use of combination gates throughout allows for optimum management flexibility.

The cost presented here for the three 48-inch diameter pipe control structure is based on the actual construction cost for a nearly identical structure installed in late 2004 at Eden Landing. Headwalls are constructed out of pressure treated lumber. The lumber on the bay side has an additional polymer coating to protect salmonids as required by permit. The polymer required for Eden Landing is a proprietary product known as 21Poly. Other products are available. Gates are 316 grade stainless steel throughout, although epoxy coated cast iron gates were also specified as acceptable. The pipe material is solid wall high-density polyethylene. Gates other than combination gates can be used on one end of each pipe with some loss in management capability, and savings of about $5,000 to $10,000 per gate location. Gates may also be omitted from one end of the pipes, with savings of between $10,000 and $20,000 per location.

The cost presented for the single 24-inch diameter pipe control structure is one-half that of the two pipe structure. The actual cost would probably be somewhat less than this.

Table 4-2. Moffett Field SWRP Feasibility Report-Restoration Alternatives Component Costs

	Cost/Unit	Alternative 1a	Alternative 1b	Alternative 2a	Alternative 2b	Alternative 3
Base Unit Costs						
Earthwork $/CY						
Onsite Borrow[1]	$11.44	$0	$358,000	$536,000	$554,000	$381,000
Imported Fill[1,2]	$14.66	$0	$2,972,000	$1,997,000	$6,233,000	$7,345,000
Water control Structures						
1x24" diam. Pipe w/ gates (lump sum)[1]	$176,000	$0	$0	$176,000	$176,000	$0
3x48" diam. Pipes w/gates (lump sum)[1,3]	$528,000	$0	$0	$528,000	$528,000	$0
Clearing and Grubbing ($/ac)[1]	$6,000	$0	$85,000	$72,000	$124,000	$152,000
Levee Revegetation (LS)[1]			$335,000	$223,000	$556,000	$699,000
Base Cost[1]		**$0**	**$3,750,000**	**$3,532,000**	**$8,171,000**	**$8,577,000**
Indirect Costs[1] (15%)		$0	$563,000	$503,000	$1,199,000	$1,287,000
Mobilization[1] (11%)		$0	$474,000	$424,000	$1,011,000	$1,085,000
Overhead & Profit[1] (17%)		$0	$814,000	$728,000	$1,735,000	$1,861,000
Sub-Total[1]		**$0**	**$5,601,000**	**$5,187,000**	**$12,116,000**	**$12,810,000**
Contingency[1] (35%)		$0	$1,960,000	$1,754,000	$4,180,000	$4,484,000
Total Construction Cost[1]		**$0**	**$7,561,000**	**$6,941,000**	**$16,296,000**	**$17,294,000**
Engineering[1] (15%)		$0	$1,134,000	$1,014,750	$2,418,000	$2,594,250
Revegetation Design, Legal & Admin.[1] (5%)		$0	$378,000	$338,250	$806,000	$864,750
Environmental Permitting[1,4]		$0	$200,000	$200,000	$200,000	$200,000
TOTAL COST		**$0**	**$9,273,000**	**$8,494,000**	**$19,720,000**	**$20,953,000**

Notes:
[1]Costs are preliminary, and cost sharing among NASA, MRSOD, USACE and SBSPRP is to be determined as USACE project progresses.
[2]This unit cost assumes that excess fill available in the South Bay area is stockpiled in advance at a cost of $1.70/CY. If fill is purchased, this unit cost increases by $15.00/CY. Imported fill would be used for levee construction only (not for increasing the SWRP bed elevation).
[3]Costs of two 3x48" diameter pipes with gates assumed to be incurred by NASA.
[4]This cost assumes that this project will tier off of the SBSPRP Programmatic EIS/R. Also anticipated are a Section 7 Endangered Species Consultation, Section 404 and 10 permits, Section 401 permit and BCDC consistency determination.

Table 4-3. New Levee Fill Requirements

	Total In-Place Fill Needed(CY)[a]	Material Available from On-Site Levee Lowering (CY)[b]	Net Imported Fill Required (CY In-Place)	Total Imported Fill Required (CY Stockpiled Volume)[c]
Alternative 1a	0	0	0	0
Alternative 1b	187,200	31,300	155,900	202,700
Alternative 2a	151,600	46,800	104,800	136,200
Alternative 2b	375,500	48,400	327,100	425,200
Alternative 3	418,700	33,300	385,400	501,000

Notes:

[a]This volume represents the difference between the finish grade of levees and existing grade, & includes nesting islands, where appropriate.

[b]This volume incorporates 10% transportation and handling losses.

[c]Stockpiled volume is 30% greater than in-place volume for imported fill due to transportation, handling and compaction losses.

Clearing and Grubbing. To calculate clearing and grubbing costs the acreage under the footprint of all new and repaired levees was estimated (Table 4-4). This area was then halved, based on professional judgment, since not all areas where fill is proposed to be placed are vegetated.

Table 4-4. Acreage Affected by Levee Construction

	Habitat Levee (1)			Regular Levee (2)				
	Length (ft)	Width (ft)	Area (ac)	Length (ft)	Width (ft)	Area (ac)	Total acres affected by levee construction	Area requiring clearing and grubbing
Alternative 1a	0	0	0	0	0	0	0	0
Alternative 1b	2200	330	16.7	6380	80	11.7	28.4	14.2
Alternative 2a	1900	330	14.4	5300	80	9.7	24.1	12.1
Alternative 2b	5000	330	37.9	1850	80	3.4	41.3	20.6
Alternative 3	6500	330	49.2	830	80	1.5	50.8	25.4

Note: As presented in Appendix E, Figure 6.

4.6.2 Operations and Maintenance Costs

Various sources cite median annual operation and maintenance (O&M) costs of $400 per acre (1993 dollars) or 2 percent of construction costs (Kadlec and Knight 1996; U.S. Environmental Protection Agency 1999) for treatment wetlands. Most of the cost issues are comparable for these proposed wetland alternatives. O&M costs include pumping energy, basic compliance monitoring, dike and access road maintenance, equipment replacement and repair, and nuisance control (e.g. mosquitoes, burrowing rodents, and invasive plants).

Assuming an annual inflation rate of 5 percent, the $400 per acre figure becomes $700 per acre in 2005 dollars. In each alternative, there are a total of 260 acres of marsh requiring management, even though the specifics of the restoration differ. This includes the Western Diked Marsh, NASA tidal marsh, the MROSD parcel, and the Central and Northeast Basins. At $700 per acre, this yields an O&M cost of $182,000. Construction costs vary greatly between the different alternatives, ranging from $8.3 million (Alternative 2a) to $21.0 million (Alternative 3), yielding O&M costs between $166,000 and $420,000. Aggregate O&M costs are not expected to differ much between the various alternatives, despite the large differences in construction costs. Hence, a mid-range value for O&M of $290,000 per annum is recommended. With an area of 54 acres, the MROSD parcel accounts for approximately 21 percent of the total 260 acres requiring management. Based on the land ownership, the MROSD share of expected O&M costs is $61,000, while the NASA share is $229,000.

A short qualitative discussion of O&M issues follows:

Pumping Costs and Pump Maintenance. Historically, portable pumps have been used to discharge excess storm water runoff from the SWRP. Pumping requirements will increase as the volume of the SWRP decreases progressively for Alternatives 1b through 2b. Alternative 3 entails the most pumping, since storage volume is minimal. Under Alternative 3, all storm water would have to be pumped to Stevens Creek.

Levee Maintenance. The introduction of tidal circulation could increase the potential for erosion of the levees surrounding the SWRP. Similarly, increased tidal circulation could put additional stress on the Stevens Creek levees downstream of the site. Two different types of levees are proposed. The massive and wide "habitat" levee will better withstand erosive forces than a much narrower "regular" levee. The gentle bay ward side-slope and active revegetation will reduce erosion potential. Three years of vegetation maintenance (weed control, irrigation) would be required to establish target salt marsh/upland transition zone habitat. Habitat levees are also much more resistant to damage by burrowing mammals because of the massive cross-section (Section 4 and Appendix E). Habitat levees are used most extensively in Alternatives 2b and 3, with correspondingly less regular levee.

Tide Gates. Tide gates are proposed only in Alternatives 2a and 2b. These gates will require periodic (monthly) clearing of debris, and annual maintenance. Structures will probably need to be replaced approximately every 25 years. Gates will need to be monitored and adjusted on at least a weekly basis during those times when they are opened. This is likely to be in late summer, and perhaps during the winter wet season. NASA Ames personnel will operate tide gates between the MROSD parcel and the Central Basin and between the expanded Stevens Creek and the Western Diked

Marsh. MROSD personnel will be responsible for operation of the tide gate controlling water within the MROSD parcel.

Mosquito Control. Areas converted to tidal marsh may develop mosquito problems over time as the base elevation increases due to sedimentation and plant colonization. Late summer shallow flooding of the Central and NE Basins proposed in Alternatives 2a and 2b could necessitate mosquito control measures. In all alternatives, most of the wetlands will be inundated by salt water. Mosquito control in salt water marshes is accomplished through drainage of stagnant areas and *Bacillus Thuringiensis israeliensus* (Bti) or Methoprene inoculation. Tidal marshes are often inoculated aerially via helicopter because of limited access. Mosquitofish (*Gambusia affinis*) are not viable in a salt water environment.

Nuisance Plant Control. Invasive smooth cordgrass (*Spartina alterniflora* and hybrids) and perennial pepperweed (*Lepidium latifolium*) comprise the two species of concern for this project. Each is discussed in detail elsewhere in this report. Special management and control restrictions may be placed in permit conditions. Installation of tide gates offers water management for the Western Diked Marsh that may be used for selective flooding to control the presence of existing perennial pepperweed.

Monitoring. No additional monitoring costs are anticipated for any of the alternatives. There is presently a monitoring program under the provisions of the storm water Industrial Permit.

4.7 Potential Regulatory Issues

4.7.1 General Overview

An assessment of regulatory issues associated with the potential restoration activities at NASA Ames was prepared based on the proposed restoration alternatives. MROSD would have similar, but perhaps somewhat different, regulatory issues. These are not covered in this report. A review of potential regulatory issues has identified three primary concerns, which are:

- potential habitat changes, including potential effects on endangered species;
- overall permitting process management; and
- effectiveness of Navy Site 25 contamination cleanup.

Potential Habitat Changes. The most critical issue will be the type of wetland that will be created and the associated effect on endangered species resulting from the changes to the habitat. The Federal and State policy of "no net loss" of wetland acreage and value will be fulfilled because the proposed alternatives do not reduce wetland acreage. The location, quality, and type of proposed habitat types (e.g., from seasonal wetland to tidal wetland) will determine whether the agency(s) and organizations overseeing the restoration will have substantial concerns. Acceptance of the type(s) of habitat in the restoration plan will be affected by the following issues:

- existing wetland habitats and proposed restoration decisions for related projects in adjacent areas (i.e., the SBSPRP);

- displacement or elimination of valuable or unusual species and habitats (for the site and region);
- threats by invasive species (e.g., invasive perennial pepperweed, *Lepidium latifolium*, in Stevens Creek); and
- the viability of sustaining and maintaining the proposed habitat.

Site surveys indicate that threatened or endangered species currently exist on the site. If habitat restoration will affect these endangered species, early coordination with National Oceanic and Atmospheric Administration-Fisheries (NOAA-Fisheries) and USFWS during the permitting process will facilitate the endangered species (Section 7) consultation process. During restoration alternative development, early informal consultation may provide guidance during the planning stages and expedite the Section 7 review process during permitting.

Due to the hydrologic connection and close proximity to the SWRP, the MROSD management methods and any proposed restoration activities will directly affect the habitat viability of the SWRP restoration. Close coordination with the MROSD will be needed to ensure that the changes they might propose to their property do not adversely affect acceptability of the NASA Ames proposal.

Management of Permitting Process. The second potential issue during the regulatory process will be the efficient management of the permitting process. The project will require permits from several regulatory agencies (Appendix G) and efficient management of the permitting process will ensure that permit approvals do not delay project development. Early consultation with the permitting agencies will flag some of the specific concerns and may expedite the planning process. Coordinating with the SBSPRP and following any permitting undertaken as part of the SBSPRP may also facilitate the SWRP permitting. In addition, NASA will need to evaluate the degree to which it plans to comply with local agency requirements. Although NASA is a Federal agency, it is likely that the local agencies have some level of input or oversight. A listing of the local agencies' regulatory requirements is included in Appendix G.

Navy Clean-up of Site 25. The third issue for the restoration process is the effectiveness of the Navy Site 25 cleanup. The degree of cleanup conducted will influence the conditions and requirements of Corps, San Francisco Bay Regional Water Quality Control Board (RWQCB), and other agency permits. Residual constituents may remain in the site after cleanup is completed, as is commonly the case. The site cleanup will be based on ecological receptors. The presence of residual levels of some constituents may not be captured by conventional (soil) chemical analyses; acceptable detection limits for soil analyses exceed allowable sediment concentrations for a number of constituents.

If residual levels of contaminants remain after the Navy Site 25 cleanup is considered to be complete, additional treatment of storm water discharges may be required in order to comply with existing and proposed National Pollutant Discharge Elimination System (NPDES) permits for the discharge of storm water that will occur when the capacity of the future, smaller SWRP is exceeded resulting in discharges of storm water to receiving waters. Creating tidal connections that could affect the water and sediment quality in Stevens Creek, other ponds, and habitat areas may require obtaining Waste Discharge Requirements from the RWQCB and could affect other permit processing such as Section 7 consultation. This issue could lengthen the time to complete the restoration projects or potentially preclude implementation of some restoration alternatives. Discussion and agreement between agencies involved in the clean-up effort (USFWS, CDFG, and the Navy) on acceptable sediment quality levels should be pursued early in the restoration planning process.

4.7.2 Storm Water Regulatory Compliance Issues

This section provides an overview of the potential storm water regulatory compliance issues that may result from the proposed alternatives and identifies any regulatory issues that would need to be resolved in order to obtain regulatory approval of the selected alternative.

Current Storm Water Regulatory Issues. Storm water discharges from NASA Ames are currently regulated by Title 40, Code of Federal Regulations, Parts 122, 123, and 124 and the requirements of the NPDES General Permit, No. CAS000001 issued by the State Water Resources Control Board (SWRCB) for discharges of storm water associated with industrial activities, excluding construction activity (Industrial Permit). Preparation and implementation of a Storm Water Pollution Prevention Plan (SWPPP) is a requirement of the Industrial Permit.

NASA Ames generates potential storm water pollutants through multiple ongoing industrial activities. The industrial activities at NASA Ames are primarily associated with research and development in aeronautics and space science and technology, aircraft operations, and site-wide property maintenance. These activities provide potential sources of storm water contamination (Professional Analysis Incorporated 2003).

The proposed restoration activities may possibly change the frequency and quality of storm water discharges that are regulated by the Industrial Permit. Any flow out of the SWRP is a considered a storm water discharge whether it is unintentional, overtopping of the levees, or intentional pumping.

Pending Storm Water Regulatory Issues

NPDES Non-Traditional, Small MS4 Permit (Phase II). NASA Ames is listed among entities anticipated to be designated by the RWQCB to be non-traditional Small Municipal Separate Storm Systems (MS4s) in Attachment 3 of the Phase II General Permit. NASA Ames has not yet received notification of official designation as a Small MS4. The MS4 permits require the discharger to develop and implement a Storm Water Management Plan/Program (SWMP) with the goal of reducing the discharge of pollutants to the maximum extent practicable (MEP). MEP is the performance standard specified in Section 402(p) of the Clean Water Act (CWA). The Minimum Control Requirements of the Phase II permit are addressed and evaluated in the NASA Ames SWPPP.

Reissuance of the Industrial Permit. The SWRCB is currently in the process of re-issuing the Industrial Permit. The proposed permit has important differences from the prior permit. First, the proposed permit contains minimum Best Management Practices (BMPs) that all dischargers must incorporate into their SWPPPs. The purpose of the minimum BMPs is to ensure that proposed permit will result in compliance with Best Available Technology and Best Control Technology requirements and that facilities will have uniform practices. Second, the proposed permit has more stringent requirements to ensure that dischargers comply with water quality standards. The Industrial Permit includes an open-ended iterative process for improving BMPs at facilities that caused or contributed to an exceedance of water quality standards. Third, the proposed permit includes more extensive monitoring requirements. The proposed permit includes a requirement for a one-time suite of monitoring for metals, chemical oxygen demand, and semi-volatile organic compounds. Fourth, the proposed permit affects the Phase II regulations by applying to all industries designated by EPA, including what it formerly considered "light industry". Therefore, it is most likely that NASA Ames will continue to be designated as an industrial discharger and will not be designated a Small MS4.

Regulatory Issues

The potential mitigative measures and associated regulatory issues are listed for each alternative in Table 4-5. The main regulatory points that need to be considered in the feasibility analysis of alternatives include:

1. Construction activities related to additional BMPs implemention will need to comply with erosion and sediment control guidelines in the NPDES General Construction Permit, which is currently being revised by the SWRCB.

2. Discharges from the SWRP will need to be monitored in order to comply with the current Industrial Permit and the proposed Industrial Permit. Monitoring requirements in the proposed permit are more stringent than the current permit and require that any discharges comply with the water quality objectives set in the RWQCB Basin Plan (San Francisco Bay Regional Water Quality Control Board (RWQCB) 1995).

3. Design of outflow or pumping structures will need to follow the NPDES erosion and sediment control guidelines.

In general, potential regulatory issues resulting from SWRP restoration will be driven by the quality of storm water discharges which will be directly related to the effectiveness of the Site 25 contamination cleanup. Assuming that the Site 25 cleanup reduces the potential for storm water discharges to exceed existing and proposed permit discharge prohibitions, storm water regulatory issues will be addressed by developing and implementing storm water monitoring activities to validate the expected quality of storm water discharges following the cleanup. If the storm water monitoring data indicates that storm water discharges comply with permit discharge prohibitions then storage capacity is not a concern. However, if storm water discharges are not in compliance with permit discharge prohibitions then modifications to existing BMPs or implementation of additional BMPs will be necessary. If the effectiveness of the additional BMPs at reducing the pollutants that are causing the exceedance of discharge prohibitions are related to the frequency of the storm water discharges then the storm water retention capacity of each alternative is critical to the cost and feasibility of each alternative.

Table 4-5. NASA Ames Storm Water Regulatory Analysis

		Alternatives			
Existing storm water permits and reports	**Current conditions**	**Alternatives 1a and 1b – no action**	**Alternative 2a – Stevens Creek expansion**	**Alternative 2b – NE basin restoration**	**Alternative 3 – full tidal restoration**
NPDES General Industrial Permit (Phase I)	The Industrial Permit in effect at NASA Ames requires that: (1) each facility notify the State, and prepare and implement a SWPPP, (2) each facility submit an annual report to the State, and (3) NASA Ames monitor storm water discharges to ensure compliance with discharge prohibitions, effluent limitations, and water quality objectives.	No anticipated changes.	No anticipated changes.	Need to add adequate storage for runoff with site modifications. Additional sampling of pumped water.	Inadequate storage for runoff. Permit requirements will not be met.
SWPPP	The SWPPP includes a storm water monitoring plan and the six Minimum Control Measures required by Phase II.	No anticipated changes.	No anticipated changes.	Additional sampling of pumped water. Erosion prevention measures for Stevens Creek.	Inadequate storage for runoff. Permit requirements will not be met.
SPCC	The NASA Ames Spill Prevention, Control, and Countermeasures (SPCC) Plan currently governs spill prevention at the facility.	No anticipated changes.	No anticipated changes.	No anticipated changes.	No anticipated changes.

Table 4-5. NASA Ames Storm Water Regulatory Analysis (Continued)

Existing storm water permits and reports	Current conditions	Alternatives: Alternatives 1a and 1b – no action	Alternatives: Alternative 2a – Stevens Creek expansion	Alternatives: Alternative 2b – NE basin restoration	Alternatives: Alternative 3 – full tidal restoration
NPDES Non-traditional, small MS4 Permit (Phase II)	Permitting under the Phase II Small MS4 is pending the designation of NASA Ames as a non-traditional MS4. NASA Ames is on the EPA's list of facilities with pending MS4 designation. The designated entities are required to develop a SWMP, which addresses the six Minimum Control Measures, reduce discharge of pollutants to the Maximum Extent Practicable, and perform inspections and monitoring.	No anticipated changes.	No anticipated changes.	Need to add adequate storage for runoff. Additional sampling of pumped water.	Inadequate storage for runoff. Permit requirements will not be met.
SWMP	Production of a SWMP is pending the designation of NASA Ames as a non-traditional MS4. Components of SWMP required under Phase II Permit (six Minimum Control Measures) are currently in the NASA Ames SWPPP: (1) Public Education and Outreach (2) Public Participation/Involvement (3) Illicit Discharge Detection and Elimination (4) Construction Site Runoff Control (5) Post-Construction Runoff Control (6) Pollution Prevention/Good Housekeeping	No anticipated changes.	No anticipated changes.	Required revisions included in SWPPP.	Inadequate storage for runoff. Permit requirements will not be met.

5

BROWN AND
CALDWELL

SECTION 5

EVALUATION OF RESTORATION ALTERNATIVES

5.1 Project Objectives and Selection Criteria

Project objectives from the SBSPRP, as detailed in the SBSPRP Alternatives Development Framework Final Report (South Bay Salt Pond Restoration Project 2004), were used as a basis for selection criteria applied to the Moffett Field restoration alternatives evaluation. Given that the main objectives for the SBSPRP and Moffett Field projects vary slightly, the objectives and emphasis are slightly different. Also, given that this effort represents a feasibility study, the Moffett Field evaluation focused on the relevant overarching objectives and did not assess the detailed evaluation criteria and metrics associated with each of the SBSPRP objectives. Four objectives were applied to evaluate the Moffett Field alternatives, including three of the most relevant SBSPRP objectives noted below and one additional objective that is particularly relevant and important for the SWRP – storm water management. Storm water management is the most important objective for the project and the other objectives are of relatively secondary importance.

Objective 1 - Storm Water Management. Manage storm water flows to avoid upland flooding, limit pumping to Stevens Creek/San Francisco Bay (i.e., pumping no more frequently than during one year in every five), and limit the potential need for additional treatment, beyond the existing settling basin, to address the water quality of storm water discharges.

Objective 2 - Biological Habitat. Create, restore, or enhance habitats of sufficient size, function, and appropriate structure.

Objective 3 - Nuisance Species Management. Implement design and management measures to maintain or improve current levels of vector management, control predation on special status species, and manage the spread of non-native invasive species.

Objective 4 - Public Access (Bay Trail Alignment). Provide public access adjacent to the SWRP by linking the currently discontinuous Bay Trail.

Objective 5 - Cost Effectiveness. Consider costs of implementation, management, and monitoring so that planned activities can be effectively executed with available funding.

Several other objectives for the SBSPRP project (i.e., flood management, water and sediment quality, infrastructure, and environmental impact) were less relevant for the Moffett Field project or had insufficient information to assess at this point in the process, and were therefore not evaluated in any detail for this Feasibility Study.

5.2 Evaluation of Alternatives

Each of the Moffett Field project objectives have been applied to evaluate the alternatives, as discussed below.

5.2.1 Storm Water Management

The hydrologic model discussed in Section 2 was used to evaluate how proposed alternatives would affect water levels within the SWRP and if storm water management could be maintained at current levels with implementation of each alternative. Seasonal runoff volume was modeled assuming the majority of the annual precipitation occurs between November and April. The number of years between overflow events, known as the recurrence interval, was estimated for each of the alternatives by comparing predicted seasonal runoff volume to the available storage volume associated with each of the alternatives (Table 5-1). The storage volume estimates for applicable alternatives include volumes for each of the relevant SWRP components (MROSD parcel, NE Basin and/or Central Basin), and approximately 57 acre-ft of storage volume associated with the Western and Eastern Diked Marshes. Available storage volume for each of the alternatives was defined as the maximum volume available before overflow, which is based on a water surface elevation of 4 ft NAVD. This assumes a minimum levee height of 4 ft NAVD and no freeboard (i.e., pumping commences when the water surface elevation reaches 4 ft NAVD). It is very possible that NASA would choose to initiate pumping before an overflow event would actually occur, to maintain a minimum freeboard and to prevent overtopping of the levees. The estimate of overflow events, therefore, may be low relative to the actual number of years when pumping would be required.

Two methods were applied to estimate recurrence interval of years with overflow events. The first method was to fit the modeled data, using the mid-point of the PET data, for the 56-year period of record (1948 to 2003) to a Log Pearson Type III distribution and to create a probability distribution plot. Figure 5-1 presents the probability distribution plot and shows the relationship between modeled seasonal runoff volume, the return interval for a given runoff volume, and the associated probability of a runoff volume being equaled or exceeded in any year (i.e., inverse of the recurrence interval). The second method to estimate recurrence interval was to count the number of modeled overflow events associated with each of the alternatives (Figures 2-7, 5-2, 5-3, and 5-4), over the 56-year period of record. In any given year, there may be one or more overflow events. The number of overflow events associated with each year is further detailed in Appendix H. In addition, Appendix H provides wet, average, and dry-year modeling results for each of the alternatives. Both of the methods used to estimate recurrence interval of years with overflow events assume that storm water runoff volumes in the future will be similar to historical volumes. The results of the two methods differ slightly, while one is based on a distribution of the evapotranspiration and the other is based on empirical historical data.

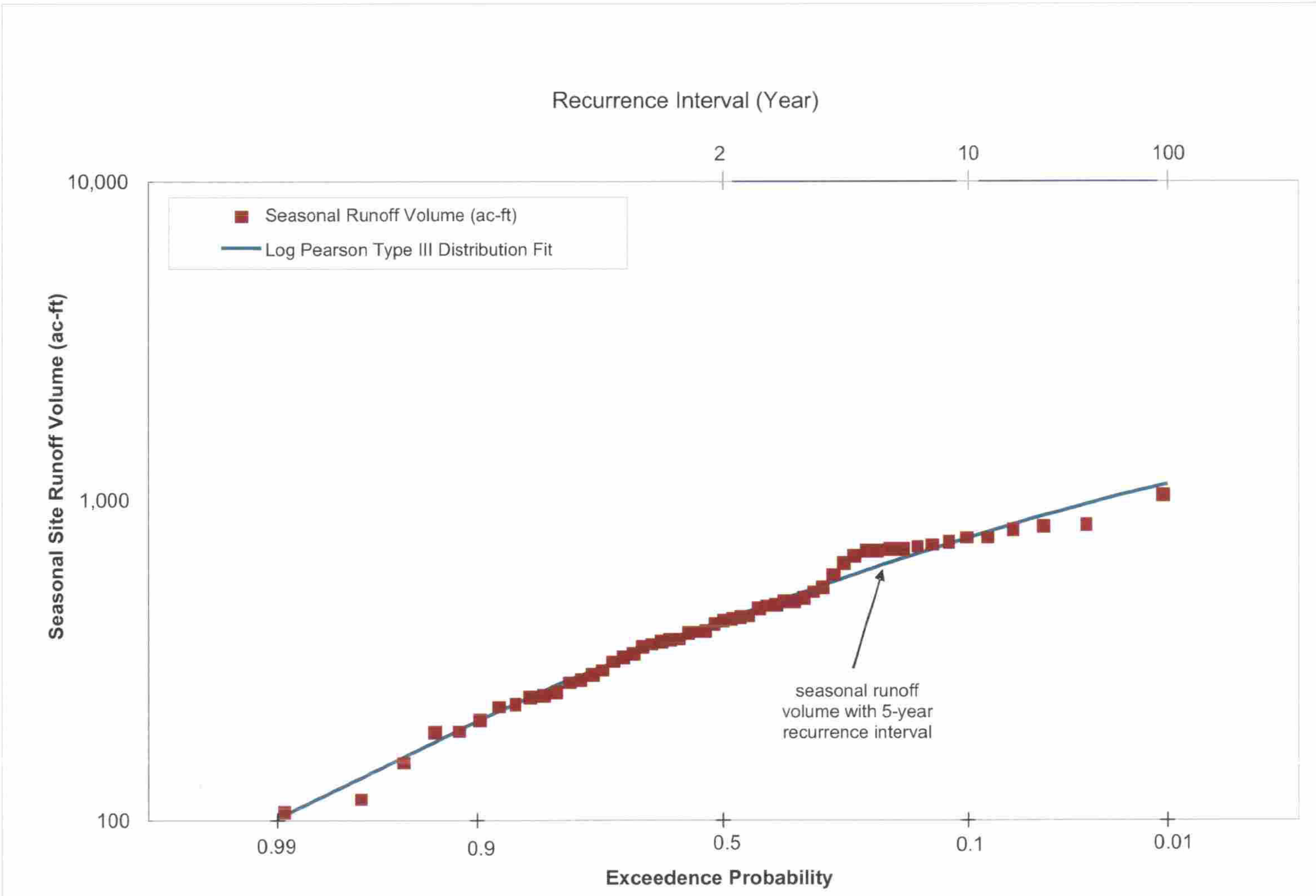
As shown in Table 5-1, the predicted frequency of overflow events varies widely, from one or two events during the 56-year period of record (recurrence interval of every 32 to 56 years) for Alternative 1a: Existing Conditions to as frequently as every year for Alternative 3: Full Restoration. As noted in Section 3, NASA has established an objective to limit pumping events to no more than once every five years. Based on the modeling results, Alternative 1a would meet the NASA pumping objective. Alternatives 1b and 2a would likely meet the objective. Alternatives 2b and 3 would not meet the objective. More detail on the storm water analysis for each of the alternatives is presented below.

Table 5-1. Summary of Storm Water Storage Volume, Return Interval, and Probability of Exceedance

Alternative	Available Storage Volume[a]	Return Interval (Years) for Overflow Events: Based on Log Pearson III Distribution[b]	Return Interval (Years) for Overflow Events: Based on Modeled Overflow Events[c]
Alternative 1a: Existing Conditions	960	32	5 to >56
Alternative 1b: No Action, Removal of MROSD Parcel	760	10	3 to 56
Alternative 2a: Stevens Creek Expansion	760	10	3 to 56
Alternative 2b: NE Basin Restoration	511	3	1.7 to 4.3
Alternative 3: Full Restoration	57	<1	1

[a] Design/available storage volume based on water surface elevations assuming a bank height of 4 ft and no freeboard (i.e. pumping commences when the water surface elevation reaches 4 ft NAVD).
[b] Based on a fit of the modeled seasonal runoff volumes to a Log Pearson Type III Distribution (Figure 5-1).
[c] Based on the HSPF model results - range of the number of years with overflow events (Figures 2-7, 5-2, 5-3, and 5-4) for the 56-year period of historic data (1948 to 2003), from the mid-point of high and low PET data to the high point of the PET data.

Figure 5-1. Moffett Field Storm Water Hydrology - Site Seasonal Runoff Volume for Specified Return Intervals



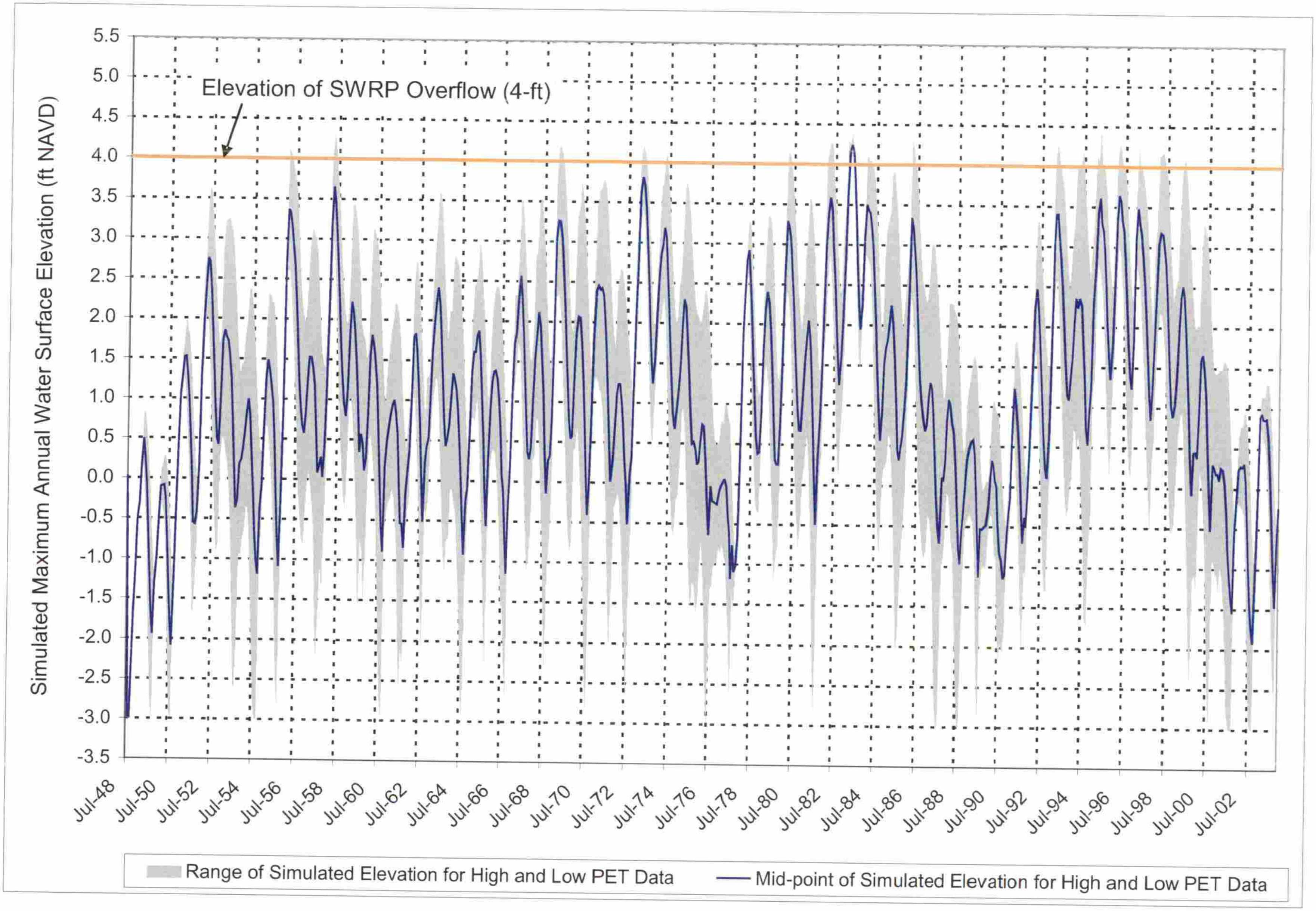


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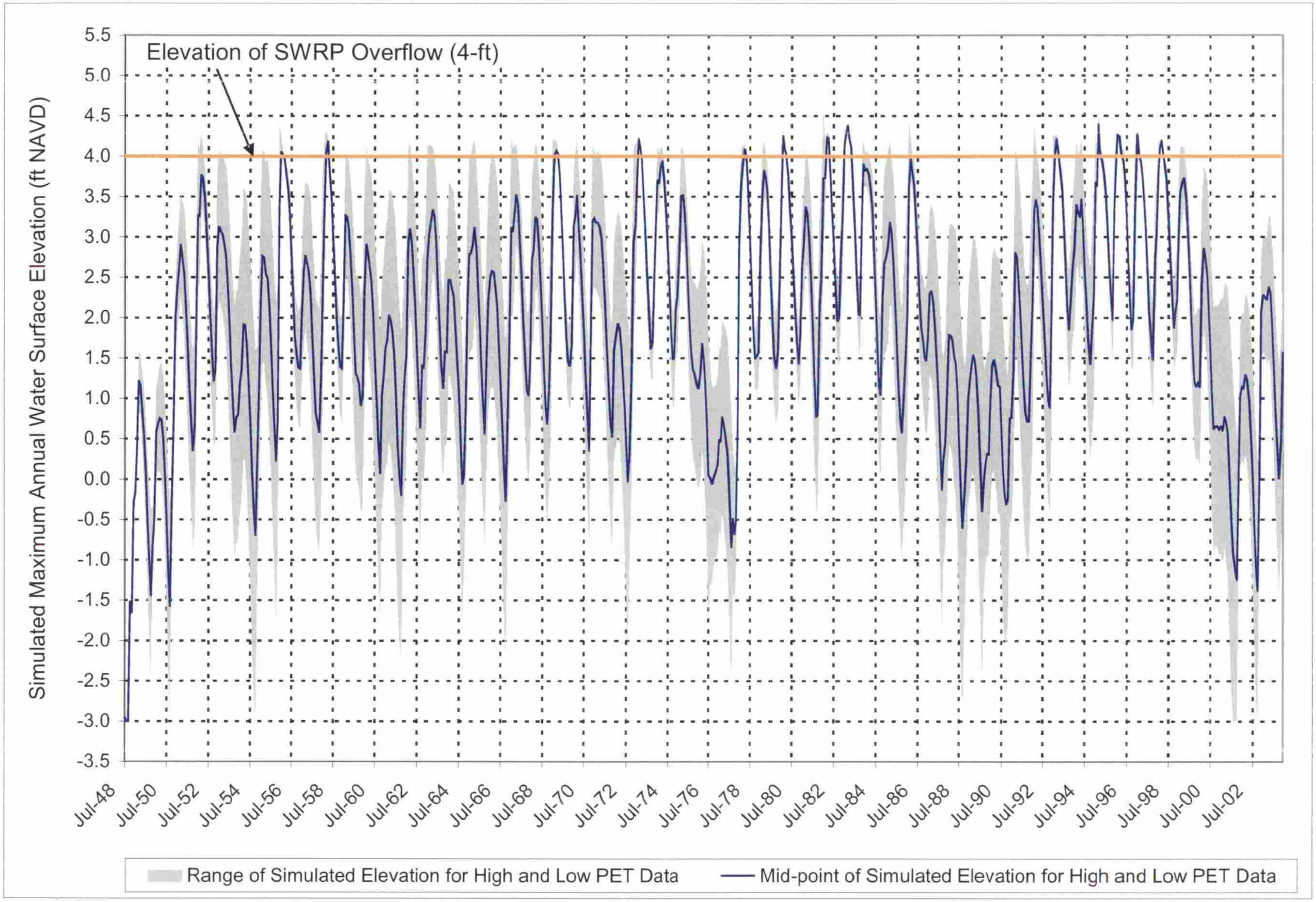
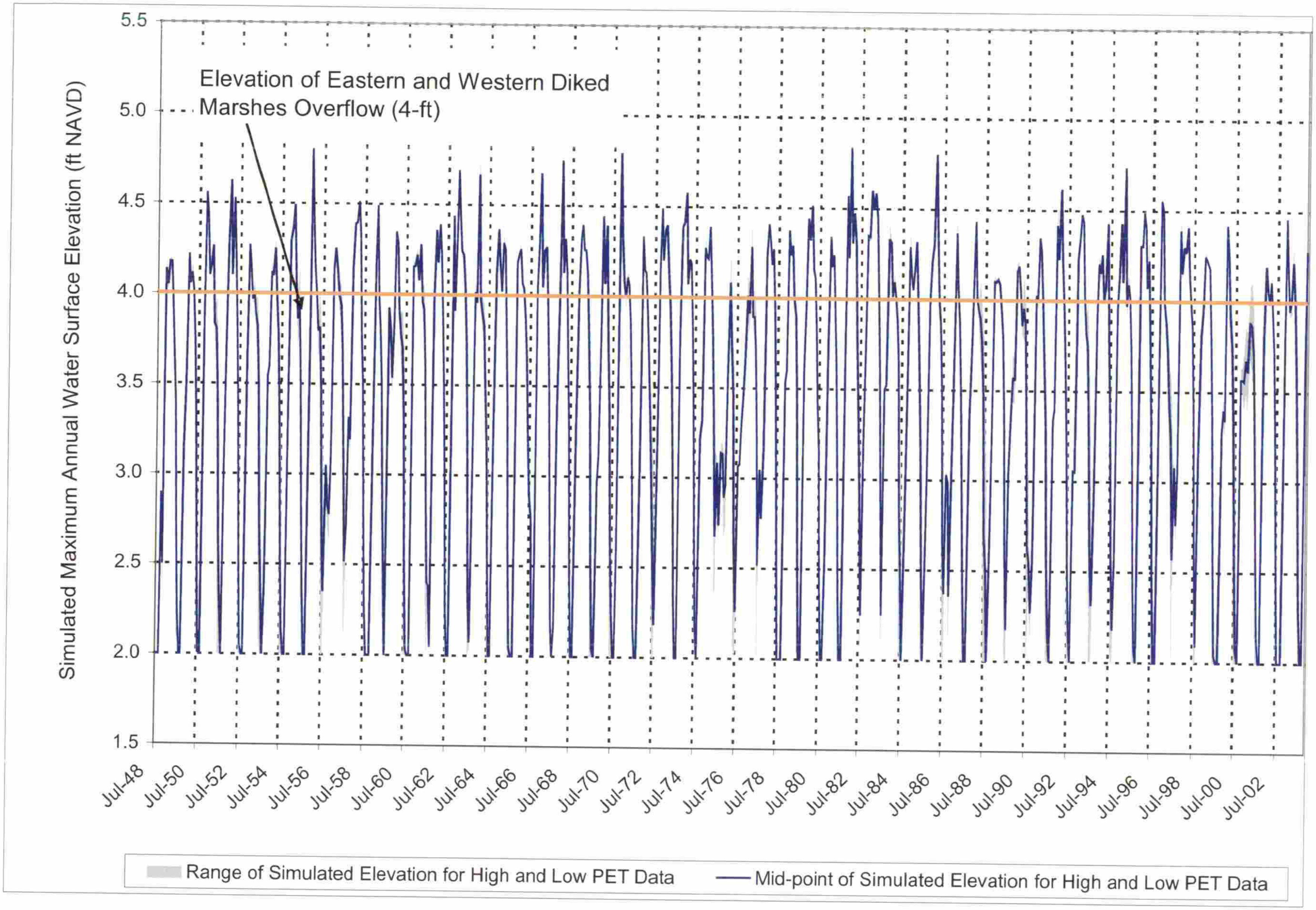
Figure 5-2
Storm Water Hydrology Model
Alternative 1b and 2a Simulated Water Surface Elevation



Moffett Field Restoration Feasibility Study

Figure 5-3
Storm Water Hydrology Model
Alternative 2b Simulated Water Surface Elevation



Moffett Field Restoration Feasibility Study

Figure 5-4
Storm Water Hydrology Model
Alternative 3 Simulated Water Surface Elevation

ALTERNATIVE 1A: NO ACTION

Storm water modeling results for the No Action alternative are presented in Section 2 on Existing Conditions. Figure 2-7 presents simulated water surface elevations within the SWRP for low end and high end potential evapotranspiration values, as well as a midrange value of evapotranspiration. Overflow events are assumed to occur at an elevation of 4 ft NAVD. As shown in Figure 2-7, the number of years with overflow events under existing conditions is estimated to be zero for the mid-point evapotranspiration data and as many as eleven for the high range. The recurrence interval for overflow events is estimated to be somewhere in the range of 32 to greater than 56 years, as summarized in Table 5-1.

ALTERNATIVE 1B: TIDAL SALT MARSH RESTORATION OF MROSD PARCEL AND ALTERNATIVE 2A: PARTIAL RESTORATION – STEVENS CREEK EXPANSION

While Alternatives 1b and 2a include different key design features, these alternatives are identical with respect to how storm water runoff is conveyed and stored in the system. Both alternatives would result in a reduction of the available storm water storage volume from 960 acre-ft to 700 acre-ft. Figure 5-2 presents simulated water surface elevations within the SWRP for low end and high end potential evapotranspiration values, as well as a midrange value of evapotranspiration. As shown in Figure 5-2, for the period of 1948 to 2003, the midrange value of evapotranspiration yields one year with an overflow event for Alternatives 1b and 2a, while the high end of evapotranspiration data yields 17 years with overflow events. This translates to a wide range in recurrence interval for an overflow event, from once every 3 to 56 years. The Log Pearson Type III distribution analysis predicts a recurrence interval of once every 10 years.

ALTERNATIVE 2B: PARTIAL RESTORATION- NE BASIN RESTORATION

Figure 5-3 presents simulated water surface elevations within the SWRP for Alternative 2b. In this alternative, the size of the retention pond area is reduced by nearly 50 percent, from 960 acre-ft to 511 acre-ft, through the conversion of the NE Basin to tidal salt marsh. The midrange value of evapotranspiration yields 13 overflow events for Alternative 2b between 1948 and 2003. The high range of evapotranspiration data yields 33 overflow events. The recurrence interval for both methods ranges from one overflow event about every 2 to 4 years. The probability that pumping will occur in any given year is approximately 38%, and as a result the potential storm water discharges resulting from the potential increased pumping would require more frequent monitoring relative to Alternatives 1b and 2a. As discussed in the regulatory compliance section (Section 4.6), if the storm water discharges require some level of treatment prior to discharge the treatment design would be driven by the storage capacity.

ALTERNATIVE 3: FULL TIDAL RESTORATION

In Alternative 3, the SWRP is lost through the full conversion of the MROSD parcel and Central and NE Basins to tidal salt marsh. Storage volume is reduced from 960 acre-ft down to 57 acre-ft provided by the Eastern and Western Diked Marshes. Figure 5-4 presents simulated water surface elevations within the Eastern and Western Diked Marshes for the low end and high end values, as well as a midrange value of evapotranspiration. The system is assumed to overflow at an elevation of 4 ft NAVD. The midrange value of evapotranspiration yields 54 overflow events for Alternative 3 over the period from 1948 to 2003, or one event nearly every year. Pumping in the wetter years would most likely occur several times per year because the probability of seasonal runoff being equaled or exceeded is greater than 99%. There is also a high likelihood of site flooding, as it would be difficult during some storm events to pump the water offsite quickly enough to keep up with the rainfall and runoff. Figure 5-5 shows the inundation that would occur under Alternative 3 if water level elevations were to exceed 5 ft NAVD. The high cost of pumping and high likelihood of flooding makes Alternative 3 infeasible from a storm water management perspective.

POTENTIAL MEASURES TO MITIGATE STORM WATER STORAGE NEEDS

As noted in Section 3 (Opportunities and Constraints), there are several measures that could potentially be implemented to reduce the probability of overflows from the SWRP and to limit pumping and discharges of storm water to receiving waters. Each of these potential measures has been evaluated, but only one of them appears to be viable, as described below.

(1) *Upstream storage in diked marshes.* As noted above, the Western and Eastern Diked Marshes provide approximately 57 acre-ft of storm water storage volume. This volume has been accounted for in the modeling of surface water elevation in the SWRP and the number of overflows.

(2) *Levee modifications for increased storage.* As noted previously, low spots in the existing levee system limit the available storm water runoff storage volume. While the average levee height is about 5 ft NAVD, there are several low spots at 4 ft NAVD, particularly in the southeast area of the SWRP. As a result, overflows would occur any time the water surface elevation exceeds 4 ft NAVD. The low spots in the levees could be raised, relatively cost effectively, to increase the storage volume available for storm water runoff. Increasing the levee height to 5 ft NAVD would provide approximately 280 acre-ft of additional storage volume with no available freeboard. However, raising the levee height would also inundate other areas upland of the SWRP that are at or below the 5 ft elevation. As shown in Figure 5-5, the Western and Eastern Diked Marshes would be completely inundated if the water surface elevation were raised to 5 ft. (For comparison, Figure 5-6 shows the inundation of the Western and Eastern Diked Marshes under the existing water surface elevation of 4 ft NAVD.) As noted under storm water hydrology constraints in Section 3, the 5 ft NAVD inundation would render the existing storm water settling basin inoperable, given that the settling basin is at about 4 ft NAVD and would be entirely under water during periods of high storm water runoff volume. A similar level of inundation would also result if the levees were raised to 4.5 ft NAVD. Given upland flooding effects, it is not a viable option to increase storm water storage volume by raising levee height.

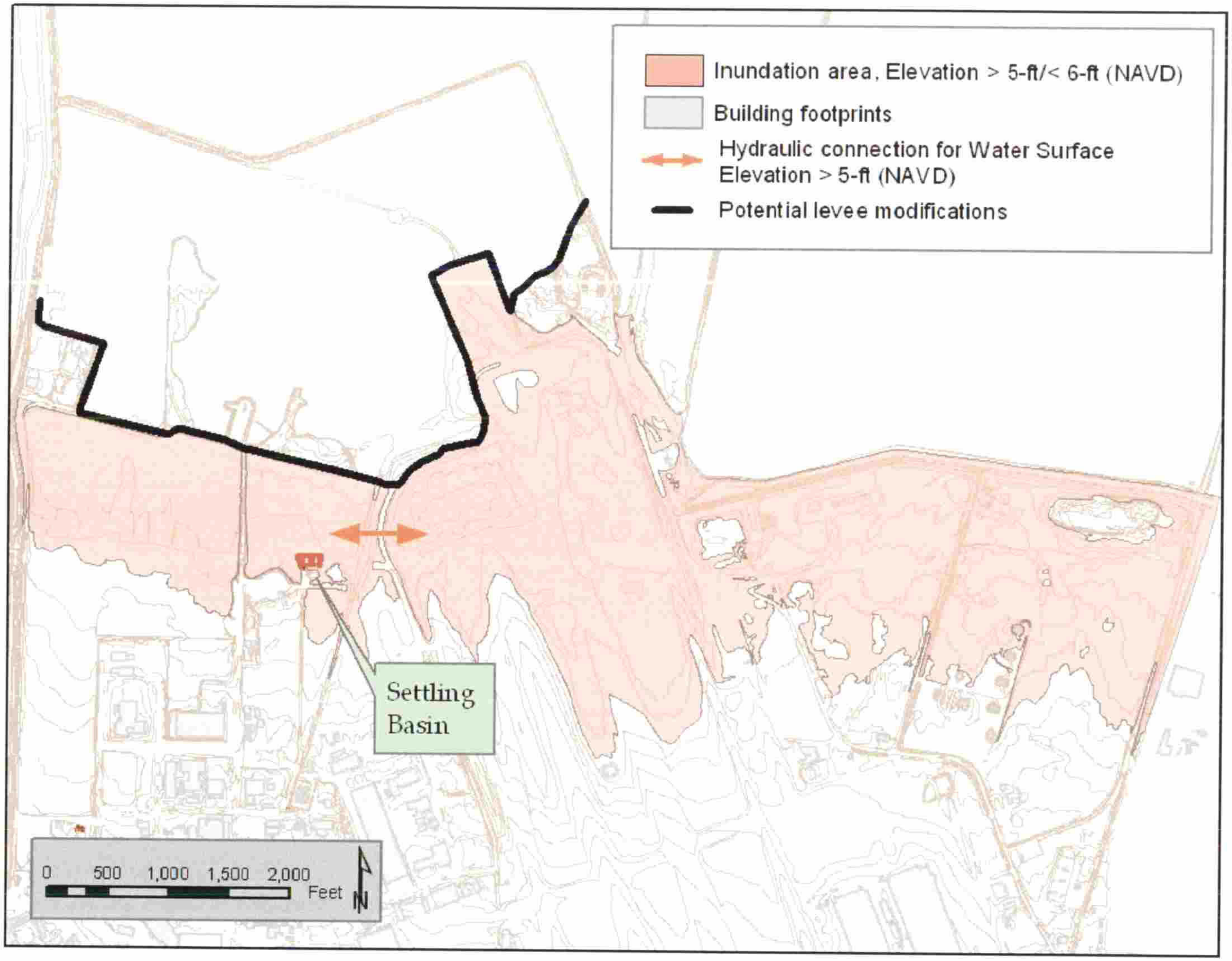


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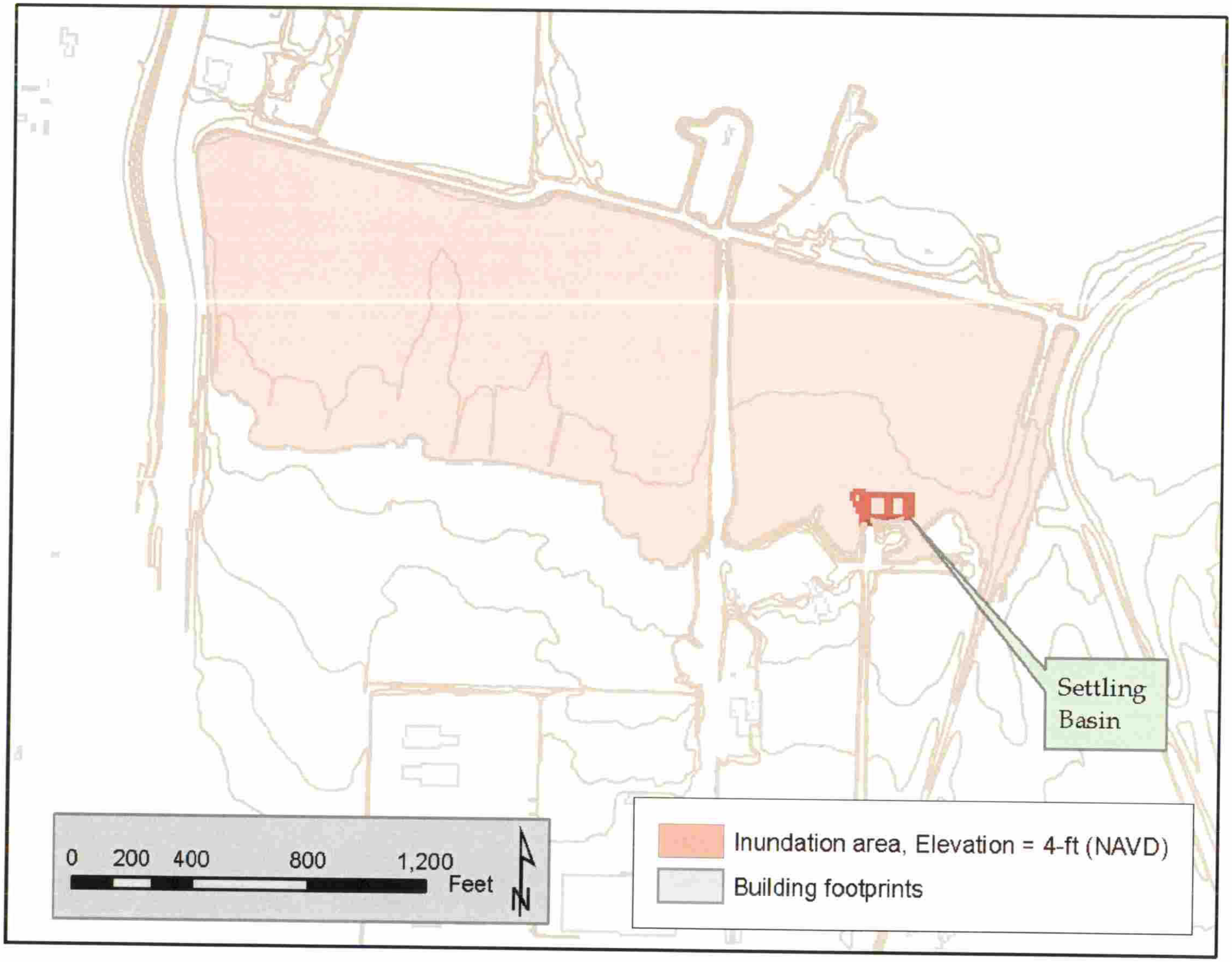
Figure 5-5
Moffett Field Inundation between 5 to 6 ft NAVD Water Surface Elevation



Moffett Field Restoration Feasibility Study

Figure 5-6
Eastern and Western Diked Marshes Inundation at 4 ft NAVD Water Surface Elevation

(3) *Upstream detention facility.* If sufficient open space were available in the Western Drainage Basin, it might be possible to develop upstream detention/retention areas for storm water runoff, and/or increased infiltration areas to reduce inflows to the SWRP. As noted in Section 3, there is approximately 385 acres of pervious area, but it is dispersed throughout the Western Drainage Basin and does not lend itself to detention facilities that would be of sufficient size. In addition, the site topography in the upland areas does not provide sufficient depth to provide for efficient storage. For example, the Western and Eastern Diked Marshes are approximately 60 acres in surface area, but provide only 57 acre-ft of storage.

(4) *Excavation of the SWRP.* As part of the Site 25 clean-up, it is anticipated that the Navy will be removing as much of 1 to 2 ft of contaminated sediment from portions of the SWRP. It would be possible to excavate further sediment to achieve an overall deepening of the SWRP, which could increase storage volume. However, there are a few significant concerns with this measure. Some remnant contamination may be present in the sediments, which may need to be capped to prevent contact with water in the SWRP. Also, as noted in Section 2 (Existing Conditions), the groundwater table is very shallow and any further excavation could result in a connection with the groundwater, which would make it difficult to effectively store storm water in the SWRP.

(5) *Storm water overflows into Pond A2E.* If the levee between the SWRP and Pond A2E to the north were lowered to a level below approximately 4 ft NAVD, then stored storm water could overflow into Pond A2E. This would require agreement from the landowner (USFWS) and would likely raise concerns about the potential for movement of pollutants from the Moffett Field site into the USFWS Don Edwards National Wildlife Refuge. This option is not likely to be viable.

5.2.2 Biological Habitat

The majority of the SWRP site currently provides non-tidal, open water/mudflat habitat for a variety of waterbird species. However, this site was historically intertidal marsh. Therefore, the preliminary restoration alternatives were developed to represent a range of endpoints from predominantly non-tidal, open water habitat to 100% restored tidal salt marsh. The following section characterizes the projected biotic habitat mosaics and associated wildlife use for the restoration alternatives. With respect to restored tidal salt marsh, this discussion is focused on the projected habitat "endpoint" after natural sedimentation or dredged sediment import has raised marshplain elevations toquilibrium (approximately MHW [7.0 ft NAVD] to MHHW [7.7 ft NAVD]) with the tidal hydrologic regime. This discussion also assumes that tidal action would be restored only if the resulting salinity regime on the restored marsh plain would be high enough to support establishment of native salt marsh vegetation and preclude dominance by the invasive weed, perennial pepperweed. This would likely be feasible, if the SBSPRP restores adjacent Ponds A2E and AB1 to tidal action. In the South Bay, perennial pepperweed can invade the tidal marsh plain where interstitial soil salinities are less than 29 ppt (H. T. Harvey & Associates 2002). In addition, it is assumed that the Invasive Spartina Project will be able to successfully control, if not eradicate, invasive smooth cordgrass and its hybrids prior to restoration of tidal action to the site. The

Invasive Spartina Project anticipates successful control of invasive cordgrass in the San Francisco Bay within 2-4 years from the present (Grijalva 2004).

Table 5-2 provides a comparison of the biotic habitat mosaics between the alternatives. The main difference between the alternatives is that the surface area of tidal salt marsh and tidal salt marsh/upland transition habitat increases going from Alternative 1b to 3, while the surface area of non-tidal, open water habitat decreases. This results in dramatic differences in projected wildlife use between the alternatives as summarized in Table 5-2.

In addition to considering the broad biological habitat objective as described in Section 5.1, two more specific biological selection criteria were evaluated. The more detailed criteria are as follows:

Detailed Objective 2a – Balanced Biological Habitat. Restore and enhance a balance of both salt marsh habitat and open water/mudflat habitat to improve conditions for salt marsh endemic species as well as for shorebirds and waterfowl. This objective would improve habitat for the federally-listed endangered salt marsh harvest mouse and California clapper rail, the salt marsh wandering shrew, and the California black rail.

Detailed Objective 2b – Salt Marsh Habitat. Restore and enhance salt marsh habitat to improve habitat for endemic salt marsh species including the federally-listed endangered salt marsh harvest mouse and California clapper rail, the salt marsh wandering shrew, and the California black rail (Table 5-2).

Depending on the objective, the preferred alternative from a biological perspective would be either Alternative 2b or 3. Alternative 2b would be the preferred alternative to restore/enhance a balance of both salt marsh and open water habitat. This alternative is superior to Alternatives 1b and 2a because it provides for an equal surface area of managed ponds for waterbirds and tidal salt marsh (Table 5-2), and additionally this alternative would restore a much greater surface area of tidal salt marsh/upland transition habitat compared to Alternatives 1b and 2a (Table 5-2). Tidal salt marsh/upland transition habitat has been identified as a critical habitat type for restoration to support the recovery of the salt marsh harvest mouse, salt marsh wandering shrew and California black rail in the San Francisco Bay. This habitat type is required by these species as high tide refugia. The Moffett Field site is one of only two suitable locations identified in the South San Francisco Bay for the restoration of a very broad transition from tidal salt marsh to existing undeveloped upland habitat (the other is in the Warm Springs area).

Table 5-2. Surface Area (Acres) of Target Biotic Habitats for Each Restoration Alternative

Biotic Habitat Type	1a-No Action (existing condition)	1b-No Action (MROSD parcel restored to tidal salt marsh)	2a-Partial Tidal Restoration, Stevens Creek Expansion	2b-Partial Tidal Restoration, NE Basin	3-Full Tidal Restoration
Diked Salt Marsh	112[b]	79	21	21	52
Freshwater Marsh	4	4	4	4	0
Managed Pond for Shorebirds	0	0	145	85	0
Non-Tidal Open Water (not actively managed for shorebirds)	160	139	0	0	0
Seasonal Tidal Salt Marsh	0	0	72	72	0
Tidal Salt Marsh[a]	0	50	41	80	192
Tidal Salt Marsh/Upland Transition	0	7	4	19	31
Shorebird Breeding/Roosting Island	0	0	2	2	0
Other	33	30	20	26	34
TOTAL	309	309	309	309	309

[a] Early successional tidal salt marsh habitat will require approximately 12-17 years to establish via natural sedimentation and vegetation establishment processes. The surface area provided above is the approximate surface area approximately 12-17 years after restoration installation.
[b] Includes the ~52 acre Western Diked Marsh

Consequently, Alternative 3 would be the preferred alternative if the primary biological objective were solely to restore salt marsh habitat for the salt marsh harvest mouse and California clapper rail. Alternative 3 provides for a large, continuous band of tidal salt marsh/upland transition habitat (Table 5-2). In addition, this alternative would restore the largest surface area of contiguous tidal salt marsh among the alternatives. The larger surface area would likely result in greater tidal habitat heterogeneity compared to the other alternatives due to the formation of higher order channels and potentially the formation of intramarsh ponds.

ALTERNATIVE 1A: NO ACTION

Biotic Habitats. The biotic habitat mosaic and wildlife use under Alternative 1a would be identical to the existing conditions described in the existing conditions section (Section 2). Non-tidal, open water habitat and diked salt marsh would continue to be the primary aquatic and wetland habitats at the site (Table 5-2). While the hydroperiod would not change under this alternative, the water and sediment quality of the open water habitat within the Central and NE Basins is expected to improve with the planned contaminated sediment remediation. Under this alternative, the contaminated sediments would be removed and replaced at the same elevation with "clean" clay sediments, according to current Navy Site 25 clean-up plans. It is assumed that the imported sediments would be suitable (fine textured, with high organic matter content) for rapid colonization by benthic invertebrates. Consequently, sediment clean-up would be expected to improve the foraging habitat for waterbirds that utilize the site.

Wildlife Use. The diked pickleweed salt marsh also provides habitat for the federally endangered salt marsh harvest mouse (*Reithrodontomys raviventris*), although trapping efforts in 1991 and 1994 resulted in only one salt marsh harvest mouse caught each year (Layne and Harding-Smith 1994; Pomeroy 1991). Other small mammals caught in the diked salt marsh during these studies included California voles (*Microtus californicus*) and house mice (*Mus musculus*). The federally endangered California Clapper Rail (*Rallus longirostris obsoletus*) has been recorded in this pickleweed marsh, although nesting habitat is currently absent from the site. Savannah Sparrows (*Passerculus sandwichensis*) nest in this diked salt marsh habitat.

Cattails in the southeastern part of the site provide nesting habitat for Marsh Wrens (*Cistothorus palustris*), Salt Marsh Common Yellowthroats (*Geothlypis trichas sinuosa*), and Red-winged Blackbirds (*Agelaius phoeniceus*). Several species of ducks nest in the salt marsh and in the grassland, ruderal, and scrub habitats along the southern edge of the site.

Coyote brush scrub provides the greatest structural complexity within the project site. Black-tailed hares (*Lepus californicus*), California voles, house mice, and Botta's pocket gophers (*Thomomys bottae*) occur here. Coyote brush provides potential nesting habitat for Song Sparrows (*Melospiza melodia*), Loggerhead Shrikes (*Lanius lucovicianus*), and White-tailed Kites (*Elanus leucurus*). The drier habitat here is also suitable for reptiles such as western fence lizards (*Sceloporus occidentalis*) and garter snakes (*Thamnophis* spp.). Large numbers of seed-eating birds, including the House Finch (*Carpodacus mexicanus*), Lesser Goldfinch (*Carduelis psaltria*), American Goldfinch (*Carduelis tristis*), Lincoln's Sparrow (*Melospiza lincolnii*), White-crowned Sparrow (*Zonotrichia leucophrys*), and Golden-crowned Sparrow (*Z. atricapilla*) forage in the coyote brush scrub and other weedy habitats along the southern edge of the site, particularly during the nonbreeding season.

ALTERNATIVE 1B: TIDAL SALT MARSH RESTORATION OF MROSD PARCEL

The mosaic of biotic habitats under Alternative 1b is similar to Alternative 1a except for the MROSD Parcel that would be converted to tidal salt marsh and salt marsh/upland transition habitat (Table 5-2).

Biotic Habitats in the Restored Tidal Salt Marsh Area. Tidal salt marsh/upland transition zone habitat would be constructed from imported soil along the outboard side of the new levee. Tidal salt marsh/upland transition habitat would consist of a gentle slope with a minimum width of 200 ft between MHHW and the levee crest elevations. This habitat type is one of the most heavily impacted habitats in the San Francisco Bay and is critical to the survival of the federally endangered salt marsh harvest mouse. Due to the presence of low-lying grasslands immediately south of the MROSD parcel, this area provides one of the only opportunities in the South Bay for restoration of a transition from tidal marsh to undeveloped upland grasslands. In addition to the soil import and grading work, restoration of marsh/upland transition zone habitat would also involve active revegetation with native plant species to minimize dominance by invasive plant species. Active revegetation would target upper marsh species such as alkali heath (Frankenia salina), marsh gumplant (Grindelia hirsutula; G. stricta.), saltgrass (Distichlis spicata), creeping wildrye (Leymus triticoides), and big saltbush (*Atriplex lentiformis*), and coastal scrub species such as California sagebrush (*Artemisia californica*), buckwheat (*Eriogonum fasciculatum*), black sage (*Salvia mellifera*), and coyote brush (*Baccharis pilularis*).

The mosaic of restored tidal habitats would gradually change over time as the elevation of the MROSD Parcel increases via natural sediment accretion. Initially after levee removal, the northern half of the parcel would become tidal open water habitat flooded approximately 1.5 ft deep even at the lower low tide, while the southern half of the site would become intertidal mudflat habitat. Estuarine benthic invertebrates and algal mats would be expected to rapidly colonize the intertidal mudflat habitat.

Natural sedimentation is expected to gradually raise the grades of the site to an elevation suitable for colonization by native tidal salt marsh plant species. Pacific cordgrass is the dominant plant species in the lowest elevation portion of the tidal salt marshes of San Francisco Bay. In fully tidal marshes its lower elevation limit is approximately 1 foot above MTL. PWA has estimated that approximately 7-12 years would be required for natural sedimentation to raise the average elevation of the site to 1 foot above MSL. Dense cover of early successional tidal salt marsh vegetation is expected to establish within 5 years after site elevation reach +1 foot above MTL (H. T. Harvey & Associates 1997; H. T. Harvey & Associates 2003). Therefore, Pacific cordgrass is expected to initially colonize and dominate the site 12-17 years after levee removal. Annual pickleweed (*Salicornia europaea*) may also initially colonize the low elevation portions of the site and co-occur with Pacific cordgrass. Alkali bulrush could also play a role in vascular plant colonization of the site given the freshwater inputs from Stevens Creek. The tidal salt marsh plant community would then gradually change over the next 1-2 decades from a cordgrass-dominated community to a pickleweed-dominated community as sedimentation raises the site elevations to form a marsh plain between MHW and MHHW elevations. The distribution of Pacific cordgrass would gradually retreat to the edges of restored slough channels. As sediment accretion rates slow and approach equilibrium with the restored tidal regime, the process of plant succession would gradually result in the formation of plant communities comparable to that found in the existing tidal salt marsh habitat at the mouth of Stevens Creek. Vascular plant height, productivity, and diversity would also gradually increase over subsequent decades as organic matter levels and inorganic nutrient levels increase in the restored marsh soils.

Assuming that the borrow-ditch along the northern edge of the site was blocked during restoration installation, a dendritic slough channel network would develop to drain the restored marsh plain.

The bottoms of the restored slough channels would provide narrow, sinuous corridors of intertidal mudflat habitat while the slough channel edges from approximately 1 foot above MSL to MHW would be dominated by Pacific cordgrass. The majority of the restored tidal salt marsh from MHW to MHHW would comprise a relatively flat marsh plain dominated by dense stands of pickleweed. The plant species diversity of the restored marsh would gradually increase over decades to include a suite of native species including salt grass, alkali heath, spearscale (*Atriplex triangularis*), gumplant (*Grindelia* sp.), jaumea (*Jaumea carnosa*), arrow-grass (*Triglochin* sp.), alkali grass (*Puccinellia* sp.), and dodder (*Cuscuta salina*).

Wildlife Use. Because the habitats in most of the site are not expected to change, wildlife use of most of the site would be as described under Alternative 1a. However, in the restored marsh in the MROSD parcel, fish and wildlife use would change over time with sediment accretion in response to the succession of tidal habitats.

Wildlife Use of Restored Tidal Salt Marsh Areas. Restoration of tidal action would initially provide a mix of subtidal and intertidal habitats. Subtidal waters in the northern portion of the restored area would provide habitat for a variety of fish species, including the federally threatened steelhead (*Oncorhynchus mykiss*) and topsmelt (*Atherinops affinis*), staghorn sculpin (*Leptocottus armatus*), threespine stickleback (*Gasterosteus aculeatus*), and shiner surfperch (*Cymatogaster aggregata*). In addition, this subtidal habitat would provide foraging habitat for piscivorous birds and waterfowl. The intertidal habitat in the southern portion of the restored area would provide foraging habitat for fish, long-legged waders such as herons and egrets, and waterfowl at high tide, while at low tide these areas would support foraging shorebirds.

As elevations increase and cordgrass colonizes the formerly subtidal and intertidal mudflat areas, the use of these areas by herons, egrets, and Clapper Rails would increase, while shorebird use is expected to decline. Song Sparrows, Marsh Wrens, and possibly Salt Marsh Common Yellowthroats may nest in the low marsh vegetation that becomes established here. As elevations continue to increase and the tidal marsh habitat becomes dominated by pickleweed, it will become more suitable for resident salt marsh species such as salt marsh harvest mice and nesting Savannah Sparrows. Cordgrass will be confined to lower areas, such as along the edges of channels, but it and marsh gumplant may still be extensive enough to provide Clapper Rail nesting habitat, and Song Sparrows and Marsh Wrens would likely continue to nest in narrower strips of cordgrass. Ducks are expected to nest in marsh vegetation and forage within the channels. The upland transition zone would be used heavily by Savannah Sparrows for nesting and would provide important high tide refugia for salt marsh harvest mice and rails. Loggerhead Shrikes, White-tailed Kites, Northern Harriers (*Circus cyaneus*), and a variety of sparrows and other bird species will forage in the upland transition zone habitat as well.

ALTERNATIVE 2A: PARTIAL RESTORATION – STEVENS CREEK EXPANSION

Biotic Habitats. Alternative 2a would improve habitat conditions for both waterbirds and resident tidal salt marsh wildlife species compared to Alternatives 1a and 1b by adding managed pond and seasonal tidal salt marsh to the habitat mosaic (Table 5-2).

Managed Pond. Waterbird habitat within the Central and NE Basins would be enhanced by the construction of five nesting/roosting islands and by creation of shallow open water foraging habitat in late summer-early fall. Each island would be at least 400 square ft in size measured at least 1 vertical foot above the maximum design water level in the SWRP. Creation of larger islands would be avoided as these may support nesting California Gulls, which could displace other birds. The islands would be oblong in shape (approximately 10 ft by 40 ft) with the long side oriented perpendicular to the prevailing wind direction to maximize the surface area on the leeward side that is buffered from the wind and wind-generated waves. The prevailing winds at Moffett Field during the main part of the breeding season (March-July) are from the north-northwest. Therefore, the islands would be situated toward the northern end of the site to use the flood control levee to minimize the wind fetch. In addition, the islands would be constructed with gentle side-slopes (approximately 8:1) to provide shallow water foraging habitat in close proximity to nesting habitat. Some birds will nest where there is some vegetation cover (e.g., a small amount of pickleweed), but ideally, islands would be maintained free of vegetation. Therefore, design and management measures would be taken to minimize vegetation establishment. Such measures could include creation of islands using hypersaline soils, addition of salt to the upper soil surface during construction, addition of a layer of shell debris to the top of the islands, and/or mechanical removal of vegetation during the non-breeding season.

The storm water retention pond currently provides good foraging habitat for shorebirds during spring, but in some years it dries out too much during late summer to provide high-quality foraging habitat. Under Alternative 2a, water levels would drawdown via evaporation during spring and early summer like the current condition. In August, however, a tide gate installed between the Central Basin and the adjacent tidal salt marsh restoration area (MROSD Parcel or Pond A2E) would be opened for a sufficient duration to allow shallow flooding of the pond (0.1-0.5 ft deep) by saline baywater to provide foraging habitat during fall migration. The use of saline baywater would be important to maintain "mudflat habitat" and minimize colonization by freshwater/brackish water emergent vegetation. This management regime would also provide suitable shorebird nesting habitat if shallow water is maintained during the summer around nesting islands (see below). It should be noted that the feasibility of installing functional tidegates at the interface between restored tidal marshes and the Central Basin would need to be investigated as this would require a slough channel extending through the restored tidal marsh to the tidegate.

Seasonal Tidal Salt Marsh. Currently, the existing diked salt marsh in both the Western Diked Marsh and southeast portion of the MROSD Parcel is of low value to resident salt marsh species such as the salt marsh harvest mouse. The low habitat value is due to the high abundance of perennial pepperweed in the Western Diked Marsh and to prolonged winter flooding from storm water inputs to the MROSD parcel. This alternative would eliminate prolonged storm water ponding by construction of a new levee that would tie into the existing upland peninsula thus preventing storm water flow from the Central Basin to the MROSD Parcel. Two tide gates would then be installed in the new levee to connect the restored tidal salt marsh in the northwest corner of the NASA property to the Western Diked Marsh and the MROSD tidal pond to the MROSD seasonal tidal pond. The purpose of the tide gates is to restore muted-tidal action seasonally (during the dry season) to the Western Diked Marsh and to the southeast corner of the MROSD parcel. The perimeter road would remain and could not be flooded. The tide gates would be designed and operated to flood and drain the marshes with saline water. This should decrease the abundance of perennial pepperweed and increase the abundance and productivity of pickleweed.

Tidal Salt Marsh. The biotic habitat description of restored tidal salt marsh in Alternative 1b above would apply to the tidal salt marsh restoration area in this Alternative.

Wildlife Use. The managed pond would improve habitat conditions for waterbirds by providing for more closely managed water levels and providing islands for bird use. Shallow flooding in late summer and fall is expected to improve (vs. the existing condition) foraging habitat for migratory shorebirds and for waterfowl during fall migration and early winter. The islands constructed in the managed pond would provide nesting habitat for Black-necked Stilts, American Avocets, Killdeer (*Charadrius vociferus*), and possibly Forster's Terns and Snowy Plovers. These islands would provide high tide roosting habitat and some foraging habitat for shorebirds and may be used as roosting/loafing sites by American White Pelicans (*Pelecanus erythrorhynchos*), Caspian Terns (*Sterna caspia*), and a variety of gulls (*Larus* spp.) and waterfowl. Salt ponds AB1 and A2E, immediately north of the site, are used as foraging and staging areas by the federally endangered California Least Tern (*Sterna antillarum browni*) after breeding; this species may also use the managed pond and islands on the restoration site for foraging and roosting during the late summer.

The seasonal tidal salt marsh is expected to provide habitat for salt marsh harvest mice, nesting ducks and Savannah Sparrows, and possibly also for Black-necked Stilts if some areas remain ponded during the breeding season. Loggerhead Shrikes, White-tailed Kites, and Northern Harriers would forage over this habitat, and Song Sparrows may nest in taller vegetation in and around this habitat.

Wildlife use of tidal salt marsh habitats under this alternative is expected to develop as described under Alternative 1b.

ALTERNATIVE 2B: PARTIAL RESTORATION- NE BASIN RESTORATION

Biotic Habitats. Alternative 2b would restore tidal salt marsh and tidal salt marsh/upland transition habitat in the NE Basin as well as the MROSD Parcel, thus restoring approximately twice the surface area of tidal salt marsh as Alternative 2a (Table 5-2). The description of restored tidal salt marsh, seasonal tidal salt marsh and managed pond habitats provided above applies equally to Alternative 2b.

Wildlife Use. Wildlife use of the habitats created by this alternative will be generally similar to those described under Alternative 2a. However, because the NE Basin would be restored to tidal marsh under this alternative, it would provide more habitat for marsh-dependent species such as: the California Clapper Rail, salt marsh harvest mouse, Song Sparrow, Savannah Sparrow, and less habitat for birds associated with open water/managed pond habitats. This alternative would increase (vs. previous alternatives) the extent of important high-marsh habitat and upland transition zones necessary for the recovery of South Bay salt marsh harvest mouse populations.

ALTERNATIVE 3: FULL TIDAL RESTORATION

Biotic Habitats. Alternative 3 would restore the entire site to tidal salt marsh and tidal salt marsh/upland transition habitat (Table 5-2). The description of these restored salt marsh habitats provided above under Alternative 1b applies to this alternative. However, the greater tidal marsh restoration that would occur under this alternative could provide for greater habitat heterogeneity within the restored marsh than alternatives that would restore less tidal marsh area. For example, this alternative has the potential for larger, higher-order channels, intra-marsh salt ponds and pans, and more spatial heterogeneity in vegetation types and habitat conditions than previously described alternatives. Under this alternative, after approximately 12-17 years, the open water habitat would be almost entirely converted to vegetated tidal salt marsh. This conversion would result in the loss of existing shorebird and waterfowl foraging habitat. Therefore, while the quality and quantity of tidal salt marsh habitat is greater under Alternative 3, this would come at the expense of losing the functions and values of the existing non-tidal, open water habitat.

Wildlife Use. Wildlife use of the project area under this alternative would be similar to that described for the restored tidal marsh in Alternative 1b. Initially, restoration of tidal action would provide a mix of subtidal and intertidal habitats used by fish, wading birds, waterfowl, and shorebirds. As elevations increase and cordgrass colonizes the formerly subtidal and intertidal habitat areas, the use of these areas by herons, egrets, and Clapper Rails may increase, while shorebird use is expected to decline. Song Sparrows, Marsh Wrens, and possibly Salt Marsh Common Yellowthroats may nest in the low marsh vegetation that becomes established here. As elevations continue to increase and the tidal marsh habitat becomes dominated by pickleweed, it will become more suitable for salt marsh harvest mice and nesting Savannah Sparrows.

Intra-marsh salt ponds and pans may naturally form over time and would provide open water foraging and roosting habitat for waterfowl and shorebirds. The channel network within the marsh would likely be more extensive under this alternative compared to the other alternatives due to the much greater tidal prism. This would enhance aquatic habitat for fish and nesting and foraging habitat for Clapper Rails, Song Sparrows, and ducks. The extent of salt marsh restoration and the broad transition from tidal marsh to upland grasslands would make this alternative highly valuable to salt marsh harvest mouse populations.

5.2.3 Nuisance Species Management

There are several nuisance species of concern for the proposed restoration. Mosquitoes, as a biting nuisance and as a vector for disease, are a major concern, particularly with the advent of West Nile virus. Two species of non-native plants, smooth cordgrass *(Spartina alterniflora*/hybrids) and perennial pepperweed (*Lepidium latifolium*) are aggressive weedy species in the South Bay, displacing native vegetation and diminishing habitat values. Finally, burrowing rodents damage levees and can create channels for water flow, thereby hastening levee deterioration and possibly failure.

Mosquitoes. Although there is public concern about mosquito outbreaks resulting from constructed wetland projects, wetlands can be designed and maintained to keep mosquito populations to a minimum. Mosquitoes lay their eggs on or near the water and the mosquito larvae live near the water surface, breathing air and feeding primarily on algae and organic debris (Floor 2004). Effective mosquito control generally targets the larval form of the insect. Minimizing hydraulically static areas, controlling water levels, disturbing water surface to drown larvae, minimizing anaerobic zones, and creating access for natural mosquito predators are common mosquito control strategies. Some of these strategies are discussed below.

Water level manipulation and topography control are two commonly used control mechanisms. Wetland topography should be constructed to avoid ponding of water in isolated areas during drawdown.

Wetland vegetation, although beneficial in other ways, can provide larvae with refuge from water surface disturbances and predators, and can decrease developmental time by increasing habitat temperature and enhancing food resources. Selective vegetation control can increase mosquito larvae mortality.

The addition of mosquito fish (*Gambusia affinis*) to a wetland is commonly used as a natural method to control mosquito populations in fresh water. However, mosquito fish are not viable in brackish or salty water; so this method of control may not be available for this project.

Bti and Methoprene are two larvicides that are commonly used for mosquito control. Both are very specific to mosquito larva, short lived in the environment, and very effective.

Mosquito management in tidal marshes is typically accomplished through aerial application. In the South Bay area this is usually done by helicopter. For areas that can be accessed on foot, this work can be done at much less expense by hand application.

Invasive Non-native Plants. Both perennial pepperweed and smooth cordgrass are found in close proximity to the project area. Changed conditions as a result of the project may create opportunities for these plants to invade habitats where they are not currently found. Pepperweed can be controlled through restoration of tidal salt marsh habitat with relatively high interstitial soil salinity. In addition, pepperweed can be controlled through water level and water salinity management in diked marshes. Pepperweed can also be controlled through the use of herbicides. Smooth cordgrass is typically controlled through use of herbicides, although covering and mechanical removal are also used where appropriate. Restoration work should be coordinated with the Invasive Spartina Project to assess constraints associated with *S. alterniflora*/hybrids.

Burrowing Rodent. California ground squirrels (*Spermophilus beecheyi*) are often found in Bay area levees. Large levees and shallow side slopes help to minimize the damage these animals can cause to levee integrity. Trapping, poisoning, and fumigation are sometimes used, but may not be appropriate for this area (University of California Agriculture and Natural Resources 2002). Natural predators such as raptors and coyotes will help keep populations down to some degree.

Summary of Alternatives

Alternatives 2a and 2b offer the greatest opportunities for cost-effective design and management tools for control of nuisance species, particularly mosquitoes and invasive plants. Alternative 3, full tidal restoration, provides fewer management tools for control of nuisance species since water management is not an option. Finally, Alternatives 1a and 1b do not allow for water level management as a tool, while still retaining the storm water ponds and Western Diked Marsh as havens for mosquitoes and pepperweed.

ALTERNATIVE 1A: NO ACTION

In this alternative the existing conditions would remain unchanged. No new opportunities for nuisance species would be created. Existing pepperweed in the Western Diked Marsh would potentially spread.

ALTERNATIVE 1B: TIDAL SALT MARSH RESTORATION OF MROSD PARCEL

Tidal restoration of the MROSD parcel entails the construction of a wide habitat levee between the Central Basin and the MROSD parcel. Mosquitoes would not initially be expected to be an issue in this parcel because it would be mostly deep open water. The MROSD parcel would potentially develop mosquito problems over time as the base elevation increases due to sedimentation and plant colonization. As the tidal marsh develops, stagnant pools that are largely unaffected by tides would potentially develop. Such pools present prime mosquito breeding habitat. Any current mosquito issues in the Central and NE Basins would remain unchanged under this alternative.

Opening of the MROSD parcel to Stevens Creek would pose the risk of colonization by smooth cordgrass, which is found in the watershed. No change in opportunities for increased colonization by perennial pepperweed would be expected.

Burrowing rodents would not likely present a problem for the proposed wide levee between the MROSD and the Central Basin. The extreme width of this levee would potentially prevent rodents from causing excessive damage or creating a through passage for water flow and subsequent erosion.

ALTERNATIVE 2A: PARTIAL RESTORATION – STEVENS CREEK EXPANSION

This alternative includes the tidal restoration of part of the MROSD parcel and the northwest corner of the NASA property. A wide habitat levee would be constructed which would have tidal gates connecting Stevens Creek with the Western Diked Marsh and with the Central/NE Basin complex. Mosquitoes would not initially be expected to be an issue in the MROSD parcel because it would mostly be deep open water. The MROSD parcel would potentially develop mosquito problems over time as the base elevation increases due to sedimentation and plant colonization. As the tidal marsh develops, stagnant pools that are largely unaffected by tides would potentially develop. Such pools present prime mosquito breeding habitat. Late summer shallow flooding of the Central and NE Basins would potentially cause mosquito outbreaks.

Permanent breaching of the Stevens Creek levee with tide gates would offer avenues for perennial pepperweed and smooth cordgrass to invade and degrade valuable habitat areas in the MROSD seasonal tidal marsh, the Central Basin, and the NE Basin. Conversely, the tide gate to the Western Diked marsh would offer a means of control of existing pepperweed through water level management, although this area would also be a source for seed.

Burrowing rodents would not be likely present a problem in the proposed wide levee between the MROSD and the Central Basin. The extreme width of this levee would potentially prevent rodents from causing excessive damage or creating a through passage for water flow and subsequent erosion.

ALTERNATIVE 2B: PARTIAL RESTORATION- NE BASIN RESTORATION

This alternative includes the tidal restoration of part of the MROSD parcel, the northwest corner of the NASA property, and the NE Basin. A wide habitat levee would be constructed which would have tide gates connecting Stevens Creek with the Western Diked Marsh, the MROSD seasonal tidal marsh, and the Central Basin. Identical levees, except without tide gates, would separate the Central Basin from the NE Basin. Mosquitoes would not initially be expected to be an issue in the MROSD parcel, Central Basin, or NE Basin because the habitat would mostly be deep open water. Both areas would potentially develop mosquito problems over time as the base elevation increases due to sedimentation and plant colonization. As the tidal marsh develops, stagnant pools would potentially develop that are largely unaffected by tides. Such pools present prime mosquito breeding habitat. Late summer shallow flooding of the Central Basin would potentially cause mosquito outbreaks.

Permanent breaching of the Stevens Creek levee with tide gates would offer avenues for perennial pepperweed and smooth cordgrass to invade and degrade valuable habitat areas in the MROSD seasonal tidal marsh and the Central Basin. Conversely, the tide gate to the Western Diked Marsh would offer a means of control of existing pepperweed through water level management, although this area would also be a source for seed. The MROSD parcel, the northwest corner of the NASA property, and the NE Basin would be exposed to colonization by smooth cordgrass under this alternative, but initial colonization would not be expected for a number of years. It would be recommended that developing mudflats are monitored for pioneer stands of smooth cordgrass.

Burrowing rodents would not be anticipated to present a problem in the proposed wide levee between the MROSD and the Central Basin and between the Central Basin and the NE Basin. The extreme width of these levees would likely prevent rodents from causing excessive damage or creating a through passage for water flow and subsequent erosion.

ALTERNATIVE 3: FULL TIDAL RESTORATION

Tidal restoration of the entire project area would eventually convert the SWRP to tidal marsh. Mosquito problems would be greatly reduced over current levels until sedimentation eventually allows for plant colonization. As the tidal marsh develops, stagnant pools that are largely unaffected by tides would potentially develop. Such pools present prime mosquito breeding habitat.

The entire area would be exposed to colonization by smooth cordgrass under this alternative, but initial colonization would not be expected for a number of years. It would be recommended that developing mudflats are monitored for pioneer stands of smooth cordgrass.

Most of the levee construction proposed under this alternative would be similar the wide habitat levee discussed earlier. This levee is resistant to rodent damage.

5.2.4 Public Access (Bay Trail)

The public access objective focuses on linkage of the Bay Trail segments that are adjacent to the existing SWRP, as the Bay Trail is currently discontinuous (Figure 5-7). Ideally, linkage of the Bay Trail would be achieved while maintaining the current level of security protection at NASA Ames. Public safety issues are an additional consideration for the Bay Trail alignment.

Summary of Alternatives

The most potential for public access (linkage of the Bay Trail adjacent to the SWRP) is provided by Alternatives 1a, 1b, and 2a. Alternative 2b offers limited public access, as the levee alignment immediately adjacent to the Moffett Field airstrip presents security issues. Because the levee closely surrounds NASA Ames for Alternative 3, this alternative offers the least potential for public access.

ALTERNATIVE 1A: NO ACTION

Alternative 1a offers potential for public access, as the Bay Trail alignment would be placed on the existing levee separating the SWRP from Pond A2E (Figure 4-1).

ALTERNATIVE 1B: TIDAL SALT MARSH RESTORATION OF MROSD PARCEL

Similar to Alternative 1a, Alternative 1b also offers potential for public access. The Bay Trail would follow the proposed levee alignment (Figure 4-2), bordering the tidally restored MROSD parcel and following the existing levee alignment separating the Central and NE Basins from Pond A2E.

ALTERNATIVE 2A: PARTIAL RESTORATION – STEVENS CREEK EXPANSION

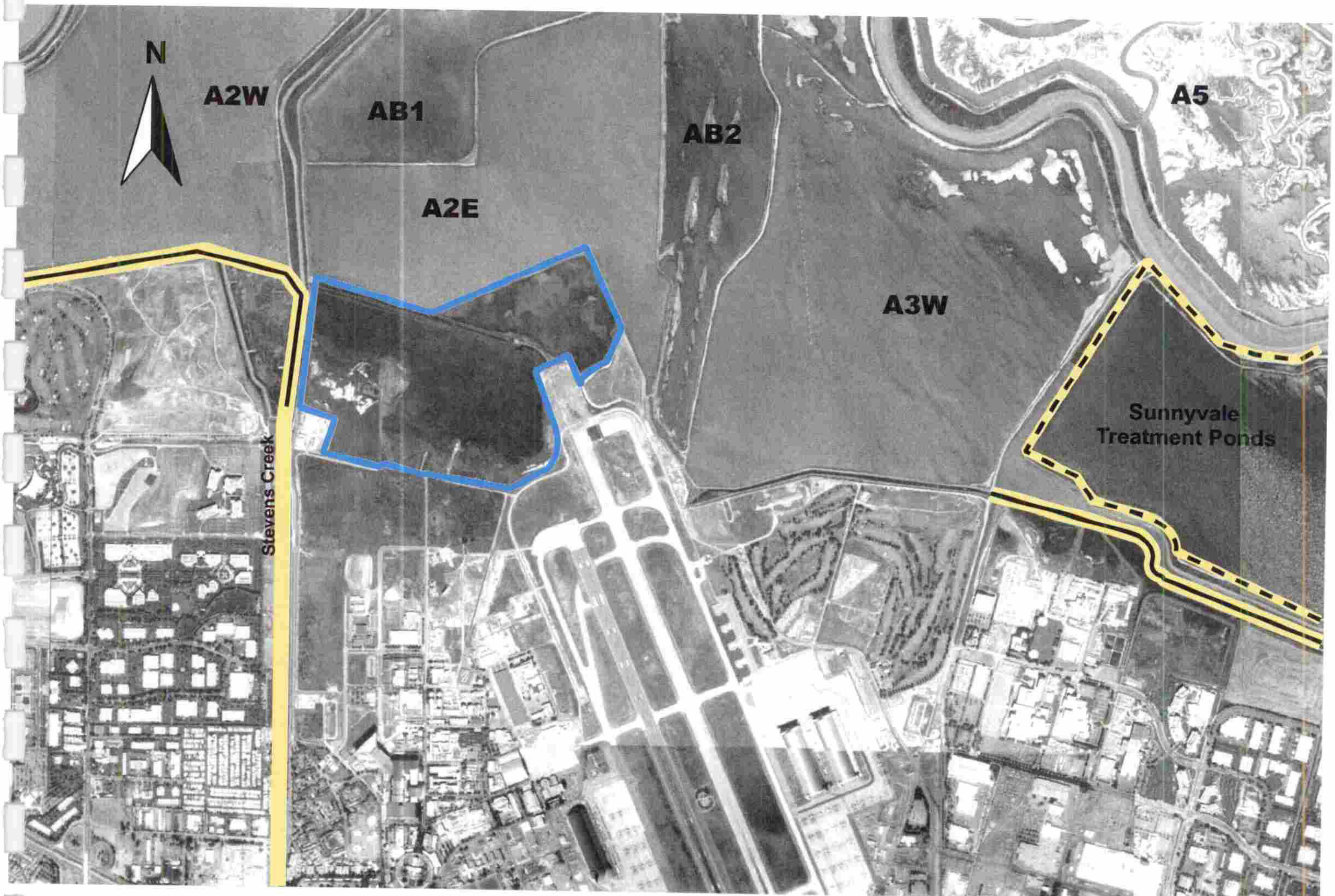
Alternative 2a provides the potential for public access. As described under Alternative 1b, the Bay Trail would follow the proposed levee alignment for Alternative 2a (Figure 4-3) by bordering the tidally restored NASA Western Diked Marsh and MROSD parcel and connecting to the existing levee separating the Central and NE Basins from Pond A2E.

ALTERNATIVE 2B: PARTIAL RESTORATION- NE BASIN RESTORATION

Alternative 2b offers less public access than Alternatives 1a, 1b, and 2a. The Bay Trail alignment for Alternative 2b would be similar to Alternative 2a, except that the trail would follow the proposed levee alignment that separates the NE Basin from Pond A2E (Figure 4-4). The proximity of the levee alignment to the Moffett Field airstrip would present potential security and public safety issues and would occasionally result in limited trail access.

ALTERNATIVE 3: FULL TIDAL RESTORATION

Alternative 3 provides the least potential for public access. The Bay Trail would follow the proposed levee alignment (Figure 4-5), which closely borders NASA Ames. Security and public safety issues associated with this alternative would result in limited trail access.



Source: South Bay Salt Pond Preliminary Program Alternatives Memorandum (2005)

Legend

- Existing SWRP Boundaries
- Existing Bay Trail (Spine)
- Existing Bay Trail (Spur)
- Existing Other Trails

Moffett Field Restoration Feasibility Study

Figure 5-7
Existing Bay Trail Alignment

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5.2.5 Cost Effectiveness

A comprehensive planning level cost evaluation is included in Section 4.5. From Table 4-2, the relative alternative costs can be compared. Note that at the planning level, there are still large uncertainties with regard to final cost. Capital improvement costs ranged from zero for the Alternative 1a to $21.0 million for Alternative 3. Incremental costs of restoration ranged from $31,000 to $98,000 per acre, with Alternative 2a being the most cost-effective.

ALTERNATIVE 1A: NO ACTION

There are no capital costs associated with Alternative 1a, as no change would occur under this alternative. Existing operations and maintenance costs for levees, water pumping, and nuisance species will be ongoing. There would be no improvement in habitat values.

ALTERNATIVE 1B: TIDAL SALT MARSH RESTORATION OF MROSD PARCEL

The capital cost of Alternative 1b is estimated to be approximately $9.3 million. With this alternative 50 acres of tidal salt marsh would be restored, and 7 acres of salt marsh/ upland transition would be improved. Since this alternative would not contain water management capability, no other improvements in habitat would occur. The incremental cost for this alternative is $163,000 per acre.

ALTERNATIVE 2A: PARTIAL RESTORATION – STEVENS CREEK EXPANSION

The capital cost for Alternative 2a is estimated to be approximately $8.3 million. With this alternative, 41 acres of tidal salt marsh and 268 acres of other habit would be restored or improved because of introduced water management capabilities. The incremental cost for this alternative is $27,000 per acre. This represents the most cost-effective alternative.

ALTERNATIVE 2B: PARTIAL RESTORATION- NE BASIN RESTORATION

The capital cost of Alternative 2b is estimated to be approximately $19.5 million. Given the uncertainties in these planning level estimates, the capital costs of Alternatives 2b and 3 are effectively identical. With this alternative, 80 acres of tidal salt marsh and 229 acres of other habitat would be restored or improved because of introduced water management capabilities. The incremental cost for this alternative is $63,000 per acre.

ALTERNATIVE 3: FULL TIDAL RESTORATION

Alternative 3 represents the most costly alternative and is estimated to cost approximately $21.0 million. Given the uncertainties in these planning level estimates, the capital costs of Alternatives 2b and 3 are effectively identical. With this alternative 192 acres of tidal salt marsh would be restored. Thirty-one acres of salt marsh/upland transition would be improved or created. Since this alternative does not include water management capability, no other improvements in habitat would occur. The incremental cost for this alternative is $94,000 per acre.

5.3 Alternatives Ranking

A qualitative analysis was performed (Table 5-3) to evaluate restoration alternatives based on the primary objectives described in Section 5.1. Each of the alternatives was evaluated against the four project objectives and rated low (1 point), medium (2 points), or high (3 points) relative to the ability of the alternative to meet the objective. Alternatives not capable of meeting a given objective were rated as not achievable (0). Storm water management is a critical success factor for any alternative. No weightings have been applied to differentiate the relative importance of the various objectives. The total score was used to compare alternatives relative to one another. From the qualitative analysis, Alternative 2a was rated the highest.

Table 5-3. Alternatives Evaluation Matrix

	Alternative Rating				
	1a	1b	2a	2b	3
Primary Objectives	**No Action (Existing Conditions)**	**No Action (Removal of MROSD parcel)**	**Stevens Creek Expansion**	**NE Basin Restoration**	**Full Tidal Restoration**
Storm Water Management	High (3)	Medium (2)	Medium (2)	Low (1)	Not Achievable (0)
Biological Habitat					
Balanced Biological Habitat	Low (1)	Low (1)	Medium (2)	High (3)	Medium (2)
Salt Marsh Habitat	Low (1)	Medium (2)	Medium (2)	Medium (2)	High (3)
Nuisance Species Management	Low (1)	Low (1)	High (3)	High (3)	Medium (2)
Public Access – Bay Trail	High (3)	High (3)	High (3)	Medium (2)	Low (1)
Cost Effectiveness	Not Achievable (0)	Low (1)	High (3)	Medium (2)	Low (1)
Total Score[a]	8	8-9	13	10-11	6-7

[a]Total scores are shown as a range to reflect the two different biological habitat scores, based on the two slightly different habitat objectives.

5.4 Recommended Alternative and Other Recommendations

Alternative 2a was rated the highest in the alternatives evaluation matrix (Table 5-3) and is the restoration alternative recommended by the Project Team. This alternative represents a cost-effective approach to restoring tidal salt marsh, creating beneficial biological habitat, and managing for nuisance species while continuing to effectively manage storm water flows.

The Project Team also has several other recommendations to be considered. The first of which is that the levee low points (i.e., levee elevations below 4 ft NAVD, located to the southeast of the Central Basin) are increased to 5 ft NAVD to allow one foot of freeboard. This recommendation includes maintaining the maximum water surface elevation at 4 ft NAVD to prevent upland flooding and providing one foot of freeboard to limit levee erosion and overtopping.

It is also recommended that a more detailed topographic survey be conducted to determine more precisely the elevations of the SWRP levees and bed. The use of accurate topographic data is important for determining the current site elevations for storm water and hydrodynamic models and for the analysis of marshplain evolution. Lack of complete site topographic data could have significant implications for the assessment of existing conditions and the prediction of potential future restoration scenarios. Though the merged topographic data are sufficient for this feasibility study, it is recommended that a detailed topographic survey is conducted during any potential restoration planning/design to guarantee full accuracy.

The Project Team recommends that two sets of data be collected for inclusion in the storm water hydrology model. The storm water hydrology model currently uses available data to drive simulations of storm water runoff from the NASA site and the corresponding water surface elevation in the SWRP. Additional site-specific data will allow for increased confidence to be placed around results of model simulations. These data are presented below, with a brief explanation of their utility.

Water surface elevation of SWRP. Installation of a semi-permanent device to measure and record water surface elevation of the SWRP for a continuous period of time is recommended. The subsequent data from this activity will allow for calibration of the storm water hydrology model. Calibration will compare measured SWRP elevation to simulated SWRP elevation and the model will be adjusted until the difference is as small as possible. Calibration of the model will better predict water surface elevations of the SWRP under proposed alternative scenarios for tidal restoration.

The recommended setup of a pond elevation measurement device includes a depth sensor (e.g., a pressure transducer) coupled with a data recorder. Power is usually self-contained in either the sensor or recorder. This setup should be housed in a stilling well to prevent the sensor from being damaged or moved during the monitoring period. Such a setup will collect continuous depth measurements at specified increments. Data will need to be downloaded from the data recorder by NASA staff at periodic intervals.

An alternative to the recommended monitoring setup would be installation of staff gauge in the SWRP. Under this setup the SWRP water surface elevation would be manually recorded by NASA staff after storm events. Relatively speaking, this setup would have less overhead cost, but would require more effort from NASA staff to record information. Also, depending on the frequency of measurements taken by NASA staff, the water surface elevation would not be measured during as many hydrologic conditions as with the continuous monitoring setup previously described.

The Project Team recommends SWRP measurements be taken for, at minimum, one wet season (approximately October through May). However, it would be ideal to collect data for an entire year or more. The goal of data collection is to capture SWRP water surface elevation throughout a wide range of hydrologic conditions, not only peak events, and the potential to record this range of conditions is minimized the less time monitoring occurs. Typically, the more SWRP water surface elevation data detailing response to varying hydrologic conditions collected via monitoring the more confidence associated with the overall accuracy of the model and model results.

Pan evaporation for vicinity near SWRP. A device to measure and record the pan evaporation or potential evapotranspiration for the area surrounding the SWRP is recommended. The SWRP has no physical outlet (other than pond overflow or pumping), thus the major outlet of storm water from the pond is via free water surface evaporation. The outflow of water via evaporation should be accurately accounted for when simulating the Moffett Field storm water system. Currently, measured pan evaporation data from Alamitos and calculated pan evaporation data from San Francisco airport are used to estimate evaporation at the NASA SWRP. Comparison of these two data sets suggests a wide range in pan evaporation values. The discrepancy in the pan evaporation data result in high variability of storm water model results. Local SWRP evaporation data will increase the confidence (and reduce variability) in simulated SWRP water surface elevations.

Collection of pan evaporation data is typically achieved using a Class A pan. The Project Team recommends NASA install a Class A pan with necessary data recording equipment to measure pan evaporation. The pan evaporation data should be collected in concert with the SWRP water surface elevation. Again, monitoring is recommended to occur for, at minimum, one wet season (October through May) with a year or more the desired duration. A longer period of monitoring is more likely to obtain useful data for accurately calibrating the model.

The Project Team recommends that protocol-level surveys are conducted during the respective blooming periods for ten (10) potentially occurring special-status plant species, as described in Section 2.5.16. It is recommended that these surveys are conducted during the conceptual restoration design phase to determine presence or absence of these special-status plant species, better define restoration opportunities, and assess project impacts, with respect to special-status plant species. Four protocol-level surveys should be conducted to coincide with the blooming periods of the 10 potentially-occurring species; two surveys in spring (April-May and May-June), one survey in mid-summer (mid-July), and one survey in fall (September-October). Expanded descriptions of these species are presented in Section 2.5.16 and in Appendix C.

If the SBSPRP converts Pond A2E to tidal salt marsh, the Project Team recommends that further study on a variation of Alternative 2b is conducted. The modified Alternative 2b would include an east-west levee alignment that restores the northern portion of the NE Basin to tidal salt marsh, while the southern portion of the NE Basin would be managed pond. This variation would potentially provide more storm water retention than Alternative 2a and more habitat improvements than Alternative 2a.

6

BROWN AND CALDWELL

SECTION 6

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7

BROWN AND CALDWELL

SECTION 7

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A

BROWN AND
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APPENDIX A

HSPF Input File

```
RUN

***       1         2         3         4         5         6         7         8
***4567890123456789012345678901234567890123456789012345678901234567890123456789O
***---------------------------------------------------------------------------------
***
*** EXISTING CONDITIONS
***
*** 09/28/2004:  Added command to output inflow to SWRP for estimation of flow
***     frequencies.
***
GLOBAL
  NASA MOFFET FIELD STORM WATER RETENTION POND ANALYSIS
  START       1948/07/01 00:00  END    2003/12/31 23:00
  RUN INTERP OUTPT LEVELS    5    3
  RESUME     0 RUN     1                        UNITS    1
END GLOBAL

FILES
<FILE>  <UN#>***<----FILE NAME------------------------------------------------->
WDM        20   w:\nasa\hspf\nasa.wdm
***MESSU      21   y:\exst_sfo.MES
***           49   y:\exst_sfo.out
MESSU      21   y:\exst_almts.MES
           49   y:\exst_almts.out
END FILES

OPN SEQUENCE
    INGRP              INDELT  1:00
      PERLND      12
      IMPLND      21
      RCHRES       2
      RCHRES       3
      RCHRES       1
      COPY        45
    END INGRP
END OPN SEQUENCE
                                                                  ***
PERLND
  GEN-INFO
*** PLS 53 parameters taken from nearby Calabazas Creek HSPF model for "commercial"
*** conditions; made available through HSPFParm
    <PLS >      Name          NBLKS   Unit-systems   Printer                  ***
    # -  #                          User  t-series Engl Metr                 ***
                                   in  out                          ***
   12      TF/MILD                 1    1    1    1   49    0
   53      COMM R5-CALABAZAS       1    1    1    1   49    0
  END GEN-INFO
  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC        ***
```

```
  12   53    0    0    1    0    0    0    0    0    0    0    0    0
 END ACTIVITY
 PRINT-INFO
   <PLS > ******************** Print-flags ************************ PIVL  PYR
   # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC *********
  12   53    0    0    6    0    0    0    0    0    0    0    0    0    1    9
 END PRINT-INFO
 PWAT-PARM1
   <PLS > **************** Flags *******************
   # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE IFFC                ***
  12         0    0    0    0    0    0    0    0    0    0
  53         0    1    1    1    0    0    0    0    1    1
 END PWAT-PARM1
 PWAT-PARM2
   <PLS > ***
   # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
  12           0.75    4.5000    0.0800    400.00    0.0500    0.5000    0.9960
  53           0.00    7.0000    0.0300    250.00    0.0083    0.0000    0.9500
 END PWAT-PARM2
 PWAT-PARM3
   <PLS >***
   # -  #*** PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
  12                             2.0000    2.0000      0.50        0.        0.
  53           40.0      35.0    2.0000    2.0000      0.45        0.        0.
 END PWAT-PARM3
 PWAT-PARM4
   <PLS >                                                              ***
   # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP***
  12         0.1000    0.2700    0.2500     3.000    0.7000    0.5000
  53         0.0000    0.4000    0.1000     0.400    0.3000    0.0000
 END PWAT-PARM4
 MON-INTERCEP
   <PLS >  Interception storage capacity at start of each month         ***
   # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC        ***
  53      0.10 0.10 0.10 0.10 0.06 0.06 0.06 0.06 0.06 0.10 0.10 0.10
 END MON-INTERCEP
 MON-LZETPARM
   <PLS >  Lower zone evapotranspiration parm at start of each month    ***
   # -  #  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC        ***
  53       0.4  0.4  0.4  0.4  0.6  0.6  0.6  0.6  0.6  0.4  0.4  0.4
 END MON-LZETPARM
 PWAT-STATE1
   <PLS >  PWATER state variables***
   # -  #***    CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
  12              0.        0.    0.0030        0.     .9540      0.00     0.017
  53              0.    0.4000    0.1000     1.400    0.3000      0.00     0.162
 END PWAT-STATE1
END PERLND

IMPLND
 GEN-INFO
*** ILS 43 parameters taken from nearby Calabazas Creek HSPF model for
*** "commercial" conditions; made available through HSPFParm
   <ILS >      Name             Unit-systems   Printer                      ***
   # -  #                     User  t-series Engl Metr                      ***
                               in  out                              ***
  21      IMPERVIOUS            1    1    1   49    0
```

```
 43      COMM-CALABAZAS          1    1    1   49    0
  END GEN-INFO
  ACTIVITY
    <ILS > ************* Active Sections ****
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL  ***
  21  43    0    0    1    0    0    0
  END ACTIVITY
  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL *********
  21  43    0    0    6    0    0    0    1    9
  END PRINT-INFO
  IWAT-PARM1
    <ILS >          Flags             ***                                  ***
    # -  # CSNO RTOP  VRS  VNN RTLI   ***                                  ***
  21         0    0    0    0    0
  43         0    0    0    0    1
  END IWAT-PARM1
  IWAT-PARM2
    <ILS >                                                                 ***
    # -  #      LSUR     SLSUR      NSUR     RETSC                         ***
  21          500.00    0.0100    0.1000    0.1000
  43          100.00    0.0141    0.0300    0.1000
  END IWAT-PARM2
  IWAT-PARM3
    <ILS >                                                                 ***
    # -  #    PETMAX    PETMIN                                             ***
  21   43
  END IWAT-PARM3
  IWAT-STATE1
    <ILS >  IWATER state variables                                         ***
    # -  #      RETS      SURS                                             ***
  21   43 1.0000E-3 1.0000E-3
  END IWAT-STATE1
END IMPLND

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer               ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG          ***
                                 in  out                          ***
    1     SWRP                    1    1    1    1   49    0    0
    2     Western Diked Marsh     1    1    1    1   49    0    0
    3     Eastern Diked Marsh     1    1    1    1   49    0    0
  END GEN-INFO
  ACTIVITY
    RCHRES *************** Active Sections ****************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG                ***
    1    3    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY
  PRINT-INFO
    RCHRES *************** Printout Flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB *********
    1    3    5    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO
  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                    ***
```

```
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
          FG FG FG FG  possible  exit  *** possible  exit     possible  exit
           *  *  *  *   *  *  *  *  *      *  *  *  *  *        ***
    1   3   0  1  0  0    4  0  0  0  0      0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1
  HYDR-PARM2
    RCHRES                                                                    ***
    # -  #     FTABNO        LEN      DELTH     STCOR        KS       DB50      ***
  <------><--------><--------><--------><--------><--------><-------->        ***
    1               1        99                   -3       0.5
    2               2        99                            0.5
    3               3        99                            0.5
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND    Initial  value  of OUTDGT
         *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1   3       0.0       4.0
  END HYDR-INIT
END RCHRES
                                                               ***
FTABLES
  FTABLE      1
 Rows Cols   SWRP                          ***
   16    4
     DEPTH      AREA    VOLUME  OUTFLOW1 ***
      (FT)  (ACRES) (ACRE-FT)    (CFS)   ***
         0         0         0         0
       0.5       1.9       0.5         0
         1       5.7       1.9         0
       1.5      18.1       7.3         0
         2     124.1      22.3         0
       2.5     132.7      86.6         0
         3     143.6     155.2         0
       3.5     152.6     229.2         0
         4     172.8     308.2         0
       4.5     180.7     396.5         0
         5     200.7       489         0
       5.5     204.4     590.4         0
         6     207.1     693.3         0
       6.5     209.6     797.5         0
         7     212.6     902.8         0
         8     212.6    1115.5        50
  END FTABLE  1

  FTABLE      2
 Rows Cols   Western Diked Marsh ***
    3    4
     DEPTH      AREA    VOLUME  OUTFLOW1 ***
      (FT)  (ACRES) (ACRE-FT)    (CFS)   ***
         0      27.4         0         0
         1      38.4      32.9      1.28
1
         2      47.2      75.7      2.51
  END FTABLE  2
```

```
  FTABLE      3
 Rows Cols   Eastern Diked Marsh ***
    4    4
      DEPTH      AREA    VOLUME  OUTFLOW1 ***
       (FT)   (ACRES) (ACRE-FT)    (CFS)   ***
          0       2.9         0         0
          1      11.8       7.3     13.71
          2      21.3      23.9     57.45
          3        28      48.5    121.05
  END FTABLE  3

END FTABLES

EXT SOURCES

                                                               ***
*** NOTE: The only RCHRES that precip and PET are applied to are lakes.
                                                               ***
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM    715 HPCP     ENGL                   PERLND  12  53 EXTNL  PREC
WDM    715 HPCP     ENGL                   IMPLND  21  43 EXTNL  PREC
WDM    715 HPCP     ENGL                   RCHRES   1     EXTNL  PREC
*** Initial potential evaporation input data
***WDM    352 HEVP     ENGL          0.82     PERLND  12  53 EXTNL  PETINP
***WDM    352 HEVP     ENGL          0.82     IMPLND  21  43 EXTNL  PETINP
***WDM    352 HEVP     ENGL          0.82     RCHRES   1  20 EXTNL  POTEV
*** PET input data with modified pan coefficient to match CIMIS monthly averages
***WDM    352 HEVP     ENGL          0.7      PERLND  12  53 EXTNL  PETINP
***WDM    352 HEVP     ENGL          0.7      IMPLND  21  43 EXTNL  PETINP
***WDM    352 HEVP     ENGL          0.7      RCHRES   1  20 EXTNL  POTEV
*** PET input data measured from a Class A pan at Los Alamitos (near San Jose) by
Aquaterra
WDM    476 HEVT     ENGL                   PERLND  12  53 EXTNL  PETINP
WDM    476 HEVT     ENGL                   IMPLND  21  43 EXTNL  PETINP
WDM    476 HEVT     ENGL                   RCHRES   1  20 EXTNL  POTEV
END EXT SOURCES

***
EXT TARGETS
*** EXT TARGETS sends ...
***
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Aggr Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>qf  tem strg strg***
Output for SFO PET simulations ***
***COPY    45 OUTPUT MEAN   2                 WDM    852 OVOL      ENGL AGGR REPL
***COPY    45 OUTPUT MEAN   1             MAX  WDM    851 STG       ENGL AGGR REPL
Output for SFO PET simulations with - 5% impervious area ***
***COPY    45 OUTPUT MEAN   1             MAX  WDM    853 STG       ENGL AGGR REPL
Output for Los Alamitos PET simulations ***
COPY    45 OUTPUT MEAN    1            MAX  WDM    855 STG       ENGL AGGR REPL
COPY    45 OUTPUT MEAN    2                 WDM    856 OVOL      ENGL AGGR REPL
COPY    45 OUTPUT MEAN    3            MAX  WDM    857 STG       ENGL AGGR REPL
COPY    45 OUTPUT MEAN    4                 WDM    859 OVOL      ENGL AGGR REPL
Output for Los Alamitos PET simulations with + 5% impervious area ***
***COPY    45 OUTPUT MEAN   1             MAX  WDM    858 STG       ENGL AGGR REPL
END EXT TARGETS
***
```

```
SCHEMATIC
*** ------------------------------------------------------------------------
*** Schematic specifies the physical structure of the watershed by providing
*** linkages of land segments to reaches and reach-reach connections.
*** (Note:  the "Mult Factor" has units of acres and is considered to be an area
*** factor)
*** ------------------------------------------------------------------------
<-Source->                  <--Mult-->     <-Target >   MSLK      ***
<Name>   #                  <-factor->     <Name>   #   Tbl#      ***
*** CHANNEL NETWORK LINKAGES ***
*** Assume only SURO contributes to storm flows -- reasonable considering
*** collection system is pipe.
***
*** Land use updated 09/26/2004

BASIN 1:  RUNOFF FROM LAND SEGMENTS ***
PERLND  12                      6.5847     RCHRES   3      1
IMPLND  21                      13.647     RCHRES   3      2

BASIN 2:  RUNOFF FROM LAND SEGMENTS ***
PERLND  12                       63.95     RCHRES   3      1
IMPLND  21                    165.4641     RCHRES   3      2

MODIFIED BASIN 2 -- ADDED 16 ACRES IMPERVIOUS (= 5% OF BASIN IMPERVIOUS) ***
***PERLND  12                    47.95     RCHRES   3      1
***IMPLND  21                 181.4641     RCHRES   3      2

MODIFIED BASIN 2 -- SUBTRACTED 16 ACRES IMPERVIOUS (= 5% OF BASIN IMPERVIOUS) ***
***PERLND  12                    79.95     RCHRES   3      1
***IMPLND  21                 149.4641     RCHRES   3      2

BASIN 3:  RUNOFF FROM LAND SEGMENTS ***
PERLND  12                     37.3771     RCHRES   3      1
IMPLND  21                     90.7773     RCHRES   3      2

BASIN 4:  RUNOFF FROM LAND SEGMENTS ***
PERLND  12                    129.6161     RCHRES   2      1
IMPLND  21                     47.9494     RCHRES   2      2

BASIN 5:  RUNOFF FROM LAND SEGMENTS ***
PERLND  12                     26.2529     RCHRES   3      1
IMPLND  21                      3.0767     RCHRES   3      2

CALTRANS RIGHT OF WAY RUNOFF (SEND TO EDM) ***
PERLND  12                     50.         RCHRES   3      1

*** Western Diked Marsh outflow conveyed to SWRP
RCHRES   2                                 RCHRES   1      3

*** Eastern Diked Marsh outflow conveyed to SWRP
RCHRES   3                                 RCHRES   1      3

*** Output total inflow to SWRP
***
*** Note:  the schematic for this was changed on 01/25/05  to coincide
*** with the current model "connections" -- a quick comparison of the
```

```
*** old and new results showed no major differences in statistics
*** computed from each data set.
RCHRES    2                                       COPY    45       8
RCHRES    3                                       COPY    45       8
RCHRES    1                                       COPY    45       7


END SCHEMATIC

NETWORK
***
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>    #       <Name> # #<-factor->strg <Name>    #   #        <Name> # #  ***
***
*** Send the output to the WDM file via the copy module.
RCHRES    1 HYDR   STAGE                          COPY    45      INPUT  MEAN   1
RCHRES    1 HYDR   ROVOL                          COPY    45      INPUT  MEAN   2
RCHRES    2 HYDR   STAGE                          COPY    45      INPUT  MEAN   3

END NETWORK

MASS-LINK

  MASS-LINK        1
*** Transfer surface outflow from PERLND to RCHRES.  Note:  the multiplication
*** factor (0.08333) converts 'in' to 'ft' - this is multiplied by the area
*** given in the SCHEMATIC block to produce 'AC-FT'
<-Volume-> <-Grp> <-Member-><--Mult-->     <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> # #<-factor->     <Name>    #   #        <Name> # #  ***
PERLND     PWATER SURO       0.0833333     RCHRES         INFLOW IVOL
***PERLND     PWATER IFWO       0.0833333     RCHRES         INFLOW IVOL
  END MASS-LINK    1

  MASS-LINK        2
*** Transfer surface outflow from IMPLND to RCHRES.  Note:  the multiplication
*** factor (0.08333) converts 'in' to 'ft' - this is multiplied by the area
*** given in the SCHEMATIC block to produce 'AC-FT'
<-Volume-> <-Grp> <-Member-><--Mult-->     <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> # #<-factor->     <Name>    #   #        <Name> # #  ***
IMPLND     IWATER SURO       0.0833333     RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
<-Volume-> <-Grp> <-Member-><--Mult-->     <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> # #<-factor->     <Name>    #   #        <Name> # #  ***
RCHRES     HYDR   ROVOL                    RCHRES         INFLOW IVOL
  END MASS-LINK    3

  MASS-LINK        4
<-Volume-> <-Grp> <-Member-><--Mult-->     <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> # #<-factor->     <Name>    #   #        <Name> # #  ***
RCHRES     HYDR   OVOL   3                 RCHRES         INFLOW IVOL
  END MASS-LINK    4

  MASS-LINK        5
<-Volume-> <-Grp> <-Member-><--Mult-->     <-Target vols> <-Grp> <-Member->  ***
<Name>            <Name> # #<-factor->     <Name>    #   #        <Name> # #  ***
```

END RUN

B

BROWN AND CALDWELL

APPENDIX B

Meterological Time Series Data used in the Continuous Simulation Hydrologic Model

A summary of the time series data used in the HSPF model are presented in Table B. 1 below. The precipitation time series were purchased from the National Oceanographic and Atmospheric Administration (NOAA) and the evapotranspiration data were taken from the EPA BASINS model for the State of California.

Table B. 1. Meterological Time Series used in NASA HSPF Modeling

COOP ID	STATION NAME	BEGIN DATE	END DATE	DATA TYPE
45747	Mountain View Moffett Fld NAS	03/01/1945	06/30/1994	Daily Precipitation
47821	San Jose	07/01/1948	01/01/2004	Hourly Precipitation
47769	San Francisco WSO Airport	01/01/1970	12/31/1995	Hourly Pan Evaporation

Prior to using the precipiation time series data, both sets of data were analyzed for quality. In particular, missing values and missing distributions (where a lump sum of precipitation is presented for a period of time rather than distributed over that time period) were desired. The summary of these missing value checks are presented below for the two precipitation data sets.

San Jose Rainfall Data Quality Summary

12 hours of missing values starting 1948/7/1 13:0:0
12 hours of missing values starting 1948/8/1 13:0:0
12 hours of missing values starting 1948/9/1 13:0:0
12 hours of missing values starting 1948/10/1 13:0:0
12 hours of missing values starting 1948/11/1 13:0:0
12 hours of missing values starting 1948/12/1 13:0:0
12 hours of missing values starting 1949/2/1 13:0:0
12 hours of missing values starting 1949/4/1 13:0:0
12 hours of missing values starting 1949/5/1 13:0:0
12 hours of missing values starting 1949/6/1 13:0:0
12 hours of missing values starting 1949/8/1 13:0:0
12 hours of missing values starting 1949/9/1 13:0:0
12 hours of missing values starting 1949/10/7 13:0:0
12 hours of missing values starting 1949/11/1 13:0:0
12 hours of missing values starting 1949/12/1 13:0:0
12 hours of missing values starting 1950/1/1 13:0:0
12 hours of missing values starting 1950/2/1 13:0:0
12 hours of missing values starting 1950/6/1 13:0:0
12 hours of missing values starting 1950/7/1 13:0:0
12 hours of missing values starting 1950/8/1 13:0:0
12 hours of missing values starting 1950/9/1 13:0:0

12 hours of missing values starting 1950/11/1 13:0:0
12 hours of missing values starting 1951/5/1 13:0:0
12 hours of missing values starting 1957/9/1 13:0:0
6 hours of missing time distribution starting 1958/1/25 19:0:0
11 hours of missing time distribution starting 1958/2/18 4:0:0
4 hours of missing time distribution starting 1958/2/18 15:0:0
19 hours of missing time distribution starting 1958/4/2 6:0:0
17 hours of missing time distribution starting 1958/4/3 1:0:0
6 hours of missing time distribution starting 1960/2/3 6:0:0
6 hours of missing time distribution starting 1961/1/25 12:0:0
13 hours of missing values starting 1961/11/1 1:0:0
720 hours of missing values starting 1963/4/1 1:0:0
11 hours of missing values starting 1963/5/8 8:0:0
8 hours of missing values starting 1963/5/10 9:0:0
3 hours of missing time distribution starting 1964/12/26 14:0:0
8 hours of missing time distribution starting 1964/12/27 5:0:0
13 hours of missing time distribution starting 1964/12/28 20:0:0
5 hours of missing time distribution starting 1964/12/29 12:0:0
5 hours of missing time distribution starting 1964/12/30 12:0:0
16 hours of missing time distribution starting 1964/12/30 17:0:0
744 hours of missing values starting 1965/12/1 1:0:0
744 hours of missing values starting 1966/7/1 1:0:0
5 hours of missing time distribution starting 1966/12/6 4:0:0
6 hours of missing time distribution starting 1967/3/12 7:0:0
6 hours of missing time distribution starting 1967/3/16 4:0:0
720 hours of missing values starting 1971/4/1 1:0:0
10 hours of missing time distribution starting 1974/12/27 13:0:0
720 hours of missing values starting 1975/4/1 1:0:0
7 hours of missing time distribution starting 1980/4/22 9:0:0
24 hours of missing values starting 1980/7/1 1:0:0
24 hours of missing values starting 1980/7/31 1:0:0
744 hours of missing values starting 1981/7/1 1:0:0
105 hours of missing values starting 1981/10/1 3:0:0
97 hours of missing values starting 1981/10/6 17:0:0
47 hours of missing time distribution starting 1981/10/26 10:0:0
26 hours of missing time distribution starting 1981/10/28 9:0:0
744 hours of missing values starting 1981/12/1 1:0:0
2 hours of missing time distribution starting 1983/11/13 18:0:0
7 hours of missing time distribution starting 1983/11/24 22:0:0
24 hours of missing values starting 1983/12/1 1:0:0
10 hours of missing values starting 1983/12/6 1:0:0
12 hours of missing values starting 1984/4/2 1:0:0
2281 hours of missing values starting 1984/6/1 8:0:0
257 hours of missing values starting 1984/9/20 8:0:0
782 hours of missing values starting 1984/11/1 1:0:0

79 hours of missing values starting 1984/12/9 16:0:0
221 hours of missing values starting 1984/12/22 20:0:0
180 hours of missing values starting 1985/3/24 13:0:0
1379 hours of missing values starting 1985/6/4 14:0:0
11 hours of missing time distribution starting 1988/12/20 11:0:0
13 hours of missing time distribution starting 1988/12/21 4:0:0
10 hours of missing time distribution starting 1988/12/22 7:0:0
34 hours of missing time distribution starting 1988/12/23 21:0:0
14 hours of missing time distribution starting 1988/12/27 8:0:0
9 hours of missing time distribution starting 1988/12/30 16:0:0
24 hours of missing time distribution starting 1989/1/5 1:0:0
5 hours of missing time distribution starting 1989/1/6 20:0:0
8 hours of missing time distribution starting 1989/1/7 4:0:0
202 hours of missing values starting 1989/3/1 1:0:0
24 hours of missing values starting 1989/3/24 1:0:0
97 hours of missing values starting 1990/11/2 17:0:0
24 hours of missing values starting 1992/4/11 17:0:0
702 hours of missing values starting 1992/11/6 9:0:0
77 hours of missing time distribution starting 1993/1/6 15:0:0
4 hours of missing time distribution starting 1993/5/24 13:0:0
705 hours of missing values starting 1993/6/1 16:0:0
208 hours of missing values starting 1994/2/20 9:0:0
401 hours of missing values starting 1994/9/6 16:0:0
22 hours of missing values starting 1995/1/9 19:0:0
10 hours of missing values starting 1995/8/31 15:0:0
1440 hours of missing values starting 1996/9/6 16:0:0
19 hours of missing values starting 1997/12/7 17:0:0
259 hours of missing values starting 1998/2/1 1:0:0
54 hours of missing values starting 1999/3/19 11:0:0
3 hours of missing values starting 1999/5/6 10:0:0
752 hours of missing values starting 1999/7/1 2:0:0
3 hours of missing values starting 1999/9/1 6:0:0
38 hours of missing values starting 1999/11/1 1:0:0
2 hours of missing values starting 1999/12/13 11:0:0
657 hours of missing values starting 2000/1/4 16:0:0
161 hours of missing values starting 2000/2/1 2:0:0
2 hours of missing values starting 2000/4/1 1:0:0
695 hours of missing values starting 2000/5/3 2:0:0
657 hours of missing values starting 2000/6/3 16:0:0
1487 hours of missing values starting 2000/7/1 2:0:0
719 hours of missing values starting 2000/9/1 2:0:0
572 hours of missing values starting 2001/1/8 5:0:0
671 hours of missing values starting 2001/2/1 2:0:0
81 hours of missing values starting 2001/3/1 2:0:0
1579 hours of missing values starting 2001/7/3 20:0:0

539 hours of missing values starting 2002/2/6 17:0:0
3 hours of missing values starting 2002/4/1 1:0:0
6 hours of missing values starting 2002/5/3 9:0:0
683 hours of missing values starting 2002/5/3 16:0:0
32 hours of missing values starting 2002/7/4 14:0:0
1214 hours of missing values starting 2002/7/22 23:0:0
3 hours of missing values starting 2002/10/1 1:0:0
6 hours of missing values starting 2002/12/1 1:0:0
26 hours of missing values starting 2003/1/12 17:0:0
660 hours of missing values starting 2003/2/6 12:0:0
26 hours of missing values starting 2003/4/6 16:0:0
2 hours of missing values starting 2003/4/18 12:0:0
234 hours of missing values starting 2003/4/20 7:0:0
5 hours of missing values starting 2003/5/6 14:0:0
3 hours of missing values starting 2003/7/7 11:0:0
2 hours of missing values starting 2003/8/6 16:0:0
3 hours of missing values starting 2003/9/22 8:0:0
4 hours of missing values starting 2003/11/5 13:0:0
2 hours of missing values starting 2003/12/5 10:0:0

130 period(s) of missing or bad data.

San Jose Rainfall Data Quality Summary

1 days of missing values starting 1946/1/19
1 days of missing values starting 1947/2/8
1 days of missing values starting 1947/12/4
1 days of missing values starting 1948/4/10
1 days of missing values starting 1948/7/1
1 days of missing values starting 1951/1/19
1 days of missing values starting 1986/5/1
1 days of missing values starting 1987/3/5
1 days of missing values starting 1987/3/18
1 days of missing values starting 1987/3/21
1 days of missing values starting 1987/12/16
2 days of missing values starting 1987/12/29

12 period(s) of missing or bad data.

A rainfall total of "0" was inserted where missing values were found. This assumes no rainfall occurred during the time no data was collected. Relative to the period of record for the data sets, the missing values were minimal and replacing them with no rainfall is assumed to be an acceptable and valid approach. For missing distributions, the rainfall total provided was distributed over the time period lacking distributed data in a symmetrical pattern with both the beginning and ending time step having no rainfall and the median time step containing the peak rainfall.

The two precipitation data sets were combined for HSPF simulation in efforts to provide the most applicable data. Combining the data sets was performed by disaggregating the daily Moffett Field precipitation data based on the hourly distribution of rainfall from the San Jose station. This approach is assumed to give an accurate rainfall data set whereby daily totals match the local Moffett weather station, but frequency is reduced to an hourly time step similar to recorded distributions from the nearby San Jose weather station.

Daily rainfall data were available at the Moffett weather station until June 1994. In an effort to extend the rainfall data record, and thus extend the simulation period of record – which provides for a longer time series of simulated results – the hourly San Jose data was appended to the rainfall data set for the time period of July 1994 to December 2003. A short, statistical analysis was completed to confirm whether combining the hourly San Jose rainfall data was feasible. In particular, n-day rainfall totals from both the San Jose and Moffett weather stations were analyzed for similarities at different frequencies. The graphical results of this analysis are shown in Figures B-1 through B-4 below.

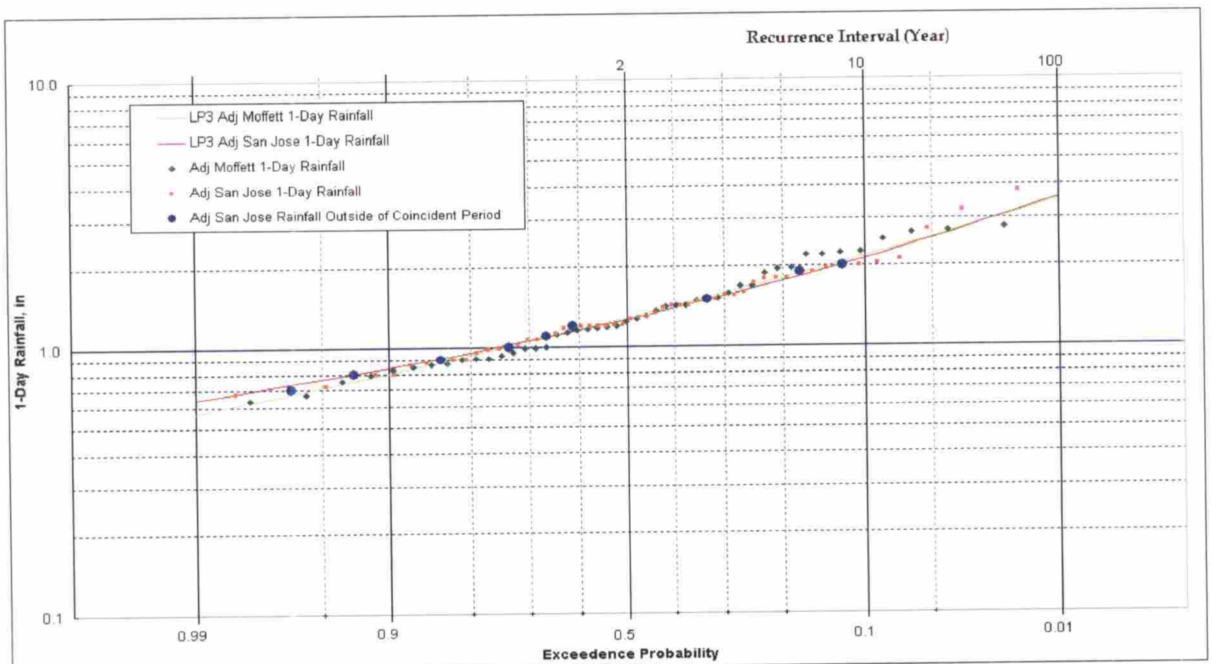


Figure B-1. Log Pearson Type III Frequency Analysis of San Jose and Moffett Weather Station Annual Maximum Daily Rainfall

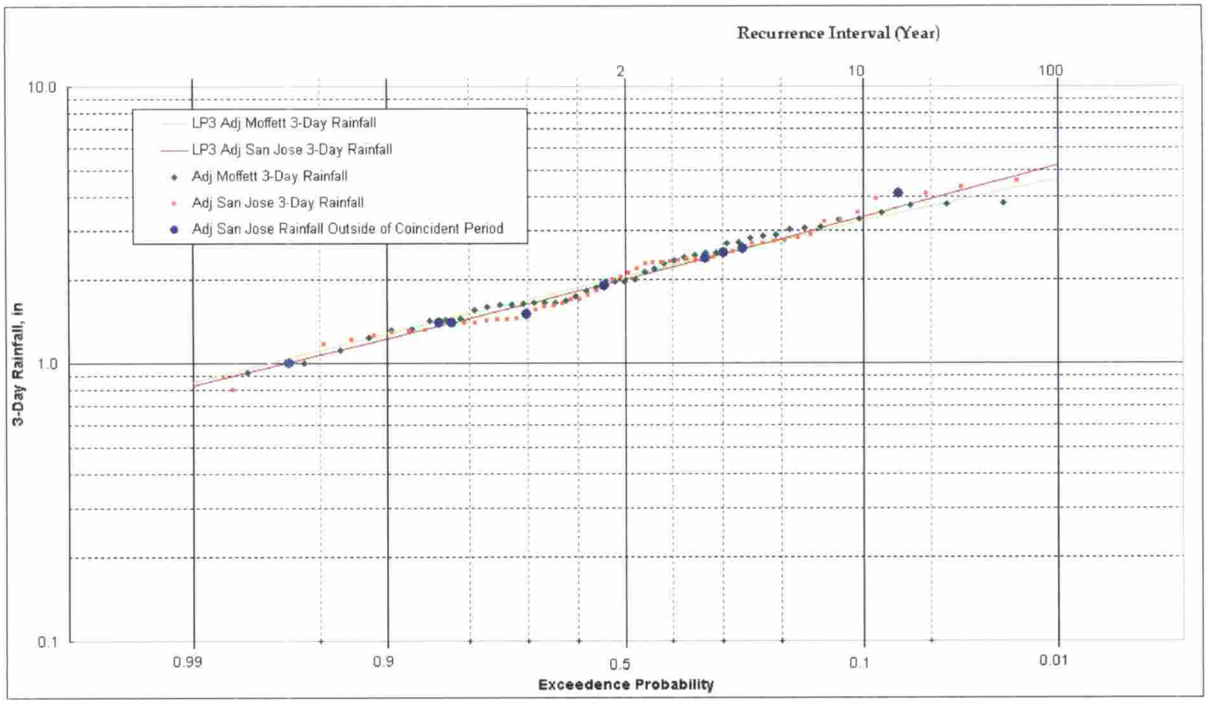


Figure B-2. Log Pearson Type III Frequency Analysis of San Jose and Moffett Weather Station Annual Maximum 3-Day Rainfall Totals

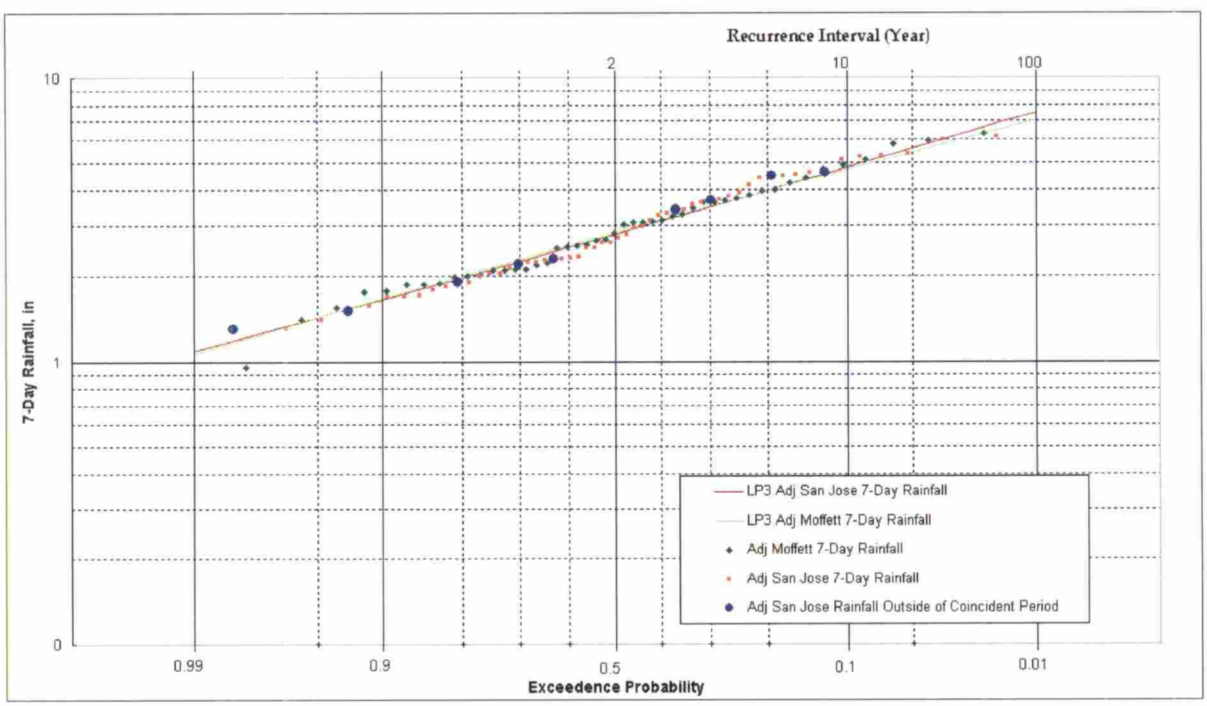


Figure B-3. Log Pearson Type III Frequency Analysis of San Jose and Moffett Weather Station Annual Maximum 7-Day Rainfall Totals

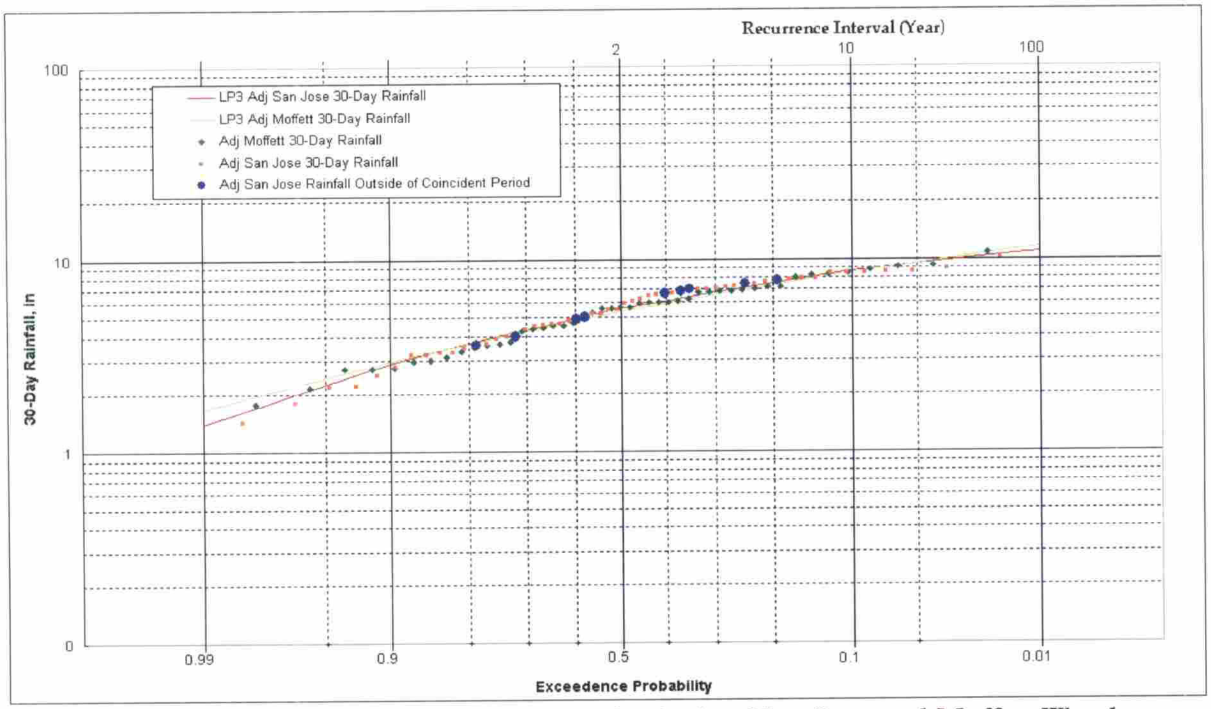


Figure B-4. Log Pearson Type III Frequency Analysis of San Jose and Moffett Weather Station Annual Maximum 30-Day Rainfall Totals

As the figures show, for all the durations (1-day, 3-day, 7-day, and 30-day) the maximum annual rainfall data from the two weather stations are closely related. In particular, between exceedance probabilities of 0.1 and 0.9 the Log Pearson Type III distribution fit to both sets of data are very similar. In an effort to gauge the impact of appending the San Jose rainfall data after June 1994, the data points from this time period were identified on each of the frequency plots. Inspection of these data points show, with the exception of the 1-day annual maximum rainfall, all are within the range of the 0.1 to 0.9 exceedance probability. This indicates the maximum annual San Jose hourly rainfall in the appended time period, for the specified duration, is similar to the Moffett station rainfall data for the same duration. This analysis gives confidence that appending the San Jose rainfall data will not significantly skew the simulated results due to usage of data from a different geographical location.

C

BROWN AND CALDWELL

APPENDIX C. Special-status Plant and Animal Species, Their Status, and Potential Occurrence at the Moffett Field Restoration Site.			
NAME	***STATUS**	**HABITAT**	**POTENTIAL FOR OCCURRENCE ON SITE**
Federal or State Endangered or Threatened Species			
Contra Costa Goldfields *Lasthenia conjugens*	FE, CNPS 1B	Mesic valley and foothill grasslands and vernal pools.	Four occurrence of this species have been documented within the nine quadrangle area surrounding the project site. Suitable habitat and associate plant species are present on site, therefore this species could occur on site.
California seablite *Suaeda californica*	FE, CNPS 1B	Coastal salt marshes.	Two occurrences of this species have been documented within the nine quadrangle area surrounding the project site. While suitable habitat and associate plant species are present on site, this species is presumed absent, since it is highly conspicuous but was not observed during reconnaissance-level surveys.
Steelhead *Oncorhynchus mykiss*	FT (Central Calif. Coast ESU)	Spawns in freswater streams, migrates to the ocean annually.	Occurs in Stevens Creek.
Chinook Salmon *Oncorhynchus tshawytscha*	FE, SE (winter) FT, ST (spring) FC, CSSC (fall)	Cool rivers and large streams that reach the ocean and that have shallow, partly shaded pools, riffles, and runs	No local spawning. Juveniles could occur in tidal marsh at the mouth of Stevens Creek.
California Brown Pelican *Pelecanus occidentalis californicus*	FE, SE, Fully protected	Undisturbed islands near estuarine, marine, subtidal, and marine pelagic waters.	Could roost and forage occasionally on site.
California Clapper Rail *Rallus longirostris obsoletus*	FE, SE, Fully protected	Coastal salt and brackish marshes and tidal sloughs.	Detected during breeding season on site, although nesting habitat appears marginal.
California Black Rail *Laterallus jamaicensis coturniculus*	ST, FSC, Fully protected	Coastal and inland marsh habitat.	Rare visitor; not expected to breed on site.
California Least Tern *Sterna antillarum browni*	SE, FE, Fully protected	Nest on sandy beaches and similar open habitats, forages in shallow marine habitats.	Does not nest locally. Forages at the project site during late summer/fall.

APPENDIX C. Special-status Plant and Animal Species, Their Status, and Potential Occurrence at the Moffett Field Restoration Site.			
NAME	***STATUS**	**HABITAT**	**POTENTIAL FOR OCCURRENCE ON SITE**
Western Snowy Plover *Charadrius alexandrinus nivosus*	FT, CSSC	Coastal wetlands and coastal dune habitat.	A few local records; no nesting records. Unlikely to nest on-site, probably occurs as occasional forager.
American Peregrine Falcon *Falco peregrinus anatum*	SE, Fully protected	Forages in many habitats; requires cliffs for nesting.	No nesting habitat; may forage on site.
Bald Eagle Haliaeetus leucocephalus	SE	Nests in trees adjacent to lakes. Forages primarily at lakes.	No nesting habitat; may occur as very rare forager.
Bank Swallow *Paria riparia*	ST	Colonial nester on vertical banks or cliffs with fine-textured soils near water.	Rare visitor; not expected to breed on site.
Salt Marsh Harvest Mouse *Reithrodontomys raviventris*	FE, SE	Salt marsh habitat dominated by pickleweed.	Known to occur on-site.
California Species of Special Concern			
Double-crested Cormorant *Phalacrocorax auritus* (rookery site)	CSSC	Inland lakes; fresh, salt and estuarine waters.	No nesting habitat present. May occasionally forage on-site.
American White Pelican *Pelecanus erythrorhynchos* (nesting)	CSSC	Nests at inland lakes, non-breeders occur in S.F. Bay area.	Does not breed locally. Occurs as an occasional forager.
White-faced Ibis *Plegadis chihi* (nesting)	CSSC	Nests in freshwater marshes. Forages in fresh, brackish, and salt marshes.	Does not breed locally. Occurs as an occasional forager.
California Gull *Larus californicus* (nesting colony)	CSSC	Nests on inland lakes and in salt ponds around S. F. Bay.	Does not breed locally, but forages and roosts on-site.
Black Skimmer *Rynchops niger* (nesting colony)	CSSC	Sandbars, beaches, and dikes for roosting and nesting; shallow calm waters for foraging.	No nesting habitat; probably occasionally forages on-site.
Elegant Tern *Sterna elegans* (nesting colony)	CSSC	Inshore coastal waters, bays, estuaries, and harbors; undisturbed beaches required for nesting.	Does not breed locally; forages on site.
Merlin *Falco columbarius*	CSSC	Uses many habitats in winter and migration.	Occasional winter visitor or migrant.

APPENDIX C. Special-status Plant and Animal Species, Their Status, and Potential Occurrence at the Moffett Field Restoration Site.			
NAME	***STATUS**	**HABITAT**	**POTENTIAL FOR OCCURRENCE ON SITE**
Golden Eagle *Aquila chrysaetos*	CCC, Fully Protected	Nests primarily in oak woodland habitats. Forages over a variety of open habitats.	No nesting habitat; may forage on site.
Cooper's Hawk *Accipiter cooperii* (nesting)	CSSC	Nests in woodlands, forages in many habitats in winter and migration.	No nesting habitat; may forage on site.
Sharp-shinned Hawk *Accipiter striatus* (nesting)	CSSC	Nests in woodlands, forages in many habitats in winter and migration.	No nesting habitat; may forage on site.
Northern Harrier *Circus cyaneus* (nesting)	CSSC	Forages in marshes, grasslands, and non-native grassland habitats; nests in extensive marshes and wet fields.	Suitable foraging habitat present; could potentially breed in Eastern or Western Diked Marshes, adjacent to project site.
Short-eared Owl *Asio flammeus* (nesting)	CSSC	Breeds in dense vegetation in open grassland and marshes.	May occur as occasional visitor. Could potentially nest in Eastern or Western Diked Marshes.
Burrowing Owl *Athene cunicularia hypugea* (burrow sites)	CSSC	Grasslands and ruderal habitats.	Limited habitat present within project site, but known to nest at southwest corner of project site, and elsewhere at Moffett Field.
Vaux's Swift *Chaetura vauxi* (nesting)	CSSC	Nests in snags in coastal coniferous forests or, occasionally, in chimneys; forages aerially.	No nesting habitat present; may occasionally forage over site.
Loggerhead Shrike *Lanius ludovicianus*	CSSC	Nests in tall shrubs and dense trees, forages in grasslands, marshes, and ruderal habitats.	Suitable forging and nesting habitat present; likely breeds on site.
Yellow Warbler *Dendroica petechia brewsteri* (nesting)	CSSC	Breeds in riparian woodlands, particularly those dominated by willows and cottonwoods.	No nesting habitat; occurs as migrant.
Salt Marsh Common Yellowthroat *Geothlypis trichas sinuosa*	CSSC	Breeds primarily in fresh and brackish marshes in tall grass, tules, willows; uses salt marshes more in winter.	Suitable forging and nesting habitat present; likely breeds on site.
Alameda Song Sparrow *Melospiza melodia pusillula*	CSSC	Salt marshes bordering south San Francisco Bay.	Suitable forging and nesting habitat present; likely breeds on site.

APPENDIX C. Special-status Plant and Animal Species, Their Status, and Potential Occurrence at the Moffett Field Restoration Site.			
NAME	***STATUS**	**HABITAT**	**POTENTIAL FOR OCCURRENCE ON SITE**
California Horned Lark *Eremophila alpestris actia*	CSSC	Nests and forages in dry open habitats.	Unlikely to breed on site, may occur as occasional visitor.
Tricolored Blackbird (nesting) *Agelaius tricolor*	CSSC	Nests in fresh and brackish marshes with tall emergent vegetation.	No local records, but potential habitat present on-site.
Salt-marsh Wandering Shrew *Sorex vagrans halicoetes*	CSSC	Medium high marsh 6-8 feet above sea level with abundant driftwood and pickleweed.	No suitable habitat present, but could occur in tidal marsh along Stevens Creek.
Pallid Bat *Antrozus pallidus*	CSSC	Forages and roosts in a variety of habitats.	Unlikely to roost on-site, but could occasionally forage on-site.
State Protected Species or CNPS Species			
alkali milk-vetch *Astragalus tener* var. *tener*	CNPS 1B	Alkaline soils in playas, vernal pools, and adobe clay areas in valley and foothill grasslands.	Six occurrences of this species have been documented within the nine quadrangle area surrounding the project site, particularly in the vicinity of Alviso, Newark, Union City, Milpitas, Palo Alto, and Albrae (CNDDB 2004). Suitable habitat and associate plant species (*Lasthenia platycarpha*) are present on site, therefore this species could occur on site.
San Joaquin saltbush *Atriplex joaquiniana*	CNPS 1B	Chenopod scrub, meadows, playas, and valley and foothill grasslands, particularly areas with alkaline substrates	Two occurrences of this species have been documented within the nine quadrangle area surrounding the project site, particularly in Warm Springs and Albrae areas of Alameda County (CNDDB 2004). Suitable habitat and associate plant species are present on site, therefore this species could occur on site.

APPENDIX C. Special-status Plant and Animal Species, Their Status, and Potential Occurrence at the Moffett Field Restoration Site.			
NAME	***STATUS**	**HABITAT**	**POTENTIAL FOR OCCURRENCE ON SITE**
Congdon's tarplant *Centromadia parryi* ssp. *congdonii*	CNPS 1B	Valley and foothill grasslands (alkaline) and sumps in disturbed areas.	Eleven occurrences of this species have been documented within the nine quadrangle area surrounding the project site, particularly in the vicinity of Alviso, Newark, Menlo Park, Milpitas, East Palo Alto, and Albrae (CNDDB 2004). Suitable habitat and associate plant species are present on site, therefore this species could occur on site.
Point Reyes Bird's-beak *Cordylanthus maritimus* ssp. *palustris*	CNPS 1B	Coastal salt marsh.	Five occurrences of this species have been documented within the nine quadrangle area surrounding the project site, particularly in the vicinity of Alviso, Palo Alto, and Redwood City, and Belmont (CNDDB 2004). Some of these occurrences are within a five mile radius of the project site; however, all are believed to be extirpated. Nevertheless, suitable habitat and associate plant species are present on site, therefore this species could occur on site.
Hoover's button-celery *Eryngium aristulatum* var. *hooveri*	CNPS 1B	Vernal pools.	No occurrences of this species have been documented in the CNDDB for the nine quadrangle query area. Nevertheless, suitable habitat and associate plant species are present on site, therefore this species could occur on site.
delta tule pea *Lathyrus jepsonii* var. *jepsonii*	CNPS 1B	Brackish and freshwater marshes between sea level and 5 meters.	No occurrences of this species have been documented in the CNDDB for the nine quadrangle query area. Nevertheless, suitable habitat and associate plant species are present on site, therefore this species could occur on site.

APPENDIX C. Special-status Plant and Animal Species, Their Status, and Potential Occurrence at the Moffett Field Restoration Site.			
NAME	***STATUS**	**HABITAT**	**POTENTIAL FOR OCCURRENCE ON SITE**
prostrate navarretia *Navarretia prostrata*	CNPS 1B	Mesic areas in coastal scrub, vernal pool, and alkaline valley and foothill grassland habitats.	Two recent occurrences of this species have been documented within the nine quadrangle area surrounding the project site, in the vicinity of the Pacific Commons Preserve and Albrae areas of Alameda County (CNDDB 2004). Suitable habitat and associate plant species are present on site, therefore this species could occur on site.
delta woolly-marbles *Psilocarphus brevissimus* var. *multiflorus*	CNPS 4	Vernal pools.	No occurrences of this species have been documented in the CNDDB for the nine quadrangle query area. Nevertheless, suitable habitat and associate plant species are present on site, therefore this species could occur on site.
saline clover *Trifolium depauperatum* var. *hydrophilum*	CNPS 1B	Marshes and swamps, mesic and/or alkaline valley and foothill grasslands, and vernal pools.	Only one historic occurrence of this species has been documented within the nine quadrangle area surrounding the project site, in the vicinity of Belmont (CNDDB 2004). Nevertheless, suitable habitat and associate plant species are present on site, therefore this species could occur on site.
White-tailed Kite *Elanus leucurus* (nesting)	Fully protected	Nests in tall shrubs and trees, forages in grasslands, marshes, and ruderal habitats.	Suitable habitat present; could nest on site.

***SPECIAL STATUS CODE DESIGNATIONS**

FE =	Federally listed Endangered
FT =	Federally listed Threatened
FC =	Federal Candidate. Sufficient biological information to support a proposal to list the species as Endangered or Threatened
SE =	State listed Endangered
ST =	State listed Threatened
SR =	State listed as Rare
CSSC =	California Species of Special Concern
CNPS 1B =	Plants rare, threatened, or endangered in California and elsewhere.

CNPS 4 = Plants of limited distribution - A watch list.

D

BROWN AND CALDWELL

APPENDIX D. Plant Species Considered but Rejected for Occurrence on the Moffett Field Restoration Site

SCIENTIFIC NAME	COMMON NAME	Lack of Serpentine Soils	Suitable Habitat or Micro-habitat Not Present on Site	Species Record in CNDDB but Habitat Not Present on Site	Species Known Outside Elevation Range of Project site	Associated Species Absent from Project site	Believed to be Extirpated in Santa Clara County
Acanthomintha duttonii	San Mateo thorn-mint	X					
Acanthomintha lanceolata	Santa Clara thornmint	X			X		
Allium peninsulare var. *franciscanum*	Franciscan onion	X			X		
Androsace elongata ssp. *acuta*	California androsace				X		
Azolla mexicana	Mexican mosquito fern		X		X		
Balsamorhiza macrolepis var. *macrolepis*	big-scale balsamroot	X			X		
Calandrinia breweri	Brewer's calandrinia		X			X	
Calochortus umbellatus	Oakland star-tulip	X			X		
Castilleja affinis ssp. *neglecta*	Tiburon Indian paintbrush	X			X		
Ceanothus ferrisae	coyote ceanothus	X			X		
Chorizanthe cuspidata var. *cuspidata*	San Francisco Bay spineflower		X				
Chorizanthe robusta var. *robusta*	robust spineflower		X				
Cirsium fontinale var. *campylon*	Mount Hamilton thistle	X			X		
Cirsium praeteriens	lost thistle						X
Clarkia breweri	Brewer's clarkia	X			X		
Collinsia multicolor	San Francisco collinsia	X			X		
Dirca occidentalis	western leatherwood		X				
Dudleya setchellii	Santa Clara Valley dudleya	X			X		
Eriogonum luteolum var. *caninum*	Tiburon buckwheat	X			X		
Eriogonum nudum var. *decurrens*	Ben Lomond buckwheat			X			
Eriogonum umbellatum var. bahiiforme	bay buckwheat		X				
Eriophyllum jepsonii	Jepson's woolly sunflower	X			X		
Erysimum franciscanum	San Francisco wallflower	X					
Fritillaria liliacea	fragrant fritillary	X					
Hesperolinon congestum	Marin western flax	X			X		
Hoita strobilina	Loma Prieta hoita	X			X		
Lessingia hololeuca	woolly-headed lessingia	X			X		
Linanthus ambiguous	serpentine linanthus	X			X		
Linanthus grandiflorus	large-flowered linanthus		X			X	
Malacothamnus hallii	Hall's bush mallow	X				X	
Meconella oregana	Oregon meconella				X		
Micropus amphibolus	Mount Diablo cottonweed		X		X		
Microseris sylvatica	sylvan microseris	X			X		
Navarretia cotulifolia	Cotula navarretia		X		X		
Perideridia gairdneri ssp. *gairdneri*	Gairdner's yampah		X				

APPENDIX D. Plant Species Considered but Rejected for Occurrence on the Moffett Field Restoration Site

SCIENTIFIC NAME	COMMON NAME	Lack of Serpentine Soils	Suitable Habitat or Micro-habitat Not Present on Site	Species Record in CNDDB but Habitat Not Present on Site	Species Known Outside Elevation Range of Project site	Associated Species Absent from Project site	Believed to be Extirpated in Santa Clara County
Piperia michaelii	Michael's rein orchid		X			X	
Plagiobothrys chorisianus var. *hickmanii*	Hickman's popcorn-flower				X		
Plagiobothrys glaber	hairless popcorn-flower						X
Potamogeton filiformis	slender-leaved pondweed				X		
Ranunculus lobbii	Lobb's aquatic buttercup		X				
Sanicula saxatilis	rock sanicle		X		X		
Senecio aphanactis	rayless ragwort		X				
Sidalcea malachroides	maple-leaved checkerbloom		X			X	
Streptanthus albidus ssp. *albidus*	Metcalf Canyon jewel-flower	X	X		X		
Streptanthus albidus ssp. *peramoenus*	most beautiful jewel-flower	X	X		X		
Trifolium amoenum	showy Indian clover	X	X		X		
Tropidocarpum capparideum	caper-fruited tropidocarpum		X				
Usnea longissima	long-beard lichen			X			

E

BROWN AND CALDWELL

APPENDIX E

Levee Construction Assumptions and Cut/Fill Calculations

PWA developed a surface model of the Moffett Field Restoration Alternatives to evaluate construction and cost feasibility. The surface model was built in AutoCAD2004 using ground survey points collected by PWA in July, 2004, as well as topographic contours from a previous coverage developed in 1992 by the National Aeronautics and Space Administration (NASA). PWA compared volume of fill required for Restoration Features to the volume of existing or available fill on-site for each alternative (Table 1). The table also provides a cost estimate for importing the remaining fill required for each Restoration Alternative. The purpose of this memo is to detail the assumptions made with each calculation, and to describe the features associated with each Restoration Alternative.

PWA made the following assumptions for all of the volume calculations:

- We assume 10% loss of borrowed on-site fill due to normal transport or movement around the site.
- Training berms are not included in the volume analysis. Instead, we assume any material, either borrowed from the existing site or imported, will be tested for constructability and suitably for levee stability. Also, the broad side slope of the new levee separating the MROSD and NASA parcels will increase levee stability on the outboard side, eliminating the need for training berms.
- All levees outside the SWRP on the tidal side will be lowered to an elevation conducive to rapid colonization by marsh vegetation. We estimated this elevation to be approximately one foot above Mean Tide Level (MTL), or for the purposes of the calculation four feet, NAVD.
- The boundary of the surface model is the levee surrounding the existing SWRP, including the road separating the Eastern and Western Diked Marshes from the SWRP on the southern side. Along this side, we assumed that the inboard sides of the levee will be lowered to two feet, NAVD. These elevations may be higher at the final stage of design but are not considered to represent a significant amount of the volume needed to complete the Restoration Alternatives.

Estimated Quantities of Design Components for Moffett Field

January 21, 2004

1. Volume of Material Needed for New Design Components

	New Levee Volume (CY)	New Levee Length (feet)	Number of Breeding Islands: Central Basin	Number of Breeding Islands: Northeast Basin	Total Breeding Island Volume at 8:1 Side Slope[1] (CY)
Alternative 1a	-	-	-	-	-
Alternative 1b	187,200	8,500	-	-	-
Alternative 2a	145,100	7,100	5	-	6,500
Alternative 2b	369,000	7,200	5	-	6,500
Alternative 3	418,700	8,100	-	-	-

2. Analysis of Available Fill

	Total In-Place Fill Needed[2] (CY)	Material Available from On-Site Levee Lowering[3] (CY)	Length of On-Site Levee Lowering (feet)	Net Imported Fill Material Required (CY, in-place)	Total Imported Fill Required[4] (CY, stockpiled volume)	Unit Cost ($/CY)	Cost of Required Imported Fill Material ($)
Alternative 1a	-	-	-	-	-	-	-
Alternative 1b	187,200	31,300	2,867	155,900	202,700	$14.66	$2,972,000
Alternative 2a	151,600	46,800	3,540	104,800	136,200	$14.66	$1,997,000
Alternative 2b	375,500	48,400	7,092	327,100	425,200	$14.66	$6,233,000
Alternative 3	418,700	33,300	7,198	385,400	501,000	$14.66	$7,345,000

Notes

[1]Volume per Breeding Island: Central Basin--1,300 CY

[2]This volume represents the difference between the finish grade of levees and existing grade.

[3]This volume incorporates 10% transportation and handling losses.

[4]Stockpiled volume is 30% greater than in-place volume for imported fill due to transportation, handling and compaction losses.

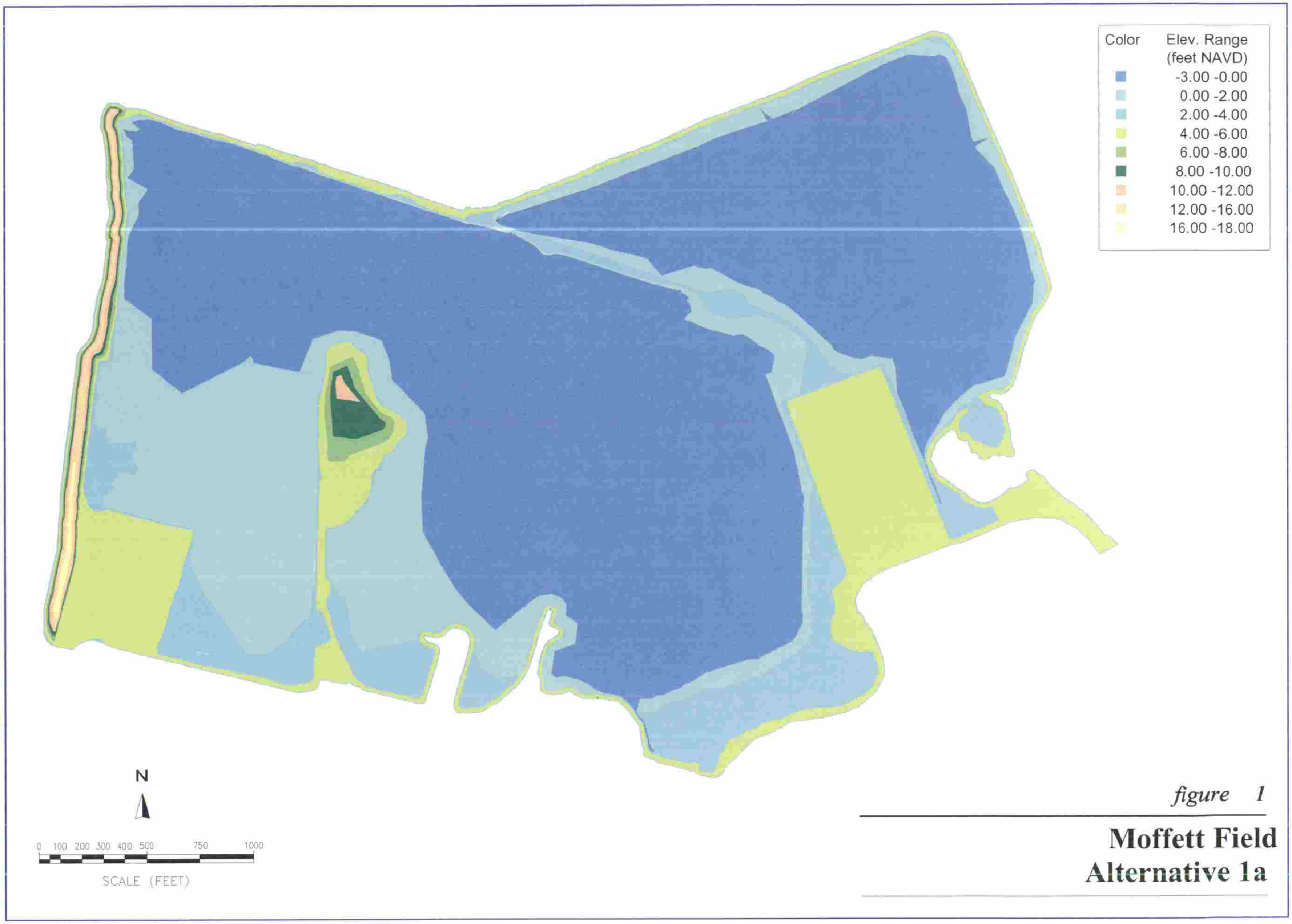


figure 1

Moffett Field
Alternative 1a

PWA

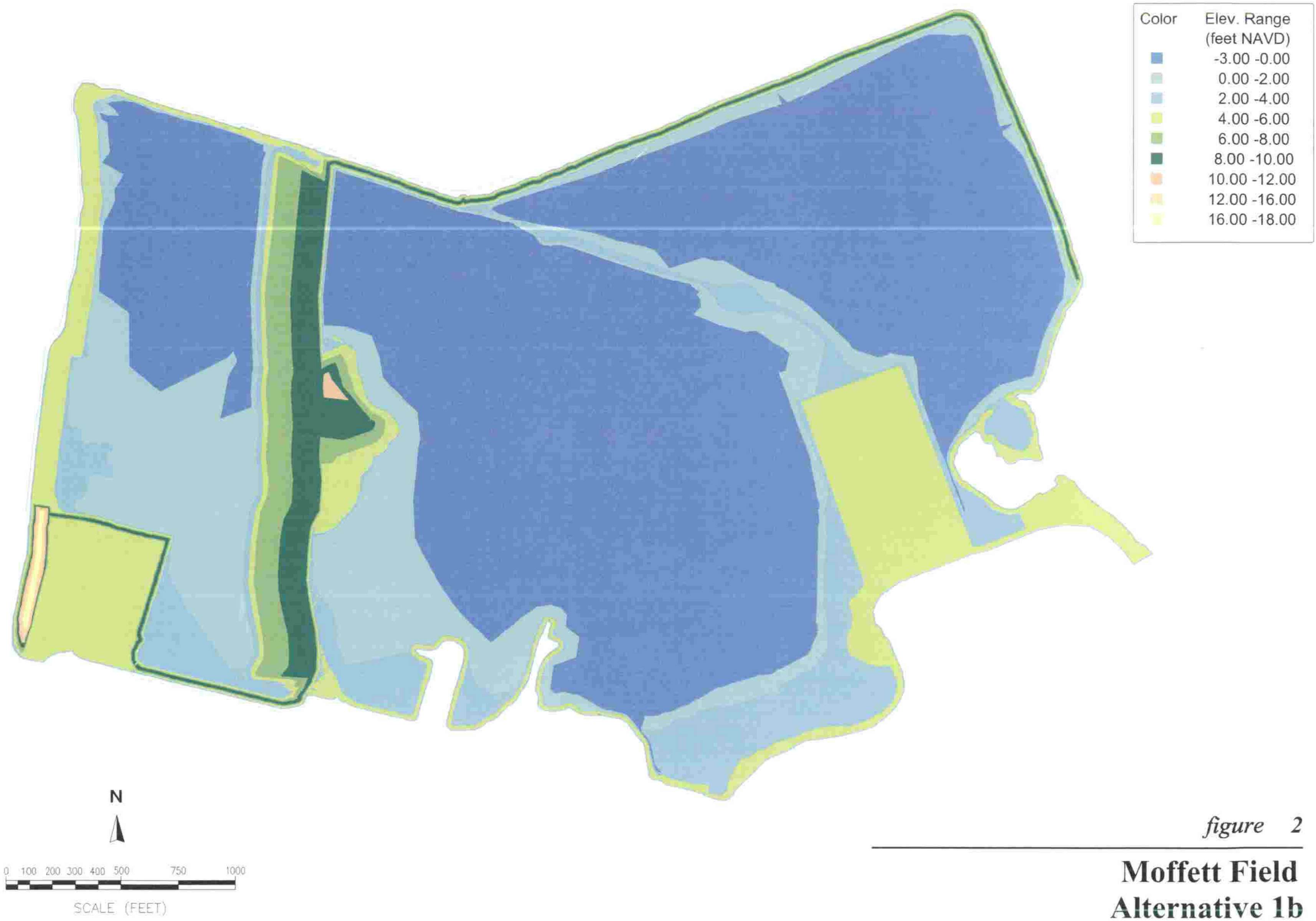


figure 2

Moffett Field
Alternative 1b

PWA

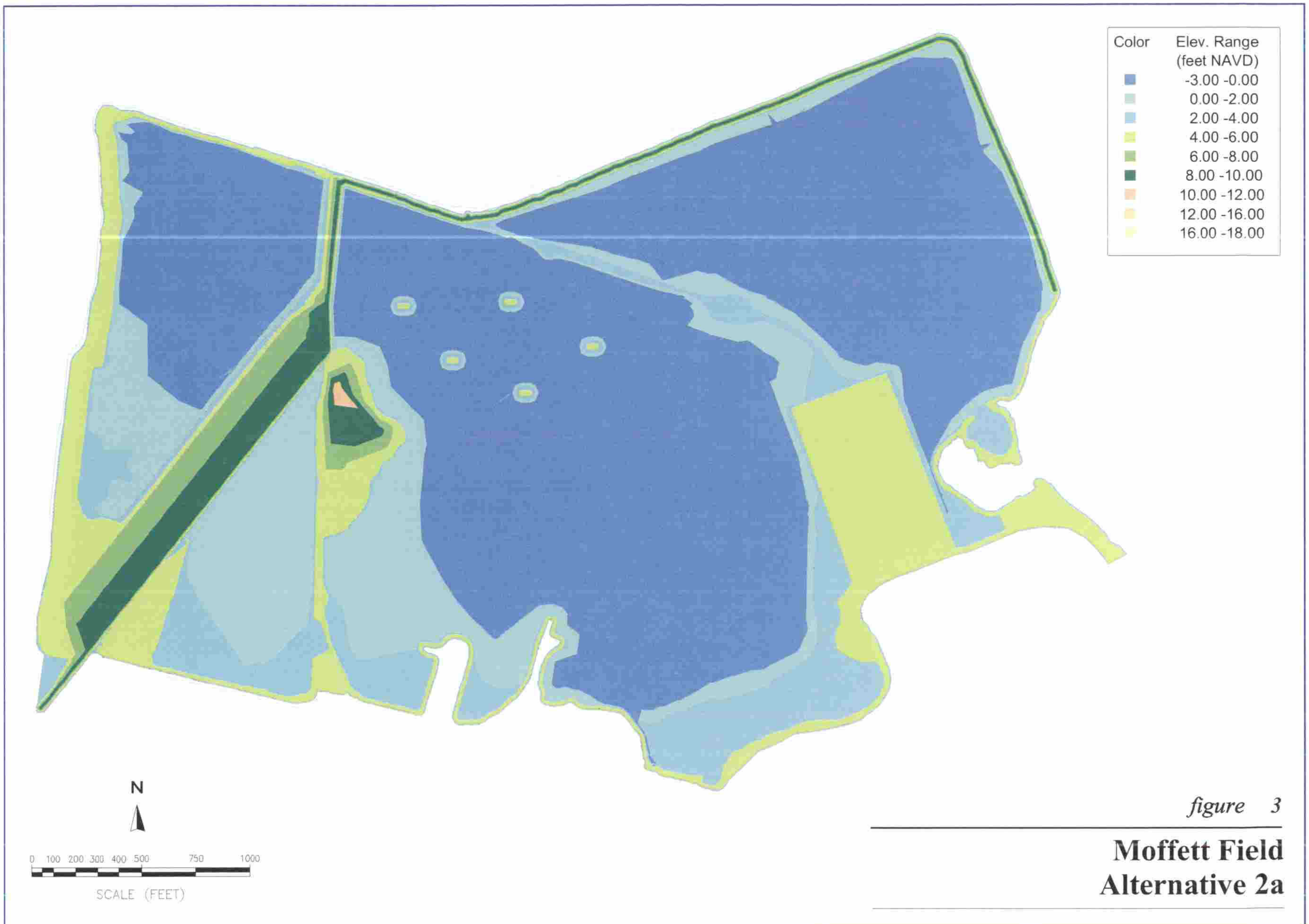


figure 3

Moffett Field Alternative 2a

PWA

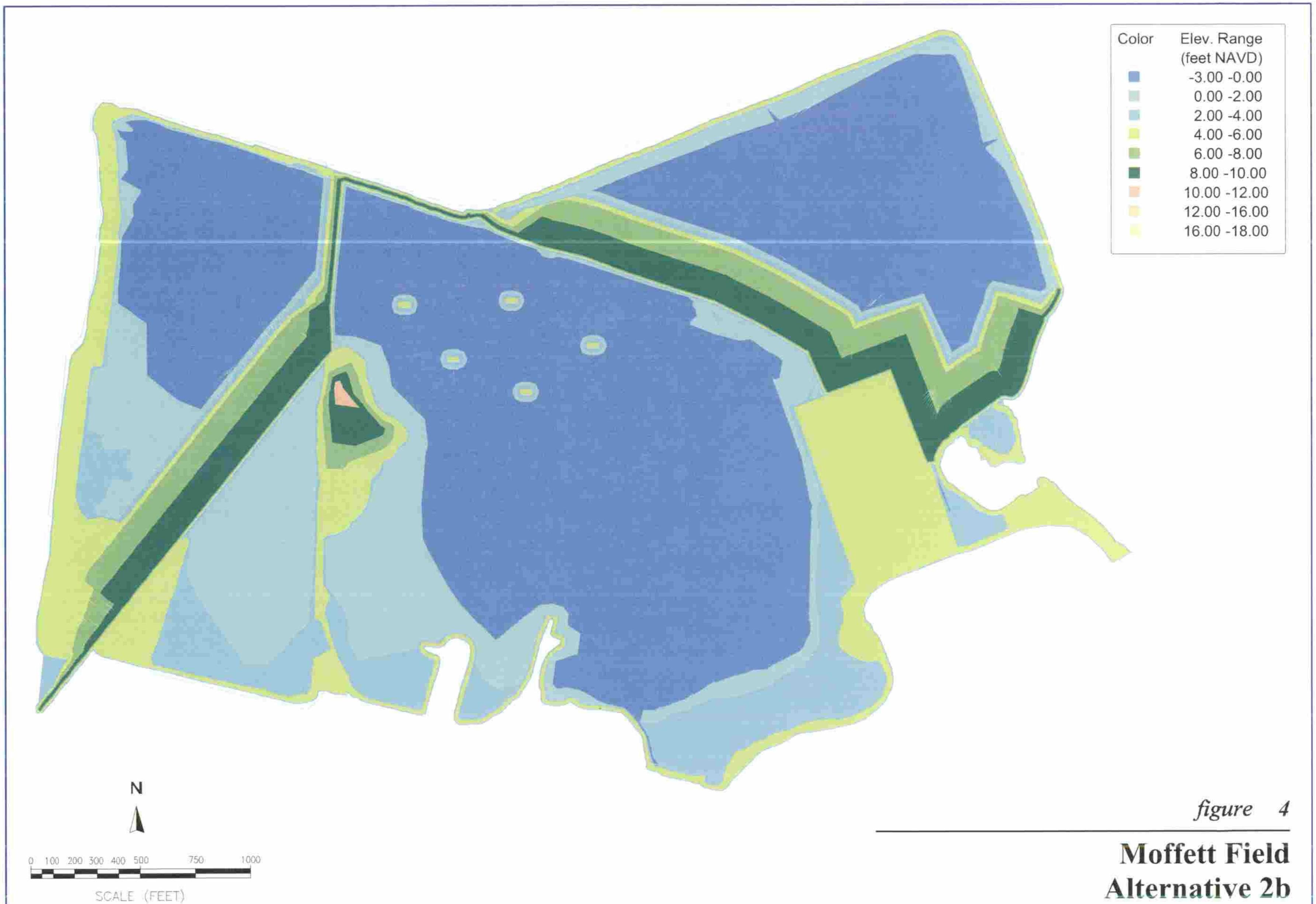


figure 4

Moffett Field
Alternative 2b

PWA

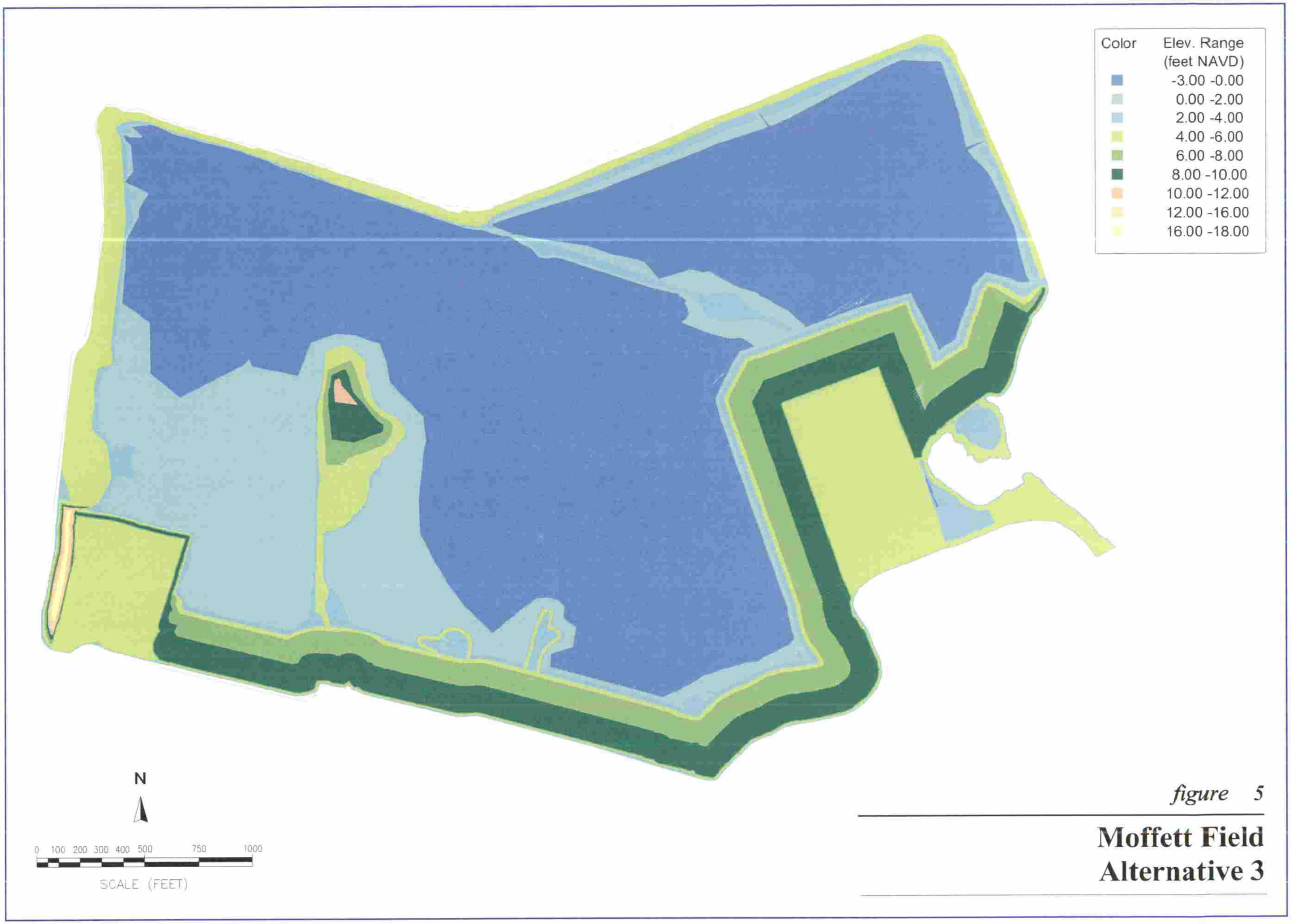
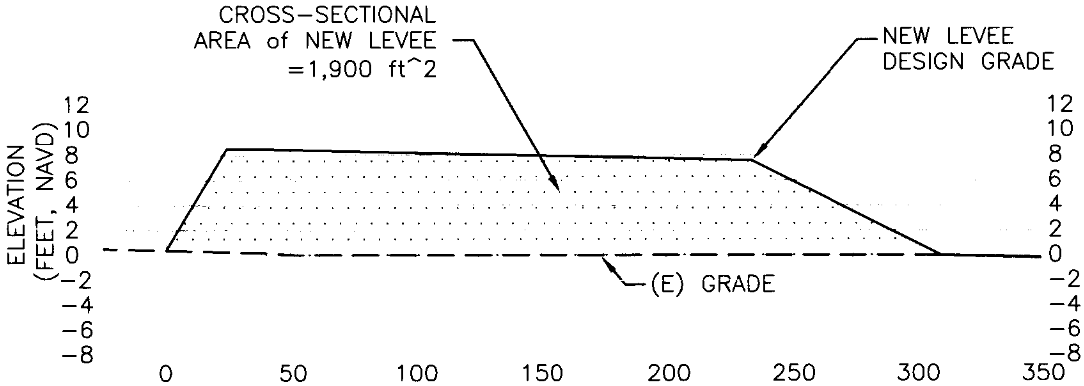


figure 5

Moffett Field
Alternative 3

PWA

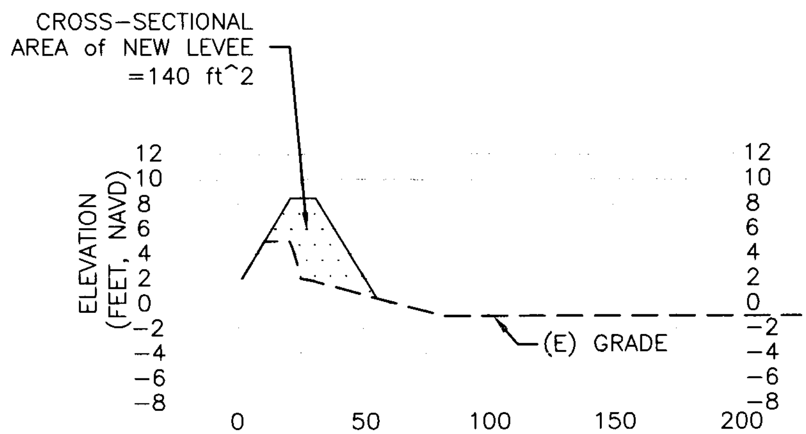


HABITAT LEVEE SECTION

A

CROSS-SECTIONAL AREA= 1,900 FT^2

SCALE:
HORIZ. 1"=75'
VERT. 1"=15'



REGULAR LEVEE SECTION

B

CROSS-SECTIONAL AREA=140 FT^2

SCALE:
HORIZ. 1"=75'
VERT. 1"=15'

figure **6**

Moffett Field
Cross-Sectional Area of New Levee

PWA

F

BROWN AND CALDWELL

APPENDIX F

Sedimentation Technical Appendix

The process of sediment accumulation is non-linear over time. In a restored site, deposition rates and sediment trapping efficiency decrease over time (much like a reservoir) as the site becomes increasingly shallow. At some point, a threshold for vegetation establishment is reached, following which sedimentation rates increase again as the vegetation provides additional particle trapping.

To characterize this non-linear process, PWA used a one-dimensional, mass-balance model (MARSH-98) that accounts for non-linear marsh sediment accumulation rates over time. MARSH-98 is a numerical model (FORTRAN code) used to estimate long-term sediment deposition on mudflats and marsh plains. The program is based on an approach to marsh plain modeling developed by Krone (1987). According to Krone (1987), marsh plain elevations rise at rates dependant on: (1) availability of suspended sediment; and (2) water depth and inundation periods.

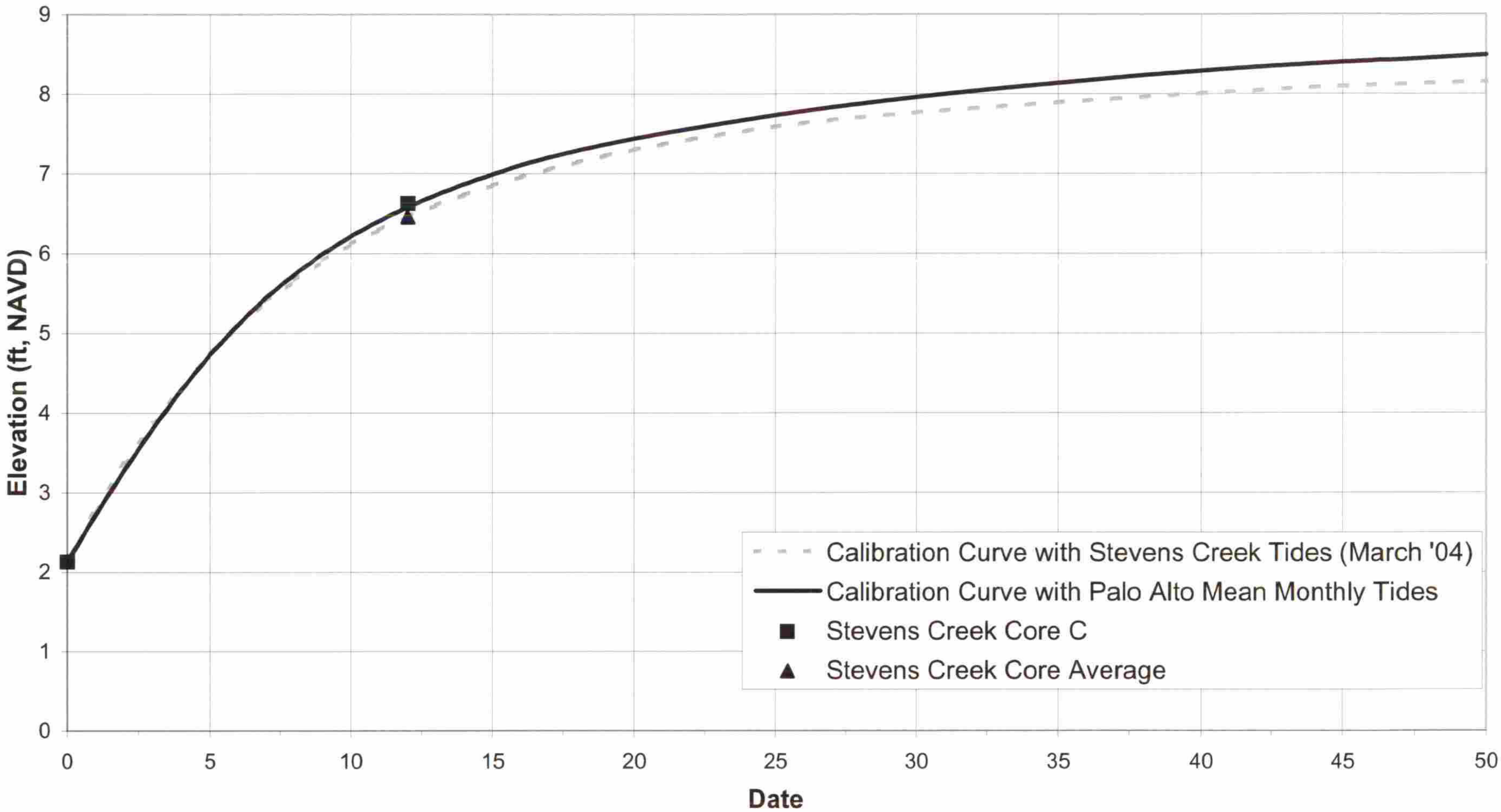
To initialize the model, input parameters that must be defined are:

- a time series of tidal elevation
- initial bed elevation
- suspended sediment concentration
- dry density of inorganic material in the sediment (given above)
- time step (600 sec)
- total run time

The two most sensitive input parameters are the tidal time series and the suspended sediment concentrations. PWA calibrated the model for the Moffett Field site using measured sedimentation rates from Stevens Creek Tidal Marsh and a measured tidal time series from Stevens Creek. Measured tides from Stevens Creek only ranged between February and April of 2004, with data gaps due to equipment error.

Because this tide data did not account for annual variability, PWA generated a synthetic tidal time series from the Palo Alto Yacht Harbor station. PWA compared model runs with the Palo Alto tidal time series and with one month of tides from Stevens Creek (March 2004) to ensure that the Palo Alto tides approximated the tidal conditions in Stevens Creek adequately.

Suspended sediment concentrations were adjusted until the resulting sedimentation curve fit the measured sedimentation rates from Stevens Creek Tidal Marsh (Figure F-1). We found that a suspended sediment concentration of 275 mg/l approximated the conditions adequately. This concentration is consistent with typical conditions measured at Channel Marker 17 by the USGS.



Note: Calibrated sediment curves uses dry density of inorganic material = 550 kg/m^3, representative for south bay marshes; suspended sediment concentraton = 275 mg/l (Palo Alto) & 300 mg/l (Stevens Creek); sea level rise = 1.5 mm/year (historic rate).

Source: PWA analysis (MARSH98 modeling), Ogden-Beeman and Krone 1992.

Moffett Field Retention Basin Restoration Feasibility Study

Figure F1. Marsh '98 Calibration

Project No. 25486

PWA

P:\Projects\1728_Moffett_Field_Retention_Basin\Sedimentation\Moffet98\1728 calibration runs1728_sediment_ST_concentration_v2MoffettCalib_Report

G

BROWN AND
CALDWELL

APPENDIX G

Regulatory Assessment

Section *Page*

❖ ❖ ❖

1 INTRODUCTION

This document is an assessment of key permitting and compliance requirements for NASA Ames as part of the Feasibility Study for the restoration of the SWRP. Because the Feasibility Study is in its conceptual phase with ongoing information gathering underway, a list of the current assumptions is included in Section 4.2 of this Appendix. If the assumptions change, then the regulatory issues should be revisited to determine if other compliance requirements are applicable. MROSD will have Federal and State permitting and compliance requirements similar to the potential NASA Ames SWRP restoration as well as additional local regulatory requirements. An assessment of MROSD regulatory issues is not covered in this appendix.

This assessment is intended to accomplish the following:

- Identify relevant federal, state, and local jurisdictional agencies with regulatory authority over the project that would grant a permit or approval, or that would engage in consultation regarding the project.
- Identify relevant non-regulatory agencies without jurisdiction, but with strong interest in resources, activities, or facilities that could result from or be affected by the project.
- Identify relevant federal, state, and local permits, approvals, and consultations, as well as their regulatory triggers.
- Identify information necessary to obtain permits and approvals, and to enter into successful consultations.
- Identify timeframes and dependencies of permit processes, approvals, and consultations.

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2 RELEVANT JURISDICTIONAL AGENCIES: PERMITS, APPROVALS, CONSULTATIONS

This chapter first describes currently applicable permits, approvals, and consultations and then the relevant jurisdictional agencies granting or participating in the process.

Agencies that would grant a permit or approval, or that would engage in consultation were considered "relevant jurisdictional agencies" for purposes of this assessment, and are included in this section of the assessment. As project design and construction methods are refined, required permits, approvals, and consultations and relevant jurisdictional agencies may also be refined.

Agencies are discussed by their federal, state, or local jurisdictional status, and within these broad classes, in alphabetical order.

Agency	**Permit, Approval, or Consultation** Regulatory Trigger/Threshold
Federal	
National Oceanographic and Atmospheric Administration Fisheries (National Marine Fisheries Service)	**Consultation for effects to federally listed anadromous fish species** Section 7 of the federal Endangered Species Act (16 USC § 1531 et seq.) and an Essential Fish Habitat (EFH) consultation under the Magnuson-Stevens Fishery Conservation and Management Act.
U.S. Army Corps of Engineers	**Permit to dispose of dredged or fill materials in waters of the US** Section 404 of the CWA (33 USC § 1344) **Permit to conduct work within jurisdictional waters of the United States** Section 10 of the Rivers and Harbors Act of 1899 (33 USC § 403)
U.S. Department of the Interior, Fish and Wildlife Service	**Consultation for effects to federally listed species (other than anadromous fish species)** Section 7 of the federal Endangered Species Act (16 USC § 1531 et seq.)

Agency	**Permit, Approval, or Consultation** Regulatory Trigger/Threshold
State	
California Department of Fish and Game	**Consultation for adverse effects to state-listed species** California Fish & Game Code §§ 2050-2089 **California Public Resources Code § 21083** **Possible streambed alteration agreement** California Fish & Game Code § 1600
California State Water Resources Control Board	**Notice of Intent to comply with the General Construction Activity Stormwater Permit** Clean Water Act § 402(p)
Regional Water Quality Control Board	**Certification of Corps permits to fill navigable waters** Section 401 of the Clean Water Act of 1977 (33 USC §§ 1251 *et seq.*) and Waste Discharge Requirements pursuant to the Porter-Cologne Water Quality Control Act
California State Lands Commission	**Consultation regarding lands held in Public Trust** PRC §§ 6001-8558
San Francisco Bay Conservation and Development Commission	**Consistency Determination** Coastal Zone Management Act of 1972 (33 USC §§1451-1464, as amended)
Local, Santa Clara County	
Santa Clara Valley Water District	**Encroachment Permit** Ordinance 83-2

For each potential permit, approval, and consultation identified, the following information is provided for Federal, State, and Local regulations in Sections 2.1, 2.2, and 2.3 (respectively):

- Name of permit, approval, or consultation requirement
- Measure, condition, or regulation that establishes the requirement
- Intent of the requirement
- Steps to obtain permit or approval, or to complete consultation, including general information requirements
- Duration of effort

2.1 Federal

2.1.1 National Oceanographic and Atmospheric Administration Fisheries (National Marine Fisheries Service)

Requirement: Consultation for effects to federally-listed anadromous fish species and for effects to Essential Fish Habitat (EFH) for federally-managed fishery species

Established by: Section 7 of the federal Endangered Species Act (16 USC § 1531 et seq.) and the Magnuson-Stevens Fishery and Conservation Act (16 USC 1801 et seq.)

Requirement intent: Section 7(a)(2) of the Endangered Species Act requires that federal agencies ensure any action authorized, funded, or carried out by such an agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When the action of a federal agency may affect certain protected fish species, that agency is required to consult with NOAA Fisheries. Section 7(b) of the Act requires the consultation be summarized in a biological opinion detailing how the action may affect protected species.

Section 305(b)(2) of the Magnuson-Stevens Fishery and Conservation Act requires federal agencies to consult with NOAA Fisheries on activities that may adversely affect EFH.

Steps to accomplish: The following assumes the project will be defined as a "major construction activity." It also assumes that Section 7 and EFH consultations will be combined.

The first step will be the consultation with NMFS to determine the need for Section 7(b) biological opinion and EFH determination given that surveys for the FS did not find federally listed anadromous fish species and EFH within the SWRP. One alternative being considered is the creation of a hydrological connection to Stevens Creek, which is habitat for steelhead, a federally-listed anadromous fish. If NMFS determines that the Section 7 and EFH consultations are required, then the following requirements apply:

Informal consultation to determine potential effect (Figure 2.1):

1. Identify relevant species
2. Identify if species and/or critical habitat present; identify if EFH is present
3. If the action is found by NOAA Fisheries to be entirely beneficial, insignificant, or discountable, informal consultation concludes; if not, continued informal consultation occurs as described below.
4. Prepare Biological Assessment
    - Project description
    - Site specific information (species, habitat, survey methods and results, etc.)
    - Effects of the action (direct, indirect, independent, interrelated, and cumulative)
    - Incidental take
    - Conservation measures
    - Determination of effect

5. If NOAA Fisheries finds the action not likely to adversely affect species or critical habitat, it may also find the action is not likely to adversely affect EFH[1], and issues a concurrence letter, and informal consultation concludes. If NOAA Fisheries finds the action likely to adversely affect species or critical habitat (result in jeopardy or adverse modification), it may also find the action is likely to adversely affect EFH. In this case, NOAA Fisheries issues a nonconcurrence letter, and formal consultation is required, as described below.

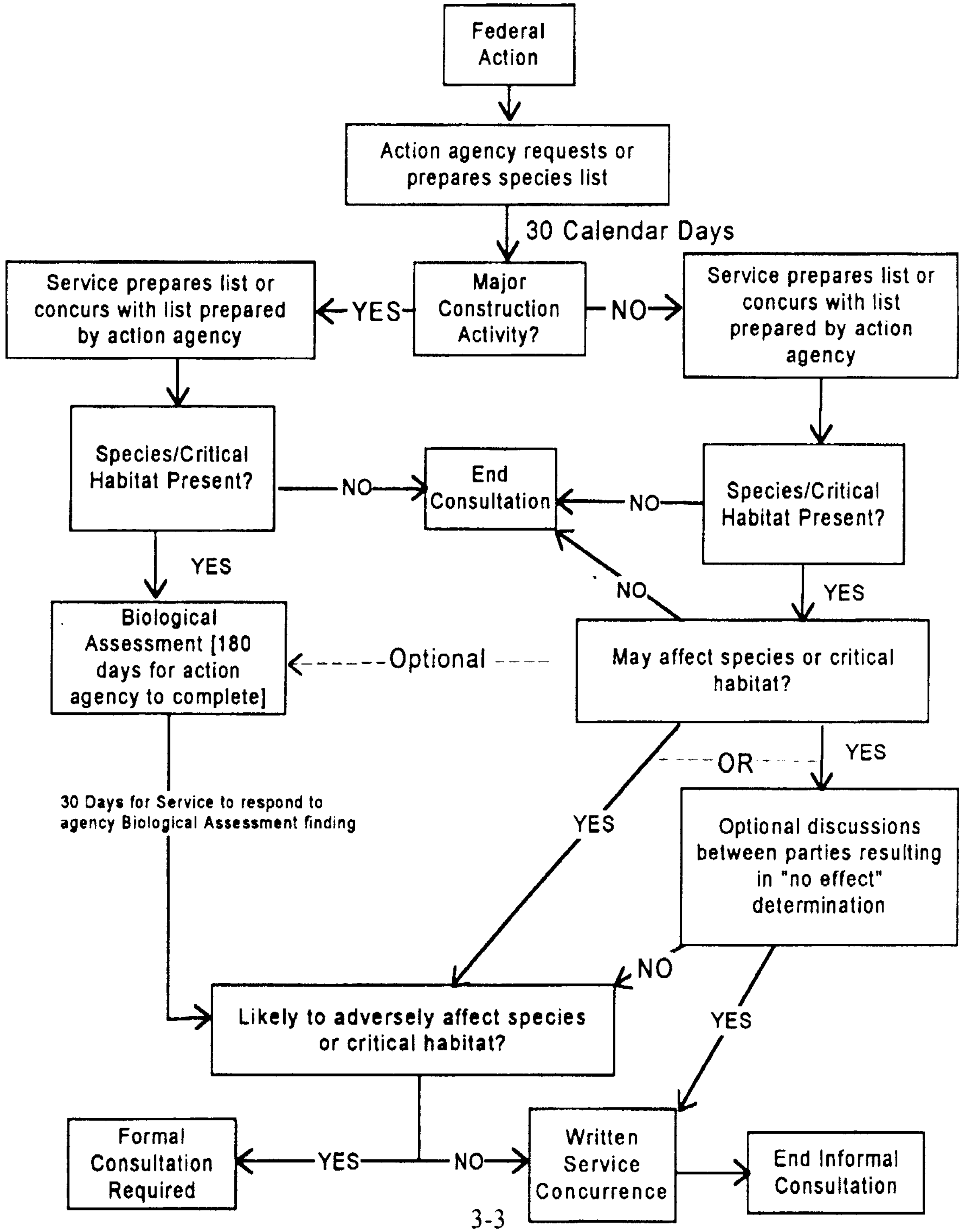
Formal consultation to protect habitat and species (Figure 2.2):

1. NOAA Fisheries may request additional information
2. NOAA Fisheries prepares draft Biological Opinion
    - Description of action
    - Status of species/critical habitat
    - Environmental baseline
    - Effects of the action
    - Cumulative effects
    - Conclusion
    - Reasonable and prudent alternatives
    - EFH conservation recommendations
3. Draft Biological Opinion reviewed by action agency
4. NOAA Fisheries delivers final Biological Opinion and incidental take statement to action agency

Duration: Informal consultation: 1 year

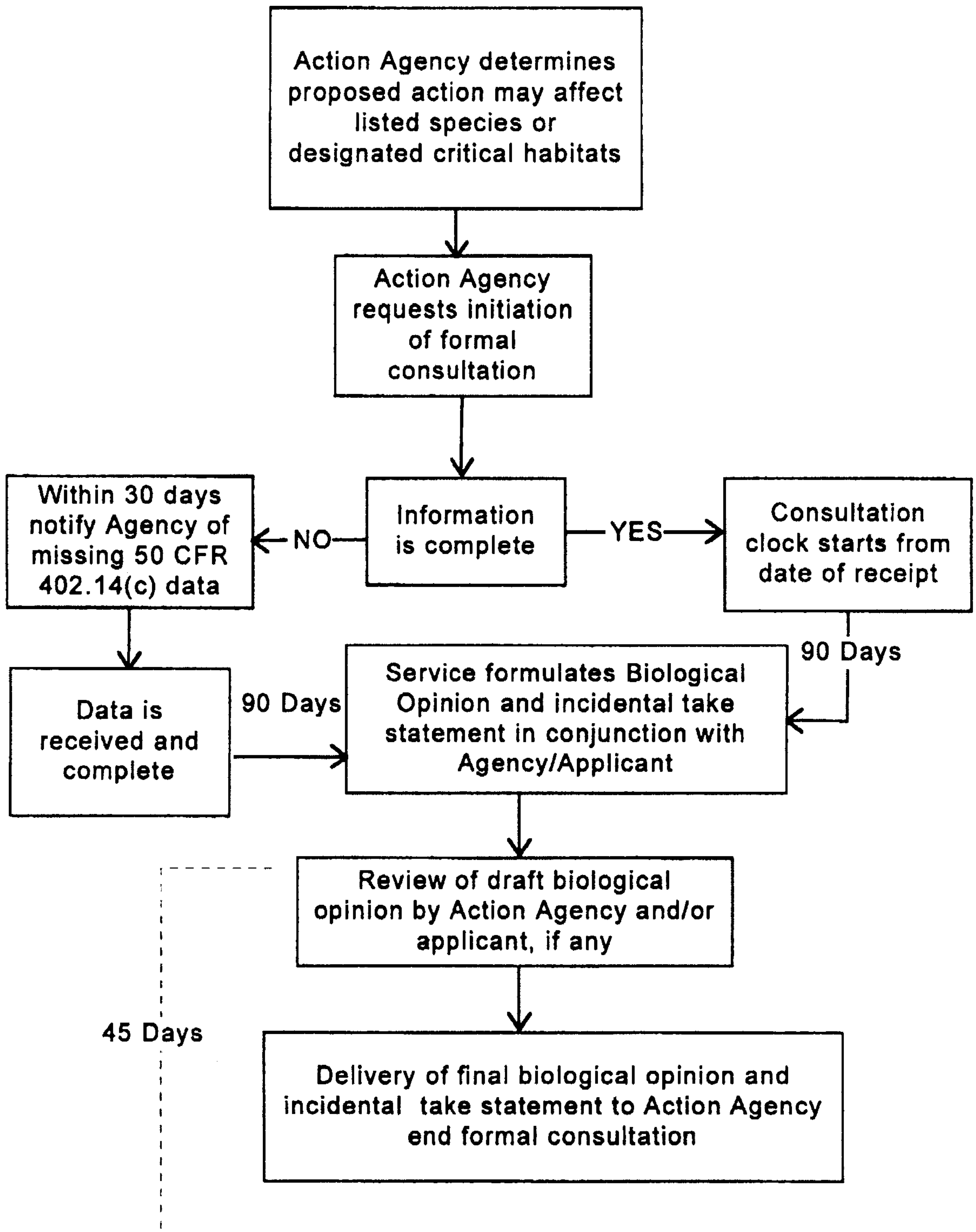
Formal consultation: an additional 6 to 9 months

[1] While NOAA Fisheries is not required to make a finding regarding EFH similar to the finding it makes regarding special status and critical habitat, more often than not, the findings are the same.



Source: U.S. Fish and Wildlife Service and National Marine Fisheries Service (now NOAA Fisheries), March 1998. Table 3-1 of *Final ESA Section 7 Consultation Handbook.*

Figure 2.1: Informal Consultation Under Section 7 of the Endangered Species Act



Source: U.S. Fish and Wildlife Service and National Marine Fisheries Service (now NOAA Fisheries), March 1998. Table 4-1 of *Final ESA Section 7 Consultation Handbook.*

Figure 2.2: Formal Consultation Under Section 7 of the Endangered Species Act

2.1.2 U.S. Army Corps of Engineers

Requirement: Permit to dispose of dredged or fill materials in waters of the US

Established by: Section 404 of the Clean Water Act (33 USC § 1344)

Requirement intent: In 1972, amendments to the Federal Water Pollution Control Act added what is commonly called Section 404 authority to the COE regulatory program. The Secretary of the Army, acting through the Corps of Engineers, is authorized to issue permits, after notice and opportunity for public hearings, for the discharge of dredged or fill material into waters of the United States at specified disposal sites. Selection of such sites must be in accordance with guidelines developed by the Environmental Protection Agency (EPA) in conjunction with the Secretary of the Army; these guidelines are known as the 404(b)(1) Guidelines. The Federal Water Pollution Control Act was further amended in 1977 and given the common name of "Clean Water Act".

The Clean Water Act uses the term "navigable waters" defined (Section 502(7)) as "waters of the United States, including the territorial seas." Section 404 jurisdiction is therefore defined as encompassing Section 10 waters (see below) plus their tributaries and adjacent wetlands where the use, degradation or destruction of such waters could affect interstate or foreign commerce.

Activities requiring Section 404 permits are limited to discharges of dredged or fill materials into the waters of the United States. These discharges include return water from dredged material disposed of upland and generally any fill material (e.g., rock, sand, dirt) used to construct fast land for site development, roadways, erosion protection, etc.

Steps to accomplish:

1. Consultation with Army Corps to determine need for permit and informational requirements
2. Completion of draft environmental review documentation, including 404(b)(1) analysis
   - Identify practicable alternatives
   - Findings of compliance or non-compliance with restrictions on discharge
   - Potential impacts on physical and chemical characteristics of aquatic ecosystems
   - Potential impacts on special aquatic sites
   - Actions to minimize adverse effects
   - Planning to shorten permit processing time
3. Completion and submittal of permit application (ENG 4345)
   - Project applicant information
   - Project description, including purpose
   - Description of discharge and waters to be filled
   - Adjacent landowners
4. Corps consultation with stakeholders

5. Potential hearing
6. Permit granted or denied

Duration: 6 months, once permit application is submitted

Requirement: Permit to conduct work within jurisdictional waters of the United States

Established by: Section 10 of the Rivers and Harbors Act (33 U.S.C. 403)

Requirement intent: Section 10 of the Rivers and Harbors Act of 1899 prohibits the unauthorized obstruction or alteration of any navigable water of the United States. This section provides that the construction of any structure in or over any navigable water of the United States, or the accomplishment of any other work affecting the course, location, condition, or physical capacity of such waters is unlawful unless the work has been recommended by the Chief of Engineers and authorized by the Secretary of the Army. The Secretary's approval authority has since been delegated to the Chief of Engineers.

Steps to accomplish:

ENG 4345, to be completed for Section 404 efforts, also applies to Section 10 (no additional submittal required)

Duration: 6 months, once permit application is submitted, concurrent with Section 404 effort described above

---

2.1.3 U.S. Department of the Interior, Fish and Wildlife Service

Requirement: Consultation for effects to federally listed species (other than anadromous fish species)

Established by: Section 7 of the federal Endangered Species Act (16 USC § 1531 et seq.)

Requirement intent, steps to accomplish, and duration: See NOAA Fisheries, Section 2.1.1 above.

2.2 State

2.2.1 California Department of Fish and Game

Requirement: Consultation for adverse effects to state-listed species

Established by: California Fish and Game Code §§ 2050-2089 and Public Resources Code § 21083

1. **Requirement intent:** In order to conserve, protect, restore, and enhance any endangered species or any threatened species and its habitat these regulations authorize Fish and Game and require project sponsors to consult with, and obtain written findings from, the Department regarding the potential impacts of a project on state-listed endangered or threatened species as well as Species of Special Concern and Fully Protected species. The DFG will be the lead State agency for the preparation of the EIR for this project, which may be tiered from the SBSPRP EIS/EIR. These requirements will be incorporated into that CEQA process.

Requirement: Possible streambed alteration agreement

Established by: California Fish and Game Code § 1600

Requirement intent: In order to protect special status species from harm, including habitat modification an agency must enter into an Agreement with the Department, if the agency proposes actions that result in any of the following: (1) divert, obstruct, or change the natural flow or the bed, channel, or bank of any river, stream, or lake designated by the department in which there is at any time an existing fish or wildlife resource or from which these resources derive benefit, (2) use material from the streambeds designated by the department, or (3) result in the disposal or deposition of debris, waste, or other material containing crumbled, flaked, or ground pavement where it can pass into any river, stream, or lake designated by the department.

Steps to accomplish:

1. Engage in early consultation with the Department (see above)
2. Complete environmental review document
3. Compete and submit forms FG2024 and FG2024 (and include draft EIR)
    - Applicant information
    - Project location
    - Project description
    - Exact activities and facilities
    - Estimate of impacts
4. Department determines application compete
5. Department develops draft Agreement (a discretionary action, which cannot be completed until environmental document is certified)
6. Department finalizes Agreement

Duration: 4 months

2.2.2 California Environmental Protection Agency, State Water Resources Control Board

Requirement: Notice of Intent to comply with the General Construction Activity Stormwater Permit (CAS000002)

Established by: Section 402(p) of the Clean Water Act

Reference Section: This permit is discussed in Section 4.4, which addresses the storm water and permit planning requirements.

2.2.3 California Environmental Protection Agency, California State Water Resources Control Board, San Francisco Regional Water Quality Control Board (Region 2)

Requirement: Certification of Corps permits to fill navigable waters and to construct in waters

Established by: Section 401 of the Clean Water Act of 1977 (33 USC §§ 1251 *et seq.*)

Requirement intent: The Clean Water Act, at Section 401, specifies that states must certify that any activity subject to a permit issued by a federal agency, such as the COE, meets all state water quality standards. In California, the State Board and the regional boards are responsible for taking certification actions for activities subject to any permit issued by the Corps pursuant to Section 404 (or for any other Corps' permit, such as permits issued pursuant to Section 10 of the Rivers and Harbors Act of 1899). Such certification actions, also known as 401 certification or water quality certification, include issuing a 401 certification that the activity subject to the federal permit complies with state water quality standards, issuing a 401 certification with conditions, denying 401 certification, or denying 401 certification without prejudice, should procedural matters preclude taking timely action on a 401 certification application. Should 401 certification be denied, the federal permit is deemed denied also. Once it has received a complete application for 401 certification, the state must act on the application within 60 days, although it may request additional time to act from the Corps, up to one year.

Regional boards or their executive officers may issue 401 certifications. The State Board issues 401 certifications for projects that will take place in two or more regions.

Steps to accomplish:

1. Complete and submit the application for water quality certification

- Application information
- Site information
    - Identify affected water bodies and special aquatic sites
    - Provide USGS 7-minute quad
    - Directions to site
- Project information

- Activities and impacts
- Describe dewatering
- Describe alternatives

- Discharge information
  - Describe need
  - Describe material types and quantities
  - Define area of fill
- Additional information
  - Describe mitigation
  - Status of project progress
  - Other certifications/denials

Duration: 4 months

2.2.4 California State Lands Commission

Requirement: Consultation and possible surface lease for use of sovereign lands held in Public Trust

Established by: Public Resources Code §§ 6001-8558

Requirement intent: California became a state on September 9, 1850, and thereby acquired nearly 4 million acres of land underlying the State's navigable and tidal waterways. Known as "sovereign lands", these lands included the beds of 1) more than 120 rivers, streams and sloughs; 2) nearly 40 non-tidal navigable lakes, such as Lake Tahoe and Clear Lake; 3) the tidal navigable bays and lagoons; and 4) the tidal and submerged lands adjacent to the entire coast and offshore islands of the State from the mean high tide line to three nautical miles offshore. This area, equal in size to Connecticut and Delaware combined, is managed by the California State Lands Commission.

The State holds its "sovereign lands" in Public Trust. They can only be used for public purposes consistent with provisions of the Public Trust such as fishing, water dependent commerce and navigation, ecological preservation and scientific study.

Public and private entities may apply to the Commission for leases or permits on State lands for many purposes including marinas, industrial wharves, tanker anchorages, harvesting of timber, dredging, grazing, mining, oil and gas production, and geothermal development.

Commission staff routinely comment on EIR for projects that affect the State's lands, and reviews permit applications submitted to the California Coastal Commission, the San Francisco Bay Conservation and Development Commission (BCDC), and the COE.

Steps to accomplish:

1. At time of EIR scoping, include the Department on the distribution list for the Notice of Preparation

2. Provide public review draft EIR to the Department, and pay required fees for Department review

Based on the current restoration alternatives it is unlikely that a lease would be required for the SWRP. The State Land Commission can be consulted informally to determine if the restoration alternative(s) are likely to require a lease. However, if a lease is required, the following additional steps should be undertaken:

1. Meet with Commission staff to identify area of jurisdiction and confirm need for lease/permit
2. Complete and submit lease application
   - General Data
     - Identification of Applicant
     - Type of Project and Authorization
     - Project Location
     - Property Description
   - Other Governmental Jurisdiction
   - Specific Project Information
   - Existing Conditions
   - Project Description
   - Project Siting and Feasibility
   - Public Benefit
   - Project Environmental Data
   - Environmental Setting
   - Assessment of Environmental Impacts
   - State Lands Commission as a Responsible Agency
   - Submittal of Fees
   - Signature and Certification

Duration: 6 months, concurrently with EIR processing

2.2.5 San Francisco Bay Conservation and Development Commission

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Requirement: Consistency Determination

Established by: Coastal Zone Management Act of 1972 (33 USC §§1451-1464, as amended)

Requirement intent: In addition to carrying out its regulatory authority under state law, the federal Coastal Zone Management Act allows BCDC to review federal projects and projects that require federal approval or are supported with federal funds. The Commission carries out its "federal consistency" responsibilities by reviewing federal projects. The Commission cannot require federal agencies to submit permit applications and cannot impose conditions in its federal consistency decisions. Nevertheless, federal agencies and applicants for federal approvals must provide the project details, data and other material required by BCDC's application form to assure the Commission has the information it needs to evaluate federal projects.

A Consistency Determination includes a statement indicating the proposed action will be undertaken in a manner consistent to the maximum extent practicable with the California Coastal Management Program (CCMP), developed pursuant to the Coastal Zone Management Act.

Steps to accomplish:

1. Consult with BCDC staff to determine the limits of jurisdiction and required level of information
2. Complete and submit BCDC application
    - Applicant information
    - Project information
    - Total project and site information
    - Bay fill information
    - Shoreline band information
    - Public access information
    - Dredging information
    - Government approvals
    - Public notice information
    - Environmental impact documentation
    - Disclosure of campaign contributions
3. Commission staff requires additional information/clarifications, or deem application complete
4. Commission conducts hearing at first public meeting
5. Commission acts on application at second public meeting

Duration: 10 weeks (2 to prepare application, 8 weeks for BCDC processing)

2.3 Options for Joint Federal and State Permitting

2.3.1 Dredged Material Management Office

The DMMO is a joint program of the San Francisco BCDC, San Francisco Bay RWQCB, State Lands Commission, the San Francisco District COE, and the U.S. Environmental Protection Agency. Also participating are the California Department of Fish and Game, NOAA Fisheries, and the U.S. Fish and Wildlife Service who provide advice and expertise to the process. The purpose of the DMMO is to cooperatively review sediment quality sampling plans, analyze the results of sediment quality sampling and make suitability determinations for material proposed for aquatic disposal and some upland/reuse sites within the DMMO's regulatory authority (e.g. wetlands in upland areas) in San Francisco Bay. The goal of this interagency group is to increase efficiency and coordination between the member agencies and to foster a comprehensive and consolidated approach to handling dredged material management issues. Applicants using DMMO fill out one application form, which the agencies then jointly review at bi-weekly meetings before issuing their respective authorizations. DMMO would be a suitable forum for some approvals if use of imported sediment is required, or if fill is required due to the removal or relocation of the Steven's Creek levee or a new MSROD levee is constructed.

2.4 Local

As a federal entity NASA Ames is not under the jurisdiction of most of the local land use authorities and is not required by law to file land use permit applications. Even though there is no permit authority, the site is within the planning area of several local agencies. NASA Ames may determine that they will informally or formally consult with the local agencies.

2.4.1 Santa Clara Valley Water District

For implementation of the project, an encroachment permit would be required through Santa Clara Valley Water District (District) under Ordinance 82-3. This ordinance requires that projects within 50 feet of District property or a District easement are reviewed and permitted through the District's Community Projects Review Unit to reduce impacts on watercourses.

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3 RELEVANT NON-JURISDICTIONAL AGENCIES

The following agencies would not grant permits, approvals, or participate in consultations relative to the project. However, each has a strong interest in resources and facilities that could benefit from or be impacted by the project, and are therefore considered relevant non-jurisdictional agencies. The basis for this determination, and the possible interest of each agency is described below.

3.1 San Francisco Bay Regional Water Quality Control Board

The SFBRWQCB protects water quality in California including in wetland habitat. SFRWQCB will be involved in the efforts to remediate Site 25. Although for the purposes of the Project it is assumed that the site will be fully remediated to Federal and State clean up standards prior to the commencement of the SWRP restoration work, there will most likely be residual activity such as monitoring and possibly low levels of contaminants still present on the site. Both for funding and technical reasons, the remediation of a Superfund site could significantly affect the progress of the restoration efforts.

3.2 Bay Area Air Quality Management District

The BAAQMD is responsible for the control of air pollution within all of seven counties—Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara and Napa, and portions of two others—southwestern Solano and southern Sonoma. While the BAAQMD has permit authority over stationary sources (not mobile sources, which are regulated by the U.S. EPA and the California Air Resources Board), construction of the project, located within the geographic jurisdiction of the Air District, will generate emissions from construction equipment and ground disturbance activities. For construction-related dust emissions, the BAAQMD takes a "Best Management Practices" (BMP) approach to such emissions. This approach requires adoption and implementation of BAAQMD-specified fugitive dust control measures at construction sites; with adoption of these BMPs, a project may assume its construction—related fugitive dust emissions would be less than significant.

3.3 Santa Clara County Vector Control District

It is the overall goal of the District to provide for the public's health and comfort by carrying on a program of mosquito source abatement which is responsive to the public, cost effective, compatible with the environment, and consistent with land use planning or zoning. This goal is met by the implementation of programs to:

- eliminate existing mosquito sources
- educate land owners to manage potential mosquito sources effectively and thereby reduce mosquito numbers to an acceptable level
- apply safe and environmentally sound larvicides to aquatic sources to prevent the emergence of unacceptable levels of pest and vector mosquitoes.

The District is likely to be interested in whether the project has the potential to affect its program by either decreasing or increasing mosquito populations in the South Bay.

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4 REGULATORY TIMEFRAME

4.1 Schedule of Regulatory Activities and Assumptions

Numerous permits, approvals, and consultations will be required prior to initiation of long-term restoration. As a general rule, state permits are obtained first and then federal permits. The overall schedule for permit acquisition will depend on the scope of the project, the alternative selected, and its relationship to the SBSPRP.

Assumptions

A list of the current assumptions that affect the scope of the regulatory assessment follows. If additional information is discovered that changes these assumptions, then the regulatory issues should be revisited to determine if other compliance requirements should be included.

Assumptions regarding the restoration activities include the following:

- The SWRP covers approximately 200 acres and receives runoff from the western drainage system (680 acres) via two pipes leading to a settling basin. From the settling basin the runoff is conveyed to the Eastern Diked Marsh through three pipes (under North Perimeter Road.) to the SWRP.
- Restoration alternatives consist of no action, partial tidal restoration, and full tidal restoration.
- The entire SWRP site is part of a Superfund clean up.
- No anadromous fish occur in the SWRP but a hydrological connection to Stevens Creek has the potential to introduce steelhead.
- No marine mammals occur in the SWRP.
- No historical resources (including Native American artifacts) occur at the SWRP.
- Contamination cleanup is performed to approved regulatory levels prior to permitting/ constructions[2].
- No previous dredging/disposal/BCDC permits have been obtained for this site.
- The restoration will provide for adequate flood management.
- There will be some public access.
- There will be no public recreation on the NASA portion of the site.

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[2] Note that this assumption includes regulatory standards sufficient to satisfy USFWS Endangered Species Branch, and that cleanup will protect ecological receptors.

- Some endangered species (e.g., clapper rail and salt marsh harvest mouse) may occur on the NASA portion of the site.
- There is the potential for an aquatic connection to Stevens Creek and/or Pond A2E.
- There may be an aquatic connection to other wetlands for the partial tidal or full tidal restoration alternatives.
- Restoration activities could include: pumping water to Stevens Creek; creating a hydrological connection to Stevens Creek and/or PondA2E, raising, removing, or adding levees; raising water levels; construction of upstream storm water retention basin or marshes; placement of sediment in the SWRP; and disturbance of existing viable wetland habitat,

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5 REFERENCES

US Fish and Wildlife Service and National Marine Fisheries Service, 1998. *Final ESA Section 7 Consultation Handbook.* March.

California Regional Water Quality Control Board, San Francisco Bay Region, undated. *Guidelines for Construction Projects.*

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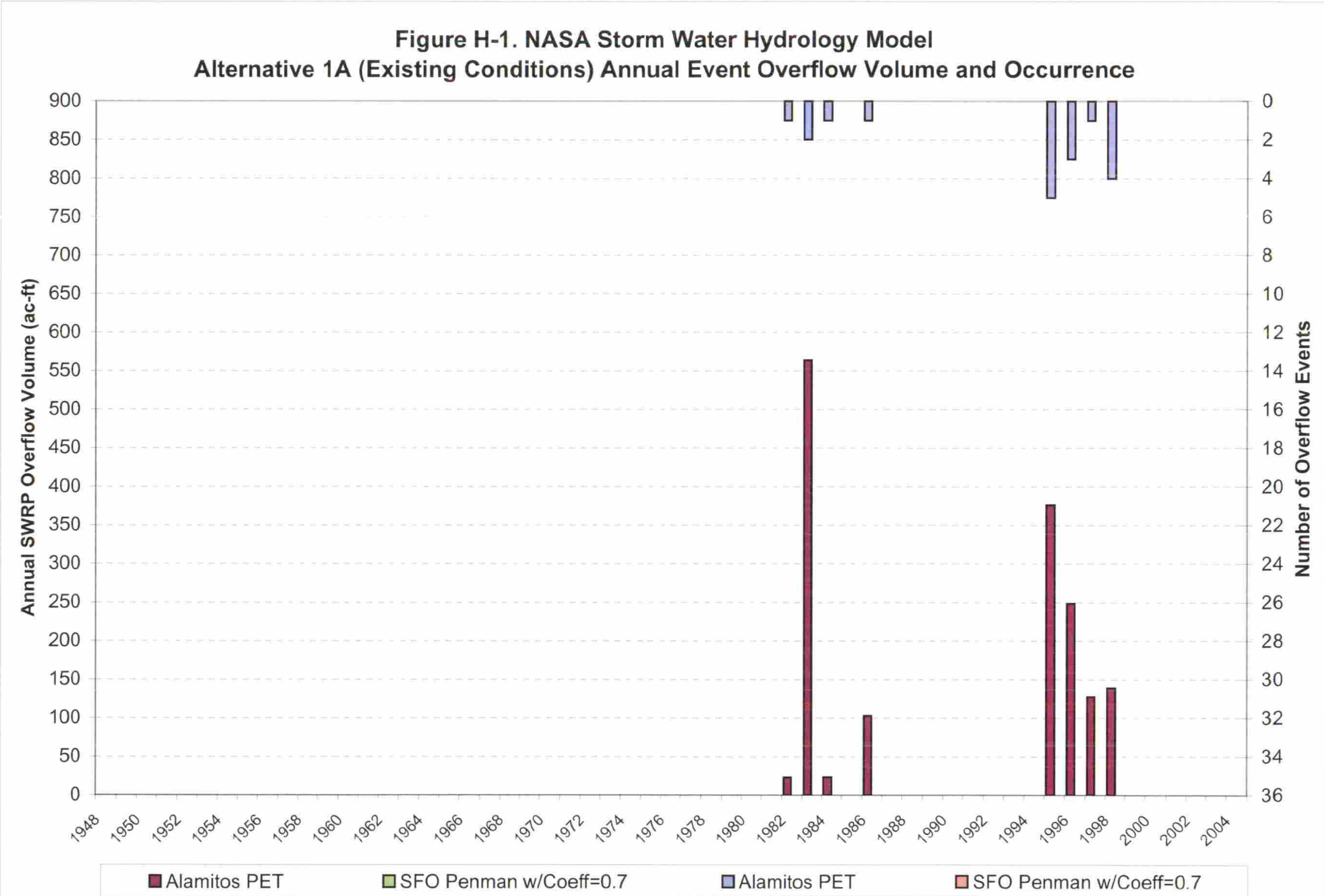
H

BROWN AND
CALDWELL

APPENDIX H

Moffett Field Storm Water Hydrology Model Supplementary Results



NOTE:
(1) Assumed pumping time for overflow events is not constant.
(2) SFO Penman (high PET dataset) resulted in no overflow for existing conditions.

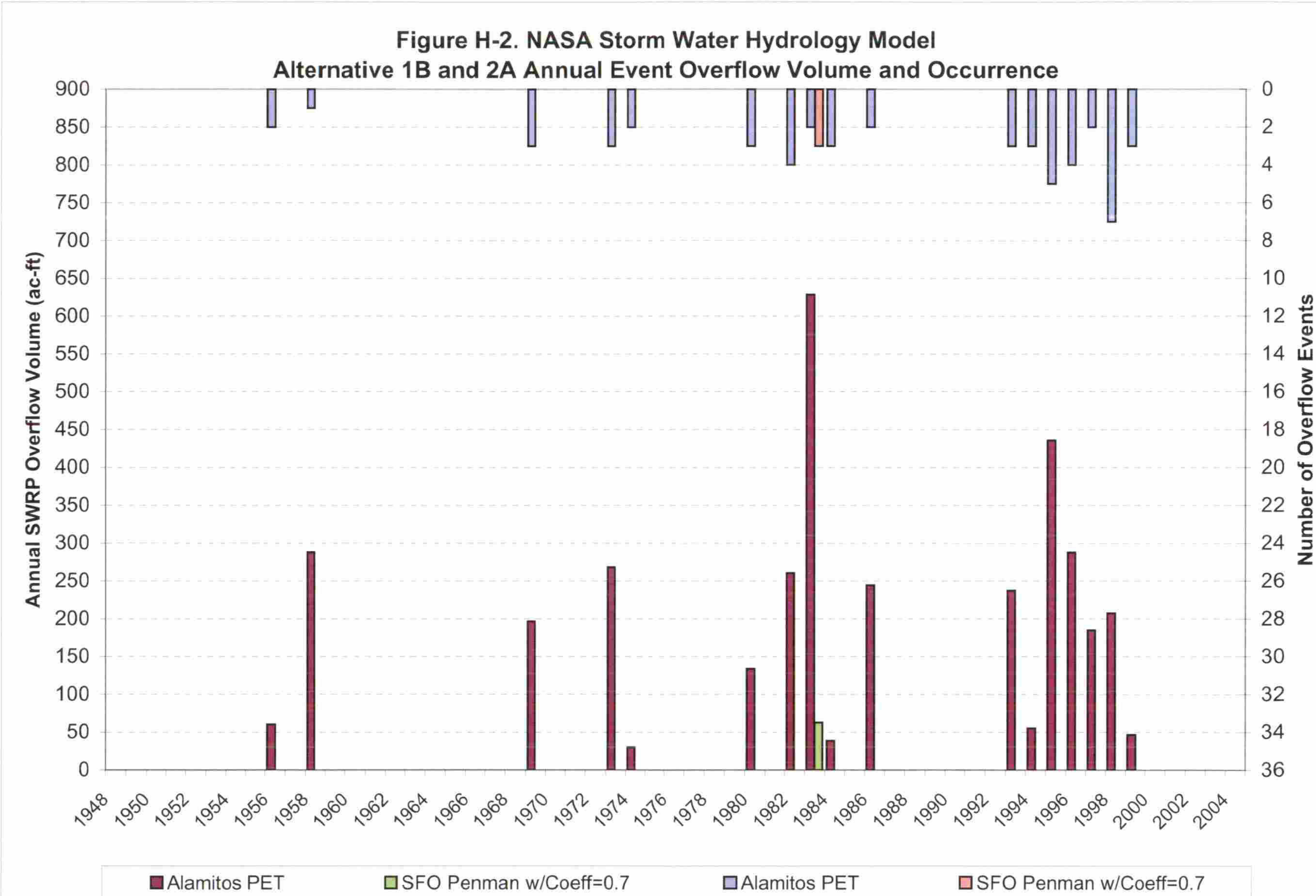


Figure H-2. NASA Storm Water Hydrology Model
Alternative 1B and 2A Annual Event Overflow Volume and Occurrence
Annual SWRP Overflow Volume (ac-ft)
Number of Overflow Events
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
1948
1950
1952
1954
1956
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1970
1972
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1998
2000
2002
2004
Alamitos PET
SFO Penman w/Coeff=0.7
Alamitos PET
SFO Penman w/Coeff=0.7

Figure H-3. NASA Storm Water Hydrology Model
Alternative 1B and 2A Simulated Water Surface Elevation during a Dry Year
(Water Year 2001)

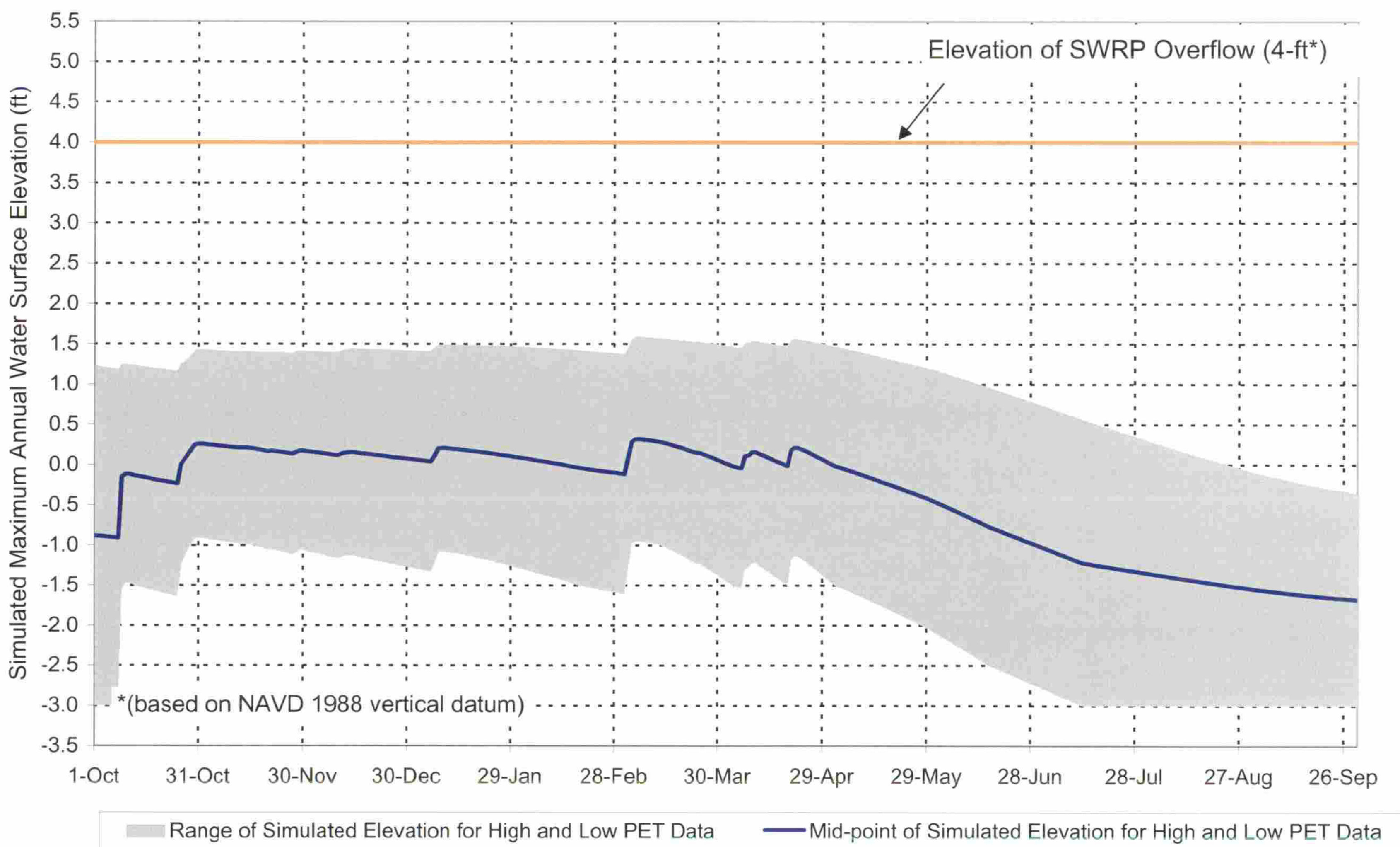
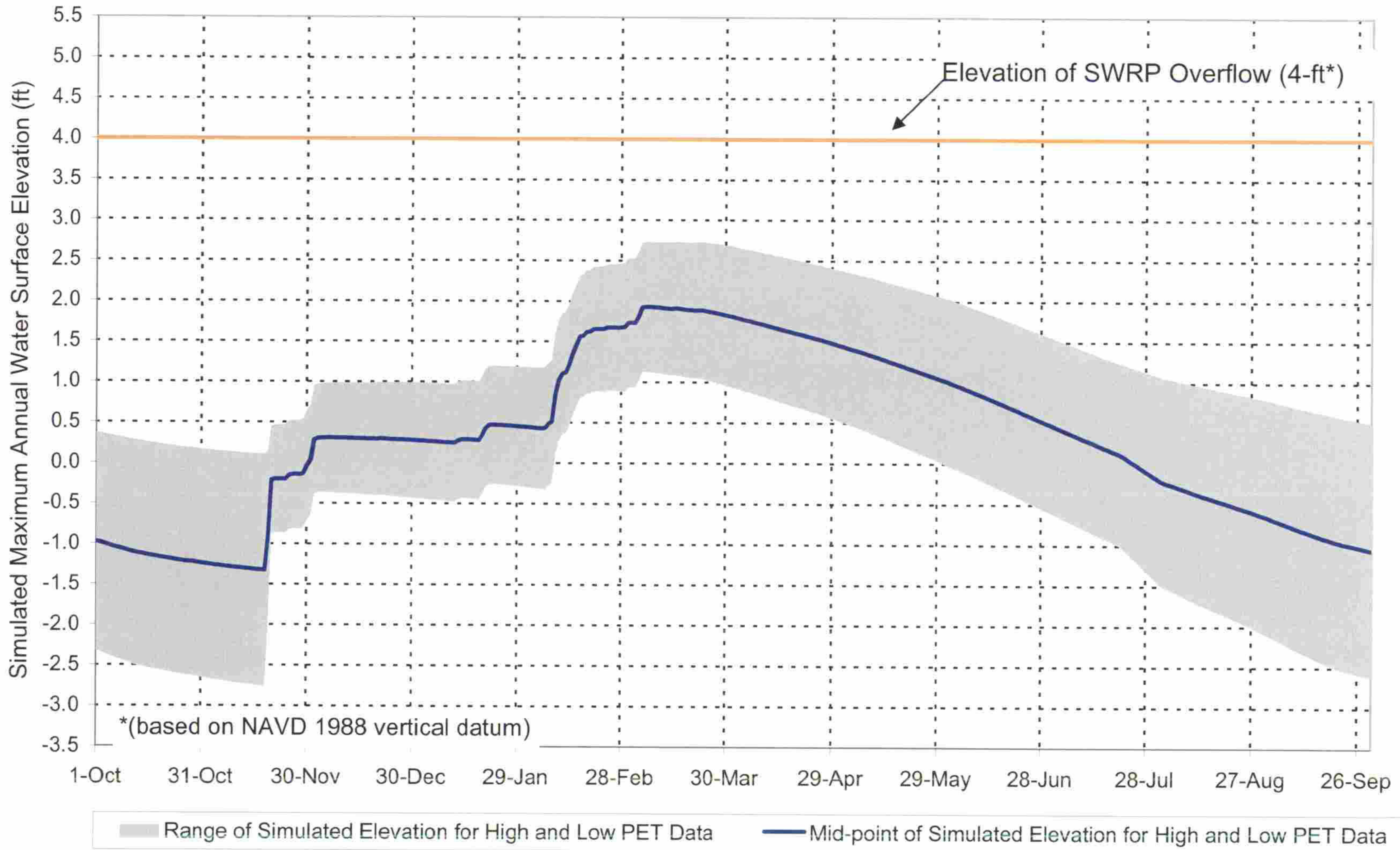


Figure H-4. NASA Storm Water Hydrology Model
Alternative 1B and 2A Simulated Water Surface Elevation during an Average Year
(Water Year 1962)



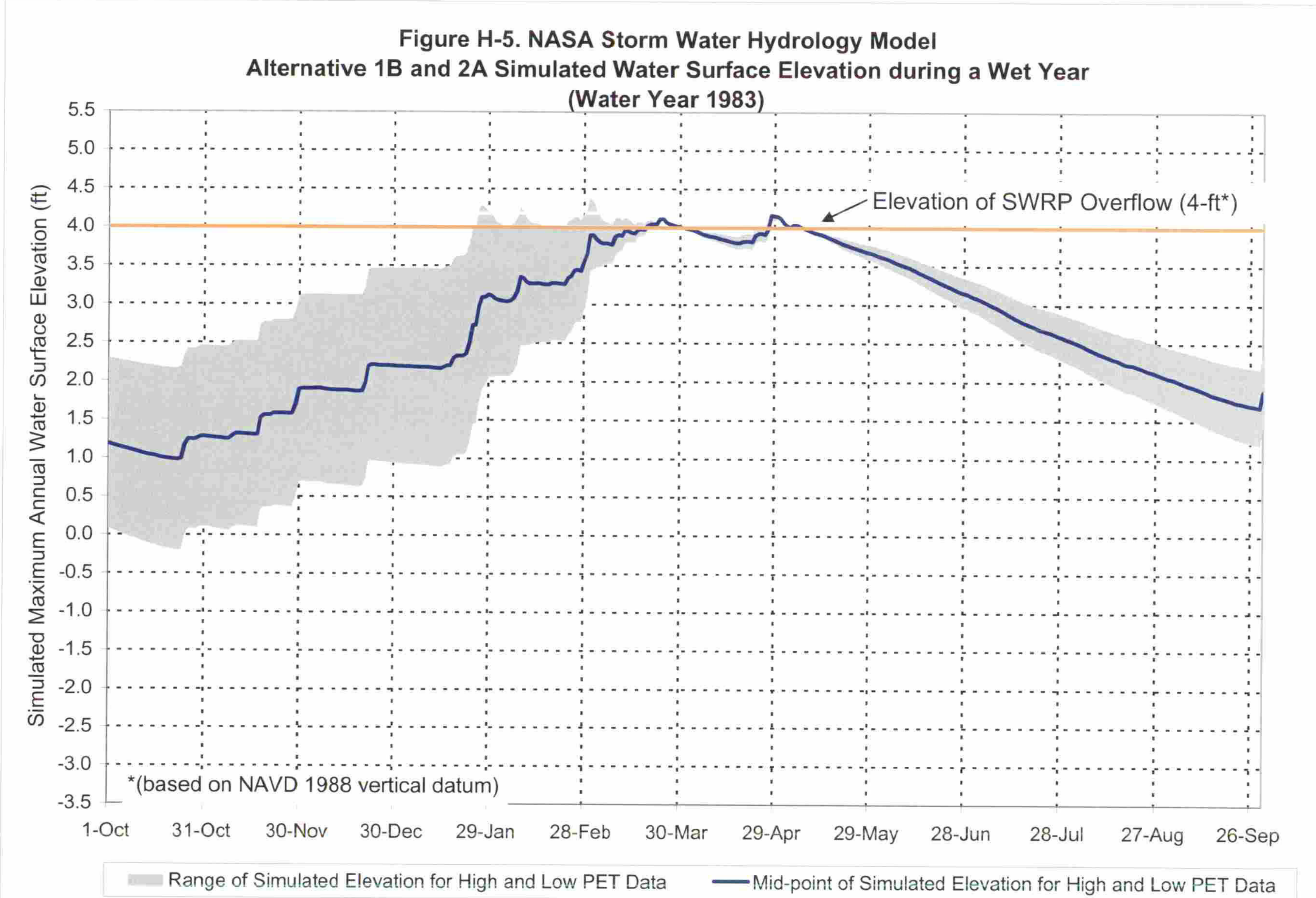
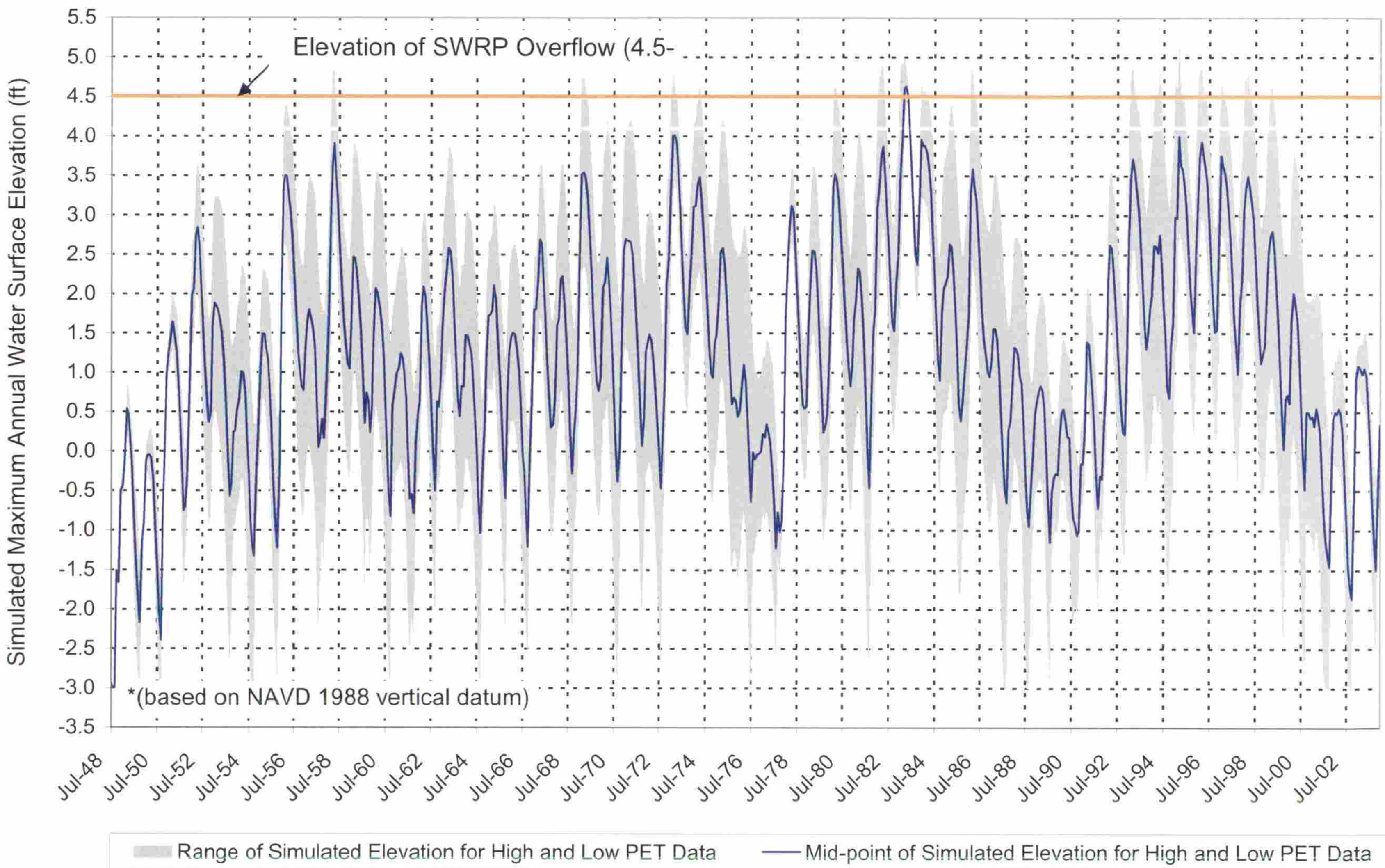


Figure H-5. NASA Storm Water Hydrology Model
Alternative 1B and 2A Simulated Water Surface Elevation during a Wet Year
(Water Year 1983)
Simulated Maximum Annual Water Surface Elevation (ft)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
Elevation of SWRP Overflow (4-ft*)
*(based on NAVD 1988 vertical datum)
1-Oct
31-Oct
30-Nov
30-Dec
29-Jan
28-Feb
30-Mar
29-Apr
29-May
28-Jun
28-Jul
27-Aug
26-Sep
Range of Simulated Elevation for High and Low PET Data
Mid-point of Simulated Elevation for High and Low PET Data

Figure H-6. NASA Storm Water Hydrology Model
Alternative 1B and 2A with 4.5' Levee Elevations Simulated Water Surface Elevation



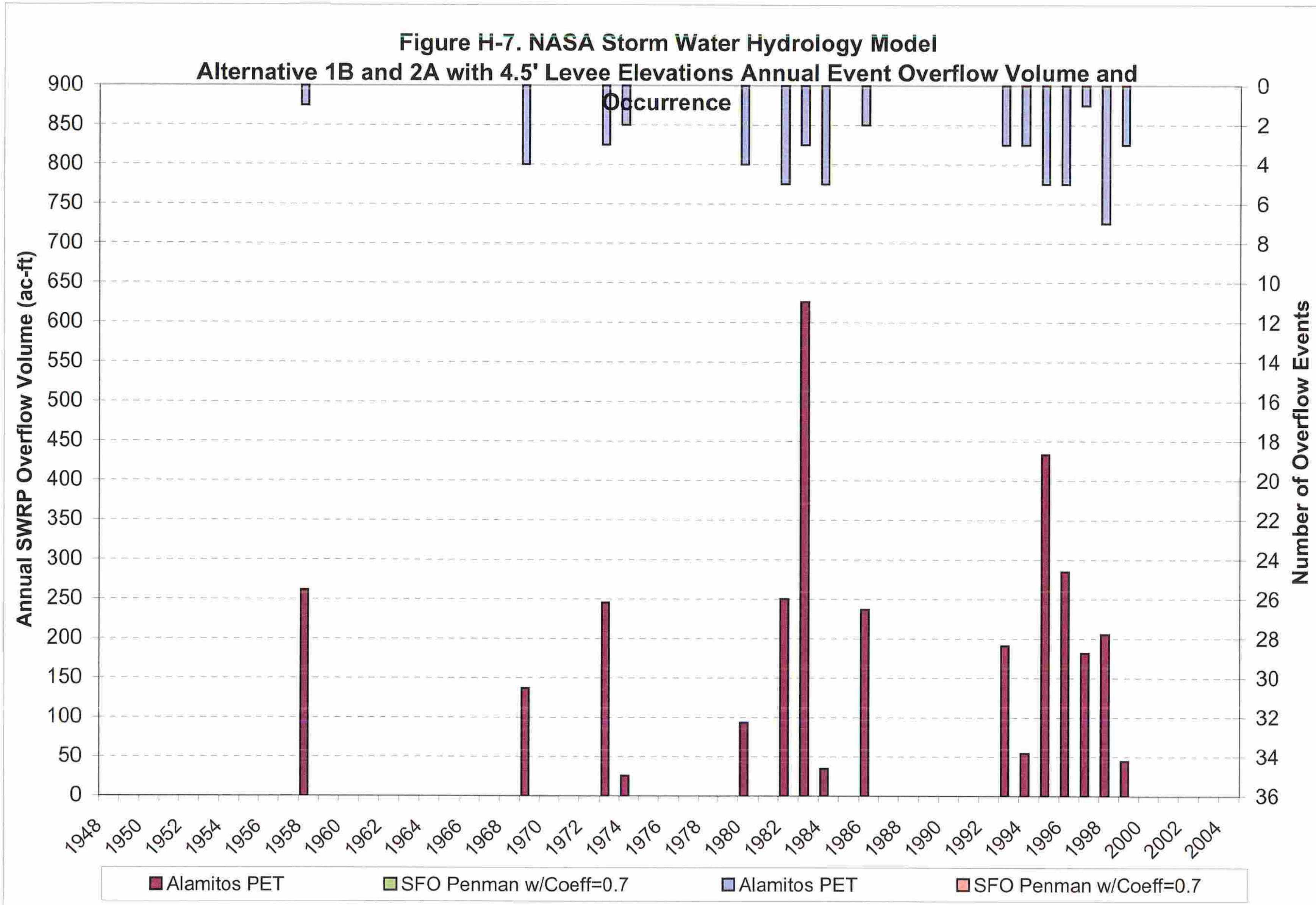


Figure H-7. NASA Storm Water Hydrology Model
Alternative 1B and 2A with 4.5' Levee Elevations Annual Event Overflow Volume and Occurrence
Annual SWRP Overflow Volume (ac-ft)
Number of Overflow Events
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
0
2
4
6
8
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1992
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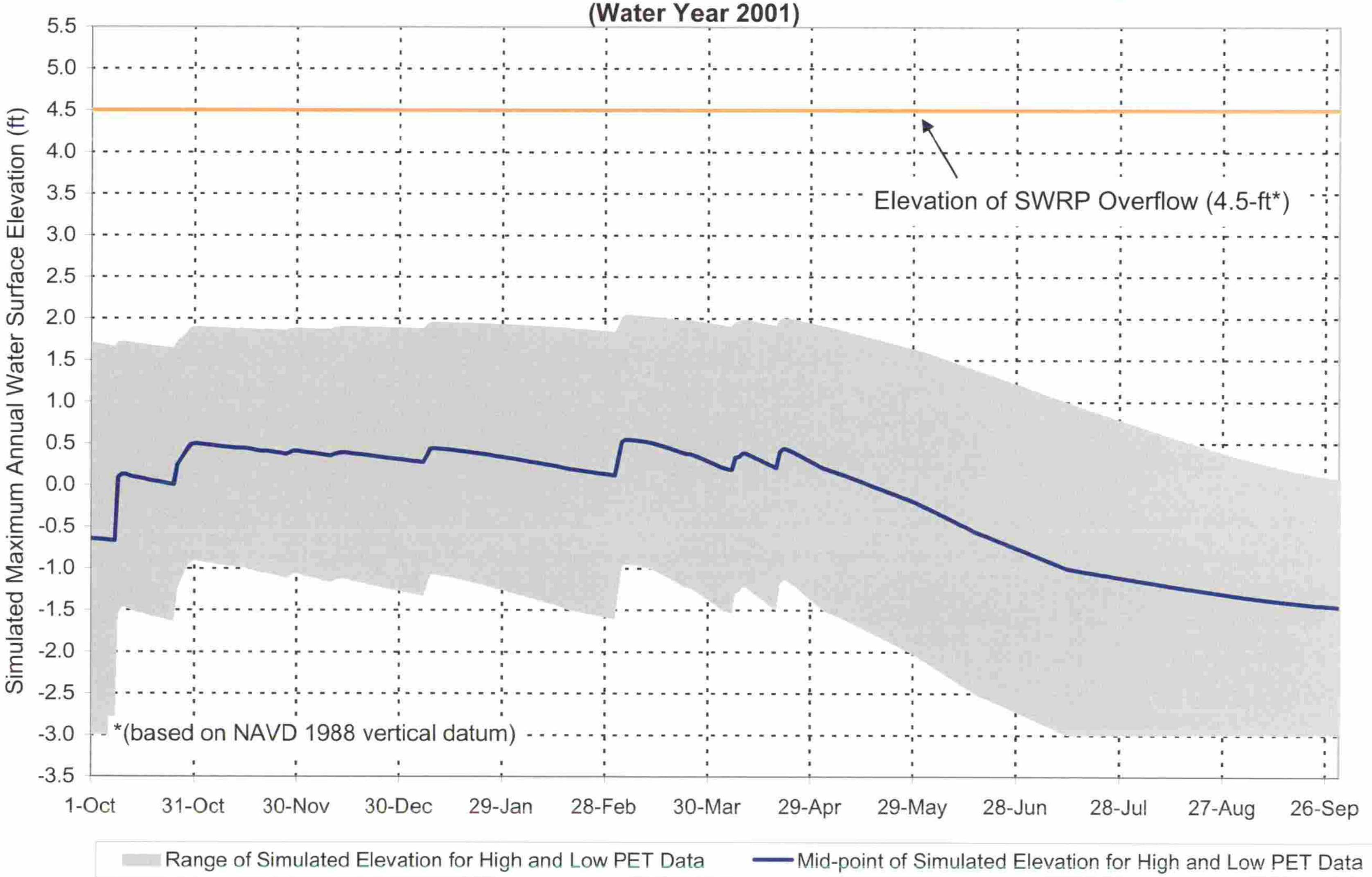
1998
2000
2002
2004
Alamitos PET
SFO Penman w/Coeff=0.7
Alamitos PET
SFO Penman w/Coeff=0.7

Figure H-8. NASA Storm Water Hydrology Model
Alternative 2A with 4.5' Levee Elevations Simulated Water Surface Elevation during a Dry Year (Water Year 2001)



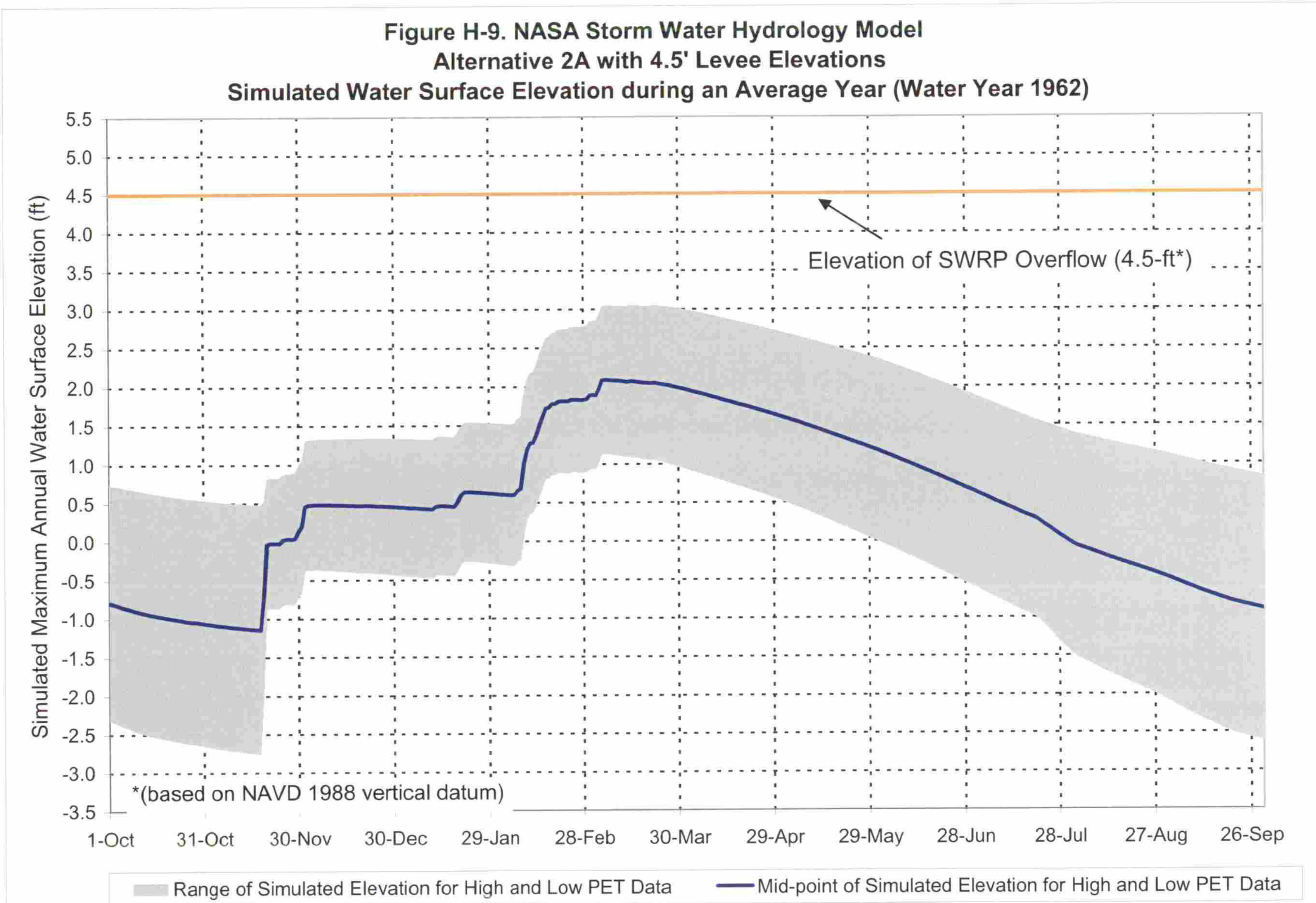


Figure H-9. NASA Storm Water Hydrology Model
Alternative 2A with 4.5' Levee Elevations
Simulated Water Surface Elevation during an Average Year (Water Year 1962)
Simulated Maximum Annual Water Surface Elevation (ft)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
Elevation of SWRP Overflow (4.5-ft*)
*(based on NAVD 1988 vertical datum)
1-Oct
31-Oct
30-Nov
30-Dec
29-Jan
28-Feb
30-Mar
29-Apr
29-May
28-Jun
28-Jul
27-Aug
26-Sep
Range of Simulated Elevation for High and Low PET Data
Mid-point of Simulated Elevation for High and Low PET Data

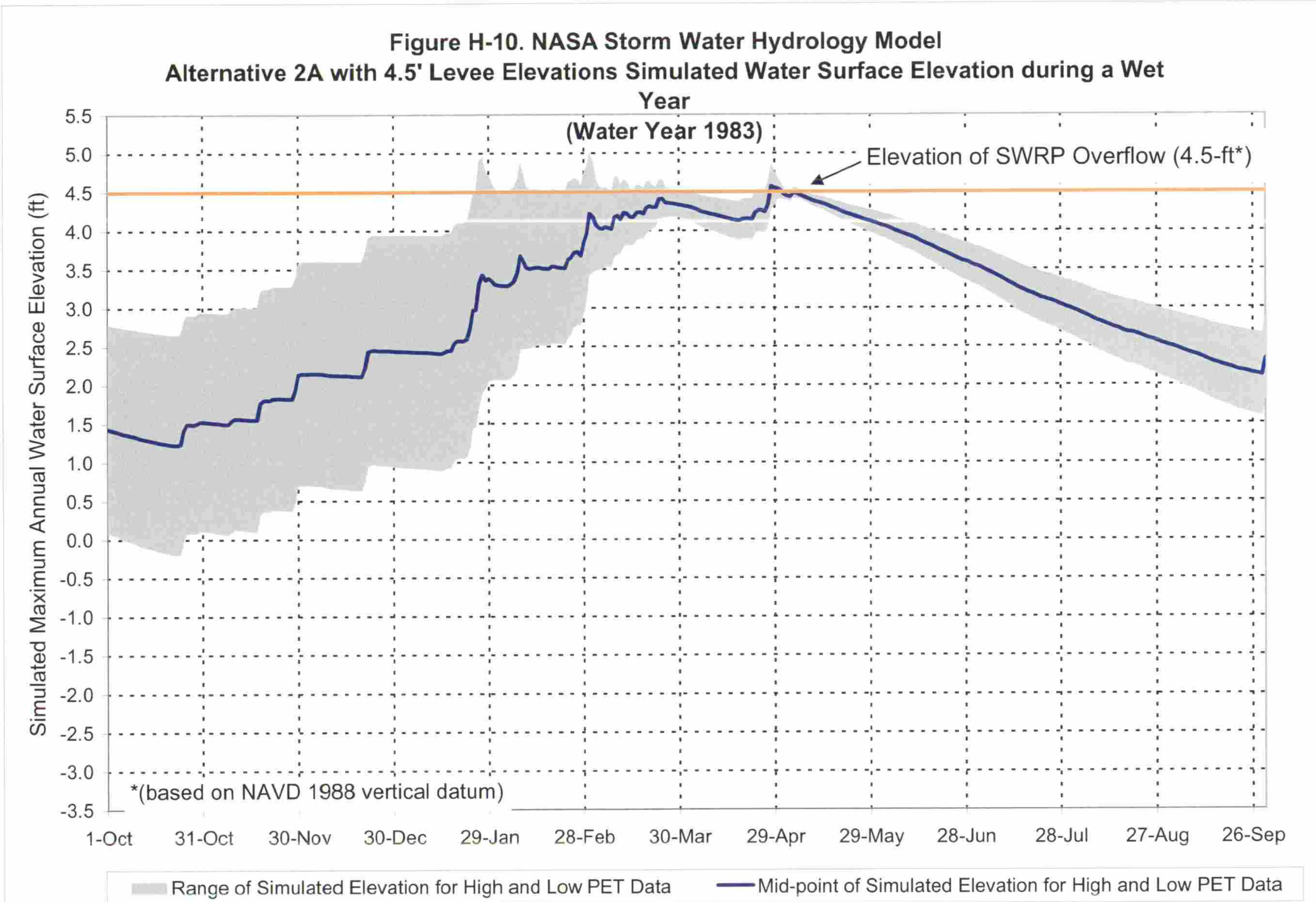


Figure H-10. NASA Storm Water Hydrology Model
Alternative 2A with 4.5' Levee Elevations Simulated Water Surface Elevation during a Wet Year
(Water Year 1983)
Elevation of SWRP Overflow (4.5-ft*)
Simulated Maximum Annual Water Surface Elevation (ft)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
*(based on NAVD 1988 vertical datum)
1-Oct
31-Oct
30-Nov
30-Dec
29-Jan
28-Feb
30-Mar
29-Apr
29-May
28-Jun
28-Jul
27-Aug
26-Sep
Range of Simulated Elevation for High and Low PET Data
Mid-point of Simulated Elevation for High and Low PET Data

Figure H-11. NASA Storm Water Hydrology Model
Alternative 1B and 2A with 5.0' Levee Elevations Simulated Water Surface Elevation

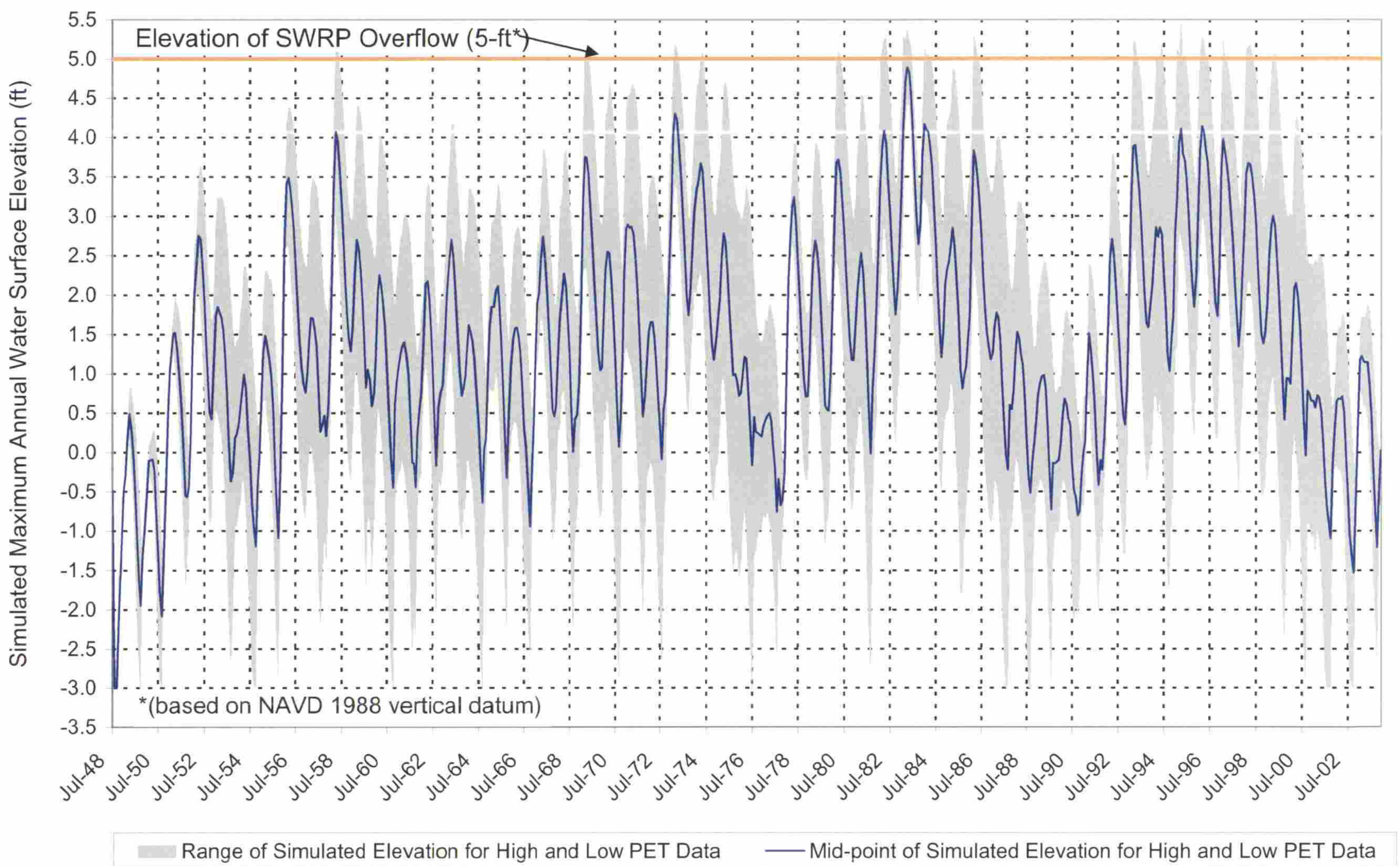
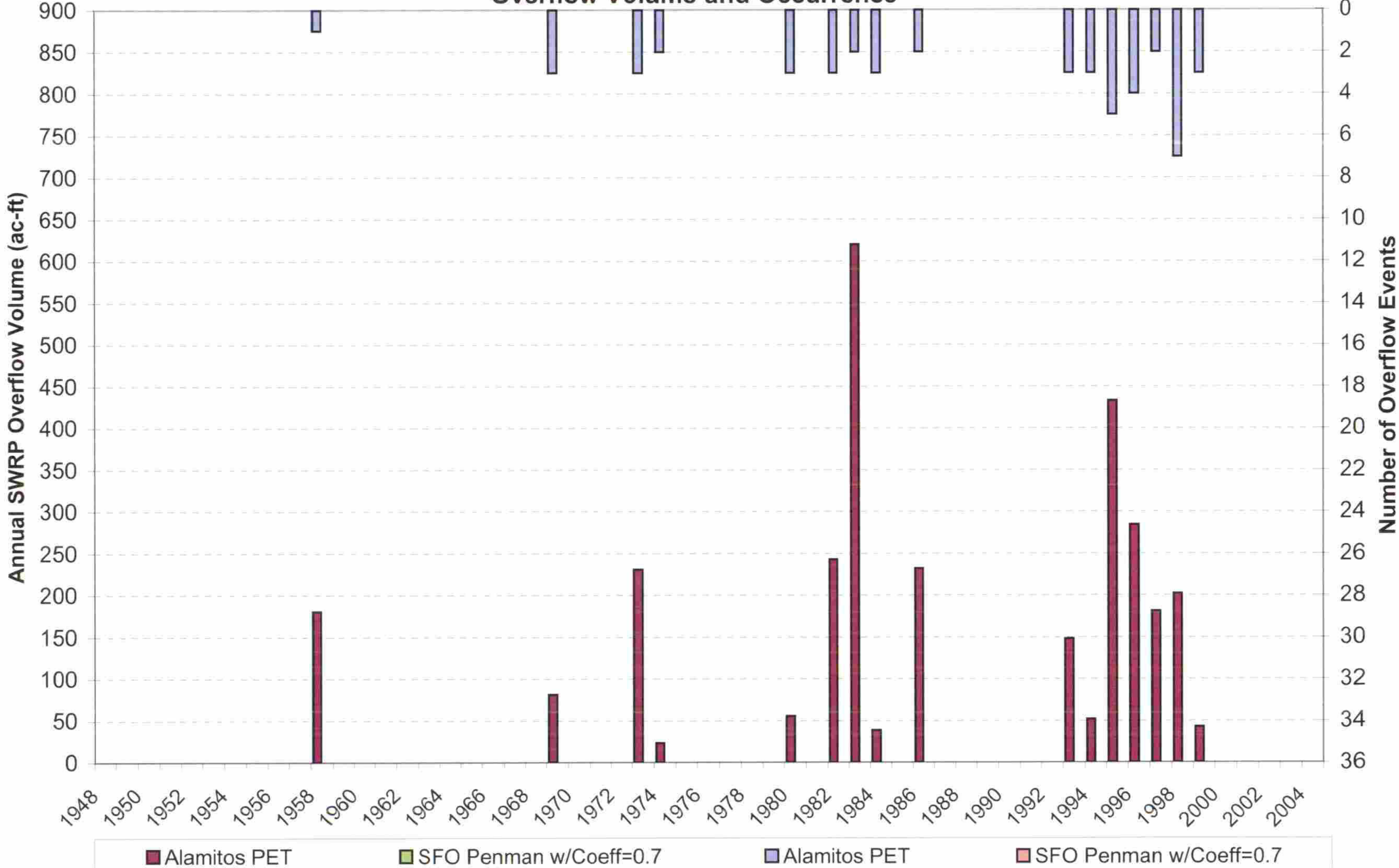


Figure H-12. NASA Storm Water Hydrology Model Alternative 1B and 2A with 5.0' Levee Elevations Annual Event Overflow Volume and Occurrence



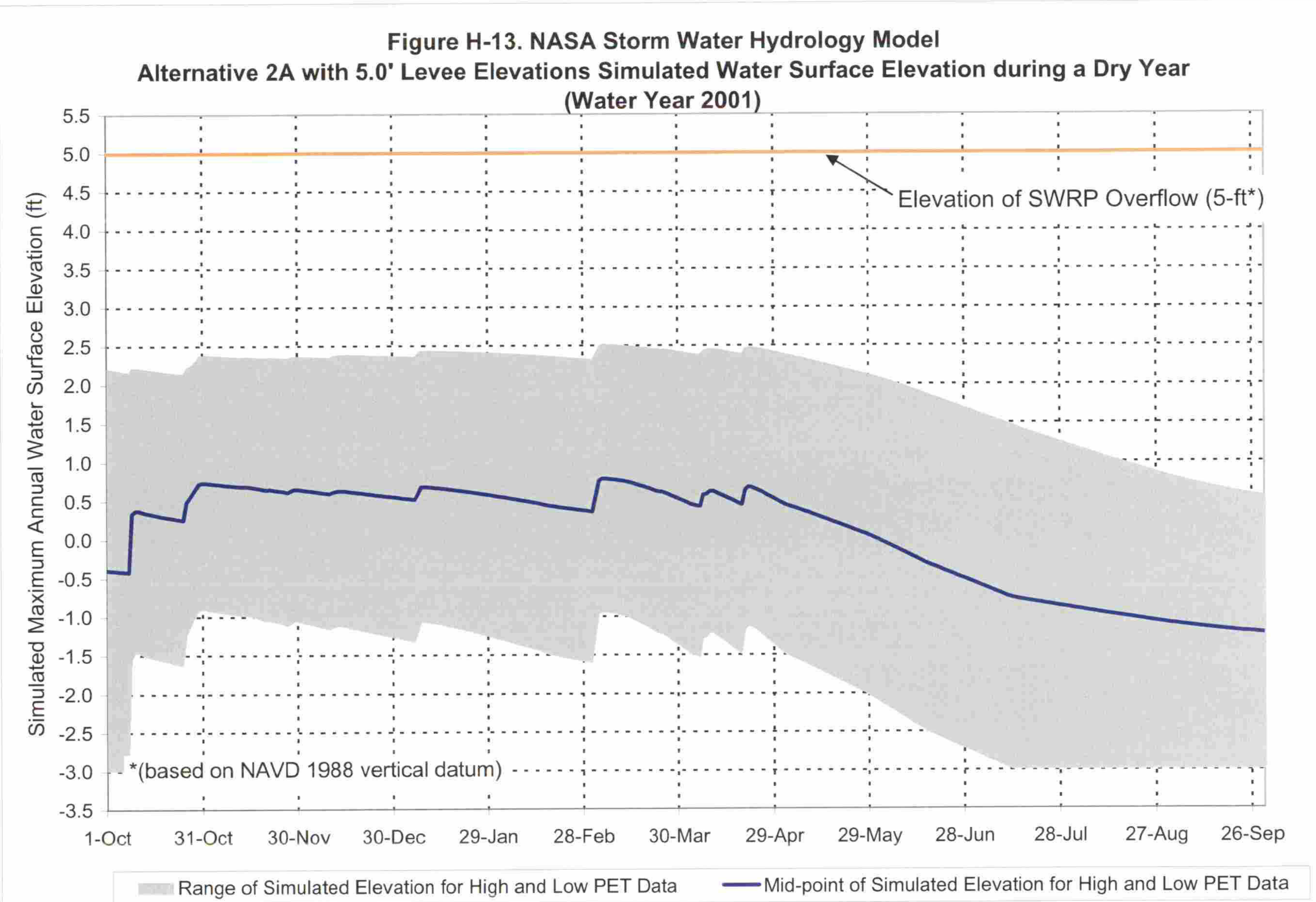


Figure H-13. NASA Storm Water Hydrology Model
Alternative 2A with 5.0' Levee Elevations Simulated Water Surface Elevation during a Dry Year
(Water Year 2001)
Simulated Maximum Annual Water Surface Elevation (ft)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
Elevation of SWRP Overflow (5-ft*)
*(based on NAVD 1988 vertical datum)
1-Oct
31-Oct
30-Nov
30-Dec
29-Jan
28-Feb
30-Mar
29-Apr
29-May
28-Jun
28-Jul
27-Aug
26-Sep
Range of Simulated Elevation for High and Low PET Data
Mid-point of Simulated Elevation for High and Low PET Data

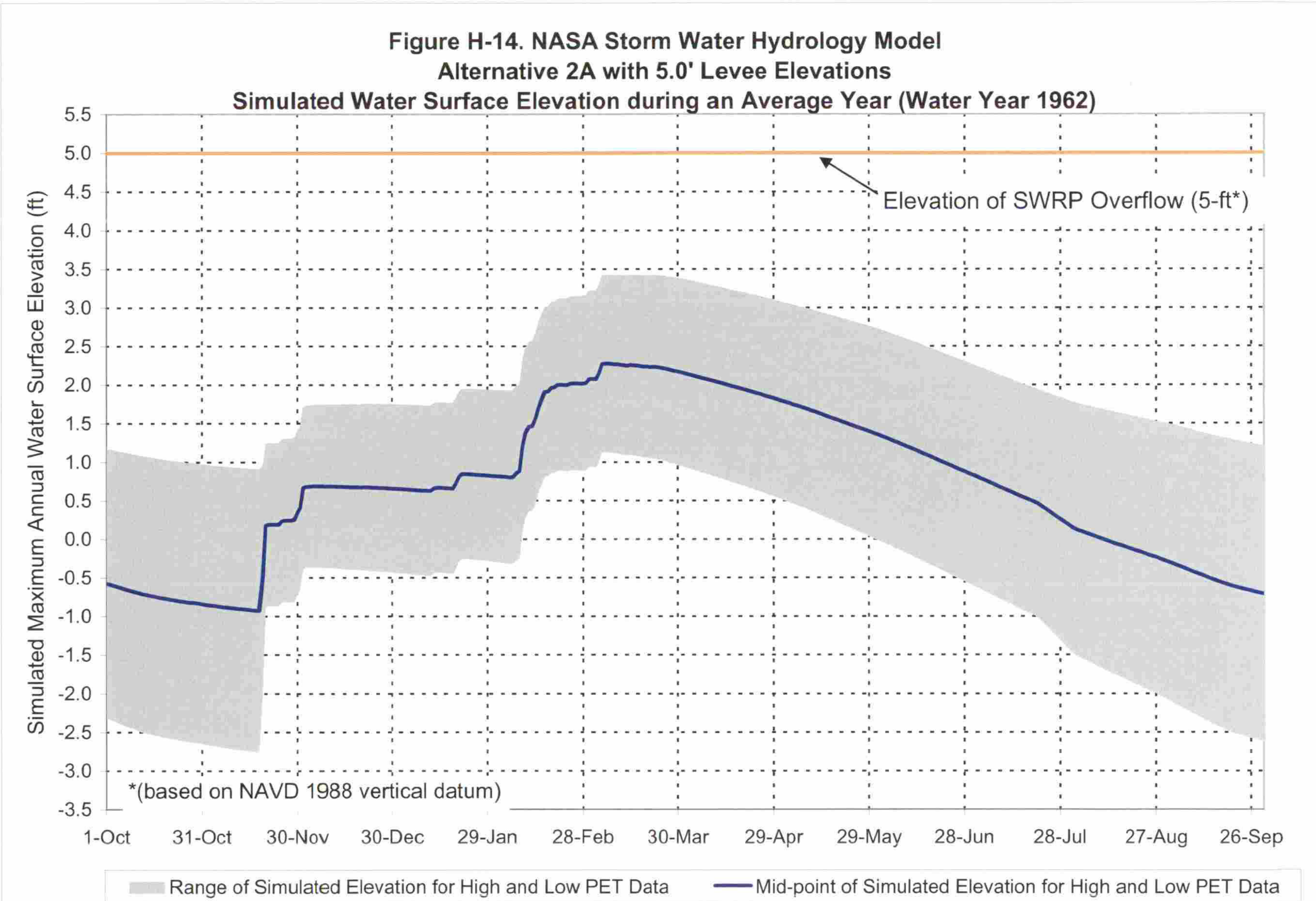


Figure H-14. NASA Storm Water Hydrology Model
Alternative 2A with 5.0' Levee Elevations
Simulated Water Surface Elevation during an Average Year (Water Year 1962)
Simulated Maximum Annual Water Surface Elevation (ft)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
Elevation of SWRP Overflow (5-ft*)
*(based on NAVD 1988 vertical datum)
1-Oct
31-Oct
30-Nov
30-Dec
29-Jan
28-Feb
30-Mar
29-Apr
29-May
28-Jun
28-Jul
27-Aug
26-Sep
Range of Simulated Elevation for High and Low PET Data
Mid-point of Simulated Elevation for High and Low PET Data

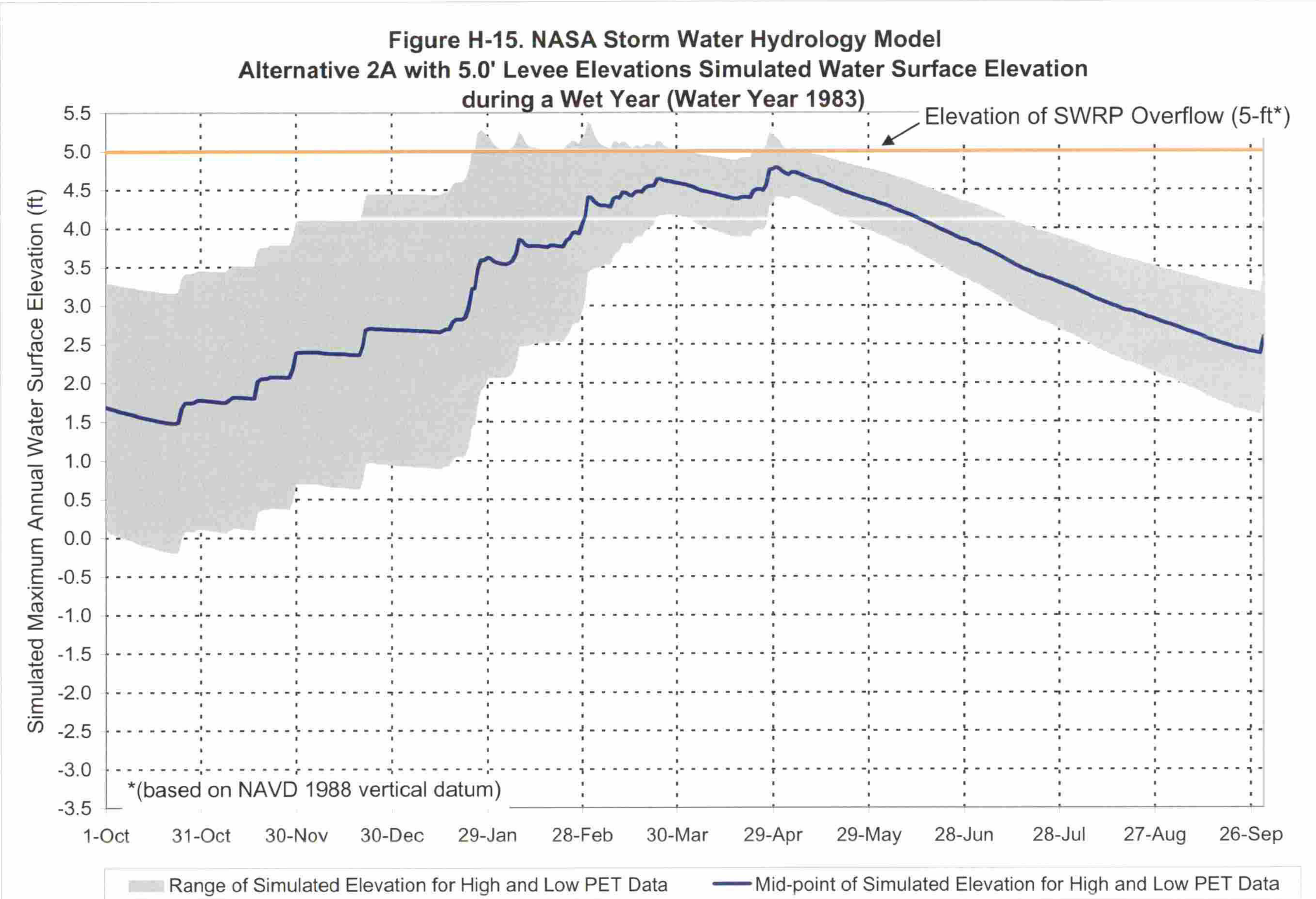


Figure H-15. NASA Storm Water Hydrology Model
Alternative 2A with 5.0' Levee Elevations Simulated Water Surface Elevation
during a Wet Year (Water Year 1983)
Elevation of SWRP Overflow (5-ft*)
Simulated Maximum Annual Water Surface Elevation (ft)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
*(based on NAVD 1988 vertical datum)
1-Oct
31-Oct
30-Nov
30-Dec
29-Jan
28-Feb
30-Mar
29-Apr
29-May
28-Jun
28-Jul
27-Aug
26-Sep
Range of Simulated Elevation for High and Low PET Data
Mid-point of Simulated Elevation for High and Low PET Data

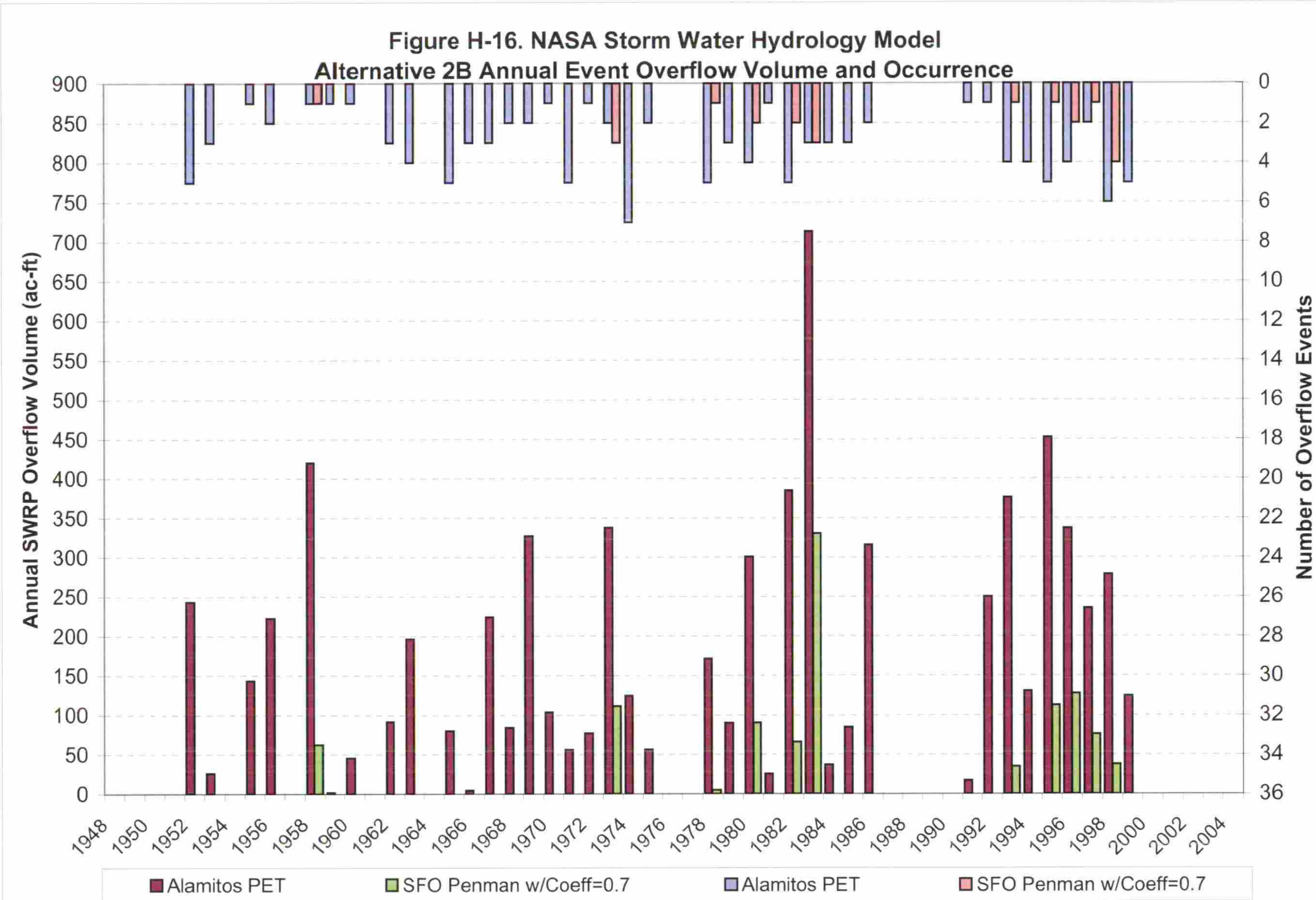


Figure H-16. NASA Storm Water Hydrology Model
Alternative 2B Annual Event Overflow Volume and Occurrence
Annual SWRP Overflow Volume (ac-ft)
Number of Overflow Events
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
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1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
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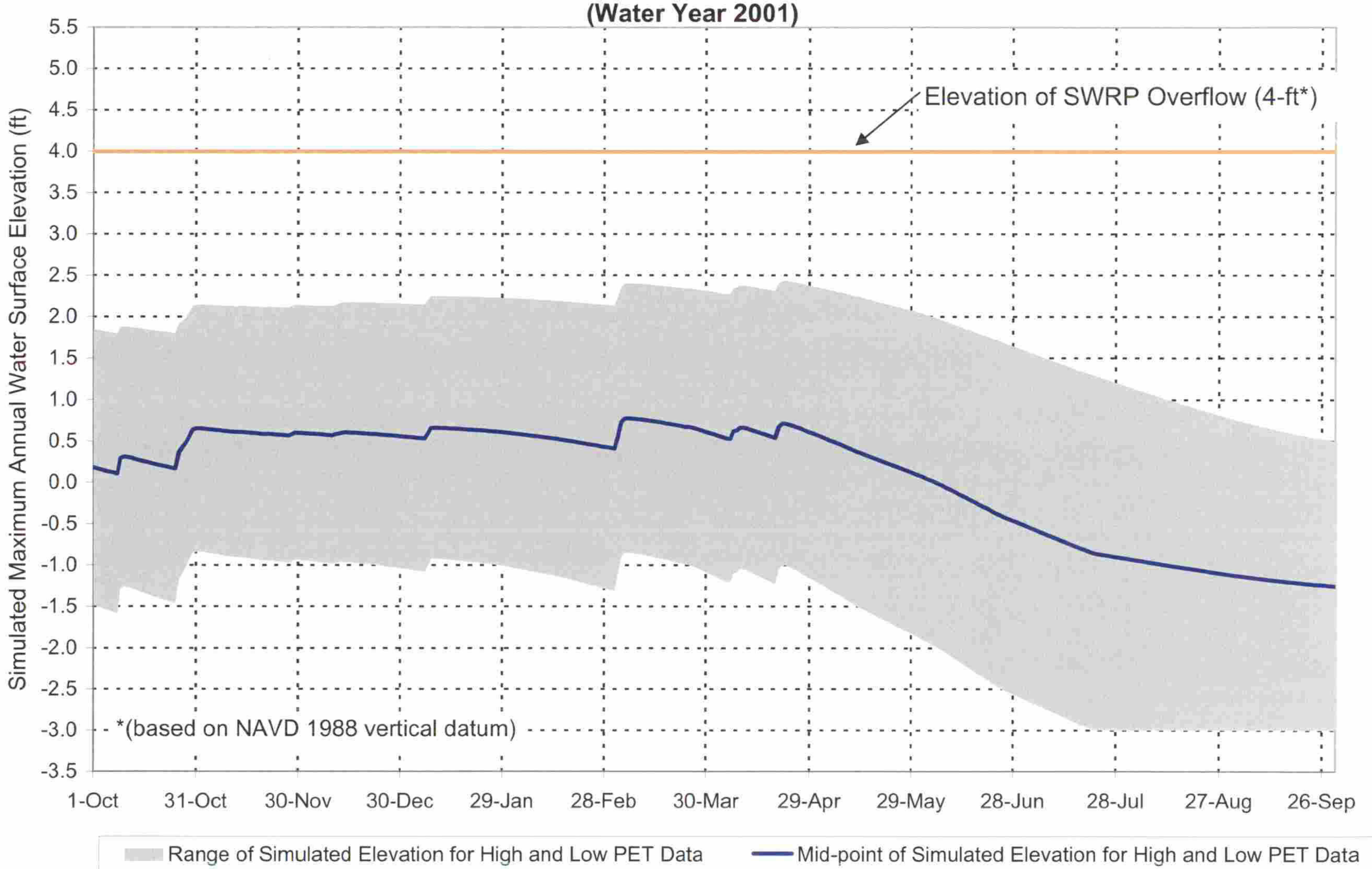
2000
2002
2004
Alamitos PET
SFO Penman w/Coeff=0.7
Alamitos PET
SFO Penman w/Coeff=0.7

Figure H-17. NASA Storm Water Hydrology Model
Alternative 2B Simulated Water Surface Elevation during a Dry Year
(Water Year 2001)



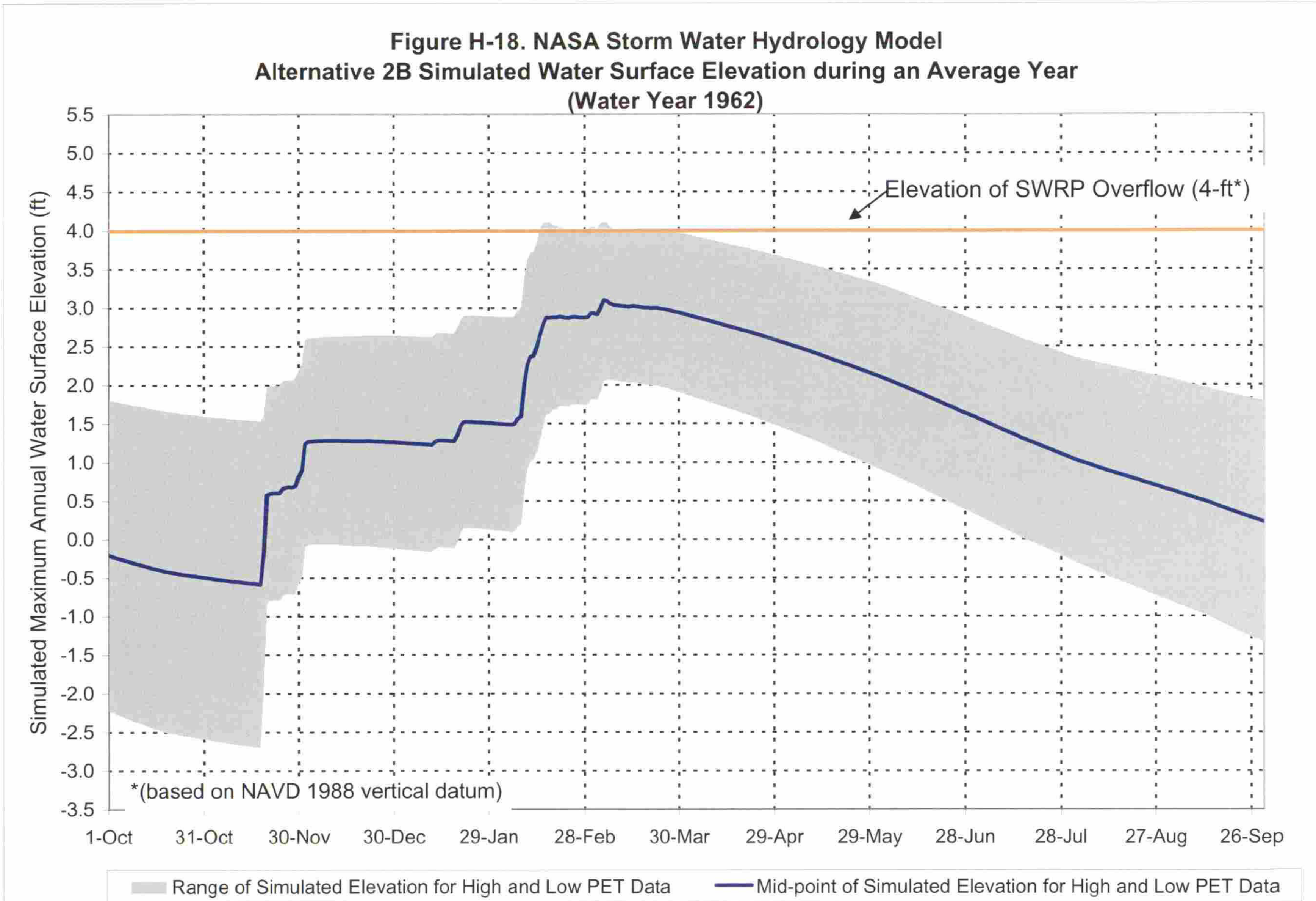
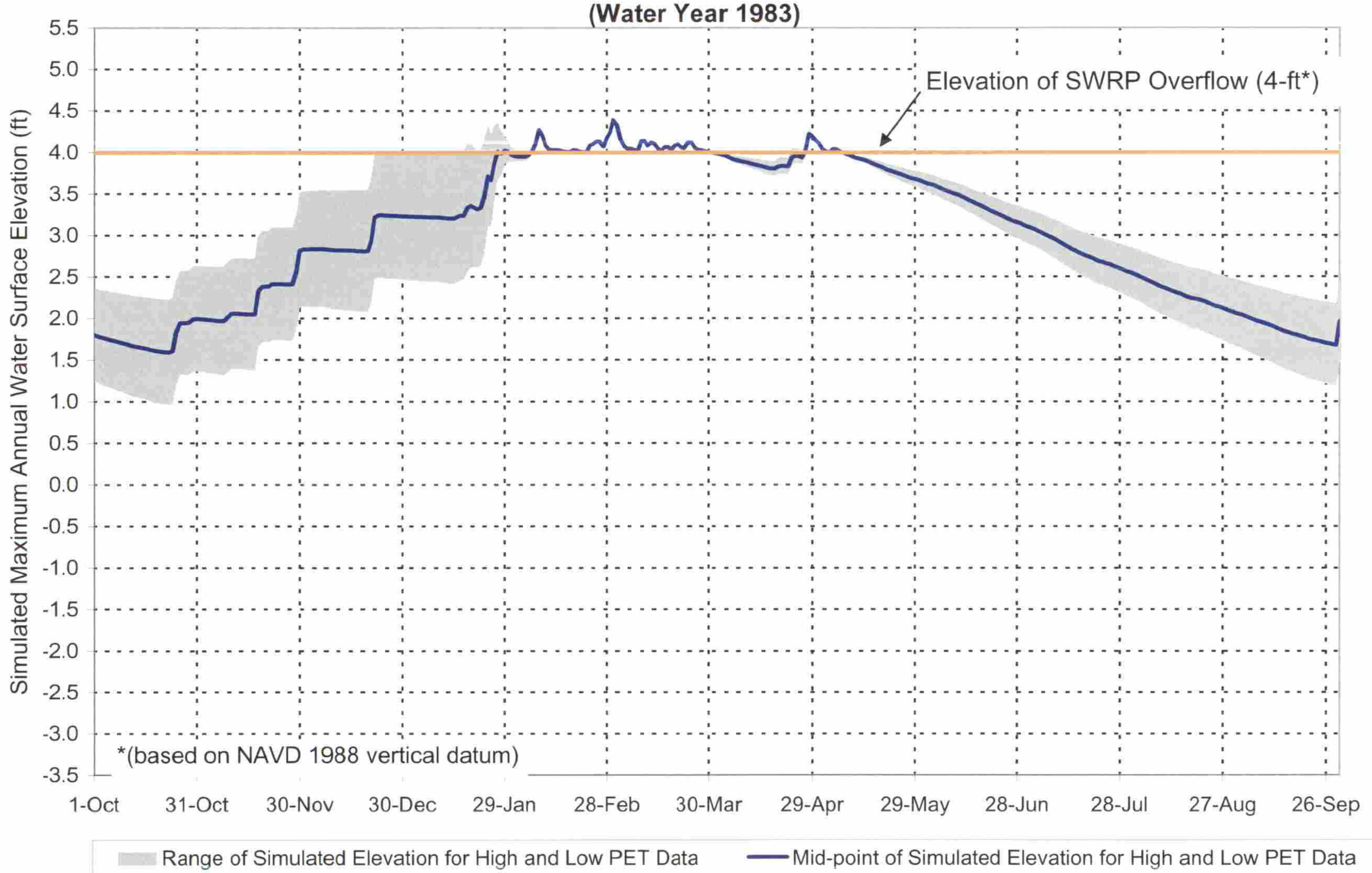


Figure H-18. NASA Storm Water Hydrology Model
Alternative 2B Simulated Water Surface Elevation during an Average Year
(Water Year 1962)
Simulated Maximum Annual Water Surface Elevation (ft)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
Elevation of SWRP Overflow (4-ft*)
*(based on NAVD 1988 vertical datum)
1-Oct
31-Oct
30-Nov
30-Dec
29-Jan
28-Feb
30-Mar
29-Apr
29-May
28-Jun
28-Jul
27-Aug
26-Sep
Range of Simulated Elevation for High and Low PET Data
Mid-point of Simulated Elevation for High and Low PET Data

Figure H-19. NASA Storm Water Hydrology Model
Alternative 2B Simulated Water Surface Elevation during a Wet Year
(Water Year 1983)



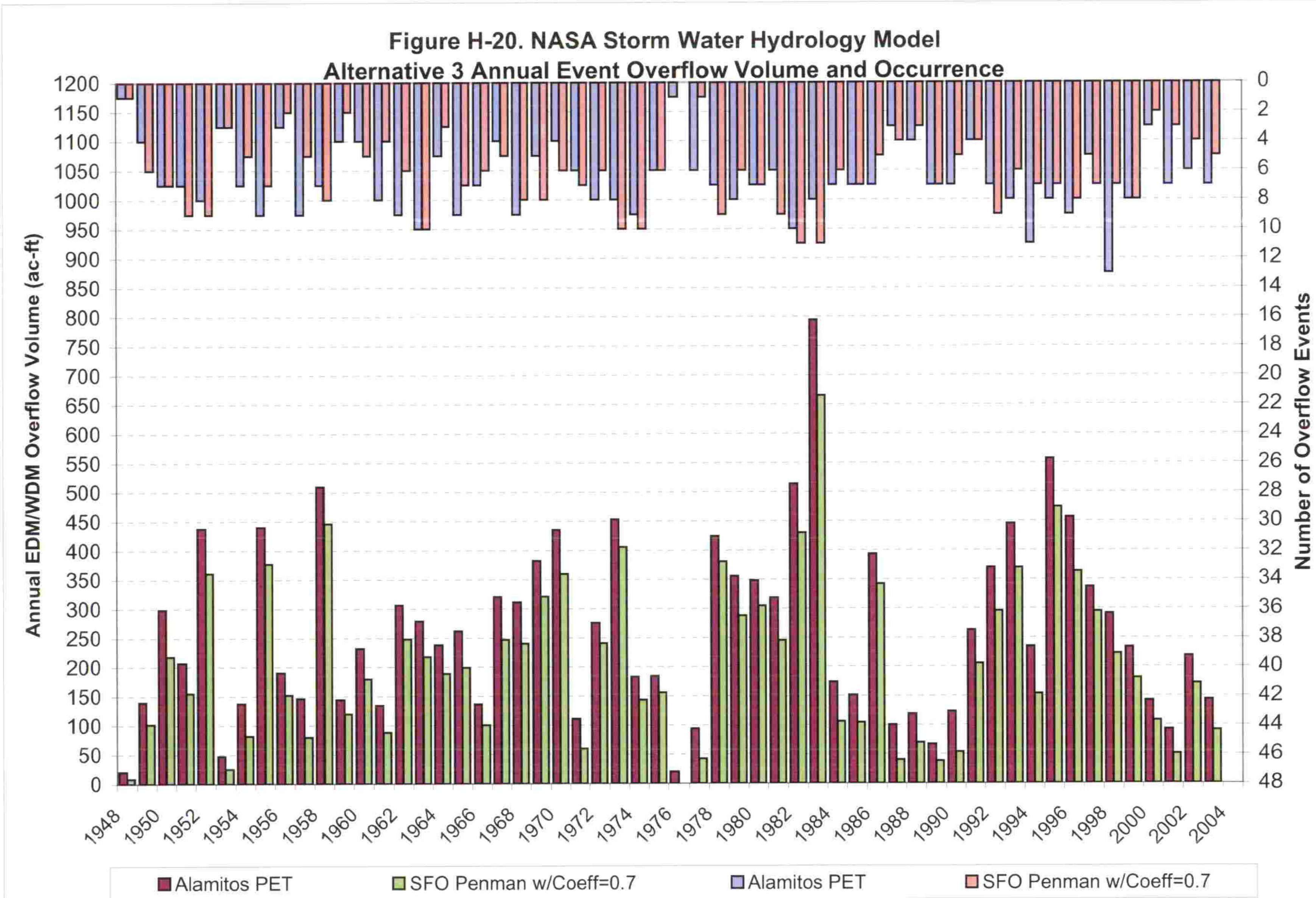


Figure H-20. NASA Storm Water Hydrology Model
Alternative 3 Annual Event Overflow Volume and Occurrence
Annual EDM/WDM Overflow Volume (ac-ft)
Number of Overflow Events
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
1050
1100
1150
1200
0
2
4
6
8
10
12
14
16
18
20
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1948
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1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
Alamitos PET
SFO Penman w/Coeff=0.7
Alamitos PET
SFO Penman w/Coeff=0.7

Figure H-21. NASA Storm Water Hydrology Model Alternative 3 Simulated Water Surface Elevation during a Dry Year (Water Year 2001)

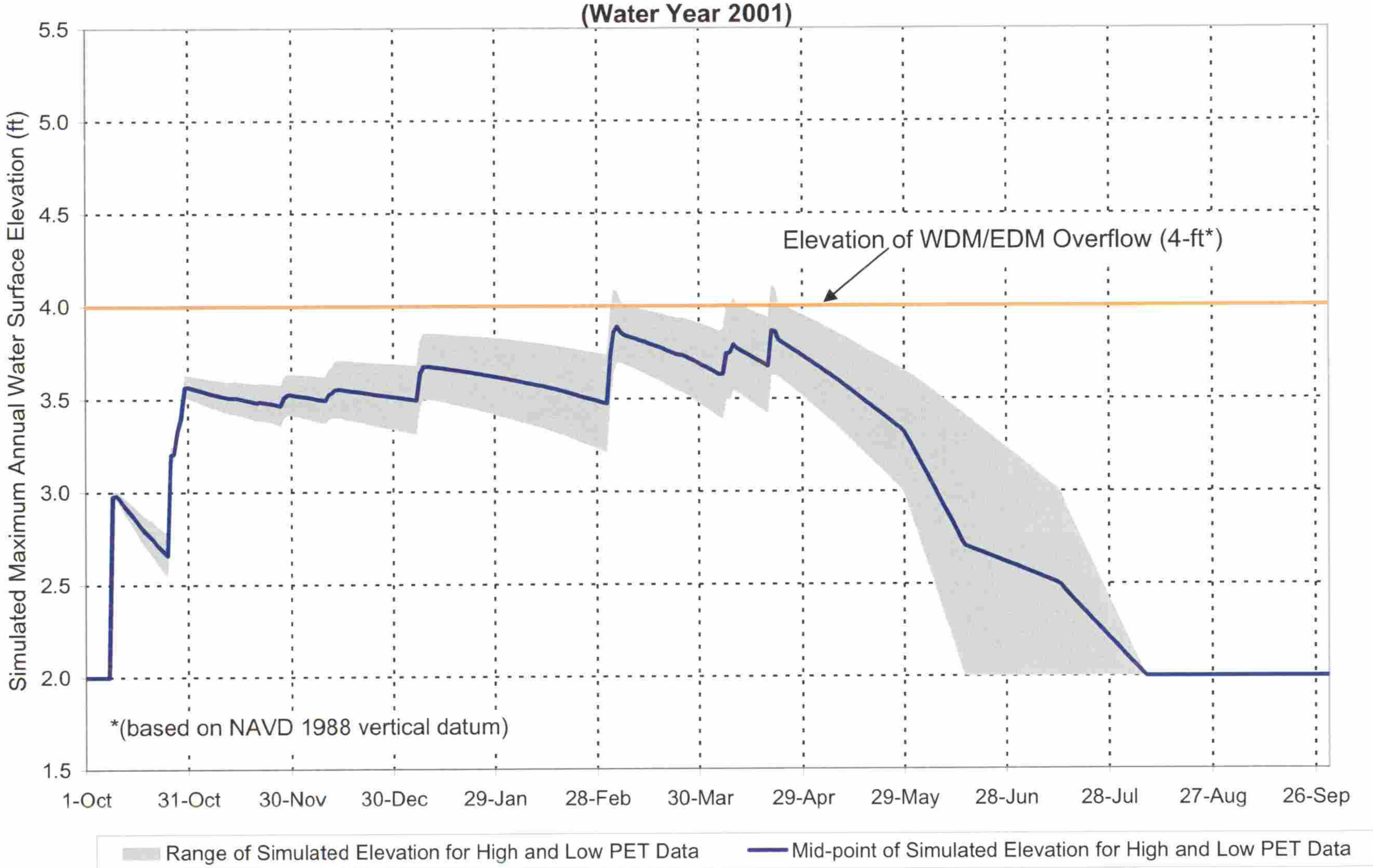

Figure H-22. NASA Storm Water Hydrology Model
Alternative 3 Simulated Water Surface Elevation during an Average Year
(Water Year 1962)

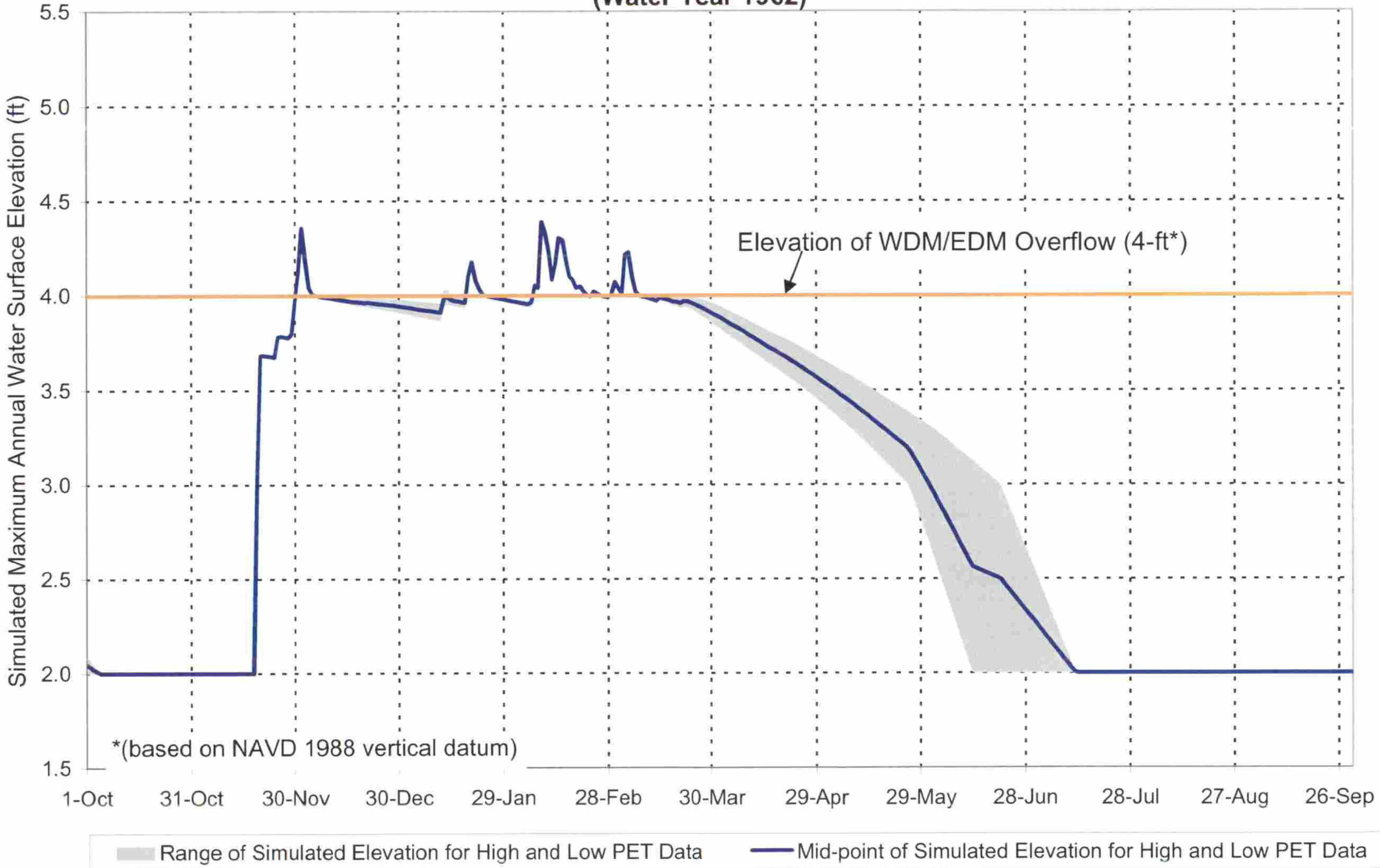

Figure H-23. NASA Storm Water Hydrology Model Alternative 3 Simulated Water Surface Elevation during a Wet Year (Water Year 1983)