Buhne Point Wetlands Preserve Mitigation and Monitoring Plan for Humboldt Bay Repowering Project,
Humboldt County, California

Prepared for

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Submitted to

Department of the Army

U.S. Army Engineer District
Sacramento Corps of Engineers
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San Francisco, California

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Contents

1.0 Overview 1-1

2.0 Existing Wetlands 2-1
2.1 Ecological Assessment of the Wetlands on Site 2-4
2.1.1 Riparian/Marsh 2-4
2.1.2 USACE Seasonal Wetlands 2-6
2.1.3 USACE Drainage Ditches.....2-6
2.1.4 California Coastal Commission One-parameter Wetlands 2-6

3.0 Mitigation Sites.....3-1
3.1 Ecological Assessment Of The Proposed Mitigation Areas 3-4
3.2 MIT-1 Ecological Assessment.....3-6
3.2.1 MIT-1 Wetland Creation Goals, Objectives, and Performance standards.....3-7
3.2.2 Engineering plans.....3-8
3.2.3 Comprehensive vegetation specifications.....3-8
3.2.4 MIT-1 Implementation Plan 3-16
3.3 MIT-2 Ecological Assessment.....3-17
3.3.1 MIT-2 Wetland Creation Goals, Objectives, and Performance Standards 3-18
3.3.2 Concept drawings and design rationale 3-18
3.3.3 Engineering plans.....3-19
3.3.4 Comprehensive vegetation specifications.....3-19
3.3.5 MIT-2 Implementation Plan 3-19
3.4 MIT-3 Ecological Assessment.....3-20
3.4.1 MIT-3 Wetland Restoration Goals, Objectives, and Performance standards.....3-22
3.4.2 Concept drawings and design rationale 3-23
3.4.3 Engineering plans.....3-23
3.4.4 Comprehensive vegetation specifications.....3-23
3.4.5 MIT-3 Implementation Plan 3-23
3.5 MIT-4 Ecological Assessment.....3-24
3.5.1 MIT-4 Wetland Restoration Goals, Objectives, and Performance Standards 3-25
3.5.2 Concept drawings and design rationale 3-25
3.5.3 Engineering plans.....3-26
3.5.4 Comprehensive vegetation specifications.....3-26
3.5.5 MIT-4 Implementation Plan 3-26
3.6 MIT-5 Ecological Assessment (Mitigation Area for SDPP) 3-27
3.6.1 MIT-5 Enhancement Mitigation Goals, Objectives, and Performance standards.....3-27
3.6.2 Concept drawings and design rationale: 3-28

3.6.3 Engineering plans....3-28
3.6.4 Comprehensive vegetation specifications....3-28
3.6.5 MIT-5 Implementation Plan....3-28
3.7 REST-1 Ecological Assessment....3-29
3.7.1 REST-1 Mitigation Restoration Goals, Objectives, and Performance Standards....3-31
3.7.2 Concept drawings and design rationale....3-31
3.7.3 Engineering plans....3-31
3.7.4 Comprehensive vegetation specifications....3-31
3.7.5 REST-1 Implementation Plan....3-33

4.0 Monitoring program....4-1

5.0 Mitigation Implementation and Monitoring Timeline....5-1

6.0 Remedial Action Plan....6-1

7.0 Operations and Maintenance Plan....7-1

8.0 References....8-1

Tables

1 USACE and CCC Verified Wetland Areas, Impacts, and Proposed Mitigation (acres)
2 Dominant plant species in one-parameter wetlands and their status as wetland indicators
3 On-Site Wetland Mitigation Areas
4 Suggested Native Plant Species for Revegetation Plantings
5 Wetland tree and shrub suitable for landscape plantings
6 Timeline for Wetlands Mitigation and Monitoring

Figures

1 Regional Location Map
2 Wetland Delineation Revised March 2007
3 Wetland Mitigation Areas MIT-1 through MIT-5 Under Deed Restriction
4 Restoration Area (REST-1) Not Under Deed Restriction
5 Wetland Mitigation Areas MIT-1 through MIT-5
6A Mitigation 1 – Cross Section A-A'
6B Mitigation 1 – Cross Section B-B'
6C Mitigation 2 – Cross Section C-C'
6D Mitigation 2 – Cross Section D-D'
6E Mitigation 2 – Cross Section E-E'
7 Mitigation 3 – Tidal Zones and Existing Vegetation
8 Landscape Plan within REST-1

SECTION 1

Overview

A delineation of waters of the United States (U.S.) (including wetlands) was conducted by CH2M HILL for Pacific Gas and Electric (PG&E) on a land parcel adjacent to Humboldt Bay near Eureka, California (Figure 1). PG&E owns 143 acres at the Humboldt Bay Power Plant property, which incorporates five existing power generation units including 2 natural gas-fired steam generating units; a currently inoperable nuclear plant (Unit 3) and 2 small turbines known as the Mobile Emergency Power Plants (MEPPs). These power generation units are collectively known as the Humboldt Bay Power Plant. The PG&E property located in unincorporated Humboldt County is entirely within the California Coastal Zone, and zoned Coastal-Dependent Industrial. PG&E is proposing to construct the Humboldt Bay Repowering Project (HBRP), a new natural gas-fired power plant south of the existing Humboldt Bay Power Plant within the PG&E property boundary (Figure 1).

Impacts to wetland habitats from HBRP construction are proposed to be mitigated through on-site wetland creation, restoration, and enhancement within the newly developed Buhne Point Wetlands Preserve (Preserve) in the western portion of the PG&E property (Figures 1 and 2).

The detailed HBRP project description is presented in the Application For Certification (AFC) (PG&E 2006). A brief summary description of the HBRP impacts to wetlands is included in Section 2.0 of this plan.

PG&E has other projects besides HBRP that will occur on the property prior to, during, and after HBRP construction. One of those projects, called the Site Decommissioning Preparatory Project (SDPP), will require the temporary use of portions of the access and laydown areas proposed for HBRP. The SDPP includes construction of a new 12kV transmission line and trailer, all of which is within the impact area for HBRP, to facilitate decommissioning portions of Unit 3. The SDPP will be constructed prior to the start of HBRP in Fall 2007 (with HBRP construction starting Spring 2008) and is mentioned here because the mitigation for that project (MIT-5) is in an area surrounded by the mitigation areas for HBRP. In addition, the management and annual monitoring of the Buhne Point Wetlands Preserve will include the mitigation areas for both the HBRP and SDPP projects together.

The wetland delineation was conducted in 2006 within a 55-acre portion of the 143-acre PG&E property (PG&E 2006); which excluded open waters of the Bay and the existing nuclear power facility (Unit 3) as it was restricted from access and surveys. The California Coastal Commission (CCC) retains jurisdiction over wetland habitats in the Coastal Zone, which include wetlands under the jurisdiction of the U.S. Army Corps of Engineers (USACE), as well as areas that have one or more wetland parameters typically not regulated by USACE (CCC, 1994). CCC wetlands with boundaries extending beyond the USACE 3-parameter method were defined only on the presence of positive criteria for hydrophytic vegetation, as all other wetlands are included under the USACE definition.

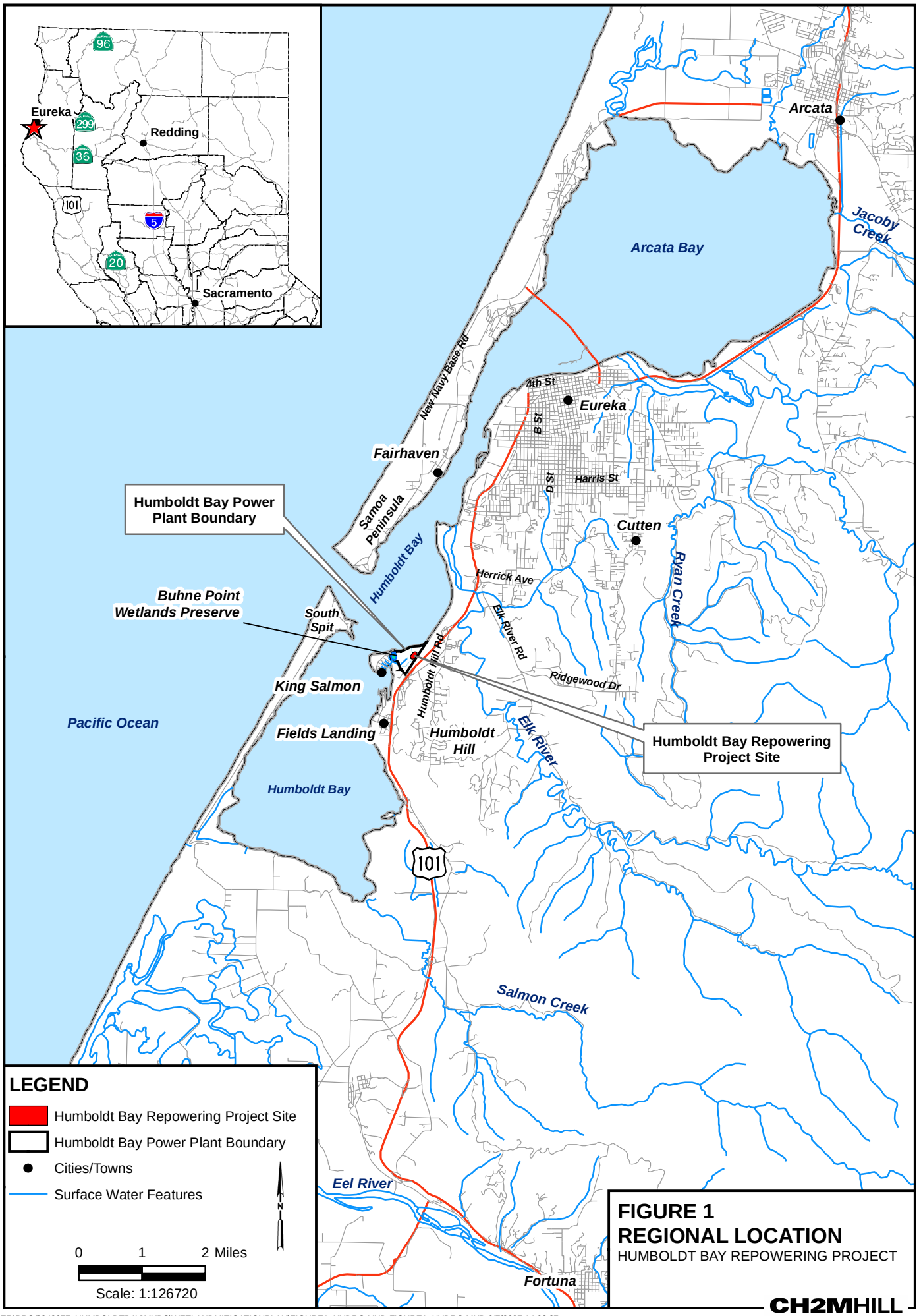

FIGURE 1
REGIONAL LOCATION
HUMBOLDT BAY REPOWERING PROJECT

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\\GLACIER\PROJ\342077_HUMBOLDTBAY\MXDS\WETLANDMITIGATIONPLAN\FIGURE1_HYDRO.MXD FIGURE1_HYDRO.MXD 6/7/2007 14:03:37

The comprehensive wetland delineation was submitted to the USACE and CCC December 1, 2006. A USACE scientist conducted a site wetland verification on February 1, 2007. A revised USACE delineation was submitted on March 1, 2007, which added two small seasonal wetland areas (approximately 0.012 acre). The wetland delineation was verified by the USACE on May 2, 2007 (USACE File No. 400205N). The CCC scientist verbally verified wetlands mapped at the HBRP site during a site visit on February 1, 2007. This wetland mitigation and monitoring plan reflects these verified wetland boundaries and acreages and addresses the wetland areas under both USACE and/or CCC jurisdiction.

SECTION 2

Existing Wetlands

A total of 26.362 acres of CCC and USACE wetlands are on the PG&E 55-acre survey area (Figure 2). Of these 22.649 will be avoided during construction and operation of HBRP. A total of 12.6 acres of land encompassing 3.71 acres of USACE and CCC wetland habitats will be used for construction of HBRP.

The permanent footprint of HBRP requires 5.4 acres of developed and landscape/grassland areas (Figure 2), which will result in the permanent loss of 0.223 acre of USACE and 0.961 acre of CCC wetland habitats (totaling 1.184 acres) on the PG&E property.

The temporary laydown, parking, and access road needed during the construction period requires 7.2 acres of developed and landscape/grassland areas, which will result in temporary disturbance to 0.032 acre of USACE and 2.49 acres of CCC wetland habitats (totaling 2.526 acres) on the PG&E property.

This mitigation plan outlines the enhancement, creation, and restoration of wetlands within the PG&E property to compensate for 2.526 acres of temporary impacts and 1.184 acres of permanent impacts (see Table 1) that would occur during construction of HBRP.

All 1.184 acres of permanent impacts to USACE and CCC wetland will be mitigated through on-site creation of 1.64 acres of in-kind and out-of kind wetlands within Mitigation Area 1 and Mitigation Area-2 (MIT-1 and MIT-2).

All 2.526 acres of temporary impacts to USACE and CCC wetlands will be mitigated on-site concurrently with project construction through enhancement and restoration of 3.52 acres of wetlands within Mitigation Area –3 and Mitigation Area –4 (MIT-3 and MIT-4). The 2.526 acres of temporary impacts include a 0.819-acre portion of the HBRP temporary construction laydown area that will be used for demolition of existing structures on the Humboldt Bay Power Plant site (identified as the SDPP above). The SDPP will occur in Fall 2007 prior to the start of HBRP construction in Spring 2008. As previously mentioned above, the small, temporary impacts (0.117 acre) from SDPP are entirely within the impact area for HBRP and MIT-5 is expected to fulfill the mitigation requirements for those impacts. MIT-5 is 0.13 acre in size and will be monitored and managed as part of the Buhne Point Wetlands Preserve. This wetland mitigation and monitoring plan is being prepared to compensate for those specific impacts from HBRP, however, the description of MIT-5 is included as it will be part of the Buhne Point Wetlands Preserve. Permits from the USACE and North Coast Regional Water Quality Control Board (NCRWQCB) for the unavoidable impacts to wetlands from both HBRP and SDPP will be obtained for both projects combined prior to the start of construction.

The resulting mitigation for impacts from HBRP and SDPP will result in a total 5.60 acres of contiguous created and existing enhanced wetland habitats within MIT-1, MIT-2, MIT-3, MIT-4, and MIT-5 (Figure 3) that will be preserved in perpetuity under a deed restriction on the PG&E property.

Wetland	Acres
Coastal Commission Wetlands	
CCW-1	0.59
CCW-2	1.15
CCW-3	0.09
CCW-4	0.98
CCW-5	0.04
CCW-6	0.16
CCW-7	0.09
CCW-8	0.02
CCW-9	1.32
CCW-10	0.13
CCW-11	1.11
Total:	5.69
Drainage Ditch	
DD-1	0.124
DD-2	0.049
DD-3	0.006
DD-4	0.038
DD-5	0.021
DD-6	0.034
DD-7	0.02
DD-8	0.014
Total:	0.306
Freshwater Marsh	
FM-1	2.345
Riparian Marsh	
RM-1	1.573
Salt Marsh	
SM-1	0.299
SM-2	1.812
SM-3	8.915
SM-4	0.362
SM-5	2.255
SM-6	2.471
Total:	16.114
Seasonal Wetlands	
SW-1	0.104
SW-2	0.059
SW-3	0.002
SW-4	0.006
SW-5	0.043
SW-6	0.032
SW-7	0.018
SW-8	0.016
SW-9	0.002
SW-10	0.008
SW-11	0.008
SW-12	0.007
SW-13	0.005
SW-14	0.012
SW-15	0.011
Total:	0.333
Grand Total USACE Wetlands:	26.36

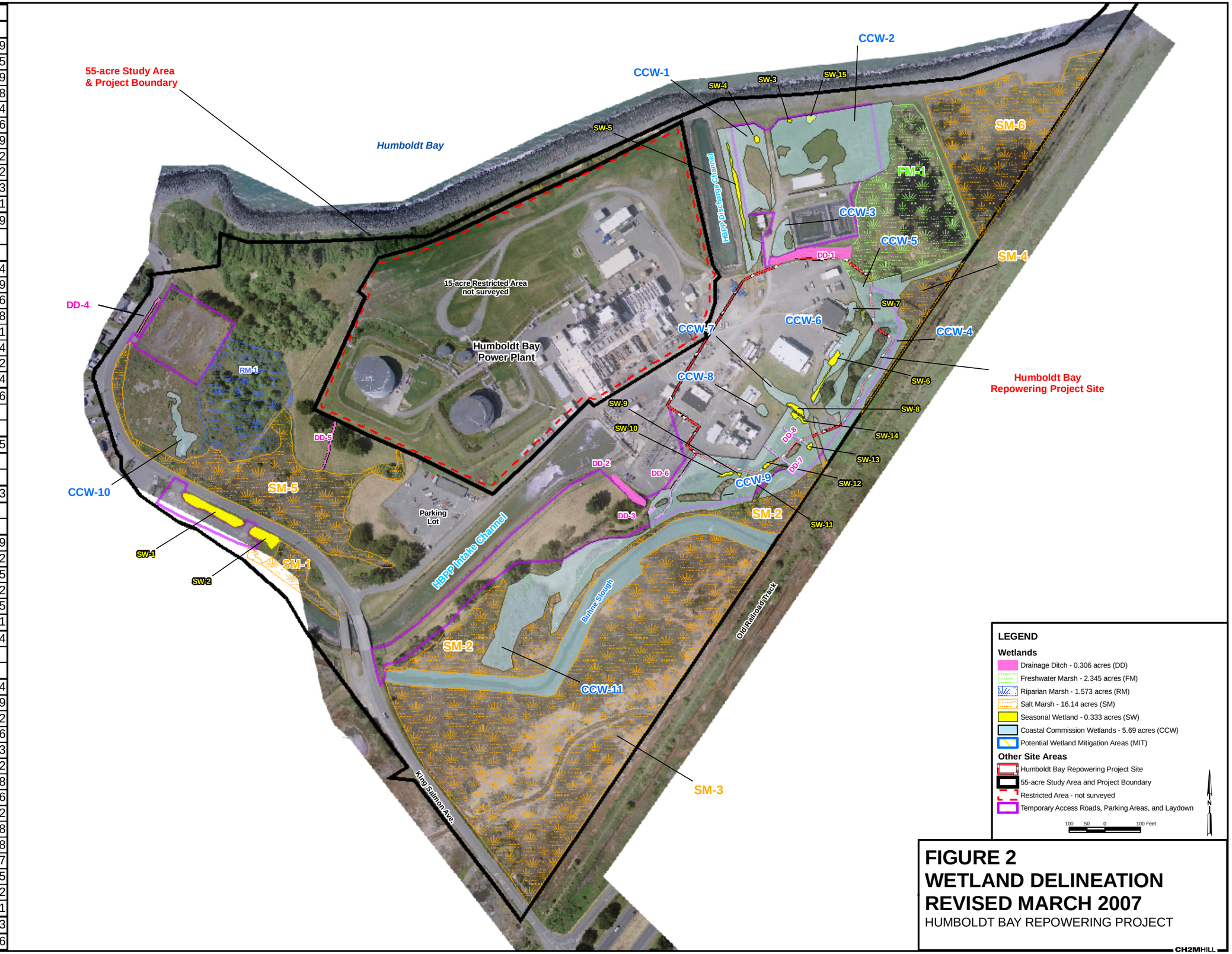

FIGURE 2
WETLAND DELINEATION
REVISED MARCH 2007
HUMBOLDT BAY REPOWERING PROJECT

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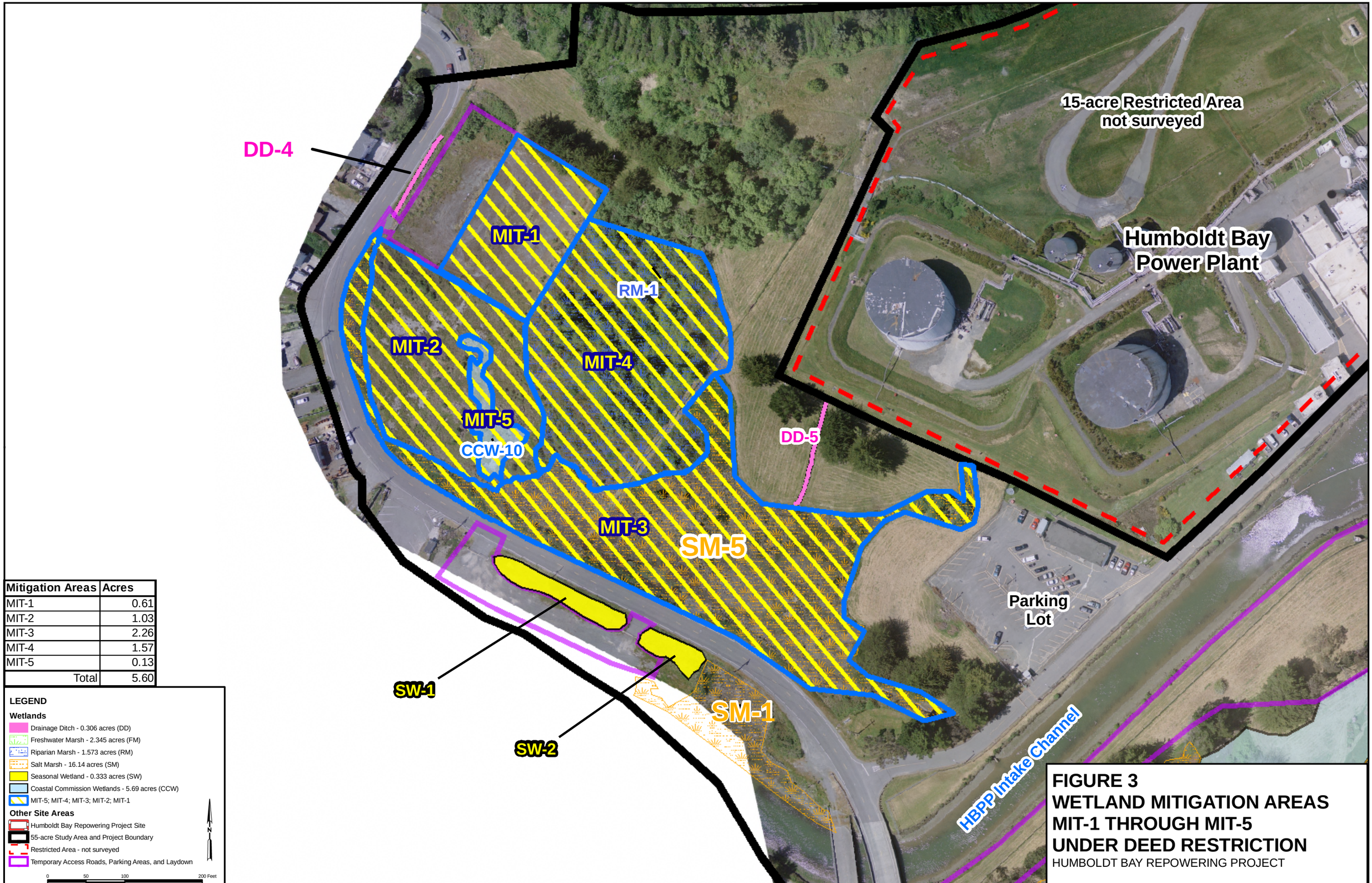


Mitigation Areas	Acres
MIT-1	0.61
MIT-2	1.03
MIT-3	2.26
MIT-4	1.57
MIT-5	0.13
Total	5.60

FIGURE 3
WETLAND MITIGATION AREAS
MIT-1 THROUGH MIT-5
UNDER DEED RESTRICTION
HUMBOLDT BAY REPOWERING PROJECT

\\GLACIER\PROJ\342077_HUMBOLDTBAY\MXD\SWETLANDMITIGATIONPLAN\FIGURE3.MXD FIGURE3.PDF 6/7/2007 16:19:14

As part of restoring temporary HBRP and SDPP construction disturbance areas on the PG&E property, an additional 1.19 acres of grasslands along the temporary access road will be restored to grassland with facultative vegetation to create CCC wetland habitat in REST-1 after HBRP construction is complete (Figure 4). This area will also incorporate the HBRP stormwater outfall with a new wetland bio swale but, these areas will not be included under a deed restriction as the area supports underground pipelines and transmission lines that may require maintenance in the future.

A total of 6.79 acres of mitigation area (5.60 acres under deed restriction and 1.19 acres of restored CCC wetland habitat that includes 0.01 acre for the new bio swale) is targeted for 4.036 acres of mitigation needs. Table 1 outlines the wetland impacts, mitigation ratios and mitigation needs. Note that the area available on the PG&E property proposed for mitigation is larger than the area required to compensate for permanent and temporary habitat loss at the proposed ratios.

TABLE 1
USACE and CCC Verified Wetland Areas, Impacts and Proposed Mitigation (acres)

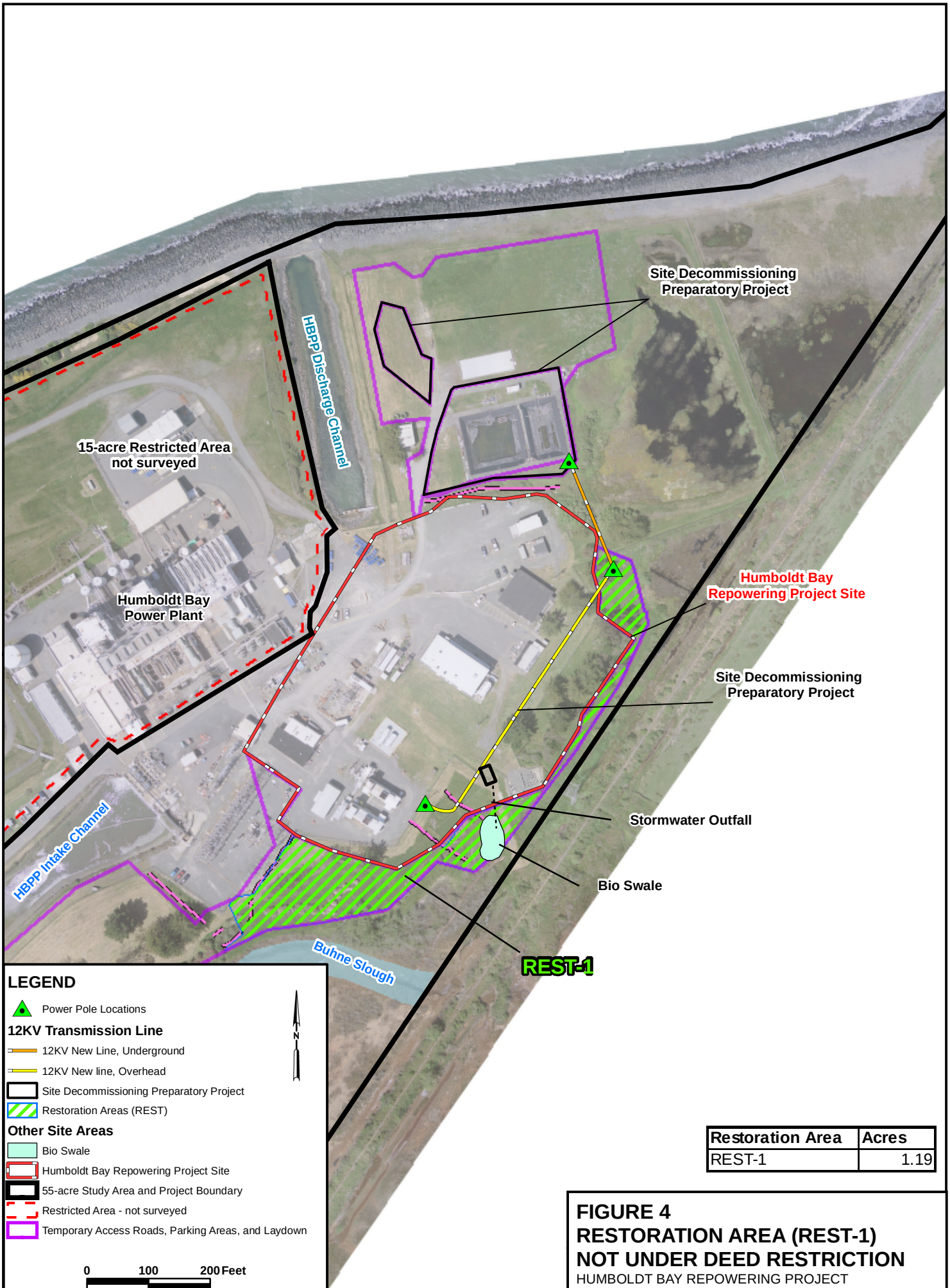
	Drainages	**Seasonal Wetlands**	**Riparian, Salt and Freshwater Marshes**	**Total USACE Wetlands**	**Total Coastal Commission One-Parameter Wetlands**	**Total CCC and USACE**
Wetland Acreages	0.306	0.333	20.032	20.671	5.691	26.362
Wetlands Avoided	0.232	0.206	19.978	20.416	2.233	22.649
Permanent Impacts	0.074	0.095	0.054	0.223	0.961	1.184
Mitigation Ratios	1.5:1	2:1	4:1		1:1	-
Mitigation Acreage for Permanent Impacts	0.111	0.190	0.216	0.517	0.961	1.478
Temporary Impacts	0.000	0.032	0.000	0.032	2.494	2.526
Mitigation Ratios	1.5:1	2:1	4:1		1:1	
Mitigation Acreage for Temporary Impacts	0.0	0.064	0.0	0.064	2.494	2.558
Total Mitigation Acreage Needed	**0.111**	**0.254**	**0.216**	**0.581**	**3.455**	**4.036**

2.1 Ecological Assessment of the Wetlands on Site

2.1.1 Riparian/Marsh

Wetlands dominated by riparian vegetation are structurally diverse, with shrub, tree and herb components. This provides wildlife value in both a regional and site-specific setting. Riparian areas can host many opportunities for nesting bird species (Ehrlich et.al, 1988) as well as forage and/or denning habitats for mule deer, raccoons, voles, and opossums.

The degraded riparian vegetation is mapped together with the adjacent marsh and is dominated by hooker's willow (*Salix hookeriana*) and underlain with herbaceous vegetation.



Restoration Area	Acres
REST-1	1.19

FIGURE 4
RESTORATION AREA (REST-1)
NOT UNDER DEED RESTRICTION
HUMBOLDT BAY REPOWERING PROJECT

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2.1.2 USACE Seasonal Wetlands

The degraded seasonally ponded depressions are manmade, small and isolated. They may be connected by overland flow to drainage ditches. The water storage function and wildlife functions are minimal given the shallow depths, short inundation period, and proximity of perennial bodies of water that provide consistent foraging opportunities for wildlife. These wetlands are dominated by native and non-native plants including pennyroyal (*Mentha pulegium*), a noxious weed (Ayres 2000). Inundation occurs only during the winter rainy season.

2.1.3 USACE Drainage Ditches

Drainage ditches are cut into landscape fill in the northern and eastern flanks of the property. These vary from densely vegetated to grass lined features that provide marginal habitat for wildlife. Deeply cut ditches are vegetated with wetland plant species such as emergent pacific oenanthe (*Oenanthe sarmentosa*) or fringed with Himalayan blackberry (*Rubus discolor*) and coyote brush (*Baccharis pilularis*). Within these densely vegetated drainage ditches, Northern red-legged frogs (*Rana aurora aurora*) and Pacific tree frogs (*Hyla regilla*) were observed. The deeper drainages may provide foraging, hiding, and nesting opportunities for a variety of bird species, including waterfowl, herons, egrets, and bitterns.

2.1.4 California Coastal Commission One-parameter Wetlands

The Coastal Commission one-parameter wetlands are mowed grasslands dominated by facultative (FAC) non-native plants. The impacted one-parameter wetlands have limited value to wildlife. Most of the use of these areas is due to their proximity to landscape trees or shrubby corridors. Wildlife species observed using the one-parameter wetlands were limited to American robins, house sparrows, European starlings, and savanna sparrows. Northern red-legged frogs were observed moving through these areas between aquatic habitats on the site. Voles, pocket gophers, and western fence lizards are also present. The one-parameter wetlands are vegetated with perennial species that reduce soil erosion. Table 2 shows the average cover for wetland indicator plants in 28 vegetation sampling plots in one-parameter wetlands.

TABLE 2
Dominant plant species in one-parameter wetlands and their status as wetland indicators.

Dominant Plant Species (28 1 m^2 plots)	Wetland Status (Reed 1988)*	Number of Occurrences	Average Percent Absolute Cover
Lotus corniculatus	FAC	19	16
Lolium perenne	FAC*	29	13
Holcus lanatus	FAC	26	9
Picris echioides	FAC	12	7
Hypochaeris radicata	FACU*	21	6
Agrostis capillaris	FAC	18	6

*FAC: Facultative plant, Equally likely to occur in wetlands or non-wetlands (estimated probability 34%-66%).
FACU Facultative upland plant, usually occurs in non-wetlands (estimated probability 67%-99%), but occasionally found in wetlands (estimated probability 1%-33%).

SECTION 3

Mitigation Sites

Five areas on the PG&E property were identified as suitable for fulfilling HBRP wetland mitigation needs. Four of these areas are adjacent to each other and in the same watershed (Figure 3). They include two areas of uplands, MIT-1 (parking lot) and MIT-2 (historic fill area), and two areas of existing wetlands, MIT-3 (salt marsh) and MIT-4 (riparian marsh). (Table 3 and Figure 3). In addition, MIT-5 shown on Figure 3, is a Coastal Commission one-parameter wetland that will fulfill the mitigation requirements for SDPP. MIT-5 is also within the watershed for MIT-1 through MIT-4. All five areas will be preserved under a deed restriction on the PG&E property.

The remaining mitigation area is REST-1 (Figure 4). This area will be restored to Coastal Commission and USACE wetlands after construction. Stormwater drainage from the HBRP site will be directed through a series of underground collection sumps and discharged through a new bio-swale constructed and planted with wetland species in REST-1 as part of HBRP construction. However, the restored and constructed wetlands in the REST-1 site will not be placed in under a deed restriction as the area will require access for maintenance of underground pipelines and transmission lines.

TABLE 3
On-Site Wetland Mitigation Areas.

Proposed Mitigation Area	Area Available (acres)	Location	Mitigation Plan/Compensation	Timing for Mitigation (Before or After HBRP construction)
MIT-1	0.61	Northwest corner of property, paved remote parking lot. Contiguous with riparian (RM-1) and salt marsh (SM-5) habitats.	Remove temporary fill and CREATE a) 0.144 acres of riparian b) 0.1 acres of seasonal wetlands c) 0.3 acres of CC wetlands Place under deed restriction. Compensates for permanent loss of Coastal Commission wetlands and permanent and temporary losses of USACE seasonal wetland, drainage ditch, and freshwater marsh habitats.	After
MIT-2	1.03	South of remote parking contiguous with SM-5 and RM-1.	Remove temporary fill and CREATE a) 0.144 acres riparian wetland b) 0.152 acre of seasonal/perennial wetland c) 0.111 acre of drainage ditch wetland d) 0.695 acres of CC wetland Place under deed restriction Compensates for permanent loss of Coastal Commission wetlands and permanent and temporary losses of USACE seasonal wetland, drainage ditch, and freshwater marsh habitats.	Before

TABLE 3
On-Site Wetland Mitigation Areas.

MIT-3	2.26	Area contains existing salt marsh (SM-5) contiguous with RM-1 and MIT-1 and MIT-2	ENHANCE wetland by removing thickspike cordgrass, replace with native salt marsh species. Place under deed restriction. Together with MIT-4 and MIT5 mitigates temporary impacts to Coastal Commission wetland and seasonal wetland habitats.	Before
MIT-4	1.57	Area contains existing riparian wetlands vegetation (RM-1).	ENHANCE wetland by removing Spanish heather, pampas grass, replant with natives. Place under deed restriction. Together with REST-1, MIT-3 and MIT-5 mitigates temporary impacts to Coastal Commission wetlands.	Before
MIT-5 (SDPP area)	*0.13*	*Area contains existing Coastal Commission wetland (CCW-10) that is surrounded by MIT-2*	*ENHANCE wetland by removing thickspike cordgrass and other exotics, replace with native wetland species that will grade into created wetlands on both sides.* *Place under deed restriction.* *Mitigates for 0.117 acre of temporary impacts to Coastal Commission (including USACE) wetlands from the SDPP.*	*Before*
REST-1	1.19	Eastern boundary of the property bordering Buhne Slough marshes and the HBRP permanent construction footprint. Contains Coastal Commission and USACE Seasonal wetlands	RESTORE Coastal Commission and USACE seasonal wetlands to pre-disturbance conditions by removing the temporary access road, re-contouring the base and planting with native wetland species. CREATE bio-swale above Buhne Slough to receive clear stormwater runoff. Together with enhancement measures in MIT-3, MIT-4, and MIT-5 this compensates for temporary impacts to Coastal Commission wetlands.	After
Total	6.79			

3.1 Ecological Assessment of the Proposed Mitigation Areas

The following sections present a summary of the ecological assessment of each proposed mitigation area on the PG&E property, as well as the goals, objectives, and performance standards identified to meet the habitat compensation requirements.

Each of the mitigation areas will require some revegetation with wetland plants. Table 4 presents a list of the wetland plant species suggested for revegetation in the mitigation areas. These are known from the area and are readily propagated and generally available in the nursery trade.

TABLE 4
Suggested Native Plant Species For Revegetation Plantings

Scientific Name	Common Name	Wetland Indicator	Growth Form
Riparian/Marsh			
Acer macrophyllum	big-leaf maple	FAC	Tree/shrub
Carex obnupta	slough sedge	OBL	tall perennial herb
Carex praegracilis	clustered field sedge	FACW-	perennial herb
Lonicera involucrata	twinberry	FAC	shrub
Lupinus rivularis	riverbank lupine	FAC	perennial herb
Myrica californica	wax-myrtle	FAC+	shrub/tree
Picea sitchensis	Sitka spruce	FAC	Tree/shrub
Rubus spectabilis	salmon berry	FAC+	vine
Rubus ursinus	California blackberry	FAC+	vine
Salix hookeriana	coastal willow	FACW	Tree/shrub
Salix lucida ssp. lasiandra	shining willow	OBL	Tree/shrub
Scirpus maritimus	alkali bulrush	OBL	perennial herb
Scirpus microcarpus	small headed bulrush	OBL	perennial herb
Scirpus robustus	big bulrush	OBL	tall perennial herb
Typha latifolia	broadleaf cattail	OBL	tall perennial herb
One-Parameter Wetlands			
Aster chilensis	common California aster	FAC	perennial herb
Carex praegracilis	clustered field sedge	FACW-	perennial herb
Festuca rubra	red fescue	FAC	grass
Juncus patens	common rush	FAC	perennial herb
Lupinus rivularis	riverbank lupine	FAC	perennial herb
Seasonal Wetland			
Carex praegracilis	clustered field sedge	FACW-	perennial herb
Deschampsia cespitosa	tufted hair-grass	FACW	grass
Distichlis spicata	saltgrass	FACW	grass
Eleocharis macrostachya	common spikerush	OBL	perennial herb
Glyceria occidentalis	western mannagrass	OBL	grass

TABLE 4
Suggested Native Plant Species For Revegetation Plantings

Scientific Name	Common Name	Wetland Indicator	Growth Form
Hordeum brachyantherum	meadow barley	FACW	grass
Juncus bolanderi	Bolander's rush	OBL	perennial herb
Juncus effusus	common bog rush	FACW+	perennial herb
Juncus patens	common rush	FAC	perennial herb
Potentilla anserina ssp. pacifica	Pacific potentilla	OBL	perennial herb
Rumex occidentalis	Western dock	OBL	perennial herb
Scirpus robustus	big bulrush	OBL	tall perennial herb
Typha latifolia	broadleaf cattail	OBL	tall perennial herb
Drainage Swale/Ditch Wetlands			
Juncus effusus	common bog rush	FACW+	perennial herb
Mimulus guttatus	common yellow monkeyflower	FACW+	perennial herb
Picea sitchensis	Sitka spruce	FAC	Tree/shrub
Potentilla anserina ssp. pacifica	Pacific potentilla	OBL	perennial herb
Rubus spectabilis	salmon berry	FAC+	vine
Rubus ursinus	California blackberry	FAC+	vine
Rumex occidentalis	Western dock	OBL	perennial herb
Scirpus maritimus	alkali bulrush	OBL	perennial herb
Scirpus microcarpus	small headed bulrush	OBL	perennial herb
Salt Marsh Enhancement Species			
Deschampsia cespitosa	tufted hair-grass	FACW	grass
Distichlis spicata	saltgrass	FACW	grass
Salicornia virginica	pickleweed	OBL	perennial herb
Scirpus maritimus	alkali bulrush	OBL	perennial herb
Triglochin maritima	seaside arrow-grass	OBL	perennial herb

* OBL: Obligate wetland plant, occurs almost always (estimated probability 99%) under natural conditions in wetlands.
FACW: Facultative wetland plant, usually occurs in wetlands (estimated probability 67%-99%), but occasionally found in non-wetlands.
FAC: Facultative plant, Equally likely to occur in wetlands or non-wetlands (estimated probability 34%-66%).
FACU Facultative upland plant, usually occurs in non-wetlands (estimated probability 67%-99%), but occasionally found in wetlands (estimated probability 1%-33%).
UPL: Obligate upland plant, Occurs in wetlands in another region, but occurs almost always (estimated probability 99%) under natural conditions in non-wetlands in the regions specified. If a species does not occur in wetlands in any region, it is not on the National List.

3.2 MIT-1 Ecological Assessment

Mitigation area 1 (MIT-1) is 0.61 acre in extent located in the eastern half of the area that will be used as a temporary remote parking lot along King Salmon Avenue (Figure 3). The site will be used as a remote overflow parking lot during HBRP construction. It is adjacent to riparian vegetation in RM-1.

- Existing vegetation is ruderal with pampas grass and other introduced and noxious weed species
- Hydrology is surface runoff. As expected, precipitation rates are at their highest in winter (December – 6.96”) and lowest in summer (July – 0.14”). The annual average precipitation over the period 1941-2007 was 39.4”. Runoff rates follow a similar pattern as precipitation. Hydrologic models predict peak runoff of 1.7” occurs in January with little to no runoff occurring between May and October (Falzone and Frank, Conceptual Hydrology Assessment for Buhne Point Wetlands Preserve in Appendix A). Evaporation, infiltration and transpiration account for the difference between precipitation and runoff amounts.
- The model simulated the potential for Mitigation Area 1 to support wetlands larger than the 0.1 acres proposed using four different soil infiltration rates. Table 2 in Appendix A summarizes the frequency of wetland inundation for at least 20 consecutive days during the growing season (assumed to be February 1 – December 31). Models using the lowest infiltration rate of 0.05” per day showed that there was sufficient runoff in 100% of the years between 1941-2007 to pond shallow wetlands for more than 20 days. At infiltration rates of 0.5 inches per day, potential are modeled to be inundated in 64% of the years. At both of the higher infiltration rates (1.0 and 2.0 in/day) inundated wetland conditions are not maintained over areas greater than 0.1 acre. Observations at the site (in March 2007) indicate that infiltration rates are likely very low, and frequent seasonal ponding on the site indicates that water table elevations are often relatively high compared to the ground surface. Therefore, it is likely that soil infiltration rates are much closer to the lowest value simulated of 0.05 in/d rather than the higher values.
- The smallest area (0.00017 acre) modeled in Mitigation Area 1 corresponds to a deep area excavated to support cattails. Due to their proximity to the water table, this area is inundated for greater than 20 days during the growing season of all years simulated. In this case, seasonally high groundwater is anticipated to be a potential source of hydrology at this site
- Assumptions about water table elevations at the power plant site as described in the Draft Geotechnical Investigation Report (Kleinfelder 2006) provided an estimate of seasonal groundwater conditions (ranging from at ground surface during the wet season to approximately five feet below ground surface during the dry season).
- Soils – the existing surface is a broken asphalt parking lot over leveled fill material. No modern soil survey exists for the PG&E lands. The entire property is included in an agricultural soil survey from 1965 (McLaughlin and Harradine, 1965) as part of a ‘residential, business and industrial area’ miscellaneous land type. The underlying native soil maybe attributed to the Hookton silt loam soil series that is transitional to the

Bayside very silty clay loam soil mapping unit found in floodplain depressions. This soil develops on uplifted marine terraces such as Buhne Point. It is a light silty clay loam that is medium acid in reaction. The floodplain Bayside soils form the lowest component of a drainage catena on alluvial fans encroaching on Humboldt Bay. They are salt affected with natural undulating surface topography. The historic line between residual Hookton and alluvial Bayside soils is not immediately apparent from historical photos or field examination. It is likely to occur in under the fill of MIT-2 which is found at a slightly lower topographic position.

- Wildlife values are minimal, with potential for bird nesting in the non-native pampas grass and adjacent riparian vegetation and potentially for ground nesters such as killdeer.
- No historic or prehistoric cultural materials are expected to occur in the excavation area outlined in MIT-1. No special-status plant or animal populations will be affected in this area.

3.2.1 MIT-1 Wetland Creation Goals, Objectives, and Performance standards

Goal 1: Re-establish a natural drainage pattern of swale and seasonal pond.

Objective 1: Creation of depressions to increase ponding and runoff retention

Performance criteria: Long (approximately 21 days) duration ponding or saturation in 0.1 acres (4,356 sq. ft.) by year 5

Objective 2: Increase cover in perennial wetland vegetation

Performance criteria:

- 70% cover in perennial plants by the fifth year.
- 50% cover in hydrophytic plants (FAC, FACW, or OBL) in 0.3 acres (13,068 sq. ft.) by year 5

Goal 2: Increase wildlife habitat value and wildlife use

Objective 1: Create structural diversity in native shrubs, trees, and understory,

Performance criteria: 30% cover in native trees, shrubs or vines within 0.144 acres (6,270 sq. ft.) area adjacent to the riparian zone (RM-1) within 5 years

Objective 2: Create vegetated perennial pond

Performance criteria: create 0.103 acres (4,486 sq. ft.) of seasonal or perennial wetlands with >50% cover dominated by hydrophytic plants (FAC, FACW, OBL) in five years.

Objective 3: promote wildlife use

Performance criteria: Within 5 years, 20% of wildlife species common in the adjacent riparian and marsh communities will be observed using (i.e. nesting, foraging, resting) in the mitigation area.

Objective 4: increase nesting opportunities

Performance criteria: observe use of nest boxes/planted canopy coverage in at least two of 5 years

Objective 5: increase foraging areas

Performance criteria: observe use of artificial perches/planted canopy and understory in at least two of 5 years. Concept drawings and design rationale.

Figure 5 shows the distribution and extent of proposed wetland creation types for MIT-1 and MIT-2. Figure 6 presents an aerial view of the locations of representative cross sections for the wetland creation areas in MIT-1 and MIT-2, with Figures 6a and 6b showing the proposed wetland profiles along each of the cross sections in MIT-1. This design is based on the natural/pre-1950s landforms that emphasize the southeasterly drainage of runoff from Buhne Point into Buhne Slough. The inclusion of shrub dominated habitats and ponded wetlands adjacent to established riparian/marsh communities in RM-1 and SM-5 expands this important habitat and buffers it with vegetated slopes from the residential and urban settings south of King Salmon Avenue.

3.2.2 Engineering plans

The engineering plans that will be used by the construction contractor are being developed by CH2M HILL and are forthcoming. The engineering plans will include:

- a grading plan for each mitigation area,
- construction details – any required notations for special needs in construction,
- cross sections and longitudinal profiles of mitigation areas including required slopes,
- construction specifications:
- erosion control needs
- materials
- soil engineering
- planting
- construction management

3.2.3 Comprehensive vegetation specifications

Table 4 provides a list of native perennial wetland species and their potential use in the created wetlands. Wetland plant species that may be used to enhance wildlife forage for waterfowl and red-winged blackbird include bulrush (*Scirpus* sp.), pondweed (*Potamogeton* sp.), water knotweed/smartweed (*Polygonum* sp.) (Martin et.al, 1961) and Western dock (*Rumex occidentalis*). Most of these are available in the local nursery trade and all can be grown from seed or cuttings collected or salvaged from the PG&E site. Plants with similar life-forms, such as rhizomatous herbs, can be considered interchangeable in the functioning of the created wetland. Final selection of the species used will be made after the soil chemistry and hydrology of the created basin and swale features are determined. All plant choices and planting densities will be made at the approval of the PG&E qualified plant ecologist or revegetation specialist in charge of the project. Recommendations of the nursery plant providers will be considered in these decisions.

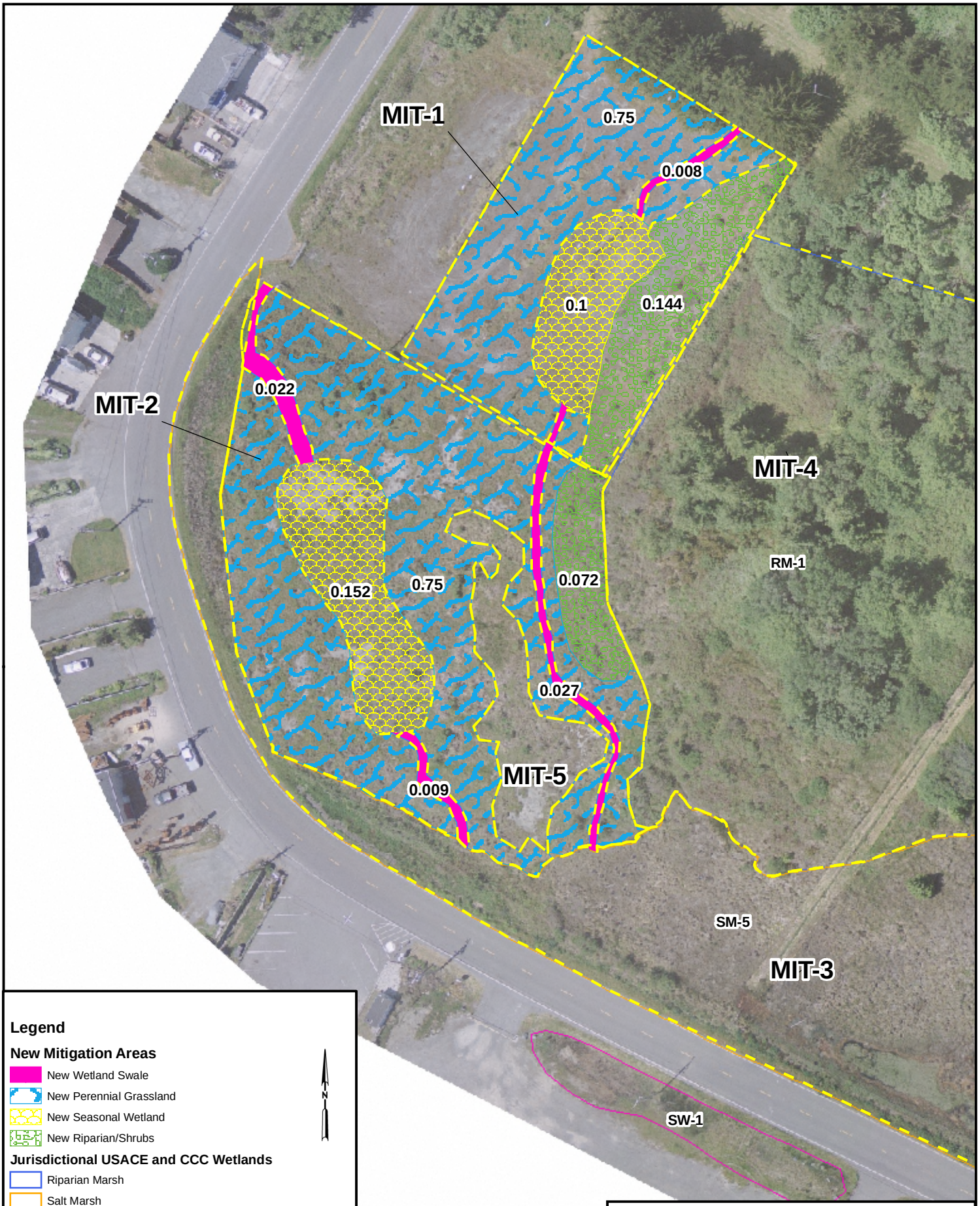

FIGURE 5
WETLAND MITIGATION AREAS MIT-1 THROUGH MIT-5
BUHNE POINT WETLANDS PRESERVE
HUMBOLDT BAY REPOWERING PROJECT

CH2MHILL

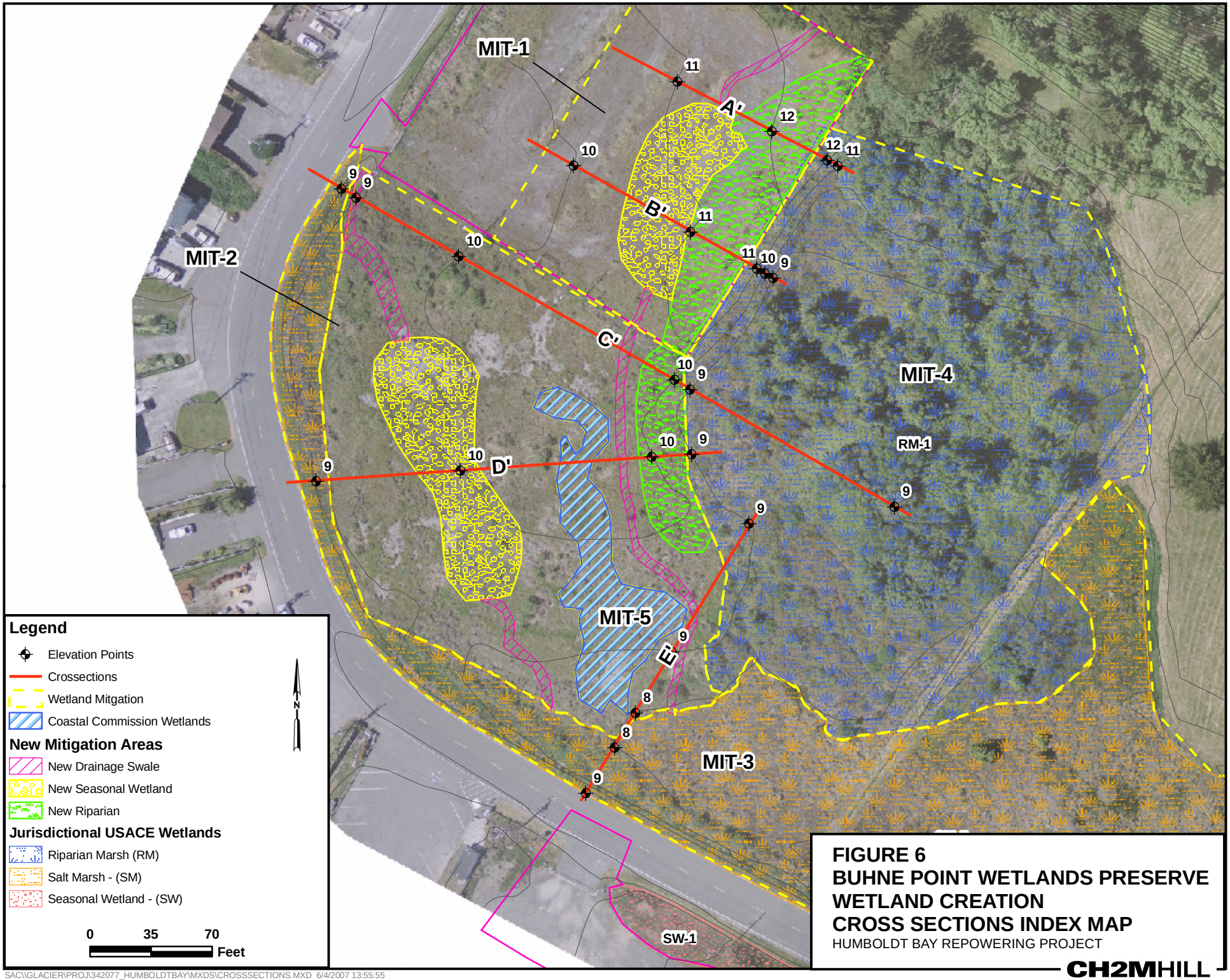

FIGURE 6
BUHNE POINT WETLANDS PRESERVE
WETLAND CREATION
CROSS SECTIONS INDEX MAP
HUMBOLDT BAY REPOWERING PROJECT

CH2MHILL

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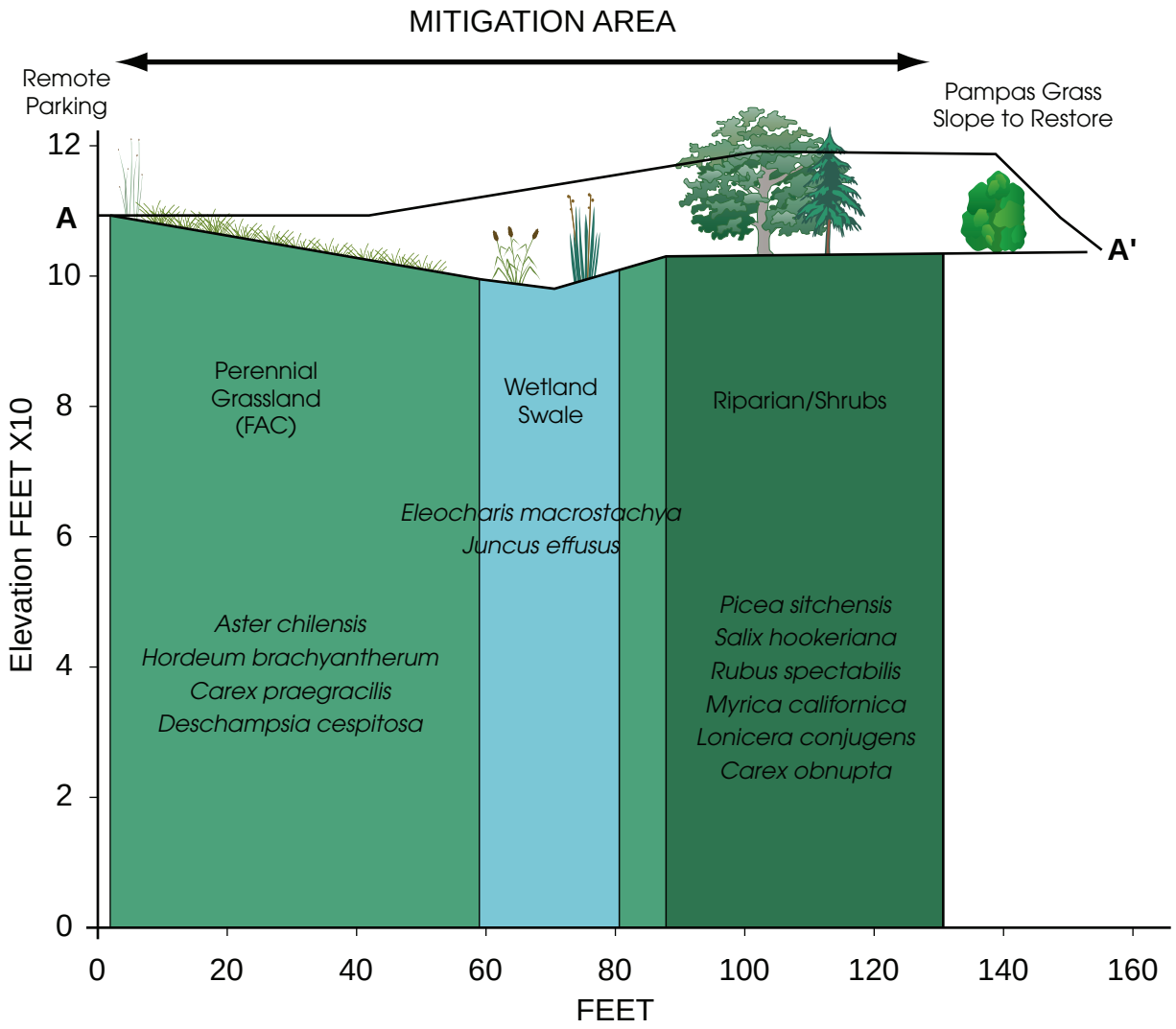

FIGURE 6A
MITIGATION 1 - CROSS SECTION A-A'
HUMBOLDT BAY REPOWERING PROJECT

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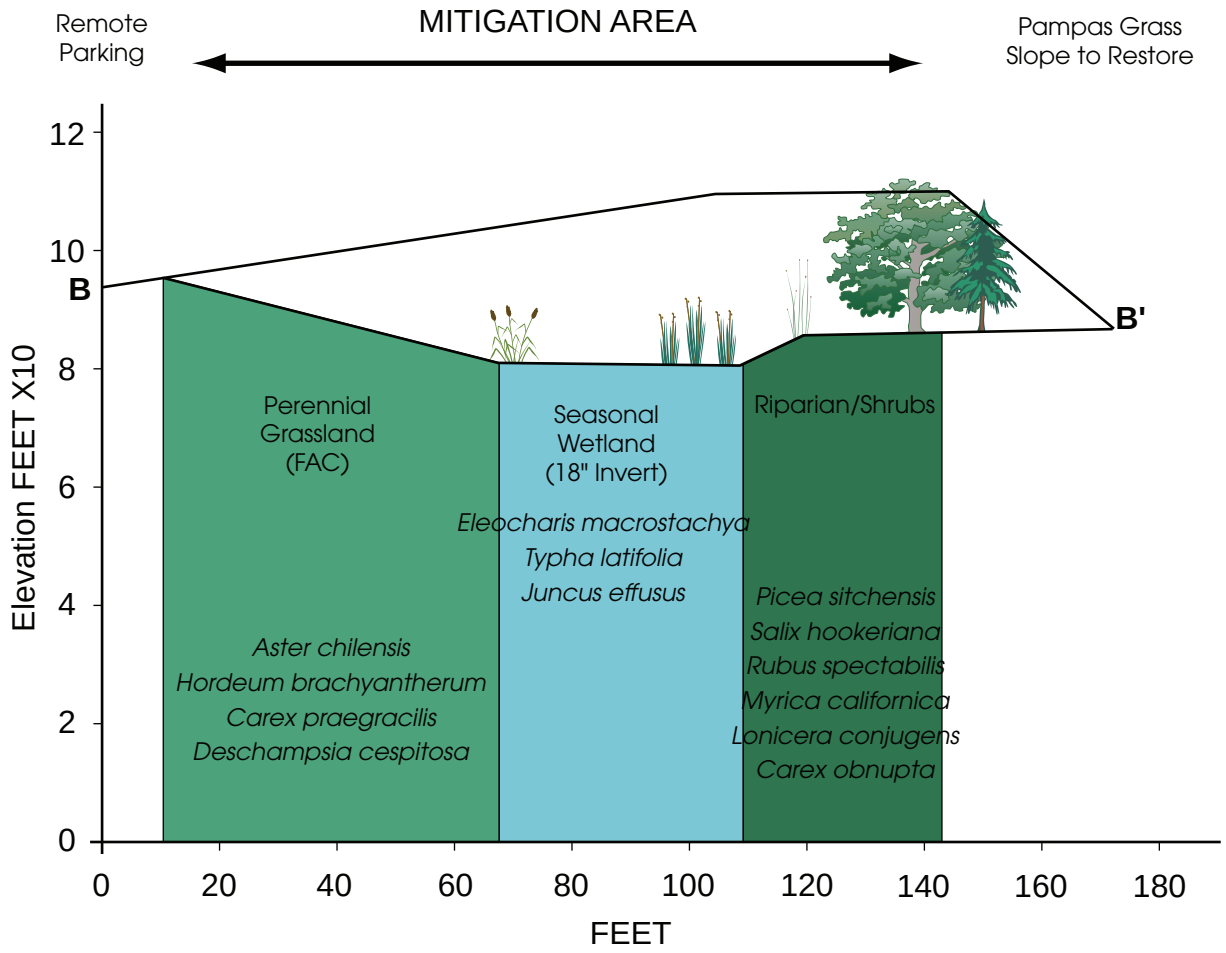

FIGURE 6B
MITIGATION 1 - CROSS SECTION B-B'
HUMBOLDT BAY REPOWERING PROJECT

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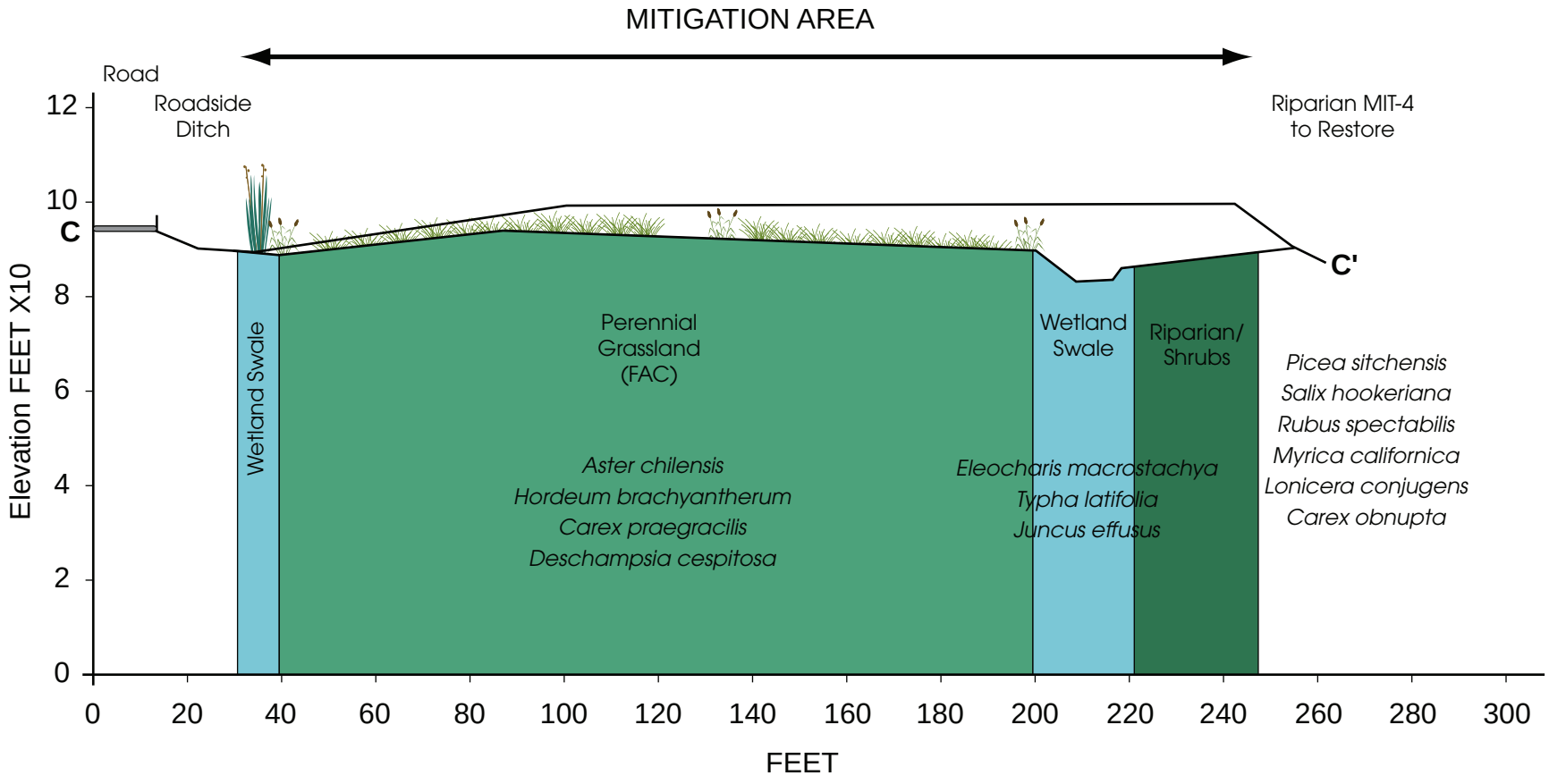

FIGURE 6C
MITIGATION 2 - CROSS SECTION C-C'
HUMBOLDT BAY REPOWERING PROJECT

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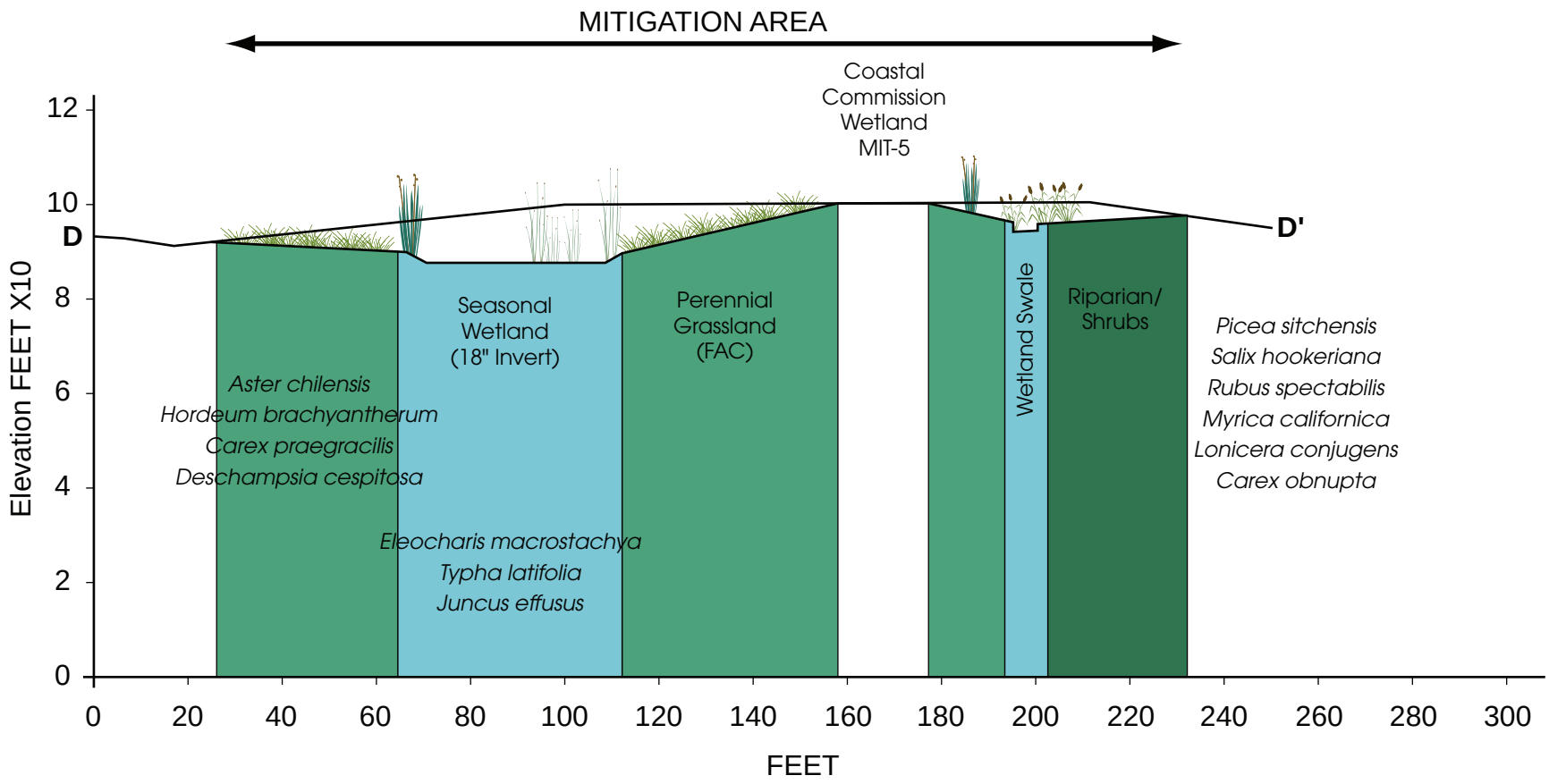

FIGURE 6D
MITIGATION 2 - CROSS SECTION D-D'
HUMBOLDT BAY REPOWERING PROJECT

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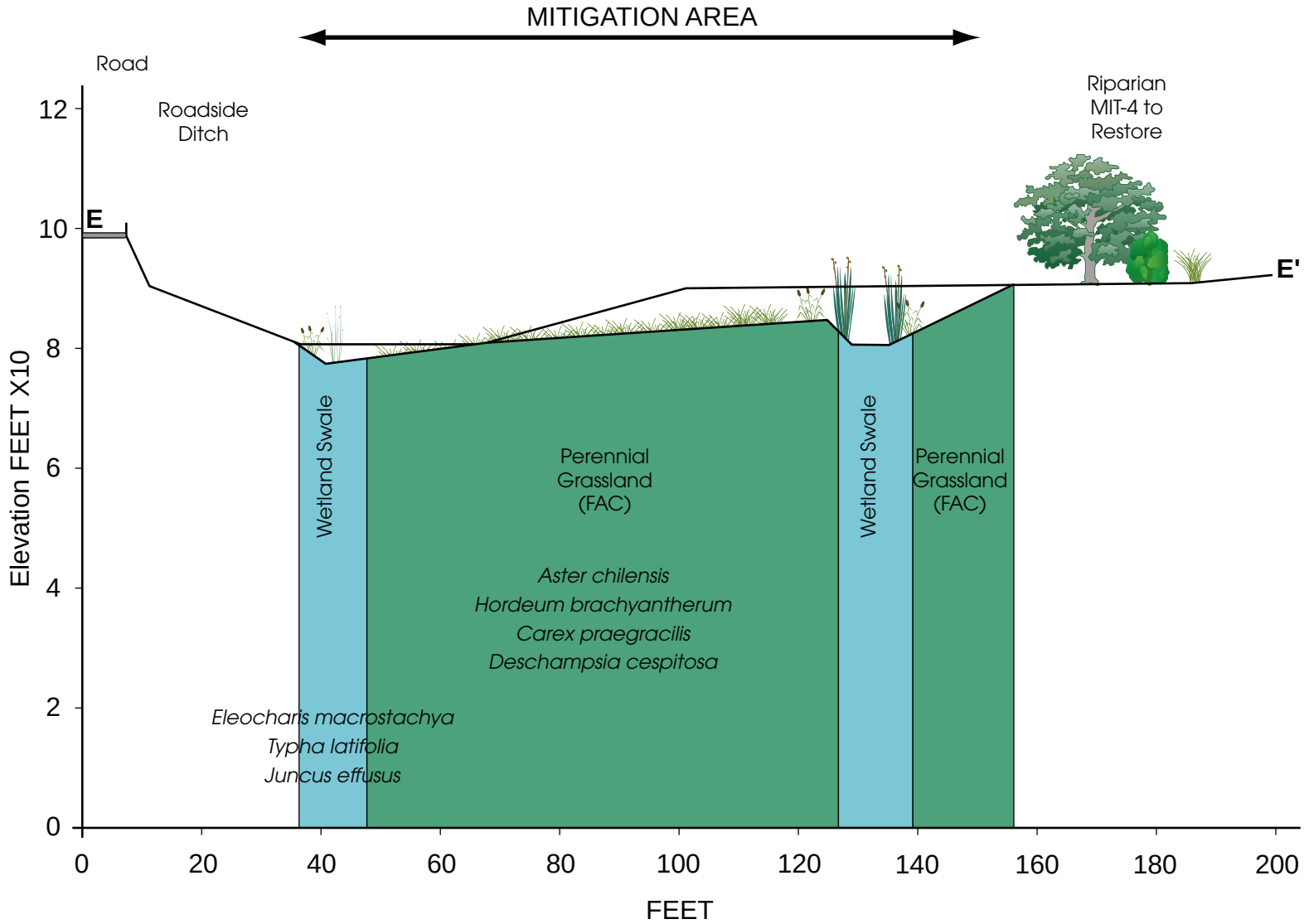

FIGURE 6E
MITIGATION 2 - CROSS SECTION E-E'
HUMBOLDT BAY REPOWERING PROJECT

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General planting densities for trees, shrubs, and vines range from 3 to 15-foot centers. Perennial herbs may be planted in 100 square foot 'islands' at densities ranging from 1 plant per 2.25 sq. ft. (18'centers) to 1 plant per 9 sq. ft (36' centers).

Natural colonization of the mitigation wetlands will also be possible from seed sources in the adjacent marsh and riparian areas. Early colonization of the site from natural seed will be promoted through the monitoring and removal of weedy, annual and non-native species that are often primary colonizers of disturbed sites. Many desirable natives such as willow, cattail, spikerush, tule, and the upland coyote brush are pioneering species that can be expected to be among the initial colonizers of the mitigation area. As these species become established, planting zones will be further defined, and the quantity and kind of nursery grown material will be determined.

3.2.4 MIT-1 Implementation Plan

Timing: Wetland creation at the MIT-1 site would commence after construction of the HBRP is complete. The remote parking area will be needed during some phases of construction. A timeline summarizing all mitigation construction and monitoring phases is provided in Table 6 in Section 5.

1. Wetland creation in this area would be accomplished through the removal of parking lot fill, reshaping the landscape to support shallow drainages and depressions (Figure 5) according to an engineered grading plan developed after project approval. The grading work will be done in the dry summer to early fall months. BMPs will be prescribed to prevent transfer of exposed soils to downstream wetlands.
2. Soil conditioning will be prescribed as needed following testing of the exposed soils. After grading of the site, a grid of soil samples will be tested for levels of salinity and nutrients. Infiltration rates of exposed soils will be measured and compared with the requirements for long-duration ponding estimated by hydrologic models. Repeated sampling will be conducted if newly created hydrologic patterns result in evidence of leaching or wicking of salts and nutrients in the soil surface.
3. Initial hydrology and early colonization by pioneering native species will be monitored bi-monthly for 4 months that includes the fall and early spring rainy season.
4. Planting zones will be defined by soil and hydrologic conditions from initial soil and hydrologic monitoring and from the natural colonization of pioneering natives. Prescriptions for early spring plantings and plant propagation needs will be outlined and implemented. Approximately 6 nest boxes and perches will be installed along the perimeter of the created wetlands between MIT-1 and MIT-4. The nest boxes will be placed at distances suitable for woodpecker and/or other cavity nesters. Perches will be placed at varying locations, some in open areas, others at the edge of the riparian vegetation.
5. Biological Monitoring: a qualified biologist will be on site during restoration activities to move wildlife such as Northern red-legged frog, Pacific tree frog, snakes, and others as necessary to minimize adverse affects to the local populations.

3.3 MIT-2 Ecological Assessment

MIT-2 is 1.03 acres in extent and consists of disturbed uplands found in the west portion of the PG&E property adjacent to the community of King Salmon. The area is bounded on the north by the paved remote parking area (MIT-1 in part), to the west and south by a roadside drainage ditch along King Salmon Avenue, and to the east by salt marsh (SM-5/MIT-3) and riparian wetlands (RM-1/MIT-4). A patch of CCC one-parameter wetland vegetation (described in the following as MIT-5) runs diagonally across the eastern half of MIT-2 and is not included in the estimate of the mitigation area.

- **Vegetation:** The vegetation at this site is grassland dominated by sweet vernal grass and dotted with pampas grass, coyote bush, rattlesnake grass and other ruderal species. The mixed fill that makes up the site has resulted in a chaotic mosaic of vegetation with no organized drainages or consistent ecological transitions.

- **Hydrology:** Drainage over the site is by surface flow trending toward the south. Sources of water available at MIT-2 potentially include tidally and seasonally affected groundwater, surface runoff from the overflow parking area, the south side of Buhne Point and a roadside drainage.

  The hydrologic model for MIT-2 provided similar findings to those described for MIT-1. Mitigation Area 2 produces more runoff than Mitigation Area 1 because of the significant contribution from King Salmon Road, which is paved and infiltrates no precipitation.

  Peak January runoff of 2.2” was modeled for MIT-2. At the slower infiltration rates of 0.05 inches per day and 0.5 inches per day, long duration ponding (greater than 20 days) in an area greater than 0.15 acres can be expected for 100% to 66% of the years. At higher infiltration rates, the model suggests that wetland conditions will not be maintained. As described above, field conditions suggest the lower infiltrations rates are appropriately applied to this model.

- **Soils:** As described for adjacent MIT-1, this area was probably at the salt marsh edge prior to the construction of the King Salmon Resort in the early 1950s. Disturbed fill that underlies the MIT-2 site was placed there in the 1971 from dredging that occurred at the mouth of King Salmon Fisherman’s Channel. The area was prepared for more temporary storage of additional dredge spoil in the 1980s by bulldozing out the center of one acre down to 3-4 feet where native ‘mud’ was encountered. (PG&E 1983). The remaining dredge materials include clay, sand, and gravels that have been compacted by heavy equipment during the past.

- **Wildlife:** As described for MIT-1, wildlife values are minimal, with potential for bird nesting in the non-native pampas grass and adjacent riparian vegetation. Foraging raptors such as red-shouldered hawk (*Buteo lineatus*), red-tailed hawk (*Buteo jamaicensis*), and Northern harrier (*Circus cyaneus*) may prey on small mammals such as pocket gopher (*Thomomys bottae*) and vole (*Microtus* sp.) in the fill area. Northern red-legged frog may cross this area between aquatic wetland habitats.

3.3.1 MIT-2 Wetland Creation Goals, Objectives, and Performance Standards

Goal 1: Re-establish a natural drainage pattern of swales and a seasonal pond.

Objective 1: Creation of a depression to increase ponding and runoff retention

Performance criteria: Long duration (approximately 21 days) of ponding or saturation in 0.152 acres (6,620 sq. ft.) by year 5

Objective 2: Establish cover in perennial wetland vegetation

Performance criteria: 70% cover in perennial plants by the fifth year.

- >50% cover in hydrophytic plants (FAC, FACW, or OBL) in 0.75 acres by year 5

Goal 2: Increase wildlife habitat value and wildlife use

Objective 1: Create structural diversity in vegetation,

Performance criteria: 30% cover in native emergent wetland plants (*Scirpus* sp. or *Typha* sp.) for nesting/forage for red-winged blackbirds and aquatic forage species (*R. occidentalis*) for waterfowl within 0.072 acres (3,136 sq. ft.) area adjacent to the riparian zone RM-1 within 5 years

Objective 2: Create seasonal or perennial pond

Performance criteria: standing water 18' deep for 4 months during the winter and spring within 0.152 acres (6,620 sq. ft.) of wetlands with 80% cover dominated by obligate (OBL) or facultative wetland (FACW) species (Reed 1988) in five years

Objective3: Increase amphibian breeding habitat to support Northern red-legged frog and/or Pacific chorus tree frog

Performance criteria: Within 5 years, 20% of wildlife species common in the adjacent riparian and marsh communities will be observed in the mitigation area.

- observe use of deeper ponding wetland areas by frog species in at least two of 5 years

3.3.2 Concept drawings and design rationale

As described in the discussion of MIT-1, Figure 5 shows the distribution and extent of proposed wetland creation types for MIT-1 and MIT-2. Figure 6 presents an aerial view of the locations of representative cross sections for the wetland creation areas in MIT-1 and MIT-2, with Figures 6c through 6e showing the proposed wetland profiles along each of the cross sections in MIT-2. The design follows the natural pre-construction drainage pattern into Buhne Slough. It expands and diversifies the habitat opportunities for wildlife. In addition to the benefits of expanding and enhancing the existing riparian/marsh area (RM-1 and SM-5),

stormwater run-off from King Salmon Avenue will be diverted through these created wetlands that will function to increase the filtration capacity of the existing roadside drainage channel. The functioning of this larger wetland area will conceptually improve the quality of water entering the Fisherman's Channel via the PG&E Intake canal.

3.3.3 Engineering plans

The engineering plans that will be used by the construction contractor are being developed by CH2M HILL and are forthcoming. The engineering plans will include:

- a grading plan for each mitigation area,
- construction details – any required notations for special needs in construction,
- cross sections and longitudinal profiles of mitigation areas including required slopes,
- construction specifications:
- erosion control needs
- materials
- soil engineering
- planting
- construction management

3.3.4 Comprehensive vegetation specifications

Vegetation specifications follow those outlined for MIT-1. MIT-2 currently includes scattered individuals of native perennial wetland species that will be salvaged prior to excavation. These include *Juncus effusus*, *Juncus patens*, *Deschampsia caespitosa*, *Salicornia virginica*, and *Juncus breweri*. Nesting substrate and forage plants for (frogs) will be promoted with plantings of emergent wetland plant species (*Scirpus* sp., *Typha* sp., *Rumex* sp., *Potamogeton* sp.). Other useful native shrubs or seedlings may be present and will be salvaged prior to construction. A local native plant nursery will be contracted to remove these individuals to their facility be propagated or held for revegetation plantings. Natural colonization of the created wetlands will be encouraged.

3.3.5 MIT-2 Implementation Plan

Timing: These mitigation measures will occur concurrent with project construction (see Table 6 in Section 5).

Grading: Re-contouring of the site will be accomplished during Spring 2008 when conditions are suitable for construction equipment.

Monitoring: Soil sampling and hydrologic monitoring conducted over the winter and spring 2007-2008 will precede revegetation plantings. Requirements for soil conditioning with textural or nutritional supplement will be determined. Weed populations will be discouraged and natural colonization by native perennial wetlands species will be encouraged during bi-monthly monitoring for 4 months prior to spring planting period.

Planting: Native perennial wetland species propagated from salvaged plants and other native transplants be planted in appropriate created habitats during spring 2008. General planting densities for trees, shrubs, and vines range from 3 to 15 foot centers. Perennial herbs may be planted in 100 square foot 'islands' at densities ranging from 1 plant per 2.25 sq. ft.

(18'centers) to 1 plant per 9 sq. ft (36' centers). All plant choices and planting densities will be made at the approval of the PG&E qualified plant ecologist or revegetation specialist in charge of the project. Recommendations of the nursery plant providers will be considered in these decisions. Needs for additional nursery grown plants will be identified and a supplier will be contracted to obtain local materials and implement a propagation program.

Biological Monitoring: a qualified biologist will be on site during restoration activities to move wildlife such as Northern red-legged frog, Pacific tree frog, snakes, and others as necessary to minimize adverse affects to the local populations.

3.4 MIT-3 Ecological Assessment

MIT-3 is 2.26 acres in extent. It is an existing degraded tidal salt marsh wetland (SM-5) adjacent to King Salmon Avenue (Figure 2), the HBPP access road, and MIT-2. This area received up to 2,000 to 3,000 cubic yards of dredging fines due to a break in the spoils dike and carry-over of sand/mud through the weir box during the 1983 Fisherman's Channel dredging (PG&E 1983). This influx of mineral soils may have promoted the colonization of this small marsh by introduced and invasive thickspike cordgrass (*Spartina densiflora*).

- **Vegetation:** Three zones of vegetation are present in this site (Figure 7). The lower marsh zone found between approximately 5.2 ft. MHW and 5.5 ft MHW is a mix of common pickleweed, arrowgrass, and thickspike cordgrass. The lower marsh contains an area of 0.074 acres (3,223 sq. ft.) that is dominated by thickspike cordgrass to the exclusion of other native species. Above the lower marsh, an intermediate zone extending from approximately 5.5 ft MHW to 6.0 ft. MHW is represented by mixed salt marsh vegetation dominated by saltgrass. This salt grass dominated zone is the most limited in extent (0.018 acre) and most comparable to habitats supporting rare plant species in a nearby setting along King Salmon Avenue. Thickspike cordgrass is found sporadically in the intermediate zone where it comprises less than 5% of the cover. From approximately 6.0 ft MHW to 7.0 ft MHW, the upper marsh is transitional to the shrub and vine dominated riparian and brackish marsh communities of MIT–4. Cordgrass occurs only sporadically in this area.

- **Hydrology:** This wetland receives stormwater run-off from the HBPP and tidal salt water from the intake canal overflow. Figure 7 shows topographic contour and local tide station data with extents of various wetland vegetation communities. Data from the National Oceanic and Atmospheric Administration (NOAA) for the nearest tide station (Eureka Slough, Humboldt Bay; #9418802) indicate the following elevations for various tide levels (given in relation to North American Vertical Datum 1988):

  - Mean Higher High Water: +6.61 feet
  - Mean High Water: +5.88 feet
  - Mean Tide Level: +3.19 feet
  - Mean Low Water: +.50 feet
  - Mean Lower Low Water: -0.78 feet

  These data indicate that because the upstream end of the culvert on-site is +2.56 feet, tidal elevations at or above Mean Tide Level should provide for tidal flows to the

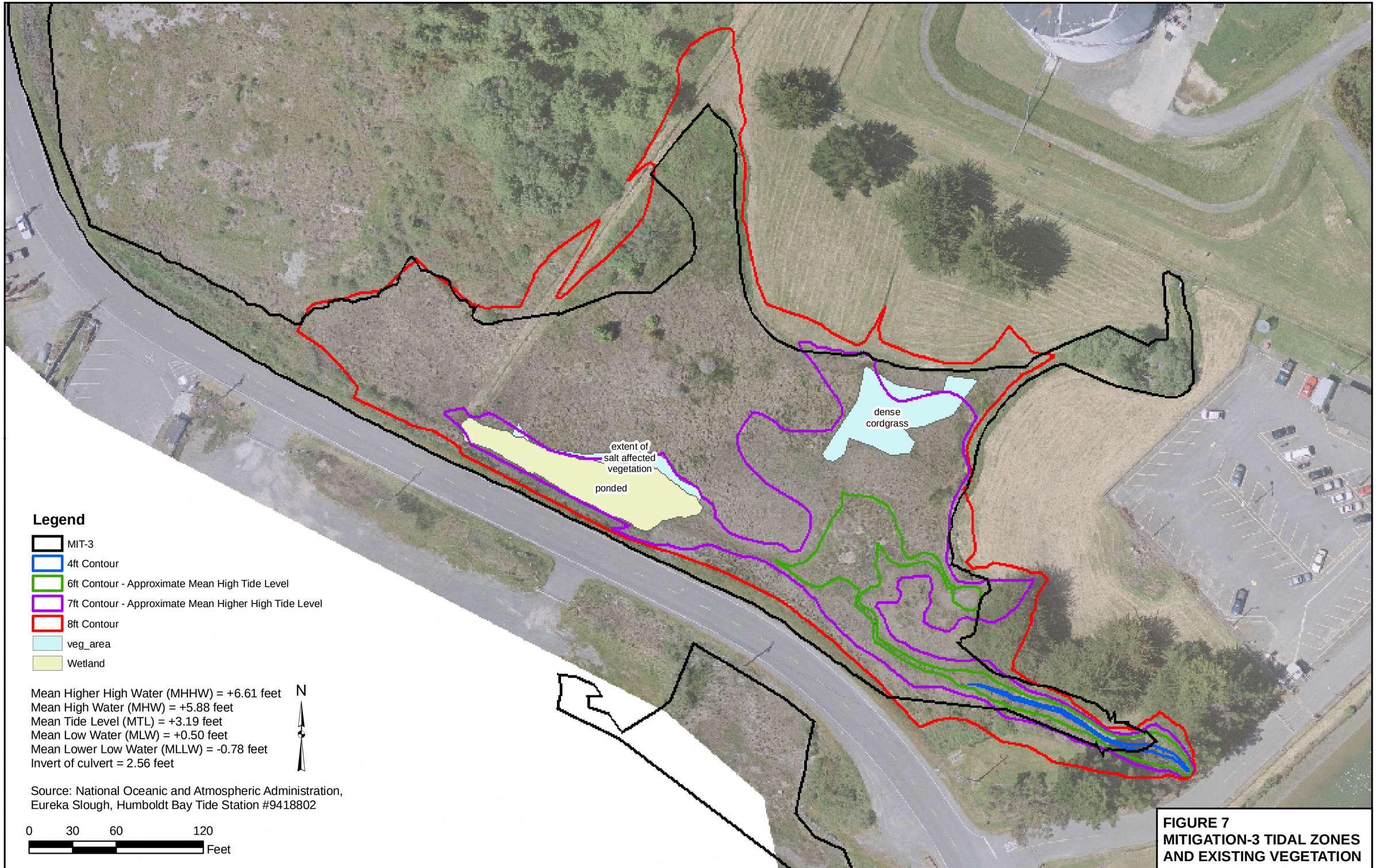

FIGURE 7
MITIGATION-3 TIDAL ZONES AND EXISTING VEGETATION

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mitigation area. However, is unknown at this time to what degree the culvert itself acts as a flow constriction or impediment, and so actual tidal inflow rates at various tide elevations are unknown. Observations on-site and elevation differences between the culvert and average daily high tides indicate that tidal flows are regularly inundating areas of the site, potentially as far back as the 6-7 foot elevation contours shown on Figure 7. Locations and elevations of bands of brackish and salt water adapted wetland plant communities further support this hypothesis. The coincidence of vegetation zones and presumed tidal inundation elevations depicted in Figure 7 illustrate this point.

In addition to tidal flows from the culvert, seasonal storm runoff from upstream areas provides freshwater to Mitigation Area-3. While this flow has not been quantified, hydrologic modeling performed for Mitigation Areas 1 and 2 (Appendix A) indicated that wetland basins in these areas will frequently discharge during storm events and therefore supplement tidal flows to support brackish marsh vegetation.

- **Soils:** As with the rest of the PG&E property, soil type in the marsh is inferred from early agricultural soil mapping to be of the Bayside very silty clay loam soil mapping unit found in floodplain depressions with salt water influence. The marsh soils that have been altered by fill and siltation from dredge spoil overflows in the 1980s.
- **Wildlife:** Wildlife in the salt marsh habitat is limited as the area is separated from the deeper ponding marshes south of King Salmon Avenue. Shorebirds such as killdeer (*Charadrius vociferous*), Western sandpiper (*Calidris mauri*), common snipe (*Gallinago gallinago*), marbled godwit (*Limosa fedoa*), and least sandpiper (*Calidris minutilla*) forage routinely in the marshes south of King Salmon Avenue and could forage in MIT-3 occasionally.

3.4.1 MIT-3 Wetland Restoration Goals, Objectives, and Performance standards

Goal 1: Restore salt marsh vegetation to native plant species

Objective 1: Remove thickspike cordgrass

Performance criteria 1: <1% cover in thickspike cordgrass in the intermediate marsh in 5 years

Performance criteria 2: <1% cover in thickspike cordgrass in the lower marsh in 5 years

Objective 2: Restore native vegetation

Performance Criteria: > 95% cover in native marsh plants in 5 years.

Objective 3: Promote wildlife use

Performance criteria: Within 5 years, 10% of wildlife species common in the adjacent marsh communities south of King Salmon Avenue will be observed in the mitigation area.

Objective 4: increase nesting opportunities

Performance criteria: observe use of nest boxes/planted canopy coverage in at least two of 5 years

Objective 5: increase foraging areas.

Performance criteria: observe shorebird use of mud flats in at least two of 5 years.

Objective 6: increase amphibian breeding habitat to support Northern red-legged frog and/or Pacific chorus tree frog.

Performance criteria: observe use of deeper ponding wetland areas by frog species in at least two of 5 years.

3.4.2 Concept drawings and design rationale

Figure 7 shows the zones of infestation of thickspike cordgrass. This marsh has limited interaction with the bay through a 12-inch culvert. Control of thickspike cordgrass in this limited area is desirable as the marsh is adjacent to populations of special status plant species: the Humboldt Bay owl's clover (*Castilleja ambigua* ssp. *humboldtiensis*) and Point Reyes bird's beak (*Cordylanthus maritimus* ssp. *maritimus*). Control of exotic cordgrass in the intermediate saltgrass zone of MIT-3 will improve habitat for natural or artificial establishment of satellite populations of these two species. Control of the central core of thickspike cordgrass in the marsh will limit the potential for spread of the plant and re-colonization of the saltgrass zone. Several thickspike cordgrass eradication projects are in progress or have been attempted in Humboldt Bay, and those with connections to special status plant populations are considered most warranted. The SM-5/MIT-3 habitat will be protected under a deed restriction and could become a refuge for these two species.

3.4.3 Engineering plans

No earthwork or engineered facilities are planned for this salt marsh enhancement area.

3.4.4 Comprehensive vegetation specifications

Replanting of native species found in the same habitat zone will follow removal of the alien cordgrass. These include pickleweed, arrow-grass, dune rush, salt grass, tufted hairgrass, Jaumea, or coastal Gumweed.

3.4.5 MIT-3 Implementation Plan

Timing: This mitigation measure will begin concurrently with project construction in Spring 2008 (see Table 6 in Section 5).

Cordgrass removal: Method of removal of existing cordgrass clumps will be dependent on the density of the population. Low-density populations in the intermediate marsh will be mechanically removed by hand pulling. Rhizomes and roots will be sought in the mud and removed together with the mature plant as these would allow the plant to resprout. The removal sites will be marked for observations of re-sprouting rootstock during following monitoring sessions. All removed plant material will be taken off-site to an upland site to dry out and die. The 0.74 acre (3,223 sq. ft.) high density population of cordgrass in the central

portion of the lower marsh will initially be mowed to mud-level with a string cutter during Spring 2008 and the cut material will be removed from the site. During spring 2008, the entire population will be covered with geo-textile fabric or high-density black plastic. The circumference of plastic cover will be weighted down with sandbags. This cover will be maintained over the population until early spring 2009.

Restoring with natives: Cordgrass individuals removed from the low density zone will be replaced with natives of the appropriate habitat zone that were salvaged from the mitigation area, or collected and transplanted from other salt marsh habitats on PG&E property. During the fall of 2008, a native plant nursery specializing in salt marsh species will be contracted to collect and propagate native saltgrass, pickle weed and other potential revegetation species for planting after removal of the solarisation fabric.

Wildlife Habitat Improvement: Periodic (every year or two) draw down water in ponding areas and promote a diversity of plantings with high seed production can increase the number of benthic invertebrates (Payne 1992) for shorebird forage. If necessary, small quantities of bottom sediments and submerged plants from nearby marshes on PG&E property could be introduced to the new wetland areas to promote invertebrates.

Monitoring: The populations of newly planted natives and the remainder of the salt marsh will be monitored for cordgrass sprouts or seedlings. Means for preventing the recolonization of the site will be investigated through collaboration with on-going cordgrass eradication projects in Humboldt Bay.

A qualified biologist will be on site during restoration activities to move wildlife such as Northern red-legged frog, Pacific tree frog, snakes, and others as necessary to minimize adverse affects to the local populations.

3.5 MIT-4 Ecological Assessment

MIT-4 is 1.57 acres in extent and supports existing degraded riparian wetlands RM-1 (Figure 2). These areas are indicated in early aerial photography of the site as part of a drainage network on the south side of Buhne Point. The area has since been invaded with noxious weeds that diminish wildlife value and provide a source of continuing recruitment of noxious weeds into the local marsh habitats. This existing riparian area will be enhanced by removal of non-native species and improvement of wildlife habitat.

Vegetation: The community is dominated by Hooker’s willow (*Salix hookeriana*), and includes Sitka spruce, twin berry, wax myrtle, slough sedge, sword fern, red-flowered current, and salmon berry. Infestations of pampas grass, Spanish heath, scotch broom, Himalayan blackberry, and cotoneaster are escaped horticultural species established in the riparian wetland. These are found mostly on the perimeter of the habitat where disturbance is the highest.

Hydrology: Surface runoff from the HBPP facility and Buhne Point feeds a high ground water table exposed in the drainage canal running along the western side of the riparian vegetation and central ponded area.

Soils: As described in previous sections this area is not mapped in a modern soil survey. It is likely to be an inclusion of wetland soils in the regional setting of Hookton series soils of Buhne Point.

Wildlife: Wildlife in the riparian marsh is limited as the vegetation is extremely dense. Birds such as hummingbirds, woodpeckers, jays, robins, and bushtits were observed along the edges of the riparian habitat and they may nest in the trees and shrubs. Opening the canopy and understory of tangled vines and shrubs would increase the wildlife use of this area.

3.5.1 MIT-4 Wetland Restoration Goals, Objectives, and Performance Standards

Goal 1: Restore riparian vegetation to native plant species

Objective 1: Remove horticultural escapes

Performance criteria 1: < 1% cover in escaped exotic shrubs, trees or vines in the riparian wetland marsh in 5 years.

Objective 2: Restore native vegetation

Performance Criteria: > 70% cover in native shrubs trees and vines in 5 years.

Goal 2: Improve wildlife habitat

Objective 1: Promote wildlife use

Performance criteria: Within 5 years, 20% of wildlife species common in the existing riparian habitat will be observed in the mitigation area.

Objective 2: increase nesting opportunities by opening the shrub canopy (blackberry and scotch broom)

Performance criteria: observe use of nest boxes/planted canopy coverage in at least two of 5 years

Objective 3: increase foraging areas

Performance criteria: observe use of artificial perches/planted canopy and understory in at least two of 5 years

Objective 4: increase amphibian breeding habitat to support Northern red-legged frog and/or Pacific chorus tree frog

Performance criteria: observe use of deeper ponding wetland areas by frog species in at least two of 5 years

3.5.2 Concept drawings and design rationale

Figure 3 shows the location of the MIT-4 (RM-1). The rationale for improving and protecting this riparian wetland is due to its part as a keystone habitat for wildlife in the Buhne Point vicinity. Structurally diverse and contiguous habitat blocks are uncommon in the local open and urbanized setting. This shrub and tree dominated riparian system currently grades into

the existing disturbed fill and parking lots of MIT-1 and MIT-2. The proposed mitigation in MIT-4 will create and extend habitat values into a block of habitat that includes salt marsh, seasonal and perennial wetlands for an integrated habitat mosaic. Currently the riparian wetland is degraded by the large perimeter/area ratio. The disturbed perimeter is subject to colonization by alien species that compete for space and nutrients with more desirable native species. Spanish heather alters the pH of its local soil environment making it harder for natives to compete (Ayres 2000). The area serves as a seed source for invasive species to become established elsewhere in the local community.

3.5.3 Engineering plans

No earthwork or engineered facilities will be part of this mitigation project.

3.5.4 Comprehensive vegetation specifications

Each invasive species found in MIT-4 has a defined prescription for eradication and control. All eradication sites will be marked and followed during the 5-year monitoring program.

Pampas grass: Seeds are wind borne. Any existing seed head will be bagged and removed from the site. Stems and roots will be chopped down and the root ball dug out and removed from the site. If the individual plants are in locations where the root ball cannot be adequately removed, the area will be covered with high-density black plastic to solarize the rootzone for 6 months.

Spanish heather, scotch broom, and cotoneaster: The stem material will be cut and removed from the site. Plant roots will be removed to the extent possible. Re-sprouting from roots and a soil seed bank can result in a re-infestation. Monitoring for regeneration will prevent re-establishment.

Replacement plantings will consist of native perennial plants that match the soil and hydrologic setting of the replacement site. Some adjacent naturally occurring perennial wetland plants will be able to colonize the exposed space. Decisions on the need for nursery plantings will be made for each location by the PG&E biologist responsible for the restoration. A mulch or weed matt cover may be prescribed by the biologist to prevent new infestations in disturbed ground while adjacent plants are responding to environmental changes.

Opening the shrub canopy (blackberry and scotch broom) will increase nesting opportunities for birds in the riparian habitat. If new plantings are recommended, plants will either be locally collected and propagated or come from local nursery grown stock. Plants potentially useful for restoration plantings in the CCC one-parameter wetlands are listed in Table 4.

3.5.5 MIT-4 Implementation Plan

Timing: Habitat restoration and enhancement at MIT-4 will commence in conjunction with construction of the HBRP.

Survey and treatment: During Spring 2008, the PG&E biologist in charge of the restoration will identify and tag individual plants targeted for removal. Removal sites will be permanently identified for future monitoring. A landscape crew will be contracted to remove

plants and roots under the supervision of the biologist in charge. Exposed soils will be protected from erosion by mulch or weed control matting.

Replanting with Natives: Where replanting with natives is prescribed, nursery stock from locally obtained material will be used. Plantings will occur during Spring and Fall 2008.

Wildlife: Nest boxes or perches will be established as designated by the wildlife biologist.

Biological Monitoring: A qualified biologist will be on site during restoration activities to move wildlife such as Northern red-legged frog, Pacific tree frog, snakes, and others as necessary to minimize adverse affects to the local populations. Also, if active bird nests (protected by CDFG Codes 3503 and 3513) are found, work in the immediate area will be postponed until the young have fledged.

3.6 MIT-5 Ecological Assessment (Mitigation Area for SDPP)

MIT-5 is a one-parameter California Coastal Commission wetland found within MIT-2 (but not counted in MIT-2 acreage). It qualifies as wetland based on a predominance of hydrophytic plants rated FAC, FACW or OBL.

Vegetation: The hydrophytic vegetation present in this wetland includes some natives such as tufted hairgrass, but predominantly the determination of wetland in this site was based on dominance of non-natives including ryegrass, birds foot trefoil, or velvet grass. This community also includes thickspike cordgrass, an invasive wetland plant.

Soils: This area, as with the rest of the PG&E property, is unmapped by modern soil surveys. As described in the section on MIT-2, it is likely that the boundary between Hookton and Bayside soils is found somewhere in this location with regard to Buhne Slough.

Hydrology: Surface runoff is the source of hydrology for the one-parameter wetlands site. The reworking of the dredge spoils underlying this site has potentially resulted in an extremely shallow and seasonally perched water table.

Wildlife: As described for MIT-1 and MIT-2, wildlife values are minimal, with potential for bird nesting in the non-native pampas grass and adjacent riparian vegetation.
Foraging raptors may prey on small mammals that tunnel in and through the grass clumps.
Northern red-legged frog may cross this area between aquatic wetland habitats.

3.6.1 MIT-5 Enhancement Mitigation Goals, Objectives, and Performance standards

Goal 1: Restore vegetation to native plant species

Objective 1: Remove noxious weeds

Performance Criteria 1: < 1% cover in noxious weeds in 5 years

Objective 2: Restore native vegetation

Performance Criteria: > 70% cover in native perennial hydrophytic herbs, shrubs, or trees and vines in 5 years.

3.6.2 Concept drawings and design rationale:

The location and extent of MIT-5, a one-parameter wetland, is shown in Figure 3.
This wetland is located in upland habitats within the area of MIT-2. The noxious or invasive species that are found there will be eradicated prior to construction of the surrounding mitigation areas. These enhancement measures will also provide a clean environment for the establishment of desired native perennial wetland species in the surrounding MIT-2 wetlands. This community will be connected to vegetated slopes, seasonal wetlands and existing saltmarsh in a contiguous protected preserve. Rational for enhancement of this one-parameter wetland lies in its proximity to proposed wetland creation sites and its position in the larger complex of wetland habitats that will be protected under a deed restriction.

3.6.3 Engineering plans

No soil moving or other engineered structures are a part of this proposed mitigation site.

3.6.4 Comprehensive vegetation specifications

As in the discussion of MIT-4, each invasive species has a defined prescription for eradication and control. All eradication sites will be marked and followed during the 5-year monitoring program. Exotic species occurring in MIT-5 include:

Pampas grass: Seeds are wind borne. Any existing seed head will be bagged and removed from the site. Stems and roots will be chopped down and the root ball dug out and removed from the site. If the individual plants are in locations where the root ball cannot be adequately removed, the area will be covered with high-density black plastic to solarize the rootzone for 6 months.

Cordgrass: Low-density populations of thickspike cordgrass in MIT-5 will be removed by hand or mechanical pulling. Rhizomes and roots will be sought in the subsoil and removed. The removal sites will be marked for observations of re-sprouting rootstock during following monitoring sessions. All removed plant material will be taken off-site to an upland site to dry out and die

Replacement plantings will consist of native perennial plants that match the soil and hydrologic setting of the replacement site. In some settings, adjacent naturally occurring seedlings or saplings may be released from competition with the removal of the exotic species and be able to occupy the open space on their own. Decisions on the need for nursery plantings will be made for each location by the PG&E biologist responsible for the restoration. A mulch or weed matt cover may be prescribed by to prevent new infestations in disturbed ground while adjacent plants are responding to environmental changes.

If new shrub or tree plantings are recommended, plants will either be locally collected and propagated or be from local nursery grown stock. Plants potentially useful for restoration plantings in the riparian/marsh community are listed in Table 4.

3.6.5 MIT-5 Implementation Plan

Timing: Habitat restoration and enhancement at MIT-5 will commence in conjunction with construction of the HBRP.

Survey and treatment: During Fall 2007, the PG&E biologist in charge of the restoration will identify and tag individual plants targeted for removal. Removal sites will be permanently identified for future monitoring. A landscape crew will be contracted to remove plants and roots under the supervision of the biologist in charge. Exposed soils will be protected from erosion by mulch or weed control matting.

Replanting with Natives: Where replanting with natives is prescribed, nursery stock from locally obtained material will be used. Plantings will occur during fall/winter 2007.

Biological Monitoring: A qualified biologist will be on site during restoration activities to move wildlife such as Northern red-legged frog, Pacific tree frog, snakes, and others as necessary to minimize adverse affects to the local populations.

3.7 REST-1 Ecological Assessment

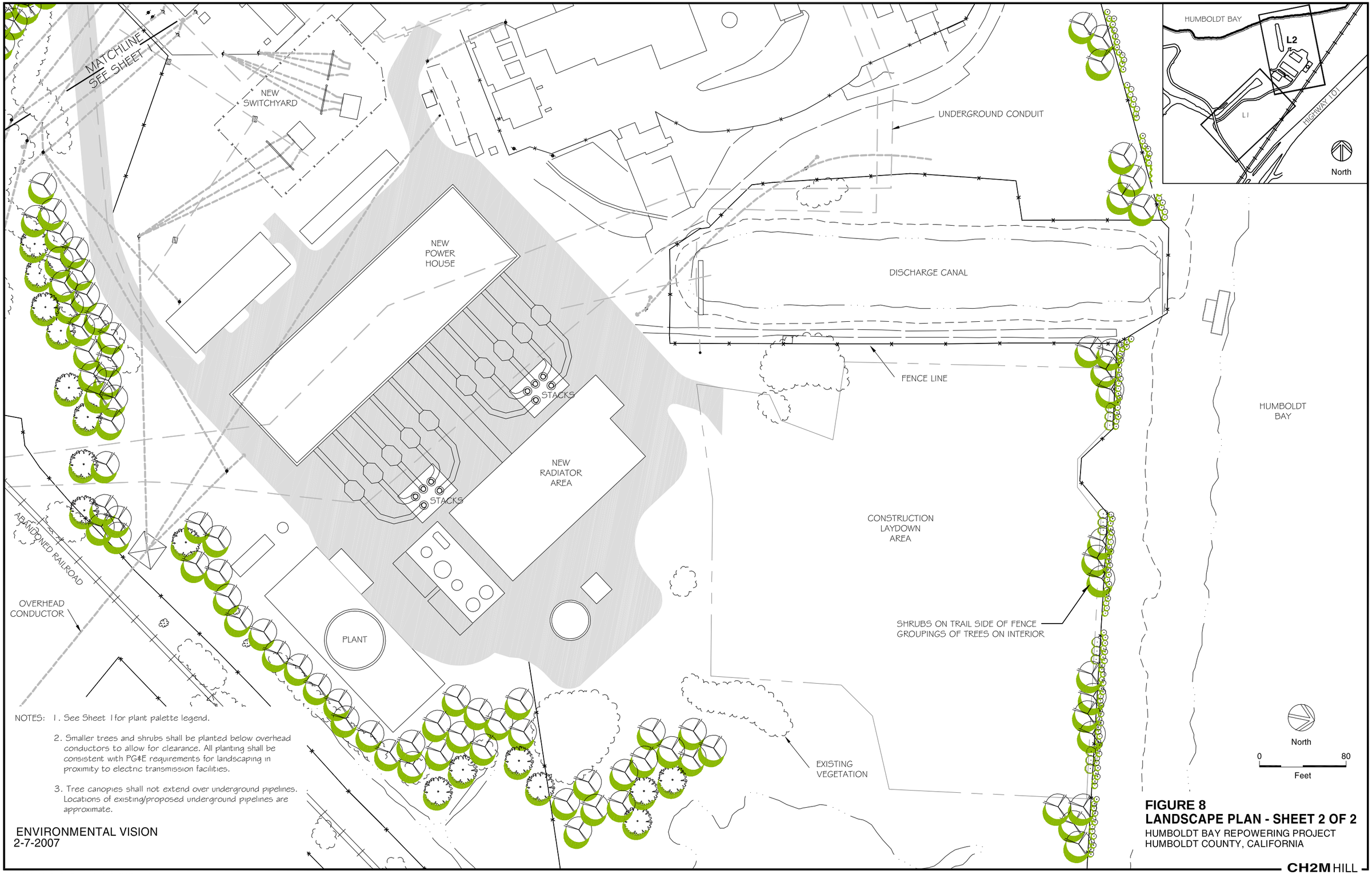
Restoration area 1 (REST-1) is comprised of California Coastal Commission (CCC) wetlands and seasonal wetlands subject to USACE regulations. A road accessing the HBRP construction area will temporarily fill these areas under a USACE permit and CCC approval. As part of the HBRP project, landscape trees will be planted in REST-1 as a visual screen from adjacent properties (Figure 8). The landscape trees planted in CCC wetlands will be natives and suitable for wetland habitats. Additionally, a new stormwater outfall will be constructed as part of this initial work that will remain as part of the facility drainage plan after construction of HBRP is complete (Figure 4). The stormwater outfall will contain oil/water separators prior to leaving the HBRP site. The outfall will be constructed as a vegetated bioswale. Existing drainage ditches will be crossed with culverts.

Vegetation: The CCC wetlands in this site are dominated by ryegrass and birds foot trefoil. They are managed by mowing for security and landscape purposes. Seasonal wetlands that will be filled have dominant plants of water foxtail and pennyroyal.

Hydrology: Wetlands in REST-1 are created by surface water runoff that collects in small depressions in the swales between landscaped berms. These drain north and east to Buhne Slough. Stormwater runoff leaves the HBPP through existing drainage channels and enters Buhne Slough.

Soils: Soils in REST-1 are fill and landscape topsoil from prior construction of the HBPP. These may bury Bayside soils at the edge of the historic Buhne Slough channel. The native soils are buried 5 to 6 feet below the fill.

Wildlife: Deep and steep-sided drainage ditch wetlands provide some escape cover habitat. Hummingbirds and other songbirds use the landscape vegetation for nesting. Northern red-legged frogs and Pacific tree frogs traverse and forage in the open grassland areas between aquatic habitats.



NOTES: 1. See Sheet 1 for plant palette legend.

2. Smaller trees and shrubs shall be planted below overhead conductors to allow for clearance. All planting shall be consistent with PG&E requirements for landscaping in proximity to electric transmission facilities.

3. Tree canopies shall not extend over underground pipelines. Locations of existing/proposed underground pipelines are approximate.

ENVIRONMENTAL VISION
2-7-2007

FIGURE 8
LANDSCAPE PLAN - SHEET 2 OF 2
HUMBOLDT BAY REPOWERING PROJECT
HUMBOLDT COUNTY, CALIFORNIA

CH2M HILL

PO052007001SAC figure_8.ai 07/06/07 tdaus

3.7.1 REST-1 Mitigation Restoration Goals, Objectives, and Performance Standards

Goal 1: Reduce sediment yield to Buhne Slough

Objectives: Establish a bioswale vegetated with perennial wetland species to catch sediments, filter water, and reduce erosion in the tributary to Buhne Slough.

Performance criteria:

- 70% cover in native perennial grasses or herbs in 5 years.
- >50% cover in plants rating FAC, FACW, or OBL.

Goal 2: Provide wildlife habitat.

Objective 1: Restore construction access road to natural vegetation to increase wildlife forage opportunities.

Performance criteria: observe Northern red-legged frog, Pacific tree frog, or other wildlife in grassland area at least one season of the year.

Objective 2: Restore wildlife movement corridor between aquatic habitats of the open water channel and surrounding salt marsh habitats.

Performance criteria: observe Northern red-legged frog, Pacific tree frog, or other wildlife in bio swale area at least one season of the year.

3.7.2 Concept drawings and design rationale

Figure 4 shows the location for the bioswale and stormwater outfall structure. The rationale for diverting water through a vegetated swale is the potential for additional filtration, nutrient recycling, and reduction of channeling in Buhne Slough. Deer are common in the buffer lands and forage in the park-like landscaping around the HBPP. In addition to clean water benefits the bioswale will provide greater wildlife benefits than a culverted drain. The bioswale will contribute landscape value to the larger Buhne Slough environment.

3.7.3 Engineering plans

The engineering plans for the bioswale and stormwater outfall are currently being prepared for contractor use. The location of the bioswale and stormwater outfall is shown on Figure 4. This plan is part of the HBRP construction activities and will occur at the beginning of project construction. Once the construction of HBRP is complete, REST-1 (and other disturbed areas) will be restored and planted with the visual screening landscape trees (Figure 8).

3.7.4 Comprehensive vegetation specifications

Bio Swale: Initial planting of the bioswale will use nursery-grown tufted hairgrass plugs at a density of 1 plant per 2.25 sq. ft. (18-foot centers) in a grid over the 625 sq. ft. (0.01 acre) excavated area. Other species or planting densities could be prescribed by the PG&E botanist or revegetation specialist in charge of the project. Changes to this planting regime would

follow an assessment of soil or hydrologic conditions after construction that suggests other species may be more suited to the site.

Landscape Plan: Figure 8 shows a detailed planting plan for wetland buffer trees and shrubs. Native species including madrone, tanoak, coast redwood, Sitka spruce, and Rhododendron are planned for buffer plantings that will occur in and around restored wetlands. Table 5 provides additional native and locally occurring tree and shrub species suitable for landscape plantings that are rated as hydrophytic plants.

Table 5. Wetland tree and shrub suitable for landscape plantings

Plant Species	Common Name	Life Form	Wetland Rating (Reed 1988)
Lonicera involucrata	twinberry	Shrub	FAC
Ribes nevadense	mountain pink currant	Shrub	FAC*
Myrica californica	wax-myrtle	Shrub	FAC+
Ribes inerme	white-stemmed gooseberry	Shrub	FAC+
Rubus spectabilis	salmon berry	Shrub	FAC+
Physocarpus capitatus	Pacific ninebark	Shrub	FACW
Ribes aureum	golden currant	Shrub	FACW
Ribes divaricatum	spreading gooseberry	Shrub	FACW
Salix sessilifolia	northern sandbar willow	Shrub	FACW
Vaccinium uliginosum ssp. occidentale	western blueberry	Shrub	FACW
Acer macrophyllum	big-leaf maple	Tree	FAC
Cornus sessilis	western cornelian cherry	Tree	FAC
Picea sitchensis	Sitka spruce	Tree	FAC
Pinus contorta ssp. contorta	shore pine	Tree	FAC
Umbellularia californica	California bay	Tree	FAC
Thuja plicata	western red cedar	Tree	FAC+
Populus fremontii ssp. fremontii	Fremont cottonwood	Tree	FAC+*
Populus balsamifera ssp. trichocarpa	black cottonwood	Tree	FACW
Salix laevigata	red willow	Tree	FACW+
Acer circinatum	vine maple	Tree, Shrub	FAC
Acer glabrum	Rocky Mountain maple	Tree, Shrub	FAC
Malus fusca	Oregon crab apple	Tree, Shrub	FAC
Salix scouleriana	Scouler's willow	Tree, Shrub	FAC
Prunus virginiana var. demissa	western choke-cherry	Tree, Shrub	FAC-
Alnus rubra	red alder	Tree, Shrub	FACW
Alnus viridis ssp. sinuata	Sitka alder	Tree, Shrub	FACW
Salix exigua	sandbar willow	Tree, Shrub	FACW
Salix hookeriana	coastal willow	Tree, Shrub	FACW
Salix lasiolepis	arroyo willow	Tree, Shrub	FACW
Salix lucida	shining willow	Tree, Shrub	FACW
Salix melanopsis	dusky willow	Tree, Shrub	FACW
Salix sitchensis	Sitka willow	Tree, Shrub	FACW+
Rubus parviflorus	thimbleberry	Vine, Shrub	FAC+
Rubus ursinus	California blackberry	Vine, Shrub	FAC+
Vitis californica	California wild grape	Vine, Shrub	FACW

Wetland Restoration: Swale and pool topography will be restored to the REST-1 site after HBRP construction is complete.

3.7.5 REST-1 Implementation Plan

Timing: The bioswale will be planted during the HBRP construction phase. Visual screen landscape trees will be planted after construction is complete.

Planting: Contract grown or salvaged tufted hairgrass plants in revegetation containers will be planted in the excavated area during Spring 2008.

BMPs will be prescribed to prevent erosion or sedimentation into Buhne slough while vegetation is becoming established.

Biological Monitoring: a qualified biologist will be on site during restoration activities to move wildlife such as Northern red-legged frog, Pacific tree frog, snakes, and others as necessary to minimize adverse affects to the local populations.

SECTION 4

Monitoring Program

The following field methods and study design will be used to quantify success criteria. A finding of no significant difference in the observed responses to the success criteria will be found when measured values reach success criteria values at the 5% significance level (alpha 0.05).

Vegetation Responses: Cover, Diversity and Canopy Structure Plots

Measurement of vegetative cover by species will be stratified by vegetation zones. The zones will correspond to CCC perennial herbaceous wetlands, USACE seasonal wetland, riparian/marsh, and salt marsh. Three sets of nested plots will be randomly established in each homogeneous vegetation zone. A total of 30 sample plots will be examined for visual estimates of total plant cover, and cover for each species. The canopy structure will be assessed with estimates of height distribution. An overall list of all species found in the target vegetation zones will be compiled. Vegetation Cover, Diversity and Canopy Structure plots will be permanently marked and sampled monthly for the first two years after planting and twice a year after that during April and October. Data sheets will be used to record data for the monitoring efforts.

Hydrology: Long Duration Ponding or Saturation Observations

The extent of soil saturation and inundation and duration of ponding will be measured after major rainfall or during seasonal high tide events. Initial observations will be followed weekly for three weeks or until the next precipitation depth of ponding or saturation and will be measured with staff gauges and soil cores. The extent of positive ponding or saturation indicators will be mapped during each sampling period.

Wildlife: Habitat use surveys that record direct and indirect (signs of scat, tracks, nests, feathers) observation of wildlife using each of the mitigation areas. The wildlife surveys would be conducted four times per year, once per season. Wildlife surveys would continue for at least 5 years. Data sheets will be used to record data for the monitoring efforts.

SECTION 5

Mitigation Implementation and Monitoring Timeline

Table 6 summarizes the timeline for implementing construction and restoration of wetland habitats and the monitoring schedule for each of the mitigation areas. The monitoring is proposed for 5 years, during and following completion of HBRP construction.

TABLE 6
Timeline for Wetlands Mitigation and Monitoring

2007-2008	2007 Fall	2008 Winter	2008 Spring	2008 Summer
MIT-1 Wetland Creation	Conduct baseline wildlife surveys	Conduct baseline wildlife surveys	Remove Pampas Grass Monitor regeneration Conduct baseline wildlife surveys	Monitor weeds, monitor hydrology and colonization of native species bimonthly for 4 months Conduct baseline wildlife surveys
MIT-2 Wetland Creation	Conduct baseline wildlife surveys	Prescribe Planting/seeding Conduct baseline wildlife use survey	Native Plant Salvage Install downstream BMPs. Grade site before rains Sample soils/amendments Monitor hydrology and salinity Monitor Natural Colonization Control Weeds Plant Nursery Stock Conduct baseline wildlife use survey	Maintain BMPs Monitor hydrology and salinity Monitor natural colonization Monitor weeds Monitor Nursery Stock Conduct baseline wildlife use survey
MIT-3 Salt Marsh Enhancement	Conduct baseline wildlife surveys	Conduct baseline wildlife surveys	Remove Dense Cordgrass Plant Nursery Stock Monitor weeds Monitor Reveg Survival Conduct wildlife use survey	Mow and Cover Dense Cordgrass Maintain Cordgrass Cover Monitor weeds Monitor Reveg Survival Conduct wildlife use survey
MIT-4 Riparian Enhancement	Conduct baseline wildlife surveys	Conduct baseline wildlife surveys	Mark and Remove Exotics Plant Nursery Stock Conduct baseline wildlife use survey	Monitor weeds Monitor Reveg Survival Conduct baseline wildlife use survey
MIT-5 CCC Wetlands Enhancement	Mark and Remove Exotics Plant Nursery Stock Conduct baseline wildlife use survey	Monitor weeds Monitor Reveg Survival Conduct baseline wildlife use survey	Monitor weeds Monitor Reveg Survival Conduct baseline wildlife use survey	Monitor weeds Monitor Reveg Survival Conduct baseline wildlife use survey

TABLE 6
Timeline for Wetlands Mitigation and Monitoring

2007-2008	2007 Fall	2008 Winter	2008 Spring	2008 Summer
REST-1 Access Road Restoration	Conduct baseline wildlife surveys	Conduct baseline wildlife surveys	Construct BioSwale: Maintain BMPs Monitor sedimentation, erosion, hydrology and salinity Plant tufted hair grass Monitor natural colonization Monitor weeds Monitor Nursery Stock Conduct baseline wildlife use survey	BioSwale: Maintain BMPs Monitor hydrology and salinity Monitor natural colonization Monitor weeds Monitor Nursery Stock Conduct baseline wildlife use survey
First Monitoring Report Due Winter 2008 – Describe As-Built Conditions				

2008-2009	2008 Fall	2009 Winter	2009 Spring	2009 Summer
MIT-1 Wetland Creation	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey
MIT-2 Wetland Creation	Maintain BMPs Monitor weeds Establish vegetation sampling Sample vegetation Conduct wildlife use survey	Maintain BMPs Monitor weeds Conduct wildlife use survey	Maintain BMPs Sample Vegetation Monitor hydrology Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey
MIT-3 Salt Marsh	Maintain Cordgrass Cover Monitor weeds Establish vegetation sampling Sample Vegetation by zone Conduct wildlife use survey	Maintain Cordgrass Cover Monitor weeds Order Nursery Grown Natives Conduct wildlife use survey	Uncover cordgrass Plant Native Nursery Stock Monitor weeds Sample vegetation by zone Conduct wildlife use survey	Monitor weeds Monitor Nursery Stock Conduct wildlife use survey
MIT-4 Riparian	Monitor weeds Monitor nursery stock Establish vegetation sampling Sample vegetation Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Monitor weeds Monitor nursery stock Sample vegetation Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey
MIT-5 CCC Wetlands	Monitor weeds Monitor Reveg Survival Establish vegetation sampling Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Monitor weeds Monitor Reveg Survival Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey
REST-1 Access Road	BioSwale: Maintain BMPs Monitor hydrology Monitor weeds Monitor Nursery Stock Establish vegetation sampling Sample vegetation Conduct wildlife use survey	BioSwale: Maintain BMPs Monitor weeds Conduct wildlife use survey	BioSwale: Maintain BMPs Sample vegetation Monitor weeds Conduct wildlife use survey	BioSwale: Monitor weeds Conduct wildlife use survey
Second Monitoring Report Due Winter 2009 – Assess Performance Criteria				

2009-2010	Fall	Winter	Spring	Summer
MIT-1 Wetland Creation	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey
MIT-2 Wetland Creation	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Sample Vegetation Monitor Hydrology Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey
MIT-3 Salt Marsh	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Sample Vegetation Monitor Hydrology Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey
MIT-4 Riparian	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Sample Vegetation Monitor Hydrology Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey
MIT-5 CCC Wetlands	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Sample Vegetation Monitor Hydrology Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey
REST-1 Access Road	BioSwale: Monitor weeds Conduct wildlife use survey	BioSwale: Monitor weeds Conduct wildlife use survey	BioSwale: Sample Vegetation Monitor hydrology Monitor weeds Conduct wildlife use survey	BioSwale: Monitor weeds Conduct wildlife use survey
Third Monitoring Report Due Winter 2010—Assess Performance Criteria/ Need for Remediation				

2010-2011	Fall	Winter	Spring	Summer
MIT-1 Wetland Creation	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey
MIT-2 Wetland Creation	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Sample Vegetation Monitor Hydrology Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey
MIT-3 Salt Marsh	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Sample Vegetation Monitor Hydrology Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey
MIT-4 Riparian	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Sample Vegetation Monitor Hydrology Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey
MIT-5 CCC Wetlands	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Sample Vegetation Monitor Hydrology Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey
REST-1 Access Road	BioSwale: Monitor weeds Conduct wildlife use survey	BioSwale: Monitor weeds Conduct wildlife use survey	BioSwale: Sample Vegetation Monitor Hydrology Monitor weeds Conduct wildlife use survey	BioSwale: Monitor weeds Conduct wildlife use survey
Fourth Monitoring Report Due Winter 2011—Assess Performance Criteria/ Need for Remediation				

2011-2012	Fall	Winter	Spring	Summer
MIT-1 Wetland Creation	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey
MIT-2 Wetland Creation	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Sample Vegetation Monitor Hydrology Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey
MIT-3 Salt Marsh	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Sample Vegetation Monitor Hydrology Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey
MIT-4 Riparian	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Sample Vegetation Monitor Hydrology Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey
MIT-5 CCC Wetlands	Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey	Sample Vegetation Monitor Hydrology Monitor weeds Conduct wildlife use survey	Monitor weeds Conduct wildlife use survey
REST-1 Access Road	BioSwale: Monitor weeds Conduct wildlife use survey	BioSwale: Monitor weeds Conduct wildlife use survey	BioSwale: Sample Vegetation Monitor Hydrology Monitor weeds Conduct wildlife use survey	BioSwale: Monitor weeds Conduct wildlife use survey
Fifth Monitoring Report Due Winter 2012 – Assess Performance Criteria/ Need for Remediation				

SECTION 6

Remedial Action Plan

Post-construction landform remediation (adjustments to wetland depths/contours) may be prescribed to obtain appropriate water depths in constructed basins. Opportunities for landscape changes to MIT-2 (if necessary) will be available post-HBRP construction and in conjunction with implementation of MIT-1 and REST-1 when construction equipment is available and on site. MIT-1 and REST-1 will be implemented after HBRP construction since these areas will be used as part of the construction access and parking.

Secondary weed treatment will be prescribed as needed.

Adaptive management of the wetland Preserve will be used during the monitoring period. Adaptive management for this plan is broadly defined as a method for examining alternative strategies for meeting measurable biological goals and objectives, and then, if necessary, adjusting future management actions according to what is learned. The adaptive strategies will be derived from the results of annual monitoring and additional knowledge gained from external sources regarding the management of wetland habitats.

No single management strategy has been developed for wetland habitats. The Preserve will be subject to a complex and variable set of environmental factors. Therefore, the success of this plan will rely on the allowance for adaptive management. The expected variables will likely include but are not limited to 1) annual fluctuating hydrologic conditions, 2) annual fluctuating weather conditions, 3) the viability of plantings, and 4) invasion of noxious weeds. The Management strategies will be reevaluated by PG&E and its botanist, CEC, CCC, and USACE on an annual basis or as necessary.

Any remediation, including any single action or combination of soil amendments, replanting, reseeding, or alternating species will initiate a new monitoring session.

SECTION 7

Operations and Maintenance Plan

PG&E will record a legal deed restriction over mitigation areas MIT-1 through MIT-4, collectively known as the Buhne Point Wetlands Preserve prior to project construction. After mitigation success criteria are met, PG&E will be responsible for the upkeep and maintenance of the mitigation site. These responsibilities will include keeping the site free of litter, major infestations of noxious weeds, and populations of feral animals including cats, domestic ducks, or other escaped or released pets or farm animals, and protect against unlawful trespass. Protection of the Preserve will be addressed during any proposed land use changes on adjoining PG&E property that may result in detrimental changes in site hydrology or vegetation. Public access to the site will be allowed for scientific research or educational or artistic uses (photography, painting) and will be facilitated by PG&E for all legitimate written requests. The status of the site including any maintenance actions taken over the year will be included as part of the annual monitoring report that will be submitted to the California Energy Commission, USACE, and California Coastal Commission.

SECTION 8

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APPENDIX A

Conceptual Hydrology Assessment for Buhne Point Wetlands Preserve

Conceptual Hydrology Assessment for Buhne Point Wetlands Preserve

PREPARED FOR: Debra Crowe

Virginia Dains

PREPARED BY: Paul Frank

Anthony Falzone

DATE: June 11, 2007

PROJECT NUMBER: 344005.DY.DR.00

Executive Summary:

Pacific Gas and Electric (PG&E) plans to expand/create wetland habitat on a portion of the 143-acre property supporting the Humboldt Bay Power Plant in Humboldt County, California. This wetland creation project is on-site mitigation to account for environmental impacts associated with the proposed Humboldt Bay Repowering Project (HBRP). The wetland mitigation project site is located on the western portion of the property owned by PG&E that currently supports salt and fresh water wetlands and upland areas.

Water supply is a primary factor limiting the extent of wetlands at the project site as surrounding areas are developed as part of the King Salmon community. PG&E contracted CH2M HILL to provide design plans for the wetland expansion and to determine whether the existing water supply is sufficient to maintain wetland functions following the wetland expansion. The U.S. Army Corps of Engineers (USACE) describes a wetland as an area that is inundated or saturated to the surface continuously for at least 5% of the growing season in most years (50%probability of recurrence). These areas are wetlands if they also meet hydrophytic vegetation and hydric soil requirements. (HQUSACE, 7 Oct 91 and 6 Mar 92). At the project site the assumed growing season occurs between February 1 and December 31, consequently, the corresponding hydroperiod for wetland designation is 334 days.

CH2M HILL performed a hydrologic investigation to determine basic hydrologic data for the wetland design on the site by estimating the frequency of wetland inundation at depths equal to or greater than 3 inches and 6 inches for a variety of wetland sizes. The wetland analysis took advantage of the linked hillslope and wetland hydrologic model capabilities of the **S**oil-**P**lant-**A**ir-**W**ater (SPAW) model (software and documentation available at http://hydrolab.arsusda.gov/SPAW/Index.htm). Input to the SPAW model includes project site geology, soil, vegetation and climatic characteristics. From these analyses, a relationship between wetland size, wetland seepage rate, and the yearly frequency the wetland hydrologic criteria is met was developed.

1. Introduction

1.1. Purpose

Virginia Dains, project botanist for Burleson Consulting, Inc., proposed the current site as a potential mitigation site to PG&E and CH2M HILL. Virginia Dains and CH2M HILL conducted an initial evaluation of the mitigation site and potential wetland creation/enhancement opportunities.

CH2M HILL, in conjunction with Virginia Dains, has conducted additional visits and developed a conceptual plan for wetland creation. To determine if the conceptual designs for wetland creation are feasible, CH2M HILL wetland engineer and geomorphologist performed a hydrologic investigation to determine the frequency of wetland inundation at depths equal to or greater than 3 or 6 inches for a variety of wetland sizes.

1.2. Project Location

The proposed mitigation area, identified as the Buhne Point Wetlands Preserve, will be located on the PG&E property approximately 3 miles southwest of downtown Eureka (Figure 1), on the east side of Humboldt Bay. This area can be found on the United States Geological Survey (USGS) Fields Landing, California, 7.5-minute quadrangle. The site is just north of the King Salmon community in unincorporated Humboldt County and is within the sphere of influence of the City of Eureka. The site is zoned Coastal-Dependent Industrial and is within the jurisdiction of the California Coastal Commission.

Buhne Point is a small peninsula along the eastern edge of Humboldt Bay. The site is located off Highway 101 on the north side of King Salmon Avenue, west of the old Northwestern Pacific Railroad tracks, and the north shoreline of Buhne Point. The Humboldt Bay Power Plant on the 143-acre site has been operating for more than 50 years.

1.3. Tasks

The tasks listed below were accomplished to complete this project:

- A site visit March 27, 2007 to measure detailed topographic elevations.
- Climatic, geologic and soil conditions of the site were investigated.
- Hillslope and wetland hydrology were modeled to determine inflow rates over time and the frequency and duration of wetland inundation. Wetland hydrology models were developed for wetlands of various sizes.
- This report was written to discuss the methods and results of the study.

2. Project Site Description:

2.1. Background

Site characteristics are an important consideration in creating and restoring wetlands. An understanding of site soils, vegetation, and climatic conditions is necessary to model both

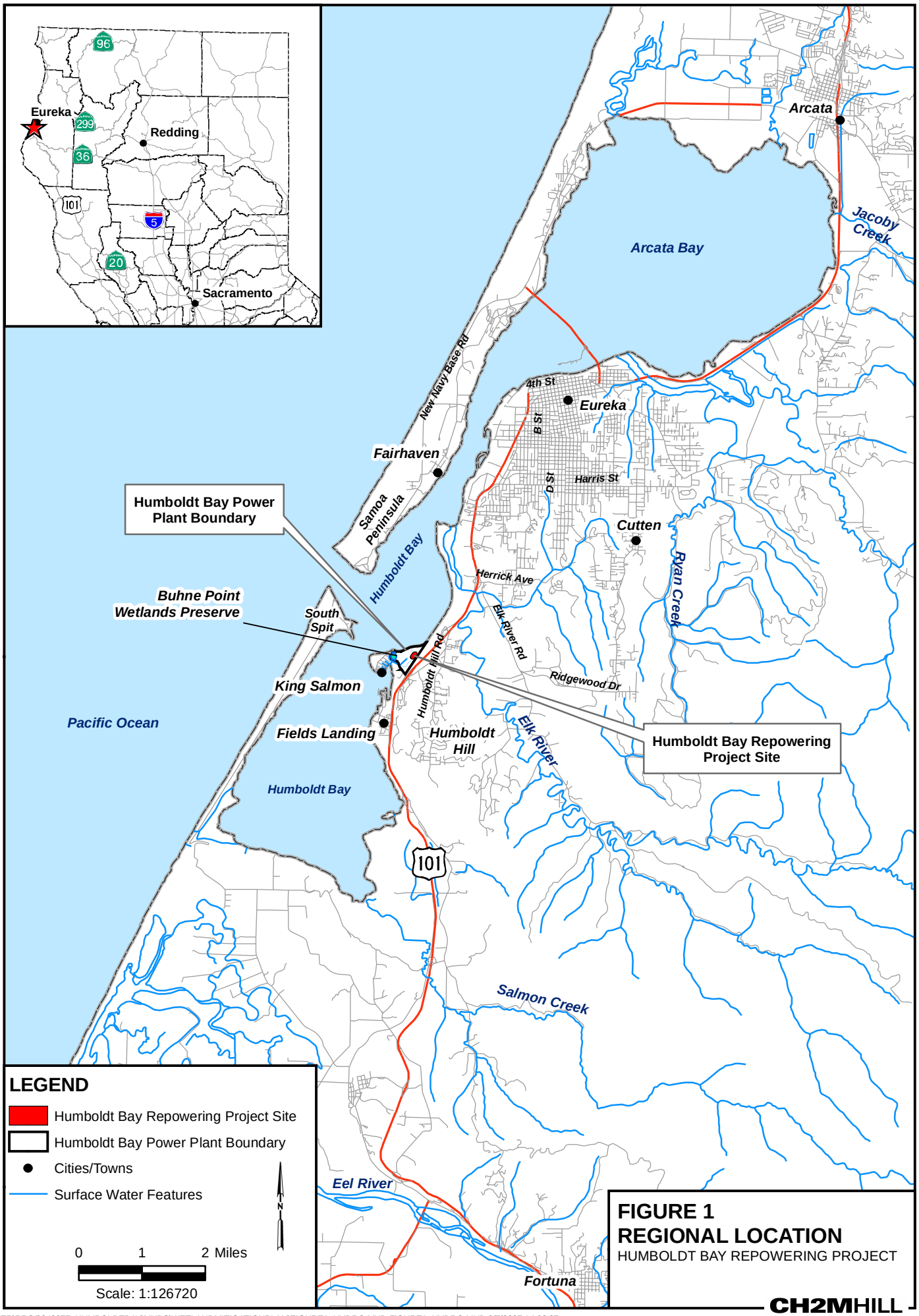

FIGURE 1
REGIONAL LOCATION
HUMBOLDT BAY REPOWERING PROJECT

CH2MHILL

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hillslope and wetland hydrology. Several parameters used to describe wetland hydrology include the depth and duration of the wetland inundation.

2.2. Site conditions

Buhne Point, on the eastern shore of Humboldt Bay, is directly across from the opening between the South Spit and Samoa Peninsula that separates the Pacific Ocean from Humboldt Bay. The Humboldt Bay watershed encompasses approximately 225 square miles containing Douglas fir and redwood forests (primarily private landownership and commercial timber production east of Highway 101), pastured grasslands, wetlands, and rivers and creeks (tributaries to the Bay) (AFC, 2006). Elevations at the project site range from mean sea level to approximately 80 feet on Buhne Point in the northern edge of in the study area. Most of the study site is vegetated with wetland and upland vegetation. It is comprised of flat topography with slight undulations and small depressions within the existing wetland channels. An existing saltwater wetland is located in the southeastern portion of the study site. An abandoned parking lot has been reclaimed by upland vegetation in the western portion of the study site.

A drainage area of about 1.31 acres drains to the proposed mitigation wetland 1 (MIT-1) and about x1.04 acres drains to the proposed mitigation wetland 2 (MIT-2) (Figure 2). Both proposed mitigation sites are located in the western portion of the study area. Approximate drainage area boundaries are depicted on Figure 2. The drainage area boundaries were determined by analysis of available topographic contour data and visual observations of likely site drainage patterns conducted during field reconnaissance conducted in March of 2007.

2.3. Climate

The climate in the Eureka area is maritime, with a mean annual temperature of 53 F (with extremes ranging from 21 to 87 F); mean annual yearly precipitation of 38 inches, and partial or full cloud cover two-thirds of the year on average. The predominant wind directions are from the north, and the average wind speed is 7 miles per hour (Western Regional Climate Center, 2006 cited in AFC, 2006).

Eureka climate is categorized as a Marine West Coast Climate with moderate temperatures and relatively small seasonal fluctuations in temperatures due to its proximity to the Pacific Ocean. Summers have little or no rainfall and low fog is common. Winters are wet, with storms coming off the Pacific Ocean. The region experiences high levels of humidity throughout the year. Humidity averages 87 percent at night and early mornings and 78 percent in the late morning and early evenings (Pacific Gas and Electric Company [PG&E], 2003 cited in AFC 2006).

Precipitation in Eureka is representative of the rainfall amounts at the project site. The rainy season generally occurs from October through April, which is when Eureka receives about 90 percent of its rainfall, with the heaviest rainfall occurring in December and January. Average annual rainfall is 38.87 inches. (PG&E, 2003 cited in AFC 2006)

The site is located on a relatively flat area at an elevation of 12 feet MLLW. Humboldt Bay is a large, shallow body of water with deep channels that is separated from the ocean by two long, narrow spits (Somoa Peninsula and South Spit). It is a tidal bay that receives and

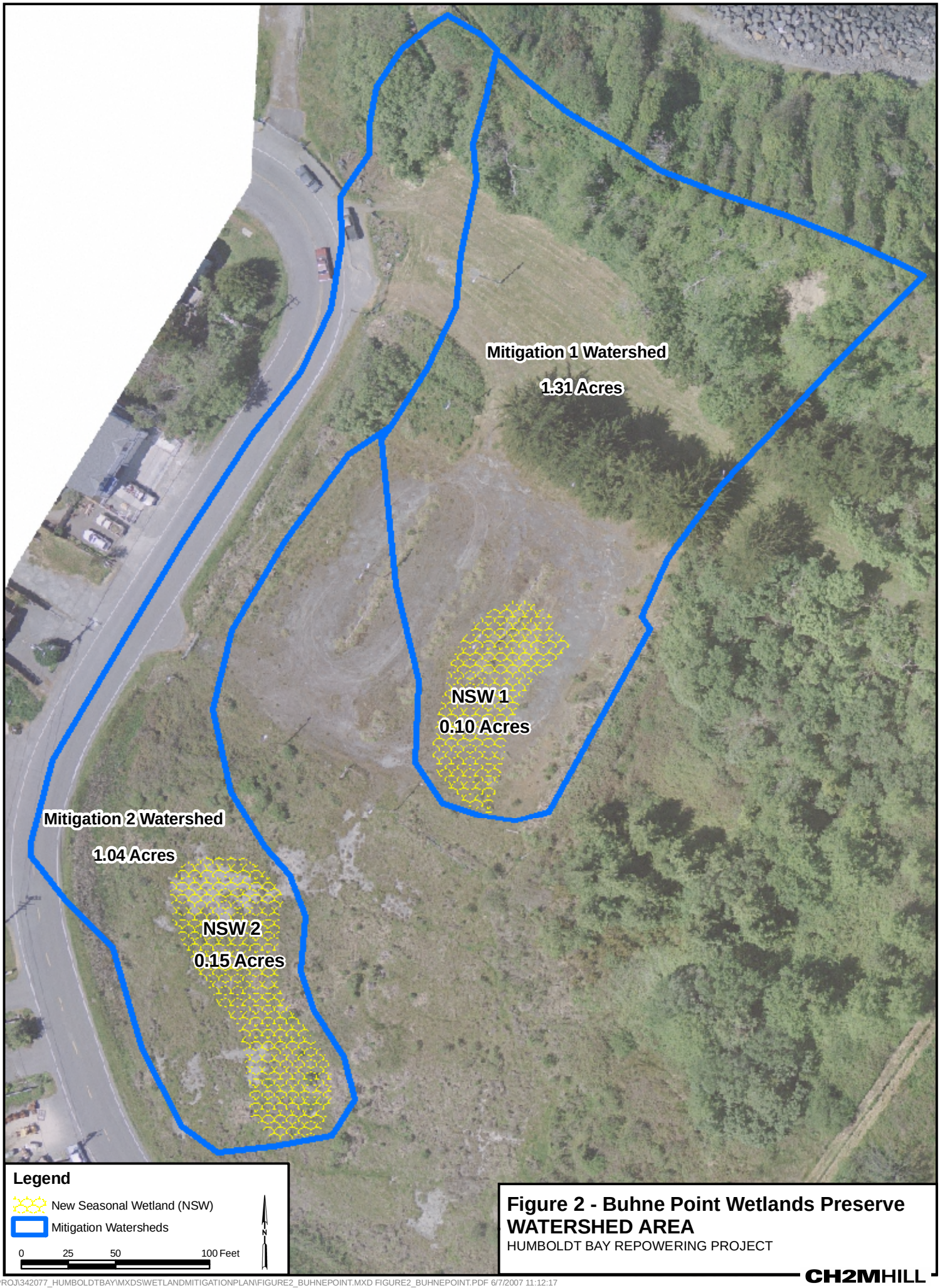

Figure 2 - Buhne Point Wetlands Preserve WATERSHED AREA

HUMBOLDT BAY REPOWERING PROJECT

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discharges ocean water through its inlet. The bay is approximately 14 miles long, and ranges in its width from 0.5 miles in the middle to more than 2 miles at the south end and 4 miles at the north end. The average depth is 12 feet mean lower low water (MLLW). Tidal influences in the bay are moderate, ranging between 4.3 and 7.0 feet throughout. Due to its shallow depth, water quality conditions in the ocean have large influence in water quality in the bay itself (AFC 2006).

2.4. Site Soils

The U. S. Department of Agriculture soil survey for Humboldt County is only partially complete. The study area, as well as, most of the county is listed as incomplete in the survey (USDA 2007). Soils within the western section of the County were surveyed in 1965 (Figure 3) in a joint effort by the University of California Davis and Humboldt County (McLaughlin and Harradine, 1965). Soils were rated for overall quality using for the following four factors: (1) character of the soil profile and its depth; (2) soil texture, slope, and nutrient level; (3) soil reaction (pH); and (4) susceptibility to erosion. The four factors are multiplied together to produce a composite rating index in accordance with the Storie Index Rating.

Storie Index Rating 1 soils (rating between 80 and 100) are well suited to general intensive agriculture. Grade 2 soils (rating between 60 and 80) are moderately suited for agricultural uses. Grade 3 soils (rating between 40 and 60) are only fairly suited for agricultural uses. Grades 4, 5, and 6 soils have poor suitability for agriculture uses. Table 8.11-1 of the AFC describes the soil mapping unit properties found at the HBRP site and within 1 mile of the surrounding area. Soils on the project site are most likely derived from young alluvial sediments of the Kerr Ranch, Franciscan, Yager, Wildcat, and Hookton formations that occupy floodplains, basins, and alluvial fans. The soil type at the HBRP is mapped as "UI," indicating previously improved areas under residential, business, and industrial uses that are not specifically mapped.

Several subsurface investigations have been completed at the Humboldt Bay Power Plant property during which soil borings were collected (Pacific Gas and Electric Company [PG&E], 1985, 1987, 1988, 1989 cited in AFC 2006), (Woodward-Clyde, 1985, cited in AFC 2006). Actual soil conditions in the project area could differ from what is described in the generalized soil descriptions because of the local grading and the presence of imported fill. Information from these investigations confirms that soil at the HBRP site is primarily Hookton silty clay loam, Hk5 (PG&E, 2002, cited in AFC 2006) with some areas overlain by Bayside silty clay loam deposits, Ba6, as described below.

• **[Hk5] Hookton silty clay loam, eroded, 3 to 8 percent slope**. This soil occurs on the gently sloping dissections of the Hookton formation. The Hookton formation consists of interbedded shallow-water marine, estuarine, and fluvial deposits of sand, silty sand, chert-rich gravel, and clay that is about 1,100 feet thick below the site. This soil has a Storie Index Rating of 3.

• **[Ba6] Bayside silty clay loam, very poorly drained, 0 to 3 percent slope.** This soil is in very low lying areas of the Bayside and overlies the Hookton formation. Bayside soils are imperfectly to poorly drained, fine-textured basin soils, developed in sedimentary alluvium from the Franciscan and Wildcat formations in the North Coast Range Mountains. They

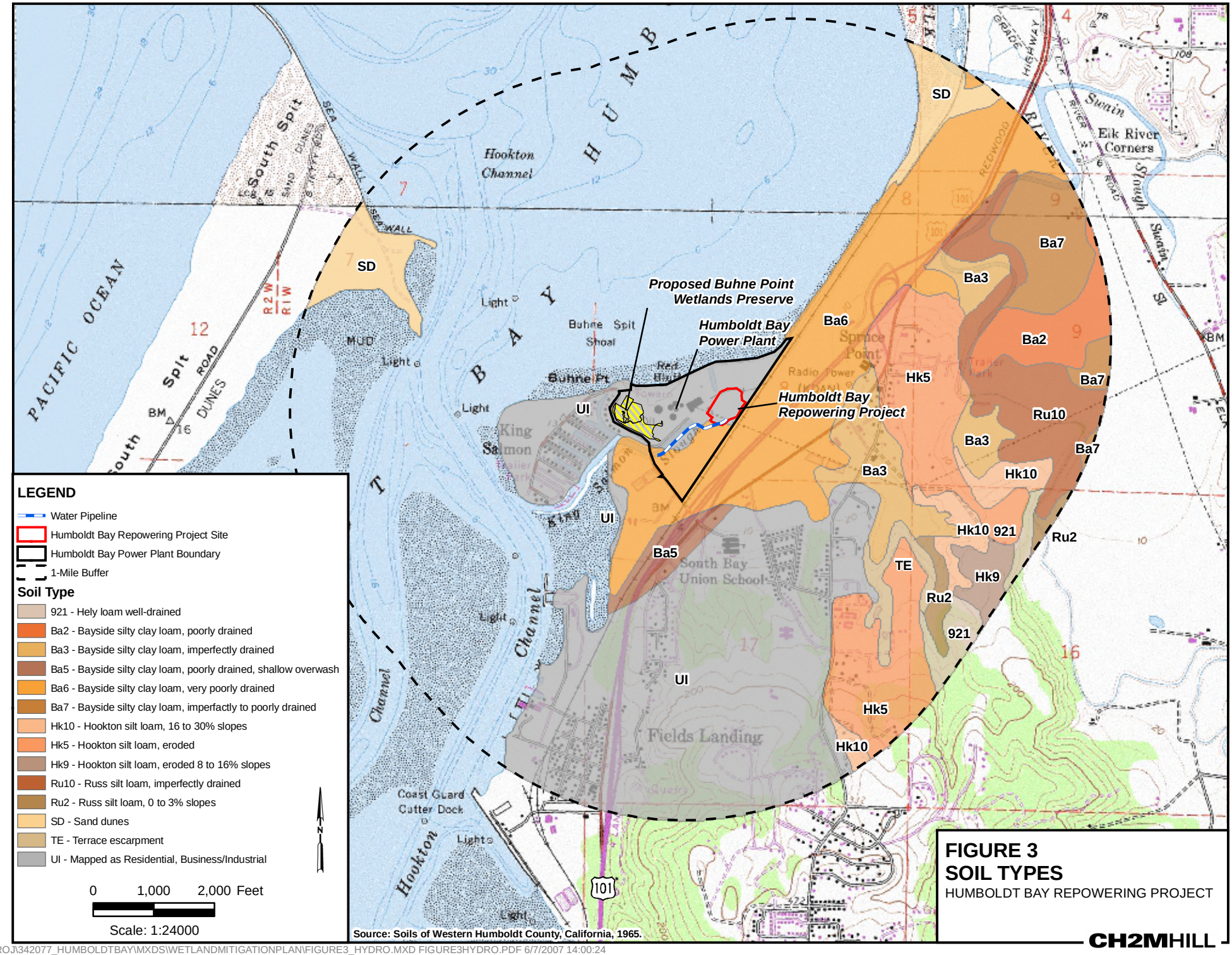

FIGURE 3
SOIL TYPES
HUMBOLDT BAY REPOWERING PROJECT

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occur at elevations from sea level to above 50 feet within about a 10-mile perimeter of Humboldt Bay. This soil has a Storie Index Rating of 5.

3. Analysis Method

The objective of this analysis was to provide basic hydrologic data for the wetland design by estimating the frequency of wetland inundation for a variety of wetland sizes and soil seepage rates.

The **S**oil-**P**lant-**A**ir-**W**ater (SPAW) model (software and documentation available at http://hydrolab.arsusda.gov/SPAW/Index.htm) was used to model runoff from the contributing watersheds for Mitigation Areas 1 and 2 and inundation in the mitigation areas themselves. The SPAW model was designed to simulate the hydrology associated with both agricultural landscapes (Fields) and impoundments such as wetland ponds, lagoons or reservoirs (Ponds). SPAW is divided into two sub-models: the Field model and the Pond model. The SPAW Field model estimates a daily vertical, one-dimensional water budget of all major hydrologic processes such as runoff, infiltration, evapotranspiration, soil water profiles and percolation. The SPAW Pond model provides water budgets by multiple input and depletion processes for impoundments. Typical applications include analyses of wetland inundation duration and frequency, wastewater storage designs, and reliability of water supply reservoirs.

The SPAW Pond model uses output from the SPAW Field model to estimate depths, areas, and durations of inundation for impoundment's fed by runoff from previously modeled drainage areas in the Field model. This analysis required the use of both the SPAW Field and SPAW Pond models. Figure 4 presents a flow chart representing the SPAW Field and Pond models used in this analysis. Note that each model uses similar climate data and that the output from the SPAW Field model is input part of the input data for the SPAW Pond model.

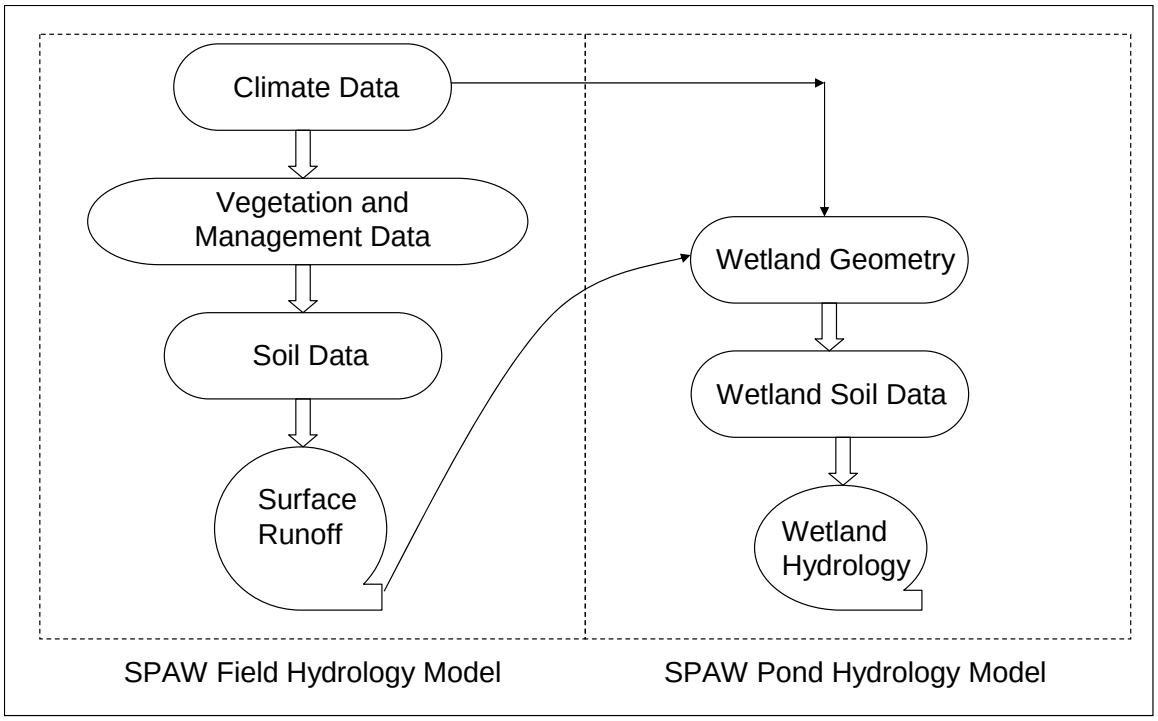

Figure 4. Flow chart illustrating the data inputs to the SPAW Field and Pond models and the linkages between the each model.

4. Data Requirements and Model Inputs

The SPAW Field hydrology is described by: 1) a daily climatic descriptions of rainfall and temperature, 2) monthly descriptions of evaporation, 3) a soil profile of interacting layers each with unique water holding characteristics, and 4) annual crop/vegetation growth with management options for rotations, irrigation and fertilization. Input data for use in modelling the proposed mitigation wetlands was obtained from the following sources:

1) Climatic data -- daily rainfall and air temperature records from 1941 to 2007 were purchased from the National Climatic Data Center (http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwDI~StnSrch~StnID~20003155).

2) Yearly evaporation for Eureka, California and monthly distribution of evaporation for were obtained from the Western Regional Climate Center (WRCC). Yearly evaporation for Eureka was obtained from a national evaporation contour map (http://www.wrcc.dri.edu/climmaps/). Monthly evaporation distribution for Eureka was assumed to be similar to that of San Francisco, which was the closest location for which a monthly distribution was available (http://www.wrcc.dri.edu/htmlfiles/westevap.final.html#CALIFORNIA).

3) The project site is dominated by the Bayside soil series. Required information on this soil type was obtained from the United States Department of Agriculture (http://ortho.ftw.nrcs.usda.gov/osd/dat/B/BAYSIDE.html).

4) Groundwater and Soil Infiltration data. Water losses from the mitigation wetlands to groundwater (and seepage from groundwater into the wetland during periods of elevated water table) are dependent on both soil infiltration rates and groundwater table elevation. Data are not available for either of these parameters at the proposed mitigation sites. Because such information is important for accurate calculation of wetland water budget, modelling results presented in this report are subject to verification of assumed water table elevations and soil infiltration rates. A range of soil infiltration rates (0.05 in/d, 0.5 in/d, 1.0 in/d, and 2.0 in/d) for general soil types similar to Bayside series were used (Rawls et al 1998). Assumptions about water table elevations at the power plant site as described in the Draft Geotechnical Investigation Report (Kleinfelder 2006) provided an estimate of seasonal groundwater conditions (ranging from at ground surface during the wet season to approximately five feet below ground surface during the dry season).

5) The project site was divided into two vegetation types -- wooded areas (riparian marsh RM-1) and grassed areas (old parking lot and fill areas). Vegetation growth input data were created from known vegetation characteristics and assuming no crop management of any kind (such as irrigation, fertilization, etc.).

The SPAW Field model was run for three "fields" or drainage area types, depending on vegetation. One approximated the heavily wooded slope area north of the project site, one approximating the generally open, grassed areas, and the third representing runoff from King Salmon Avenue. Together, these three “fields” encompass the contributing watershed areas to both mitigation areas as shown in Figure 2. Table 1 summarizes acreages of each of the watershed areas by type as modelled by SPAW.

TABLE 1. SUMMARY OF ACREAGES OF CONTRIBUTING WATERSHED LAND TYPES FOR MITIGATION AREAS 1 AND 2

Land Type	Area (ac)
MITIGATION AREA 1 Watershed	
Wooded	0.52
Grassed	0.79
MITIGATION AREA 2 Watershed	
Wooded	0.09
Grassed	0.81
Roadway	0.14

The SPAW Pond model was then run using output from the SPAW Field model for the seasonal wetlands proposed in Mitigation Areas 1 and 2. The modelling process was used to determine whether sufficient runoff exists to provide for wetland (saturated soils) conditions for a minimum of 20 consecutive days during the growing season over the

period of modelling record (1941-2007). For the purposes of modelling, the growing season for the project site was defined as February 1 through December 31, because this corresponds to the average frost-free period (McLaughlin and Harradine 1965).

The SPAW model requires input of wetland geometry as a table of depths (ranging from 0 feet at the lowest point of the wetland basin to the height of the top of the basin) and corresponding surface areas (the corresponding area of the water surface at each depth specified). Simplified depth-area tables were calculated for each of the two mitigation areas assuming uniform side slopes, flat bottoms, and a small portion of the downstream end of each mitigation area excavated 18 inches deeper to facilitate the growth of emergent plant species such as cattails and bulrush. Figures 5a through 5d depict cross-sections and longitudinal profiles of the simplified geometries for each mitigation area. Note that cross-sections and longitudinal profiles presented here are simplified sections used in calculation of depth-area relationships for the purposes of modelling, and are therefore only conceptual abstractions of the actual intended shape and dimension of the mitigation area wetlands. It was assumed during modelling that "inundation" of a portion of the wetland meant that any depth of standing water was present above the ground surface of that area.

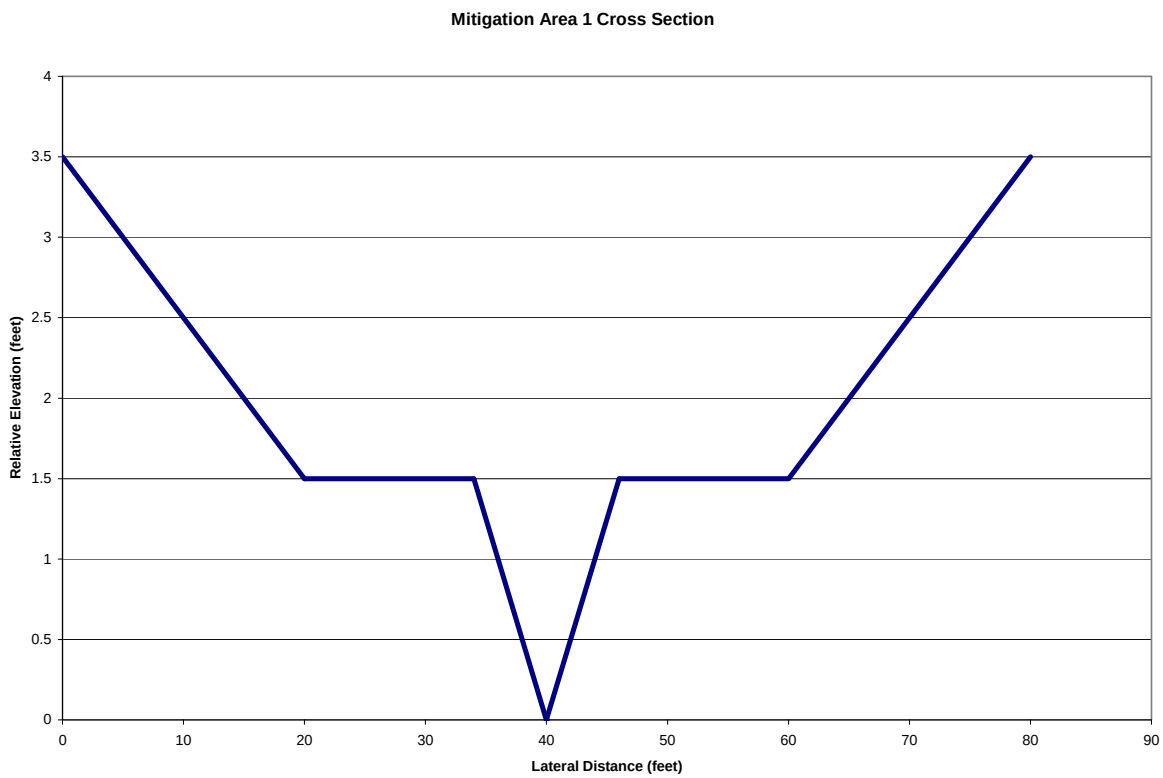

Figure 5a. Conceptual Cross-Section for Mitigation Area 1 As Used in SPAW Model

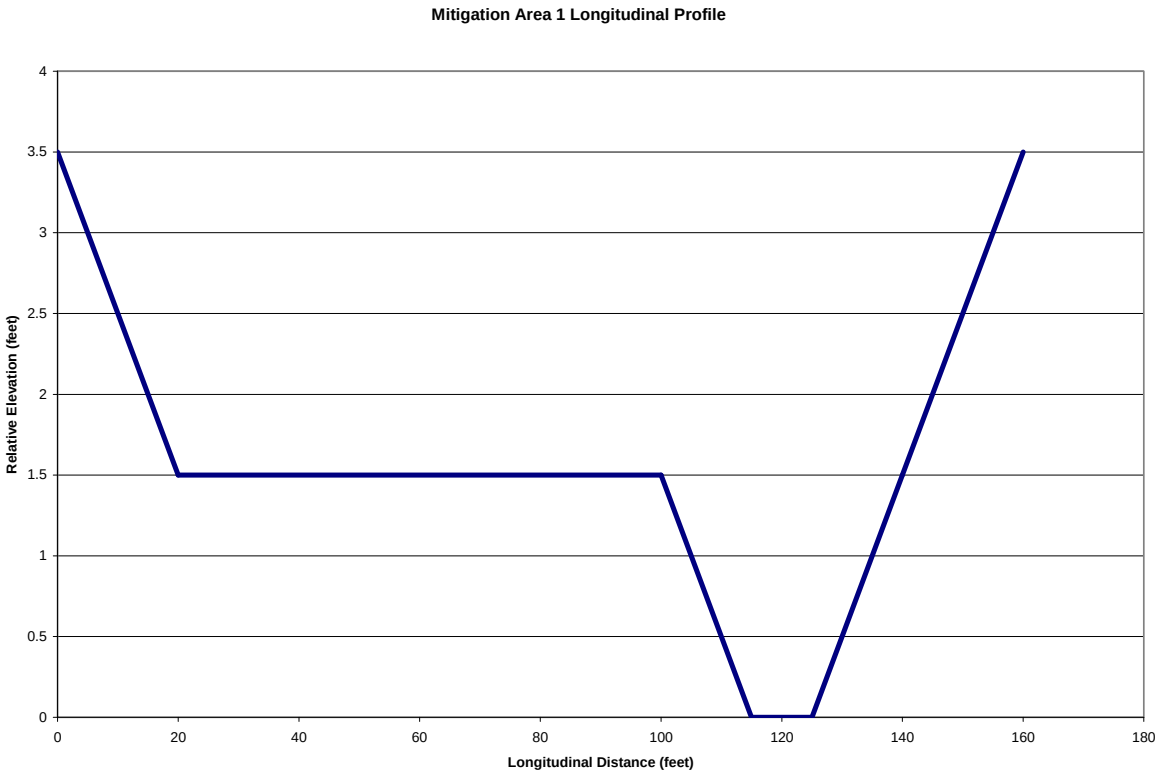

Figure 5b. Conceptual Longitudinal Profile for Mitigation Area 1 As Used in SPAW Model

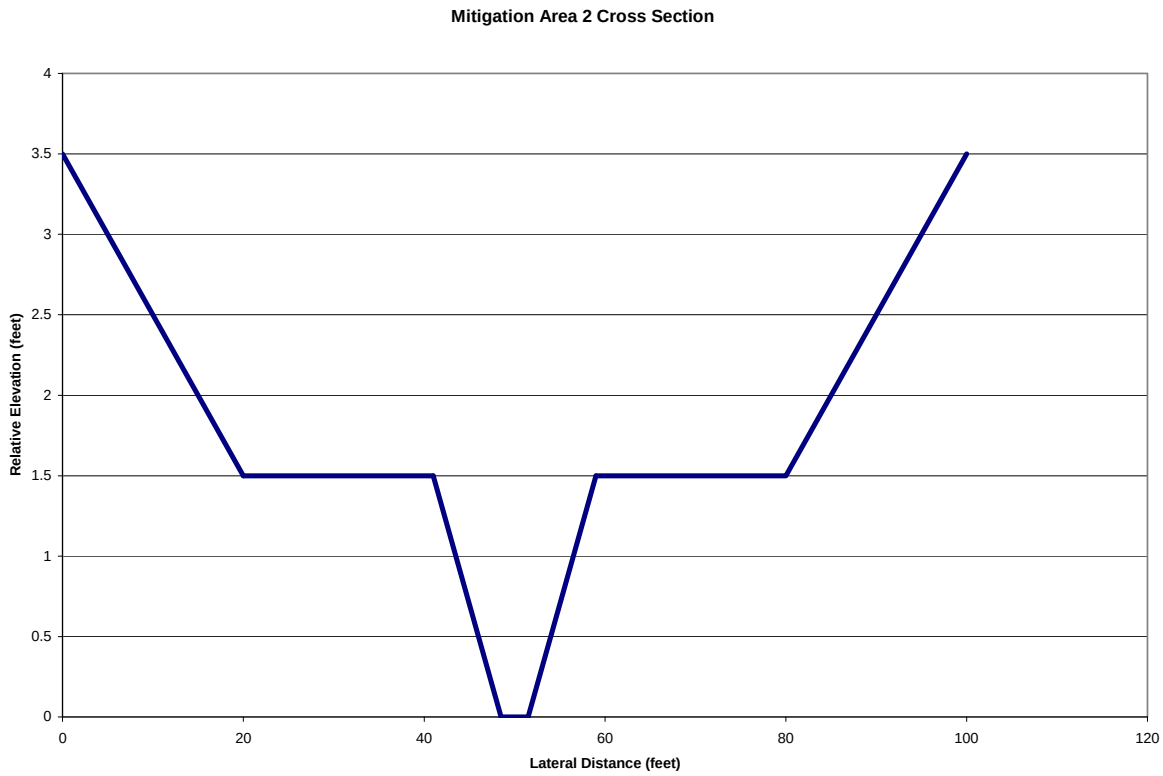

Figure 5c. Conceptual Cross-Section for Mitigation Area 2 As Used in SPAW Model

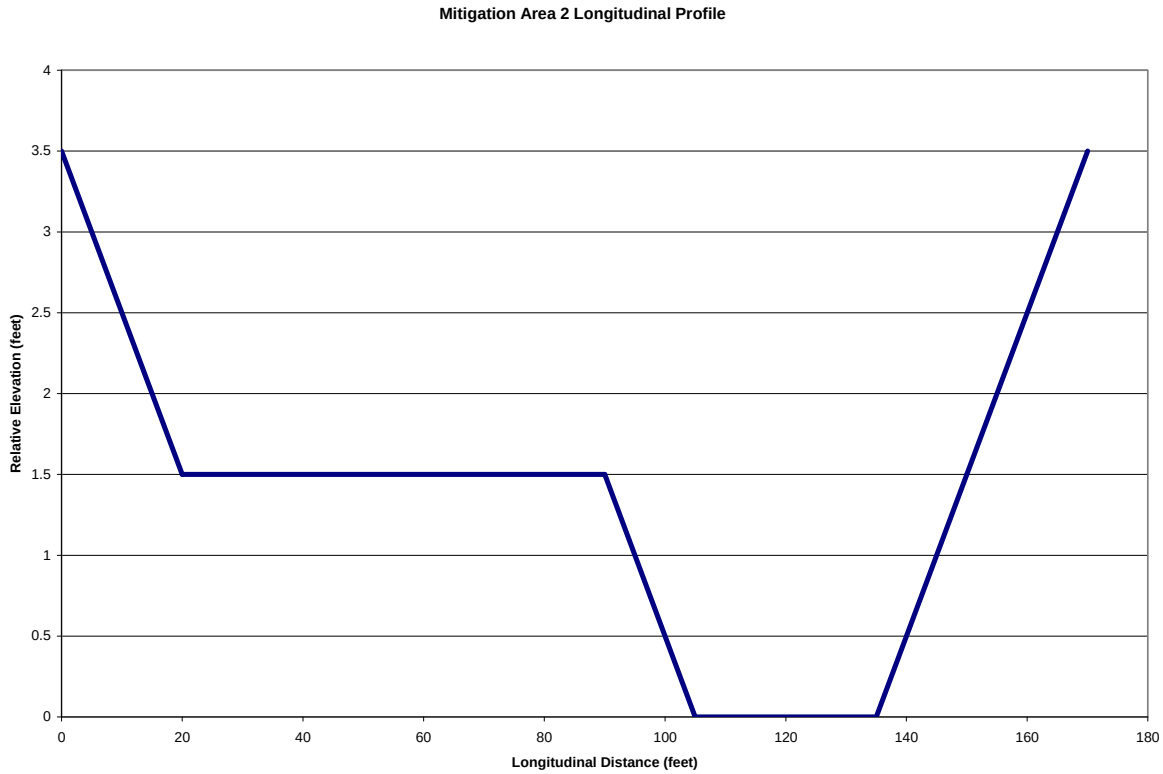

Figure 5d. Conceptual Longitudinal Profile for Mitigation Area 2 As Used in SPAW Model

5. Results and Discussion

Average monthly precipitation and runoff output from the SPAW model for the contributing watershed areas for Mitigation Areas 1 and 2 are shown in Figure 6. As expected, precipitation rates are at their highest in winter (December – 6.96″) and lowest in summer (July – 0.14″). The annual average precipitation over the period 1941-2007 was 39.4″. Runoff rates follow a similar pattern as precipitation, however, the SPAW model predicts little to no runoff occurring between May and October. Peak runoff occurs in January (1.7 inches in Mitigation Area 1 and 2.2inches in Mitigation Area 2). Evaporation, infiltration, and transpiration account for the difference between precipitation and runoff amounts. Mitigation Area 2 produces more runoff than Mitigation Area 1 because of the significant contribution from King Salmon Avenue, which is paved and infiltrates no precipitation.

We simulated both mitigation area wetlands using four different seepage rates. The Bayside-series soils found at the project site are silty-clay and poorly drained and therefore infiltration rates ranging from 0.05 to 2.0 inches/day were modeled. These rates were intended to brag at the range of infiltration rates for similar soils as estimated by Rawls et al. (1998). Table 2 summarizes the frequency of wetland inundation for at least 20 consecutive days during the growing season (assumed to be February 1 – December 31). Both

mitigation areas are modelled to be inundated in 100% of the years between 1941-2007 for areas larger than required for mitigation (Mitigation Area 1 requires 0.1 acre, Mitigation Area 2 requires 0.15 acre) using the lowest infiltration rate of 0.05 inch/day. When modeled using an infiltration rate of 0.5 inch/day, Mitigation Area 1 is inundated in 64% of the years while Mitigation Area 2 is inundated in 66% of the years. At both of the higher infiltration rates (1.0 and 2.0 inch/day) inundated wetland conditions are not maintained. The small areas (0.00017 acre in Mitigation Area 1 and 0.0025 acre in Mitigation Area 2) correspond to the small, deep areas excavated to support cattails as described above in Section 4. Due to their proximity to the water table, these areas are inundated for greater than 20 days during the growing season of all years simulated. Appendix A contains detailed output charts for both mitigation areas displaying daily precipitation, flow volume to the wetlands, and inundated surface area. Graphs are displayed for simulations at infiltration rates of 0.05 and 1.0 inch/day.

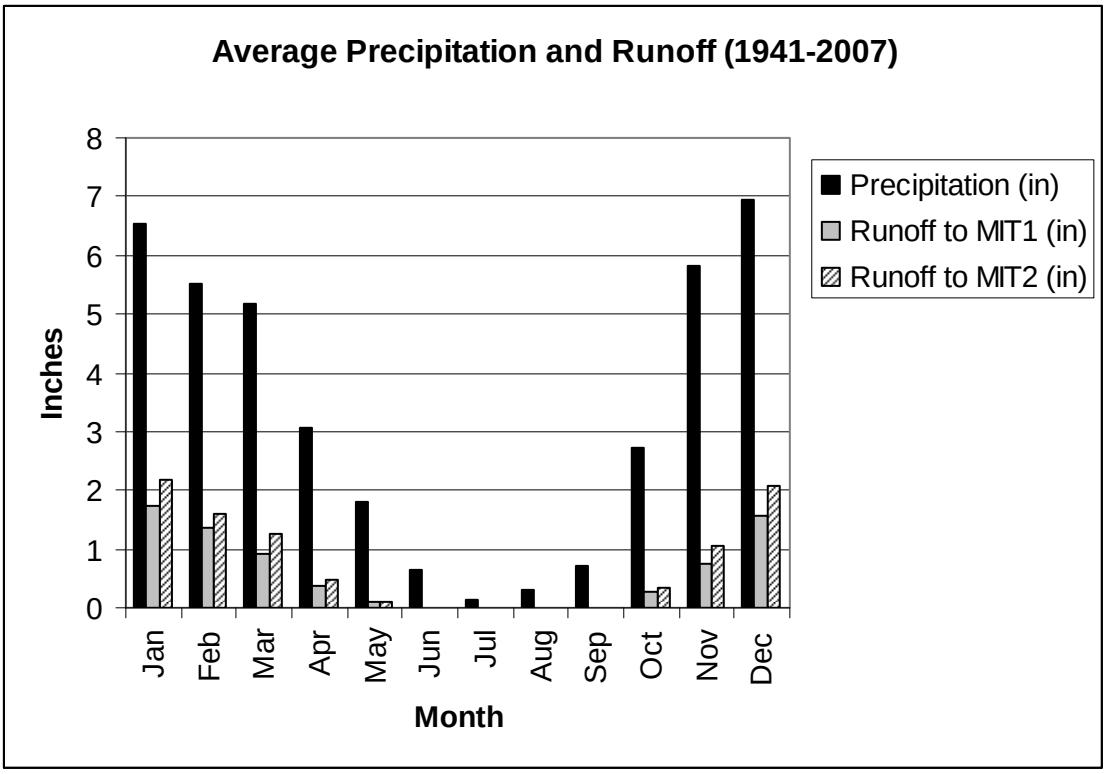

Figure 6. SPAW Model average monthly precipitation and runoff amounts.

TABLE 2. PERCENT OF SIMULATION YEARS (1941-2007) WHEN WETLANDS ARE INUNDATED FOR AT LEAST 20 CONSECUTIVE DAYS DURING THE GROWING SEASON (FEBUARY 1 – DECEMBER 31) FOR FOUR DIFFERENT WETLAND SEEPAGE RATES.

	Seepage Rate (in/d)	**Area (ac)**	**% Years Inundated > 20 consecutive days**
MITIGATION AREA 1	0.05	0.00017	99%
	0.05	0.12	99%
	0.05	0.14	99%
	0.5	0.00017	99%
	0.5	0.12	64%
	0.5	0.14	18%
	1.0	0.00017	99%
	1.0	0.12	12%
	1.0	0.14	0%
	2.0	0.00017	99%
	2.0	0.12	0%
	2.0	0.14	0%
MITIGATION AREA 2	0.05	0.0025	100%
	0.05	0.19	100%
	0.05	0.21	100%
	0.5	0.0025	100%
	0.5	0.19	66%
	0.5	0.21	16%
	1.0	0.0025	100%
	1.0	0.19	9%
	1.0	0.21	0%
	2.0	0.0025	100%
	2.0	0.19	0%
	2.0	0.21	0%

6. Summary

This technical memorandum describes the data collection and analysis performed to assist in the conceptual design of seasonal wetlands at the Buhne Point Wetlands Preserve site.

To determine whether sufficient runoff exists to create wetland hydrology on the proposed mitigation areas, the SPAW Field and Pond models were used to estimate the volume of water delivered to the wetland from its watershed and the hydrology of the wetland. Local climate and soil data were used to describe the runoff from the wetlands watershed on a daily basis between 1941 and 2007. Using the same climate information and the daily values of runoff from the watershed, wetland hydrology was modeled assuming seepage rates of 0.05, 0.5, 1.0, and 2.0 inches per day and a necessary inundation period of 20 consecutive days during the growing season. A range of seepage rates was modelled because actual infiltration rates likely at the site have not yet been determined, and such a range of estimates is appropriate for the conceptual design level. The probability of achieving the necessary inundation periods for any given year between 1941 and 2007 was found to be a function of these seepage rates (see Table 2). For future design phases, more accurate determination of expected seepage rates on site will be required to conclusively determine whether sufficient hydrology exists to sustain wetland conditions in the mitigation areas. Therefore, it is recommended that soil infiltration testing be performed at the wetland site to verify the rates used during the simulations.

While the two greatest estimates of infiltration rate used resulted in the determination of insufficient acreages of inundation, it is believed based on site reconnaissance that these analyses have been overly conservative. Observations at the site (in March 2007) indicate that infiltration rates are likely very low, and frequent seasonal ponding on the site indicates that water table elevations are often relatively high compared to the ground surface. It is believed that soil infiltration rates are much closer to the lowest value simulated of 0.05 inch/day rather than the higher values. Therefore, site hydrology is likely sufficient to support the desired mitigation wetlands at this site. This conclusion can be verified when a determination of local seepage rate is performed and compared to the seepage rate range used during modelling.

7. References

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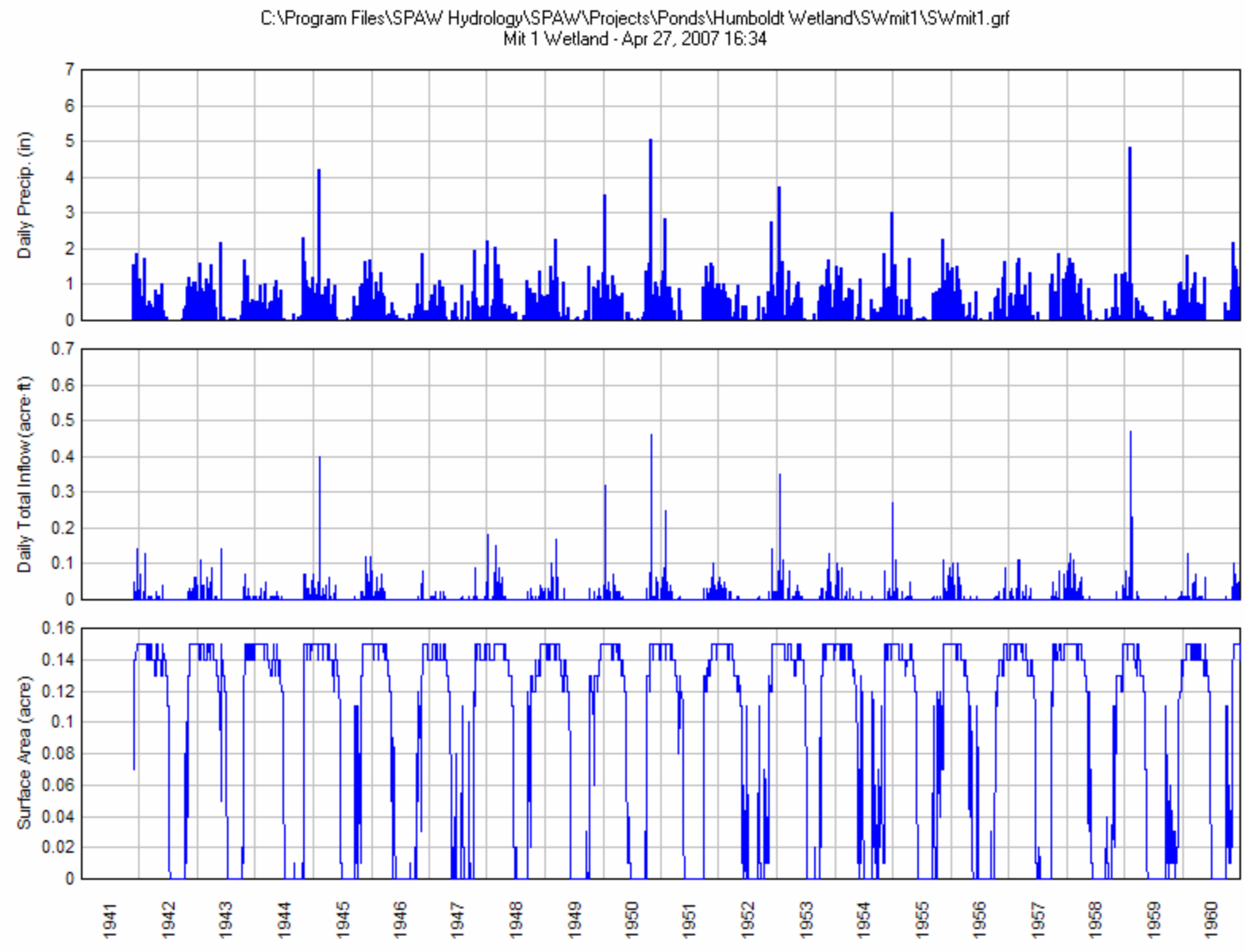
APPENDIX A

Precipitation and Runoff Calculations

Mitigation Area 1, Infiltration Rate = 0.05 in/d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Daily Total Inflow (acre-ft)
Surface Area (acre)
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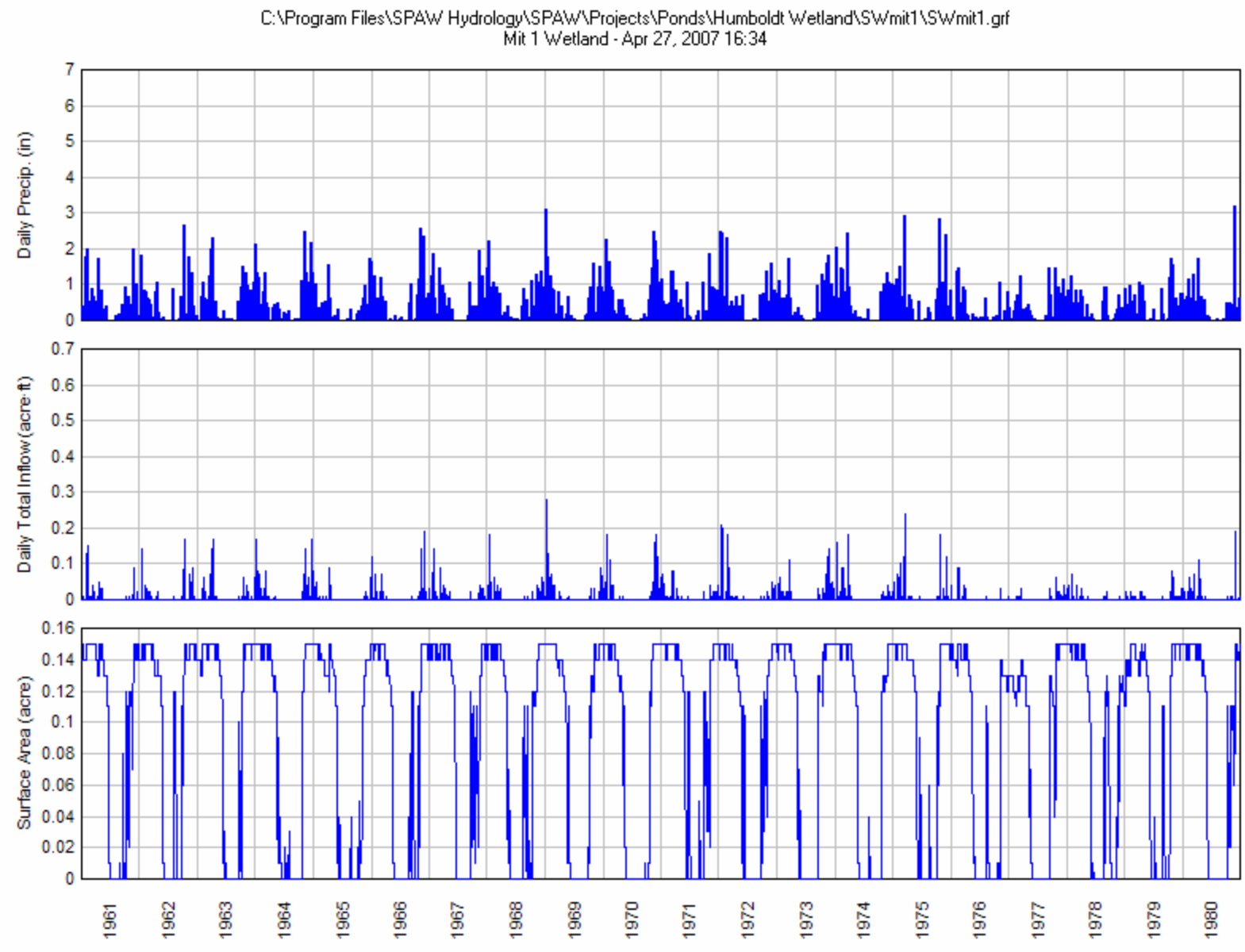
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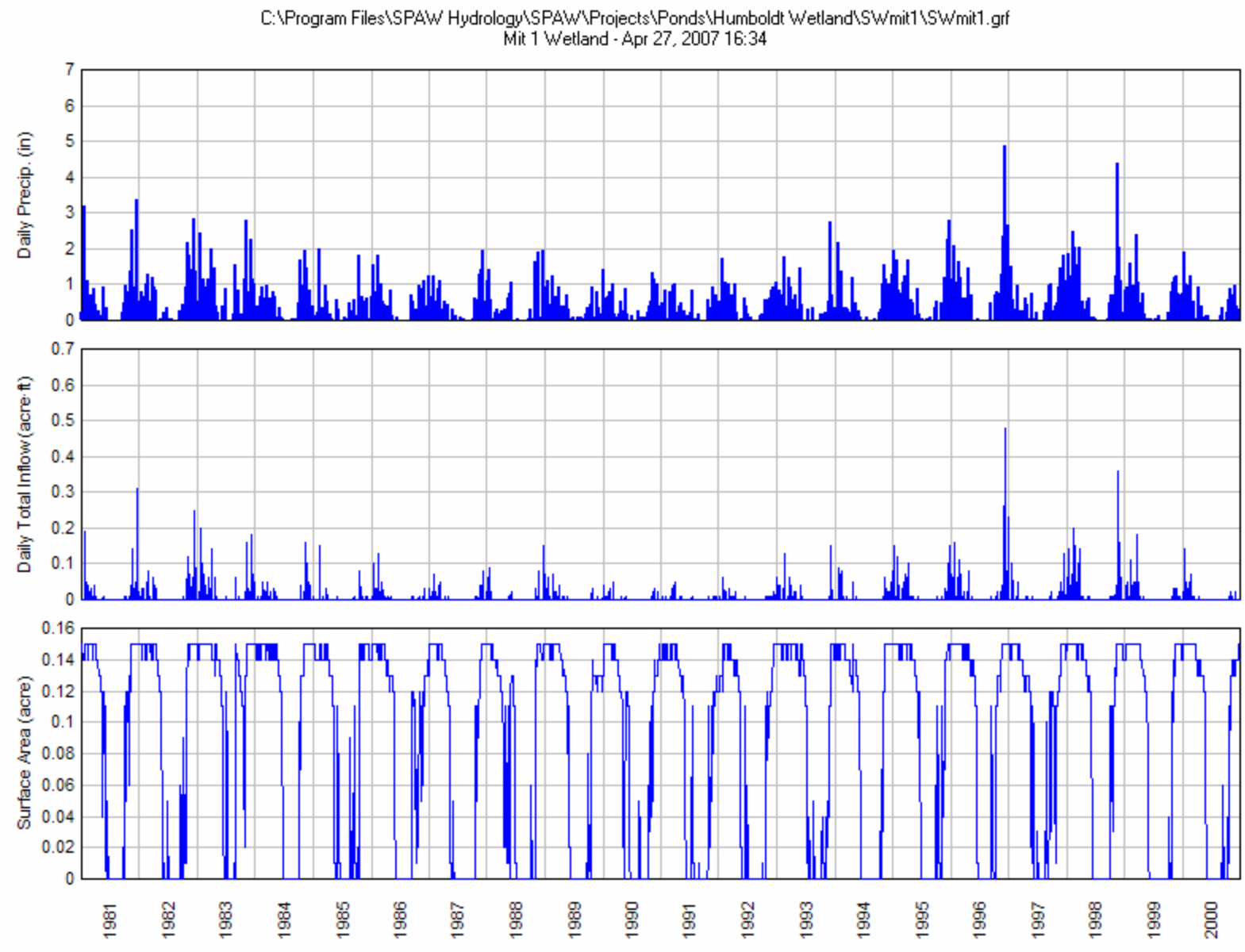
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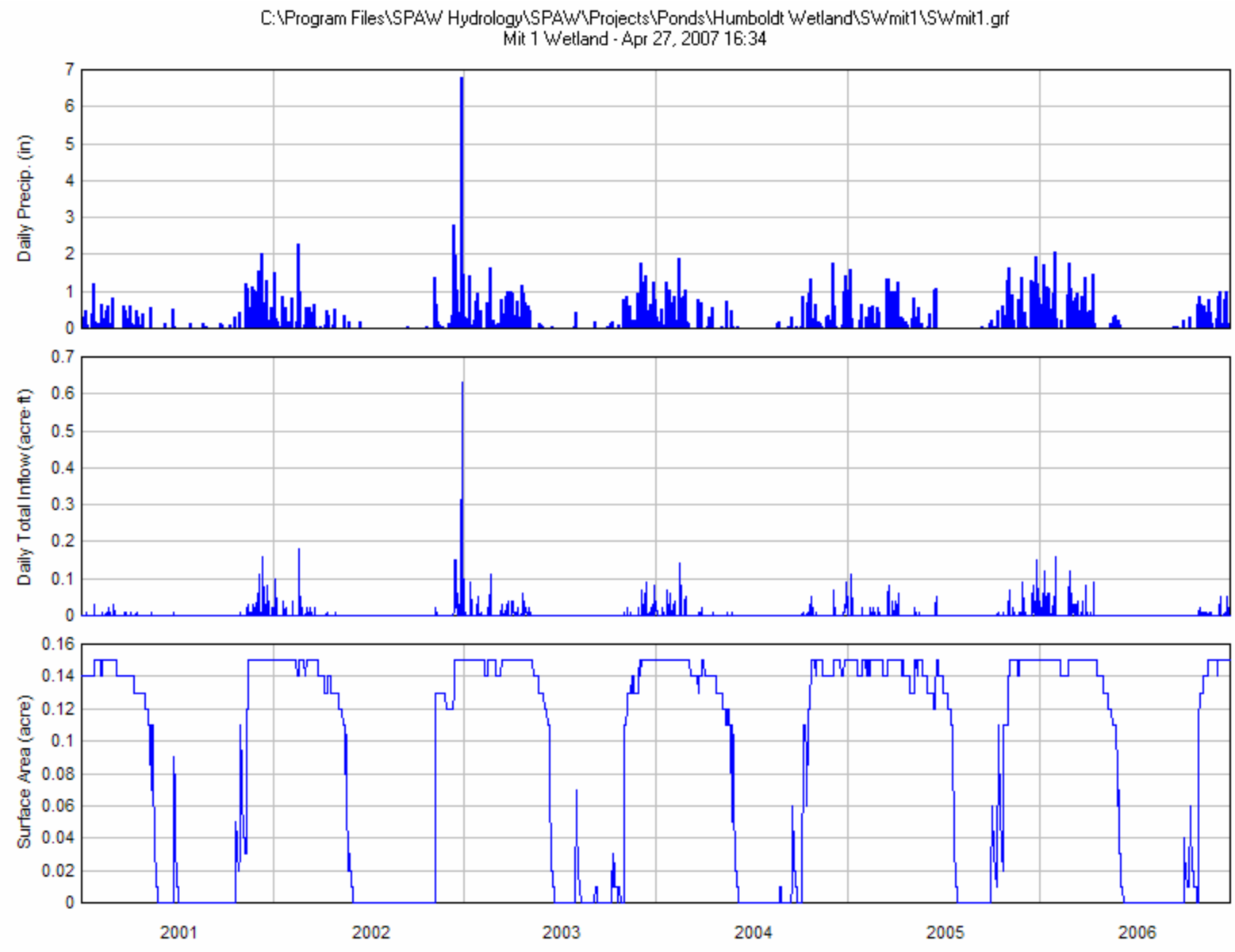
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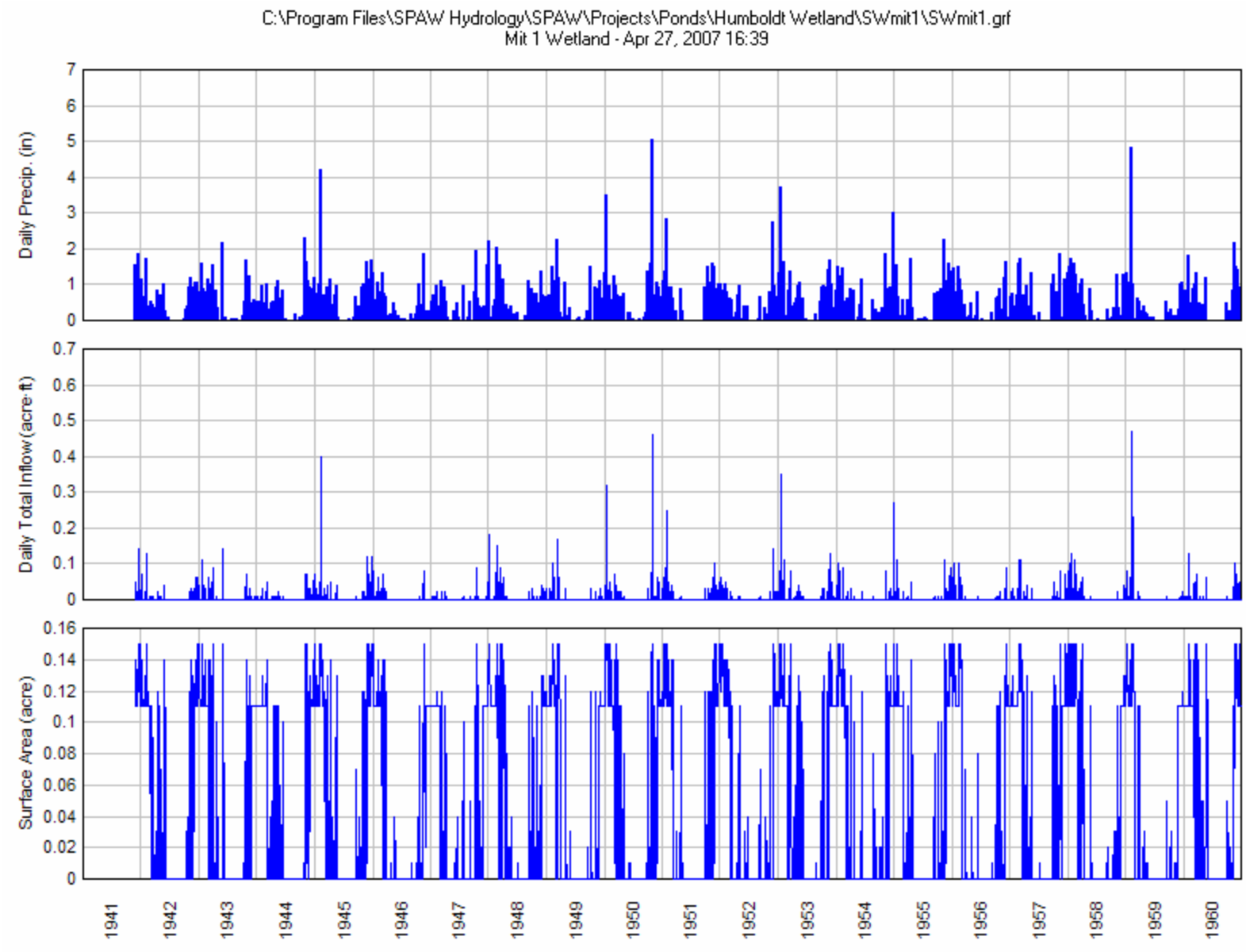
Mitigation Area 1, Infiltration Rate = 1.0 in/d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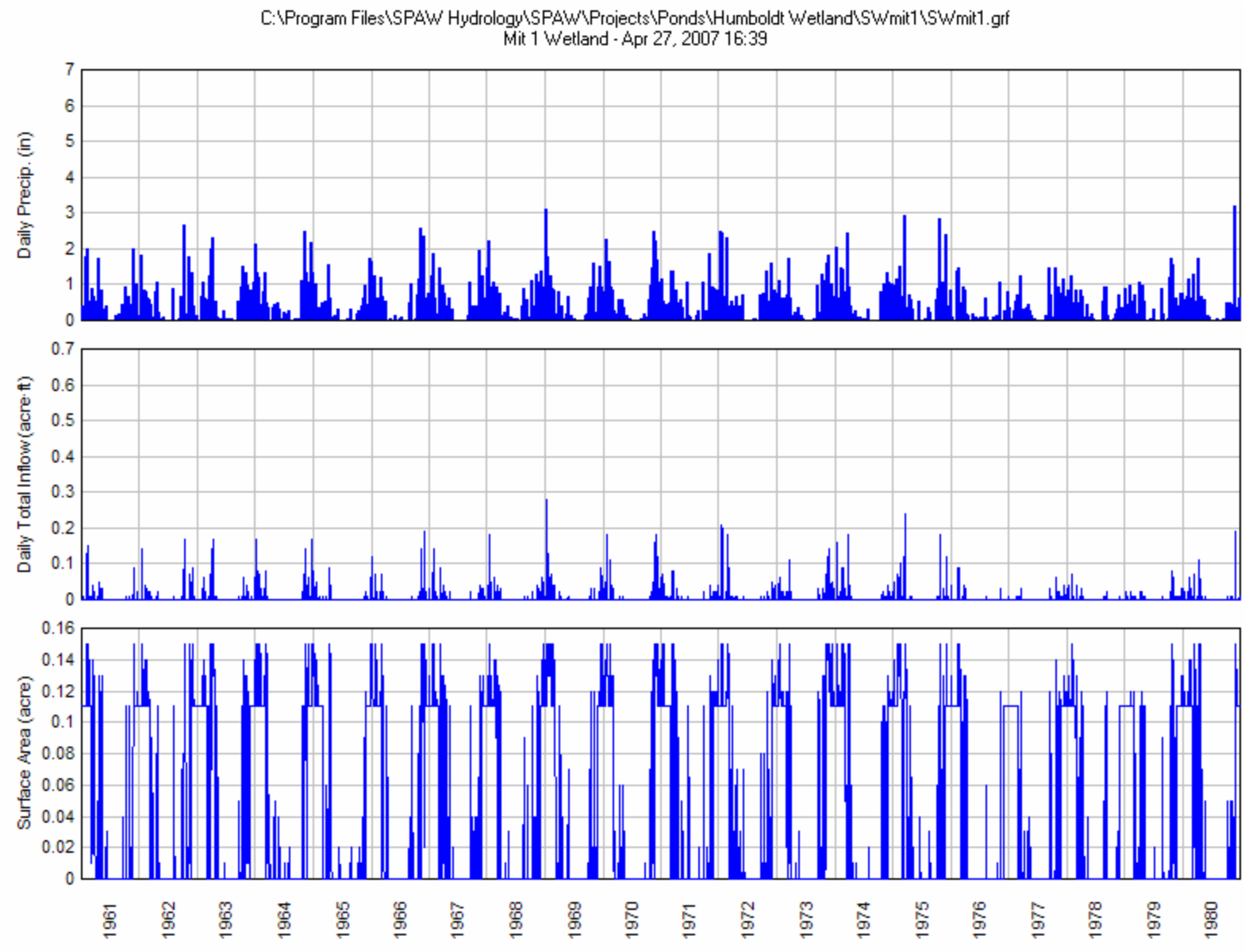
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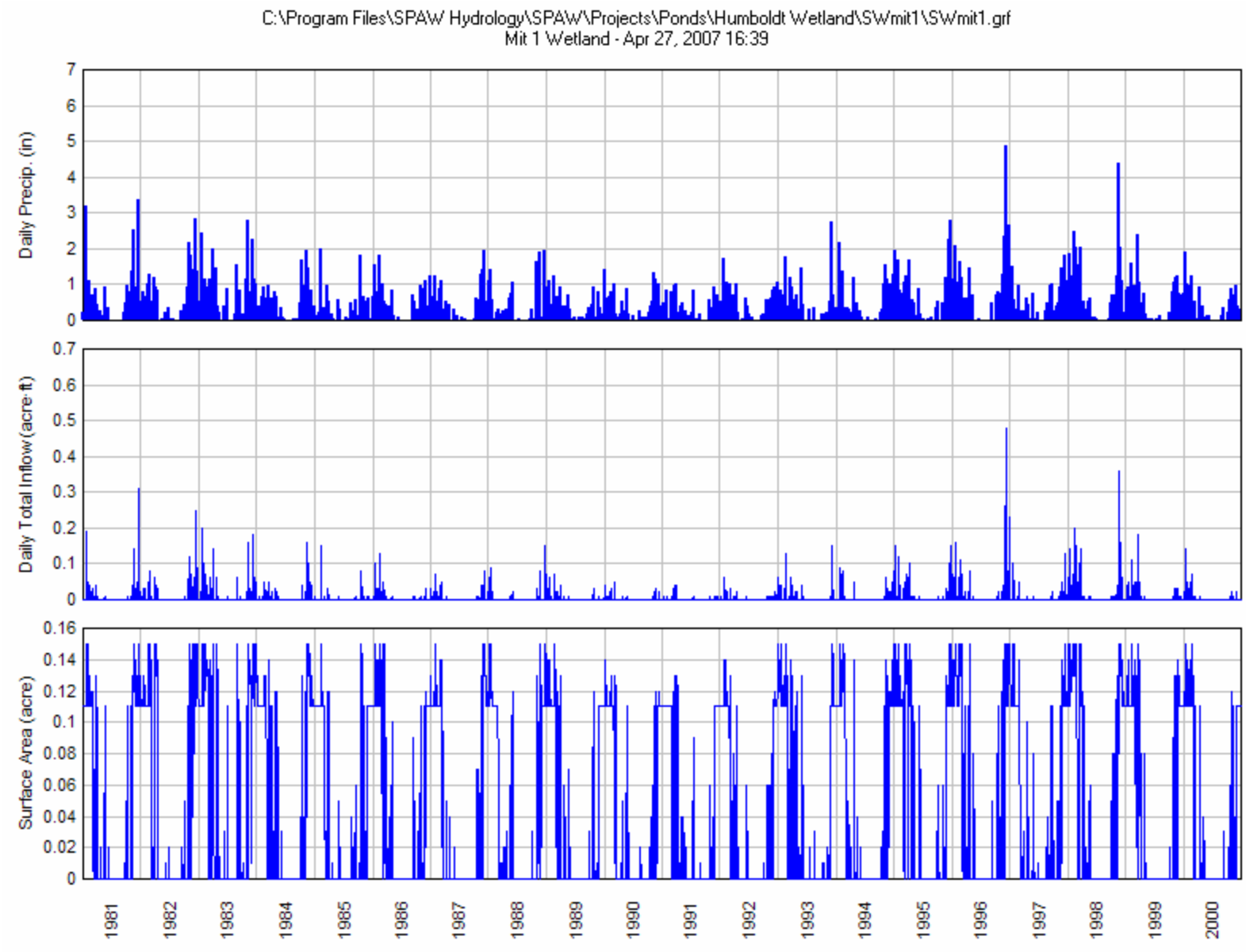
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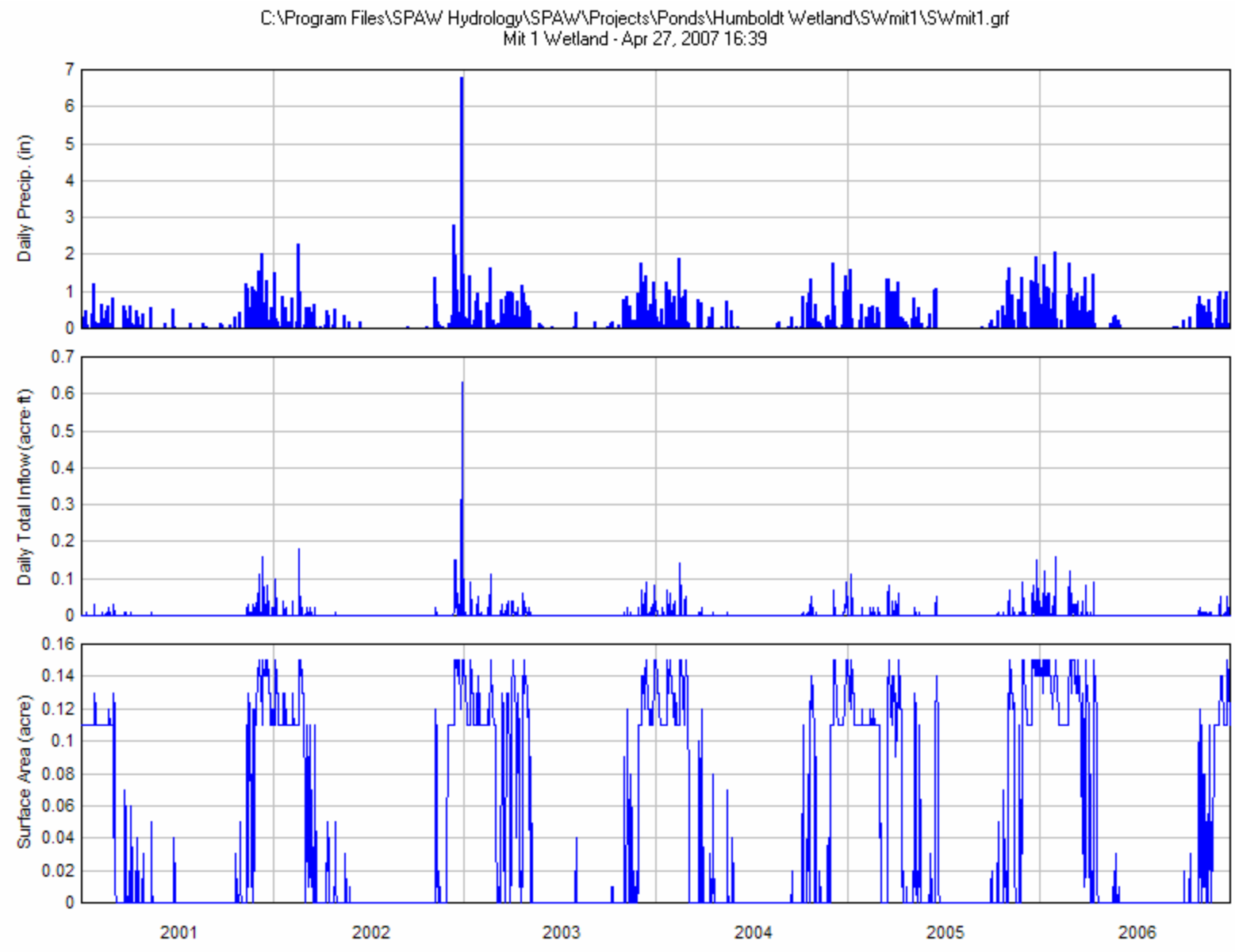
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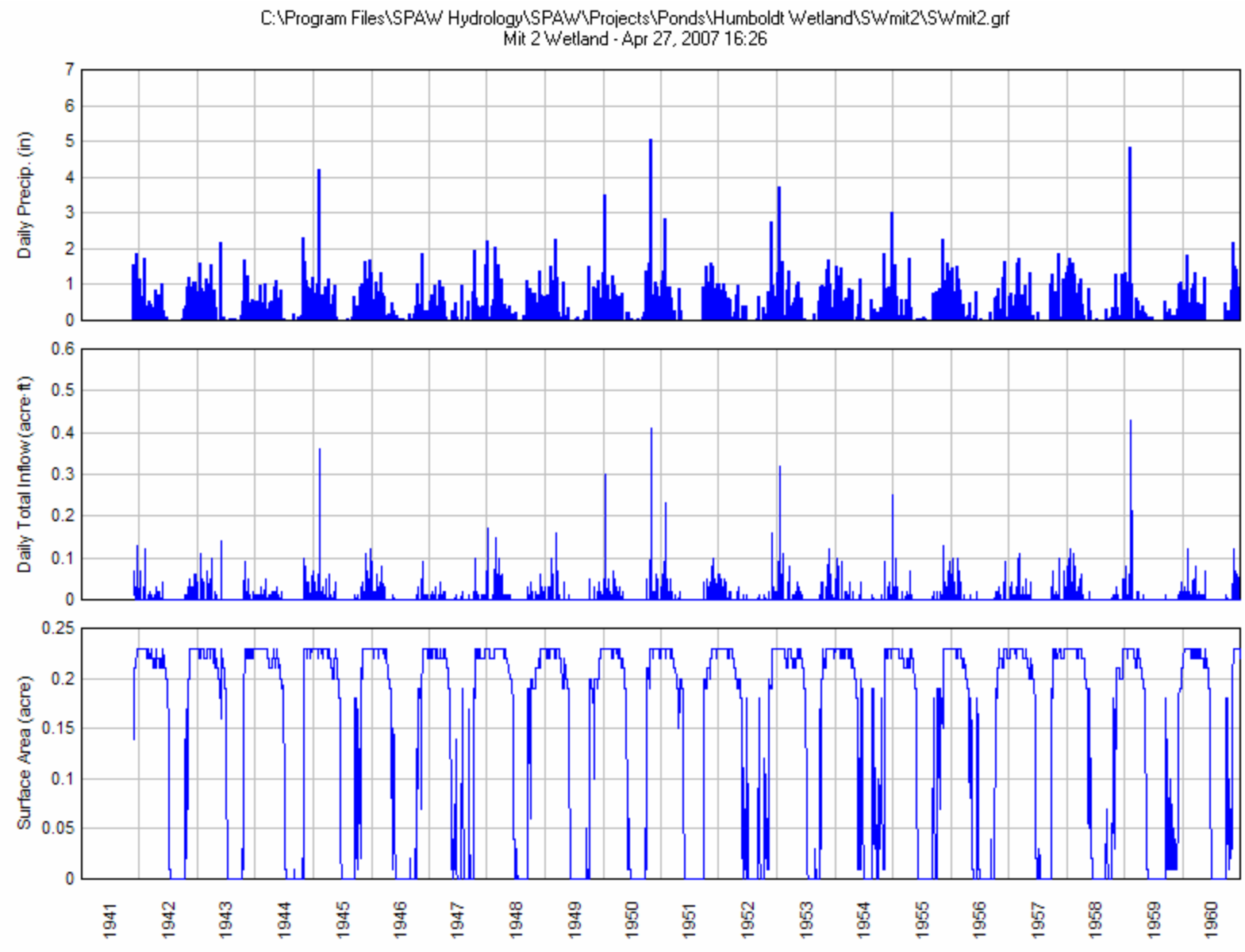
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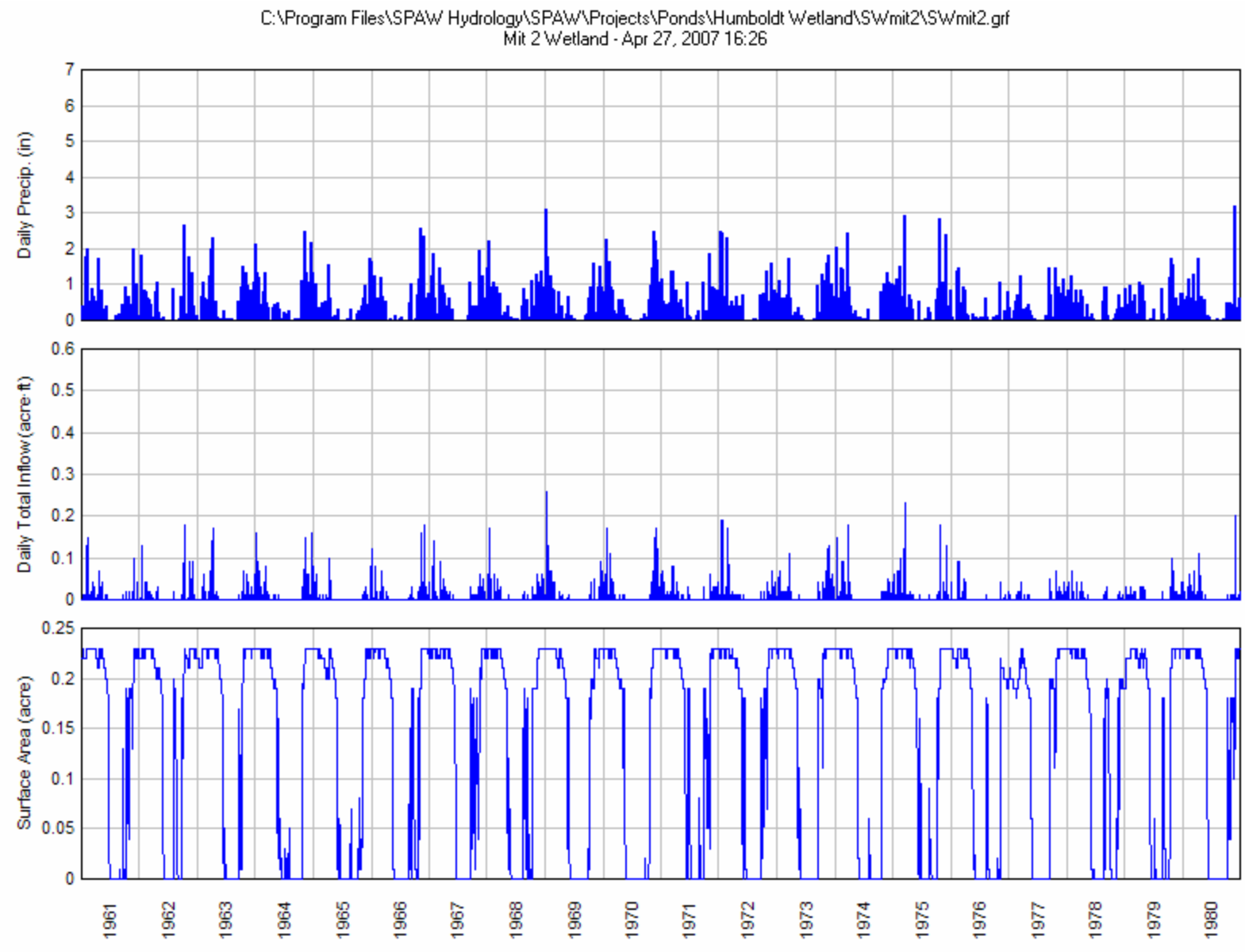
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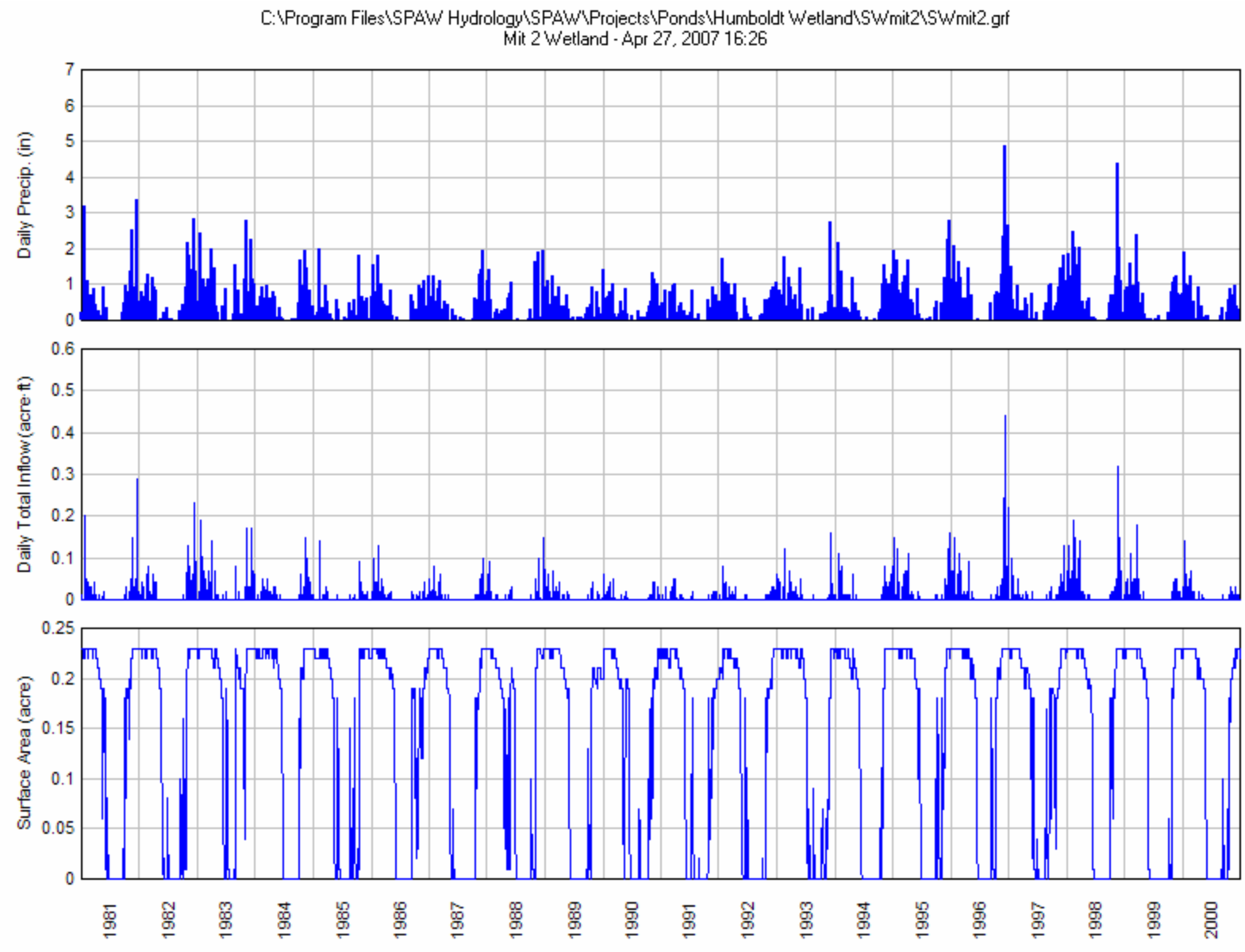
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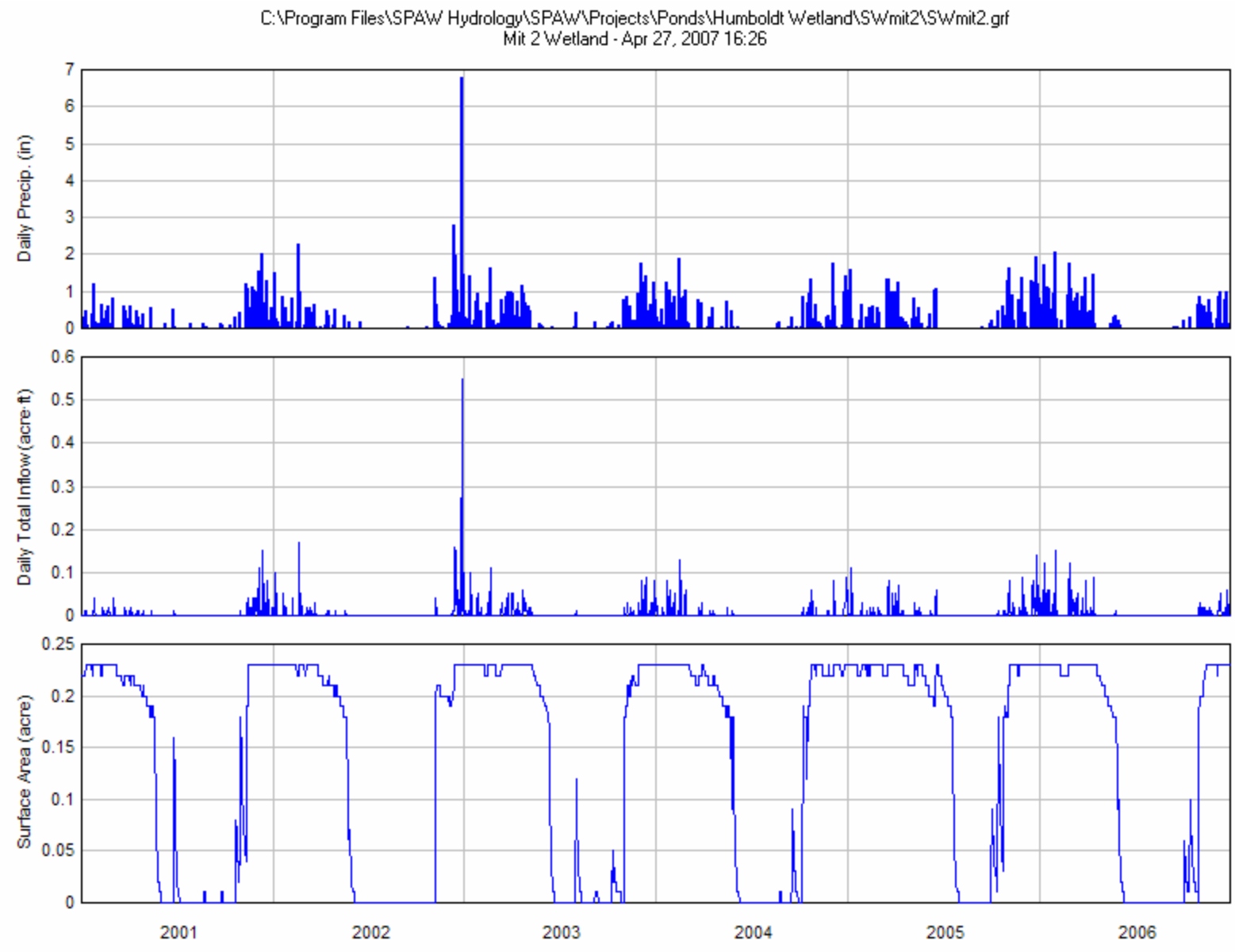
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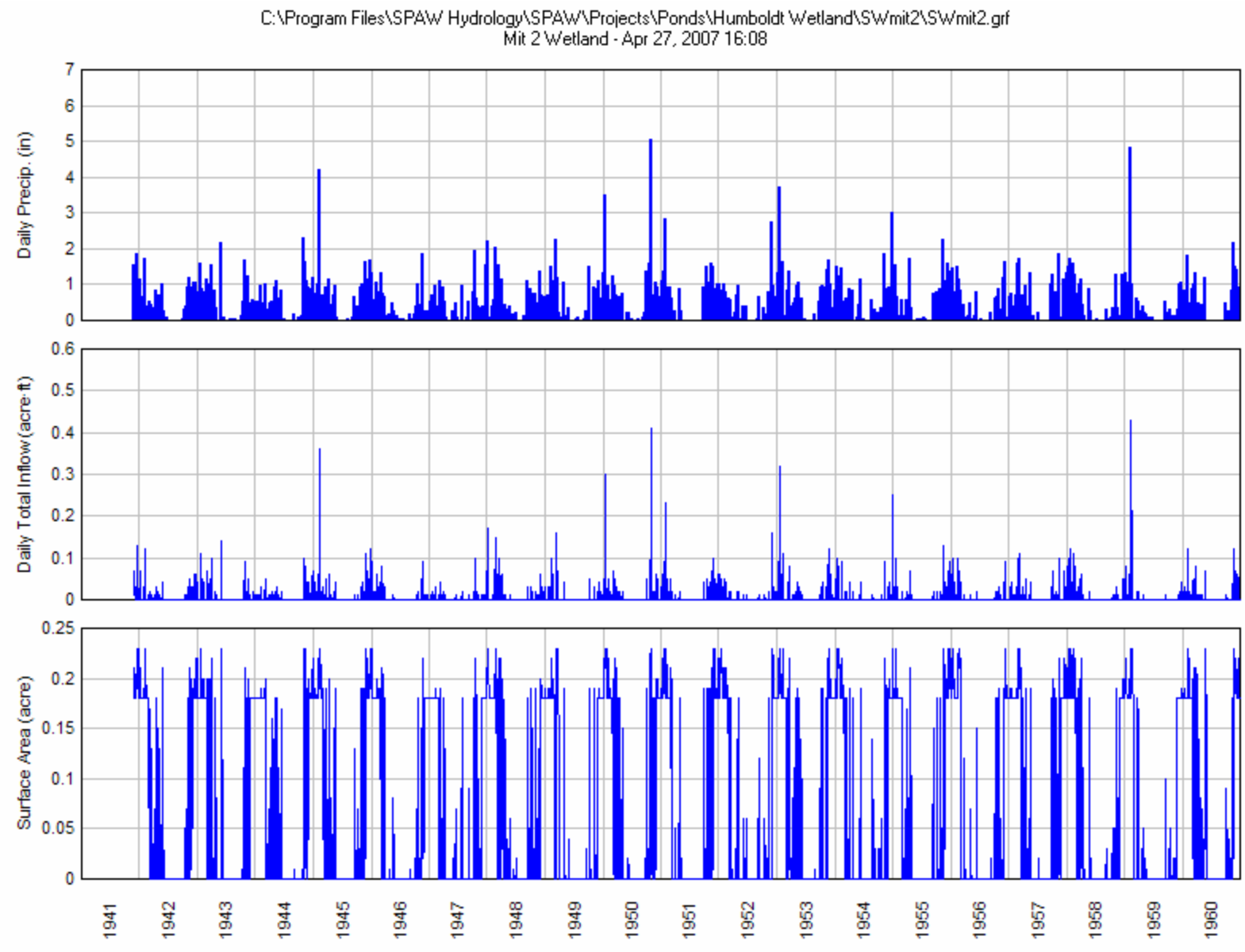
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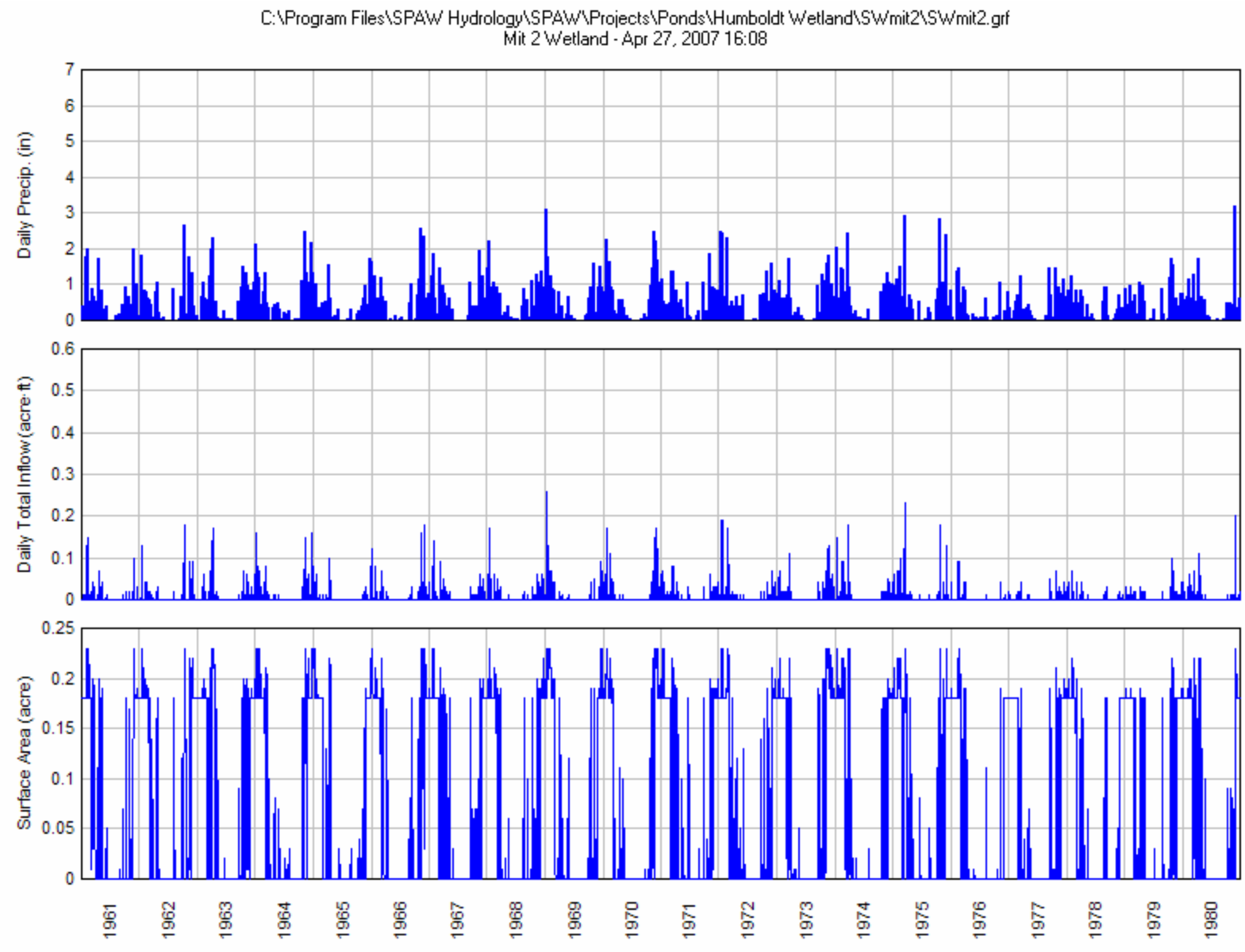
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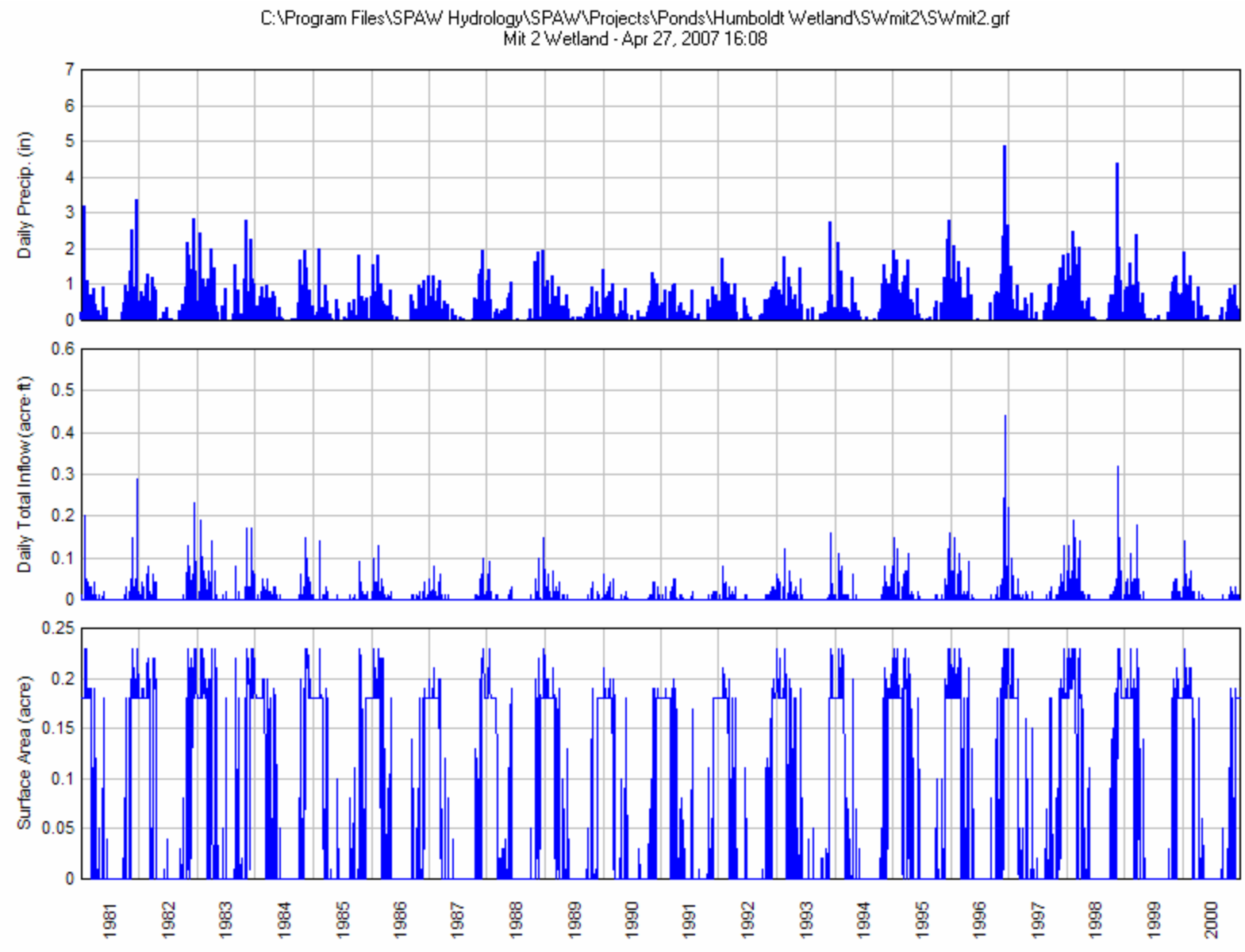
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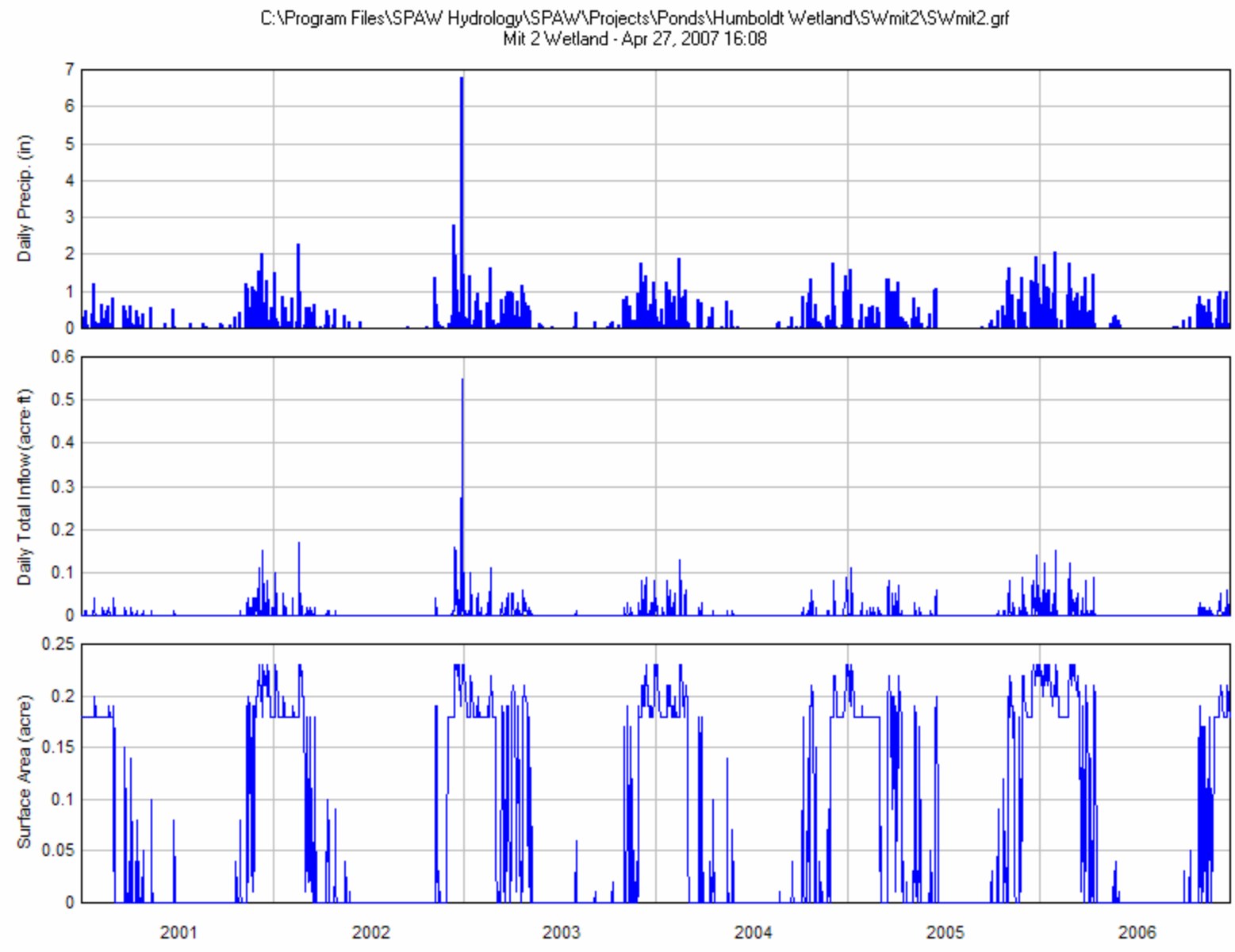
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