Compensatory Wetland Mitigation and Monitoring Plan

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Acronyms and Abbreviations

CESA	California Endangered Species Act
CLR	Campus Land Reserve
CNR	Campus Natural Reserve
Conservation Strategy	*Proposed Conservation Strategy for the UC Merced Project*
Corps	U.S. Army Corps of Engineers
CRT	California Rangeland Trust
CST	Cyril Smith Trust lands
CWMMP	Compensatory Wetlands Mitigation and Monitoring Plan
DA	Department of the Army
DFG	California Department of Fish and Game
EIP	EIP Associates
EPA	U.S. Environmental Protection Agency
ESA	federal Endangered Species Act
FCI	functional capacity index
FCU	functional capacity units
GIS	geographic information systems
HGM	Hydrogeomorphic Model
lbs/acre	pounds per acre
m^2	square meters
NCAA	National Collegiate Athletics Association
NRCS	Natural Resources Conservation Service
Plan	Compensatory Wetland Mitigation and Monitoring Plan
RDM	residual dry matter
SNRI	Sierra Nevada Research Institute
SUDP	Specific Urban Development Plan
TNC	The Nature Conservancy
UC Merced	University of California, Merced
USFWS	U.S. Fish and Wildlife Service
VST	Virginia Smith Trust lands
WCB	California Wildlife Conservation Board

Chapter 1
Introduction

Purpose and Objectives

The purpose of this document is to describe the proposed Compensatory Wetland Mitigation and Monitoring Plan (CWMMP) for mitigating the potential impacts to wetlands that would result from the proposed University of California, Merced (UC Merced) project. The UC Merced project consists of the establishment of a major research university in Merced County that would ultimately support 25,000 full-time equivalent students and a contiguous, associated community needed to support the university. This plan is intended to satisfy the anticipated mitigation requirements of the Department of the Army (DA) permit for UC Merced.

The proposed mitigation measures set forth in this Plan are intended to compensate for UC Merced project impacts that would result from both the Campus and the Community North. The proposed compensatory mitigation measures described in this Plan address the direct, indirect, and cumulative impacts associated with the proposed Campus and the Community North. A separate plan will be prepared for impacts resulting from the Community South and will incorporate preservation, enhancement, and restoration measures similar to those contained in this Plan to the extent applicable.

The overall objective of the CWMMP is to ensure that there will be no net loss of wetland function or area resulting from the construction and long-term operation of UC Merced in accordance with the U.S. Army Corps of Engineers (Corps) compensatory mitigation policies as set forth in Regulatory Guidance Letter No. 02-2, (USACE 2002) as well as the Memorandum of Agreement between the U.S. Environmental Protection Agency (EPA) and the Department of the Army Concerning the Determination of Mitigation under the Clean Water Act Section 404(b)(1) Guidelines dated November 15, 1989. This Plan was designed to be consistent with the Corps Sacramento District's Habitat Mitigation and Monitoring Proposal Guidelines, dated October 25, 1996 as updated on December 30, 2004. On April 10, 2008, The Corps of Engineers and Environmental Protection Agency issued a Final Rule governing compensatory mitigation for activities authorized by permits issued by the Department of the Army (Corps of Engineers 2008). Although this Final Rule does not apply to applications received prior to the effective date of the regulation (June 9, 2008), this plan is intended to substantially comply with many of the provisions of that Final Rule.

This document is a revision to the CWMMP submitted with the original Department of the Army permit application. The Department of the Army permit application for the UC Merced project has been subsequently revised. The revised application modified the campus footprint with resulting in substantially reduced wetland impacts. It also incorporated a portion of the University Community (the Community North) into the application. The primary purpose of this revision to the CWMMP, is to reflect the impacts that would result from the modified Campus footprint and the Community North.

Scope

This CWMMP:

1. classifies the wetlands existing within the project area and assesses their functions under baseline conditions,
2. quantitatively assesses the direct and indirect impacts of the project in terms of area of wetlands lost and wetland functions lost,
3. identifies proposed mitigation measures believed necessary to achieve the goal of "no net loss," and
4. summarizes the results of a functional assessment that quantitatively assesses the efficacy of the proposed compensatory mitigation measures.

Functional Assessment

Traditionally, the Corps has evaluated wetland impacts and proposed compensatory mitigation based primarily on an acre basis. This comparison has often been expressed in terms of the ratio of acres of wetlands preserved, restored, created, and/or enhanced per each acre of wetlands directly impacted. Given the currently proposed mitigation, such a comparison would yield a wetland preservation ratio of greater than 29 acres preserved and enhanced per each acre directly impacted (29:1), and a minimum of 1 acre of wetlands restored or created per each acre of wetlands directly impacted (1:1).

In order to provide a quantitative basis for assessing wetland impacts and proposed mitigation in terms of wetland function, the Corps directed that a wetland functional assessment methodology be developed based on the Hydrogeomorphic Model (HGM). Such a methodology would consider both direct and indirect impacts to wetland function. The functional assessment methodology that was developed is used as the basis for quantitatively assessing potential losses in wetland function that would result from the proposed UC Merced project as well as the potential gain in wetland function that would result from the proposed mitigation measures.

Relationship to the USFWS Biological Opinion and Conservation Strategy

This plan is further intended to complement, and integrate with, the overall mitigation plan for biological resources for UC Merced required by the August 19, 2002 U.S. Fish and Wildlife Service (USFWS) *Final Biological Opinion on the Proposed University of California Merced Campus, Phase 1 and Campus Buildout (Corps #199900203) and Infrastructure Project (Corps #200100570)* (Biological Opinion), and to be consistent with the *Proposed Conservation Strategy for the UC Merced Project* (Conservation Strategy) for threatened and endangered species (Jones & Stokes 2008), the Management Plan for Conservation Lands and the Adjacent Campus Buildout for the University of California Merced (Airola 2008a), and the 2008 Supplement to the Biological Assessment for the University of California Merced Campus and University Community North (Airola 2008b).

The project area contains habitat supporting threatened and endangered species listed under the federal Endangered Species Act (ESA) and the California Endangered Species Act (CESA) as well as habitat for species that are proposed for, or candidates for, listing. Federally listed species are:

- succulent owl's clover (*Castilleja campestris* ssp. *succulenta*),
- Colusa grass (*Neostapfia colusana*),
- San Joaquin Valley Orcutt grass (*Orcuttia inequalis*),
- vernal pool fairy shrimp (*Branchinecta lynchi*),
- Conservancy fairy shrimp (*Branchinecta conservatio*),
- vernal pool tadpole shrimp (*Lepidurus packardi*),
- valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*),
- California tiger salamander (*Ambystoma californiense)*, and
- San Joaquin kit fox (*Vulpes macrotis mutica*).

Nothing in this CWMMP is intended to supersede or otherwise be inconsistent with the Conservation Strategy. The mitigation and management measures identified in this Plan will also mitigate potential impacts to various threatened and endangered species. A more detailed description of potential impacts to threatened and endangered species, as well as the proposed mitigation measures corresponding to these impacts, is provided in the Conservation Strategy.

Chapter 2
Project Summary

Location of Project

The proposed UC Merced project is located in eastern Merced County, on the northeastern edge of the City of Merced growth boundary, known as the Specific Urban Development Plan (SUDP) limits. The proposed Campus and Community North are situated east of Lake Yosemite and Lake Road. The proposed locations of UC Merced and the University Community are shown in Figure 2-1.

Project Purpose

The overall project purpose is:

> To establish a major research university in Merced County that would ultimately support 25,000 full-time equivalent students with a contiguous, associated community needed to support the university.

Project Description

The revised UC Merced project consists of three major components: the Campus (815 acres); the Community North (833 acres); and, the Community South (1,118 acres). The lands comprising the Campus are owned by the University. The lands comprising the Community North are owned by the University Community Land Company, LLC (UCLC), a not-for-profit corporation. The Community South is owned by LWH Farms, LLC.

The revised application for a Department of the Army permit seeks authorization for those portions of the proposed project controlled by the University (the UC Merced Campus and the Community North). A Department of the Army permit is not being requested at this time for the Community South because that area is not under the control of the University. Nonetheless, because the Community South is an interdependent and interrelated activity to the UC Merced Campus and Community North, it is considered part of the proposed project, not for purposes of the permit, but for purposes of NEPA review. The additional project

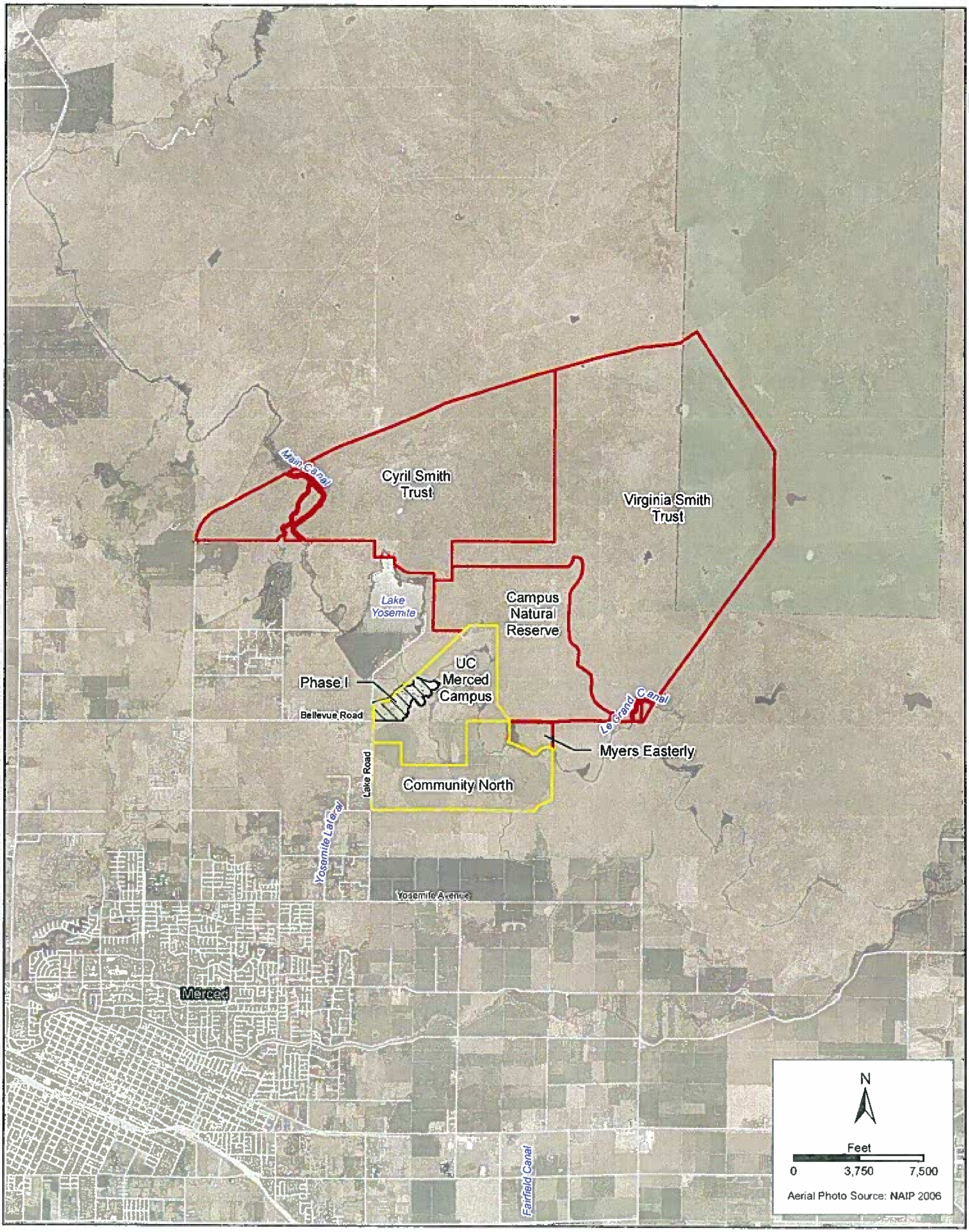

Figure 2-1
Regional Location of the UC Merced Project

description provided below, as well as the description of the impacts, applies to all three major components of the proposed project.

The new plan will consolidate the campus and its reserve development capacity onto 815 acres, buffered on the north and east from the natural landscape by a series of perimeter road and canals. UC Merced continues to employ best practices in sustainable development through on-site storm water management. Passive and active recreation areas are located to receive upland flows, along drainage pathways and at the western and eastern edges of development.

The application drawings show the locations of the five districts described below and provide conceptual descriptions of the block types within the districts. The following is a general description of each district and the corresponding block type(s).

The LRDP describes a campus community built around a 200-acre academic core that houses classrooms, laboratories, administration, research and development and related activities. The core will consist of <u>four parts</u>:

- The North (current) Campus, which is largely complete.
- The Central West Campus, to be built just south of the current campus. This section, to be built during phase 2.0, will take the university to the 10,000-student level. It will have a north-south grid system featuring a prominent mixed-use main street and a variety of arcades, courtyards and small open spaces.
- The Central East Campus, which will be just east of the West Campus and take the campus to full build-out, estimated at 25,000 students. This section, the largest of the academic core components, will become the heart of the campus in the long term. It will also feature a prominent main street, student union and recreation center facing a large formal open space to be called Central Park.
- The Gateway District, situated along Lake Road near the Bellevue Road intersection. This area will serve as primary campus entrance and "public face" of the university, with links to the community and to private-sector partners vital to the university's mission.

Bordering the academic core to the north, northwest and northeast will be four student neighborhoods comprising approximately 225 acres. The housing options will include traditional residence halls, apartments, townhouses, stacked flats and walk-up units in various high-, medium- and low-density configurations. The goal is to house half of the UC Merced student population in campus housing facilities.

The balance of the campus's 815 acres will be allocated to athletics and recreation (140 acres), parking (110 acres), passive open space (100 acres) and campus services (40 acres).

As described above, the University does not control the Community South portion of the University Community and a Department of the Army Permit application is not being submitted at this time. For this reason, this Plan only pertains to mitigation proposed for Campus and Community North. The

Community South portion of the University Community may be subject to a future permit and environmental review process at such time as the LWH Farms LLC may decide to submit an application. It is anticipated that the Community South will be developed in accordance with the adopted University Community Plan which designates the Community South property for Multiple Use Urban Development and agricultural uses and establishes planning principles and policies consistent with planned development of the Community-North.

The revised application no longer proposes the 340-acre Campus Land Reserve that was included in the original application as a contingency against long-term future needs. The 340-acre Campus Land Reserve as well as the previously proposed 750-acre Campus Natural Reserve have been incorporated into the overall Virginia Smith Trust mitigation lands along with additional lands owned by the University that were included within the originally proposed Campus footprint. It is expected that future long term land needs of the campus and community will be accommodated through increases in development density, rather than expansion of development areas.

Development of the University Community includes certain infrastructure necessary to serve the Campus. This infrastructure includes construction of a major north-south arterial north of Yosemite Drive, portions of two additional minor arterial roadways and collector streets, and construction of utility lines (storm drainage, sewer, potable water, fire and irrigation water, telecommunications, electric and gas) within the rights-of-way secured for those roadways. Although this infrastructure is required for the Campus alone, it is proposed to be located and configured in a manner as to allow expansion to serve the proposed University Community. The proposed backbone infrastructure, and alternatives to its proposed size and location, will be considered in the Section 404(b)(1) analysis prepared for the UC Merced Campus and University Community North application.

Background of Mitigation Plan Development

In 1999, $30 million was appropriated by the State of California legislature to fund the acquisition of conservation easements in eastern Merced County to mitigate for the effects of UC Merced and support regional conservation efforts. Accordingly, the University of California, in cooperation with the California Department of Fish and Game (DFG) and the California Wildlife Conservation Board (WCB), and the Packard Foundation embarked on a program to secure the permanent protection and preservation of a large tract of land supporting a concentration of vernal pools and related aquatic habitats in the vicinity of the proposed UC Merced Project. Such acquisitions assure the preservation, in perpetuity, of their ecosystems and habitats as well as the species that depend on them.

To help guide the acquisition of properties in eastern Merced County, a conceptual area protection plan was developed by the DFG. The overall objective of the plan is to protect grasslands in eastern Merced County through acquisition of easements and fee title on properties containing high conservation values. The plan envisioned the promotion of grazing practices and land use management regimes that would improve the ecological health, biodiversity, and diversity of the habitat, including implementation of specific enhancement or restoration projects.

Chapter 3

The Hydrogeomorphic Methodology Approach to Wetland Functional Assessment

Introduction

The HGM Assessment methodology is an approach to wetland functional assessment that typically includes the following components:

- classify wetlands into regional subclasses consistent with the HGM classification system,
- identify wetland functions appropriate to each regional subclass,
- identify variables affecting these functions,
- develop assessment models and indices,
- identify reference wetlands, and
- develop application protocols.

These components are then consolidated into a regional guidebook for each regional subclass. These regional guidebooks are then used to conduct functional assessments for specific projects. The regional guidebooks are developed by an assessment team whereas the functional assessments can be conducted by a multitude of end users including agency personnel, applicants, consultants, etc.

There are no regional guidebooks that have been developed for the regional subclasses of wetlands existing within the project area. The Corps initiated a pilot project in 1995 to develop a regional guidebook for vernal pools in California. That effort proceeded as far as development of initial function models and field data gathering but was never completed. Without a regional guidebook, the Corps determined that a modified project-specific functional assessment methodology should be developed for the UC Merced project. The intent was to devise a functional assessment methodology based on HGM concepts but in an abbreviated form that would not include preparation of a regional guidebook and would be based, in part, on best professional judgment. Because of the number of discrete wetlands existing within the project area (thousands) and the number of discrete wetlands existing on the mitigation lands (tens of thousands), it is not practicable to implement an assessment methodology requiring an on-site evaluation of each wetland. It was therefore imperative that a functional assessment methodology be designed so that it can be performed using geographic information systems (GIS) technology.

Pursuant to the Corps directive, a modified HGM functional assessment (the functional assessment) was developed to assess the efficacy of the proposed compensatory mitigation measures (USACE 2006). The functional assessment was developed by Mr. Tom Skordal of Gibson & Skordal, LLC, Ms. Nancy Haley and Mr. Kevin Roukey of the Corps Sacramento District, and Mr. Ellis Clairain, Ph.D. of the U.S. Army Engineer Research and Development Center Environmental Laboratory in consultation with an interagency Technical Advisory Committee composed of representatives of the Corps, the EPA, USFWS, and DFG. The functional assessment has been completed and a report has been prepared. A copy of the report is included in Appendix A. The report provides a detailed description of how the methodology was developed and the protocol for implementing the methodology. The following sections provide an overview of the HGM approach used and the results obtained for the functional assessment.

HGM Classification

The HGM Classification of wetlands was designed to classify groups of wetlands that function similarly based on shared criteria. Those criteria are geomorphic setting, water source, and hydrodynamics. Geomorphic setting refers to the landscape position of the wetland. Water source refers to the dominant source of water for the wetland (i.e., groundwater, precipitation from runoff, backwater flooding, and overbank flooding). Hydrodynamics refers to the direction in which water moves into, through, and out of the wetland and the energy associated with that movement.

There are seven hydrogeomorphic classes of wetlands (Brinson 1993). Table 3-1 lists these classes, their dominant water sources, and dominant hydrodynamics. Of these seven classes, three are found within the project area: depressional, slope and riverine.

Table 3-1. Hydrogeomorphic Classes

Hydrogeomorphic Class	Water Source (dominant)	Hydrodynamics (dominant)
Riverine	Overbank flow from channel	Unidirectional and horizontal
Depressional	Return flow from groundwater and interflow	Vertical
Slope	Return flow from groundwater and interflow	Unidirectional, horizontal
Mineral Soil Flats	Precipitation	Vertical
Organic Soil Flats	Precipitation	Vertical
Estuarine Fringe	Overbank flow from estuary	Bidirectional, horizontal
Lacustrine Fringe	Overbank flow from lake	Bidirectional, horizontal

Source: Adapted from Smith 1995.

The jurisdictional waters of the United States, including wetlands, existing within the project area were delineated by EIP Associates (EIP) and verified by the Corps. Separate delineations were completed for the Campus including the Campus Land Reserve and the Campus Natural Reserve, the Merced Hills Golf Course and the associated community. EIP classified the delineated waters/wetlands as vernal pools, vernal pools/swales, vernal swales, swales, clay playas, clay flats, seasonal wetlands, freshwater marsh, marsh, stock ponds, drainages, wooded channels, and canals (Figure 3-1).

The functional assessment team reviewed the characteristics of each of the wetland classifications used by EIP to determine their appropriate HGM classification. All of the wetlands were then classified into five regional subclasses: vernal pools (depressions class), irrigation wetlands (depression class), clay slope wetlands (slope class), swale wetlands (slope class), intermittent channel (riverine class), and canal wetlands (riverine class) (Figure 3-2).

Vernal pools are abundant within the project area. Vernal pools occur within defined topographic depressions and their water source is direct precipitation, run-off from precipitation, and/or inter-flow. The clay playa classification used by EIP delineation would also fall into this regional subclass. Clay playas are essentially very large vernal pools. In some cases (e.g., the delineation of the wetlands on the former Merced Hills Golf Course), the seasonal wetland classification used by EIP refers to seasonally flooded depressions similar to vernal pools except the plant community is more characteristic of generic seasonal wetlands than vernal pools. Accordingly, these depressional seasonal wetlands were considered to be degraded vernal pools and most appropriately classified as such for HGM purposes.

Irrigation wetlands are the second regional subclass of depression wetlands. Irrigation wetlands are highly disturbed wetlands occurring within depressions that are influenced directly or indirectly by flood and/or sprinkler irrigation. They differ from degraded vernal pools in that they appear to have been created as a by-product of land leveling and irrigation activities. Some of the wetlands classified as seasonal wetland and freshwater marsh by EIP are included in the irrigation wetland subclass.

There are two distinct types of slope wetlands located within the project area, those that occur in narrow, topographically distinct drainage ways (swale wetlands) and those that occur as broad, poorly defined features that are subject to sheet flow (clay slope wetlands). The swale and vernal pool/swale classifications used by EIP would fall within the swale subclass. The swale and drainage classifications used by EIP would also fall within the swale subclass. Some of the wetlands classified as seasonal wetlands by EIP (e.g., those in the Campus delineation) are included within the clay slope regional subclass.

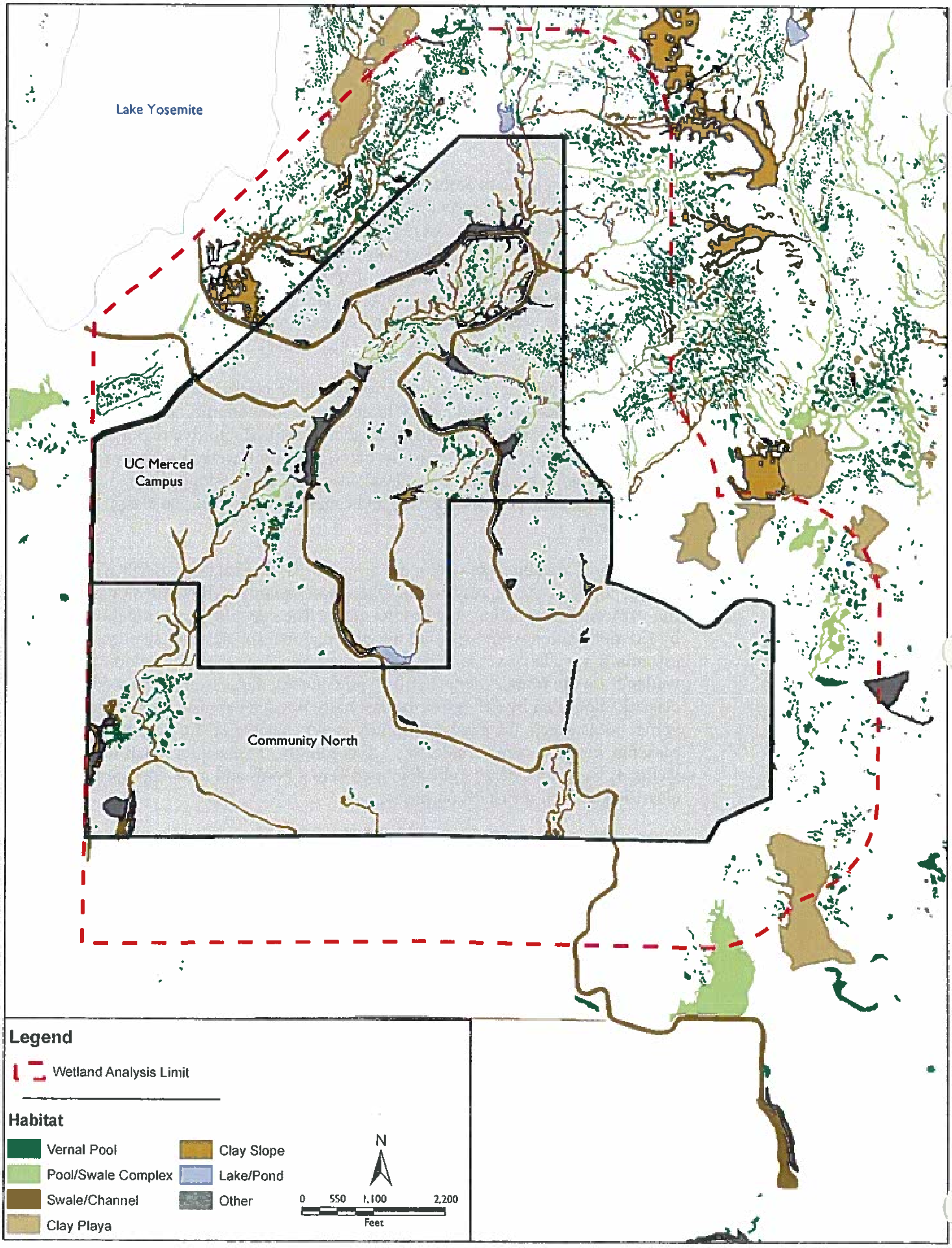

Figure 3-1
Wetlands in Project Region, EIP Classification

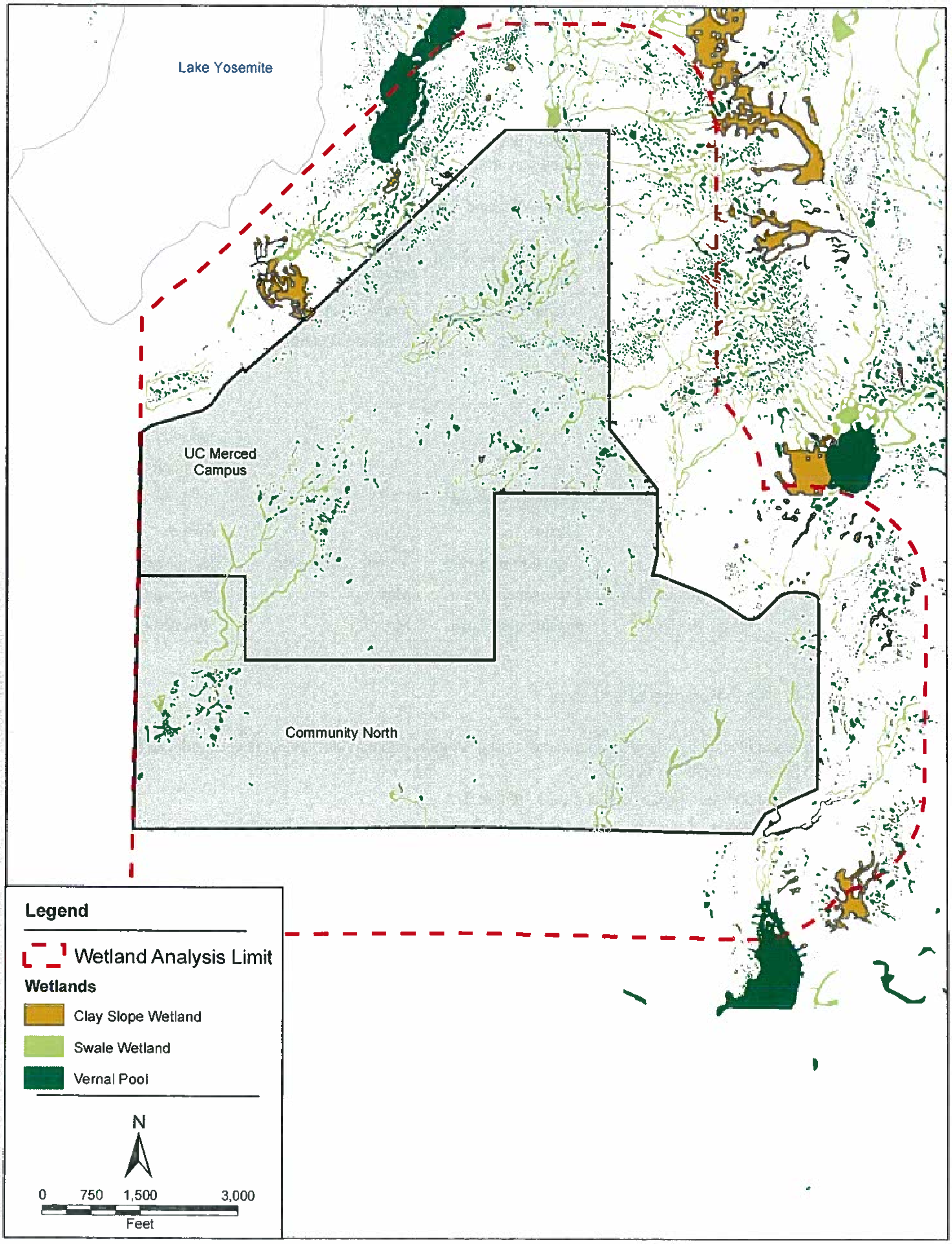

Figure 3-2
Waters of the United States in Project Area, HGM Classification

Table 3-2 is a list of the HGM classes and regional subclasses, cross-referenced to the classification used by EIP in each of their jurisdictional delineations. Table 3-3 is a key for identifying these regional subclasses.

Table 3-2. Comparison of HGM Regional Wetland Subclasses and Wetland Delineation Classifications

HGM Class	HGM Subclass	Campus Delineation Classification	Golf Course Delineation Classification	Community Delineation Classification
Depression	Vernal Pool	Vernal Pool	Vernal Pool	Vernal Pool
		Clay Playa	Seasonal Wetland	
	Irrigation Wetland	–	–	Stock Pond
				Freshwater Marsh
				Seasonal Wetland
				Wooded Channel
Slope	Clay Slope	Seasonal Wetland	–	–
	Swale	Swale	Swale	Swale
		Vernal Pool/Swale	Vernal Pool/Swale	Drainage
Riverine	Intermittent Channel	Freshwater Marsh	Marsh	Wooded Channel
	Canal Wetland	Freshwater Marsh	Marsh	Wooded Channel

Table 3-3. Key to Regional Subclasses

1a	Wetland located in a depression that has closed contours and may or may not have an inlet or outlet. (Go to 2, Depression Class)
1b	Wetland does not have closed contours. (Go to 3)
2a	Wetland located within closed contours and dominated by non-persistent emergent vegetation. (D-Vernal Pool)
2b	Wetland located within closed contours and hydrologically influenced by irrigation. (D-Irrigation Wetland)
3a	Wetland lacking closed contours and located on a slope without well-defined bed, banks, and ordinary high water line. (Go to 4, Slope Class)
3b	Wetland lacking closed contours and located on a slope within or adjacent to a watercourse with well-defined bed, banks, and ordinary high water line. (Go to 5, Riverine)
4a	Seasonally inundated/saturated wetland located on sloping ground that conveys water in somewhat narrow, linear drainage ways. (S-Swale Wetland)
4b	Seasonally inundated/saturated wetland located on sloping ground that conveys surface water as primarily sheet flow across a relatively broad, poorly defined plane. (S-Clay Slope Wetland)
5a	Wetland located within or adjacent to and intermittent drainage course whose hydrology is derived from precipitation and interflow. (R-Intermittent Channel Wetlands)
5b	Wetland adjacent to an irrigation canal whose hydrology is primarily derived from that irrigation canal. (R-Canal Wetlands)

The functional assessment was designed for the naturally occurring regional wetland subclasses existing within the project area. Those regional subclasses are vernal pools, swale wetlands, and clay slope wetlands. Canals, canal wetlands, irrigation wetlands, and intermittent channel wetlands are all artificially created and as such are not included in this functional assessment.

Functions, Variables, and Models

The following is a discussion of the functions likely to be performed by one or more of the regional wetland subclasses and the variables that affect a given wetland's capability to perform the function. Table 3-4 provides a summary of the wetland functions likely to be performed by each regional subclass.

Table 3-4. Wetland Function by Regional Subclass

Regional Subclass	SWS	SSWS&I	MS&SSWF	E&CC	OCE	MCPC	MCFC	FHI&C
Vernal Pools	X	X		X	X	X	X	X
Swales			X	X	X	X	X	X
Clay Slopes			X	X	X	X	X	X

Notes:
SWS = Surface Water Storage.
SSWS&I = Subsurface Water Storage and Interchange.
MS&SSWF = Moderation of Surface and Shallow Subsurface Water Flow.
E&CC = Element and Compound Cycling.
OCE = Organic Carbon Export.
MCPC = Maintenance of Characteristic Plant Communities.
MCFC = Maintenance of Characteristic Faunal Communities.
FHI&C = Faunal Habitat Interspersion and Connectivity

Surface Water Storage (SWS)

Definition: This function refers to the capability of a wetland or other water to collect and retain surface and shallow subsurface water as static water above the soil surface. The volume of the basin determines the potential volume of storage while surface water from the contributing watershed plus the infiltration of shallow subsurface water from the adjacent uplands determines the volume of water potentially contributing to the basin.

Variables Affecting Surface Water Storage: The average depth of a wetland multiplied by its area yields an estimate of the volume of surface storage within the wetland. The surface water storage capacity of a wetland can be modified by altering the amount of surface and shallow subsurface water entering it, raising or lowering the elevation that water will spill from it, raising or lowering its bed, or eliminating the restrictive layer in the soil. Therefore, a model of this function should include a variable for the depth of the wetland, the elevation of the outlet (if present), the integrity of the wetland's watershed, and the integrity of the soil profile (particularly the restrictive layer) both within and adjacent to the wetland.

Applicable Regional Subclasses: Vernal pools and irrigation wetlands.

Subsurface Water Storage and Interchange (SWS&I)

Definition: This function refers to the capability of a wetland to store water below the soil surface and allow exchange of shallow subsurface water laterally with the contributing uplands bordering the wetland.

Variables Affecting Subsurface Water Storage and Interchange: The soil profile within the vernal pool as well as bordering uplands largely determines the capability of a given wetland to perform this function. If the soil profiles in either the wetland or its adjacent upland are substantially disrupted, this function will be impaired.

Applicable Regional Subclasses: Vernal pools and irrigation wetlands.

Moderation of Surface and Shallow Subsurface Water Flow (MS&SSWF)

Definition: This function refers to a slope wetland's capacity to moderate the rate at which water passes through the wetland and the watershed.

Variables Affecting Moderation of Surface Flow and Shallow Subsurface Water: The slope of a wetland, the cross-sectional area of a wetland, the condition of its watershed, and the integrity of the soil profile both within the wetland and in its surrounding uplands significantly affect the capacity of a wetland to perform this function.

Applicable Regional Subclasses: Swale wetlands and clay slope wetlands.

Element and Compound Cycling (E&CC)

Definition: Element and compound cycling refers to the biological and physical processes that convert compounds from one form to another. These processes cycle various elements and compounds between the atmosphere, soil, water, and vegetation. This cycling contributes to the nutrient capital of the ecosystem and reduces downstream particulate loading and thereby helps to maintain and improve water quality.

Variables Affecting Element and Compound Cycling: The physical and biological variables that determine the capability of a particular wetland to perform this function are the vegetation in the vernal pool and the contributing watershed and the soil in the wetland and the contributing watershed. The plants absorb, transform, and temporarily store various elements and compounds. The soil contains various microorganisms that are critical to the cycling of these nutrients. The soil also provides a medium for short and long-term storage of elements and compounds.

Applicable Regional Subclasses: Vernal pools, irrigation wetlands, swale wetlands, and clay slope wetlands.

Organic Carbon Export (OCE)

Definition: This function refers to amount of dissolved or particulate organic carbon that is exported from a wetland. The export of carbon enhances the decomposition and mobilization of metals and supports aquatic food webs and downstream biogeochemical processes.

Variables Affecting Organic Carbon Export: The amount of organic carbon available for export is the sum of the input from the watershed and the biomass produced within the wetland itself. The degree to which this carbon can be exported downstream is affected by whether there is an outlet to convey water from the wetland to downstream waters.

Applicable Regional Subclasses: Vernal pools, irrigation wetlands, swale wetlands, and clay slope wetlands.

Maintenance of Characteristic Plant Communities (MCPC)

Definition: This function refers to the capability of wetlands to support and sustain endemic plant communities that are characteristic of the regional wetland subclass with respect to species composition, abundance, and structure. This, in turn, helps to maintain ecosystem health and biodiversity.

Variables Affecting Maintenance of Characteristic Plant Communities: The soil profile and its integrity, the integrity of the watershed, the duration and depth of ponding, and the degree of disturbance of the wetland and its adjacent uplands can all have a profound affect on the plant community that a wetland supports.

Applicable Regional Subclasses: Vernal pools, irrigation wetlands, swale wetlands, and clay slope wetlands.

Maintenance of Characteristic Faunal Communities (MCFC)

Definition: This function refers to the capability of wetlands to support and sustain endemic faunal communities that are characteristic of the regional subclass with respect to species composition, abundance, and age structure. For purposes of this assessment, this function includes both vertebrate and invertebrate fauna.

Variables Affecting the Maintenance of Characteristic Faunal Communities: The soil profile and its integrity, the integrity of the watershed, the duration and depth of ponding, and the degree of disturbance of the wetland and its adjacent uplands can all have a profound affect on the faunal community that a wetland is capable of sustaining.

Applicable Regional Subclasses: Vernal pools, irrigation wetlands, swale wetlands, and clay slope wetlands.

Faunal Habitat Interspersion and Connectivity (FHI&C)

Definition: This function refers to the capability of a wetland to act as a conduit of interspersion and connectivity for vertebrates and invertebrates normally associated with wetlands. This, in turn, supports landscape and regional faunal biodiversity.

Variables Affecting Faunal Habitat Interspersion and Connectivity: The capability of a wetland to perform this function is affected by the integrity of the watershed, the presence or absence of an outlet and a mechanism for longitudinal connectivity, and the proximity of other wetland habitats.

Applicable Regional Subclasses: Vernal pools, irrigation wetlands, swale wetlands, and clay slope wetlands.

Functional Assessment Methodology

The functional assessment for the UC Merced project focuses on identifying and assessing the various disturbances that can potentially reduce the capacity of wetlands to perform one or more of the various functions identified above. Table 3-5 is a list of the disturbance index ratings used in the functional assessment. The disturbance index ratings were assigned based on the relative extent each type of disturbance is expected to impair the functional capacity of a wetland. A rating of 0.00 indicates that the disturbance is so severe that no wetland functional capacity remains. A rating of 1.00 indicates that there is no diminution of wetland function. Both the severity of impairment to any given function as well as the number of wetland functions impaired were considered in assigning these disturbance index ratings.

Table 3-5. Disturbance Index

Disturbance Factors	Index Rating
Agriculture	
None	1.00
Mowing	0.70
Disking/Harrowing/Chiseling	0.40
Plowing/Planting	0.25
Chemical Spraying	0.10
Deep Plowing, Restoration Possible	0.10
Land Leveling	0.10
Deep Ripping and Leveling	0.00
Grazing	
Specially Managed to Benefit Wetlands	1.00
Managed per NRCS Standards*	0.80
Moderate Grazing	0.70
No Grazing	0.50
Severe Grazing	0.50
Landscape Modification	
None	1.00
Non-graded Roads/Trails	0.75
Scraping	0.25
Excavating in Wetland	0.10
Filling in Wetland	0.00
Hydrologic Modifications	
None	1.00
Irrigation	0.25
Diversions of Flows Away	0.10
Impounding Wetland	0.10
Interceptions of Inflows	0.10
Wetland Drained	0.00

*NRCS = Natural Resources Conservation Service.

The magnitude of disturbance both within and outside of the wetland was considered in assessing wetland function. All of the disturbances under baseline conditions were mapped from aerial photography and digitized for GIS analysis. A grid of 3–square meter (m^2) cells was established over the project area. Each 3-m^2 cell was then assigned a corresponding disturbance index rating. Where more than one disturbance was present within a given 3-m^2 cell, the most severe index rating was assigned. Where only a portion of a given 3-m^2 cell was disturbed, the whole cell was considered to be disturbed.

The disturbance index ratings were then used to calculate the functional capacity index (FCI) for each wetland. The range of the FCI is 0.00–1.00. The FCI is calculated as the square root of the product of:

1. the average index ratings of all 3-m^2 cells within the wetland, and
2. the average decayed index ratings of all 3-m^2 cells outside the wetland out to a distance of 500 meters.

Any 3-m^2 cell containing a portion of a wetland was considered to be within that wetland. For purposes of this functional assessment, we assumed that any disturbances beyond 500 meters would have a negligible effect on wetland function.

It should be noted that several different distance standards have been used in reference to indirect impacts to vernal pools and/or the species supported by these vernal pools. The *Biological Assessment CWA Section 404 Permit Applications for UC Merced Campus Project and County of Merced Infrastructure in Support of UC Merced Project* (Biological Assessment) used a standard of 250 feet and the Conservation Strategy used a standard of 200 meters (656 feet). The 250-foot standard was derived from the USFWS's programmatic consultation for fairy shrimp, which assumes that disturbances within 250 feet of vernal pools may result in take as defined for purposes of Section 9 of the ESA. The Conservation Strategy used the 200-meter standard as the basis for evaluating potential indirect effects to the broad list of threatened or endangered species potentially occurring within wetlands in the project area, whether or not those impacts would result in a take as defined by Section 9 of the ESA. The functional assessment's use of a broader 500-meter standard is based on the potential indirect effects to the previously discussed wetland functions that could result from various disturbances. It is not intended to imply that disturbances within 500 meters will result in a take or even necessarily a measurable effect to any threatened or endangered species.

The disturbance indices of all 3-m^2 cells outside the wetland but within 500 meters of the wetland are decayed based on their distance from the wetland. In other words, the further a given disturbance is from a given wetland, the less effect that disturbance has on wetland function. These disturbance indices are decayed on an exponential curve so that there is a negligible decay in the disturbance index out to approximately 100 meters with the rate of decay progressively increasing beyond 100 meters. This type of curve was selected because the watersheds of a large majority of wetlands extend less than 100 meters beyond the edge of the wetland. An exponential curve results in a negligible decay of the disturbance indices within the approximate watersheds of a large majority of the wetlands. In other words, the exponential curve is an attempt to factor in the watersheds of various wetlands without actually mapping them.

Calculating the FCI based on the square root of the product often results in a lower FCI as compared to calculating it based on an average of the index ratings within and outside the wetland. Where the disturbance index ratings within and outside a wetland are identical, the FCI will be the same. Where there is a difference between the two disturbance index ratings, calculating the FCI based on the square root of the product yields a lower FCI. For instance, if a wetland has a disturbance index rating of 0.10 and outside the wetland has a decayed disturbance index rating of 0.90, the FCI will be 0.30. The same would be true if the disturbance index rating within the wetland is 0.10 and the decayed disturbance index rating outside the wetland is 0.90. If the FCI were to be calculated based on the average of the two, the FCI would be 0.50 under either scenario. Thus, although the disturbance index ratings within and outside the wetland are given equal weight, the FCI is more influenced by greater disturbance.

The formula for calculation of the FCI is as follows:

$$FCI = \sqrt{\left[\frac{\sum_{1}^{n_{cw}} I_{cw}}{n_{cw}}\right]\left[\frac{\sum_{1}^{n_{cnw}} I_{cnw} + \left((1 - I_{cnw})\left(\frac{D_{cw-cnw}}{D_m}\right)^2\right)}{n_{cnw}}\right]}$$

where:

FCI	=	Functional capacity index of wetland
I_{cw}	=	Disturbance index rating of cell in wetland
I_{cnw}	=	Disturbance index rating of cell not in wetland but within 500 meters (D_m)
n_{cw}	=	Number of cells in wetland
n_{cnw}	=	Number of cells not in wetland but within the maximum distance
$D_{cw\text{-}cnw}$	=	Distance from non-wetland cell to nearest wetland cell
D_m	=	Maximum distance is 500 meters

Figure 3-3 illustrates the effect of a disturbed area on the FCI for wetlands at varied distances.

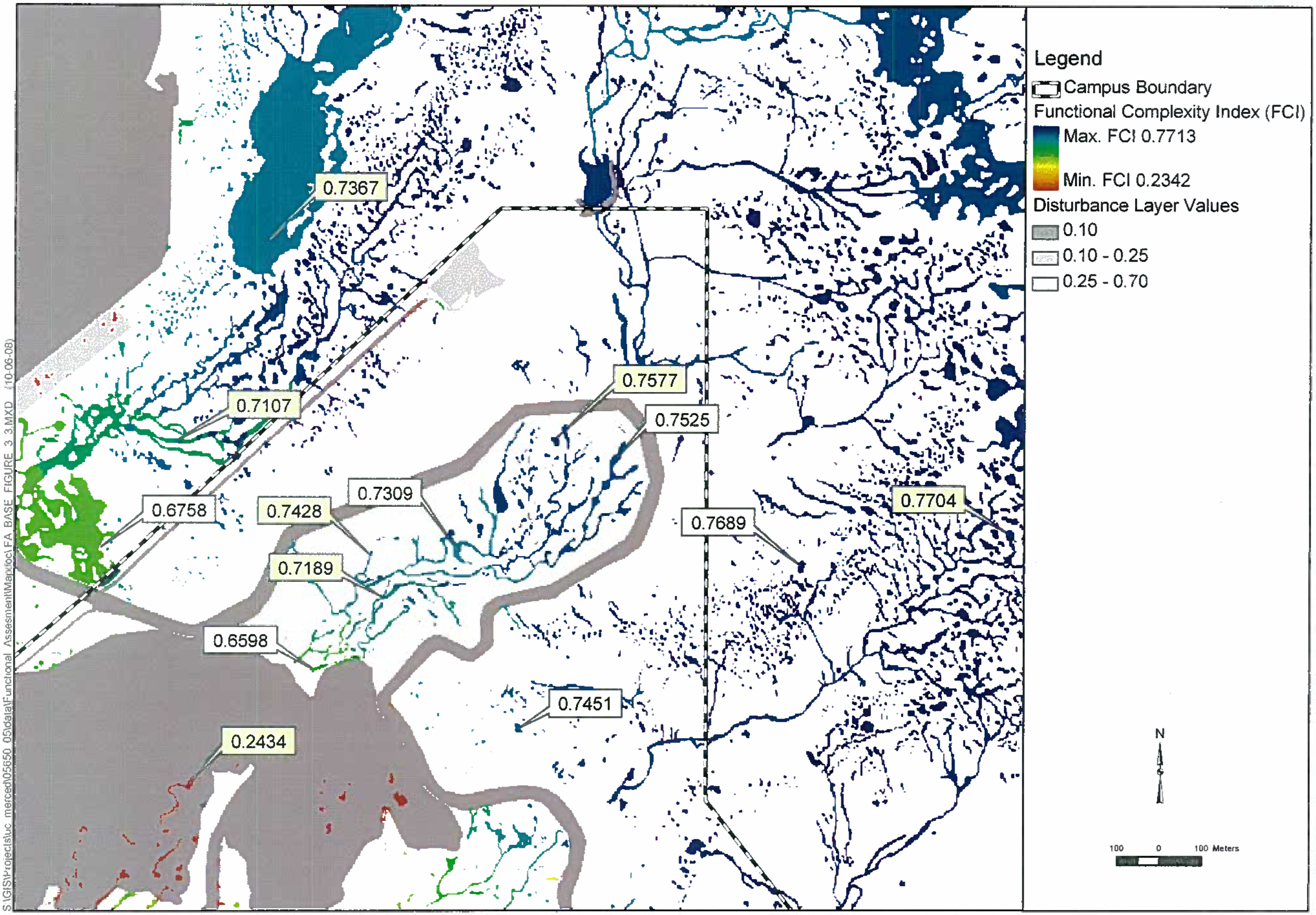

Figure 3.3
Functional Assesment Example
Baseline cenario

Once the FCI is calculated for each wetland, functional capacity units (FCUs) are calculated by multiplying the FCI of each wetland times its area (in acres). The formula for calculation of FCUs is as follows.

$$FCU = [(FCI)(A)]$$

where:

FCU	=	Functional capacity units of wetland
FCI	=	Functional capacity index of wetland
A	=	Area of the wetland (acres)

The sum of all FCUs represents the functional capacity under baseline conditions. To calculate the impact of the project, the FCUs are recalculated for all wetlands using new disturbance index ratings based on the proposed campus. The difference between FCUs with the proposed campus and FCUs under baseline conditions represents the wetland functional impacts of the proposed project.

Chapter 4
Impacts

For purposes of the revised application the project area was redefined to include the proposed Campus, the Community North and surrounding lands extending laterally to a point 500 meters from the footprint of the edge of proposed development excluding those lands lying west of Lake Drive and the Community South. The proposed Campus and Community North would directly impact 77.79 acres of wetlands of which 40.41 acres are vernal pools, swale wetlands and clay slope wetlands. Table 4-1 provides a summary of the direct impacts, by Regional Subclass, to waters of the United States within the footprint of the Campus and Community North.

Table 4-1. Summary of Wetland Areas Impacted

Regional Subclass	Impacted (acres)
Vernal Pools	15.03
Swale Wetlands	25.05
Clay Slope Wetlands	0.33
Irrigation Wetlands	12.23
Canal Wetlands	25.15
Total	**77.79**

The HGM functional assessment protocol was used to calculate the FCUs for the vernal pools, swale wetlands, and clay slope wetlands within the revised project area under baseline conditions. Baseline conditions are defined as existing conditions without the proposed UC Merced project. The assessment protocol was then used to calculate the FCUs with the proposed Campus and Community North. To calculate the FCUs within the Campus and Community North, those wetlands lying within the footprint were assigned an FCI of 0.00 yielding FCU values of 0.00. The FCUs of all wetlands lying with 500 meters of the footprint were then recalculated using the functional assessment model with the Campus and Community North added as a new disturbance layer.

The difference between the two FCU totals is the projected loss of wetland function, expressed as FCUs, for the vernal pool, swale wetland, and clay slope wetland regional subclasses that would result from the proposed project. It is important to remember that the functional assessment does not evaluate the loss of non-naturally occurring wetlands (i.e. canal wetlands and irrigation wetlands).

Under baseline conditions, the highest FCU for vernal pools, swale wetlands, and/or clay slope wetlands was 0.771. This FCU was achieved where the only disturbance within 500 meters is moderate grazing. The lowest FCUs for vernal pools, swale wetlands, and clay slope wetlands were 0.234, 0.242 and 0.631, respectively.

Tables 4-2, 4-3 and 4-4 provide a summary of the functional impacts under the baseline and with-project scenarios for clay slope wetlands, swale wetlands and vernal pools, respectively. These tables summarize impacts to wetland functions in FCUs by regional wetland subclass categorized in terms of within the proposed campus footprint, outside the proposed campus footprint but within 500 meters, and more than 500 meters from the proposed campus footprint. The wetland acreages cited in these tables are slightly higher than the acreages cited in Table 4.1 above, because they are based on $3M^2$ cells occurring within and partially within each wetland polygon. Since a fraction of some of the 3M cells also include upland, this methodology slightly overestimates wetland area.

As shown in Table 4-5, the total difference between baseline conditions and with the proposed campus is 28.8 FCUs. This represents the loss of functional capacity from direct and indirect impacts attributable to the proposed UC Merced Campus, without implementation of the compensatory mitigation measures presented in this Plan.

Table 4-2. Functional Impacts to Clay Slope Wetlands

			Mean FCI		Range of FCI (min-max)		Total FCUs[1]	
Location	No.	Area[2]	Existing	With Project	Baseline	With Project	Baseline	With Project
Within footprint	3	0.363	0.707	0.000	0.634–0.771	0.000–0.000	0.258	0.000
Within 500 meters of footprint	40	62.567	0.759	0.749	0.676–0.770	0.648–0.770	46.570	46.233
Total	43	62.930	-	-	-	-	46.828	46.233

Notes:

[1] Total FCUs are the sum of the individual wetland FCUs, which are the product of wetland area and FCI.

[2] Values are in acres.

Table 4-3. Functional Impacts to Swale Wetlands

Location	No.	Area[2]	Mean FCI		Range of FCI (min-max)		Total FCUs[1]	
			Existing	With Project	Baseline	With Project	Baseline	With Project
Entirely Within Campus Footprint	144	25.026	0.691	0.000	0.243–0.771	0.000–0.000	15.328	0.000
Within 500 meters of Campus	387	57.249	0.759	0.744	0.258–0.771	0.255–0.771	42.359	41.235
Total	531	82.275	-	–	-	-	57.687	41.235

Notes:

[1] Total FCUs are the sum of individual wetland FCUs, which are the product of wetland area and FCI.

[2] Values are in acres.

Table 4-4. Functional Impacts to Vernal Pools

Location	No.	Area[2]	Mean FCI		Range of FCI (min-max)		Total FCUs[1]	
			Existing	With Project	Baseline	With Project	Baseline	With Project
Entirely Within Campus Footprint	750	15.379	0.715	0.000	0.246–0.771	0.000–0.000	10.718	0.000
Within 500 meters of Campus	2,131	102.450	0.757	0.742	0.252–0.771	0.235–0.771	70.453	69.419
Total	2,881	117.829	-	–	-	-	81.171	69.419

Notes:

[1] Total FCUs are the sum of the individual wetland FCUs, which are the product of wetland area and FCI.

[2] Values are in acres.

Table 4-5. Wetland Functional Capacity Units Baseline and Proposed Project Scenarios

Regional Subclass	Baseline (FCUs)	Proposed Project (FCUs)	Difference (FCUs)
Vernal Pools	81.171	69.419	11.752
Swale Wetlands	57.687	41.235	16.452
Clay Slope Wetlands	46.828	46.233	0.595
Total	185.686	156.887	28.799

Chapter 5
Proposed Mitigation Measures

Overview of Mitigation Plan

The CWMMP consists of two major components: (1) preservation and management to prevent reasonably foreseeable degradation of existing wetlands, and (2) restoration of previously existing wetlands and/or establishment of new wetlands. From a broad perspective, the preservation and management component is primarily intended to ensure that there will be no net loss of wetland functions for naturally occurring wetlands (vernal pools, swale wetlands and clay slope wetlands). The restoration and creation component is primarily intended to ensure that there will be no net loss in the overall areal extent of wetlands. From a functional standpoint, the wetland creation is also intended to compensate for the loss of function to non-naturally occurring wetlands (canal wetlands and irrigation wetlands).

This CWMMP is based on a comprehensive ecosystem approach focusing on the watershed level involving a wide range of aquatic habitats and their surrounding upland environments. In selecting and securing mitigation areas, emphasis has been placed on securing large parcels encompassing intact watersheds. Securing larger parcels allows for a more comprehensive ecosystem landscape approach and increases the opportunity to minimize indirect impacts and perturbations from adjacent lands. In many instances, these mitigation measures will serve a dual function in mitigating impacts to rare, threatened, or endangered species. The mitigation will not be "on-site" in that it will not be located within the confines of the proposed campus. It will be located within the same general watershed, geographical regions, soil types, and environments as UC Merced, often on adjacent lands.

Background on Preservation and Enhancement

Corps mitigation policy provides some flexibility in terms of the types of strategies that can be utilized to mitigate the impacts of a project. It allows the use of preservation of existing wetlands and other aquatic resources in conjunction with restoration, rehabilitation, establishment and enhancement activities where "it is demonstrated that the preservation will augment the functions of the established, restored, rehabilitated or enhanced aquatic resource"

(U.S. Army Corps of Engineers 2002). Corps policy allows for preservation as the sole basis of mitigation. Corps policy also allows mitigation credit to be given for the preservation of upland areas to the degree that the protection and management of such upland areas is an enhancement of the overall value of the mitigation project.

Approximately 40.41 acres of the aquatic habitats that would be impacted by UC Merced are vernal pools, swale wetlands and clay slope wetlands. Preservation of these types of wetlands and their surrounding uplands to compensate for wetland impacts is consistent with Corps mitigation policy for the following reasons:

- There are numerous agricultural activities, such as grazing, normal plowing, and disking that are not regulated under Section 404 of the Clean Water Act. These activities can seriously degrade the functional capacity of these wetlands. Therefore, preservation and enhancement of such lands can reduce or eliminate this potential degradation.
- Certain wetlands may not be regulated under Section 404 of the Clean Water Act because they are isolated and do not otherwise have a nexus to interstate commerce. Therefore, preservation and enhancement of such wetlands would also protect them from potential degradation.
- The uplands surrounding these wetlands are not regulated pursuant to Section 404 of the Clean Water Act. As a result, these uplands can be substantially modified to such an extent that the adjacent aquatic habitats would be significantly impacted. With respect to non-vernal aquatic habitats, the USFWS routinely recommends, and the Corps Sacramento District routinely requires, the preservation of upland buffers adjacent to the preserved aquatic resources.
- The USFWS routinely requires preservation of vernal pools and seasonal wetlands as the cornerstone of mitigation projects designed to compensate for impacts to these wetlands where such wetlands are considered habitat for threatened or endangered species. Similar requirements are anticipated for UC Merced.

Proposed Preservation

Figure 5-1 is a map showing the location and boundaries of the lands to be preserved and managed ("Conservation Lands"). The proposed Conservation Lands include the following:

- Lands which are owned wholly or in part by UCM and will be managed by UCM for conservation purposes with granted conservation easements (hereinafter referred to as Tier 1a lands);

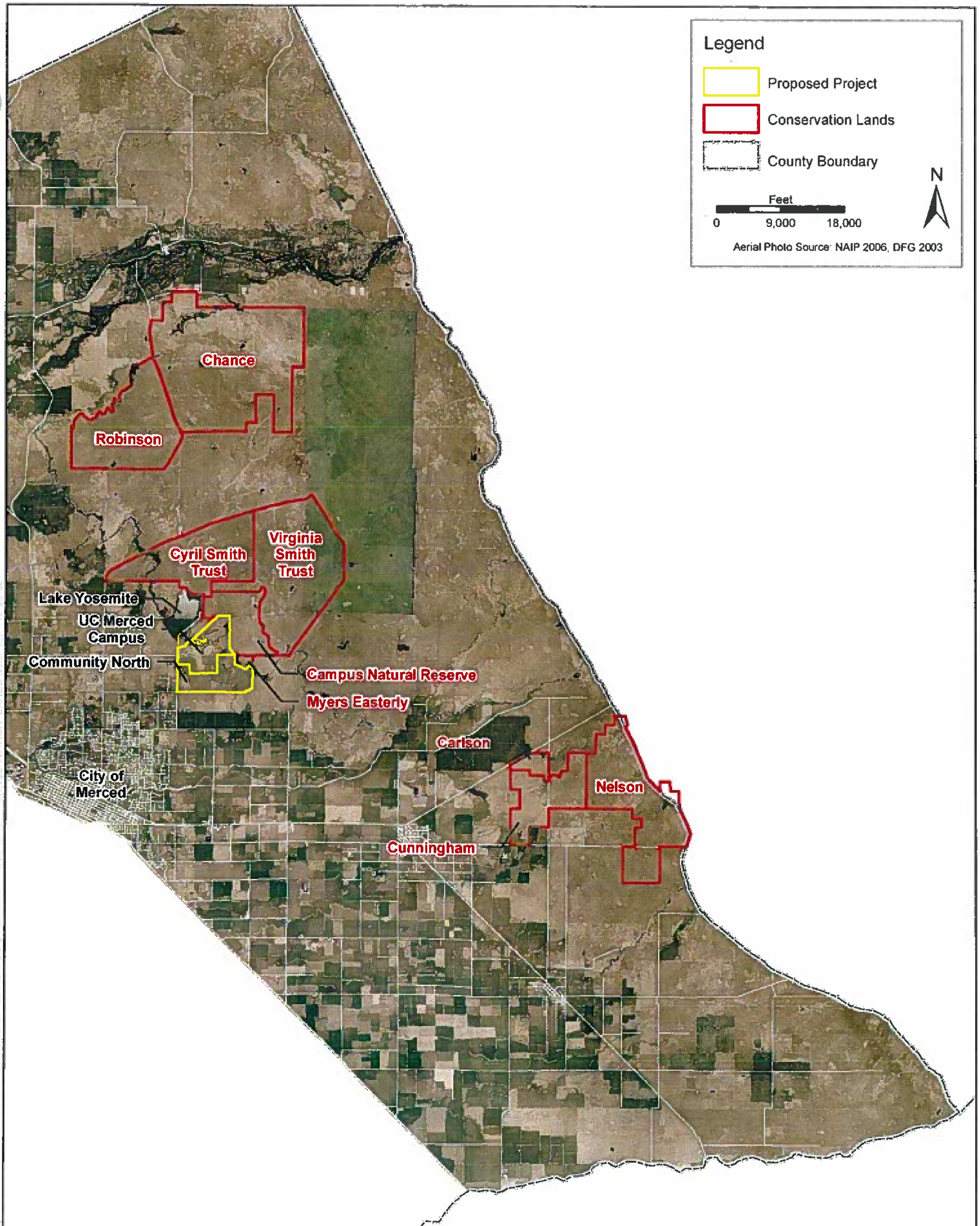

Figure 5-1
UC Merced Project and Proposed Mitigation Lands

- Lands currently owned in fee title by The Nature Conservancy (TNC), to be protected by a comprehensive conservation easement (hereinafter referred to as Tier 1b lands); and,

- Lands under private ownership currently protected under conservation easements (hereinafter referred to as Tier 2 lands).

The Tier 1a lands include the Virginia Smith Trust (VST) property (5,030 acres), 1,307 acres of lands previously proposed as the Campus Natural Reserve (750 acres) and the Campus Land Reserve (338 acres), 221 acres of land that were included in the originally proposed Campus and 91 acres of land known as the Myers Easterly property. Tier 1b lands are the Cyril Smith Trust (CST) property (3,074 acres). The CST property is currently owned in fee title and managed for grazing and habitat protection by TNC.

Tier 2 lands are comprised of five properties encompassing 17,141 acres that were selected for mitigation because of the high value of their existing biological resources. The Tier 2 lands include the Carlson (305 acres), Chance (7,619 acres), Cunningham (1,761 acres), Nelson (3,861 acres) and Robinson (3,595 acres) properties.

A plan has been prepared which describes the proposed long-term management of these lands (Airola 2008a). A copy of the Management Plan is attached as Appendix B. The management objectives and mitigation potential for Tier 1a, Tier 1b and Tier 2 lands, will vary because of ownership status and the presence or absence of existing conservation easements. Tier 1a lands are owned wholly or in part by UCM (Tier 1a) thereby allowing for a more active and adaptive approach to long-term management. Tier 1b lands will be protected under a conservation easement that will provide for long-term management and insure agency access to monitoring results. The conservation easements for Tier 2 lands have already been granted and, as a result, management discretion is substantially less detailed and less flexible.

The wetlands and other aquatic resources on the Conservation Lands were delineated by EIP for Merced County as part of a preliminary delineation of all wetlands in western Merced County. Figures 5-2a–5-2h are maps showing the wetlands delineated by EIP. Table 5-1 is a tabulation of the wetlands delineated on the Tier 1 lands. Table 5-2 is a tabulation of the wetlands delineated on the Tier 2 lands. The wetland classifications used by EIP preceded and are not consistent with the HGM regional subclasses adapted for the functional assessment. Generally speaking, the vernal pool and clay playa classifications used by EIP are equivalent to the HGM vernal pool subclass, the pool/swale and swale/channel classifications used by EIP are equivalent to the HGM swale subclass, and the seasonal wetland EIP classification is equivalent to the HGM clay slope subclass. The "other" category encompasses several EIP classifications for wetlands that have been created or substantially influenced by anthropogenic modifications to the landscape such as farm ponds, irrigation wetlands, etc.

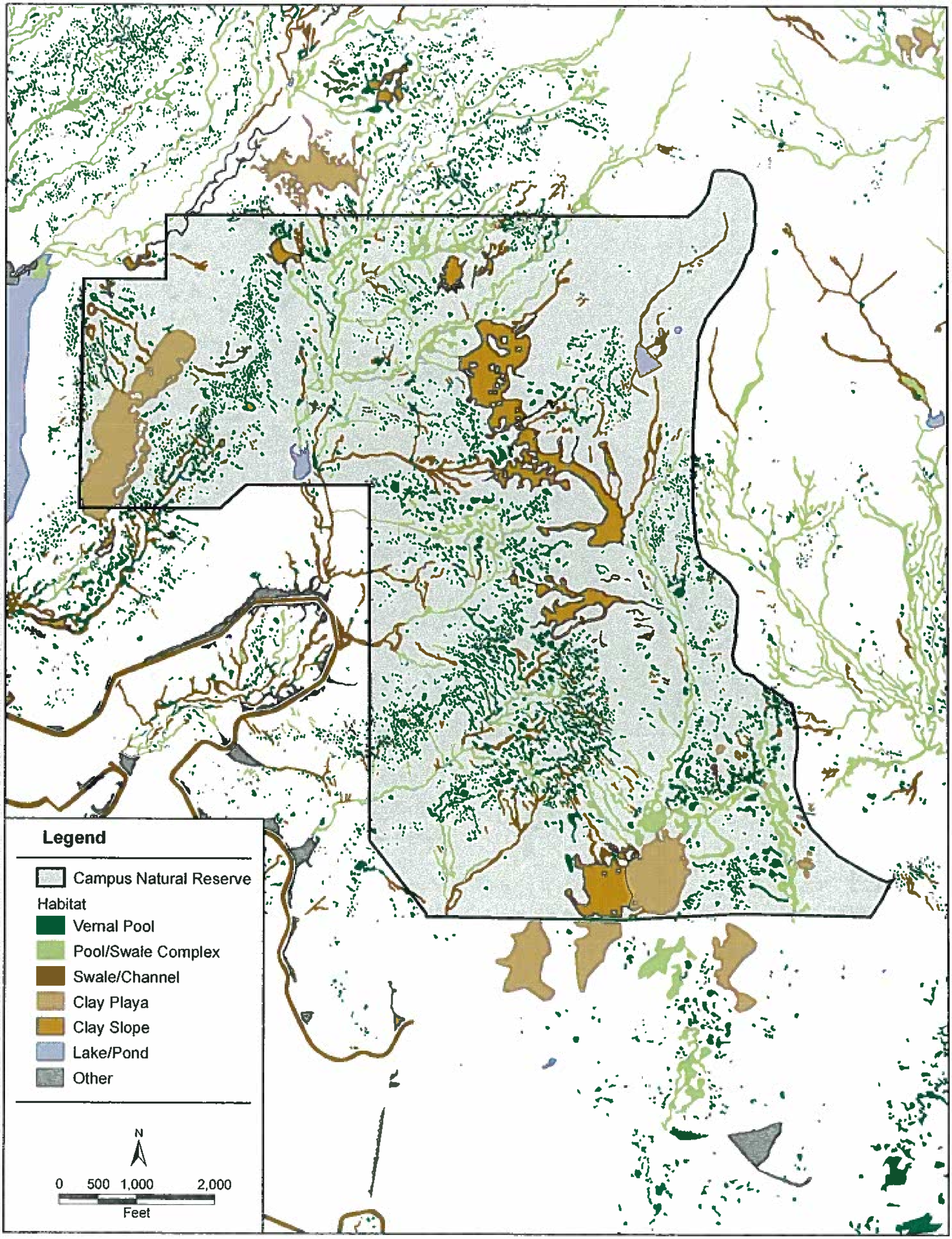

Figure 5-2a
Waters of the United States
Campus Natural Reserve

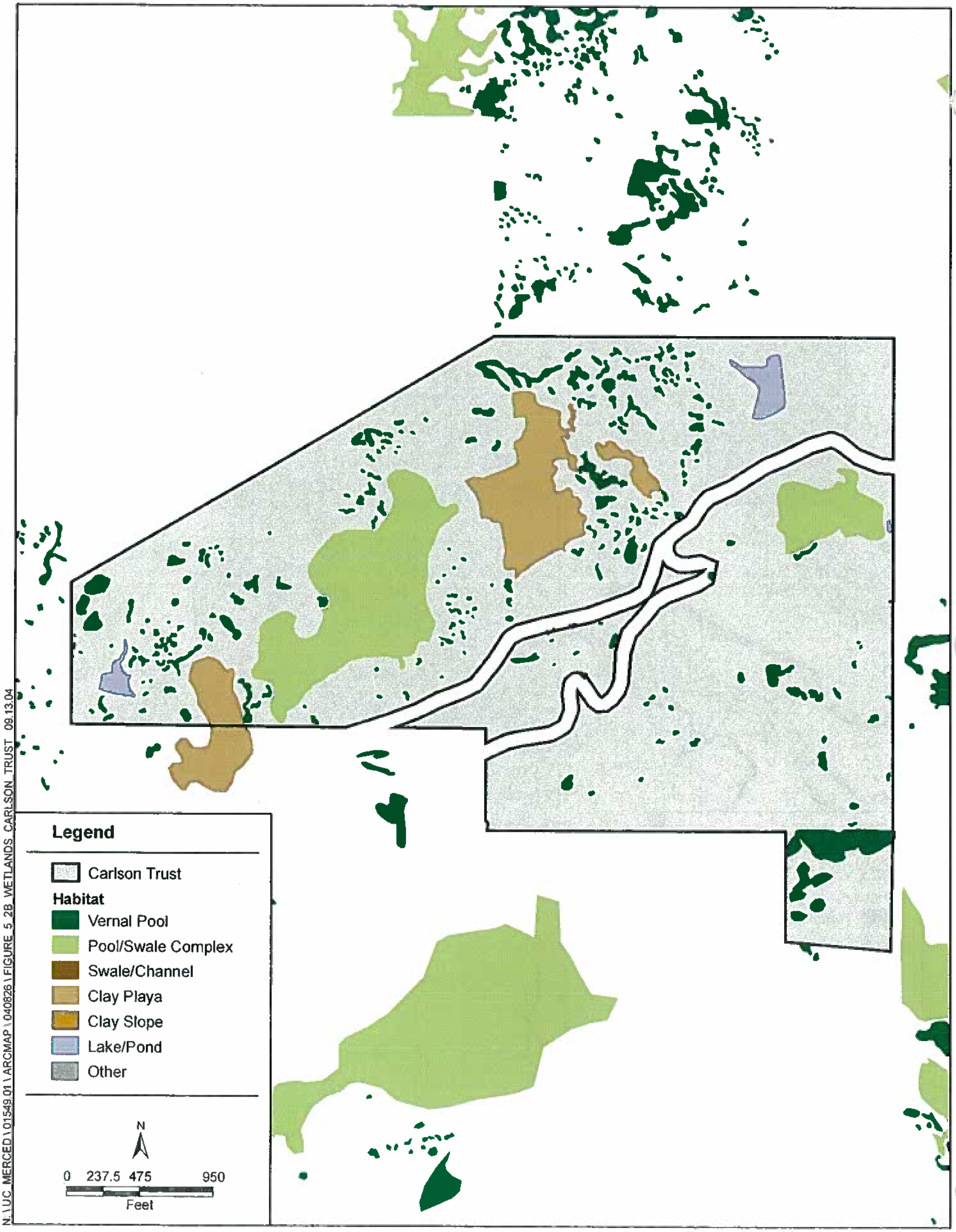

Figure 5-2b
Waters of the United States
Carlson Trust

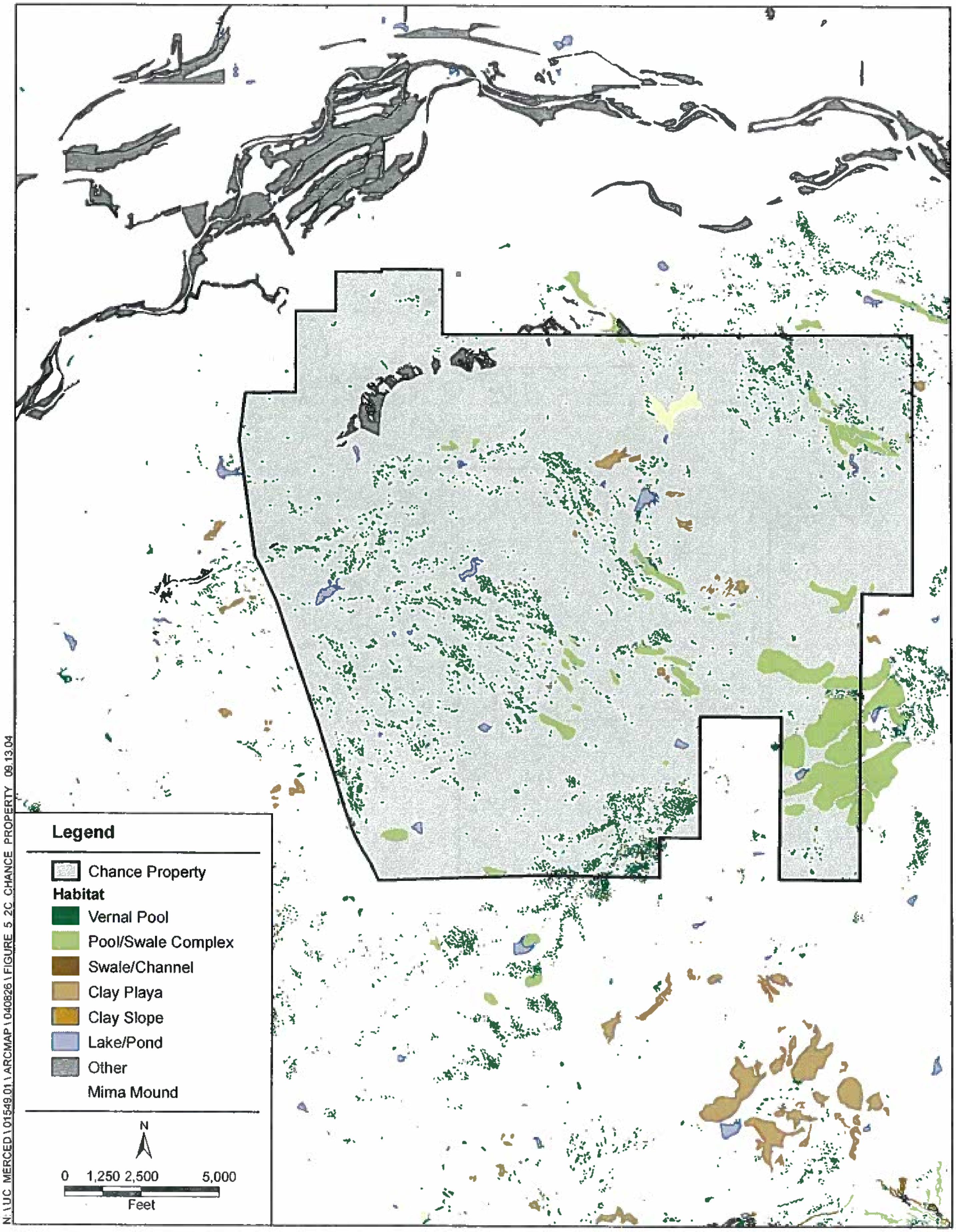

Figure 5-2c
Waters of the United States
Chance Property

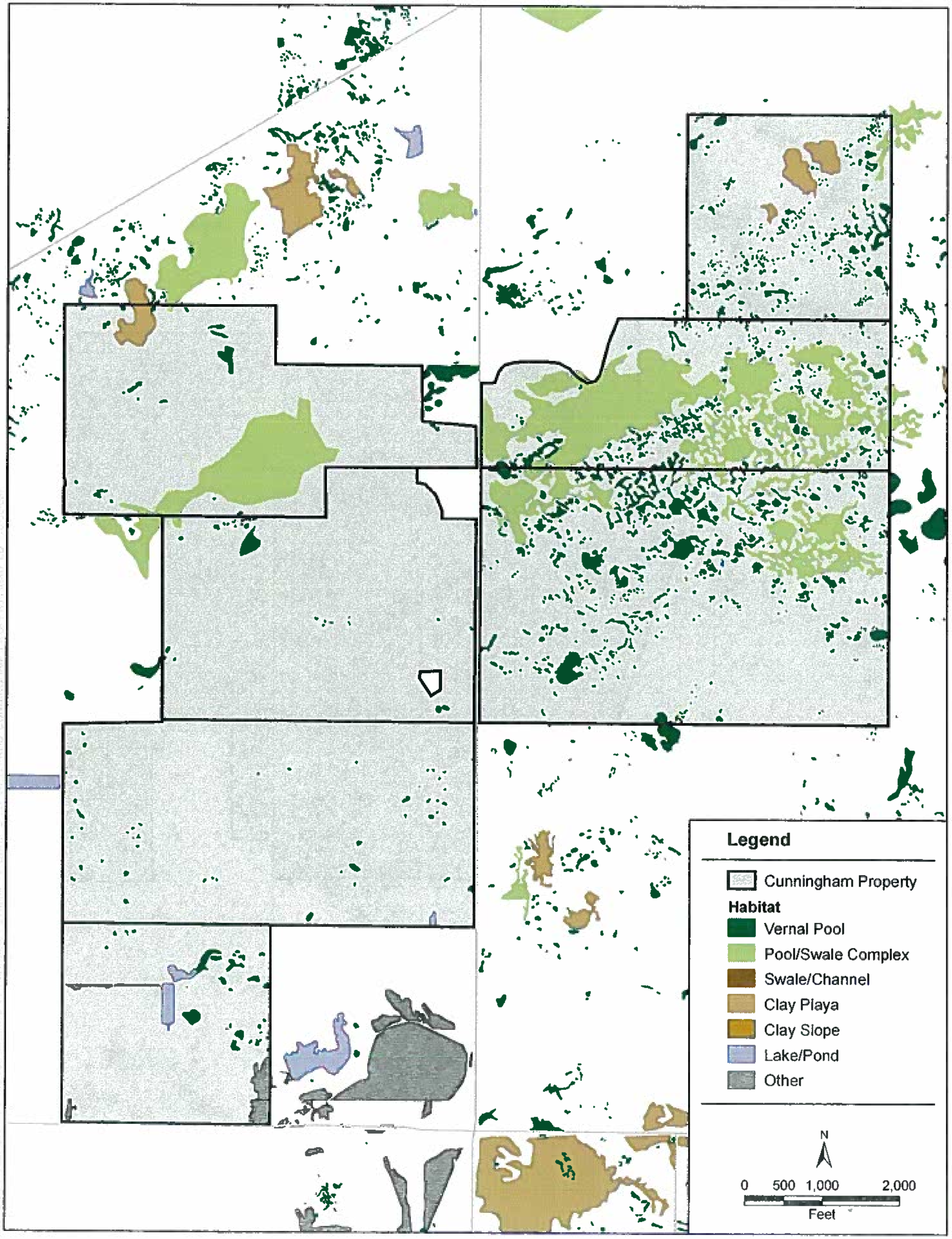

Figure 5-2d
Waters of the United States
Cunningham Property

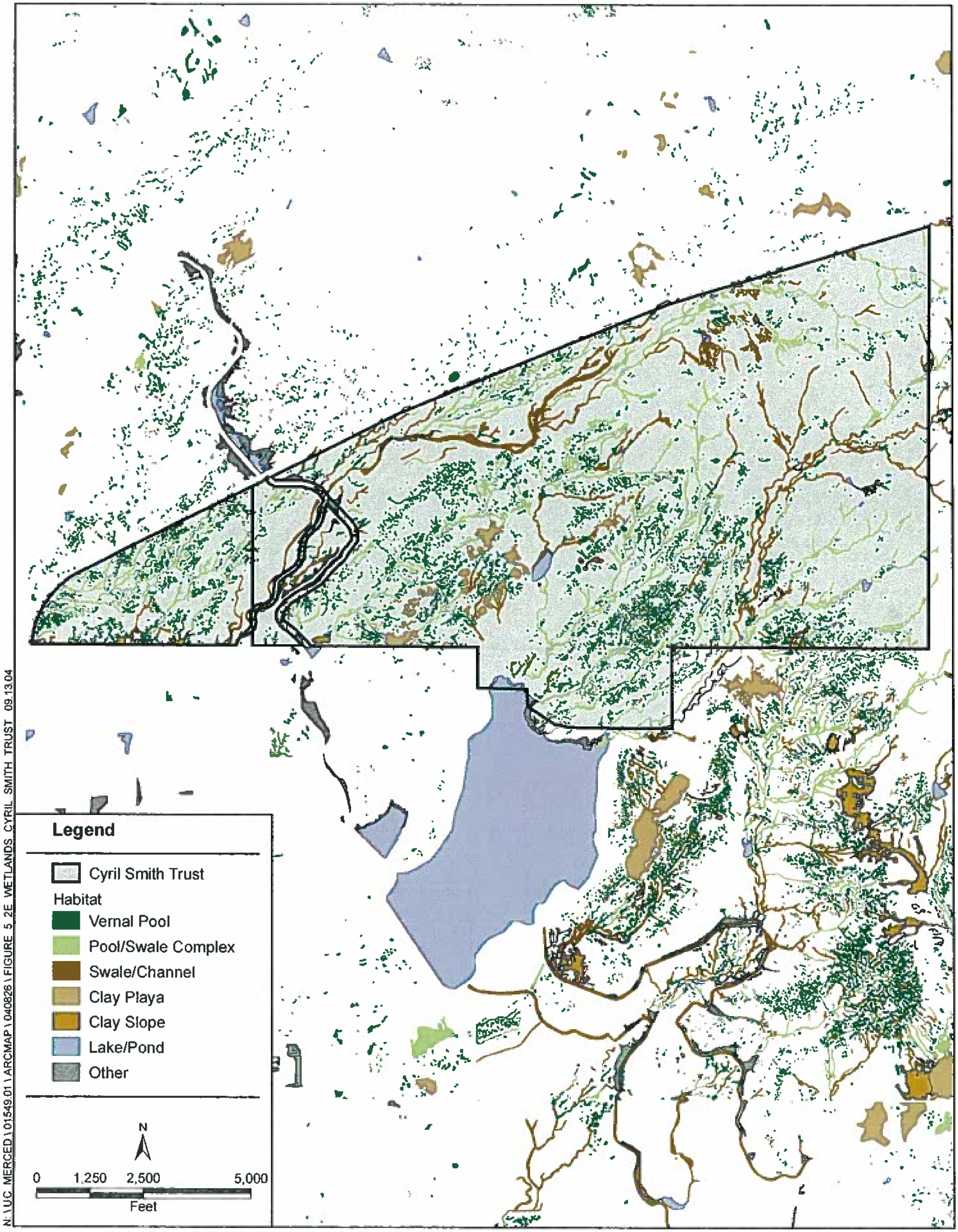

Figure 5-2e
Waters of the United States
Cyril Smith Trust

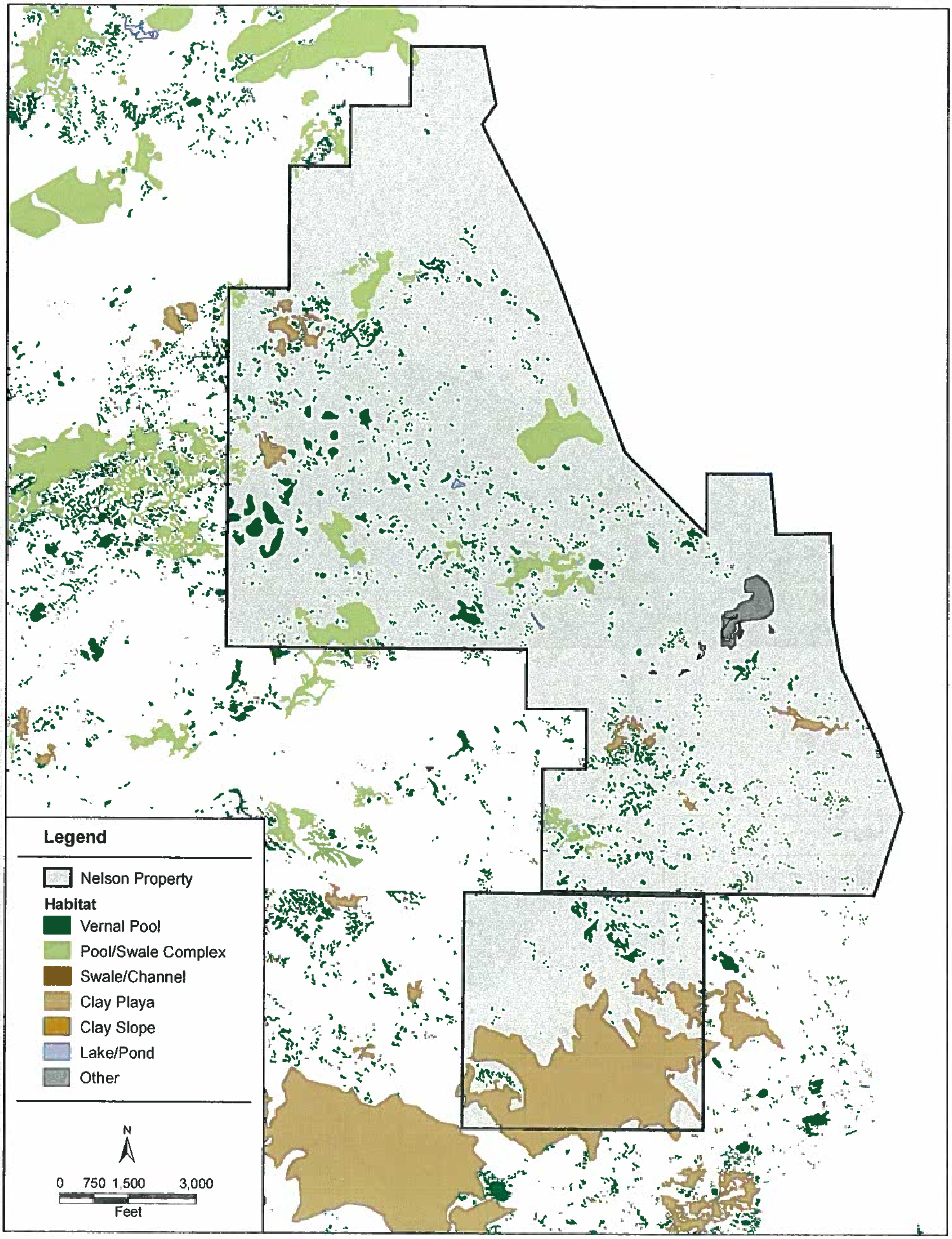

Figure 5-2f
Waters of the United States
Nelson Property

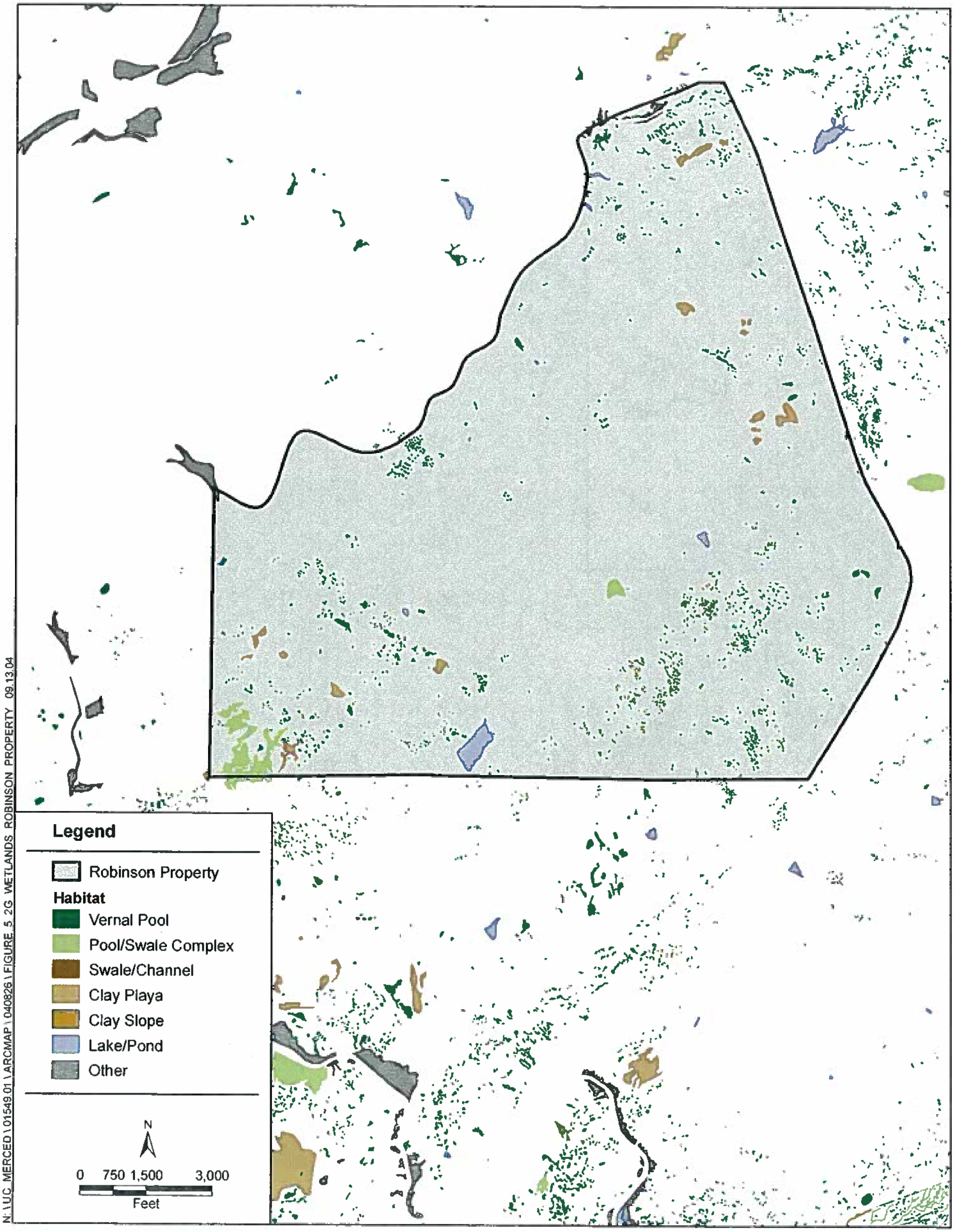

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Figure 5-2g
Waters of the United States
Robinson Property

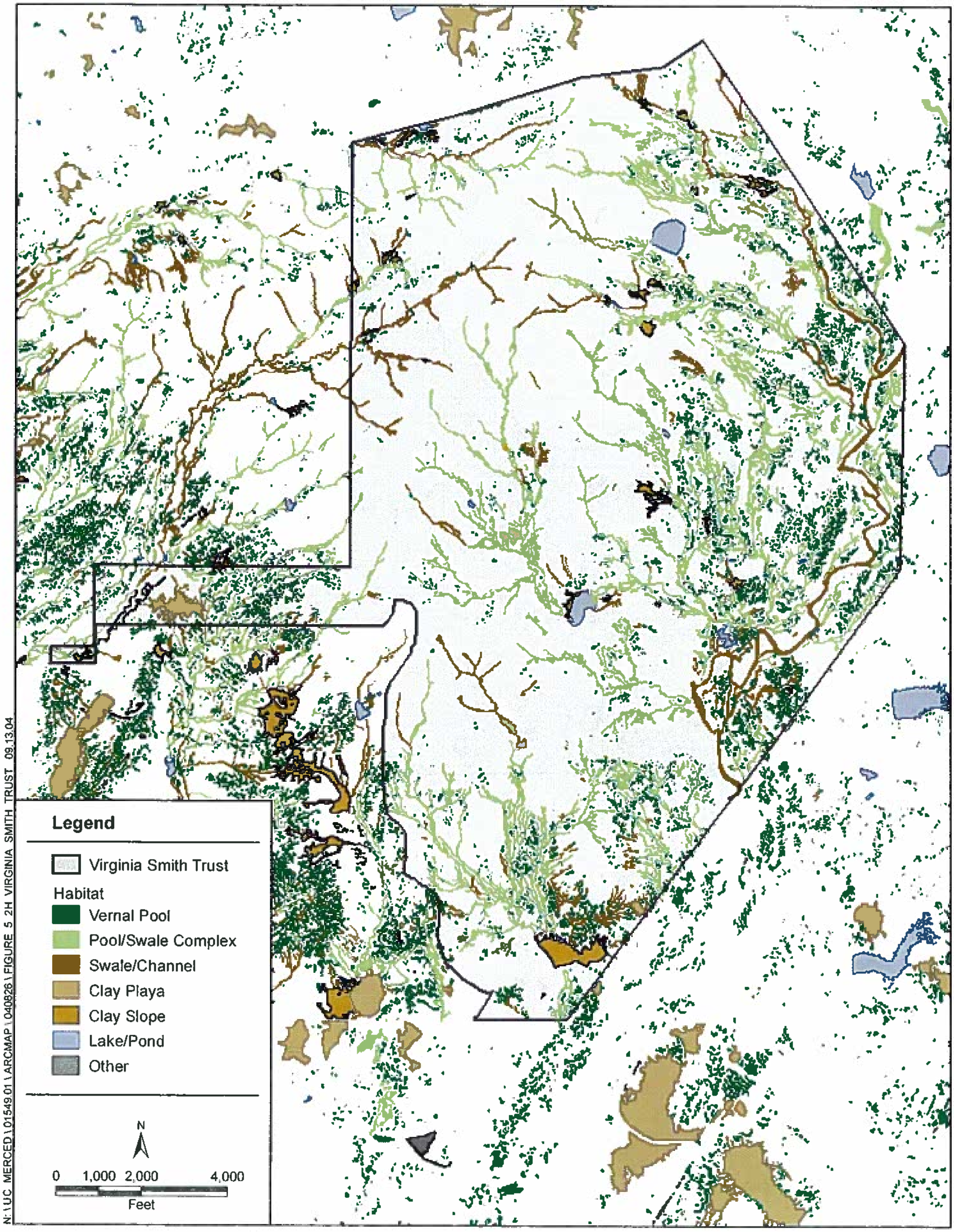

Figure 5-2h
Waters of the United States
Virginia Smith Trust

Table 5-1. Wetland Areas (acres) on Tier 1 Lands

Name	Vernal Pool	Swale Wetlands	Clay Slope Wetlands	Other	**Total**
Tier 1a	181	437	104	16	**738**
Tier 1b	106	173	15	16	**310**
Total	**287**	**610**	**119**	**32**	**1,048**

Table 5-2. Wetland Areas (acres) on Tier 2 Lands

Property	Vernal Pool	Swale Wetlands	Clay Slope Wetlands	Other	**Total**
Carlson	13	26	13	2	**54**
Chance	63	301	18	68	**450**
Cunningham	47	141	12	7	**207**
Nelson	79	137	246	25	**487**
Robinson	22	19	16	13	**70**
Total	**224**	**624**	**305**	**115**	**1,268**

These delineations were reviewed in the field jointly by Corps staff and Gibson & Skordal. Based on this field review and subsequent aerial photo interpretation, it is our opinion, concurred with by the Corps, that the delineations are sufficiently accurate for assessment of the adequacy of the mitigation. It was also the opinion of Gibson & Skordal and Corps staff that the relative levels of disturbance and wetland functional performance at each of the Conservation Lands is approximately equal to the disturbance level and wetland functional performance within the project area.

Calculation of Functional Replacement

The functional replacement derived from preservation and management can be calculated based on enhancement of existing values or on prevention of degradation. The calculation of increased function from enhancement would involve lowering disturbance ratings (i.e. increasing the disturbance index rating) over existing conditions. The calculation of functional replacement from prevention of degradation would involve implementing measures designed to preclude reasonably foreseeable activities that would result in increase disturbance ratings (i.e. decreasing the disturbance index rating) over existing conditions. In estimating functional replacement derived from preservation and management of the Conservation Lands, we based our calculations primarily on the benefits derived from implementing an adaptive grazing management program, relying more on the benefits of preventing degradation rather than enhancement of existing (baseline) conditions.

Under the functional assessment methodology, the current grazing regime (moderate) is assigned a disturbance index rating of 0.70. The optimum condition (1.00 disturbance index rating) would theoretically be achieved through an adaptive grazing management program designed to maximize wetland function. This would result in an incremental functional improvement of 0.30 which would be an approximate 43 percent improvement. Given the relatively high level of existing wetland function, it is uncertain whether an adaptive grazing management program would actually result in this level of improvement. For this reason, we have opted to use the more conservative approach of basing the calculation of functional replacement on prevention of degradation through maintenance of current grazing regimes and the prevention of potential future overgrazing and undergrazing as well as implementation of additional management measures designed to maintain existing resource values in perpetuity.

A copy of the proposed Management Plan is attached as Appendix B. The Management Plan describes the various management goals, objectives and management guidelines for Tier 1 and Tier 2 lands. The assumptions used for projecting functional replacement from preservation and management are derived from the Management Plan.

Under the functional assessment methodology, severe grazing is assigned a disturbance index rating of 0.50. This index rating assumes a level of grazing that is so severe that there is an obvious substantial degradation of both the upland and wetland plant communities. The functional assessment assigns a disturbance index rating of 0.70 to moderate grazing. This index rating is intended to encompass the broad range of grazing conditions observed within the project area and on the preservation lands, without specific institutionally required and managed grazing regimes. Absence of grazing is assigned a disturbance index rating of 0.50.

The assigned index ratings are, in large part, based on research by Dr. Jaymee Marty (Marty 2005). Dr. Marty's research examined the effect of different grazing treatment (ungrazed, continuously grazed, wet-season grazed, and dry-season grazed) on vernal pool plant communities and vernal pool aquatic faunal diversity in the Central Valley of California. Dr. Marty found that removal of grazing results in significant reductions in native plant species richness and aquatic invertebrate species richness as compared to moderate grazing. The research also documented a significant reduction in vernal pool inundation periods resulting from cessation of grazing. These findings strongly indicated that cessation of grazing results in significant reductions in overall wetland function.

Cessation of grazing, diminished grazing, and severe grazing are all plausible future scenarios that would adversely impact overall wetland function. Both reduced grazing and no grazing conditions were observed during field surveys conducted in development of the HGM functional assessment methodology. Severe overgrazing conditions, as defined per the functional assessment methodology, were not observed within the project area or on any of the Conservation Lands but have been observed in other vernal pool landscapes and are considered to be a potential future scenario. The livestock industry responds to specific market changes that occur from year to year. Additionally, the livestock industry is undergoing substantial long-term changes and has become less viable in many areas, particularly those areas in proximity to urban expansion.

The HGM functional assessment methodology assigns a small incremental improvement to the disturbance index rating for a grazing regime designed to be consistent with Natural Resources Conservation Service (NRCS) guidelines for management of annual rangelands (Cooperative Extension 1982). These standards are based on the amount of residual dry matter (RDM), measured in pounds per acre (lbs/acre) and are adjusted for various precipitation regions and topographies. In the Central Valley (10 to 40 inches of precipitation annually) the standards are 400 lbs/acre in lower or flat slopes, 600 lbs/acre in average to gentle slopes, and 800 lbs/acre in upper or steep slopes. These are considered to be minimum standards necessary to prevent degradation of range land. They are not necessarily indicative of standards that would maximize wetland function or species habitat.

The assigned disturbance index rating for grazing managed to meet NRCS standards (0.80) is only slightly higher than the index rating for moderate grazing (0.70). Managing grazing to meet NRCS standards could enhance the condition of the watersheds somewhat and therefore enhance related functions (e.g., subsurface water storage and interchange, element and compound cycling, organic carbon transport, etc.). However, it cannot necessarily be assumed that the overall net functions within the wetlands themselves would be substantially enhanced. The conservation easements that have been established over the Tier 2 lands require that the NRCS's RDM standards be met. For this reason, the incremental functional benefit on Tier 2 lands was assumed to be 0.10.

On the Tier 1a lands, the University of California is proposing to establish, in coordination with TNC, a standard to assure that the NRCS's RDM standards are met and that grazing be maintained at its current levels. By maintaining grazing at its current levels, the degradation that could result from removal of grazing and overgrazing will be prevented. Preventing this degradation will result in an incremental functional benefit of 0.20.

In order to quantitatively assess the adequacy of the proposed mitigation, we calculated the number of replacement FCUs that would result from preventing degradation that would result from overgrazing and/or ceasing or significantly reducing grazing for the Tier 1 lands. On Tier 1a and Tier 1b lands, the average reduction in FCI that would result from cessation or significantly reducing grazing intensity would be approximately 0.20. Table 5-3 lists the resulting increase in terms of FCUs, by regional subclass on Tier 1a lands. Table 5-4 lists the resulting increase in terms of FCUs, by regional subclass on Tier 1b lands. The total functional replacement on Tier 1 lands resulting from assuring that moderate grazing practices continue would be 203.2 FCUs.

Table 5-3. Replacement in FCUs from Prevention of Overgrazing and Undergrazing on Tier 1a Lands

Regional Subclass	Area (acres)	Replacement FCUs[1]
Vernal Pools	181	36.2
Swale Wetlands	437	87.4
Clay Slope Wetlands	104	20.8
Total	722	144.4

[1] Assumes an average FCI change of 0.20.

Table 5-4. Replacement in FCUs from Prevention of Overgrazing and Undergrazing on Tier 1b Lands

Regional Subclass	Area (acres)	Replacement FCUs[1]
Vernal Pools	106	21.2
Swale Wetlands	173	34.6
Clay Slope Wetlands	15	3.0
Total	294	58.8

[1] Assumes an average FCI change of 0.20.

Table 5-5 is a comparison of the projected loss in FCUs attributable to the proposed Campus and Community North compared to the replacement of FCUs that would result from prevention of overgrazing and undergrazing on Tier 1 lands.

Table 5-5. Comparison of Project Impacts and Resulting Compensation from Preservation and Management of Tier 1 Lands

Regional Subclass	Projected Functional Impact (FCUs)	Projected Functional Replacement (FCUs)[1]	Net Projected Functional Increase (FCUs)[2]
Vernal Pools	11.7	57.4	45.7
Swale Wetlands	16.5	122.0	105.5
Clay Slope Wetlands	0.6	23.8	23.2
Total	28.8	203.2	174.4

[1] Total increase in FCUs on all preservation lands resulting from modified grazing regimes.
[2] Total increase in FCUs minus projected loss in FCUs.

As is shown in Table 5-5, the preservation and management of Tier 1 lands alone would result in a net increase of 174.4 FCUs, assuming an incremental improvement of 0.2 in the FCI. Even if the incremental improvement in FCI were halved (0.1), there would be a net increase of 72.8 FCUs. Assigning an incremental improvement of only 0.03 in the FCI would still result in full functional replacement. Based on this, the proposed preservation and management of Tier 1 lands alone would fully compensate for the loss of wetland function of vernal pools, swale wetlands and clay slope wetlands.

The Management Plan also proposes to develop and implement an adaptive grazing management program on the Tier 1a lands (see Appendix B of Management Plan). The intent of this adaptive management program will be to maintain and enhance the existing wetlands, their surrounding grasslands and their associated resource values, including the conservation values. Because of the uncertainty in projecting the scale and extent to which wetland function would be enhanced from implementation of the adaptive management program, we have not attempted to quantify the resulting functional replacement that would result from implementation of the adaptive grazing management program. We, likewise, have not attempted to quantify the functional benefit of implementing other aspects of the Management Plan designed to minimize degradation and maintain habitat values.

As stated previously Tier 2 lands are comprised of 5 separate properties under private ownership currently protected under conservation easements. These lands will remain in private ownership but their use will be restricted by conservation easements. TNC is the easement holder for the Chance, Carlson, Cunningham, and Robinson properties. The California Rangeland Trust (CRT) is the easement holder for the Nelson property. These conservation easements are similar for each of the properties but there are differences. Each of the conservation easements places restrictions on grazing. None of these restrictions necessarily allow for an adaptive grazing management program designed to optimize wetland function nor do they contain a requirement that grazing must be maintained at current levels. These restrictions require that grazing be limited to the extent that the RDM standards specified in the NRCS guidelines are met. These minimum standards vary from 600 lbs/acre to 800 lbs/acre in normal and wet years and 400 lbs/acre in drought years.

Because of the limitations of the existing conservation easements, the same level of incremental improvement projected for the Tier 1 lands should not be projected for the Tier 2 lands. Although severe grazing would be prevented, there are no assurances that moderate grazing will be maintained. There are approximately 224 acres of vernal pools, 624 acres of swale wetlands, and 305 acres of clay slope wetlands existing on the on the Tier 2 lands. A small incremental benefit of 0.10 in FCI would, result in an increase of 22.4 FCUs for vernal pools, 62.4 FCUs for swale wetlands, and 30.5 FCUs for clay slope wetlands. Thus the total increase in FCUs on the easement lands would be approximately 115.3. A very minor incremental improvement of 0.01 in the FCI would result in an increase of 11.5 FCUs.

Preservation and management of Tier 1 and Tier 2 lands may also provide compensatory mitigation by eliminating other potential future degradation from unregulated activities such as sprinkler irrigation or plowing. While some level of future degradation would be likely over time, it is impossible to predict with any reasonable degree of accuracy when or to what extent these degradations would occur. For that reason, we have not attempted to quantify any resulting benefits to wetland function attributable to preventing potential degradation from other unregulated activities.

Proposed Restoration and Creation

Both restoration and creation involve manipulation of existing physical, chemical, and/or biological characteristics to establish wetlands. Restoration activities seek to re-establish a previously existing wetland or wetland landscape that has been destroyed or degraded to the extent that wetland functions are minimal. Creation activities seek to establish functioning wetlands where they previously did not exist or where that type of wetlands did not previously exist.

The goal of the proposed restoration and creation efforts will be to establish wetlands that are similar to the impacted wetlands in terms of their physical and biological characteristics. To the extent that the characteristics of the mitigation site(s) allow, the composition of the restored and created wetlands will be roughly proportional to the impacted wetlands in terms of their hydrogeomorphic characteristics and plant communities. In other words, the wetlands restoration and creation will be "in-kind." It may not be practicable or possibly desirable to establish certain types of impacted aquatic habitats such as ephemeral channels or seasonally saturated wetlands occurring on convex surfaces underlain by clay soils (clay slope wetlands). In those cases, out-of-kind wetland restoration and/or creation would be preferable. Out-of-kind wetland restoration and/or creation may also be preferable if there is insufficient or inadequate land available to satisfy the requirements to successfully restore or create certain types of wetlands.

Restoration of wetlands will be the mitigation methodology for impacts to naturally occurring wetlands (vernal pools, swale wetlands and clay slope wetlands). The intent is to select a mitigation site or sites where similar wetlands previously existed but have subsequently been eliminated or substantially reduced in extent and degraded in terms of function. As discussed in the preceding paragraph, restoration of clay slope wetlands is not feasible. Because of this, it is anticipated that the restoration goal will be re-establishment of a vernal pool landscape containing vernal pools and swale wetlands.

Creation of wetlands will be the mitigation methodology for impacts to non-naturally occurring wetlands (irrigation wetlands and canal wetlands). Because these wetland types are not naturally occurring, restoration would be oxymoronic. The goal will be to create seasonal wetlands and/or emergent marsh similar to the impacted wetlands.

A sufficient amount of wetlands will be restored and/or constructed to assure that there is no net loss in functioning wetland area. Wetlands will be considered functioning when they have met or exceeded the performance criteria. In order to achieve this goal, more wetlands will be constructed than is necessary to meet the 1:1 replacement goal. The amount of wetlands that must ultimately meet all performance criteria will be equal to the total area of wetlands impacted by the project. The intent is to restore and construct enough wetlands to provide an adequate allowance for failure given reasonable expectations derived from other similar mitigation projects.

In many cases, it may not be desirable to attempt to restore or create wetlands on the lands that have been secured for preservation because of potential indirect impacts. In order to avoid indirect impacts to existing wetlands and the sensitive biota they support, it will be necessary to secure additional lands to accommodate the restoration and creation. The amount of land that will need to be secured will depend on the restoration and creation potential of the mitigation lands to be acquired.

Gibson & Skordal conducted an initial review of potential mitigation sites using aerial photography and field reconnaissance to determine whether there is a sufficient area of land amenable to wetland restoration/creation. Based on this, it appears that there is sufficient acreage within close or reasonable proximity to accomplish this purpose. The University has contacted and received several expressions of interest from the owners or agents of suitable restoration and creation sites to satisfy these requirements. Although negotiations with these landowners are in the preliminary stages, it appears that the University should be able to secure an appropriate site or sites without great difficulty. When a potential site(s) has been tentatively selected, it will be presented to the Corps, EPA, USFWS, and DFG for approval. Once a site(s) has been approved and secured, detailed site plans will be prepared by UC Merced to implement the restoration and creation measures. This plan will be forwarded to the Corps for review and approval (see Implementation Schedule).

Implementation Schedule

In addition to revising the Campus and Community footprint to further avoid and minimize impacts to pristine vernal pool habitat on the VST and UCLC properties, to date, UC Merced and the State of California have secured more than 26,000 acres for the preservation of vernal pool grassland habitat in Eastern Merced County. UC Merced proposes a phased implementation schedule for the restoration and creation efforts contemplated in the CWMMP within the context of UC Merced's prior commitments to habitat preservation and conservation in Eastern Merced County. Such prior and ongoing commitments include:

- UC's redesign of the Campus and Community footprint to reduce impacts to aquatic resources,
- the State's funding and acquisition of mitigation lands for impacts to aquatic resources in advance of permit issuance, and

- the substantial amount of vernal pool habitat preservation in Eastern Merced County implemented by the UC Merced Project in furtherance of recovery.

Although construction of the project will be phased over many years, UC Merced proposes to complete construction of all of the wetlands restoration/creation within three to four years of initiation of project construction. UC Merced plans to begin construction of Phase II during the first construction seasonal following issuance of the DA permit. The following restoration/creation implementation schedule takes into account the considerable lead time needed to select and secure the mitigation site(s), prepare and obtain approval of site-specific addendums to the CWMMP, and mobilize the construction of a mitigation project of this size.

Tentative site selection. Within one year of issuance of the permit, UC Merced will select, identify and characterize preferred restoration/creation sites and submit them to the Corps, Service and CDFG for approval.

Submit site specific plans. Within six months of receiving agency approval of the mitigation sites, UC Merced will secure the mitigation sites and prepare site-specific addendums to the CWMMP and submit them to the Corps, Service and CDFG for approval.

Begin Mitigation Construction. UC Merced will begin construction of the restoration/creation in May immediately following agency approval of the site-specific addendums to the CWMMP. This assumes that agency approval is received by at least January 1 of that year to allow sufficient time to prepare for mobilization of mitigation construction.

Complete Mitigation Construction. Because all work will be done during the dry season (May – October), it is anticipated that the mitigation construction will require two construction seasons.

Responsibilities for Implementing Plan

The University of California will be responsible for implementing all aspects of the mitigation plan except for the management of the Tier1b and Tier 2 lands. Tier 1b will be managed by the TNC unless the land is sold with a conservation easement, in which case TNC or another conservation entity would administer the terms of the easement. Tier 2 lands will be managed by the conservation easement holders (TNC and CRT) pursuant to grant agreements they have in place with the WCB. In the event management of any of the Tier 2 lands is transferred to another conservation organization, the new managing organization will be responsible for managing the lands pursuant to the grant agreements.

Estimated Cost of Mitigation

The total cost of the restoration/creation component of the mitigation is the sum of the estimated cost of land acquisition, designing, and constructing the wetlands, monitoring their success for a minimum of five years, and long-term management. The estimated cost of implementing the proposed mitigation measures, exclusive of long-term monitoring and management, would range from $18,675,000 up to $20,675,000. A discussion of these estimated costs is provided below.

Creation/Restoration

The estimated cost of acquiring the land will range from $1,000,000 up to $3,000,000. The estimated cost of designing, constructing, and monitoring these wetlands for five years is $2,675,000. The combined estimated cost would range from $3,675,000 up to $5,675,000.

Preservation/Enhancement

The total cost of the preservation/enhancement component of the mitigation is the sum of the costs of acquiring titles and securing the conservation easements and the costs of the long-term management of these lands. A total of more than $15,000,000 has been spent to date acquiring titles and conservation easements.

Long-Term Maintenance

These costs will include the cost of maintaining the restoration/creation lands as well as maintaining the preservation/enhancement lands that are owned by the University. These costs, which can be substantial, have not been estimated at this time.

Chapter 6
Performance Standards

Creation/Restoration

As stated previously, the restoration/creation element of the CWMMP is primarily intended to assure that there will be no net loss of wetland acreage resulting from construction of the UC Merced project. The restoration component for naturally occurring wetlands (vernal pools, swale wetlands and clay slope wetlands) is not necessarily intended to replace losses of wetland function; though, as discussed in previous chapters, some lost functions will be replaced in the restored wetlands. The creation component for non-naturally occurring wetlands is intended to replace functional losses of canal wetlands and irrigation wetlands. The following standards will be used to assess the relative success of the wetland creation and restoration components of the CWMMP.

Creation

1. To achieve a 1:1 replacement for impacts to non-naturally occurring wetlands (27.76 acres) with an adequate margin of error, a minimum of 34.7 acres of wetlands will be constructed.
2. To achieve a 1:1 replacement of lost wetland area, a minimum of 27.76 acres of constructed wetlands (80% of total constructed) must satisfy the following criteria.
    a. The plant community within the constructed wetlands must be dominated by species with a wetland indicator status of Facultative, Facultative Wetland, or Obligate (Reed 1998)
    b. The absolute plant cover within the constructed wetland must be at least 70 percent.
    c. The wetlands must be inundated and/or saturated to the surface for a minimum duration of approximately 14 days during the growing season in normal rainfall years.

The above standards must be met for three successive years without human intervention.

Restoration

1. To achieve a 1:1 replacement for impacts to vernal pools, swale wetlands and clay slope wetlands (40.01 acres) with an adequate margin of error, a minimum of 50.01 acres will be constructed.
2. To achieve a 1:1 replacement of lost wetland area, a minimum of 40.01 acres of restored vernal pools and swale wetlands (80% of total constructed) must satisfy the following criteria.
   a. The plant community within the restored vernal pools and swale wetlands must be dominated by species with a wetland indicator status of Facultative, Facultative Wetland, or Obligate (Reed 1998).
   d. The plant communities within the restored vernal pools and swale wetlands must be dominated by vernal pool endemics and vernal pool associates. For purposes of this criterion, vernal pool endemics are defined to be native species commonly found in vernal pools and swale wetlands. Vernal pool associates are defined to be non-native, naturalized species commonly found in vernal pools and swale wetlands.
   e. The absolute plant cover within the restored vernal pools and swale wetlands must be at least 70 percent.
   f. The wetlands must be inundated (vernal pools) and/or saturated (swale wetlands) for a minimum duration of approximately 14 consecutive days during the growing season in normal rainfall years.

The above standards must be met for three successive years without human intervention.

Preservation and Management

The performance standard proposed for the preservation and management of Tier 1 and Tier 2 lands is necessary to assure that the assumptions used to predict functional replacement are met. As discussed in Chapter 5, full functional replacement is anticipated to result from maintenance of the current moderate grazing regime on Tier 1a and 1b lands and prevention of cessation of grazing, significant reduction in grazing intensity or severe over-grazing. While additional benefits to wetland function are also likely to result from the prevention of other potential degradations to Tier 1 and Tier 2 lands and from the implementation of the adaptive grazing management program on Tier 1a lands, these functional benefits are not quantified and are not necessary to compensate for the projected loss of wetland function.

Based on the above rationale, it is proposed that the performance standard for preservation and management be the maintenance of moderate grazing regime on Tier 1 lands. Based on an examination of existing grazing practices, a standard(s) will be developed that provides a quantitative metric that reasonably reflects moderate grazing under baseline conditions. This standard can either be based on the timing and intensity of grazing, on measurements of residual dry matter and/or on plant community composition.

No specific performance criteria are proposed for Tier 2 lands because no functional improvement was quantified for these lands and the functional improvement derived from these lands is not necessary to compensate for projected impacts. Additionally, although TNC and the CRT are legally responsible for assuring compliance with the conservation easements, the easements do not require compliance reporting. The conservation easements for each of the Tier 2 lands establish minimum RDM requirements. Table 6-1 summarizes the minimum RDM requirements for each of these properties as specified in the approved conservation easements.

Table 6-1. Minimum RDM Requirements for Conservation Easement Lands

Property Under Easement	Area (acres)	Easement Holder	RDM Requirement (lbs/acre)
Carlson	305	TNC	800 (400 in drought years)
Chance	7,619	TNC	600 (400 in drought years)
Cunningham	1,761	TNC	800 (400 in drought years)
Nelson	3,861	CRT	600 (400 in drought years)
Robinson	3,595	TNC	600

Notes:
CRT = California Rangeland Trust.
lbs/acre = pounds per acre.
TNC = The Nature Conservancy.
RDM = Residual Dry Matter.

Chapter 7
Monitoring

Monitoring Protocol

Restoration/Creation

The University of California, Merced will be responsible for monitoring the constructed wetlands. The constructed wetlands will be monitored for a period of five years or until all performance criteria have been met for three successive years without human intervention, whichever is longer. The purpose of the monitoring is to assess the relative success of the mitigation as compared to performance criteria described in Chapter 6 and to determine whether remedial actions are necessary to assure the performance criteria are met.

Monitoring of the constructed wetlands will consist of collecting and evaluating quantitative data on the hydrology and plant communities within the constructed wetlands. Photographic points will be established to qualitatively monitor trends in the establishing plant communities. Aerial photography will be used to monitor the areal extent of constructed wetlands.

Monitoring of the hydrology of the constructed wetlands will be emphasized in the first growing season following construction. Sampling will be conducted at a frequency sufficient to document the depth and duration of inundation within the constructed wetlands. Once the hydrology of the constructed wetlands has been adequately characterized, additional detailed hydrology monitoring will not be conducted over subsequent growing seasons unless specific problems are identified that warrant further monitoring.

Vegetation monitoring will be conducted during each growing season throughout the monitoring period. The plant communities in the constructed and reference wetlands will be characterized. Each plant observed will be identified and its relative cover will be recorded. The total cover of all species will also be estimated.

Preservation Lands Compliance Monitoring

The monitoring programs for the Tier 1a, Tier 1b and Tier 2 lands will vary in intensity due to differences in ownership and varying degrees of management. A detailed description of the monitoring programs is presented in the Management Plan (Appendix B). The main body of the Management Plan addresses the management of Tier1a and Tier1b lands while Appendix A of the Management Plan addresses management of the Tier 2 lands. Appendix B of the Management Plan describes the Adaptive Grazing Management Plan. The following is a brief summary description of the proposed monitoring program.

Tier 1a Lands

UC Merced, through its Sierra Nevada Research Institute (SNRI) will be responsible for the monitoring program on Tier 1a lands. The monitoring program for Tier 1a lands will incorporate annual monitoring activities (performed at least once each year), regular periodic monitoring activities (performed at regular intervals, e.g., every 5 years), and irregular activities (actions conducted in response to specific conditions that do not occur on a predictable basis. Compliance with the Management Plans requirements will be documented by completing an annual reporting checklist that verifies and discusses management activities that were undertaken as well as those not undertaken.

An annual reporting checklist, schedule and reporting form is included in the Management Plan. The form provides the following:

- a concise summary list of required actions;
- a checklist of completed management actions; and,
- a checklist of items that may require modification through adaptive management.

Effectiveness monitoring will evaluate how well the Management Plan performs in meeting its ultimate goals. Effectiveness monitoring will evaluate the physical, biological and cultural conditions of the Tier 1a lands. Effectiveness monitoring requires specific monitoring protocols. These protocols will be developed under the leadership of the SNRI to be consistent with the goals and objectives of the Management Plan. Individual monitoring protocols will be developed to address specific resource issues and management actions. These protocols will share the basic framework listed below.

- Monitoring goals and objectives.
- Monitoring locations.

- Monitoring methods.
- Analysis and reporting.
- Success criteria.
- Recommendations for future management actions and monitoring.

Tier 1b Lands

The CST easement holder will be responsible for the monitoring program on Tier 1b lands. The CST easement holder will conduct annual monitoring to determine compliance with the terms of the easement and effectiveness of management actions taken. The primary focus of annual monitoring will be on compliance. In addition to compliance, monitoring should also include important resource issues to include the presence and extent of noxious weeds and the presence of non-native reptiles, amphibians, and fish.

Where monitoring identifies non-compliance with easement terms that has or is likely to adversely affect wetlands and/or species of conservation concern, the easement holder should, in a timely manner, proceed to work directly with the landowner or take other actions to achieve compliance.

Tier 2 Lands

TNC and the CRT are responsible for monitoring Tier 2 lands to assure compliance with the conditions of the conservation easements on an annual basis throughout the life of the conservation easements. Random samples will be taken on each of these properties consistent with the methodologies outlined in Guidelines for Residue Management on Annual Range (Cooperative Extension 1982). RDM may be estimated by direct clipping and weighing, double sampling (visual estimates with clipped herbage reference points) and, with sufficient field experience, visual estimates. The normal procedure for determining the RDM is to use 0.10 square meter circular plots where the vegetation within each plot is clipped as close to the ground as possible and weighed. Sampling is conducted in late summer or early fall when forage is dead and dried. The number of samples collected is determined based on the size of the property.

Easement compliance monitoring will involve, not just RDM monitoring, but also monitoring to ensure that the other terms of the easement are being met, such as restrictions on various activities such as road building, use of pesticides and herbicides, etc.

Reporting

Restoration/Creation Reporting

UC Merced will be responsible for preparing and submitting monitoring reports results of each year's monitoring which will be compiled into an annual monitoring report. The annual monitoring reports will present all monitoring data, assess the implications of that data, and make recommendations for remedial actions, where warranted. The annual reports will be submitted to the Corps, Service and CDFG no later than January 1 for the preceding year's monitoring.

Preservation/Management Reporting

The University of California, Merced will be responsible for report submittal for Tier 1a lands. TNC will be responsible for report submittal for the Tier 1b lands. As stated previously, although TNC and the CRT are responsible for assuring compliance with the conditions of the conservation easements on Tier 1 lands, neither the easements nor the grant agreements with the WCB require submittal of reports. The University does not have legal authority to conduct monitoring or require monitoring reports on Tier 2 lands.

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Appendix A
FUNCTIONAL ASSESSMENT METHODOLOGY

April 2006

A Guidebook for Applying a Modified Hydrogeomorphic Approach to Assessing Wetlands Functions for the UC Merced Project, Merced, California.

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Final Report
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CHAPTER 1 – INTRODUCTION

The Hydrogeomorphic (HGM) Approach is a collection of concepts and methods used to develop and apply functional indices to the assessment of wetlands. The approach was initially designed for use in the Clean Water Act Section 404 Regulatory Program including: reviewing permits to consider alternatives, minimizing impacts, assessing unavoidable project impacts, determining mitigation requirements, and monitoring the success of mitigation projects. However, a variety of other potential applications for the HGM Approach have been identified including: determining minimal effects under the Food Security Act, designing mitigation projects, and aiding in wetlands restoration and management.

On June 20, 1997, the National Action Plan (NAP) to implement the HGM Approach was published (National Interagency Implementation Team 1997). The NAP was developed cooperatively by the U.S. Army Corps of Engineers (USACE), U.S. Environmental Protection Agency (USEPA), Natural Resources Conservation Service (NRCS), Federal Highways Administration (FHWA), and U.S. Fish and Wildlife Service (USFWS). Publication of the NAP was designed to outline a strategy and promote the development of Regional Guidebooks for assessing the functions of regional wetland subclasses using the HGM Approach, solicit the cooperation and participation of Federal, State, and local agencies, academia, and the private sector in this effort, and update the status of Regional Guidebook development.

Objectives

There are no regional guidebooks that have been developed for the regional subclasses of wetlands existing within the UC Merced project area. The Corps initiated a pilot project in 1995 to develop a regional guidebook for vernal pools in the Central Valley of California. That effort proceeded as far as development of initial function models and field data gathering but was never completed. Without a regional guidebook, the Corps determined that a modified project-specific functional assessment methodology should be developed for the UC Merced project. The intent was to devise a functional assessment methodology based on HGM concepts but in an abbreviated form that would not include preparation of a regional guidebook and would be based, in part, on best professional judgment. Because of the large number of discrete wetlands existing within the project area (thousands) and the much larger number of discrete wetlands existing on the mitigation lands (tens of thousands), it is not practicable to implement an assessment methodology requiring an on-site evaluation of each wetland. It was therefore imperative that a functional assessment be devised based on geographic information system (GIS) technology.

Pursuant to the Corps' directive, a modified HGM functional assessment methodology was developed to assess the efficacy of the proposed compensatory mitigation measures. This methodology is intended to provide a basis for qualitatively assessing relative reductions in function that could result from both the direct and indirect impacts from the proposed project and its on-site alternatives. It is also intended to provide a basis for qualitatively assessing the relative functional replacement that would result from proposed mitigation measures. It should be noted that this modified HGM functional assessment methodology is not intended to provide an absolute measure or threshold of wetland impact. This functional assessment methodology was developed by Mr. Tom Skordal (Gibson & Skordal, LLC), Mr. Ellis Clairain, Ph.D. (ERDC), and Sacramento District Corps of Engineers staff (Ms. Nancy Haley, Mr. Kevin Roukey and Mr. Mike Jewell) in consultation with an Interagency Technical Committee composed of representatives from the Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (FWS) and California Department of Fish and Game (CDFG).

Organization

This document is organized in the following manner: Chapter 1 provides the background, objectives, and organization of the document. Chapter 2 provides a brief overview of the major components of the HGM Approach and the Development and Application Phases required to implement the approach. Chapter 3 characterizes the naturally occurring wetlands within the UC Merced project area in terms of geographical extent, climate, geomorphic setting, hydrology, vegetation, soils, and other factors that influence wetland function. Chapter 4 discusses each of the wetland functions, model variables, and functional indices. This discussion includes a definition of the function, a quantitative, independent measure of the function for the purposes of validation, a description of the wetland ecosystem and landscape characteristics that influence the function, a definition and description of model variables used to represent these characteristics in the assessment model, a discussion of the assessment model used to derive the functional index, and an explanation of the rationale used to calibrate the index with reference wetland data. Chapter 5 outlines the steps of the assessment protocol for conducting a functional assessment for the UC Merced project area. Appendix A contains a glossary.

CHAPTER 2 – OVERVIEW OF THE HGM APPROACH

The Hydrogeomorphic (HGM) Approach to Wetland Functional Assessment is a collection of concepts and methods that are used to develop and apply functional indices to the assessment of wetlands (Smith et al. 1995). The HGM Approach includes four integral components: 1) HGM classification, 2) reference wetlands, 3) assessment variables and assessment models from which functional indices are derived, and 4) application protocols. The four components of the HGM Approach are integrated into a regional, subclass-specific guidebook.

In the Development Phase of the HGM Approach, research scientists and regulatory managers work cooperatively to select a list of functions and indicators of function that will best represent the functional range of variation among wetlands of the subclass and region. Data are gathered by an Assessment Team from an array of wetlands that represent that range of variation; the Assessment Team then establishes a data set of Reference Wetlands. The assessment models and data are combined, along with field protocols and methods for analysis, to formulate a Regional Guidebook. In this case, the goal was to develop a modified HGM functional assessment methodology for the UC Merced project. The end-users of Regional Guidebooks then use the models during the Application Phase to conduct HGM functional assessments on project wetlands. In this case, the modified HGM functional assessment methodology will be used to assess functional losses that would result from the proposed UC Merced project and its on-site alternatives and assess the efficacy of proposed mitigation measures. Each of these components of the HGM Approach is discussed briefly below. More extensive discussions of these topics can be found in Brinson (1993, 1995a, 1995b), Brinson et al. (1995, 1996 1998), Hauer and Smith (1998), Smith et al. (1995), Smith (2001), Smith and Wakeley (2001), and Wakeley and Smith (2001).

The task of the Assessment Team is to develop and integrate the classification, reference wetland, assessment variables, models, and application protocol components of the HGM Approach into a Regional Guidebook. In developing a Regional Guidebook, the team completes the tasks outlined in the National Action Plan (National Interagency Implementation Team 1996). These tasks include:

Task 1: Organize the Assessment Team.

A. Identify team members.
B. Train team in the HGM Approach.

Task 2: Select and Characterize Regional Wetland Subclass.

A. Identify and prioritize regional wetland subclasses.
B. Select regional wetland subclass and define reference domain.
C. Initiate literature review.
D. Develop preliminary characterization of regional wetland subclass.
E. Identify and define wetland functions.

Task 3: Select Assessment Variables and Metrics and Construct Conceptual Assessment Models.

A. Review existing assessment models.
B. Identify assessment variables and metrics.
C. Define initial relationship between assessment variables and functional capacity.
D. Construct conceptual assessment models for deriving functional capacity indices.
E. Complete Pre-calibrated Draft Regional Guidebook (PDRG).

Task 4: Conduct Peer Review of PDRG.

A. Distribute PDRG to peer reviewers.
B. Conduct interdisciplinary, interagency workshop of PDRG.
C. Revise PDRG to reflect peer review recommendations.
D. Distribute revised PDRG to peer reviewers for comment.
E. Incorporate final comments from peer reviewers on revisions into the PDRG.

Task 5: Identify and Collect Data From Reference Wetlands.

A. Identify reference wetland field sites.
B. Collect data from reference wetland field sites.
C. Analyze reference wetland data.

Task 6: Calibrate and Field Test Assessment Models.

A. Calibrate assessment variables using reference wetland data.
B. Verify and validate (optional) assessment models.
C. Field test assessment models for repeatability and accuracy.
D. Revise PDRG based on calibration, verification, validation (optional), and field testing results into a Calibrated Draft Regional Guidebook (CDRG).

Task 7: Conduct Peer Review and Field Test of CDRG.

A. Distribute CDRG to peer reviewers.
B. Field test CDRG.
C. Revise CDRG to reflect peer review and field test recommendations.
D. Distribute CDRG to peer reviewers for final comment on revisions.
E. Incorporate peer reviewers' final comments on revisions.
F. Publish Operational Draft Regional Guidebook (ODRG).

Task 8: Technology Transfer.

A. Train end users in the use of the ODRG.
B. Provide continuing technical assistance to end users of the ODRG.

The development of this modified HGM functional assessment methodology followed these tasks up to a point. Tasks 1, 2, 3, and 5 were completed. Tasks 4 and 7 were not performed per the Corps of Engineers direction. Task 6 was initiated but was abandoned after it was determined by the Assessment Team that calibration of the models was not practicable (see discussion below in Chapter 5). Instead, the Assessment Team elected to develop a modified methodology based on rating disturbances that degrade the aggregate of wetland functions. Task 8 is not applicable since a Regional Guidebook was not prepared.

CHAPTER 3 – CHARACTERISTICS OF REGIONAL SUBCLASSES

As indicated in Chapter 1, the HGM Approach is a collection of concepts and methods for developing functional indices and subsequently using them to assess the capacity of a wetland to perform functions relative to similar wetlands in a region. The HGM Approach includes four integral components: (a) the HGM classification, (b) reference wetlands, (c) assessment models/functional indices, and (d) assessment protocols. During the development phase of the HGM Approach, these four components are integrated in a Regional Guidebook for assessing the functions of a regional wetland subclass. Subsequently, during the application phase, end users, following the assessment protocols outlined in the Regional Guidebook, assess the functional capacity of selected wetlands. Each of the components of the HGM Approach and the development and application phases are discussed in this chapter.

Hydrogeomorphic Classification

Wetland ecosystems share a number of features, including relatively long periods of inundation or saturation, hydrophytic vegetation, and hydric soils. In spite of these common attributes, wetlands occur under a wide range of climatic, geologic, and physiographic situations and exhibit a wide variety of physical, chemical, and biological characteristics and processes (Cowardin et al. 1979; Ferren et al. 1996a,b,c; Mitsch and Gosselink 2000; Semeniuk 1987). The variability of wetlands makes it challenging to develop assessment methods that are both accurate (i.e., sensitive to significant changes in function) and practical (i.e., can be completed in the relative short time available for conducting assessments). Existing "generic" methods designed to assess multiple wetland types throughout the United States are relatively rapid, but lack the resolution necessary to detect significant changes in function. However, one way to achieve an appropriate level of resolution within the available time frame is to reduce the level of variability exhibited by the wetlands being considered (Smith et al. 1995).

The HGM Classification was developed specifically to accomplish this task (Brinson 1993). It identifies groups of wetlands that function similarly using three criteria that fundamentally influence how wetlands function: geomorphic setting, water source, and hydrodynamics. Geomorphic setting refers to the landform and position of the wetland in the landscape. Water source refers to the primary water source in the wetland, such as precipitation, overbank floodwater, or groundwater. Hydrodynamics refers to the level of energy and the direction that water moves in the wetland. Based on these three classification criteria, any number of "functional" wetland groups can be identified at different spatial or temporal scales. For example, at a continental scale, Brinson (1993) identified five hydrogeomorphic wetland classes. These were later expanded to the seven classes (Smith et al. 1995). In many cases, the level of variability in wetlands encompassed by a continental scale hydrogeomorphic class is still too great to allow development of assessment models that can be rapidly applied while being sensitive enough to detect changes in function at a level of resolution appropriate to the 404 review process.

To reduce both inter- and intra-regional variability, the three classification criteria are applied at a smaller, regional geographic scale to identify regional wetland subclasses. Regional subclasses, like the continental classes, are distinguished on the basis of geomorphic setting, water source, and hydrodynamics. In addition, certain ecosystem or landscape characteristics may also be useful for distinguishing regional subclasses in certain regions. For example, depressional subclasses might be based on water source (i.e., groundwater versus surface water), or the degree of connection between the wetland and other surface waters (i.e., the flow of surface water in or out of the depression through defined channels). Slope subclasses might be based on the degree of slope, landscape position, the source of water (i.e., throughflow versus groundwater), or other factors. Riverine subclasses might be based on water source, position in the watershed, stream order, watershed size, channel gradient, or floodplain width. Examples of potential regional subclasses are shown in Table 1, Smith et al. (1995). Regional Guidebooks include a thorough characterization of the regional wetland subclass in terms of its geomorphic setting, water sources, hydrodynamics, vegetation, soil, and other features that were taken into consideration during the classification process.

Table 1. Potential Regional Subclasses in Relation to Geomorphic Setting, Dominant Water Source and Hydrodynamics.

Geomorphic Setting Source	*Dominant Water*	*Dominant Hydrodynamics*	*Potential Regional Wetland Subclasses*	
			Eastern USA	**Western USA/Alaska**
Depression	Groundwater or interflow	Vertical	Prairie potholes, marshes, Carolina bays	California vernal pools
Fringe (tidal)	Ocean	Bidirectional, horizontal	Chesapeake Bay and Gulf of Mexico tidal marshes	San Francisco Bay marshes
Fringe (lacustrine)	Lake	Bidirectional, horizontal	Great Lakes marshes	Flathead Lake marshes
Slope	Groundwater	Unidirectional, horizontal	Fens	Avalanche chutes
Flat (mineral soil)	Precipitation	Vertical	Wet pine flatwoods	Large playas
Flat (organic soil)	Precipitation	Vertical	Peat bogs, portions of Everglades	Peatlands over permafrost
Riverine	Overbank flow from channels	Unidirectional, horizontal	Bottomland hardwood forest	Riparian wetlands

Reference Wetlands

Reference wetlands are wetland sites selected to represent the range of variability that occurs in a regional wetland subclass as a result of natural processes and disturbance (e.g., succession, channel migration, fire, erosion, and sedimentation) as well as cultural alteration. The reference domain is the geographic area occupied by the reference wetlands (Smith et al. 1995). Ideally, the geographic extent of the reference domain will mirror the geographic area encompassed by the regional wetland subclass; however, this is not always possible because of time and resource constraints.

Reference wetlands serve several purposes. First, they establish a basis for defining what constitutes a characteristic and sustainable level of function across the suite of functions selected for a regional wetland subclass. Second, they establish the range and variability of conditions exhibited by model variables and provide the data necessary for calibrating model variables and assessment models. Finally, they provide a physical representation of wetland ecosystems that can be observed and measured.

Reference standard wetlands are the subset of reference wetlands that perform the suite of functions selected for the regional subclass at a level that is characteristic in the least altered wetland sites in the least altered landscapes. Table 2 outlines the terms used by the HGM Approach in the context of reference wetlands.

Table 2. Wetland Reference Terms and Definitions

Term	***Definition***
Reference domain	The geographic area from which reference wetlands representing the regional wetland subclass are selected (Smith et al. 1995).
Reference wetlands	A group of wetlands that encompass the known range of variability in the regional wetland subclass resulting from natural processes and disturbance and from human alterations.
Reference standard wetlands	The subset of reference wetlands that perform a representative suite of functions at a level that is both sustainable and characteristic of the least human altered wetland sites in the least human altered landscapes. By definition, the functional capacity index for all functions in reference standard wetlands is assigned a 1.0.
Reference standard wetland variable condition	The range of conditions exhibited by model variables in reference standard wetlands. By definition, reference standard conditions receive a variable sub-index score of 1.0.
Site potential (mitigation project context)	The highest level of function possible, given local constraints of disturbance history, landuse, or other factors. Site potential may be less than or equal to the levels of function in reference standard wetlands of the regional wetland subclass.
Project target (mitigation project context)	The level of function identified or negotiated for a restoration or creation project.
Project standards (mitigation context)	Performance criteria and/or specifications used to guide the restoration or creation activities toward the project target. Project standards should specify reasonable contingency measures if the project is not being achieved.

For purposes of this functional assessment methodology, the Corps of Engineers has determined that the reference domain encompasses the UC Merced project area which includes the proposed Campus, the proposed Campus Land Reserve, the proposed Campus Natural Reserve and the proposed support community. The total area comprising this reference domain is approximately 4,000 acres. Figure 1 is a map illustrating the approximate limits of the reference domain.

The jurisdictional waters of the United States, including wetlands, existing within the reference domain have been delineated by EIP Associates (EIP). Separate delineations were completed for: the Campus which included the Campus Land Reserve and the Campus Natural Reserve

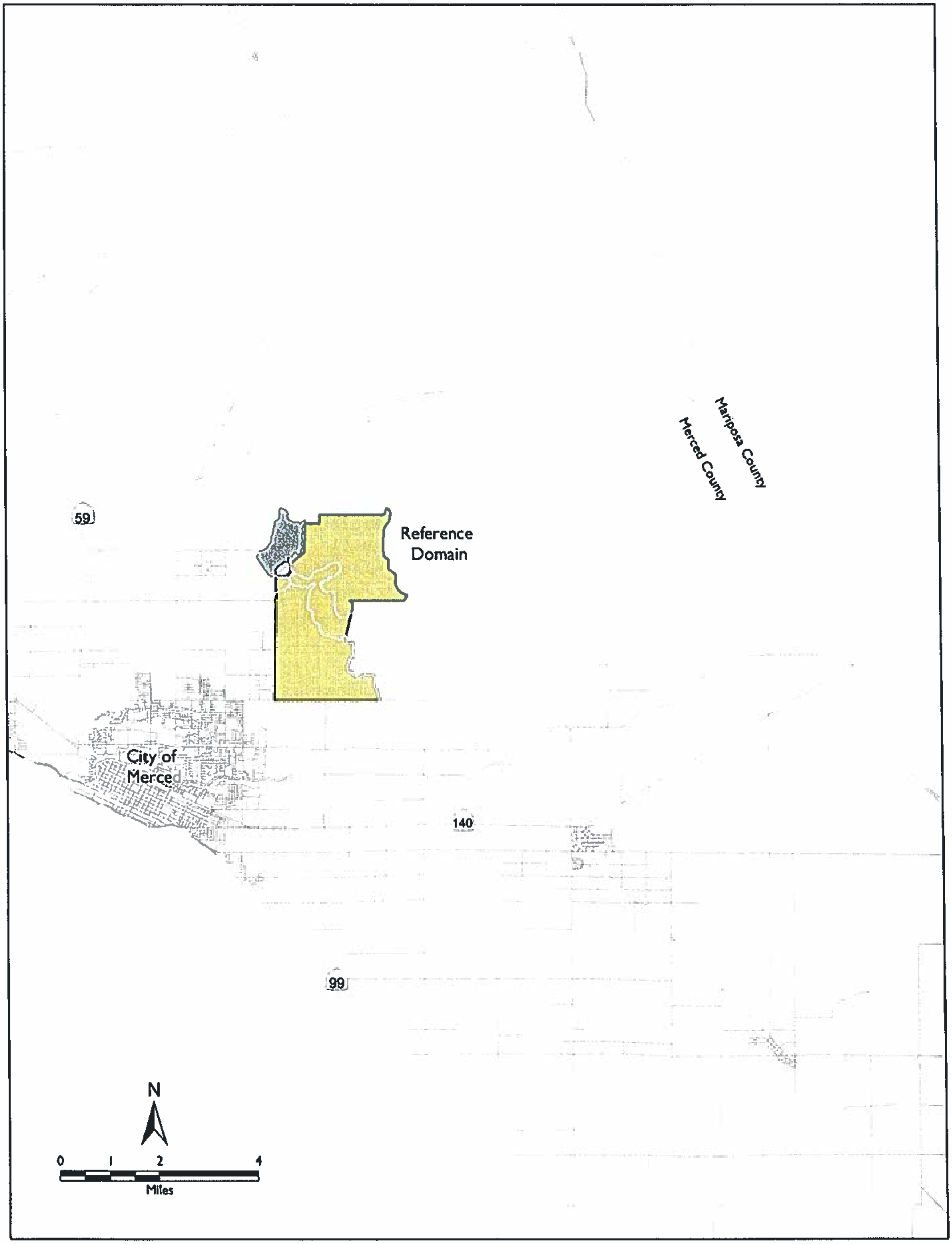

Figure 1
Reference Domain

(EIP 2001a); the Merced Hills Golf Course (EIP 2001b); and, the support community (EIP 2001c). EIP classified the delineated waters/wetlands as vernal pools, vernal pools/swales, vernal swales, swales, clay playas, clay flats, seasonal wetlands, freshwater marsh, marsh, stock ponds, drainages, wooded channels and canals. Figure 2 is a map showing the wetlands within the UC Merced project area as delineated by EIP.

The assessment team then reviewed the regional subclasses in the Borden Ranch HGM Assessment (Lee 1997). Lee used three regional subclasses for depression wetlands, two regional subclasses for slope wetlands, and one regional subclass for riverine wetlands. The three regional subclasses of depression wetlands used by Lee were; 1) closed and/or hydrologically isolated (perched) depressions; 2) surface and/or shallow sub-surface flow through depressions; and, 3) discharge depressions with or without outlets. The discharge depressions with or without outlets are often regionally referred to as groundwater seeps. This type of wetland is not present within the UC Merced reference domain. The first two regional subclasses are types of vernal pools found within the UC Merced reference domain.

Vernal pools are present in abundance within the UC Merced reference domain. In addition to the wetlands classified as vernal pools, the clay playa classification used by EIP in the Campus delineation would also fall into this regional subclass and is appropriately considered a type of vernal pool. The seasonal wetland classification used by EIP in the Golf Course delineation refers to seasonally flooded depressions similar to vernal pools except the plant community is more characteristic of other types of seasonal wetlands. The Assessment Team concluded that these seasonal wetlands are degraded vernal pools and most appropriately classified as such for HGM purposes.

While classifying depression wetlands (vernal pools) as either isolated or flow through may have been appropriate for the Borden Ranch functional assessment, the Assessment team did not consider it appropriate for this functional assessment for several reasons. The primary reason is that there are approximately 4,000 vernal pools within the reference domain. Unless a vernal pool is contiguous with a delineated swale or channel, it is very difficult to determine whether or not it is isolated by photo interpretation or other remote sensing techniques. In addition, even if it were feasible to visit each vernal pool in the field, it is often not possible to determine with certainty the extent to which a vernal pool is, in fact, hydrologically linked to other wetlands. In some cases, a topographically distinct outlet may be present (e.g. swale) while in other situations it may not. The absence of a topographically distinct outlet does not necessarily mean that a vernal pool does not spill and flow into other, down-gradient waters. Conversely, even where a topographically distinct outlet is present, it does not necessarily mean that water spills regularly on an annual basis. For this reason, the assessment team chose to establish a vernal pool regional subclass but not to distinguish between isolated and flow-through vernal pools for classification purposes. Using the vernal pool subclass by itself, however, will not provide the Corps the resolution needed to distinguish between the functional capacities of vernal pools located within various portions of the reference domain, thus defeating the primary purpose of the functional assessment. Because of this, additional stratification is needed to differentiate between the functional capacities of vernal pools located within the reference domain.

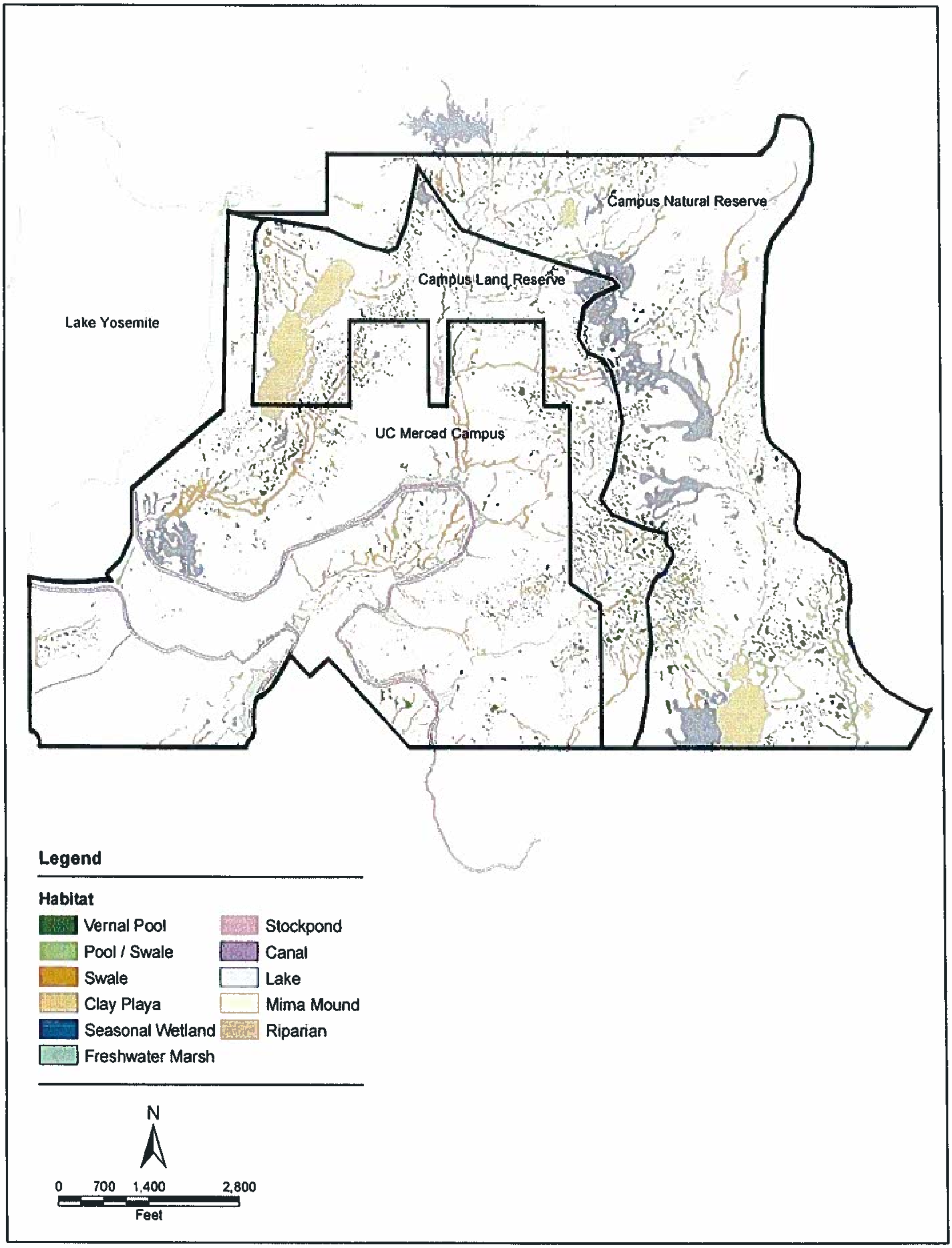

Figure 2
Wetland Delineation Map

Soil mapping units provide an additional level of resolution. Vernal pools within given soil types share a common soil profile, parent material and topography and often approximately share other characteristics such as hydrology. These physical variables, in turn, affect the functional capacity of the vernal pools. Table 3 is a list of soil mapping units within the reference domain. These soil mapping units are taken from Soil Survey, Merced Area, California (USDA 1962). While this is not a modern soil survey and some of the soil names are no longer valid (e.g. Raynor), it provides an extra level of stratification to facilitate comparison of vernal pool functions within the reference domain.

Table 3. Soil Mapping Units (USDA 1962)

Mapping Symbol	*Soil Name*
CgB	Corning gravelly loam, 0-8% slopes
CkB	Corning gravelly sandy loam, 0-8% slopes
3HA	Hopeton clay loam, 0-3% slopes
2HB	Hopeton clay loam, 0-8% slopes
3HB	Hopeton clay loam, 3-8% slopes
MrA	Montpelier course sandy loam, 0-3% slopes
MrB	Montpelier course sandy loam, 3-8% slopes
PkD	Pentz gravelly loam, 0-8% slopes
PnB	Peters clay, 0-8% slopes
PoB	Peters cobbly clay, 0-8% slopes
RaA	Raynor clay, 0-3% slopes
RbA	Raynor cobbly clay, 0-3% slopes
ReB	Redding gravelly loam, 0-8% slopes
RgA	Rocklin loam, 0-3% slopes
WhB	Whitney fine sandy loam, 3-8% slopes

The second type of wetland occurring in depressions within the reference domain is irrigation wetlands. This type of wetland was not present in the reference domain assessed by Lee and consequently was not classified by Lee. These irrigation wetlands are highly disturbed wetlands occurring within depressions that are influenced directly or indirectly by flood and/or sprinkler irrigation. They differ from degraded vernal pools in that they appear to have been created as a by product of land leveling and irrigation activities. The seasonal wetland and freshwater marsh classifications used by EIP in the Community delineation are included in the irrigation wetland subclass. As stated above, the seasonal wetland classification used by EIP in the Golf Course delineation refers to seasonally flooded depressions similar to vernal pools except the plant community is more characteristic of seasonal wetlands as opposed to vernal pools. For HGM purposes, we classified these seasonal wetlands as vernal pools because they are shallow seasonally inundated depressional wetlands.

The two regional subclasses of slope wetlands used by Lee are slope wetlands that are located at the headwater extent of riverine waters/wetlands and slope wetlands that form as inter-connections between or among depressions. Because of problems in differentiating between these two subclasses similar to that discussed above with vernal pools, the assessment team elected to not use these subclasses. There are two distinct types of slope wetlands located within the reference domain, those that occur in narrow, topographically distinct drainage ways (swale wetlands) and those that occur as broad, poorly defined features that are subject to sheet flow (clay slope wetlands). The Assessment Team elected to use swales and clay slope wetlands as regional subclasses for slope wetlands. The swale and vernal pool/swale classifications used by EIP on the Campus and Golf Course delineations would fall within the swale subclass. The swale and drainage classifications used by EIP in the Community delineation would also fall within the swale subclass.

Table 4 is a list of the regional subclasses selected by the assessment team. The regional subclasses are cross-referenced to the classification used by EIP in each of their jurisdictional delineations. Table 5 is a key to identifying these regional subclasses.

Table 4. Comparison of HGM Regional Wetland Subclasses and Wetland Delineation Classifications

HGM Class	*HGM Subclass*	*Campus Delineation Classification*	*Golf Course Delineation Classification*	*Community Delineation Classification*
Depression	Vernal Pool	Vernal Pool	Vernal Pool	Vernal Pool
		Clay Playa	Seasonal Wetland	
	Irrigation Wetland	–	–	Stock Pond
				Freshwater Marsh
				Seasonal Wetland
				Wooded Channel
Slope	Clay Slope	Seasonal Wetland	–	–
	Swale	Swale	Swale	Swale
		Vernal Pool/Swale	Vernal Pool/Swale	Drainage
Riverine	Intermittent Channel	Freshwater Marsh	Marsh	Wooded Channel
	Canal Wetland	Freshwater Marsh	Marsh	Wooded Channel

Table 5. Key to Regional Subclasses

1a	Wetland located in a depression that has closed contours and may or may not have an inlet or outlet. (Go to 2, Depression Class)
1b	Wetland does not have closed contours. (Go to 3)
2a	Wetland located within closed contours and dominated by non-persistent emergent vegetation. (D-Vernal Pool)
2b	Wetland located within closed contours and hydrologically influenced by irrigation. (D-Irrigation Wetland)
3a	Wetland lacking closed contours and located on a slope without well-defined bed, banks and ordinary high water line. (Go to 4, Slope Class)
3b	Wetland lacking closed contours and located on a slope within or adjacent to a watercourse with well-defined bed, banks and ordinary high water line. (Go to 5, Riverine)
4a	Seasonally inundated/saturated wetland located on sloping ground that conveys water in somewhat narrow, linear drainage ways. (S-Swale Wetland)
4b	Seasonally inundated/saturated wetland located on sloping ground that conveys surface water as primarily sheet flow across a relatively broad, poorly defined plane. (S-Clay Slope Wetland)
5a	Wetland located within or adjacent to an intermittent drainage course whose hydrology is derived from precipitation and interflow. (R-Intermittent Channel Wetlands)
5b	Wetland adjacent to an irrigation canal whose hydrology is primarily derived from that irrigation canal. (R-Canal Wetlands)

As stated previously, this functional assessment methodology has been designed to address wetland functions in naturally occurring wetlands. Of the regional subclasses described above, vernal pools, swale wetlands and clay slope wetlands are naturally occurring. The other regional subclasses (irrigation wetlands and canal wetlands) are wetlands which have been created as a by-product of physical modifications to the landscape. Using the Key to Regional Subclasses, the wetlands delineated by EIP were reclassified into HGM regional subclasses. Table 6 provides a listing of the total area of wetlands within the UC Merced project area as delineated and classified by EIP. Table 7 lists the respective areas of the vernal pool, swale wetland and clay slope wetland subclasses. Figure 3 is a map showing the vernal pool, swale wetland and clay slope wetland regional subclasses as well as canal wetlands and intermittent channel within the UC Merced project area.

Table 6. Wetland Areas as Delineated by EIP (Acres)

Water/Wetland Type	*Main Campus*	*Land Reserve*	*Natural Reserve*	*Total*
Canals	22.64	0.00	0.00	**22.64**
Channels	0.00	0.00	0.00	**0.00**
Clay Playas	1.01	27.51	15.45	**43.97**
Marsh	16.77	0.00	0.00	**16.77**
Seasonal Wetlands	11.35	7.94	49.88	**69.17**
Stockponds	0.00	1.63	2.20	**3.83**
Swales	22.18	8.87	11.67	**42.72**
Vernal Pools	23.97	18.67	27.93	**70.57**
Pools/Swales	10.75	10.38	28.51	**49.64**
Total	**108.67**	**75.00**	**135.64**	**319.31**

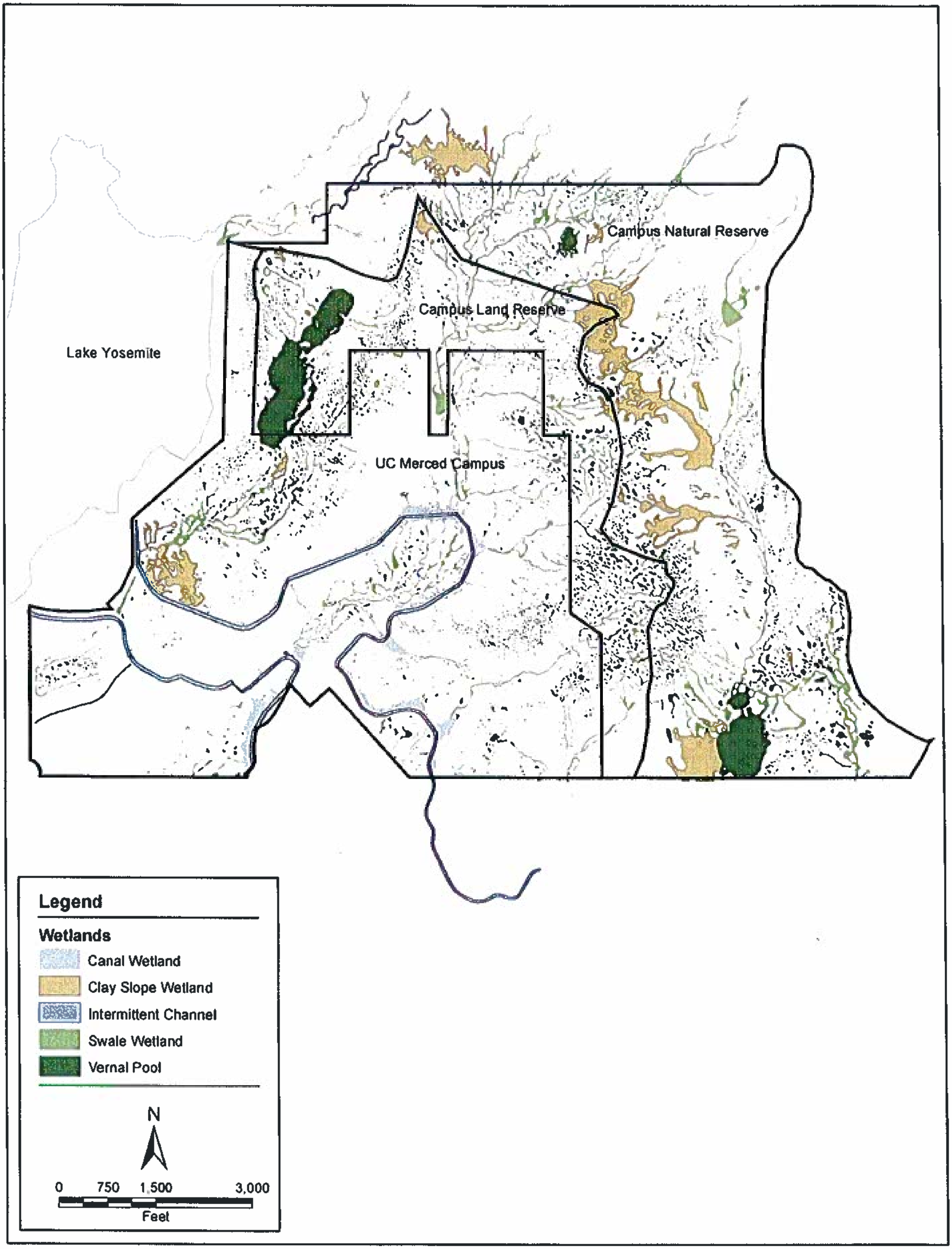

Figure 3
HGM Regional Wetlands Subclasses

Table 7. Areas of HGM Regional Subclasses

Regional Subclass	*Area (acres)*
Vernal Pools	112.98
Swale Wetlands	92.37
Clay Slope Wetlands	62.79
Total	**268.14**

Community Profiles of Regional Subclasses

Vernal Pools

There have been numerous studies of vernal pools and their ecology including Barry (1995), Bauder (1987), Bliss and Zedler (1988), Griggs and Holland (1976), Helm (1998), Holland (1976 and 1986), Holland and Jain (1981), Holland and Dains (1990), Jain (1976), Jokerst (1990), Keeler-Wolf et al. (1998), Keeley (1981 and 1990), Lin (1970), Macdonald (1976), Macior (1978), McClintock (1976), Marty (in prep), Medeiros (1976a and 1976b), Morey (1998), Platenkamp (1988), Robins and Vollmar (in print), Rosario and Lathrop (1981), Silveira (1998), Taylor et al (1992), Thorpe and Loeng (1994 and 1998), Vollmar (1999 and 2001), Wiggens et al. (1980), Winfield et al. (1998), and Zedler (1987, 1990 and 1998). Vollmar (2002) provides a comprehensive synopsis of the wildlife and rare plant ecology of Eastern Merced County's vernal pools grasslands.

Vernal pools are shallow, seasonally inundated depressions underlain by an impervious soil layer (aquatard) that typically flood in the winter and early spring and dry out in the late spring. Zedler (1987) defines vernal pools in California as "a natural habitat of the Mediterranean climate region of the Pacific Coast covered by shallow water for extended periods during the cool season but completely dry for most of the warm season drought." They are typically dry by late spring or early summer (May-June) and remain so until throughout the summer and fall. Vernal pools occur throughout the Central Valley of California, south to San Diego and north to the Modoc Plateau. Vernal pools range is size from as small as 1 m^2 and as large as 0.5 hectare. They can occur as isolated features or in large complexes.

Vernal pools typically are characterized by unique plant assemblages composed primarily of endemic annuals including many rare, threatened and endangered species. Invertebrate faunal communities also consist of many endemic species including rare, threatened and endangered species. These endemic plants and animals have life cycles that are specifically adapted to the wetting and drying cycles governing the hydrology of vernal pools.

The hydrology of vernal pools is determined by the Mediterranean climate and the presence of an aquatard in the soil which restricts the vertical infiltration of water. In soils that have moderately deep to deep profiles above the hardpan such as within the UC Merced reference domain, water exchange between the pool and surrounding upland plays a major role in controlling the water level relationships as compared to relatively minor watershed contributions. From a volumetric perspective, direct rainfall is sufficient to fill vernal pools beyond capacity in most years and overland flows are excess to that needed to flood vernal pools (Haines and Stromberg 1998).

Vernal pools typically undergo four distinct phases each year: wetting; aquatic; drying; and drought (Zedler 1987). The wetting phase occurs after the rains begin in the fall or early winter. Initially, the vernal pools do not flood as the rainwater percolates downward to the aquatard.

The aquatic phase begins once the soils have absorbed enough water to create a perched water table restricting vertical infiltration of water at or near the surface of the soil. In years with above normal early rainfall, the aquatic phase can begin in early December. In years where there is below normal rainfall in early winter, the aquatic phase can be delayed until late January. At this point, the vernal pools will begin to pond water and will continue to do so with additional rainfall. It is during this period that many of the plants germinate and sprout. It is also during this period that aquatic invertebrates hatch and complete their life cycle.

As rainfall decreases, temperatures rise and evapotransporation increases in the late spring, the drying phase begins. It is during this phase, that vernal pools develop the concentric rings of blossoming plants relative to the moisture gradient. However, due to sporadic rainfall patterns, it is not unusual for vernal pools to begin drying out earlier in the winter and then subsequently reflood with additional rainfall. In normal years, the drying phase typically ends by late April or early May.

The drought phase occurs after the soils within the vernal pools have dried out. The annual plants that germinated, blossomed, and set seed during the aquatic and drying phases die. Some upland species that germinate later may be present during the drought phase but little other live vegetation is present.

Swale Wetlands

Swale wetlands are sloped wetlands underlain by an impervious soil layer occurring on convex surfaces. They are subject to seasonal inundation in the winter and early spring and dry out in the late spring. Unlike vernal pools, the water moves down gradient as shallow sheet flow rather than impounding. Swale wetlands may have vernal pools in shallow depressions within their beds. Water flowing in swale wetlands is rarely deeper than 2 to 3 centimeters.

Topographically, swale wetlands are narrow (1 to 10 meters in width) linear features with a bed and gently sloping banks. They range, in length, from tens to thousands of meters. They are differentiated from ephemeral and intermittent stream channels in that their beds are composed of loams and clays as opposed to gravels and cobbles and channels have steeper banks. Swale wetlands are also well-vegetated across their beds whereas the beds of channels are sparsely to not vegetated.

Swales occur in the same soils and landscape positions as vernal pools and have similar hydrology phases. Unlike vernal pools, individual swales are generally located in multiple soil types and landscape positions. While swale wetlands typically have plant communities composed, in part, of species common to vernal pools, they often are not dominated by such species. Introduced non-native species such as perennial rye (*Lolium perenne*) and Mediterranean barley (*Hordeum hystrix*) are commonly dominants in swale wetlands.

Clay Slope Wetlands

Clay slope wetlands are large, broad, and sloping wetlands that occur on convex surfaces in deeper clay soils. The hydrology of clay slope wetlands is quite similar to swale wetlands except that they appear to be, as a group, subject to shorter durations of inundation. Inundation results from very shallow sheet flow (less than 1 centimeter). While clay slope wetlands may experience shorter durations of sheet flow as compared to swale wetlands, their deeper profile stores more water for a longer duration than do the shallower soils in swales.

The primary source of water sustaining sheet flow appears to be infiltration from adjacent uplands. As the soils in adjacent uplands near their water holding capacity, groundwater is discharged from the toe of the slopes around the periphery of the clay slope wetlands. Direct rainfall on clay slope wetlands appears to be insufficient to solely sustain wetland hydrology.

The plant communities in clay slope wetlands are dominated by non-native species such as perennial rye and Mediterranean barley. Plants common to vernal pools are rare in clay slope wetlands and never dominant.

CHAPTER 4 – FUNCTIONS AND VARIABLES

Overview of Wetland Functions

In the HGM Approach, an assessment model is a simple representation of a function performed by a wetland ecosystem. It defines the relationship between one or more characteristics or processes of the wetland ecosystem. Functional capacity is simply the ability of a wetland to perform a function compared to the level of performance in reference standard wetlands.

Model variables represent the characteristics of the wetland ecosystem and surrounding landscape that influence the capacity of a wetland ecosystem to perform a function. Model variables are ecological quantities that consist of five components: (a) a name, (b) a symbol, (c) a measure of the variable and procedural statements for quantifying or qualifying the measure directly or calculating it from other measures, (d) a set of variables (i.e., numbers, categories, or numerical estimates (Leibowitz and Hyman 1997)) that are generated by applying the procedural statement, and (e) units on the appropriate measurement scale. Table 8 provides several examples.

Table 8. Examples of Model Variable Components

Name (Symbol)	*Measure / Procedural Statement*	*Resulting Values*	*Units (Scale)*
Substrate Disturbance ($V_{DISTURB}$)	The alteration of the soils by activities such as addition of fill material, soil oxidation, rock plowing, or removal of sediment.	present absent	Unitless (nominal scale)
Presence of Ditches (V_{DITCH})	The presence of ditches within a certain distance of the wetland.	1.0 0.8 0.3	Unitless (interval scale)
Cover of Woody Vegetation (V_{WOODY})	The average percent aerial cover of leaves and stems of shrubs and trees (> 1 m).	0 to >100	Percent

Model variables occur in a variety of states or conditions in reference wetlands. The state or condition of the variable is denoted by the value of the measure of the variable. For example, percent herbaceous groundcover, the measure of the percent cover of herbaceous vegetation, could be large or small. Based on its condition (i.e., value of the metric), model variables are assigned a variable subindex. When the condition of a variable is within the range of conditions exhibited by reference standard wetlands, a variable subindex of 1.0 is assigned. As the condition deflects from the reference standard condition (i.e., the range of conditions within which the variable occurs in reference standard wetlands), the variable subindex is assigned based on the defined relationship between model variable condition and functional capacity. As the condition of a variable deviates from the conditions exhibited in reference standard wetlands, it receives a progressively lower subindex, reflecting its decreasing contribution to functional capacity.

Model variables are combined in an assessment model to produce a Functional Capacity Index (FCI) that ranges from 0.0 to 1.0. The FCI is a measure of the functional capacity of a wetland relative to reference standard wetlands in the reference domain. Wetlands with an FCI of 1.0 perform the function at a level characteristic of reference standard wetlands. As the FCI decreases, it indicates that the capacity of the wetland to perform the function is less than that of reference standard wetlands.

The Assessment Team identified and defined eight functions that are performed by the vernal pool, swale wetland, or clay slope wetland regional subclasses within the UC Merced project area. These functions were selected based on best professional judgment after reviewing regional guidebooks developed for hydrogeomorphically similar wetlands (Hauer, et al. 2002, Noble et al. 2004 and Stutheit et al. 2004). The team also examined the guidebook for assessing vernal pools and seasonal wetland swales developed for the Borden Ranch near Sacramento, California (Lee, et al 1997). The guidebooks were examined in light of the characteristics of these regional subclasses within the UC Merced project area. The functions are as follows:

- Surface Water Storage
- Subsurface Water Storage and Interchange
- Moderation of Surface and Shallow Subsurface Water Flow
- Element and Compound Cycling
- Organic Carbon Export
- Maintenance of Characteristic Plant Communities
- Maintenance of Characteristic Faunal Communities
- Faunal Habitat Interspersion and Connectivity

Each of these functions is defined and discussed below. The variables affecting the capacity of particular wetlands are defined and discussed and conceptual models describing how these variables influence functional attainment are presented.

Functions

Surface Water Storage (SWS)

Definition: This function refers to the capability of a wetland or other water to collect and retain surface and shallow subsurface water as static water above the soil surface. The volume of the basin determines the potential volume of storage while surface water from the contributing watershed plus the infiltration of shallow subsurface water from the adjacent uplands determines the volume of water potentially contributing to the basin.

Variables Affecting Surface Water Storage: The average depth of a wetland multiplied by its area yields an estimate of the volume of surface storage within the wetland. The surface water storage capacity of a wetland can be modified by altering the amount of surface and shallow subsurface water entering it, raising or lowering the spill elevation, raising or lowering its bed, or eliminating the restrictive layer in the soil. Therefore, a model of this function should include a variable for the depth of the wetland, the elevation of the outlet (if present), the integrity of the wetland's watershed, and the integrity of the soil profile (particularly the restrictive layer) both within and adjacent to the wetland.

Applicable Regional Subclasses: Vernal pools.

Subsurface Water Storage and Interchange (SWS&I)

Definition: This function refers to the capability of a wetland to store water below the soil surface and allow exchange of shallow subsurface water laterally with the contributing uplands bordering the wetland.

Variables Affecting Subsurface Water Storage and Interchange: The soil profile within the vernal pool as well as bordering uplands largely determines the capability of a given wetland to perform this function. If the soil profiles in either the wetland or its adjacent upland are substantially disrupted, this function will be impaired.

Applicable Regional Subclasses: Vernal pools.

Moderation of Surface and Shallow Subsurface Water Flow (MS&SSWF)

Definition: This function refers to a slope wetland's capacity to moderate the rate at which water passes through the wetland and the watershed.

Variables Affecting Moderation of Surface Flow and Shallow Subsurface Water: The slope of a wetland, the cross-sectional area of a wetland, the condition of its watershed, and the integrity of the soil profile both within the wetland and in its surrounding uplands significantly affect the capacity of a wetland to perform this function.

Applicable Regional Subclasses: Swale wetlands and clay slope wetlands.

Element and Compound Cycling (E&CC)

Definition: Element and compound cycling refers to the biological and physical processes that convert compounds from one form to another. These processes cycle various elements and compounds between the atmosphere, soil, water, and vegetation. This cycling contributes to the nutrient capital of the ecosystem and reduces downstream particulate loading and thereby helps to maintain and improve water quality.

Variables Affecting Element and Compound Cycling: The physical and biological variables that determine the capability of a particular wetland to perform this function are the vegetation in the vernal pool and the contributing watershed and the soil in the wetland and the contributing watershed. The plants absorb, transform, and temporarily store various elements and compounds. The soil contains various microorganisms that are critical to the cycling of these nutrients. The soil also provides a medium for short and long-term storage of elements and compounds.

Applicable Regional Subclasses: Vernal pools, swale wetlands, and clay slope wetlands.

Organic Carbon Export (OCE)

Definition: This function refers to amount of dissolved or particulate organic carbon that is exported from a wetland. The export of carbon enhances the decomposition and mobilization of metals and supports aquatic food webs and downstream biogeochemical processes.

Variables Affecting Organic Carbon Export: The amount of organic carbon available for export is the sum of the input from the watershed and the biomass produced within the wetland itself. The degree to which this carbon can be exported downstream is affected by whether there is an outlet to convey water from the wetland to downstream waters.

Applicable Regional Subclasses: Vernal pools, irrigation wetlands, swale wetlands, and clay slope wetlands.

Maintenance of Characteristic Plant Communities (MCPC)

Definition: This function refers to the capability of wetlands to support and sustain endemic plant communities that are characteristic of the regional wetland subclass with respect to species composition, abundance, and structure. This, in turn, helps to maintain ecosystem health and biodiversity.

Variables Affecting Maintenance of Characteristic Plant Communities: The soil profile and its integrity, the integrity of the watershed, the duration and depth of ponding, and the degree of disturbance of the wetland and its adjacent uplands can all have a profound affect on the plant community that a wetland supports.

Applicable Regional Subclasses: Vernal pools, irrigation wetlands, swale wetlands, and clay slope wetlands.

Maintenance of Characteristic Faunal Communities (MCFC)

Definition: This function refers to the capability of wetlands to support and sustain endemic faunal communities that are characteristic of the regional subclass with respect to species composition, abundance, and age structure. For purposes of this assessment, this function includes both vertebrate and invertebrate fauna.

Variables Affecting the Maintenance of Characteristic Faunal Communities: The soil profile and its integrity, the integrity of the watershed, the duration and depth of ponding, and the degree of disturbance of the wetland and its adjacent uplands can all have a profound affect on the faunal community that a wetland is capable of sustaining.

Applicable Regional Subclasses: Vernal pools, swale wetlands, and clay slope wetlands.

Faunal Habitat Interspersion and Connectivity (FHI&C)

Definition: This function refers to the capability of a wetland to act as a conduit of interspersion and connectivity for vertebrates and invertebrates normally associated with wetlands. This, in turn, supports landscape and regional faunal biodiversity.

Variables Affecting Faunal Habitat Interspersion and Connectivity: The capability of a wetland to perform this function is affected by the integrity of the watershed, the presence or absence of an outlet and a mechanism for longitudinal connectivity, and the proximity of other wetland habitats.

Applicable Regional Subclasses: Vernal pools, irrigation wetlands, swale wetlands, and clay slope wetlands.

Table 9 provides a tabular summary of the wetlands wetland functions for vernal pools, swale wetlands and clay slope wetlands and the variables affecting these functions.

Table 9. Summary of Wetland Functions

Regional Subclass	SWS	SWS&I	MS&SSWF	E&CC	OCE	MCPC	MCFC	FHI&C
Vernal Pools	X	X		X	X	X	X	X
Swales			X	X	X	X	X	X
Clay Slopes			X	X	X	X	X	X

Notes:

SWS = Surface Water Storage.
SWS&I = Subsurface Water Storage and Interchange.
MS&SSWF = Moderation of Surface and Shallow Subsurface Water Flow.
E&CC = Element and Compound Cycling.
OCE = Organic Carbon Export.
MCPC = Maintenance of Characteristic Plant Communities.
MCFC = Maintenance of Characteristic Faunal Communities.
FHI&C = Faunal Habitat Interspersion and Connectivity

Variables

The following is a discussion of each of the variables affecting wetland function in vernal pools, swale wetlands and clay slope wetlands.

Estimated Depth of Wetland (V_{DW}). This variable is an approximation of the average depth of depression class wetlands. It represents the average elevational difference between the bed of the wetland and it upper edge. This variable would be scaled by plotting the range of depths observed within depressional wetlands. The greatest depth would be assigned a score of 1.0 while the shallowest would be assigned a score of 0.1. The remainder of the depths would be scaled accordingly.

Outlet (V_{OUT}). This variable refers to the presence or absence of a natural or constructed outlet for surface water. This variable would be scaled with a score of 1.0 assigned where an outlet is present and a score of 0.0 where no outlet is present.

Inlet (V_{IN}). This variable refers to the presence or absence of a natural or constructed inlet for surface water. This variable would be scaled with a score of 1.0 assigned where an inlet is present and a score of 0.0 where no inlet is present.

Bed Restrictive Layer (V_{BEDRL}). This variable refers to the presence or absence of an intact layer in the upper soil horizon restricting the downward movement of shallow subsurface water. This restrictive layer can be a hard pan, duripan or clay pan, depending on the soil type. This layer is naturally present in soils supporting vernal pools. It can be destroyed by deep ripping or land leveling. Where this restrictive layer is destroyed within the bed of a vernal pool, the capability of the vernal pool to pond water for long duration is also destroyed.

The presence of a restrictive layer is determined by examination of the soil profile within the vernal pool. If the soil profile reveals an intact restrictive layer, it will be assumed that that layer is intact throughout the bed of the vernal pool, absent an observable indication that the soil profile of the vernal pool has been disturbed. Likewise, an intact restrictive layer can be assumed in undisturbed vernal pools.

The presence of an intact restrictive layer underlying the wetland would be assigned a score of 1.0. The absence of an intact restrictive layer underlying the bed of the vernal pool would be assigned a score of 0.0.

Bank Restrictive Layer (V_{BANKRL}). This variable refers to the presence or absence of an intact layer in the upper soil horizon of adjacent uplands restricting the downward movement of shallow subsurface water. This restrictive layer can be a hard pan, duripan or clay pan, depending on the soil type. This layer is naturally present in soils adjacent to vernal pools. It can be destroyed by deep ripping or land leveling. Where this restrictive layer is destroyed in the lands bordering a vernal pool, the capability of the vernal pool to pond water for long duration is adversely affected.

The presence of a restrictive layer is determined by examination of the soil profile in the uplands bordering the vernal pool. If the soil profile reveals an intact restrictive layer, it will be assumed that that layer is intact in all of the lands bordering the vernal pool, absent an observable indication that the soil profile has been disturbed.

The presence of an intact restrictive layer underlying the uplands bordering a wetland will be given a score of 1.0. The absence of an intact restrictive layer underlying the bed of the vernal pool will be given a score of 0.0.

Available Water Capacity of the Bed (V_{BEDAWC}). This variable refers to the capacity of the upper soil profile within the vernal pool to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at the wilting point. It is commonly expressed as inches of water per inch of soil.

The available water capacity of a given soil profile down to the restrictive layer can range from very low – 0.0" to 2.5"; low – 2.5" – 5.0"; moderate – 5.0" to 7.5"; high – 7.5" to 10.0"; to very high – more than 1.0".

Available Water Capacity of the Bank ($V_{BANKAWC}$). This variable refers to the capacity of the upper soil profile of the uplands bordering vernal pools to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at the wilting point. It is commonly expressed as inches of water per inch of soil. The available water capacity of a given soil profile down to the restrictive layer can range from very low – 0.0" to 2.5"; low – 2.5" – 5.0"; moderate – 5.0" to 7.5"; high – 7.5" to 10.0"; to very high – more than 1.0".

Bed Soil Profile Integrity (V_{BEDP}). This variable refers to the degree to which the observed soil profile within the wetland is consistent with the established range of conditions for the soil type. It will be determined by excavating a soil test pit within the vernal pool and noting the characteristics of the soil profile down to the restrictive layer. The textures and chromas and depths of each profile will be determined. This will then be compared to the range of conditions normal to the respective soil. The test pit will be characterized by a qualified soil scientist.

This variable would be scaled according to the estimated relative variation from the established range of conditions normally present within the appropriate soil type. A complete and intact soil profile would be assigned a score of 1.0 and a soil profile that has been ripped or otherwise compromised so that the restrictive layer is no longer acts as a barrier to the infiltration of water would be assigned a score of 0.00. Where the restrictive layer is still intact but the soil profile has been truncated or filled, the values will be scaled accordingly to the degree to which they deviate from the range of conditions present in the soil profiles of the least disturbed sites.

Bank Soil Profile Integrity (V_{BANKP}). This variable refers to the degree to which the observed soil profile in the uplands adjacent to the wetland is consistent with the established range of conditions for the soil type. It will be determined by excavating a soil test pit within the vernal pool and noting the characteristics of the soil profile down to the restrictive layer. The textures and chromas and depths of each profile will be determined. This will then be compared to the range of conditions normal to the respective soil. The test pit will be characterized by a qualified soil scientist.

This variable would be scaled according to the estimated relative variation from the established range of conditions normally present within the appropriate soil type. A complete and intact soil profile would be assigned a score of 1.0 and a soil profile that has been ripped or otherwise compromised so that the restrictive layer is no longer acts as a barrier to the infiltration of water would be assigned a score of 0.00. Where the restrictive layer is still intact but the soil profile has been truncated or filled, the values will be scaled accordingly to the degree to which they deviate from the range of conditions present in the soil profiles of the least disturbed sites.

Sediment Deposition (V_{SED}). This variable is an estimate of the depth and areal extent of sedimentation within a vernal pool. Sedimentation within vernal pools degrades the vernal pools capability to retain and pond surface water. Normally, observable sedimentation does not occur within vernal pools. Any observable sedimentation would therefore be an indication of disturbance within the contributing watershed of the vernal pool and an increase in sedimentation rates. The areal extent of sediment deposits within the vernal pool will be estimated along with its maximum depth.

The variable would be scaled where no observable sedimentation is given a score of 1.00 and sedimentation resulting in elimination of the inundated basin of the vernal pool will be given a score of 0.00.

Watershed Disturbance Quotient (V_{WDQ}). This variable refers to disturbances within the contributing watershed of the vernal pool. It factors in the type of disturbance, the weighted distance of that disturbance from the wetland and the relative proportion of the watershed affected by that disturbance. A disturbance index (Table 10) is used to weight the types of disturbances. Where several types of disturbance are noted, the most severe level is used for calculating this function. This variable is adapted from Clairain (2000). This variable incorporates elements of numerous variables potentially affecting wetland function including watershed condition, buffer condition, buffer continuity, and buffer width. The highest calculated value(s) would be assigned a score of 1.0 and the lowest would be assigned a score of 0.1 with the remaining value scaled accordingly.

The contributing watershed is characterized by measuring the distance to disturbances within the contributing watershed of the vernal pools in four sectors established at 45 degrees starting north of the observation point. The observation point is the downhill edge of the vernal pool. Disturbances are characterized as to type and proximity to the vernal pool. Proximity is characterized as to whether the disturbance occurred within the vernal pool, within the immediate basin of the vernal pool or within the contributing watershed of the vernal pool.

Using these data, the Watershed Disturbance Quotient is calculated using the following formula.

$$Vwdq = \frac{\underline{\Sigma ni=1((3xI) + (2xWx((SQRT(1/(0.9999+(D))-0.0001))))+(K))/6}}{8}$$

Where;

- Σni=1 = summation of the disturbance components for sectors 1 to n
- n = number of sectors where some type of disturbance is observed
- I = disturbance index for the most sever type of disturbance occurring within the vernal pool for each sector
- W = disturbance index for the most severe type of disturbance occurring within the immediate basin of the vernal pool for each sector
- SQRT = square root
- D = distance in meters from the edge of the vernal pool to the nearest most severe disturbance; anything less than one meter is zero and then in whole numbers thereafter with 1 = 1 to < 2 meter, 2 = 2 to < 3 meters, etc.
- K = disturbance index for the most severe type of disturbance occurring within the contributing watershed within one kilometer of the outside edge of the vernal pool for each sector

Table 10. V_{WDQ} Disturbance Index

DISTURBANCE FACTORS	*DISTURBANCE INDEX*
AGRICULTURE	
CHEMICAL SPRAYING	
None	1.00
Within one km but out of complex	0.75
Within the vernal pool complex	0.10
TILLAGE	
None	1.00
Harrowing	0.75
Mowing	0.75
Chiseling/disking	0.50
Plowing	0.25
Deep plowing, restoration possible	0.10
Deep Ripping and Leveling	0.00
Land Leveling	0.25
GRAZING	
None	0.75
Light	1.00
Moderate	0.50
Severe	0.10
SPECIAL MNGT. PRACTICES	1.00 or 0.00
DEVELOPMENT	
RESIDENTIAL/COMMERCIAL:NONE	1.00
Low-density Residential	0.50
High-Density Residential	0.25
Low-density Commercial	0.50
High-density Commercial	0.25
PUBLIC ACCESS	
None	1.00
Limited	0.75
Open w/disturbance	0.50
HYDROLOGIC MODIFICATIONS	
None	1.00
Interceptions of Inflows	0.10
Diversions of Flows Away	0.10
Irrigation within Vernal Pool Subclass	0.10*
Irrigation within Slope Class	0.50*
Wetland Drained	0.00*

* Where these disturbances occur in the wetland they will be considered to have occurred in all 8 sectors.

Organic Matter (V_{OM}). This variable refers to the amount of detritus (primarily algal matting) within the wetland. It is a variable reflecting a portion of the total primary productivity of a wetland. During the wetted phase, algae develops in the water column. After the vernal pool dries out, this algae leaves thin dried mats on the bed of the wetland. The areal coverage by algal matting will be estimated as a percentage of the total area of the wetland. The highest percentage observed would be assigned a score of 1.0. Since organic matter is always present, whether or not it is visually observable, a score of 0.1 would be assigned where no organic matter is observed. The remainder of the percentages would be scaled accordingly.

Percent Cover ($V_{\%COV}$). This variable refers to the estimated absolute cover by vascular plants within the vernal pool. This along with Organic Matter is a variable reflecting a portion of the total primary productivity of a vernal pool. The percent absolute cover of vascular plants will be visually estimated. The range of percent cover observed in the least disturbed wetlands would be assigned a score 1.0 while the remaining values will be scaled according to the degree to which they vary from the range in the least disturbed wetlands.

Vernal Wetland Plant Index (V_{VWPI}). This variable is a measure of the degree to which the plant community is dominated by species normally found in vernal pools. The index is calculated by the following formula:

$$V_{VWPI} = \frac{(No.\ VPE\ Dom.\ Species) + (.25)(No.\ VPA\ Dom.\ Species)}{Total\ No.\ of\ Dom.\ Species}$$

Where: VPE = Vernal pool endemic species
VPA = Vernal pool associate species

Vernal pool endemic species are those plants that are endemic to vernal pools whereas vernal pools associate species are those plants that are commonly found in vernal pools but are also found in other types of wetlands. Appendix C is a master plant list that have been observed within vernal pools within the reference domain along with a notation as to whether each plant is considered to be a vernal pool endemic or associate.

For purposes of this variable, dominant species will be assumed to be those plants comprising an estimated 50 percent of the total vegetative cover as well as any other species having an estimated cover of at least 10 percent. The highest possible V_{VWPI} (1.0) would be where all dominant plants are vernal pool endemic species. The lowest calculated V_{VWPI} would be assigned a score of 0.1. The remaining values would be scaled appropriately.

Native Plant Index (V_{NPI}). This variable is a measure of the relative dominance of native plants. Native plants are considered to be those species that are considered to be indigenous to California. The source used for making these determinations was The Jepson Manual (Hickman 1993). The V_{NPI} is calculated by dividing the number of dominant native species by the total number of dominant species. The highest possible V_{NPI} (1.0) would be where all dominant plants are native species. The lowest V_{NPI} would be assigned a score of 0.1. The remaining values would be scaled appropriately.

Wetland Density (V_{WD}). This variable refers to the proximity and relative abundance of other wetlands. This variable would be measured using GIS. It would be calculated as the percent of the total wetland area within a specific radius of the centroid of the wetland. The greatest percentage of wetland area would be assigned a score of 1.0 while the lowest percent wetland would be assigned a score of 0.1. The remainder would be scaled appropriately.

Conceptual Function Models

A series of conceptual models were developed to describe how the variables discussed above influence wetland function. In almost all cases, these models were constructed using variables that influence their functional capacity rather than directly measure the function. In one case (MCPC) the variables used provide a direct measure of the function. The models are designed so that they will yield a score ranging from 0.0 up to 1.0. A score of 0.0 implies that the wetland would not perform that particular function. A score of 1.0 implies that the wetland would perform the function at maximum capacity relative to the reference standards. Various components of these models are comprised of single and/or multiple variables. Where these components are multiplied, a value of zero for one of the components will result in a functional rating of zero. Where the components are added, a value of zero for one of the components will not result in a function rating of zero unless all components are rated as zero. The following is a description of each of the conceptual function models.

Surface Water Storage (SWS)

$$SWS = \sqrt{(V_{BEDRL})\left(\frac{V_{WDQ} + V_{BEDP} + V_{SED}}{3}\right)}$$

Where:
V_{BEDRL} = Restrictive layer within the wetland
V_{WDQ} = Watershed Disturbance Quotient
V_{BEDP} = Bed soil profile integrity
V_{SED} = Sediment deposition

A vernal pool's capacity to store water is dependent on the presence of an intact restrictive layer in the soil (V_{BEDRL}) and is substantially influenced by the condition of its watershed (V_{WDQ}) and the integrity of its soil profile (V_{BEDP}). If disturbance to the watershed increases sedimentation within the vernal pool, it will reduce the capacity of the vernal pool to store surface water (V_{SED}).

Subsurface Water Storage and Interchange (SWS&I)

$$SWS \;\&\; I = \sqrt{\left(\frac{V_{BEDRL} + V_{BEDAWC}}{2}\right)\left(\frac{V_{BANKRL} + V_{BANKAWC} + V_{WDQ}}{3}\right)}$$

Where:
V_{BEDRL} = Restrictive layer within the wetland

V_{BEDAWC} = Available water capacity in the wetland soils
V_{BANKRL} = Restrictive layer in the adjacent upland
$V_{BANDAWC}$ = Available water capacity in adjacent upland soils
V_{WDQ} = Watershed Disturbance Quotient

There are two main components of the model: the capacity of the soil profile above the restrictive layer within the wetland to retain perched groundwater (**V_{BEDRL}**, **V_{BEDAWC}**); and, the condition of the watershed including the capacity of the soil profile above the restrictive layer in the adjacent uplands to retain perched groundwater (**V_{WDQ}**, **V_{BANKRL}** and **$V_{BANDAWC}$**).

Moderation of Surface and Shallow Subsurface Water Flow (MS&SSWF)

$$MS\ \&\ SSWF = \frac{V_{SLOPE} + V_{\%COV} + V_{\%COB}}{3}$$

Where: V_{SLOPE} = Slope within the wetland
$V_{\%COV}$ = Percent plant cover in wetland
$V_{\%COB}$ = Percent cover by cobbles in wetland

The degree to which a sloped wetland moderates surface water flow is determined primarily by its slope (**V_{SLOPE}**) and the hydraulic roughness within the wetland (**$V_{\%COV}$** and **$V_{\%COB}$**).

Element and Compound Cycling (E&CC)

$$E\ \&\ CC = \left(\frac{V_{WDQ} + V_{OUT} + V_{BEDRL} + V_{SED} + \left(\frac{V_{OM} + V_{\%COV}}{2} \right)}{5} \right)$$

Where: V_{WDQ} = Watershed Disturbance Quotient
V_{OUT} = Presence or absence of an outlet
V_{BEDRL} = Restrictive layer within the wetland
V_{SED} = Sediment deposition
V_{OM} = Organic matter in wetland
$V_{\%COV}$ = Percent plant cover in wetland

There are five components of the model: the overall condition of the watershed influences the amount of water and its element and compound constituents (**V_{WDQ}**); the presence or absence of an outlet determines whether these elements and compounds can be transported to down-gradient waters (**V_{OUT}**); the presence or absence of a restrictive layer determines the wetlands ability to pond water (**V_{BEDRL}**), the presence or absence of recently deposited (**V_{SED}**) and the vascular and non-vascular plant community influences how elements and compounds are cycled (**V_{OM}** and **$V_{\%COV}$**).

Organic Carbon Export (OCE)

$$OCE = \sqrt{\left(\frac{V_{WDQ} + V_{BEDRL} + V_{OM} + V_{\%COV}}{4}\right)(V_{OUT})}$$

Where: V_{WDQ} = Watershed Disturbance Quotient
V_{BEDRL} = Restrictive layer within the wetland
V_{OM} = Organic matter in wetland
$V_{\%COV}$ = Percent plant cover in wetland
V_{OUT} = Presence or absence of an outlet

The primary factors influencing this function include the organic contribution derived from adjacent uplands (V_{WDQ}); the organic matter contribution within the wetland (V_{OM} and $V_{\%COV}$); and the topographic conveyance by which the organic matter can be transported to down-gradient waters/wetlands (V_{OUT}).

Maintenance of Characteristic Plant Communities (MCPC)

$$MCPC\ (Vernal\ Pools) = \frac{V_{VWPI} + V_{\%COV}}{2}$$

$$MCPC\ (Swale\ \&\ Clay\ Slope) = \frac{V_{NPI} + V_{\%COV}}{2}$$

Where:

V_{VWPI} = Vernal pool plant index
$V_{\%COV}$ = Percent plant cover in wetland
V_{NPI} = Native plant index

There are two main components of this model; the species composition of the plant community relative to the least disturbed plant reference plant communities (V_{VWPI} and V_{NPI}); and, the percent cover of the plant community relative to the cover in the least disturbed plant communities ($V_{\%COV}$).

Maintenance of Characteristic Faunal Communities (MCFC)

$$MCFC\ (Vernal\ Pools) = \sqrt{(V_{BEDRL})\left(\frac{V_{VWPI} + V_{WDQ} + V_{\%COV}}{3}\right)}$$

$$MCFC\ (Slope\ wetlands) = \sqrt{(V_{BEDRL})\left(\frac{V_{NPI} + V_{WDQ} + V_{\%COV}}{3}\right)}$$

Where:

V_{BEDRL} = Restrictive layer within the wetland

V_{VWPI} = Vernal pool plant index
V_{NPI} = Native plant index
V_{WDQ} = Watershed Disturbance Quotient
$V_{\%COV}$ = Percent plant cover in wetland

Faunal Habitat Interspersion and Connectivity (FHI&C)

$$FHI\,\&\,C = \frac{\left(\frac{V_{OUT} + V_{IN}}{2}\right) + V_{WDQ} + V_{WD}}{3}$$

Where:

V_{IN} = Presence or absence of an outlet
V_{OUT} = Presence or absence of an inlet
V_{WDQ} = Watershed Disturbance Quotient
V_{WD} = Wetland density

There are three components of this model, all pertaining to the mechanisms by which faunal species can move or be transported from one wetland to another. They include the overall condition of the adjoining uplands (**V_{WDQ}**), the presence or absence of an inlet and/or an outlet contributing flow to up-gradient and/or down-gradient waters/wetlands (**V_{IN}** and **V_{OUT}**), and the proximity of other wetlands (**V_{WD}**).

CHAPTER 5 – ASSESSMENT METHODOLOGY

Field Sampling Protocol

Sample Site Selection. A field testing protocol was established to sample the variables discussed in Chapter 4 representing the broad range of conditions existing within the reference domain. The purpose of the field sampling was to collect data on the variables within reference wetlands to calibrate these models. Sample sites were established based on a stratified random sampling protocol. Sample sites were first stratified based on regional subclasses. The number of wetlands to be sampled within each regional subclass was determined based on the proportional distribution of that regional subclass relative to the total number of wetlands.

The samples were then stratified based on relative disturbance zones. Three broad disturbance zones were established based on overall landscape conditions (e.g. proximity to roads, canals, irrigation, etc.). Generally speaking, Disturbance Zone 3 represents the least disturbed conditions within the reference domain. Therefore, the majority of the reference standards would be located within Disturbance Zone 3. Disturbance Zone 3 encompasses those wetlands occurring north and east of the old Merced Hills Golf Course (what is now Phase I of the UC Merced campus) but north of the Flying M Ranch lands. Disturbance Zone 2 represents a greater level of disturbance than Disturbance Zone 3. Disturbance Zone 1 encompasses those areas that were previously part of the Flying M Ranch in the area proposed for the campus support community. Disturbance Zones 1 and 2 are both substantially more disturbed than Zone 3. The disturbances within Zone 1 are generally associated with development (grading, filling, excavating, paving, etc.) whereas the disturbances in Zone 2 are associated with agriculture (e.g. irrigation, drainage, and land leveling, etc.)

The third stratification was based on soil type. As shown in Table 3, there are fifteen soil mapping units within the reference domain. The decision to stratify the sample sites based on soil mapping units was made in an effort to capture some of the variability based on topography and soils. The large majority of wetlands are located within a few soil mapping units and there are many soil mapping units with only a few wetland polygons located within them. The large majority of vernal pools are located totally within one soil mapping unit whereas many of the swale and clay slope wetlands are located in more than one soil mapping unit.

Sample sites were randomly selected within each strata using GIS software. Each sample site was assigned a number reflecting the above stratification. The first digit of the sample site number reflects the Disturbance Zone in which the wetland is located (i.e. 1, 2 or 3). The next two characters of the sample site designation refer to the regional subclass of the wetland (i.e. VP for vernal pools, SW for swale wetlands, or CS for clay slope wetlands). The next three characters refer to the soil mapping unit in which the wetland is located. The next one to two digits refer to the sequential number of that sample site. For example, for sample site number 3VPCgB4, refers to Disturbance Zone 3, the regional subclass is vernal pool (VP), the soil mapping unit is CgB (Corning gravelly loam, 0-8 % slopes) and the site number is 4.

Data Sampled. A data form was prepared to facilitate collecting field data for the model variables influencing wetland function at each of the designated sample sites. A blank copy of this data form, along with instructions for filling out the form in the field, is attached in Appendix B. The following is a listing of the specific data gathered, the associated regional subclass (VP, SW, or CS), and the model variable to which the data are applicable.

- Presence or absence of a topographically distinct inlet (vp, sw and cs - V_{IN}).
- Presence or absence of a topographically distinct outlet (vp, sw and cs - V_{OUT}).
- Estimated percent cover of recently deposited sediment (vp, sw, and cs - V_{SED})
- Estimated percent cover by algal matting (vp, sw and cs - $V_{\%OM}$).
- Estimated percent cover of vascular plants (vp, sw and cs - $V_{\%COV}$).
- Plants with and estimated cover of 10 percent or greater (vp, sw and cs – V_{VWPI} and V_{NPI}).
- Average depth of wetland (vp - V_{DW}).
- Percent slope (sw and cs - V_{SLOPE}).
- Disturbance(s) observed within the vernal pools and its contributing watershed (vp, sw and cs – V_{WDQ}). Disturbances were noted and recorded in Sectors consistent with the V_{WDQ} formula.
- Disturbance index rating for the most severe disturbance observed within the wetland by sector (vp, sw and cs - V_{WDQ}).
- Disturbance index rating for the most severe disturbance observed within the contributing watershed of the wetland by sector (vp, sw and cs - V_{WDQ}).
- Distance from the edge of the wetland to the nearest most severe disturbance in the contributing watershed by sector (vp, sw and cs - V_{WDQ}).
- A best professional judgment (BPJ) estimate of the overall functional rating of the wetlands. The scale of the rating was 0.0 – 1.0 where a rating of 0.0 equated to no wetland functions performed and a rating of 1.0 equated to maximum functional attainment. Each individual team member first rated each respective wetland. The team then discussed the basis for each member's ratings and agreed to a single group rating.

In addition to the above, soil profile descriptions for selected wetlands and their adjacent uplands were obtained. The descriptions included the depth, thickness and textural class of all soil horizons down to the restrictive layer. Other data obtained included the probable soil series and soil mapping unit, evidence of soil profile truncation or burying (filling), evidence of restrictive layer disturbance (ripping) and other observations, where appropriate. This soil data were collected for all regional subclasses (vp, sw and cs) and is applicable to the V_{BEDP}, V_{BANKP}, V_{BEDAWC}, and V_{BANKRL} model variables.

Field Sampling. The field surveys were conducted April 14-18 and April 21-23, 2003. These field surveys were scheduled to correspond with the period of time when the maximum number of plants was in flower. The surveys were conducted by the following participants.

- Mr. Tom Skordal, Gibson & Skordal, LLC
- Mr. Jim Gibson. Gibson & Skordal, LLC
- Dr. Buddy Clairain, Corps of Engineers, Environmental Laboratory
- Ms. Nancy Haley, Corps of Engineers, Sacramento District

- Mr. Matt Hirkala, Corps of Engineers, Sacramento District
- Dr. Rob Leidy, Environmental Protection Agency, Region 9
- Mr. Joel Butterworth, Jones & Stokes Associates
- Mr. Scott Fraser, Jones & Stokes Associates

The participants were organized into three survey teams. Two teams of three were responsible for collecting data other than soil profile data while one team of two was responsible for collecting all soil profile data. The team collecting soil profile data was composed of Messrs. Butterworth and Fraser. The other two teams rotated personnel but maintained a composition of one Corps of Engineers, Sacramento District representative and one Gibson & Skordal representative per team.

A total of 340 wetlands were surveyed by the two teams responsible for collecting other than soil profile data. This total consisted of 180 vernal pools, 121 swale wetlands and 39 clay slope wetlands. The soil profile team examined and described 91 wetlands in the field.

Data Analysis

Data from the field surveys were entered onto spreadsheets, one for vernal pools, one for swale wetlands and one for clay slope wetlands. Prior to entering plant data, all plants occurring in or near wetlands within the reference domain were classified as either vernal pool endemic species or non-vernal pool endemics and either native or non-native species. Appendix C contains a master plant list with these classifications listed. Using these plant classifications, the V_{VWPI} and V_{NPI} variables were calculated for each wetland and entered onto the appropriate spreadsheets. Using the disturbance data, a portion of the V_{WDQ} variables were calculated. During this process, we noted certain anomalies in the equation that did not appropriately account for disturbances observed in the field. Therefore, this variable was omitted from the field data compilations. Using the soil profile data, the V_{BEDAWC}, $V_{BANKAWC}$, and $V_{PROFILE}$ variables were calculated for each wetland sampled and entered onto the spreadsheets. Copies of these spreadsheets are included in Appendix D.

This reference wetland data were then analyzed to determine its suitability for calibrating the model variables and verifying/validating the assessment models. The Assessment Team examined the variables data from the least disturbed sites and compared them to the range of conditions in more disturbed sites for each regional wetland subclass. The analysis was further stratified by soil type. The data were also compared to the BPJ ratings recorded in the field. As stated previously, under the HGM methodology, the reference standards (least disturbed) wetlands should be used to scale the upper limits of assessment models while the more disturbed wetlands are used to scale the lower limits of the assessment models.

However, it was concluded that the data did not provide an adequate basis to discriminate between reference standard wetlands and more disturbed wetlands. Table 11 is a comparative listing, by regional subclass and disturbance zone, of the ranges and means of data observed for each model variable excluding those involving presence/absence data (V_{IN} and V_{OUT}), those for which there was very little variability between the large majority of reference wetlands (V_{SED}, $V_{\%OM}$, and $V_{\%COB}$), and those involving soil profile data (V_{BEDAWC}, $V_{BANKAWC}$, V_{BEDP}, and

V_{BANKP}). The BPJ functional rating of the survey teams is included within this table for a qualitative reference. As stated above, the V_{WDQ} model variable is not included in the table because subsequent evaluation of this variable revealed anomalies inconsistent with conditions observed at the site (see discussion in the following section).

Table 11. Ranges of Selected Variables by Regional Subclass and Disturbance Zones

Regional Subclass	Disturbance Zone	BPJ		V_{VWPI}		V_{DW}		V_{NPI}		V_{SLOPE}	
		High	Low	High	Low	High	Low	High	Low	High	Low
Vernal Pool	3	1.0	0.2	1.00	0.25	1.3	0.1	na	na	na	na
Vernal Pool	2	0.9	0.1	0.88	0.25	0.8	0.1	na	na	na	na
Vernal Pool	1	1.0	0.2	1.00	0.25	1	0.1	na	na	na	na
Swale Wetland	3	1.0	0.1	na	na	na	na	1.00	0.00	3.8%	0.1%
Swale Wetland	2	1.0	0.1	na	na	na	na	0.60	0.00	3.0%	0.1%
Swale Wetland	1	0.7	0.1	na	na	na	na	0.75	0.00	1.3%	0.1%
Clay Slope Wetland	3	0.9	0.4	na	na	na	na	0.67	0.14	3.9%	0.1%

The ranges of conditions observed in the least disturbed reference wetlands (Disturbance Zone 3) are so broad that they capture the ranges of conditions observed within the more disturbed wetlands (Disturbance Zones 1 and 2). For example, the number of vernal pool endemic plant species in Disturbance Zone 3 vernal pools ranges from 0 to 6 while the number in Disturbance Zones 1 and 2 vernal pools ranges from 0 to 4 and 0 to 5, respectively. Likewise, the V_{VWPI} variable ranges from 0.25 up to 1.0 in Disturbance Zone 3 vernal pools while the Disturbance Zones 1 and 2 range from 0.25 up to 1.0 and 0.25 up to 0.88, respectively. This same pattern is exhibited with respect to the other model variables in both the vernal pools and swale wetland subclasses. The only clay slope wetlands within the reference domain are all located within Disturbance Zone 3, so there is no comparative data for clay slope wetlands in Disturbance Zones 1 and 2. Although the BPJ ratings are subjective, they reveal a similar pattern for vernal pools and swales. The BPJ ratings of Disturbance Zone 3 vernal pools ranged from 0.2 up to 1.0 while the BPJ ratings of Disturbance Zone 1 and 2 vernal pools ranged from 0.1 up to 1.0 and 0.1 up to 1.0, respectively.

There are several possible initial explanations. They include the following.

- The natural variability within these regional subclasses is so great and the number of individual wetland polygons comprising the reference domain and reference standards is so large, that it may not be possible to accurately scale the model variables within the scope of this effort.

- The disturbance zones may not provide enough resolution to capture all of the disturbances affecting model variables. For instance, plowing, disking and deep ripping were not observed.
- Although a large number of wetlands were examined, they were stratified into three disturbance zones, three regional wetland subclasses, and fifteen soil types so that the number of samples within each stratified category may not have been large enough to calibrate the models.

Of the above, the Assessment Team considered the first to be the primary explanation. The Assessment Team examined the wetland-specific disturbance data taken in the field for individual wetlands within given disturbance zones and noted numerous examples where the only disturbance observed was grazing. The intensity of grazing in a large majority of the wetlands was similar but widely disparate data were obtained for given model variables. Conversely, the Assessment Team noted numerous examples where substantial disturbance was noted in close proximity to a particular wetland yet many or all model variables exceeded other wetlands of the same regional subclass where no disturbance was noted. Comparing BPJ ratings yielded similar results.

It is possible that a larger sample could yield results that allow calibration of the variables. As stated previously, a total of 180 vernal pools, 121 swale wetlands and 39 clay slope wetlands were sampled. Given the number of wetlands sampled and the lack of any resolution that would allow scaling, the number of wetlands that would have to be sampled would be extremely high and far beyond the scope of this study.

Because of the above, the Assessment Team decided to abandon the classic HGM assessment methodology and develop a modified assessment methodology that, while based on HGM principals, accounts for the broad range of functional performance found within large vernal pool landscapes. This methodology is discussed in the following section.

Functional Assessment Methodology

Overview. The Assessment Team initially examined the WDQ and subsequently modified it to more accurately assess conditions at the UC Merced project area. Rather than rating the individual functions of individual wetlands, this modified functional assessment methodology assesses and rates disturbances that from functional capacity In a large vernal pool landscape, there may be hundreds to thousands of broadly scattered wetlands performing a whole suite of functions. There are large variations in the degree to which individual wetlands are capable of performing these various functions. When these wetlands are disturbed, the degree to which they are capable of performing one or more of these functions can be diminished depending on the type of disturbance and its proximity to the wetlands.

This functional assessment methodology rates disturbances based on the extent to which they can detract from functional performance. It assumes that, absent disturbances, each wetland is at full functional capacity. Each disturbance is assigned a disturbance index (DI) rating based on the potential severity of functional impairment and number of functions that could be impaired (Table 12). Disturbances directly to the wetland as well as to the surrounding uplands are considered. For disturbances occurring in the surrounding upland, the DIs are decayed over distance so that the same disturbance will have a lower disturbance index as distance from the wetland is increased. The combined functional capacity index (CFCI) of each wetland is derived from the disturbance index rating within the wetland combined with the functional rating of the surrounding uplands. The combined functional capacity units (CFCU) of each wetland are calculated by multiplying the functional capacity index of each wetland by its area.

Because of the size of the UC Merced Project as well as the number of wetlands existing within the reference domain, this functional assessment methodology has been designed so that it can be performed using Geographic Information System (GIS) software. It relies on aerial photographic interpretation of disturbances with limited ground truthing rather than field surveys and data gathered in the field.

Development of the Methodology. Initially, in development of this methodology, the watershed disturbance quotient (WDQ) developed by Clairain (2000) and previously adopted for the V_{WDQ} function variable was examined to determine if it could provide an adequate basis for calculating the CFCI of wetlands. After considerable review, several anomalies were identified that limit use of the WDQ for this assessment methodology. The following problems were identified.

Table 12. Disturbance Index

Disturbance Factors	Index Rating
Agriculture	
None	1.00
Mowing	0.70
Disking/Harrowing/Chiseling	0.40
Plowing/Planting	0.25
Chemical Spraying	0.10
Deep Plowing, Restoration Possible	0.10
Land Leveling	0.10
Deep Ripping and Leveling	0.00
Grazing	
Specially Managed to Benefit Wetlands	1.00
Moderate Grazing, Managed per NRCS Standards	0.80
Moderate Grazing	0.70
No Grazing	0.50
Severe	0.50
Landscape Modification	
None	1.00
Non-graded Roads/Trails	0.75
Scraping	0.25
Excavating in Wetland	0.10
Filling in Wetland	0.00
Hydrologic Modifications	
None	1.00
Irrigation	0.25
Diversions of Flows Away	0.10
Impounding Wetland	0.10
Interceptions of Inflows	0.10
Wetland Drained	0.00

- While the formula for calculating the WDQ provides for decay of disturbance indices over distance, upon further review the Assessment Team determined that this portion of the formula actually works inversely to its intended purpose.
- The WDQ formula relies on being able to distinguish the watershed of each individual wetland. Since this cannot be accomplished by GIS using available topographic map, the watershed of each wetland would have to be individually surveyed. Since there are thousands of individual wetlands within the UC Merced project area, this would be impracticable.
- While the WDQ does account for the areal extent of disturbance somewhat by rating disturbances within eight sectors, the Assessment Team desired a rating system that would more accurately account for the total area disturbed.
- The WDQ weights disturbances within the wetland, within uplands comprising the contributing watershed of the wetland and within uplands outside of the contributing watershed of the wetland. While this weighting does yield the intended results in some scenarios, it does not in others. For instance, where a wetland is undisturbed but all of its watershed and surrounding uplands are developed, the functional capacity of the wetland would be approximately halved. Likewise, where a disturbance within the wetland severely compromises its functional capacity but where the contributing watershed and surrounding uplands outside the watershed are not disturbed, the functional capacity of the wetland would be approximately halved. In both cases, we believe that the impact to the functional capacity of the wetland should be greater than that indicated by use of the WDQ formula. While this particular problem can be solved by changing the weighting, other similar problems are created.

For these reasons, the Assessment Team decided to discard the WDQ as the basis for calculating the CFCI of wetlands and developed an assessment protocol based on a formula derived from the WDQ. As stated previously, this methodology has been designed to be performed by GIS. All of the disturbances under baseline conditions are mapped from aerial photography and digitized for GIS analysis. A grid of 3–square meter (m^2) cells is then established over the project area. Each 3-m^2 cell is then assigned a corresponding disturbance index rating. Where more than one type of disturbance is present within a given 3-m^2 cell, the most severe index rating is assigned to that cell. Where only a portion of a given 3-m^2 cell is disturbed, the whole cell is considered to be disturbed.

In calculating the CFCI of a given wetland, a distinction is made between those cells occurring within the wetland being rated and those cells occurring in the uplands surrounding that wetland. Where any portion of a cell is located within the wetland being rated, the whole cell is considered to be within that wetland. These disturbance indices are then used to calculate the CFCI of the wetland.

Calculating the CFCI. The formula for calculating the CFCI is shown and explained below.

$$\text{CFCI} = \sqrt{\left[\frac{\sum_{1}^{n_{cw}} I_{cw}}{n_{cw}}\right]\left[\frac{\sum_{1}^{n_{cnw}} I_{cnw} + \left((1 - I_{cnw})\left(\frac{D_{cw-cnw}}{D_m}\right)^2\right)}{n_{cnw}}\right]}$$

where:

CFCI	= Combined Functional Capacity Index of the wetland
I_{cw}	= Disturbance index rating of a cell in the wetland
I_{cnw}	= Disturbance index rating of a cell not in the wetland but within 500 meters (D_m)
n_{cw}	= Number of cells in the wetland
n_{cnw}	= Number of cells not in the wetland but within the 500 meters
$D_{cw\text{-}cnw}$	= Distance from a non-wetland cell to the nearest wetland cell
D_m	= Maximum distance is 500 meters

The CFCI is scaled to yield values ranging from 0.00 up to 1.00 with the lowest possible CFCI being 0.00 and the highest possible CFCI being 1.00.

To paraphrase this formula, the CFCI is calculated as the square root of the product of:

- the average index ratings of all 3-m^2 cells within the wetland, and
- the average decayed index ratings of all 3-m^2 cells located outside the wetland to a distance of 500 meters.

Within a 500-meter radius circle surrounding a given wetland, there is a minimum of 87,222 3-m^2 cells. As the size of the wetland increases, the number of 3-m^2 cells also increases.

Disturbance Index Ratings. Disturbance index ratings are obtained from the disturbance index (Table 12). This table was derived from the disturbance table used for calculating the WDQ with modifications to better address the characteristics of the UC Merced project area. Each type of disturbance is assigned a rating ranging from 0.00 to 1.00. A rating of 0.00 equates to a disturbance of such severity that no wetland function capacity remains. In essence, it means that the wetland and all its capacity for performing all wetland functions is be eliminated. A rating of

1.00 equates to no reduction in the capacity of the wetland to perform the whole suite of wetland functions.

The disturbance index ratings were assigned by the Assessment Team based on their best professional judgment including a review of relevant literature and communication with other experts in the field regarding the degree to which each disturbance could impair individual and collective functions. By considering functions collectively in assigning disturbance ratings, the CFCI values thusly obtained were averaged as opposed to generating individual values for each function. The Assessment Team concluded that this was appropriate since many of the variables affected by these disturbances influence numerous wetland functions and because the functional ratings must ultimately be combined (i.e. averaged) to determine the CFCI.

While the rationale for assigning many of the disturbance ratings listed in Table 11 is fairly straightforward and intuitive, the impacts to wetland function resulting from grazing are more problematic. There have been numerous anecdotal observations that grazing may benefit certain biological functions in vernal pools and swale wetlands. Recent research by Dr. Jaymee Marty, however, indicates that moderate levels of grazing benefit many of the functions performed by vernal pools and swale wetlands (Marty, J.T. In press). Dr. Marty's research examined the effect of different grazing treatments (ungrazed, continuously grazed, wet-season grazed and dry-season grazed) on vernal pool plant and aquatic faunal diversity in the Central Valley of California. Dr. Marty found that removal of grazing results in significant reductions in native plant species richness and aquatic invertebrate species richness as compared to continual grazing. The research also documented a significant reduction in the duration of vernal pool inundation resulting from removal of grazing. It should be noted that Dr. Marty's research examined only cattle grazing and did not address grazing by other livestock such as sheep or horses. However, no sheep or horse grazing was observed within the reference domain by the Assessment Team.

The disturbance index ratings are based primarily on Dr. Marty's research as well as direct consultation with her (Marty 2005). Severe grazing was assigned a disturbance index rating of 0.50. This index rating assumes a level of grazing that is so severe that there is an observable substantial degradation of both the upland and wetland plant communities. This level of grazing was not observed during the field surveys. No grazing was also assigned a disturbance index rating of 0.50. Moderate grazing was assigned a disturbance index rating of 0.70. This index rating is intended to encompass the broad range of grazing conditions observed within the project area. An adaptive grazing management program designed and implemented to maximize wetland functions was assigned an index rating of 1.0 since it would, by definition, represent maximum functional attainment.

Disturbance Index Decay Curve. The CFCI formula incorporates a decay curve that reduces the severity of disturbance relative to the distance that the disturbance is from the edge of the wetland being rated. The decay curve is a logarithmic curve that results in no disturbance (a 1.00 disturbance rating) at 500 meters or greater, irrespective of the severity of the impact. Since it is impracticable to map the contributing watersheds of thousands of individual wetlands accurately, a logarithmic curve was selected because it results in a negligible reduction in the disturbance rating out to approximately 50 meters. Beyond 50 meters, there is an accelerated reduction in the disturbance's effect. The large majority of wetlands do not have contributing watersheds extending beyond 50 meters. As a result, although watersheds are not directly factored into the formula, since a majority of watershed limits are within 50 meters of their receiving wetlands and since disturbances are only negligibly decayed within 50 meters, the formula indirectly weights disturbances to watersheds similarly to disturbances within the wetlands. Figure 4 illustrates the decay curves for three levels of disturbance.

Weighting. The formula has been designed to weight the CFCI toward the most severe impact occurring either inside or outside the wetland. Rather than averaging the disturbance rating inside and outside the wetland, the CFCI is calculated as the square root of the product of the average rating within the wetland and the average decayed rating outside the wetland. This weights the CFCI toward the greater disturbance. Where the disturbance index ratings within and outside a wetland are identical, the CFCI will be the same. Where there is a difference between the two disturbance index ratings, calculating the CFCI based on the square root of the product yields a lower CFCI. For instance, if a wetland has an averaged disturbance index rating of 0.10 and outside the wetland has an averaged decayed disturbance index rating of 0.90, the CFCI will be 0.30. The result would be the same where the disturbance index ratings are reversed.

If the CFCI were to be calculated based on the average of the two, the CFCI would be 0.50 under either scenario instead of 0.30. Thus, although the disturbance index ratings within and outside the wetland are given equal weight, the CFCI is weighted toward greater disturbance. While disturbances within and outside the wetland are equally weighted, they are also equally important to the functional capacity of the wetland. So, if either is substantially more disturbed than the other, the CFCI should be reduced more than just the average of the two. Calculating the CFCI as the square root of the product of the two accomplishes that.

Figure 5 illustrates the reduction in CFCI for a portion of the project area as the distance from various degrees of disturbance is increased. In this figure, the ranges of disturbance are shown in gray scale ranging from dark gray (most severe) to white (least severe). The ranges of CFCI are shown in color. The spectrum ranges from dark blue representing the highest CFCIs to red representing the lowest CFCIs. Representative CFCIs are labeled.

Calculating CFCUs. Once the CFCI is calculated for each wetland, combined functional capacity units (CFCUs) are calculated by multiplying the CFCI of each wetland times its area (in acres). The formula for calculation of CFCUs is as follows:

$$CFCU = [(CFCI)(A)]$$

where:

$CFCU$	=	Combined functional capacity units of wetland
$CFCI$	=	Combined functional capacity index of wetland
A	=	Area of the wetland (acres)

The sum of the CFCUs for all wetlands then represents the wetland functional capacity under assessment conditions.

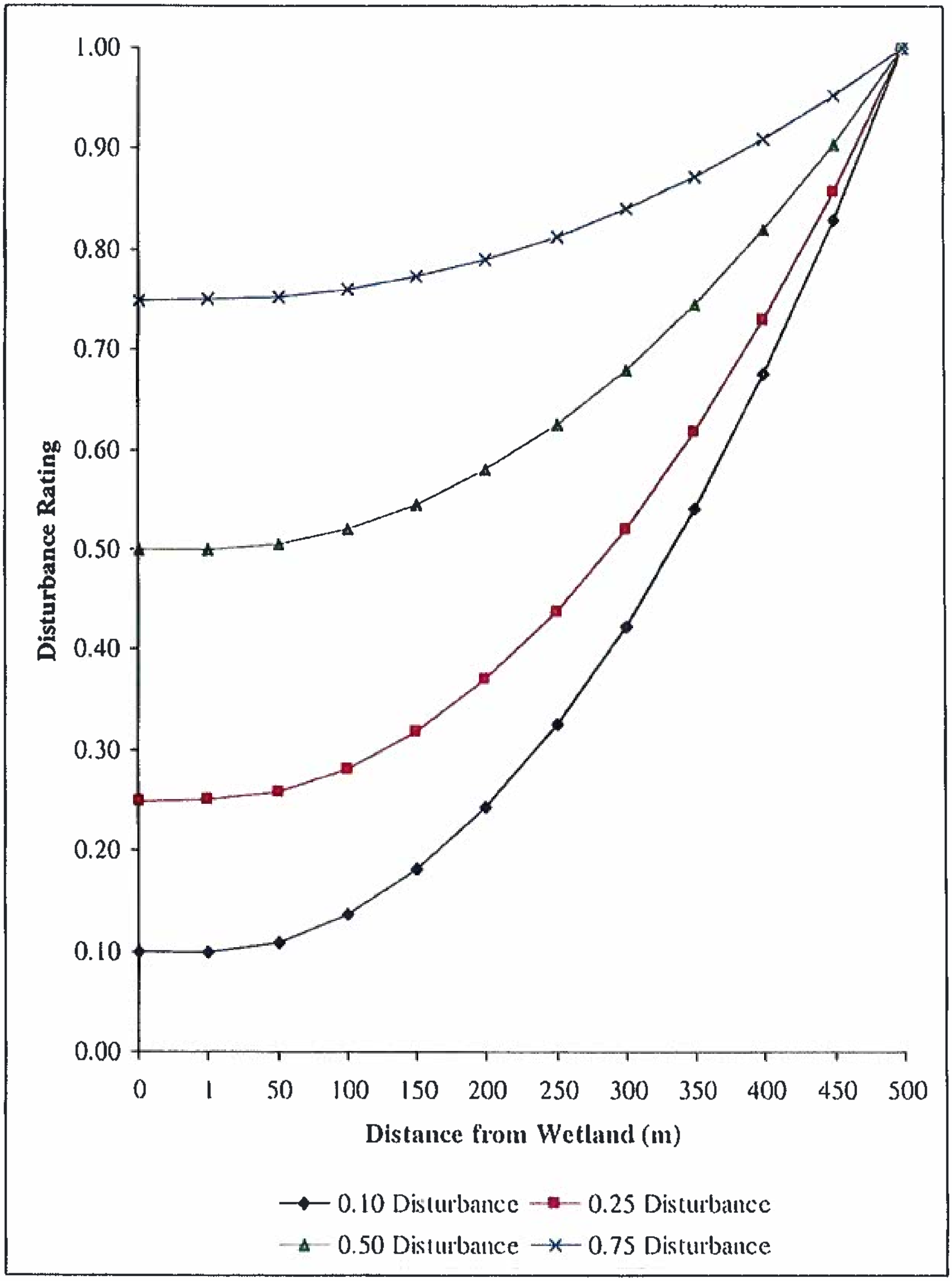

Figure 4
Disturbance Decay Curves

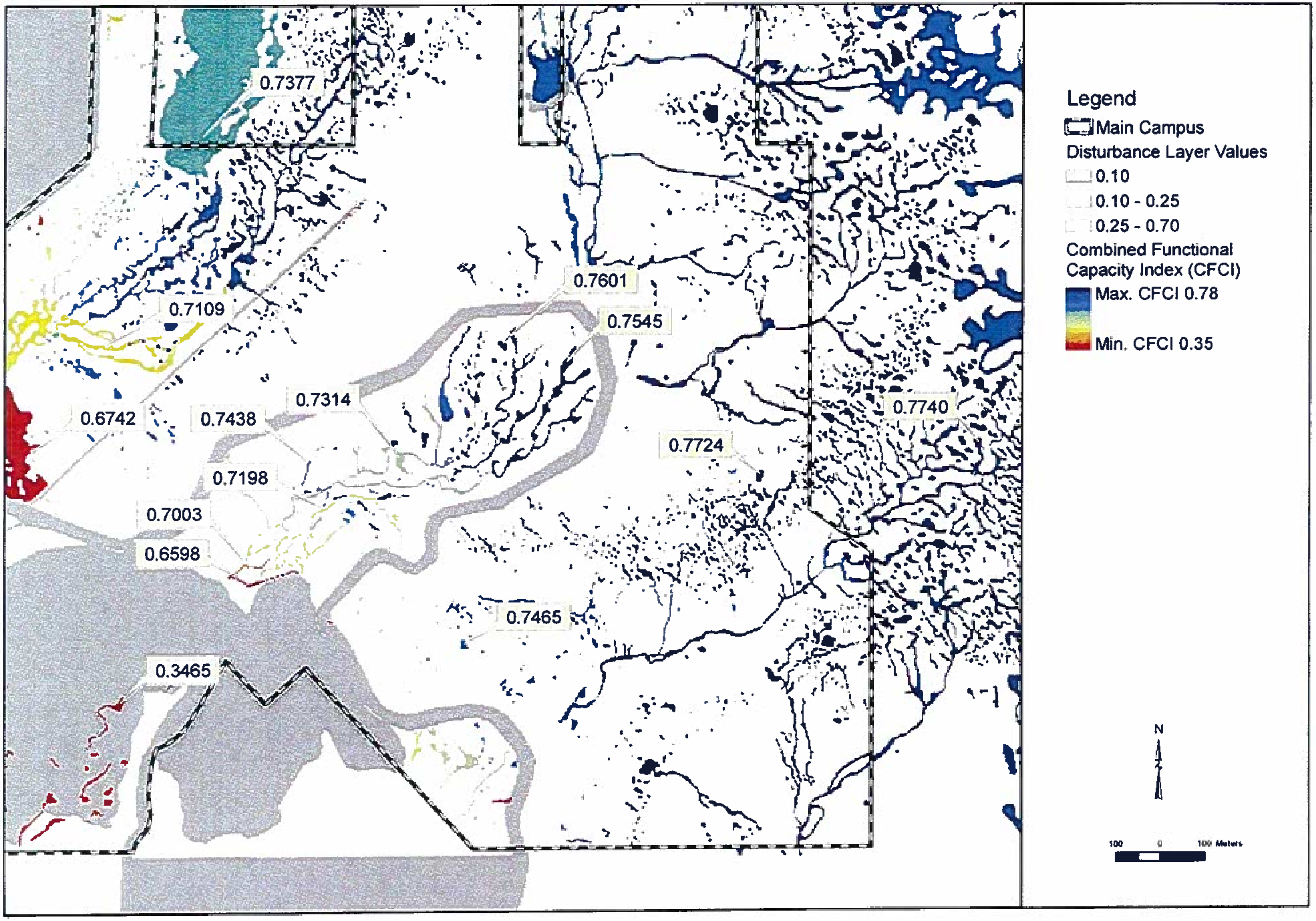

Figure 5
Reduction in CFCI

CHAPTER 6 – APPLICATIONS AND LIMITATIONS

Applications

The primary goal is to present a proposed functional assessment methodology. The goal of the functional assessment methodology is to provide a function-based method comparing the direct and indirect project impacts to vernal pools, swale wetlands and clay slope wetlands. This methodology is intended to provide the basis for assessing functional attainment of wetlands occurring in the UC Merced project area, reductions of function that would result from the proposed project and its on-site alternatives, and assessment of the efficacy of proposed compensatory mitigation measures.

Comparing Impacts. To calculate the impact of the proposed project, the CFCUs with the proposed project are subtracted from the CFCUs without the proposed project. The CFCUs with the proposed project would be calculated in three steps. First, all wetlands within the foot print of the proposed project are assigned a CFCU rating of 0.00. Second, the CFCUs of all wetlands lying within 500 meters of the footprint of the proposed project would then be calculated using revised disturbance ratings. Thirdly, the total of these revised CFCUs is then added to the total CFCUs of all wetlands occurring greater than 500 meters from the edge of the proposed project. This sum would then yield the total number of CFCUs with the proposed project. Comparison of different on-site alternatives can be conducted in a similar manner.

Assessing Adequacy of Mitigation. The compensatory mitigation that has been proposed for the UC Merced project incorporates both preservation/enhancement of existing wetlands and restoration/creation of wetlands. The preservation/enhancement component of the UC Merced compensatory mitigation plan has been proposed primarily to ensure that there will be no net loss of wetland functions for naturally occurring wetlands. The restoration and creation component is primarily intended to ensure that there will be no net loss in the overall areal extent of wetlands. From a functional standpoint, the restored/created wetlands are also intended to compensate for the impacts to non-naturally occurring wetlands.

This functional assessment methodology can be used to assess the adequacy of the proposed preservation/enhancement measures in two different ways. The first and probably most accurate and labor intensive way would be to calculate the baseline CFCUs for each preservation site and then calculate the CFCUs that would result from the preservation and/or enhancement measures. The difference between the two totals for all of the preservation properties would then be the total amount of compensatory mitigation. This total would then be compared to the loss of CFCUs resulting from the proposed project.

The second and somewhat less accurate but more cost-efficient method of calculating the replacement CFCUs resulting from the preservation/enhancement measures would be to estimate the incremental CFCI improvement that would result from these measures and then multiply that by the total area of vernal pools, swale wetlands and clay flats for each of the preservation properties.

Limitations

This functional assessment methodology was designed to rate wetland functions of naturally occurring wetlands within the UC Merced project area and bordering lands. Those naturally occurring wetlands include vernal pools, swale wetlands and clay slope wetlands. It does not provide a basis for rating other types of wetlands occurring within the project area that were created as a result of the activities of man. Such wetlands include irrigation induced seasonal wetlands and emergent marshes, seasonal wetlands and emergent marshes created by damming seasonal drainage courses, seasonal wetlands or marshes created by leakage from irrigation canals or ponds created by damming drainage courses. Likewise, this functional assessment methodology would not be appropriate for use with other types of wetlands not occurring within the UC Merced project area.

This functional assessment methodology was developed based on reference data collected within the UC Merced project area. Because of this, the disturbance index ratings and the CFCI formula are not directly applicable at regional scales or areas external the reference domain. This functional assessment methodology may be adaptable for use with the same regional subclasses elsewhere in the region but only after modifying the disturbance index ratings and CFCI formula to reflect the specific conditions present within the area being assessed. Such modifications would need to take into account the type and proximity of disturbances present within the assessment area and the projected severity of their effect on wetland function. For instance, plowing and disking disturbance was not evident within the UC Merced project area. In areas where wetlands have been plowed and/or disked at varying frequencies (e.g. only once, every year, intermittently over many years) it would be appropriate to assign different disturbance ratings to reflect their relative impact on wetland function.

Lastly, this functional assessment methodology is a relative assessment tool. It is not intended for use in absolute assessment of wetland impacts. It is also not intended for use in designing specific mitigation measures although it may be a valid tool for assessing the relative efficacy of mitigation measures.

CHAPTER 7 - REFERENCES

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APPENDIX A

GLOSSARY

Glossary

Aquatard: An impervious or nearly impervious layer in the soil that restricts the downward movement of water through the soil profile.

Assessment model: A simple model that defines the relationship between ecosystem and landscape scale variables and functional capacity of a wetland. The model is developed and calibrated using reference wetlands from a reference domain.

Assessment team: An interdisciplinary group of regional and local scientists responsible for classification of wetlands within a region, identification of reference wetlands, construction of assessment models, definition of reference standards, and calibration of assessment models.

Biotic: Of or pertaining to life; biological.

Combined Functional Capacity Index (FCI): An index of the capacity of an aggregate of wetlands to perform a suite of functions relative to other wetlands in a regional wetland subclass. Combined functional capacity indices are by definition scaled from 0.0 to 1.0. An index of 1.0 indicates the wetland is performing a suite of functions at the highest sustainable functional capacity, the level equivalent to a wetland under reference standard conditions in a reference domain. An index of 0.0 indicates the wetland does not perform the functions at a measurable level, and will not recover the capacity to perform these functions through natural processes.

Direct impacts: Project impacts that result from direct physical alteration of a wetland, such as the placement of dredge or fill.

Direct measure: A quantitative measure of an assessment model variable.

Exotics: See **Invasive Species.**

Facultative (FAC): Equally likely to occur in wetlands or non-wetlands (estimated probability 34-66 percent).

Facultative wetland (FACW): Usually occurs in wetlands (estimated probability 67-99 percent), but occasionally found in non-wetlands.

Functional assessment: The process by which the capacity of a wetland to perform a function is measured. This approach measures capacity using an assessment model to determine a functional capacity index.

Functional capacity: The rate or magnitude at which a wetland ecosystem performs a function or suite of functions. Functional capacity is dictated by characteristics of the wetland ecosystem and the surrounding landscape, and interaction between the two.

Functional Capacity Index (FCI): An index of the capacity of a wetland to perform a function relative to other wetlands in a regional wetland subclass. Functional capacity indices are by definition scaled from 0.0 to 1.0. An index of 1.0 indicates the wetland is performing a function at the highest sustainable functional capacity, the level equivalent to a wetland under reference standard conditions in a reference domain. An index of 0.0 indicates the wetland does not perform the function at a measurable level, and will not recover the capacity to perform the function through natural processes.

Highest sustainable functional capacity: The level of functional capacity achieved across the suite of functions by a wetland under reference standard conditions in a reference domain. This approach assumes that the highest sustainable functional capacity is achieved when a wetland ecosystem and the surrounding area are undisturbed.

Hydrogeomorphic wetland class: The highest level in the hydrogeomorphic wetland classification. There are five basic hydrogeomorphic wetland classes: depression, riverine, slope, fringe, and flat.

Hydrogeomorphic unit: Hydrogeomorphic units are areas within a wetland assessment area that are relatively homogeneous with respect to ecosystem scale characteristics such as microtopography, soil type, vegetative communities, or other factors that influence function. Hydrogeomorphic units may be the result of natural or anthropogenic processes.

Hydroperiod: The annual duration of flooding (in days per year) at a specific point in a wetland.

Indicator: Indicators are observable characteristics that correspond to identifiable variable conditions in a wetland or the surrounding landscape.

Indirect measure: A qualitative measure of an assessment model variable that corresponds to an identifiable variable condition.

Indirect impacts: Impacts resulting from a project that occur concurrently or at some time in the future, away from the point of direct impact. For example, indirect impacts of a project on wildlife can result from an increase in the level of activity in adjacent, newly developed areas, even though the wetland is not physically altered by direct impacts.

Invasive species: Generally exotic species without natural controls that out-compete native species.

Jurisdictional wetland: Areas that meet the soil, vegetation, and hydrologic criteria described in the "Corps of Engineers Wetlands Delineation Manual" (Environmental Laboratory 1987),[1] or its successor.

Mitigation: Restoration or creation of a wetland to replace functional capacity that is lost as a result of project impacts.

Mitigation plan: A plan for replacing lost functional capacity resulting from project impacts.

Mitigation wetland: A restored or created wetland that serves to replace functional capacity lost as a result of project impacts.

Model variable: A characteristic of the wetland ecosystem or surrounding landscape that influences the capacity of a wetland ecosystem to perform a function.

Obligate wetland (OBL): Occurs almost always (estimated probability 99 percent) under natural conditions in wetlands.

Oligotrophic: Environments in which the concentration of nutrients available for growth is limited. Nutrient-poor habitats.

Oxidation: The loss of one or more electrons by an ion or molecule.

Project alternative(s): Different ways in which a given project can be done. Alternatives may vary in terms of project location, design, method of construction, amount of fill required, and other ways.

Project area: The area that encompasses all activities related to an ongoing or proposed project.

Red flag features: Features of a wetland or the surrounding landscape to which special recognition or protection is assigned on the basis of objective criteria. The recognition or protection may occur at a Federal, State, regional, or local level and may be official or unofficial.

Reference domain: All wetlands within a defined geographic area that belong to a single regional wetland subclass.

Reference standards: Conditions exhibited by a group of reference wetlands that correspond to the highest level of functioning (highest sustainable capacity) across the suite of functions of the regional wetland subclass. By definition, highest levels of functioning are assigned an index of 1.0.

Reference wetlands: Wetland sites that encompass the variability of a regional wetland subclass in a reference domain. Reference wetlands are used to establish the range of conditions for construction and calibration of functional indices and to establish reference standards.

Region: A geographic area that is relatively homogeneous with respect to largescale factors such as climate and geology that may influence how wetlands function.

Regional wetland subclass: Regional hydrogeomorphic wetland classes that can be identified based on landscape and ecosystem scale factors. There may be more than one regional wetland subclass for each of the hydrogeomorphic wetland classes that occur in a region, or there may be only one.

Soil surface: The soil surface is the top of the mineral soil; or, for soils with an O horizon, the soil surface is the top of the part of the O horizon that is at least slightly decomposed. Fresh leaf or needle fall that has not undergone observable decomposition is excluded from soil and may be described separately (Carlisle and Collins 1995).

Variable: An attribute or characteristic of a wetland ecosystem or the surrounding landscape that influences the capacity of the wetland to perform a function.

Variable condition: The condition of a variable as determined through quantitative or qualitative measure.

Variable index: A measure of how an assessment model variable in a wetland compares to the reference standards of a regional wetland subclass in a reference domain.

Wetlands: "...areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (Corps Regulation 33 CFR 328.3 and EPA Regulations 40 CFR 230.3). In a more general sense, wetland ecosystems are three-dimensional segments of the natural world where the presence of water at or near the surface creates conditions leading to the development of redoximorphic soil conditions, and the presence of a flora and fauna adapted to the permanently or periodically flooded or saturated conditions.

Wetland functions: The normal activities or actions that occur in wetland ecosystems, or simply, the things that wetlands do. Wetland functions result directly from the characteristics of a wetland ecosystem and the surrounding landscape, and their interaction.

Wetland restoration: The process of restoring wetland function in a degraded wetland. Restoration is typically done as mitigation.

APPENDIX B

FIELD DATA FORM

UC MERCED
HGM FUNCTIONAL ASSESSMENT
FIELD DATA FORM (Sheet 1)

Wetland No: BPJ Rating: Photo No: Date:
Investigators (s):

V_{IN} - Is a topographically distinct inlet present? (Yes or No)

V_{OUT} - Is a topographically distinct outlet present? (Yes or No)

V_{SED} - Estimated cover of recently deposited sediment in the wetland (%, in increments of 10):

$V_{\%OM}$ - Estimated cover by algal matting in the wetland (%, in increments of 10):

$V_{\%COV}$ - Estimated cover by vascular plants in the wetland (%, in increments of 10):

$V_{\%COB}$ - What is the estimated cover by cobbles in the wetland (%, in increments of 10):

V_{VWPI} & V_{NPI} - List all plants with an estimated cover of 10 % or more:

V_{DW}- Depth of Wetland (Depression subclass only, in tenths of a foot):

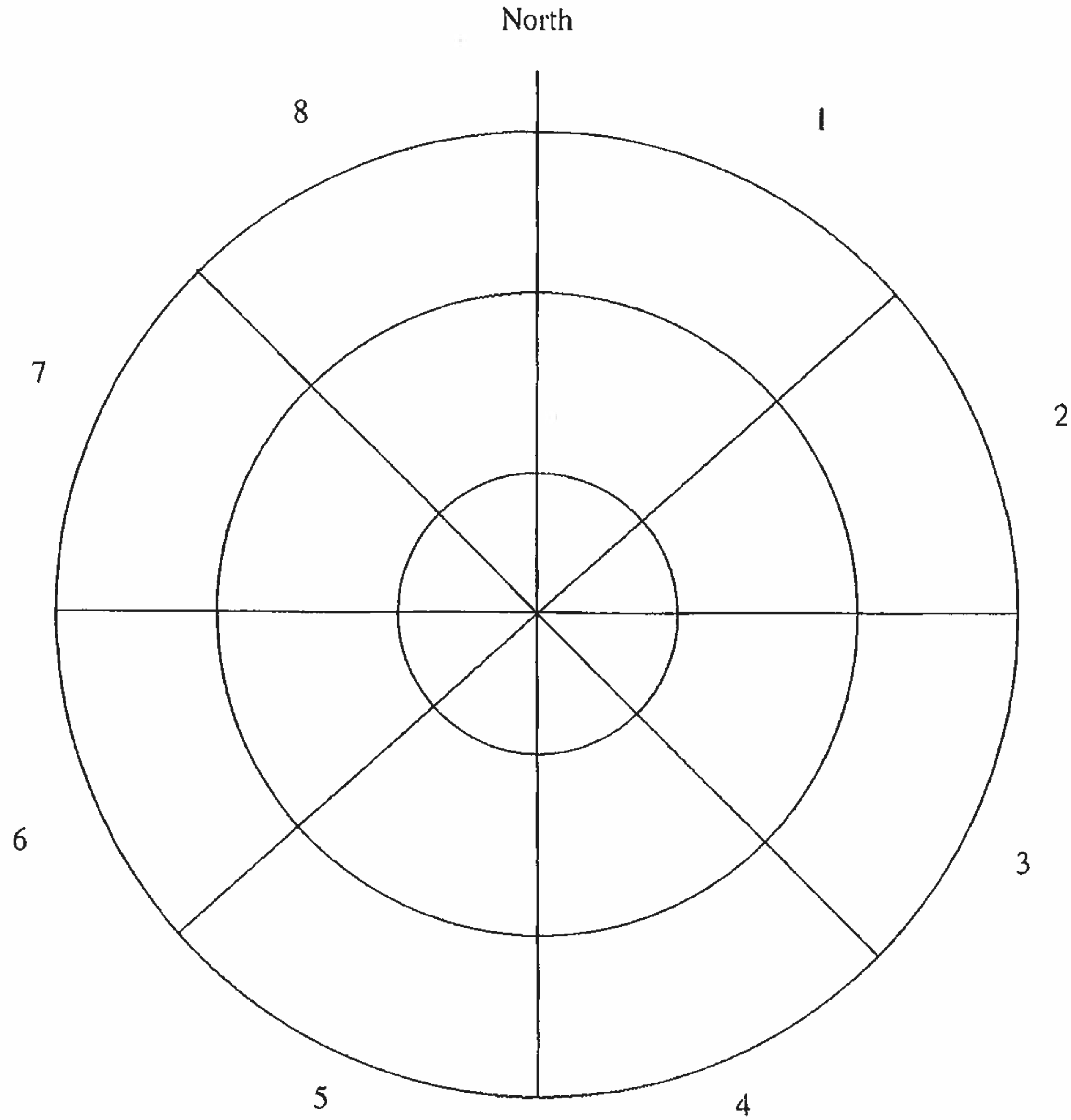
V_{SLOPE}- Slope (Slope subclass only, %):

V_{WDQ}-

- No. of sectors where some disturbance is observed (0 – 8):
- Disturbance index rating for the most severe type of disturbance within the wetland:
- Disturbance index rating for the most severe type of disturbance within the immediate basin of the wetland:
- Distance from the edge of the wetland to the nearest most severe disturbance:
- Disturbance index rating for the most severe type of disturbance within the contributing watershed within 100 meters of the edge of the wetland:

Comments:

DISTURBANCE GRID



Comments:

UC MERCED
HGM FUNCTIONAL ASSESSMENT
FIELD DATA FORM (Sheet 1)

Wetland No: BPJ Rating:*Avg of Investigators* Photo No:*Roll#-Exp#* Date:
Investigators (s):*Initials*

V_{IN} - Is a topographically distinct inlet present? (Yes or No): ***We are looking for a distinct topographic feature such as a swale that appears to transport surface flow (not sheet flow) during periods of precipitation.***

V_{OUT} - Is a topographically distinct outlet present? (Yes or No): ***We are looking for a distinct topographic feature such as a swale that appears to transport surface flow (not sheet flow) during periods of precipitation.***

V_{SED} - Estimated cover of recently deposited sediment in the wetland (%, in increments of 10): ***If it is not obvious, do not count it. Use the % cover template.***

$V_{\%OM}$ - Estimated cover by algal matting in the wetland (%, in increments of 10): ***We are looking for clear deposits of algae. If it is not obvious, do not count it. Use the % cover template.***

$V_{\%COV}$ - Estimated cover by vascular plants in the wetland (%, in increments of 10): ***Use the % cover template.***

$V_{\%COB}$ - What is the estimated cover by cobbles in the wetland (%, in increments of 10): ***Use the % cover template.***

V_{VWPI} & V_{NPI} - List all plants with an estimated cover of 10 % or more: ***Use the % cover template.***

V_{DW}- Depth of Wetland (Depression subclass only, in tenths of a foot): ***Stretch tape from edge to edge across the deepest point. Measure depth at deepest point and both midpoints and divide by three to obtain average.***

V_{SLOPE}- Slope (Slope subclass only, %): *Δ elev.(ft) /distance(ft.).*

V_{WDQ}-

- No. of sectors where some disturbance is observed (0 – 8): ***Only contributing watershed.***
- Disturbance index rating for the most severe type of disturbance within the wetland: ***From table.***
- Disturbance index rating for the most severe type of disturbance within the immediate basin of the wetland: ***From table.***
- Distance from the edge of the wetland to the nearest most severe disturbance: ***Meters.***

- Disturbance index rating for the most severe type of disturbance within the contributing watershed within 100 meters of the edge of the wetland: *Meters*

<u>Comments</u>:

Any observations/clarifications that appear pertinent. These will not be electronically entered in the field.

APPENDIX C

MASTER PLANT LIST

MASTER PLANT LIST FOR UC MERCED FUNCTIONAL ASSESSMENT

Scientific Name	Abbreviation	Native?	VP Endemic?	Indicator Status
Achyrachaena mollis	Ach mol	Y	N	FAC
Agrostis hendersonii	Agr hen	Y	Y	FACW
Alopecurus howellii	Alo how	Y	Y	FACW+
Avena fatua	Ave fat	N	N	UPL
Bergia texana	Ber tex	Y	Y	OBL
Blennosperma nanum var. nanum	Ble nan nan	Y	Y	OBL
Boisduvalia cleistogamum	Boi cle	Y	Y	OBL
Briza minor	Bri min	N	N	FACW
Brodiaea minor	Bro min	Y	N	UPL
Bromus mollis	Bro mol	N	N	FACU-
Callitriche heterophylla	Cal het	Y	Y	OBL
Callitriche marginata	Cal mar	Y	Y	OBL
Castilleja campestris ssp. campestris	Cas cam cam	Y	Y	OBL
Castilleja campestris ssp. succulenta	Cas cam suc	Y	Y	OBL
Centunculus minimus	Cen min	Y	Y	FACW
Cerastium viscosum	Cer vis	N	N	UPL
Chamaesyce hooveri	Cha hoo	Y	Y	NI
Cicendia quadrangularis	Cic qua	Y	N	UPL
Convolvulus arvensis	Con arv	N	N	UPL
Cotula coronopifolia	Cot con	N	N	OBL
Crassula aquatica	Cra aqu	Y	Y	OBL
Cuscuta howelliana	Cus how	Y	Y	NI
Cynodon dactylon	Cyn dac	N	N	FAC
Cyperus eragrostis	Cyp era	Y	N	FACW
Damasonium californicum	Dam cal	Y	Y	OBL
Deschampsia danthonioides	Des dan	Y	Y	FACW
Downingia bella	Dow bel	Y	Y	OBL
Downingia bicornuta	Dow bic	Y	Y	OBL
Downingia concolor var. concolor	Dow con con	Y	Y	OBL
Downingia cuspidata	Dow cus	Y	Y	OBL
Downingia insignis	Dow ins	Y	Y	OBL
Downingia ornatissima	Dow orn	Y	Y	OBL
Downingia pulchella	Dow pul	Y	Y	OBL
Downingia pusilla	Dow pus	Y	Y	OBL
Eleocharis acicularis	Ele aci	Y	Y	OBL
Eleocharis macrostachya	Ele mac	Y	Y	OBL
Eleocharis montevidensis	Ele mon	Y	N	OBL
Epilobium ciliatum	Epi cil	Y	N	FACW
Eremocarpus setigerus	Ere set	Y	N	UPL
Erodium botrys	Ero bot	N	N	UPL
Erodium cicutarium	Ero cic	N	N	UPL
Eryngium castrense	Ery cas	Y	Y	FACW
Eryngium spinosepalum	Ery spi	Y	Y	NI
Eryngium vaseyi	Ery vas	Y	Y	FACW
Festuca arundinacea	Fes aru	N	N	FAC
Geranium dissectum	Ger dis	N	N	UPL

Scientific Name	Abbreviation	Native?	VP Endemic?	Indicator Status
Glyceria sp.	Gly sp	N	N	OBL
Gratiola ebracteata	Gra ebr	Y	Y	OBL
Hedypnois cretica	Hed cre	N	N	NI
Hemizonia pungens	Hem pun	Y	N	FAC
Hesperevax caulescens	Hes cau	Y	Y	NI
Holocarpha virgata	Hol vir	N	N	NI
Hordeum hystrix	Hor hys	N	N	FAC
Hypochaeris glabra	Hyp gla	N	N	NI
Isoetes howellii	Iso how	Y	Y	OBL
Isoetes nuttallii	Iso nut	Y	N	NI
Isoetes orcuttii	Iso orc	Y	Y	OBL
Juncus balticus	Jun bal	Y	N	OBL
Juncus bufonius	Jun buf	Y	N	FACW+
Juncus capitatus	Jun cap	N	N	FACU
Juncus effusus	Jun eff	Y	N	OBL
Juncus leiospermus var leiospermus	Jun lei lei	Y	Y	NI
Juncus leiospermus var. ahartii	Jun lei aha	Y	Y	NI
Juncus uncialis	Jun unc	Y	Y	OBL
Lactuca serriola	Lac ser	N	N	FAC
Lasthenia californica	Las cal	Y	N	UPL
Lasthenia chrysantha	Las chr	Y	Y	FACU
Lasthenia ferisiae	Las fer	Y	Y	NI
Lasthenia fremontii	Las fre	Y	Y	OBL
Lasthenia glaberrima	Las gla	Y	Y	OBL
Lasthenia glabrata	Las gla	Y	Y	FACW
Layia fremontii	Lay fre	Y	Y	NI
Leersia oryzoides	Lee ory	Y	N	OBL
Legenere limosa	Leg lim	Y	Y	OBL
Leontodon leysseri	Leo ley	N	N	FACU
Lepidium dictyotum	Lep dic	Y	N	UPL
Lepidium latipes var. latipes	Lep lat lat	Y	Y	OBL
Lepidium nitidum	Lep nit	Y	N	UPL
Lilaea scilloides	Lil sci	Y	Y	OBL
Limnanthes alba	Lim alb	Y	Y	OBL
Limnanthes douglasii var nivea	Lim dou niv	Y	Y	OBL
Limnanthes douglasii var. rosea	Lim dou ros	Y	Y	OBL
Limnanthes floccosa	Lim flo	Y	Y	OBL
Limnanthes floccosa ssp. floccosa	Lim flo flo	Y	Y	OBL
Lolium perenne	Lol per	N	N	FAC
Ludwigia peploides	Lud pep	Y	N	OBL
Lupinus bicolor	Lup bic	Y	N	UPL
Lythrum hyssopifolia	Lyt hys	N	N	FACW
Marsellia oligospora	Mar oli	Y	Y	FAC
Marsellia vestita	Mar ves	Y	Y	OBL
Medicago polymorpha	Med pol	N	N	UPL
Mimulus guttatus	Mim gut	Y	N	OBL
Mimulus tricolor	Mim tri	Y	Y	OBL
Montia fontana	Mon fon	Y	Y	OBL
Muilla maritima	Mui mar	Y	N	UPL
Myosurus minimus	Myo min	Y	Y	OBL

Scientific Name	Abbreviation	Native?	VP Endemic?	Indicator Status
Myosurus sessilis	Myo ses	Y	Y	NI
Navarretia intertexta ssp. intertexta	Nav int int	Y	Y	OBL
Navarretia leucocephala	Nav leu	Y	Y	OBL
Navarretia myersii	Nav mye	Y	Y	NI
Navarretia prostrata	Nav pro	Y	Y	OBL
Navarretia tagetina	Nav tag	Y	Y	NI
Neostapfia colusana	Neo col	Y	Y	OBL
Orcuttia inaequalis	Orc ina	Y	Y	NI
Orcuttia pilosa	Orc pil	Y	Y	NI
Orthocarpus erianthus	Ort eri	Y	N	UPL
Paspalum dilatatum	Pas dil	N	N	FAC
Phalaris lemmonii	Pha lem	Y	N	FACW-
Pilularia americana	Pil ame	Y	Y	OBL
Plagiobothrys acanthocarpus	Pla aca	Y	Y	OBL
Plagiobothrys austinae	Pla aus	Y	Y	NI
Plagiobothrys bracteatus	Pla bra	Y	Y	OBL
Plagiobothrys greenei	Pla gre	Y	N	FACW
Plagiobothrys humistratus	Pla hum	Y	Y	OBL
Plagiobothrys leptocladus	Pla lep	Y	Y	OBL
Plagiobothrys stipitatus var. micranthus	Pla sti mic	Y	Y	OBL
Plagiobothrys stipitatus var. stipatatus	Pla sti sti	Y	Y	OBL
Plagiobothrys trachycarpus	Pla tra	Y	Y	FACW
Plantago bigelovii	Pla big	Y	N	OBL
Plantago elongata	Pla elo	Y	Y	FACW
Poa annua	Poa ann	N	N	FACW-
Pogogyne zizyphoroides	Pog ziz	Y	Y	OBL
Polygonum aviculare	Pol avi	N	N	FAC
Polygonum sp.	Pol sp		N	NI
Polypogon monspeliensis	Pol mon	N	N	FACW+
Psilocarphus brevissimus	Psi bre	Y	Y	OBL
Psilocarphus oregonus	Psi ore	Y	Y	OBL
Psilocarphus tenellus var. tenuis	Psi ten ten	Y	Y	FAC
Ranunculus alveolatus	Ran alv	Y	Y	OBL
Ranunculus aquatilis	Ran aqu	Y	N	OBL
Ranunculus muricatus	Ran mur	N	N	FACW+
Rumex crispus	Rum cri	N	N	FACW
Sagina decumbens ssp. occidentalis	Sag dec occ	Y	Y	FAC
Scirpus acutus	Sci acu	Y	N	OBL
Sibara virginica	Sib vir	Y	Y	NI
Sidalcea calycosa	Sid cal	Y	Y	OBL
Sidalcea hirsuta	Sid hir	Y	Y	OBL
Soliva sessilis	Sol ses	N	N	UPL
Sonchus oleraceus	Son ole	N	N	NI
Trichostema lanceolatum	Tri lan	Y	N	UPL
Trifolium depauperatum	Tri dep	Y	N	FAC-
Trifolium sp.	Tri sp	N	N	UPL
Trifolium variegatum	Tri var	Y	N	FACW-
Triteleia hyacinthina	Tri hya	Y	Y	FACW
Tuctoria greenei	Tuc gre	Y	Y	OBL
Tuctoria mucronata	Tuc muc	Y	Y	NI

Scientific Name	Abbreviation	Native?	VP Endemic?	Indicator Status
Typha angustifolia	Typ ang	Y	N	OBL
Typha latifolia	Typ lat	Y	N	OBL
Veronica peregrina	Ver per	Y	N	OBL
Vulpia bromoides	Vul bro	N	N	FACW
Vulpia bromoides	Vul bro	N	N	FACW
Vulpia myouros	Vul myo	N	N	FACU

APPENDIX D

FIELD DATA SPREADSHEETS

UC MERCED
COMPILED VERNAL POOL FIELD DATA

SITE	BPJ	Vin	Vout	Vsed	V%om	V%cov	V%cob	Vvwpi	Vdw	#Vpe	#NonVpe	Total Dom
3VPRbA13	0.65	Y	Y	0	0	70	20	0.75	0.2	4	2	6
3VPRbA10	0.75	Y	Y	0	0	80	10	0.75	0.3	4	2	6
3VPRbA12	0.8	Y	Y	0	0	80	20	0.63	0.2	2	2	4
3VPReB2	0.7	Y	Y	0	0	70	20	0.75	0.3	4	2	6
3VPReB13	0.8	Y	N	0	0	70	20	0.85	0.3	4	1	5
3VPCgB5	0.5	N	Y	0	50	80	20	0.50	0.3	1	2	3
3VPCkB5	0.8	Y	N	0	0	60	40	0.81	0.5	3	1	4
3VPReB3	0.7	N	N	0	0	70	20	0.79	0.3	5	2	7
3VPCkB8	0.7	N	N	0	0	90	10	0.55	0.2	2	3	5
3VPBcA7	0.8	Y	Y	0	0	90	0	0.72	0.3	5	3	8
3VPBcA4	0.8	Y	Y	0	0	90	0	0.68	0.2	4	3	7
3VPBcA5	0.8	Y	Y	0	0	90	0	0.50	0.2	2	4	6
3VPReB6	0.5	Y	Y	0	0	90	10	0.50	0.4	1	2	3
3VPReB12	0.4	N	N	0	0	70	20	0.44	0.3	1	3	4
3VPReB14	0.5	Y	Y	0	0	100	0	0.63	0.3	3	3	6
3VPReB15	0.4	N	N	0	0	100	0	0.75	0.5	2	1	3
3VP2HB10	0.4	N	N	0	0	90	10	0.25	0.2	0	3	3
3VPReB10	0.8	N	Y	0	30	20	80	1.00	0.4	2	0	2
3VP2HB18	0.6	N	N	0	0	80	10	0.63	0.2	2	2	4
3VP2HB4	0.8	Y	N	0	0	50	30	1.00	0.3	4	0	4
3VPCkB4	0.7	Y	N	0	0	40	60	0.63	0.3	2	2	4
3VPCkB7	0.3	N	N	0	20	70	30	0.50	0.2	1	2	3
3VP2HB17	1	N	N	0	0	70	20	1.00	0.4	5	0	5
3VP2HB16	0.9	N	N	0	0	70	20	0.63	0.2	3	3	6
3VP2HB3	0.8	N	N	0	0	60	30	0.79	0.3	5	2	7
3VP2HB8	0.7	N	N	0	0	60	30	0.75	0.2	4	2	6
3VP2HB2	0.6	N	N	0	0	90	10	0.55	0.2	2	3	5
3VPRbA15	0.5	N	N	0	0	60	40	0.63	0.1	2	2	4
3VPCgD2	0.7	N	N	0	0	90	10	0.85	0.4	4	1	5
3VPCgD1	0.6	N	N	0	0	80	20	0.63	0.3	3	3	6
3VP2HB11	0.8	Y	Y	0	0	90	10	0.67	0.3	5	4	9
3VP2HB7	0.9	Y	Y	0	0	80	20	0.72	0.5	5	3	8
3VP2HB12	0.8	Y	Y	0	0	60	30	0.72	0.4	5	3	8

SITE	BPJ	Vin	Vout	Vsed	V%om	V%cov	V%cob	Vvwpi	Vdw	#Vpe	#NonVpe	Total Dom
3VPCgD4	0.7	Y	N	0	30	80	10	0.75	0.4	4	2	6
3VPReB11	0.6	N	Y	0	0	90	0	0.40	0.2	1	4	5
3VPCgB11	0.7	N	Y	0	10	90	0	0.63	0.3	3	3	6
3VPBcA1	0.8	Y	N	0	0	90	0	0.88	0.3	5	1	6
1VPRbA1	0.6	N	N	0	0	90	10	0.50	0.1	1	2	3
1VPRbA2	0.6	N	N	0	0	70	10	0.50	0.2	1	2	3
3VPRbA9	0.4	N	N	0	0	50	10	0.50	0.1	1	2	3
1VPCgB4	0.8	N	N	0	100	70	0	1.00	0.4	4	0	4
1VPRbA3	0.8	N	N	0	0	60	30	0.81	0.2	3	1	4
1VPCgB10	0.5	N	N	0	60	90	0	0.50	0.3	1	2	3
1VPCgB12	1	N	N	0	100	100	0	0.75	0.4	4	2	6
1VPCgB3	0.4	N	N	0	0	100	0	0.40	1.2	1	4	5
1VPCgB8	0.3	N	N	0	0	100	0	0.44	0.4	1	3	4
2VPMRa1	0.1	N	N	0	0	100	0	0.25	0.2	0	3	3
2VPMRa2	0.1	N	N	0	0	100	0	0.25	0.2	0	3	3
1VPCgB1	0.1	N	N	0	0	100	0	0.25	0.2	0	2	2
1VPCgB7	0.2	N	N	0	70	100	0	0.63	0.2	1	1	2
1VPCgB9	0.3	N	N	0	100	90	0	0.50	0.5	1	2	3
3VPRbA7	0.2	N	N	0	0	40	20	0.50	0.1	1	2	3
3VPReB1	0.8	N	N	0	0	100	0	0.81	0.2	3	1	4
1VPCkB1	0.5	N	N	0	0	90	10	0.63	0.3	2	2	4
3VPCkB10	0.8	Y	Y	0	0	50	50	0.85	0.4	4	1	5
3VPCkB14	0.6	Y	Y	0	0	20	30	1.00	0.7	4	0	4
3VPCkB11	0.5	N	N	0	0	80	10	0.63	0.3	2	2	4
3VPCkB12	0.7	Y	Y	0	0	50	40	0.85	0.4	4	1	5
3VPMRc1	0.6	N	N	0	0	90	0	0.55	0.3	2	3	5
3VPPoB5	0.5	N	N	0	0	90	0	0.50	0.3	1	2	3
1VP3HA1	0.3	N	N	0	0	100	0	0.25	0.2	0	3	3
1VPCgB13	0.7	Y	Y	0	80	90	10	0.63	0.3	1	1	2
1VPCgB6	0.3	N	N	0	0	100	0	0.25	0.1	0	3	3
2VPRgB1	0.5	N	N	0	0	90	0	0.25	0.3	0	1	1
2VPCgB4	0.4	N	N	0	30	90	0	0.44	0.7	1	3	4
1VPCgB5	0.4	N	N	0	0	100	0	0.25	0.2	0	2	2
2VPAcA3	0.7	N	N	0	0	100	0	0.63	0.2	2	2	4
2VPAcA4	0.6	N	N	0	50	90	0	0.70	0.2	3	2	5
2VPAcA11	0.7	N	Y	0	60	90	0	0.70	0.3	3	2	5

SITE	BPJ	Vin	Vout	Vsed	V%om	V%cov	V%cob	Vvwpi	Vdw	#Vpe	#NonVpe	Total Dom
2VPSbA10	0.6	N	N	0	0	100	0	0.81	0.3	3	1	4
2VPSbA8	0.5	N	N	0	0	90	0	0.63	0.2	2	2	4
2VPAcA12	0.4	N	N	0	0	100	0	0.25	0.3	0	2	2
2VPAcA14	0.2	N	N	0	10	100	0	0.63	0.1	3	3	6
2VPSbA11	0.5	N	N	0	0	90	0	0.44	0.1	1	3	4
2VPSbA5	0.4	N	N	0	20	100	0	0.50	0.2	1	2	3
2VPRgB4	0.8	N	N	0	0	80	0	0.63	0.7	3	3	6
2VPRgB5	0.7	N	N	0	0	90	0	0.63	0.2	2	2	4
2VPRgB2	0.6	N	N	0	0	90	0	0.63	0.4	2	2	4
2VPAcA8	0.6	N	N	0	0	90	0	0.50	0.3	1	2	3
1VPCgB11	0.3	N	N	0	0	100	0	0.50	0.5	1	2	3
1VPAcA6	0.6	N	N	0	0	100	0	0.63	0.2	2	2	4
2VPAcA5	0.1	N	N	0	0	100	0	0.25	0.2	0	3	3
2VPAcA1	0.3	N	N	0	0	90	0	0.63	0.4	2	2	4
2VPRgB3	0.7	N	N	0	10	90	0	0.70	0.5	3	2	5
2VPCgB12	0.6	N	N	0	0	100	0	0.25	0.4	0	3	3
2VPCgB16	0.7	Y	Y	0	0	100	0	0.70	0.4	3	2	5
2VPHtA2	0.3	N	N	0	0	100	0	0.50	0.2	1	2	3
2VPSbA13	0.3	N	N	0	0	100	0	0.50	0.2	1	2	3
2VPSbA14	0.3	Y	Y	0	0	100	0	0.44	0.7	1	3	4
2VPSbA2	0.2	N	N	0	0	90	0	0.25	0.2	0	2	2
2VPSbA4	0.3	N	N	0	0	100	0	0.50	0.2	1	2	3
3VPCgB6	0.6	Y	Y	0	10	70	0	0.81	0.3	3	1	4
3VPCgB1	0.7	N	N	0	0	90	0	0.68	0.3	4	3	7
3VPCgB14	0.9	Y	N	0	0	80	10	0.88	0.3	5	1	6
3VPBcA2	0.5	N	N	0	0	100	0	0.44	0.5	1	3	4
3VPBcA3	0.5	N	N	0	0	100	0	0.44	0.4	1	3	4
3VPCgB3	0.7	Y	Y	0	0	90	0	0.70	0.4	3	2	5
3VPRbA1	0.9	N	N	0	0	90	0	0.63	0.3	3	3	6
3VPRbA180	0.9	Y	Y	0	0	70	10	0.89	0.5	6	1	7
3VPRbA2	0.5	N	N	0	0	80	0	0.70	0.2	3	2	5
3VPRbA5	0.7	N	Y	0	10	60	30	0.79	0.5	5	2	7
3VPRbA4	0.8	N	N	0	0	90	0	0.79	0.3	5	2	7
3VPRbA11	0.9	N	N	0	0	80	0	0.88	0.4	5	1	6
3VPRbA14	0.9	N	Y	0	0	70	20	0.85	0.4	4	1	5
2VPRgA5	0.7	N	N	0	0	80	10	0.88	0.4	5	1	6

SITE	BPJ	Vin	Vout	Vsed	V%om	V%cov	V%cob	Vvwpi	Vdw	#Vpe	#NonVpe	Total Dom
2VPRgA2	0.4	N	N	0	0	100	0	0.75	0.3	2	1	3
2VPReB1	0.8	N	N	0	40	90	0	0.81	0.3	3	1	4
2VPReB6	0.8	N	N	0	20	70	0	0.81	0.4	3	1	4
2VPReB10	0.7	N	N	0	50	90	0	0.81	0.3	3	1	4
2VPReB7	0.5	N	N	0	0	100	0	0.63	0.2	2	2	4
2VPCkB4	0.4	N	N	0	0	100	0	0.50	0.4	1	2	3
2VPReB5	0.5	N	N	0	50	90	0	0.75	0.4	2	1	3
2VPReB4	0.4	N	N	0	0	100	0	0.50	0.2	1	2	3
2VPCgB1	0.5	N	N	0	0	100	0	0.63	0.4	2	2	4
2VPCgB9	0.3	N	N	0	40	100	0	0.25	0.1	0	2	2
2VPCgB11	0.9	N	N	0	0	100	0	0.79	0.8	5	2	7
2VPCgB3	0.3	N	N	0	0	100	0	0.25	0.2	0	2	2
2VPCgB2	0.5	N	N	0	0	90	0	0.81	0.4	3	1	4
2VPCgB10	0.3	N	N	0	0	100	0	0.50	0.4	1	2	3
2VPReB9	0.8	N	N	0	0	90	10	0.75	0.3	4	2	6
2VPReB12	0.5	N	N	0	0	100	0	0.63	0.3	2	2	4
2VPReB13	0.6	N	N	0	0	90	0	0.81	0.5	3	1	4
2VPCkB1	0.4	Y	Y	0	0	100	0	0.25	0.1	0	3	3
2VPReB8	0.6	N	N	0	0	90	0	0.70	0.3	3	2	5
2VPWhB2	0.6	N	N	0	10	90	0	0.50	0.3	1	2	3
2VPWhB1	0.3	N	N	0	0	100	0	0.25	0.4	0	5	5
2VPReB11	0.8	N	N	0	0	80	10	0.75	0.7	4	2	6
2VPCgB8	0.6	Y	Y	0	0	90	0	0.63	0.5	3	3	6
2VPCgB13	0.1	Y	Y	0	0	90	0	0.25	0.2	0	2	2
2VPCgB6	0.6	N	N	0	0	90	0	0.55	0.4	2	3	5
2VPAcA13	0.2	N	N	0	0	100	0	0.40	0.1	1	4	5
2VPAcA9	0.1	N	N	0	0	100	0	0.25	0.4	0	2	2
2VPAcA7	0.6	N	N	0	0	100	0	0.63	0.4	2	2	4
2VPCkB2	0.1	N	N	0	0	100	0	0.25	0.6	0	5	5
3VPRbA8	0.3	N	N	0	0	90	0	0.63	0.2	2	2	4
3VPRgA11	0.2	N	N	0	0	90	10	0.50	0.1	1	2	3
3VPCgB7	0.6	N	N	0	10	70	30	0.63	0.3	3	3	6
3VPCgB2	0.2	N	N	0	0	80	20	0.38	0.2	1	5	6
3VPCgB8	0.8	Y	Y	0	0	90	0	0.85	0.6	4	1	5
3VPReB60	0.9	N	N	0	0	70	10	0.70	1.3	3	2	5
3VPPoB6	0.2	N	Y	0	0	100	0	0.25	0.2	0	5	5

SITE	BPJ	Vin	Vout	Vsed	V%om	V%cov	V%cob	Vvwpi	Vdw	#Vpe	#NonVpe	Total Dom
3VPPoB3	0.3	N	N	0	0	100	0	0.81	0.2	3	1	4
3VPPoB2	0.8	N	N	0	60	80	10	0.88	0.3	5	1	6
3VPPoB1	0.7	N	N	0	60	100	0	0.79	0.3	5	2	7
3VPRbA16	0.9	N	N	0	0	90	0	0.81	0.3	3	1	4
3VPPoB4	0.8	N	N	0	0	80	0	0.75	0.4	4	2	6
3VPPoB7	0.5	N	N	0	0	80	0	0.25	0.3	0	4	4
3VPRbA6	0.6	N	N	0	20	70	20	0.70	0.4	3	2	5
3VPCgB4	0.6	Y	N	0	0	60	60	0.63	0.3	1	1	2
3VPRgA7	0.4	N	Y	0	0	100	0	0.57	0.2	3	4	7
3VPRgA13	0.4	Y	N	0	0	100	0	0.75	0.1	4	2	6
3VPRgA8	0.7	N	N	0	60	100	10	0.81	0.3	3	1	4
3VPRgA14	0.4	N	N	0	30	50	0	0.50	0.6	1	2	3
3VPRgA4	0.2	N	N	0	0	80	0	0.40	0.3	1	4	5
3VPRgA3	0.7	N	N	0	0	80	0	0.81	0.4	3	1	4
3VPRgA9	0.7	N	N	0	0	80	10	0.75	0.3	4	2	6
3VPRgA6	0.3	N	N	0	0	100	0	0.50	0.1	1	2	3
2VPRgA7	0.3	N	N	0	0	30	0	0.63	0.5	1	1	2
3VPRgA5	0.5	N	N	0	0	60	0	0.63	0.5	2	2	4
3VPRgA12	0.4	N	N	0	0	90	0	0.63	0.1	2	2	4
3VPReB9	0.9	Y	Y	0	0	80	20	0.85	0.4	4	1	5
3VPReB5	0.6	N	N	0	0	80	10	0.63	0.2	2	2	4
3VPReB4	0.3	N	N	0	0	50	50	0.44	0.4	1	3	4
3VPReB8	0.9	N	N	0	0	70	30	0.70	0.7	3	2	5
3VPReB7	0.4	N	N	0	0	70	40	0.75	0.4	2	1	3
3VPCkB2	0.6	Y	Y	0	0	80	30	0.70	0.2	3	2	5
3VPCgB10	0.6	N	N	0	0	100	0	0.75	0.3	4	2	6
3VPPkD3	0.2	N	N	0	0	90	10	0.44	0.1	1	3	4
3VP3HA12	0.5	N	N	0	0	80	20	0.44	0.3	1	3	4
3VP3HA13	0.3	N	N	0	0	90	10	0.50	0.1	1	2	3
3VP3HA15	0.6	N	N	0	0	60	30	0.75	0.2	4	2	6
3VP3HA14	0.5	N	N	0	0	80	20	0.44	0.3	1	3	4
3VP3HA6	0.5	Y	N	0	0	70	30	0.44	0.3	1	3	4
3VP3HA2	0.5	N	N	0	0	90	10	0.70	0.2	3	2	5
3VP3HA7	0.5	N	N	0	0	80	10	0.55	0.2	2	3	5
3VP3HA8	0.6	N	N	0	0	70	20	0.63	0.2	2	2	4
3VP3HA10	0.6	N	N	0	0	70	20	0.81	0.3	3	1	4

SITE	BPJ	Vin	Vout	Vsed	V%om	V%cov	V%cob	Vvwpi	Vdw	#Vpe	#NonVpe	Total Dom
3VP3HA5	0.6	N	Y	0	0	80	10	0.57	0.2	3	4	7
3VP3HA4	0.5	Y	Y	0	0	70	20	0.55	0.2	2	3	5
3VP3HA1	0.5	N	Y	0	0	80	10	0.38	0.2	1	5	6
3VPCgB9	0.9	N	N	0	0	70	10	0.89	0.4	6	1	7

UC MERCED
COMPILED SWALE FIELD DATA

SITE	BPJ	Vin	Vout	Vsed	V%om	V%cov	V%cob	Vnpi	Vslope	#Nat	#NonNat	Total Doms	Vertical	Horizontal
3SWCkB4g	0.8	Y	Y	0	0	60	30	0.67	0.5%	4	2	6	0.7	141
3SW2HB8g	0.6	Y	Y	0	0	90	10	0.25	1.7%	1	3	4	0.9	54
3SW2HB3g	0.9	Y	Y	0	0	60	30	0.75	0.5%	3	1	4	0.2	39
3SWRbA6g	0.6	Y	Y	0	0	70	0	0.50	2.7%	2	2	4	0.3	11
3SWRbA8g	0.8	Y	Y	0	0	70	10	0.67	1.1%	4	2	6	0.9	81
3SWReB3g	0.9	Y	Y	0	0	80	20	0.40	0.6%	2	3	5	0.6	96
3SWCkB15g	0.6	Y	Y	0	0	70	30	0.50	1.0%	3	3	6	0.6	60
3SWCkB9g	0.6	Y	Y	0	0	80	20	0.40	1.7%	2	3	5	1.3	78
3SWCkB13g	0.8	N	Y	0	0	40	50	0.80	1.0%	4	1	5	0.9	90
3SW2HB1g	0.8	Y	Y	0	0	80	20	0.50	2.1%	3	3	6	1.5	72
3SW2HB12g	0.8	Y	Y	0	0	70	30	0.43	1.6%	3	4	7	1.6	102
3SWRbA15g	0.8	Y	Y	0	0	80	0	0.50	1.1%	2	2	4	0.8	72
3SWCkB10g	0.2	Y	Y	30	10	50	10	0.40	0.6%	2	3	5	0.4	66
3SWCkB11g	0.2	Y	Y	0	0	10	90	0.00	0.4%	0	3	3	0.2	51
3SWCgD3g	0.6	Y	Y	0	0	70	30	0.25	2.9%	1	3	4	1.8	63
3SWCkB1g	0.8	Y	Y	0	0	90	10	0.57	0.4%	4	3	7	0.2	54
3SWCkB17g	0.6	Y	Y	0	0	90	10	0.60	0.3%	3	2	5	0.2	60
3SWRbA16g	1	Y	Y	0	0	60	20	0.67	0.5%	2	1	3	0.5	111
3SW2HB11g	0.5	Y	Y	0	0	80	10	0.20	0.6%	1	4	5	0.3	48
3SW2HB10g	0.6	Y	Y	0	0	70	20	0.25	0.7%	1	3	4	0.5	72
3SW2HB4g	0.6	Y	Y	0	0	70	30	0.20	2.1%	1	4	5	1.8	87
3SWCkB2g	0.8	Y	Y	0	0	90	10	0.67	1.4%	2	1	3	2.1	150
1SWCkB18g	0.7	Y	Y	0	0	100	0	0.67	0.6%	2	1	3	0.7	114
3SWCkB5g	0.8	Y	Y	0	0	100	0	0.33	0.3%	1	2	3	0.2	78
2SWReB16g	0.2	Y	N	0	0	60	0	0.60	0.5%	3	2	5	0.68	138
1SWCgB3g	0.3	Y	Y	0	0	100	0	0.00	0.6%	0	2	2	0.3	54
1SWCgB2g	0.3	Y	Y	0	0	100	0	0.33	0.1%	1	2	3	0.1	69
3SWReB2g	0.7	Y	Y	0	0	50	0	0.50	0.4%	3	3	6	0.3	78
3SWCkB7g	0.8	Y	Y	0	0	50	30	0.60	0.1%	3	2	5	0.1	72
3SWCkB12g	0.5	Y	Y	0	0	60	30	0.40	0.4%	2	3	5	0.3	78
3SWCkB9g	0.6	N	Y	0	0	80	20	0.80	2.4%	4	1	5	1.3	54
3SWPkD5g	0.6	Y	Y	0	0	90	10	0.60	0.1%	3	2	5	0.1	114
3SWPkD4g	0.5	Y	Y	0	0	60	20	0.50	0.4%	2	2	4	0.2	48

SITE	BPJ	Vin	Vout	Vsed	V%om	V%cov	V%cob	Vnpi	Vslope	#Nat	#NonNat	Total Doms	Vertical	Horizontal
3SWCkB3g	0.6	Y	Y	0	0	80	20	0.50	0.4%	2	2	4	0.2	54
3SWCkB16g	0.5	Y	Y	0	0	50	50	0.20	0.3%	1	4	5	0.2	72
3SWReB10g	0.6	Y	Y	0	0	100	0	0.25	0.3%	1	3	4	0.2	60
3SW3HA8g	0.6	Y	Y	0	0	60	40	0.50	0.3%	1	1	2	0.2	60
3SWReB14g	0.7	Y	N	0	0	90	20	1.00	0.3%	3	0	3	0.2	60
3SWCkB6g	0.7	Y	Y	0	0	100	0	0.33	0.3%	1	2	3	0.2	60
3SWPoB5g	0.6	Y	Y	0	0	100	0	0.60	1.4%	3	2	5	0.8	57
3SWReB12g	0.7	Y	Y	0	0	80	10	0.40	3.0%	2	3	5	1.6	54
3SWReB7g	0.7	Y	Y	0	0	60	50	0.33	0.4%	1	2	3	0.4	96
1SWCgB5g	0.7	Y	Y	0	0	80	10	0.25	0.6%	1	3	4	0.4	72
3SWReB9g	0.8	Y	Y	0	0	70	40	0.50	1.5%	2	2	4	0.9	60
3SWReB4g	0.8	Y	Y	0	0	60	60	0.75	0.3%	3	1	4	0.2	75
3SWMRB2g	0.5	Y	Y	0	0	100	0	0.25	1.4%	1	3	4	1	72
3SWMRB1g	0.6	Y	Y	0	0	100	0	0.50	1.7%	2	2	4	0.9	54
3SWAcA4g	0.3	Y	Y	0	0	90	0	0.50	0.7%	2	2	4	0.5	72
1SWCgB1g	0.4	Y	Y	0	0	100	0	0.00	1.3%	0	2	2	0.2	15
1SWCgB9g	0.4	Y	N	0	0	100	0	0.00	0.5%	0	2	2	0.3	57
1SWCgB13g	0.5	N	Y	0	0	100	0	0.00	0.3%	0	3	3	0.2	78
1SWCgB17g	0.6	Y	Y	0	50	100	0	0.60	1.1%	3	2	5	0.7	63
1SWCgB12g	0.4	Y	Y	0	0	100	0	0.20	0.1%	1	4	5	0.1	84
1SWCgB16g	0.3	Y	Y	0	0	100	0	0.00	0.1%	0	3	3	0.1	96
1SWCgB7g	0.1	Y	Y	0	0	100	0	0.25	0.2%	1	3	4	0.3	153
1SWCgB8g	0.2	Y	Y	0	30	100	0	0.75	0.2%	3	1	4	0.1	54
1SWCgB10g	0.1	Y	Y	0	30	100	0	0.60	0.8%	3	2	5	0.5	60
1SWCgB4g	0.1	Y	Y	0	0	100	0	0.50	1.3%	2	2	4	0.8	60
2SWCgB8g	0.6	Y	Y	0	0	100	0	0.00	1.8%	0	2	2	1.2	66
1SWCgB15g	0.4	Y	Y	0	0	100	0	0.33	0.2%	1	2	3	0.2	96
3SWReB8g	0.5	N	Y	0	0	90	0	0.60	1.1%	3	2	5	0.4	36
3SWReB5g	0.7	N	Y	0	0	90	0	0.50	1.0%	4	4	8	0.3	30
3SWBcA3g	0.7	Y	Y	0	20	100	10	0.43	0.3%	3	4	7	0.1	39
3SWReB1g	0.3	Y	Y	0	0	70	20	0.25	1.8%	1	3	4	0.8	45
3SWBcA6g	0.8	Y	Y	0	0	100	0	0.60	0.6%	3	2	5	0.3	48
3SWBcA4g	0.7	Y	Y	20	10	90	0	0.25	0.7%	1	3	4	0.4	54
3SW2HB15g	0.9	Y	Y	0	0	70	10	0.67	0.9%	6	3	9	0.9	105
3SW2HB6g	0.9	N	Y	0	0	80	10	0.67	0.9%	4	2	6	0.7	81
3SWRbA10g	0.7	Y	Y	0	0	60	40	0.33	2.9%	2	4	6	2	69

SITE	BPJ	Vin	Vout	Vsed	V%om	V%cov	V%cob	Vnpi	Vslope	#Nat	#NonNat	Total Doms	Vertical	Horizontal
3SWRbA9g	0.8	Y	Y	0	0	70	30	0.60	2.1%	3	2	5	1	48
3SWRbA3g	0.7	Y	Y	0	0	80	20	0.50	0.6%	3	3	6	0.4	72
2SWReB2g	0.2	Y	Y	0	0	100	0	0.00	1.5%	0	3	3	1.3	87
2SWCgB4g	0.7	Y	Y	0	0	80	10	0.00	0.1%	0	2	2	0.1	69
3SWCgB9	0.6	Y	Y	0	0	100	0	0.00	2.2%	0	2	2	0.8	36
2SWReB4	0.3	Y	Y	0	0	90	0	0.33	3.0%	1	2	3	0.9	30
2SWRgA1	0.2	Y	Y	0	0	100	0	0.33	0.9%	1	2	3	0.6	66
2SWCkB4	0.2	Y	Y	0	0	100	0	0.20	1.4%	1	4	5	0.9	66
2SWReB3	0.1	Y	Y	0	0	100	0	0.00	1.0%	0	3	3	1.1	108
2SWCgB3	0.2	Y	Y	0	0	100	0	0.25	0.4%	1	3	4	0.3	72
2SW3HA1	0.1	Y	Y	0	0	100	0	0.25	0.8%	1	3	4	1.2	144
2SWCgB10	0.2	Y	Y	0	0	100	0	0.40	0.6%	2	3	5	0.7	108
2SWCgB11	0.2	Y	Y	0	0	100	0	0.33	0.6%	1	2	3	0.9	150
2SWCgB12	0.2	Y	Y	0	0	90	0	0.33	0.3%	1	2	3	0.2	60
2SWAcA1	0.2	Y	Y	0	0	100	0	0.33	0.5%	1	2	3	0.4	78
2SWRgB1	0.2	Y	Y	0	0	100	0	0.33	0.9%	1	2	3	0.7	78
2SWAcA2	0.2	Y	Y	0	0	80	0	0.25	0.7%	1	3	4	0.5	72
2SW3HB1	0.1	Y	Y	0	0	100	0	0.33	0.8%	1	2	3	0.9	120
2SWCgB2	0.1	Y	Y	0	0	100	0	0.00	0.3%	0	3	3	0.3	120
2SWReB17	0.5	Y	N	0	0	40	0	0.33	0.5%	1	2	3	0.6	132
3SWRgA4	0.3	Y	Y	0	0	100	0	0.20	0.2%	1	4	5	0.2	96
3SWRgA10	0.4	Y	Y	0	0	90	10	0.40	1.3%	2	3	5	1.1	87
3SWRgA7	0.3	Y	Y	0	0	90	10	0.00	0.8%	0	5	5	0.5	60
3SWRgA1	0.4	Y	Y	0	0	90	0	0.20	0.3%	1	4	5	0.3	99
3SWRgA13	0.4	Y	Y	0	0	90	0	0.17	1.7%	1	5	6	1.3	78
3SWRgA3	0.2	Y	N	0	0	100	0	0.25	0.9%	1	3	4	0.7	78
3SWRgA16	0.3	Y	Y	0	0	50	0	0.33	0.8%	1	2	3	0.4	51
3SWCgB12	0.6	Y	Y	0	0	90	0	0.60	0.7%	3	2	5	0.5	72
3SWRbA1	0.7	Y	Y	0	0	80	10	0.50	1.0%	2	2	4	0.6	60
3SWPoB2	0.6	Y	Y	0	20	90	0	0.40	2.3%	2	3	5	0.7	30
3SWRbA4	0.7	Y	Y	0	0	70	0	0.25	0.2%	1	3	4	0.2	96
3SWCgB13	0.2	Y	Y	0	0	90	0	0.20	0.3%	1	4	5	0.2	60
3SWCgB15	0.6	Y	Y	0	0	90	10	0.33	1.1%	2	4	6	0.8	72
3SW3HA4	0.6	Y	Y	0	0	90	0	0.20	0.1%	1	4	5	0.1	72
3SW3HA7	0.6	Y	Y	0	0	100	0	0.40	0.4%	2	3	5	0.5	117
3SW3HA3	0.5	Y	Y	0	0	70	20	0.00	0.4%	0	5	5	0.5	120

SITE	BPJ	Vin	Vout	Vsed	V%om	V%cov	V%cob	Vnpi	Vslope	#Nat	#NonNat	Total Doms	Vertical	Horizontal
3SW3HA6	0.6	Y	Y	0	0	70	30	0.33	1.3%	2	4	6	0.8	60
3SWCgB5	1	Y	Y	0	0	70	30	0.83	0.7%	5	1	6	0.8	111
3SWRbA5	0.8	Y	Y	0	0	70	20	0.80	1.9%	4	1	5	1.3	69
3SWCgB4	0.6	Y	Y	0	0	90	10	0.20	2.9%	1	4	5	2.3	78
3SWRbA14	0.6	Y	Y	0	0	90	0	0.25	1.5%	1	3	4	0.7	48
3SWRbA11	0.6	N	N	0	0	100	0	0.20	0.7%	1	4	5	0.2	30
3SWReB6	0.7	Y	Y	0	0	100	10	0.60	0.4%	3	2	5	0.1	24
3SWRbA13	0.6	Y	Y	0	0	70	30	0.20	1.4%	1	4	5	1.6	114
3SWCgB11	0.7	Y	Y	0	0	80	10	0.50	1.7%	3	3	6	1.5	90
3SWRbA12	0.8	Y	Y	0	0	80	10	0.57	1.5%	4	3	7	0.8	54
3SWCkB1	0.8	Y	Y	0	0	70	30	0.67	0.4%	4	2	6	0.2	54
3SWCkB14	0.6	Y	Y	0	0	50	30	0.50	0.3%	3	3	6	0.2	66
3SWCgB6	0.6	Y	Y	0	0	50	50	0.57	1.9%	4	3	7	1	54
3SWCgB9	0.4	N	Y	0	0	90	10	0.40	3.3%	2	3	5	1.4	42
3SWMrC1	0.2	N	Y	0	0	100	0	0.25	3.8%	1	3	4	2.6	69
3SWCgB1	0.7	Y	Y	0	0	70	0	0.40	0.7%	2	3	5	0.2	30
3SWPoB1	0.1	Y	Y	10	0	40	0	0.33	3.8%	1	2	3	1.6	42

UC MERCED
COMPILED CLAY SLOPE FIELD DATA

SITE	BPJ	Vin	Vout	Vsed	V%om	V%cov	V%cob	Vnpi	Vslope	#Nat	#NonNat	Total Dom	Vertical	Horizontal
3CSReB10	0.6	N	N	0	0	80	0	0.50	0.8%	2	2	4	0.2	26
3CSReB14	0.7	N	N	0	0	80	10	0.60	0.5%	3	2	5	0.1	20
3CSRbA3	0.7	Y	Y	0	0	80	10	0.40	0.4%	2	3	5	0.4	96
3CSReB11	0.8	N	N	0	0	70	20	0.86	0.5%	6	1	7	0.4	87
3CSCgD2	0.6	Y	Y	0	0	60	30	0.25	3.3%	1	3	4	2	60
3CSCgD3	0.6	Y	N	0	0	90	0	0.50	2.0%	2	2	4	1.2	60
3CSRbA14	0.7	N	Y	0	0	80	0	0.50	0.9%	3	3	6	0.5	54
3CSRbA30	0.8	Y	Y	0	0	70	10	0.50	0.1%	2	2	4	0.1	81
3CSRbA9	0.7	N	Y	0	0	60	20	0.33	0.5%	1	2	3	0.4	75
3CS2HB16	0.6	N	Y	0	0	60	20	0.33	1.5%	1	2	3	0.9	60
3CS2HB5	0.9	N	Y	0	0	80	10	0.33	0.1%	2	4	6	0.2	141
3CSPoB4	0.6	N	N	0	0	90	0	0.33	3.2%	2	4	6	1.9	60
3CSPmD2	0.8	N	N	0	0	80	0	0.67	1.0%	4	2	6	0.5	51
3CSRbA7	0.6	N	N	0	0	70	10	0.14	0.2%	1	6	7	0.1	60
3CSRbA4	0.7	Y	N	0	0	70	0	0.75	0.6%	3	1	4	0.7	120
3CSCgA1	0.7	N	N	0	0	80	0	0.33	0.2%	1	2	3	0.3	132
3CSRbA2	0.8	N	N	0	0	70	0	0.67	0.4%	4	2	6	0.3	72
3CSRbA16	0.7	N	Y	0	0	70	0	0.40	0.2%	2	3	5	0.2	120
3CSRbA17	0.6	N	N	0	0	90	0	0.20	0.3%	1	4	5	0.2	60
3CSCgB2	0.6	N	N	0	0	90	0	0.25	0.4%	1	3	4	0.3	72
3CS3HA3	0.9	Y	N	0	0	70	30	0.50	1.1%	2	2	4	0.7	66
3CS3HA17	0.7	N	N	0	0	90	10	0.40	1.7%	2	3	5	0.7	42
3CS3HA2	0.7	N	N	0	0	70	30	0.40	0.4%	2	3	5	0.2	54
3CSReB7	0.8	N	N	0	0	90	10	0.50	0.3%	2	2	4	0.2	66
3CSReB13	0.9	N	N	0	0	90	10	0.50	0.1%	2	2	4	0.1	78
3CSReB6	0.8	N	Y	0	0	90	10	0.40	0.9%	2	3	5	0.9	102
3CSCgB5	0.7	N	Y	0	0	100	20	0.50	2.4%	2	2	4	2.2	90
3CSCgB4	0.7	Y	Y	0	0	80	10	0.43	1.2%	3	4	7	1.6	132
3CSRbA6	0.6	N	N	0	0	70	20	0.25	3.9%	1	3	4	2.8	72
3CSCgB1	0.7	Y	Y	0	0	70	30	0.25	3.0%	1	3	4	2.7	90
3CSRbA11	0.6	Y	N	0	0	90	10	0.50	1.3%	2	2	4	1.2	96
3CSRbA12	0.6	Y	N	0	0	90	10	0.33	0.2%	2	4	6	0.4	162
3CSReB5	0.5	N	Y	0	0	70	30	0.50	0.9%	3	3	6	0.7	81

SITE	BPJ	Vin	Vout	Vsed	V%om	V%cov	V%cob	Vnpi	Vslope	#Nat	#NonNat	Total Dom	Vertical	Horizontal
3CSCkB16	0.7	N	N	0	0	70	30	0.40	0.9%	2	3	5	0.7	78
3CSReB2	0.8	Y	N	0	0	80	10	0.50	0.4%	3	3	6	0.4	90
3CSReB9	0.6	Y	N	0	0	80	10	0.29	1.6%	2	5	7	0.8	51
3CSRbA13	0.5	N	N	0	0	90	0	0.20	0.1%	1	4	5	0.1	72
3CSRbA26	0.8	N	N	0	0	70	20	0.40	0.2%	2	3	5	0.2	114
3CSReB4	0.4	N	N	0	0	80	10	0.25	0.7%	1	3	4	0.7	94
3CS3HA16	0.4	N	N	0	0	80	0	0.33	2.6%	1	2	3	1	39