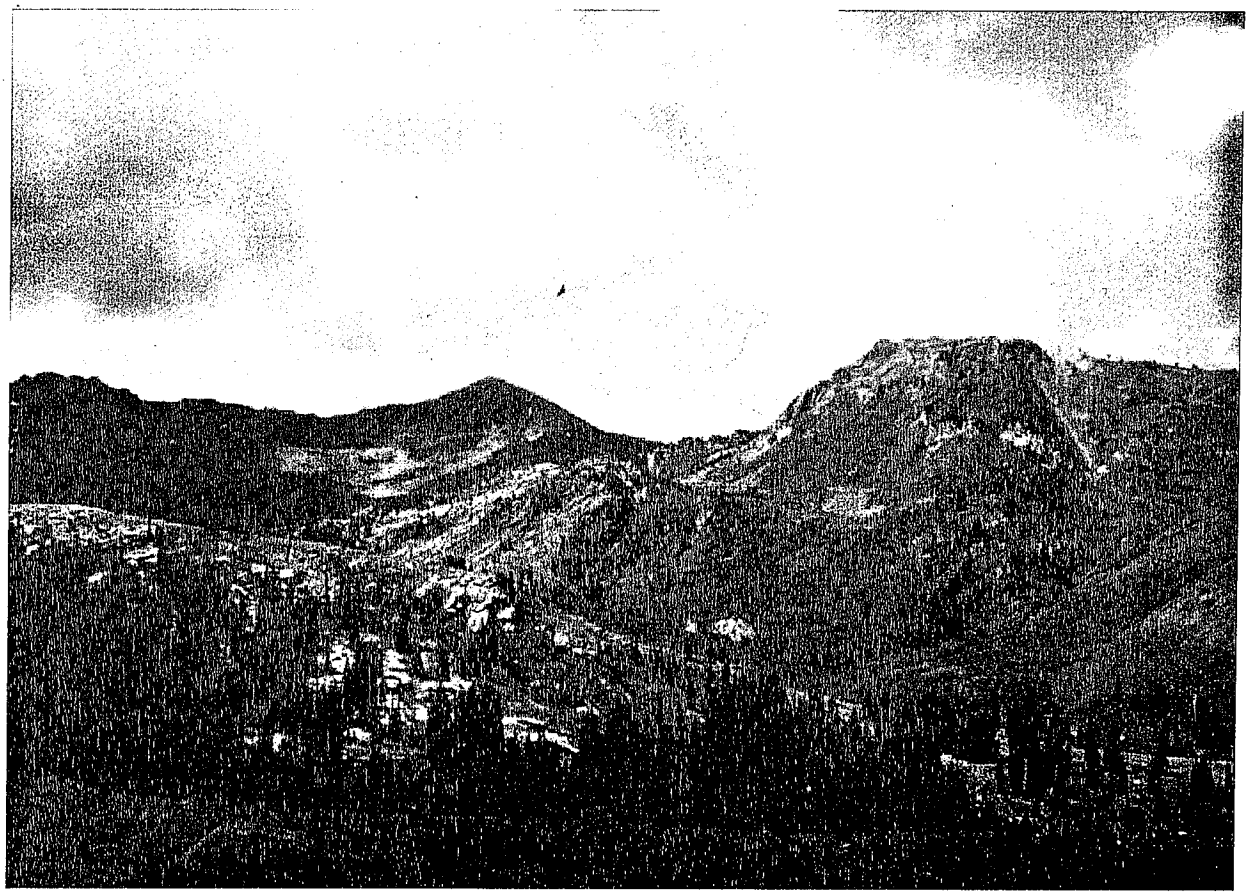
ECOLOGICAL CHARACTERIZATION AND FUNCTIONAL EVALUATION OF SUBALPINE AND LOWER MONTANE WETLANDS IN THE ALBION BASIN REGION OF UTAH



THE BOARD OF SALT LAKE COUNTY COMMISSIONERS

SALT LAKE COUNTY COMMISSION STAFF OFFICE

ECOLOGICAL CHARACTERIZATION AND FUNCTIONAL EVALUATION OF SUBALPINE AND LOWER MONTANE WETLANDS IN THE ALBION BASIN REGION OF UTAH

Performed for Region VIII
Environmental Protection Agency
and the Town of Alta

by

Steven F. Jensen, M.P.A.
Water Resources Planning Coordinator
Project Director

June 25, 1993

Funded by Region VIII Environmental Protection Agency
Denver, Colorado
and
The Friends of Alta & Alta Municipal Corporation
Alta, Utah

TABLE OF CONTENTS

LIST OF FIGURES

ACKNOWLEDGEMENTS

Several individuals and agencies contributed their time to the completion of this project. The following deserve special recognition:

Mayor William Levitt.....Town of Alta
John Gouldner, Administrator.....Town of Alta
Kate Black, Clerk.....Town of Alta
Mark LaFrance.....Town of Alta
Anne Crowley, Botanist.....Town of Alta
Mimi Levitt.....Friends of Alta

Dale Vodenahl.....Region VIII EPA
Gene Reetz.....Region VIII EPA
Bob Mairley.....Region VIII EPA

Mike Schwinn.....Corps of Engineers
Patricia Lock.....Utah Wildlife Resources
Mike Sieg.....U.S. Forest Service
Jim White.....U.S. Forest Service
Russ Hone, Watershed Adm.....Salt Lake City Corp.
Dan Schenck, Hydrologist.....Salt Lake City Corp.

April Montgomery.....San Miguel Co.,Colorado
Lois Arnow, Curator (Retired).....Museum of Nat.History
Russ Harmer.....Alta Ski Lift Company
Al Tunbridge.....Alta Ski Lift Company
Dawn Jensen.....Park City Corporation
Terry Way, P.E.....Salt Lake County

INTRODUCTION

Salt Lake County was approached early in 1992 by the Town of Alta to assist in the development of a wetland ordinance similar to that developed in San Miguel County, Colorado. In order to support the Town, the County proposed an advance identification of wetlands in the area of interest to provide a basis for future administration of such an ordinance. A similar study was conducted by the County along the Jordan River in 1986, and has since become the flagship for wetland conservation efforts in Salt Lake Valley.

A proposal was submitted to Region VIII Environmental Protection Agency to fund the wetland inventory and functional assessment, and the County was awarded a modest grant from EPA, subsequently matched by the Town of Alta with financial support from the Friends of Alta, a private, non-profit group of people concerned about conservation of Alta's unique qualities.

The area selected for inventory and development of the functional assessment was Albion Basin, a glacially carved upper sub-watershed to Salt Lake Valley, with a rich history in silver mining. The area is a popular world renowned ski resort, famous for its powder skiing and home of the "Greatest Snow On Earth." It is also a popular summer resort area, with numerous hiking & biking trails, lakes, streams, campgrounds and seasonal homes, and meadows noted for outrageously beautiful wildflower displays.

With elevations ranging from 8,600 ft. to 11,000 ft, Albion Basin is a rugged, yet sensitive ecological area, providing about 15% of the total surface culinary water supply to Salt Lake Valley, a sprawling community of over 750,000 inhabitants. The Wasatch Front Canyons collectively provide 70% of the recharge to the deep confined acquifer in the valley, which supplies about 25% of all culinary water for valley residents. The importance of Albion Basin as a water supply resource cannot be overstated.

Because wetlands are known to provide important benefits to the community ranging from water recharge to flood storage and wildlife habitat to recreation, the identification and conservation of these resources in Utah's lower montane and subalpine environments must become a high priority. This assessment provides a model for other federal, state and local land management agencies to follow along the Wasatch Front, the Uinta Mountains, Basin & Range provinces, and other important watersheds throughout the State of Utah.

This document synthesizes information compiled in the technical reports entitled, "Soil & Hydrology of Albion Basin Wetlands," and "Plant Communities of Albion Basin Wetlands," published by the County late in 1992. As with the Jordan River project, this assessment relies on "A Method for Wetland Functional Assessment," (Adamus, 1983) to document wetland values.

PROJECT SCOPE

The scope of this inventory and functional assessment of wetlands is limited to a regional basin sub-watershed located in the Wasatch Range of North-Central Utah. The area is quite characteristic of similar lower montane/subalpine basins in the Rocky Mountains, which are popular summer and winter recreation areas. The pressure for development and over-use of such areas is increasing with a population demanding more recreational areas and more multiple resource utilization.

Albion Basin includes over 2300 acres within its sub-watershed boundaries **(Figure One)**. It is a relatively small part of the total Little Cottonwood Canyon watershed, which contains approximately 25 square miles of drainage area, and an annual water yield of 45,000 acre feet. This is second only to Big Cottonwood Canyon, which possesses twice the drainage area and almost 55,000 acre-feet of water per year.[1]

The importance of concentrating on this Basin reflects not only the local emphasis to conserve its unique values, but calls attention to the fact that Utah possesses thousands of acres of watershed with montane wetlands performing valuable functions not previously identified in the National Wetland Inventory, state wetland inventory, or previous advance identification studies.

In order for effective multiple use management to occur, while still conserving functions and values essential to future growth, it is critical that such areas be identified and granted the benefit of maximum conservation efforts. Although the majority of these lands are under the National Forest system, its mission is the optimum multiple use of natural resources, including timber harvest & silviculture, mining operations, livestock grazing, off-road vehicle recreation, hunting, as well as a host of other recreation forms.

Although downstream water supply and water quality are obligated protection under Forest Service policy and anti-degradation policies of the State of Utah and the Federal Clean Water Act, there is little awareness of the functional values these areas provide in maintaining water supply and quality.

Wetlands are typically thought to consist of cattails, bulrushes, and sedges surrounding duck marshes. The wetlands in Albion Basin are very different, and perform different--but no less valuable--functions for everyone living "downstream."

Therefore, although the scope of this project is focused on Albion Basin, it has regional implications for future wetland conservation in the highlands of all Utah and its Rocky Mountain neighbors.

PROJECT OBJECTIVES

The objectives of the Albion Basin wetland advance identification study (WAIDS) encompass:

1. The inventory of soils, hydrology, and vegetation within a typical Utah regional sub-basin watershed, using modified wetland methodology set forth in federal guidelines for jurisdictional delineation.

2. Mapping the location of these areas, determining which of them meet federal wetland delineation criteria, and characterizing the ecological relationships between them.

3. Applying functional assessment criteria to identified wetlands, in order to determine relative priority for possible future land use permit management, enforcement activities, acquisition, or long-term trust resource/reserve management.

Insofar that the Town of Alta initiated the study for purposes of developing a locally administered wetland ordinance, one of the principal objectives has been to develop enough scientifically defensible information to enable this program to be effective. The use of jurisdictional delineation techniques, modified to provide coverage of large acreage tracts, was considered to be the most appropriate methodology.

PROJECT METHODOLOGY

The project employed two levels of analysis, an aerial interpretation phase, which included use of literature data, and a field inventory phase. Review of information such as local soils reports, geologic studies, and plant occurrence was incorporated into mapping which guided the selection of potential geographical wetland "provinces" or "rangesites" (a term commonly used in soil interpretation studies).

o Soils, Hydrology and Vegetation Data Collection

The three parameters used to define wetlands are discussed in two technical reports produced as elements of the Albion Basin project: **"Soil and Hydrology of Albion Basin Wetlands,"** (Jensen) and **"Plant Communities of Albion Basin Wetlands,"** (Crowley) were produced and written between July and December, 1992.[2]

The voluminous nature of the data necessitated separate reports. Although the same transects were used across the potential wetland "rangesites," the nature and future use of the information implied the need to divide the factors for ease of reporting. Both of these reports are available from Salt Lake County at cost.

Within the 2300+ acre watershed sub-basin, approximately 485 acres were selected for detailed inventory. Of this acreage, about 235-240 acres meet wetland definition criteria, that is:

> "...areas inundated or saturated by surface or groundwater 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..."[3]

Selection of the potential wetlands was based on priorities established by the Town of Alta for future regulation and management, preponderance of facultative or facultative wetland vegetation, and occurrence of surface water drainage features. Land use and ownership were generally not factors considered in study selection, although one rangesite, Emma Hill, was added in view of past mining impacts **(Figure Two)**.

o Mapping Transect Data for Wetland Interpretation

Full-color aerial photography was obtained from the U.S.D.A. Aerial Survey Center, Salt Lake City, and enlarged to an approximate scale of 1"= 250'. Field data was transferred to this mapping in the form of potential wetland boundaries where saturated or wet soils, intermittent or perennial hydrology, and facultative, facultative wetland, or obligate vegetation dominated the site.[4]

The occurrence and distribution of various geology and soil arrangements were reviewed to gain insight about the origin and pathways of both surface and sub-surface hydrology. Soil texture and potential hydric rating was performed using Munsell Color Charts, Soil Conservation Service data, and reference to national soils classification methodology.

Where perennial or intermittent hydrology was not apparent, i.e. where flowing water was not present, methods referenced in the "Federal Manual for Identifying and Delineating Jurisdictional Wetlands" were used to trace hydrologic conditions.

Vegetation was estimated using point-intercept methodology also contained in the "Federal Manual" with slight modifications which employed a larger geographic zone distribution based on vegetation density & diversity dominance.

Detailed methods are discussed at length in **"Soil & Hydrology of Albion Basin Wetlands,"** and **"Plant Communities of Albion Basin Wetlands."**

o Correlating the Data for Wetland Delineation Mapping

The occurrence of combined vegetation densities of facultative (FAC), facultative wet (FACW), and obligate (OBL) vegetation is equated with locations of apparent seasonal saturation (or flowing water) and hydric soil characteristics to enable mapping the wetlands. Correlations between the factors is enabled by uniformity of the transects **(Figure Three)**.

Hydrologic conditions reflecting perennial or intermittent discharge, or areas determined to be seasonally saturated, are shown in **Figure Four**. Hydrologic conditions were intercepted in point transects, and noted on the aerial photography in the field. Normal circumstances were not present during the 1992 field inventory season, because snowpack conditions were about 50% of normal. Many areas normally wet were drying up, as evidenced by various levels of observed plant stress (Crowley, 1992).

Soil characteristics along transects were approximated in a variety of saturation conditions, in order to determine changes between identified hydric soils, as well as delineating between hydric and non-hydric soils. Test pits were most often located in areas of saturation or proximity to surface hydrology, but were also dug between hydrologic features. This is a slight modification to the basic "point intercept" transect sampling approach.

Consistent hydric soil traits along a transect in some cases modify the mapping to include areas which may be FAC> dominant. In these cases, the normal circumstances of the site would predicate higher densities of FACW and OBL vegetation.

For example, in the most complex study rangesite, West Albion Basin, Transect 4 begins in a relatively dry area and extends into one progressively wetter **(Figure Five)**. The soils begin as dry/damp fine sandy loams, change to gravelly loams, and end as mottled, saturated, fine silty clay loams. Plant densities begin with 40% FAC> (of which 10% is FACW), and end with 55% FAC> (15% FACW).

In these instances, it is difficult to distinguish definitive changes in plant density and diversity along these wetter transect areas without employing detailed plot analysis and quantifying the fixed interval area. Therefore, the mosaic of diversity must be more approximated, densities more averaged. Lower plant density averages can easily extend into areas which are only damp, but with obvious hydric soil indicators; likewise, they may extend into areas which are saturated, with hue chroma/values of 3/4.

For complex systems such as this, only quantified, site-specific jurisdictional delineation methods can more definitively draw the line. This level of detail was not possible for Albion Basin advance identification.

o Wetland Delineation Mapping

The results of correlating soil, hydrology and vegetative data is the wetland delineation map **(Figure Six).** It should be termed final for purposes of the advance identification study, but preliminary for purposes of providing information which can be confirmed by more site-specific, detailed jurisdictional delineation techniques.

o Albion Basin Wetland Classification

With the exception of some areas located adjacent to the principal third order segment of Little Cottonwood Creek (which could be considered Riverine), the majority of the wetlands in Albion Basin are classified as Palustrine wetlands (Cowardin, 1979).[5] The following Palustrine sub-orders and water regime modifiers are present throughout the Basin:

SUB-ORDER	WATER REGIME MODIFIER
1. Scrub-Shrub Wetlands	Seasonally saturated.
2. Forested Wetlands	Temporarily or seasonally flooded.
3. Emergent Persistent Wetlands	Saturated or temporarily, seasonally, or permanently flooded.
4. Aquatic Beds	Permanently flooded, or intermittently exposed.
5. Moss-Lichen Wetlands	Saturated or temporarily, seasonally, or permanently flooded.

Wetlands in Albion Basin often exhibit a combination of traits and are not limited to one specific classification type. This is apparent in areas of the West Albion province which include needle-leaved evergreen forested, scrub-shrub, emergent persistent, and moss-lichen wetlands. Facultative spruce communities comprise the overstory stratum, and scrub-shrub communities are mixed with emergent persistent wetlands dominating the understory. Moss communities are divergent and ubiquitous throughout the wetter portions of the persistently-classed wetlands.

Similar problems occur with water regimes. Again, the West Albion province exhibits a variety of hydrologic conditions throughout the season. The majority of the area is seasonally or semi-permanently flooded, but identified fens are permanently flooded and saturated during the entire growing season.

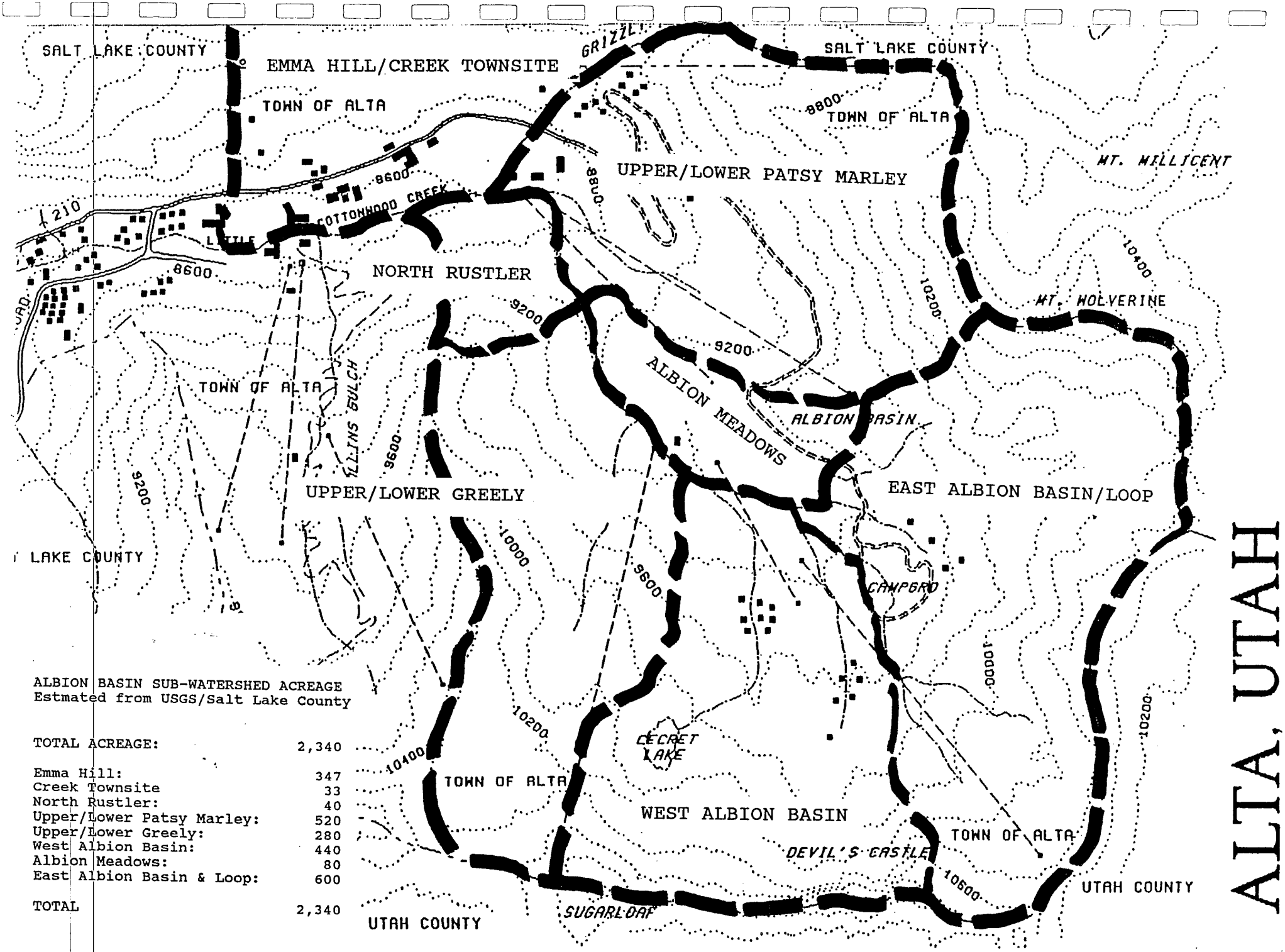
o **General Rangesite Wetland Classifications**

The following classification percentages are estimated from both field and aerial interpretation:

RANGESITE	WETLAND CLASSIFICATION	%
Patsy Marley Hill	Scrub-Shrub, Seasonally Saturated	(70%)
	Emergent-Persistent, Seasonally Sat.	(30%)
West Albion Basin	Emergent Persistent, Perm. Flooded	(50%)
	Forested, Seasonally Flooded	(28%)
	Scrub-Shrub, Seasonally Flooded	(13%)
	Moss-Lichen, Permanently Flooded/Sat.	(9%)
Albion Meadows	Emergent-Persistent, Seasonally Sat.	(50%)
	Scrub-Shrub, Seasonally Saturated	(50%)
Albion Loop	Forested, Seasonally Flooded	(30%)
	Scrub-Shrub, Seasonally Flooded	(30%)
	Emergent-Persistent, Seasonally Sat.	(30%)
	Moss-Lichen, Seasonally Saturated	(10%)
East Albion Basin	Forested, Seasonally Flooded/Sat.	(13%)
	Emergent-Peristent, Seasonally Flooded or Saturated	(43%)
	Scrub-Shrub, Seasonally Saturated	(40%)
	Moss-Lichen, Seasonally Saturated	(7%)
Greely Bowl	Scrub-Shrub, Seasonally Saturated	(50%)
	Emergent-Persistent, Seasonally Sat.	(50%)
Lower Greely	Scrub-Shrub, Seasonally Saturated	(85%)
	Emergent-Persistent, Seasonally Sat.	(15%)
North Rustler	Scrub-Shrub, Seasonally Saturated	(85%)
	Emergent-Persistent, Seasonally Sat.	(15%)
Creek Townsite	Scrub-Shrub, Seasonally Flooded/Sat.	(38%)
	Emergent-Persistent, Seasonally Sat.	(12%)
	Riverine, Intermittently Flooded	(50%)
Upper Patsy Marley	Scrub-Shrub, Seasonally Saturated	(82%)
	Emergent-Persistent, Seasonally Sat.	(18%)
Emma Hill	Scrub-Shrub, Seasonally Flooded	(100%)

o **Estimated Acreage of Rangesite Wetland Classifications**

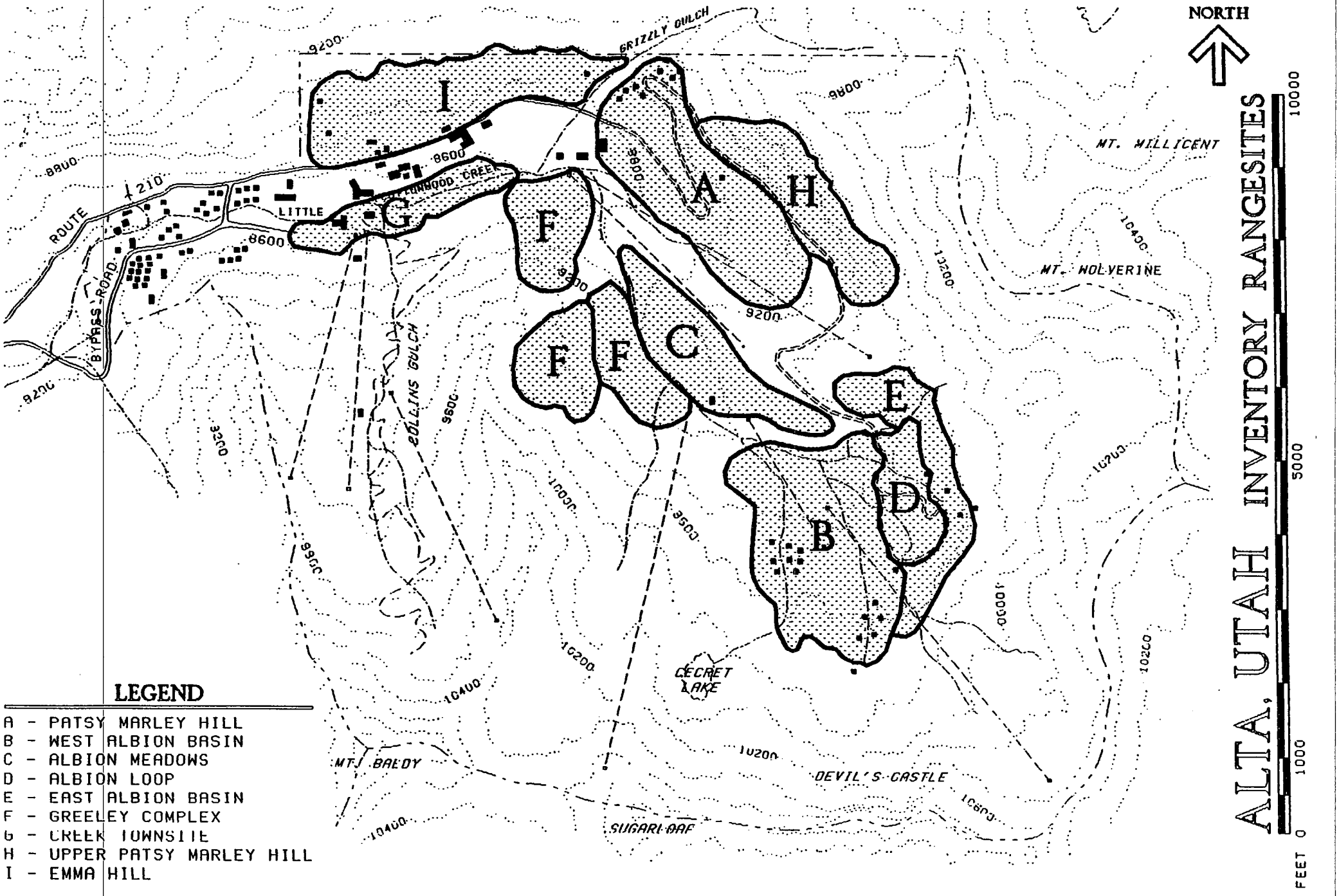
RANGESITE MAPPING UNIT	ACREAGE OF WETLANDS BY CLASSIFICATION Acreage	Classification
Patsy Marley Hill	28	Scrub-Shrub
Rangesite Acres 81	6	Emergent-Persistent
Wetland Acres: 40	6	Forested
West Albion	29	Emergent-Persistent
Rangesite Acres: 109	17	Forested
Wetland Acres: 59	8	Scrub-Shrub
	5	Moss-Lichen
Albion Meadows	3	Emergent-Persistent
Rangesite Acres: 30	3	Scrub-Shrub
Wetland Acres: 6		
Albion Loop	1.8	Forested
Rangesite Acres: 29	1.8	Scrub-Shrub
Wetland Acres: 6	1.8	Emergent-Persistent
	.6	Moss-Lichen
East Albion Basin	2	Forested
Rangesite Acres: 26	7	Emergent-Persistent
Wetland Acres: 16	6.5	Scrub-Shrub
	.5	Moss-Lichen
Greely Bowl	3.5	Emergent-Persistent
Rangesite Acres: 34	3.5	Scrub-Shrub
Wetland Acres: 7		
Lower Greely	29	Scrub-Shrub
Rangesite Acres: 36	5	Emergent-Persistent
Wetland Acres: 34		
North Rustler	5	Scrub-Shrub
Rangesite Acres: 29	1	Emergent-Persistent
Wetland Acres: 6		
Creek Townsite	5	Scrub-Shrub
Rangesite Acres: 33	1.5	Emergent-Persistent
Wetland Acres: 13	6.5	Riverine
Upper Patsy Marley	6.5	Scrub-Shrub
Rangesite Acres: 29	1.5	Emergent-Persistent
Wetland Acres: 8		
Emma Hill	5	Scrub-Shrub
Rangesite Acres: 49		
Wetland Acres: 5		
TOTAL WETLAND ACREAGE:	**200**	

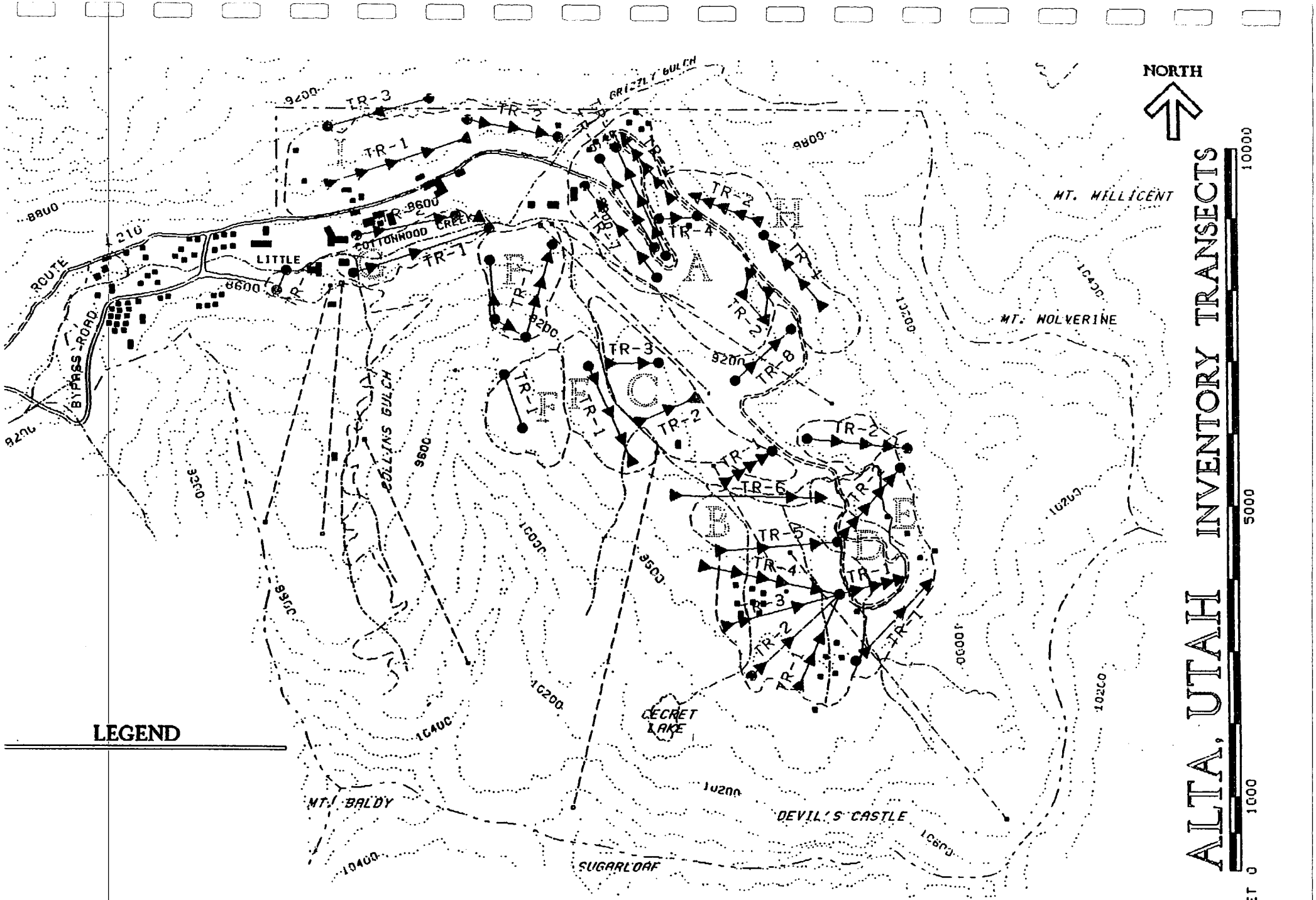


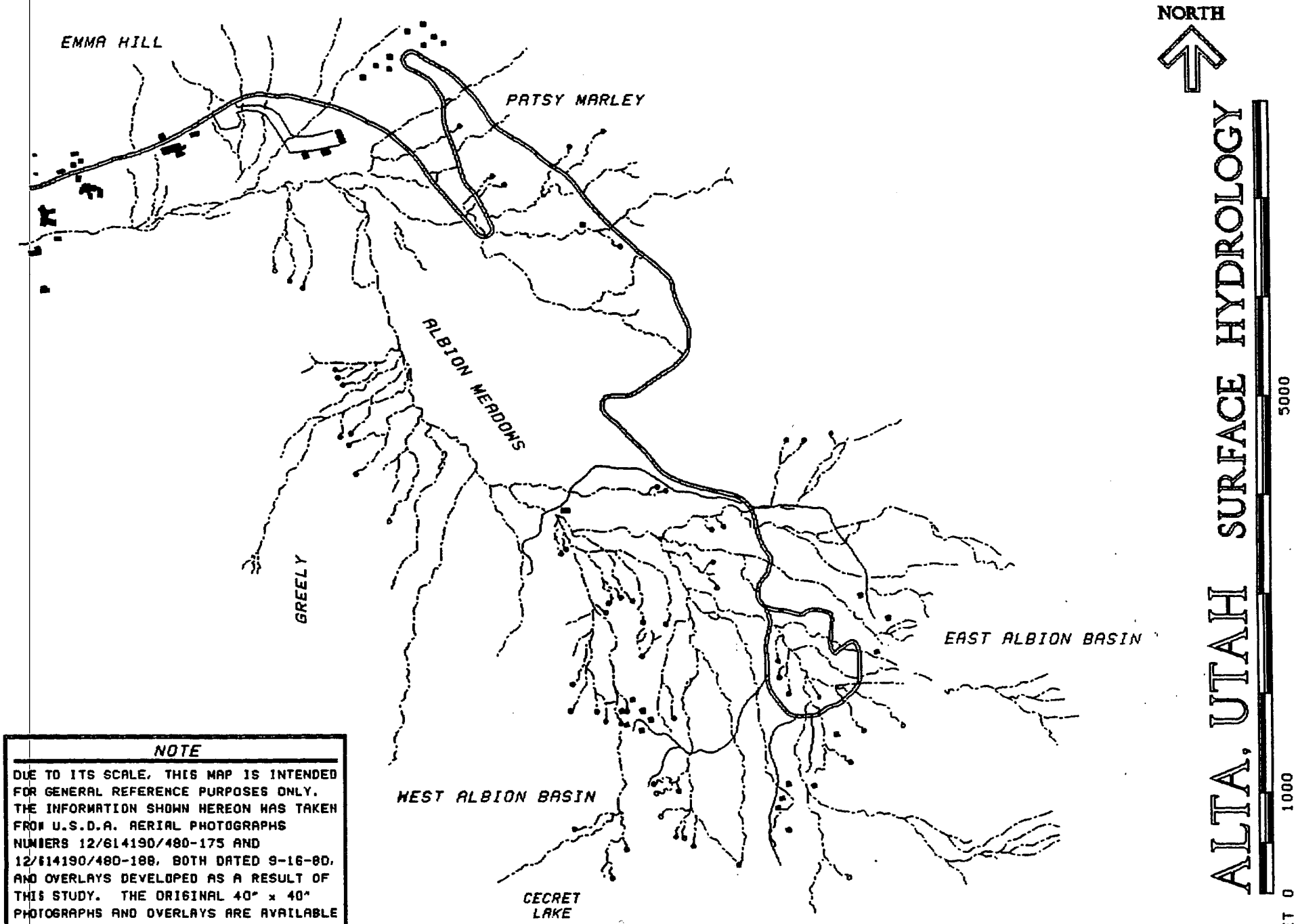
ALTA, UTAH

ALBION BASIN SUB-WATERSHED ACREAGE
Estmated from USGS/Salt Lake County

TOTAL ACREAGE:	2,340
Emma Hill:	347
Creek Townsite	33
North Rustler:	40
Upper/Lower Patsy Marley:	520
Upper/Lower Greely:	280
West Albion Basin:	440
Albion Meadows:	80
East Albion Basin & Loop:	600
TOTAL	2,340

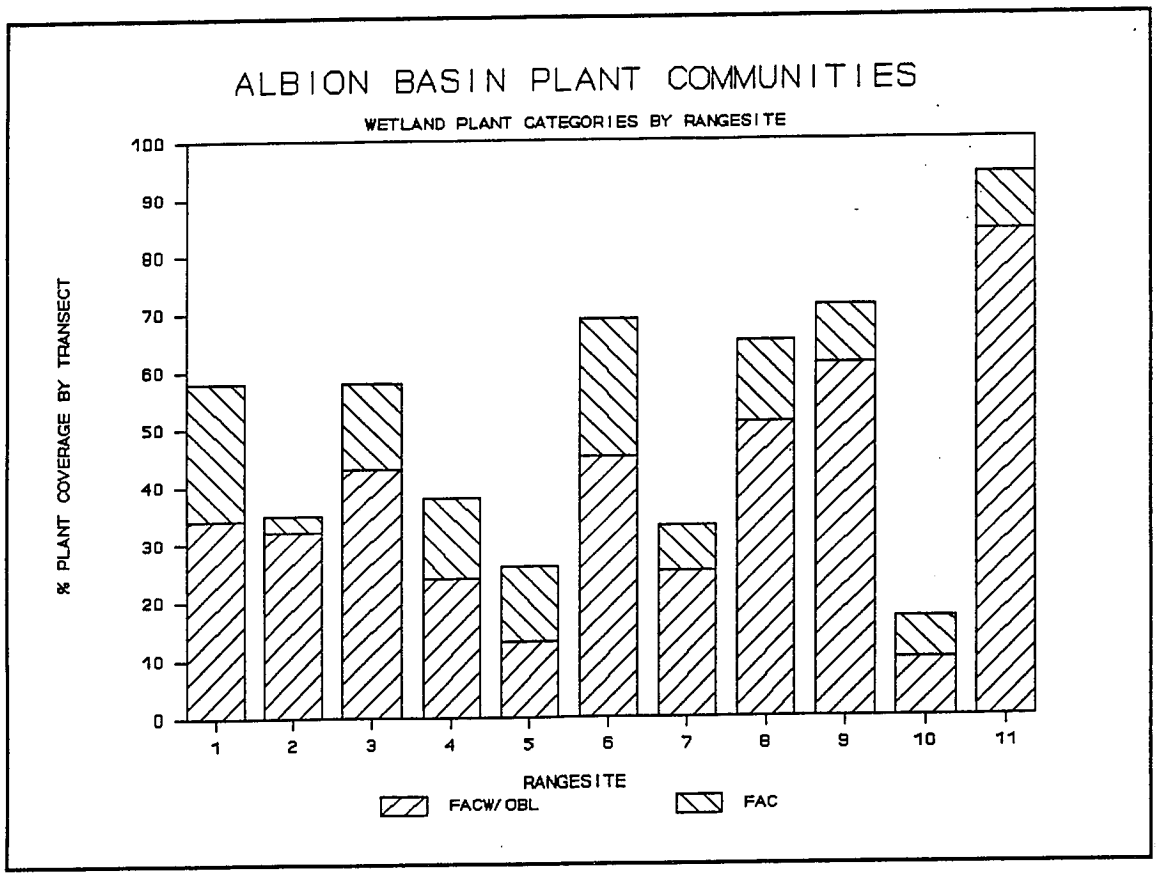

NORTH
ALTA, UTAH INVENTORY RANGESITES
10000
5000
1000
0
FEET
LEGEND
A - PATSY MARLEY HILL
B - WEST ALBION BASIN
C - ALBION MEADOWS
D - ALBION LOOP
E - EAST ALBION BASIN
F - GREELEY COMPLEX
G - CREEK TOWNSITE
H - UPPER PATSY MARLEY HILL
I - EMMA HILL
GRIZZLY GULCH
MT. MILLICENT
MT. WOLVERINE
ROUTE 210
LITTLE
COTTONWOOD CREEK
BYPASS ROAD
COLLINS GULCH
SECRET LAKE
MT. BALDY
DEVIL'S CASTLE
SUGARLOAF

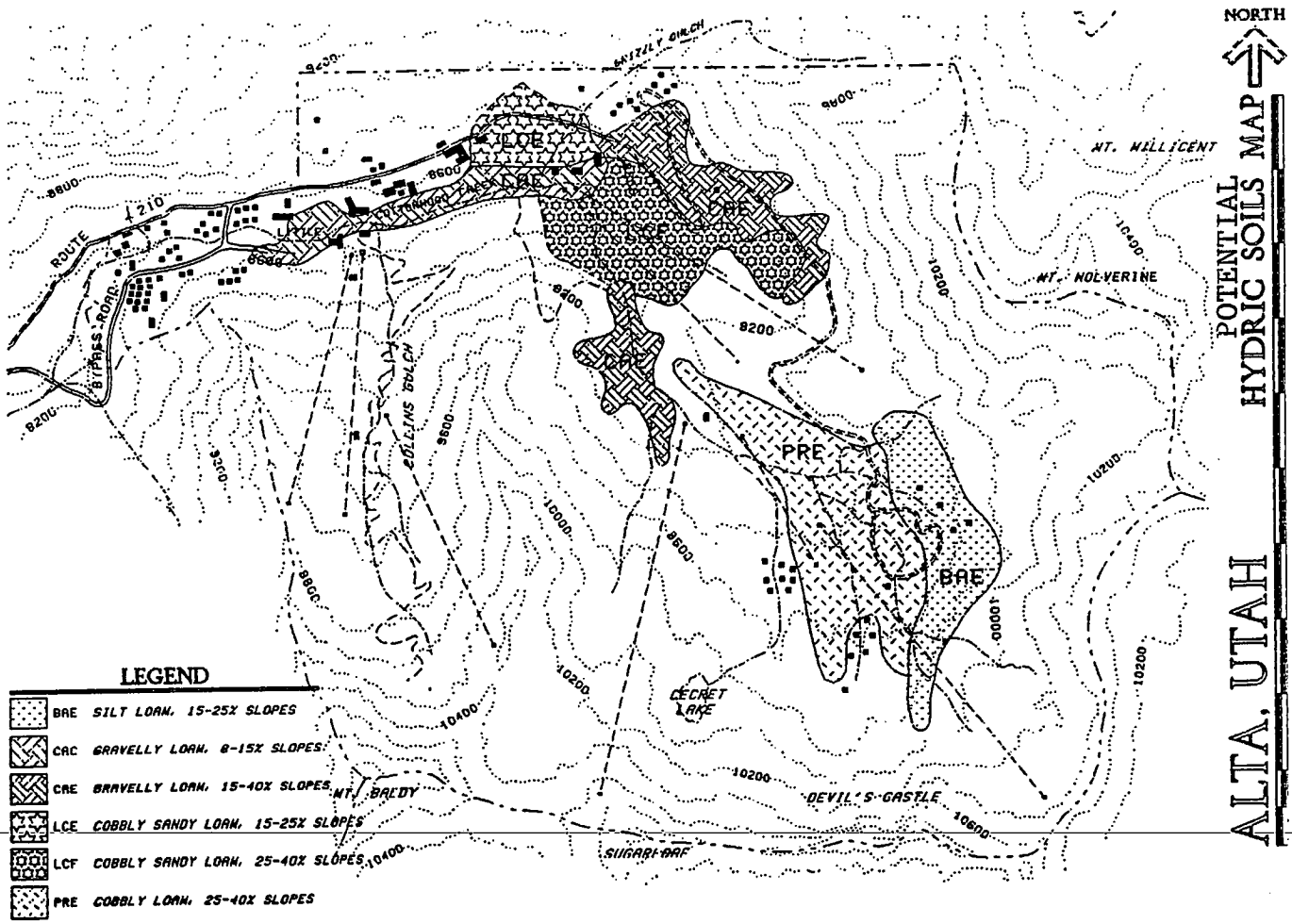

NORTH
ALTA, UTAH INVENTORY TRANSECTS
FEET 0 1000 5000 10000
LEGEND
MT. MILLICENT
MT. WOLVERINE
MT. BALDY
DEVIL'S CASTLE
SUGARLOAF
SECRET LAKE
COTTONWOOD CREEK
GRIZZLY GULCH
COLLINS GULCH
LITTLE
BYPASS ROAD
ROUTE 210
A
B
C
D
E
F
G
H
TR-1
TR-2
TR-3
TR-4
TR-5
TR-6
TR-8
9400
9600
9800
10000
10200
10400

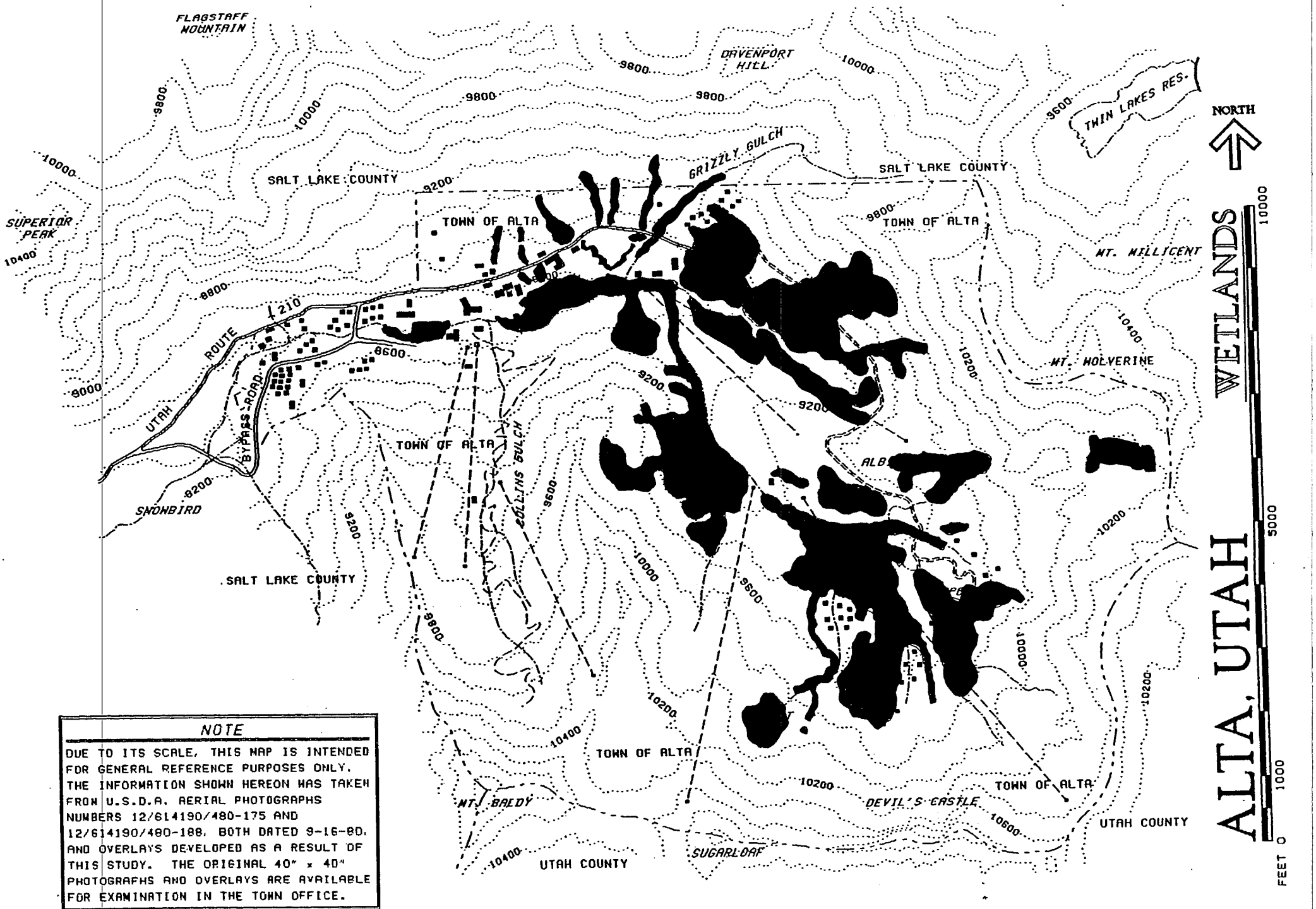


NOTE

DUE TO ITS SCALE, THIS MAP IS INTENDED FOR GENERAL REFERENCE PURPOSES ONLY. THE INFORMATION SHOWN HEREON WAS TAKEN FROM U.S.D.A. AERIAL PHOTOGRAPHS NUMBERS 12/614190/480-175 AND 12/614190/480-188, BOTH DATED 9-16-80, AND OVERLAYS DEVELOPED AS A RESULT OF THIS STUDY. THE ORIGINAL 40" x 40" PHOTOGRAPHS AND OVERLAYS ARE AVAILABLE FOR EXAMINATION IN THE TOWN OFFICE.


ALBION BASIN PLANT COMMUNITIES
WETLAND PLANT CATEGORIES BY RANGESITE
% PLANT COVERAGE BY TRANSECT
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
RANGESITE
FACW/OBL
FAC


NORTH
POTENTIAL HYDRIC SOILS MAP
ALTA, UTAH
LEGEND
BAE SILT LOAM, 15-25% SLOPES
CAC GRAVELLY LOAM, 8-15% SLOPES
CAE GRAVELLY LOAM, 15-40% SLOPES
LCE COBBLY SANDY LOAM, 15-25% SLOPES
LCF COBBLY SANDY LOAM, 25-40% SLOPES
PRE COBBLY LOAM, 25-40% SLOPES
MT. MILLICENT
MT. WOLVERINE
MT. BALDY
DEVIL'S CASTLE
SUGARLOAF
SECRET LAKE
ROLLINS GULCH
GRIZZLY GULCH
BYPASS ROAD
ROUTE 210
LCE
PRE
BAE



NOTE

DUE TO ITS SCALE, THIS MAP IS INTENDED FOR GENERAL REFERENCE PURPOSES ONLY. THE INFORMATION SHOWN HEREON WAS TAKEN FROM U.S.D.A. AERIAL PHOTOGRAPHS NUMBERS 12/614190/480-175 AND 12/614190/480-188, BOTH DATED 9-16-80, AND OVERLAYS DEVELOPED AS A RESULT OF THIS STUDY. THE ORIGINAL 40" x 40" PHOTOGRAPHS AND OVERLAYS ARE AVAILABLE FOR EXAMINATION IN THE TOWN OFFICE.

WETLAND FUNCTIONAL EVALUATION

Albion Basin wetlands are part of an upper watershed network which provides important benefits to a community of over 750,000 residents. The wetland functional assessment developed by Adamus (U.S. Department of Transportation, 1983)[6] was utilized to estimate the nature and extent of the wetlands in this upper sub-basin watershed.

The following wetland functions were evaluated for hydrophytic plant communities in Albion Basin:

1. Groundwater Discharge
2. Groundwater Recharge
3. Flood Storage
4. Shoreline Anchoring
5. Sediment Trapping
6. Pollutant Retention
7. Food Chain Support
8. Fishery Habitat
9. Wildlife Habitat
10. Recreation

The following narrative describes the relative functional values present in the Basin, together with the significance of the values for this assessment.

GROUNDWATER DISCHARGE

Stream flow augmentation is considered to be the most important function supported by groundwater discharge. In upper municipal watersheds, there is no doubt that this function is among the most important. Base flows provide long-term culinary water during the driest of months, and maintain a wealth of aquatic life important to the maintenance of good water quality, wildlife habitat and recreational values.

The total water volume discharged by Albion Basin has been only a fraction of its normal water supply; snowpack and water content has been low for the past four years, and was only about 50% of normal last year. Average volumes estimated at the Little Cottonwood Sunnyside Lift Water Quality Monitoring Station are approximately 2,787 acre-feet, compared to what normally should be at least 4,200 acre-feet.[7]

Based on snow-course data compiled near Cecret Lake in Albion Basin beginning in 1992, continuous snowpack total water equivalents extrapolated from the Alta Central snow-course, and an average Wasatch Canyon snowpack surface runoff percentage of 60%, the total surface water yield for the Basin is approximated at 4,700 acre-feet.

o Effectiveness of Groundwater Discharge in Albion Basin

Wetlands in Albion Basin provide an important stream flow maintenance function for the entire Little Cottonwood watershed. Of the entire stream flow volume contributed to the culinary water supply for Salt Lake Valley, Albion Basin contributes approximately 10%, or about 4,700 acre-feet. Since Little Cottonwood creek provides 15% of the total water supply (average of 50,000 acre-feet), it is estimated that Albion Basin supplies approximately 11,250 residents with high quality culinary water. This population is roughly equivalent to that of Midvale or Riverton, Utah.

Snowmelt storage in the upper sub-basin cirques, bowls, tarns, and geologic strata, is slowly and evenly discharged through the most of the lower montane and sub-alpine wetland communities of Albion Basin **(Figure Seven)**. The effectiveness of alpine water storage cannot be underestimated, particularly during periods of drought. The following rangesite wetlands provide effective groundwater storage and discharge functions:

WETLAND RANGESITE	WETLAND ACREAGE	SUB-BASIN ACREAGE %	SURFACE DISCHARGE	RATING
Patsy Marley Hill (Upper & Lower)	48	27%	1,269 A.F.	Very High
West Albion Basin	59	22%	1,034 A.F.	Very High
Albion Meadows	6	4%	188 A.F.	Low
Albion Loop & East Albion	22	30%	1,410 A.F.	Very High
Greely Bowl & Lower Greely	41	14%	658 A.F.	High
North Rustler	6	2%	94 A.F.	Low
TOTALS	182	99%	4,653 A.F.	
Emma Hill*	5	14%	833 A.F.	High
Creek Townsite*	13	1%	79 A.F.	Low
TOTAL	18	15%	912 A.F.	

Both of these rangesites are outside of the gaged discharge sub-basin area measured at the Sunnyside Lift Monitoring Station (includes 1960 acres), but included within the total sub-watershed area of 2,340 acres.

GROUNDWATER RECHARGE

The Wasatch Canyons in Salt Lake County are the principal recharge area to the deep confined aquifer, providing 70% of the total annual rate. The remainder of the recharge area occurs on alluvial fans at the base of the mountains, characterized by sand & gravel composition with very high permeability. As urban development increases in the valley, these foothill recharge areas will be lost, focusing more emphasis on mountain recharge.[8]

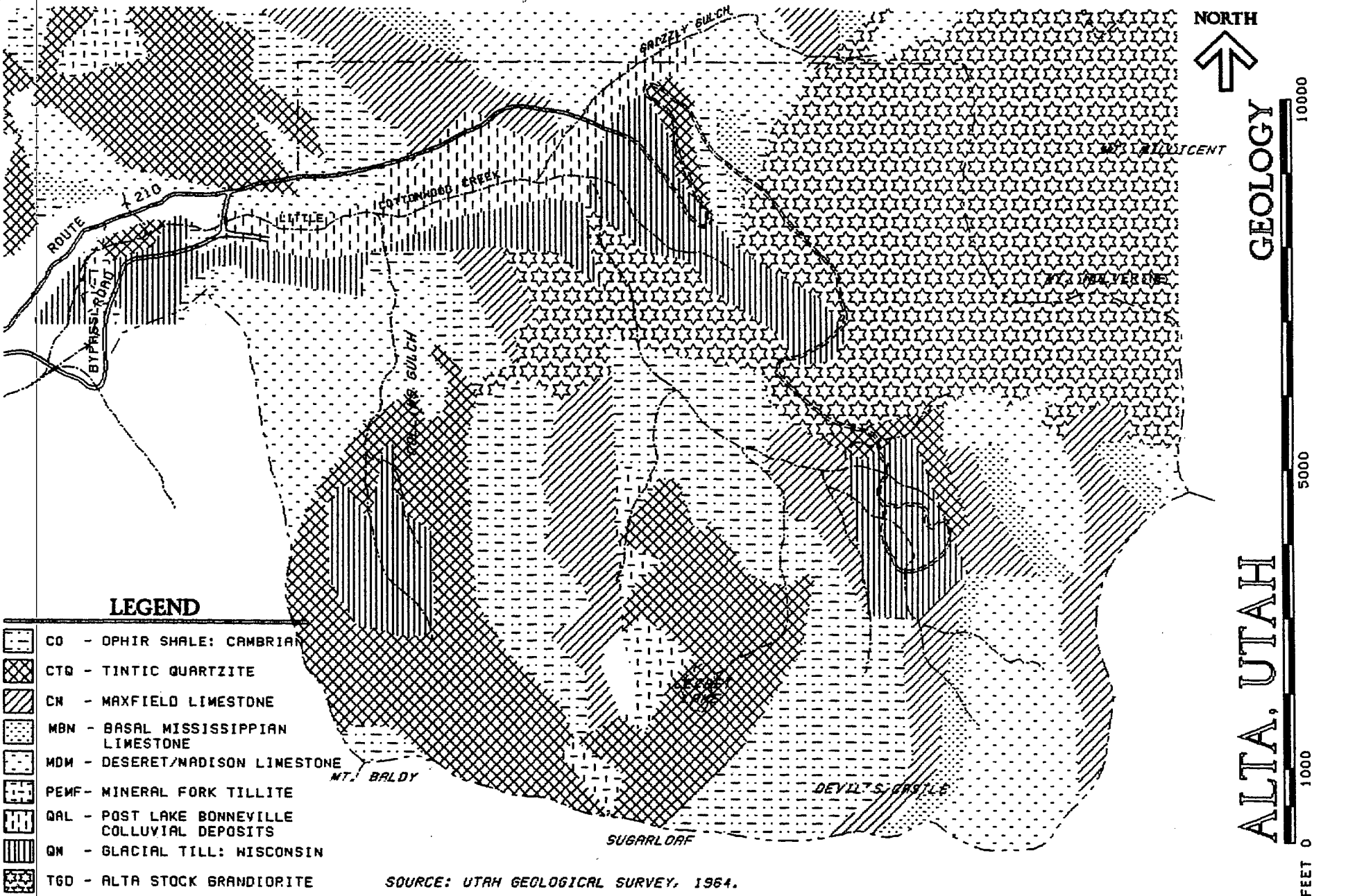
o Effectiveness of Groundwater Recharge in Albion Basin

The value and effectiveness of the groundwater recharge factor is reflected in the volume of water stored in the principal confined aquifer, and the relative source of the recharge. The U.S. Geological Survey estimates that the principal aquifer stores 60 million acre-feet of water annually, which provides a major source of the total water supply to Salt Lake valley. About 40% of the annual recharge (137,000 acre-feet) occurs in the Wasatch Canyons, through stream channel underflow and seepage from bedrock.

Based on bedrock structure, hydraulic gradient & conductivity, and saturated cross-sections, Little Cottonwood Canyon contributes the greatest proportion of underflow recharge, or 33,000 acre-feet per year. A larger proportion of the relative recharge from the Little Cottonwood watershed occurs in high mountain valleys heavily shaped and carved by glaciation. Albion Basin alone contributes approximately 3,200 acre-feet of groundwater recharge annually, which is 40% of the total water volume yield for the Basin.

Figure Seven shows the geologic features in the Basin which provide the greatest recharge opportunities. These are principally the sub-alpine cirques located near the base of the peaks, and include Devil's Castle, Catherine's Pass & Supreme Bowl, Glory Hole and Cecret Lake, and Greely Bowl. The wetlands which lie at the base of these features provide a substantial portion of this recharge, due to a combination of seasonal saturation, flatter hydraulic gradient, soil permeability and volume of water conveyed during snowmelt.[9]

The relationship between **exchange** of groundwater discharge and recharge has not been well documented, except in Wisconsin, where a study of glaciated lakes, dominated by wetland vegetation, showed 20% recharge rates, much lower than the 40% rate of the Wasatch Range.[10] The geologic structure of Albion Basin suggests that the greatest source of recharge to the principal aquifer are the tilted bedrock interstices prevalent in the upper watersheds. In this regard, the wetland communities which overlay this structure provide secondary storage for this principal recharge area later in the season.



SOURCE: UTAH GEOLOGICAL SURVEY, 1964.

- **Functional Groundwater Recharge Values for Albion Basin Wetlands**

The following rangesite wetlands provide effective storage related to groundwater discharge in Albion Basin:

WETLAND RANGESITE	WETLAND ACREAGE	SUB-BASIN ACREAGE %	GROUNDWATER RECHARGE	RATING
Patsy Marley Hill (Upper & Lower)	48	27%	864 A.F.	Very High
West Albion Basin	59	22%	704 A.F.	Very High
Albion Meadows	6	4%	128 A.F.	Low
Albion Loop & East Albion	22	30%	960 A.F.	Very High
Greely Bowl & Lower Greely	41	14%	448 A.F.	High
North Rustler	6	2%	64 A.F.	Low
TOTALS	182	99%	3,168 A.F.	
Emma Hill	5	14%	555 A.F.	High
Creek Townsite	13	1%	53 A.F.	Low
TOTALS	18	15%	608 A.F.	

- **The Combined Importance of Groundwater Recharge/Discharge**

Among the functional values provided by wetlands, the combined values of groundwater discharge and recharge are most evident in lower montane and sub-alpine communities. Water supply for both surface and sub-surface downstream uses are provided by these unique ecosystems.

The weight of these functions for local watersheds should not be discounted, particularly in view of the high quality of the resource, and its status as an anti-degradation segment protected under federal, state, and local water quality legislation.

FLOOD STORAGE

Peak flow de-syncronization is considered to be very high in certain lower montane and sub-alpine ecosystems, because of storage functions performed by deep cirque sub-basins, and permeability & water holding capacity of soils associated with wetlands. Wetlands which occur in these ecosystems help to attenuate seasonal flood peaks downstream, which in Salt Lake valley have the potential for great amounts of damage.

> In a Wisconsin study (Novitzki, 1979), peak stream discharge was significantly lower in basins with large lake and wetland areas than in basins with little or no wetland area. Consequently, loss of wetland from basins with already limited wetland surface areas was expected to have a greater impact on stream discharge than in those with a large wetland area.[11]

Flood peak reduction has been estimated as high as 75-80% in watersheds occupied by 30% wetlands. Watersheds with 15% of its area in wetlands will produce flood peaks 60-65% lower than if wetlands were absent.

o Characteristics of Wetlands with High Flood Storage Value

The major watershed factors which affect wetland functional value for flood storage are described by Adamus (1983). These include ability of upslope areas to retain and dissipate runoff, above and below-ground basin storage capacity, frictional resistance, and position of the wetland in a watershed.

Upslope retention and dissipation of runoff is performed in the same upper basin cirques and glacial structures shown in **Figure Seven.** These areas provide significant below-ground storage capacity for snowmelt, and gradually release water to above-ground storage in broad wetland complexes.

A good example is the hydraulic relationship between Devil's Castle Cirque and the broad, saturated, persistent-emergent wetlands of the West Albion province. The vegetation in this area provides extensive frictional resistance from dense high-altitude wetland plant communities. Many of the wetlands, particularly peat-dominated fens, store water year-round, and have remarkably high storage capacity, in both surface and sub-surface horizons.

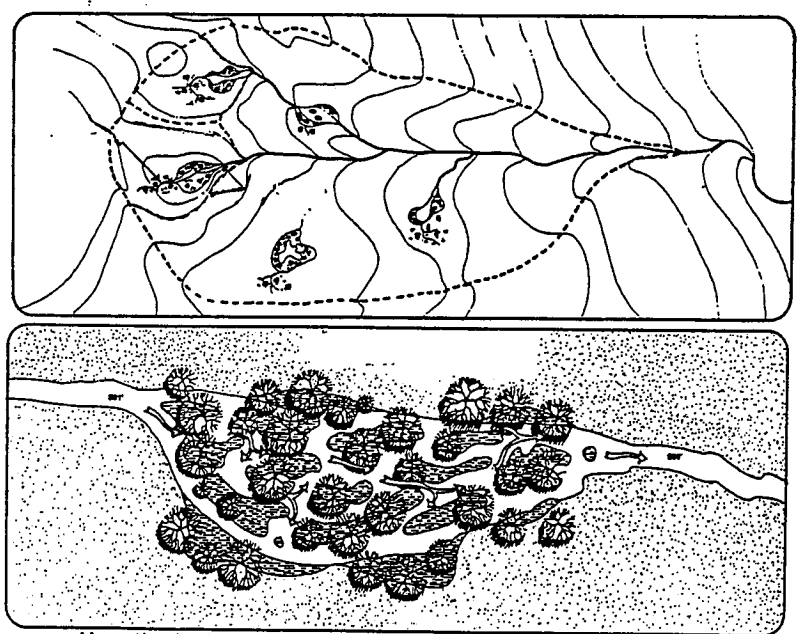
Based on Novitzki's studies the following ratings are derived:

5% Wetland Area = 50% flood peak reduction = moderate
15% Wetland Area = 65% flood peak reduction = high
30% Wetland Area = 80% flood peak reduction = very high

o Effectiveness of Flood Storage in Albion Basin

The following rangesite wetlands are significant for flood storage, based on ratios of wetlands to total sub-watershed acreage:

WETLAND RANGESITE	SUB-BASIN ACRES	WETLAND ACRES	RATIO %	RATING
Patsy Marley Hill (Upper & Lower)	520	40	8%	Moderate
West Albion	440	59	13%	High
Albion Meadows	80	6	7%	Moderate
E.Albion Basin/Loop	600	22	3%	Low
Upper/Lower Greely	280	41	15%	High
North Rustler	40	6	15%	High
Creek Townsite	33	13	40%	Very High
Emma Hill	347	5	1%	Low
TOTALS	2340	200	9%	Moderate/High



(8)

Hypothetical example of one type of wetland whose probability of being effective for flood storage and desynchronization might be high

STREAMBANK ANCHORING AND DISSIPATION OF EROSIVE FORCES

Fibrous root complexes of a variety of wetland plants provide stability in mountain watersheds by anchoring streambanks, thus preventing bank degradation from erosion. Dissipation of erosive forces is defined here as diminishment of energy associated with seasonal peak flows, which reduces downstream sedimentation or aggradation.

This diminishment of peak flow energy occurs not only streamside, but in upstream plant communities which interact with flood storage to reduce peak flows and erosion and interrupt degradation to the receiving stream. Since Little Cottonwood Creek and its tributaries are "anti-degradation" segments with special protection under federal, state, and local water quality regulations, this particular function is an important resource conservation value.

Adamus summarizes some of the principal processes which affect this function. They include: Erodibility of the area and banks being protected, location of wetlands relative to areas with high erosion hazard and areas needing protection, ability of wetland plants to anchor the soil, frictional resistance, and energy associated with erosive forces.

o Soil Erosion Hazard in the Basin

The Soil Conservation Service has identified soils in the Basin which are rated from low to high erodibility. Instability hazard has also been documented, which identified soils which tend to slip, slide or creep, especially when saturated during spring runoff.[12] These features are shown in **Figures Nine and Ten.**

o Wetlands Located Relative to Areas of Hazard

Figure Nine shows wetlands located down-gradient of high erosion hazard and instability. These wetlands have high functional values for the protection of the upper watershed against erosion and stream degradation.

o Frictional Resistance and Soil Anchoring

Figure Ten (Instability Hazard) places a value on wetlands which provide efficient soil anchoring. These wetlands are generally wide and quite dense in both surface and subsurface structure, and located on slopes which provide more extensive rooting, by performing important energy dissipation. Wetlands with persistent or perennial vegetation are likelier to be more effective on a net annual basis.

- **Effectiveness of Albion Basin Wetlands in Providing Streambank Anchoring and Erosion Control**

The table below illustrates index values developed for processes which influence the natural erosion control and anchoring of the Basin. Methods used to estimate these indices are described in **Appendix B.**

RANGESITE WETLAND ACREAGE	EROSION/INSTABILITY HAZARD INDEX	EROSIVE ENERGY INDEX	FRICTIONAL RESISTANCE
Lower Patsy Marley 40 Acres	148	60	28
West Albion Basin 59 Acres	100	77	64
Albion Meadows 6 Acres	15.2	9.6	11.4
Albion Loop 6 Acres	13.4	8.4	7.5
East Albion Basin 16 Acres	72	32.4	18
Greely Bowl 7 Acres	Not Rated	18.2	11.2
Lower Greely 34 Acres	55.7	46.5	33
North Rustler 6 Acres	25.8	18	19
Creek Townsite 13 Acres	39	14.3	23.4
Upper Patsy Marley 8 Acres	20.8	23.2	17
Emma Hill 5 Acres	23	11.2	8.3

SEDIMENT TRAPPING, NUTRIENT AND METAL ION RETENTION

Wetlands trap sediment in mountain environments by intercepting runoff from erodible land and settling inorganic particulate matter within upper root zones and soil substrate. Most sediment is inorganic, with a very small fraction of organic colloidal substance (more characteristic of dissolved solids).

Adamus defines either short or long term sediment trapping. Short term is considered 30 days to 5 years, and long term is considered over five years. Except for steep terrain in the Basin that possesses a high fraction of fine sediment, most loads to upper Basin streams originate from land disturbance associated with construction, silviculture, ski slope development, stream diversions, or other man-induced perturbations.

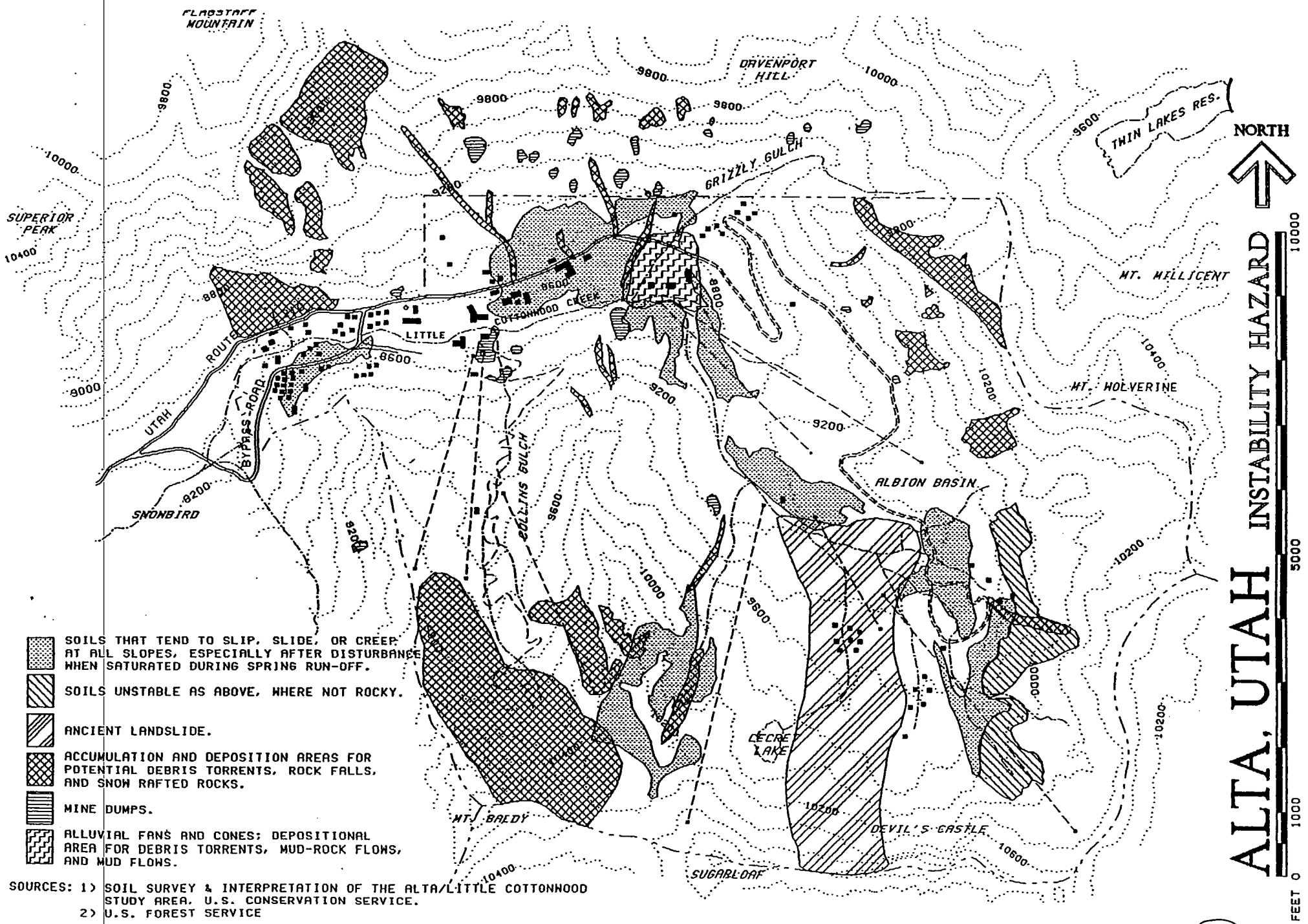
Under the regulations governing anti-degradation of high quality streams, natural background turbidity cannot be exceeded by more than 10%. This makes upper watershed wetlands increasingly valuable for water quality protection. Studies on wetlands show retention of up to 94% of the incoming sediment.[13] Regression studies in Minnesota indicate that by maintaining 10% of a watershed in wetland, sediment retention is maximized. Larger acreages of wetland yield minimal additional reduction.[14]

Sediment trapping capacity of individual wetlands is also defined in terms of vertical accretion rates. Riverine-associated palustrine wetlands have been reported accreting at 1.70 cm/yr.[15]

o Characteristics of Wetlands with High Sediment Trapping

Albion Basin wetlands provide sediment trapping particularly in areas where disturbance has occurred or where watershed conditions are prone to and are actively eroding. Within the context of high erosion hazard potential, known areas of excess sedimentation have been documented using remote sensing and field techniques **(Figure Eleven)**. This figure indicates the main sources of sediment degradation or erosion, as well as areas of aggradation, or accretion.

Accretion is more pronounced on wetland rangesites with flatter gradients, and is observed in certain emergent-persistent plant communities composed largely of carex aquatilis and juncus species. Some accretion occurs within veratrum communities adjacent to drainages dominated by salix. The steep hillside communities display both reduction and accretion of sediment, i.e. degradation within the channels, and aggradation adjacent to the channels.



SOILS THAT TEND TO SLIP, SLIDE, OR CREEP AT ALL SLOPES, ESPECIALLY AFTER DISTURBANCE WHEN SATURATED DURING SPRING RUN-OFF.

SOILS UNSTABLE AS ABOVE, WHERE NOT ROCKY.

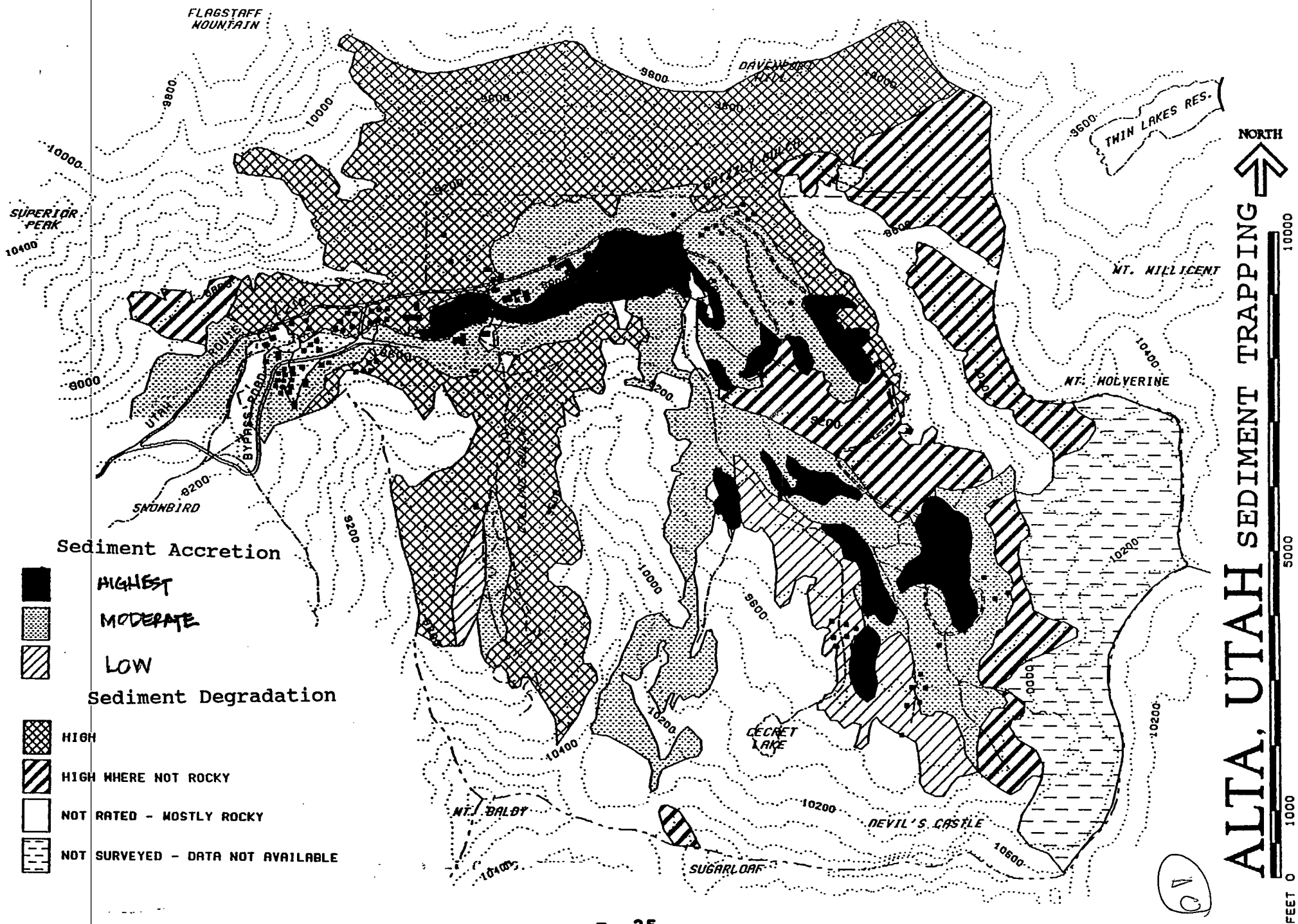
ANCIENT LANDSLIDE.

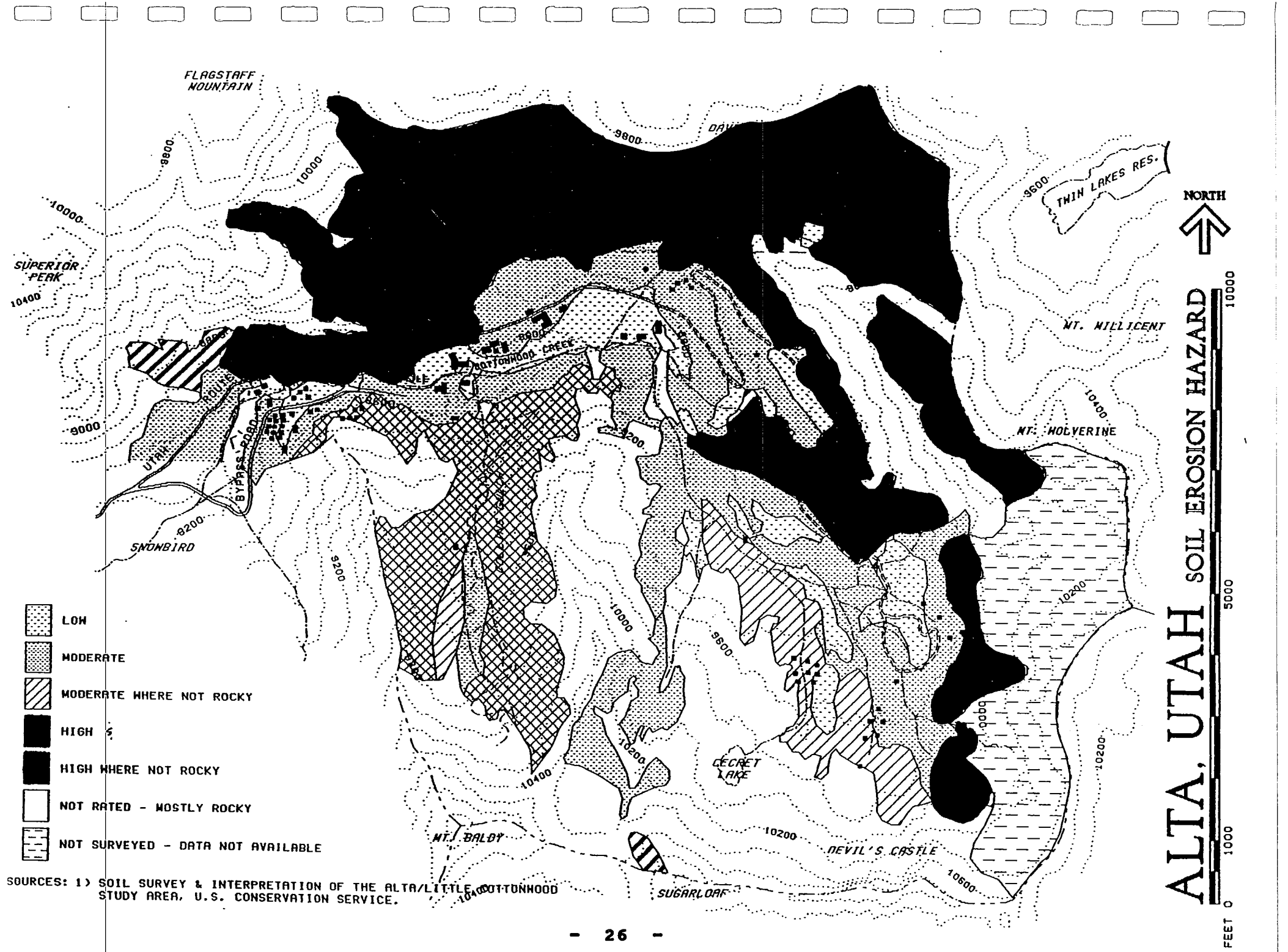
ACCUMULATION AND DEPOSITION AREAS FOR POTENTIAL DEBRIS TORRENTS, ROCK FALLS, AND SNOW RAFTED ROCKS.

MINE DUMPS.

ALLUVIAL FANS AND CONES: DEPOSITIONAL AREA FOR DEBRIS TORRENTS, MUD-ROCK FLOWS, AND MUD FLOWS.

SOURCES: 1) SOIL SURVEY & INTERPRETATION OF THE ALTA/LITTLE COTTONWOOD STUDY AREA. U.S. CONSERVATION SERVICE.
2) U.S. FOREST SERVICE


FLAGSTAFF MOUNTAIN
SUPERIOR PEAK
SNOWBIRD
TWIN LAKES RES.
NORTH
MT. MILLICENT
MT. WOLVERINE
SECRET LAKE
MT. BALDY
DEVIL'S CASTLE
SUGARLOAF
ALTA, UTAH SEDIMENT TRAPPING
FEET 0 1000 5000 10000
Sediment Accretion
HIGHEST
MODERATE
LOW
Sediment Degradation
HIGH
HIGH WHERE NOT ROCKY
NOT RATED - MOSTLY ROCKY
NOT SURVEYED - DATA NOT AVAILABLE


ALTA, UTAH SOIL EROSION HAZARD
NORTH
FEET 0 1000 5000 10000
LOW
MODERATE
MODERATE WHERE NOT ROCKY
HIGH
HIGH WHERE NOT ROCKY
NOT RATED - MOSTLY ROCKY
NOT SURVEYED - DATA NOT AVAILABLE
SOURCES: 1) SOIL SURVEY & INTERPRETATION OF THE ALTA/LITTLE COTTONWOOD STUDY AREA, U.S. CONSERVATION SERVICE.
FLAGSTAFF MOUNTAIN
SUPERIOR PEAK
TWIN LAKES RES.
MT. MILLICENT
MT. WOLVERINE
DEVIL'S CASTLE
SUGARLOAF
MT. BALDY
SNOWBIRD
SECRET LAKE
BYPASS ROAD
UTAH
9800
10000
10400
9600
9200
9000
10200
10600

o Characteristics of Wetlands with High Nutrient Retention

Like sediment, nutrients (mainly nitrogen and phosphorus) are retained and stored in wetland substrate. Persistent emergent species have higher rates of uptake and storage due the structure and type of plant biomass, but also are more likely to export or "pump" nitrogen back into water columns. Woody vegetation, such as scrub-shrub wetlands, possess lower rates of uptake, but store nutrients over a long period of time, and so have a higher capacity for retention.

An exception to this general rule is peat, normally accumulated in sub-alpine fens, where nutrient storage has been estimated between 3,000 to 12,000 years. Fens are characterized by very low sub-basin gradients and sheet flows within irregularly shaped, densly wooded or vegetated meadows with constricted outlets. The fen beneath Cecret Lift possesses these traits.

Average percentages of retained or removed nutrients are reported by Adamus for palustrine emergent and palustrine forested wetlands. The range for Phosphorus is between 7-91%, with an average of 38%. The range for Nitrogen is between 21-61%, with an average of 44%.

o Retention of Metal Ions

In a 1989-90 study of a 1/10th acre wetland swale and pond adjacent to the Goldminer's Daughter parking area in Alta, sediment and metal ions were substantially reduced during runoff events.

Average retention of sediment during this period was 84%; retention of total lead was 83%; retention of total zinc was 85%.

The retention of polluted runoff occurred in a 300' wetland swale occupied principally by juncus and equisetum species. Some retention occurred within the terminal constructed wetland aquatic bed with an average depth of 18" and an area of 750 sq.ft, inhabited by the same plant species. Given the relative small density of the plant communities, this case study provides a conservative index for effectiveness of retention in upper basin wetlands.[16]

Treatment efficiencies for Albion Basin should be greater because the ratio of disturbed area to wetlands in the upper Basin is higher. The ratio of impervious area to wetland is 50/1 at the Goldminer's site (5 acres disturbed area to 1/10th acres wetland), where pollutant reduction percentages are approximately 85% for all parameters. The ratio in Albion Basin is roughly 1/15 (1 acre disturbed area to 15 acres of wetland).

- **Effectiveness of Albion Basin Wetlands in Providing Sediment Trapping, Nutrient and Metal Ion Retention**

The table below illustrates index values derived from literature and local data sources. Emergent-persistent wetlands are most effective at short-term trapping & retention functions. The trapping rating is derived from the product of acreage, source, and accretion rate. Pollutant retention is the sum of values developed in the index located in Appendix B-5.

WETLAND ACREAGE Emergent-Persistent		SEDIMENT SOURCE	ACCRETION RATE	TRAPPING RATING	POLLUTANT RETENTION
Patsy Marley:	6	1	10.2	61	310
West Albion:	29	3	49.3	4289	1499
Albion Meadows:	3	2	5.1	31	154
Albion Loop:	1.8	3	3.0	16	93
East Albion:	7.5	3	12.8	288	389
Greely Bowl:	3.5	1	5.9	21	180
Lower Greely:	5	3	8.5	128	259
North Rustler:	1	1	1.7	2	51
Creek Townsite:	1.5	3	2.5	11	77
Upper Patsy Marley:	1.5	1	2.5	4	77
Emma Hill:	0	3	< 1	N/A	N/A

FOOD CHAIN SUPPORT: PRIMARY AND SECONDARY PRODUCTIVITY

Food chain support is specifically defined by Adamus as:

> "...the direct or indirect use of nutrients, in any form, by animals inhabiting aquatic environments...and pertains to use of nutrients by fish and aquatic invertebrates of commercial or sport value."

The major processes described relative to this definition include: Productivity and nitrogen-fixing ability of potential food sources and their dispersal and cycling; the utilization of food sources in terms of quantity, quality, sequencing and availability, and dependance.

This process is subdivided into primary production values and secondary production values:[17]

Primary productivity values apply to "the direct and indirect relationships of plant morphology and biomass to higher levels in the food web" and include food source, substrate for plant and animal growth, animal shelter and nesting material, and sediment traps."

Secondary values apply to resource interactions which maintain the capacity of any ecosystem to partially or completely sustain animal life cycles and populations. Density and diversity of interacting populations are a typical measure used to determine these conditions. Kusler (1983) identifies some of these interactions within wetlands including:[18]

A. The amount of open water and arrangement of vegetation around it.
B. Diversity of wetland vegetation and distribution of plant associations.
C. Size of wetland and accessiblity to surrounding habitats.
D. Proximity to other wetlands, lakes, streams, and other topographic features.
E. Water chemistry and permanence.
F. Frequency and severity of water level fluctuations.

The Jordan River Wetland Advance Identification Study completed in 1986 conducted inventories of macroinvertebrate populations within representative wetland sub-basins along the River corridor. The inventory established macroinvertebrate density and diversity indices which were correllated mainly with local avian populations. This rather narrow relationship formed the basis of the food chain functional value in that study.[19]

- **Effectiveness of Albion Basin Wetlands in Providing Food Chain Support**

Food chain support in upper Albion Basin is interpreted more broadly, in that without specific aquatic biological data, values based on known habitat interactions must apply. The table below illustrates how Kusler's interactions (A thru F) may prioritize wetlands in the Basin for food chain values:

WETLAND RANGESITE	APPLICABLE ECOSYSTEM INTERACTIONS						
	A	B	C	D	E	F	Totals
Patsy Marley Hill	2	2	2	3	2	2	13
West Albion Basin	3	3	3	3	3	3	18
Albion Meadows	1	3	2	3	0	1	10
Albion Loop	3	1	3	3	2	1	13
East Albion Basin	2	3	2	2	2	1	12
Greely Bowl	1	2	1	1	1	1	7
Lower Greely	3	3	3	3	3	2	17
North Rustler	2	2	2	2	2	2	10
Creek Townsite	3	2	2	1	2	3	13
Upper Patsy Marley	2	2	2	3	2	2	13
Emma Hill	1	1	1	2	1	1	7

High Value = 3 Moderate Value = 2 Low Value = 1

These criteria provide a partial framework for evaluating food chain support. Wildlife habitat functional values provide additional interactions and weights for this value, since they deal with primary productivity factors, mainly food source, substrate for plant & animal growth, and animal shelter & nesting habitat.

FISHERY AND WILDLIFE HABITAT

Fishery habitat is restricted in Albion Basin by seasonal flow, obstructions (Snake Pit Falls), and climate. The Utah Division of Wildlife Resources usually plants the creek segment in the Townsite, which provides the only functional value for fisheries in the Basin.

Wildlife habitat is diverse in Albion Basin. Availability of cover, food, and habitat support a wide variety of terrestrial animals, including a large and interesting avian population.

o Diversity and Interspersion

Wetland diversity within a single basin is characterized by linear exposures or "edge effects," resulting in both wetland and upland bird density and diversity.[20] Fur-bearing animals also use networks composed of these linear edges for feeding, nesting, and resting. The literature assume that the limits to this edge effect are generally size restricted:

> "This threshold is presently unknown for most species, but preliminary data from nonwetland habitats, possibly applicable to forested wetlands, suggests that diversity decreases rapidly once the stand becomes smaller than about 80 acres. The exact threshold may vary not only by species, but also by season, and the 'hardness' of the edge. For example, edges between open water and blocks of tall vegetation are probably of greater ecological consequence than 'soft' edges at the transition between scrub-shrub and forested wetlands."[21]

This model applies to specialized habitat needs or systems like valley riverways, dominated by migratory waterfowl. Other literature clarify the values of upper elevation systems:

> "Rocky Mountain floodplains and wetlands have the highest avifauna species richness and density in habitats with mature hydric shrub cover and complex plant species composition."[22]

Willow carrs and diverse mountain riparian zones are valuable nesting sites for Wilson warblers, Lincoln sparrows, fox sparrows, nighthawks, violet-green swallows, tree swallows, water ouzels, white ptarmigan, coots, and red-tailed hawks. Deer populations in Albion Basin extensively utilize willow carrs for feeding, resting, and nesting habitat between April and November when snowpack begins to clear on lower elevations.

- **Effectiveness of Albion Basin Wetlands in Providing Wildlife Habitat Values**

Based on estimated "edge effects" provided by topographic conditions, hydrology, and diversity of plant cover in the Basin, the following wetland rangesites provide effective wildlife habitat:

WETLAND RANGESITE Linear Edge (Ft.)	AVIAN/SMALL MAMMAL Index	LARGE MAMMAL Index	TOTAL Value
Lower Patsy Marley 17,600	704	493	1197
West Albion Basin 47,000	2773	376	3149
Albion Meadows 6,000	36	10	46
Albion Loop 12,500	75	22	97
East Albion Basin 10,700	171	70	241
Greely Bowl 3,000	21	11	32
Lower Greely 16,000	544	464	1008
North Rustler 4,000	24	20	44
Creek Townsite 11,000	143	72	215
Upper Patsy Marley 5,600	45	36	81
Emma Hill 7,700	39	39	78

(Index equals product of linear area and acreage of appropriate wetland classification. Only scrub-shrub used for large mammal index; total wetland acreage for avian/small mammal).

PASSIVE RECREATION & HERITAGE VALUE

Active recreational values are typically applied to water-dependent sporting activities such as swimming, canoing, or kayaking. Although none of these recreational forms apply to Albion Basin wetlands, many passive activities are known to occur during summer months.

For purposes of this discussion, passive recreational activities include the use of wetlands for nature study, educational field trips or scientific research, picnicking, camping, hiking and backpacking. The enjoyment of unique botanical features and birdwatching are important components of nature study in the Basin during much of the summer season.

The most applicable wetland recreational value criteria suggested by Larson (1976) and Schuldiner, et.al., (1979) in the Adamus functional assessment framework include:[23]

A. Presence of rare, restricted, or endemic flora/fauna.
B. Having flora or fauna at or very near the limits of their geographic range.
C. Wetland types relatively scarce in a geographic region.
D. Having flora of unusually high visual quality and locally infrequent occurrence.
E. Having outstanding or uncommon geomorphological features.
F. Having several stages of wetland succession in close juxtaposition.

- **Effectiveness of Albion Basin Wetlands in Providing Passive Recreation and Heritage Values.**

Based on data compiled during the study and local observations, the following wetlands provide passive recreation values based on recreational value criteria A-F above:

WETLAND RANGESITE	APPLICABLE PASSIVE RECREATION CRITERIA						
	A	B	C	D	E	F	Totals
Patsy Marley Hill	1	3	2	2	2	1	11
West Albion Basin	3	3	3	3	3	3	18
Albion Meadows	3	3	3	3	2	1	15
Albion Loop	1	1	1	2	2	1	8
East Albion Basin	3	3	2	3	3	2	16
Greely Bowl	1	3	2	2	2	1	11
Lower Greely	1	3	1	3	3	1	12
North Rustler	1	3	1	2	2	1	10
Creek Townsite	1	2	1	2	2	1	9
Upper Patsy Marley	1	3	1	2	2	1	10
Emma Hill	1	3	1	3	2	1	11

High Value = 3 Moderate Value = 2 Low Value = 1

The following activity criteria are suggested to further categorize wetlands based on known passive recreation values:

WETLAND RANGESITE	HIKE	PICNIC	CAMP	BIRD-WATCH	SCIENTIFIC STUDY	WINTER SPORTS	TOTAL
Patsy Marley Hill	1	1	1	3	2	1	9
West Albion Basin	3	2	2	3	3	3	16
Albion Meadows	2	2	1	3	3	3	14
East Albion Basin	3	2	1	3	3	3	15
Albion Loop	2	3	3	3	3	3	17
Greely Bowl	3	3	2	2	3	3	16
Lower Greely	1	1	1	2	2	3	10
North Rustler	3	1	1	2	2	3	12
Creek Townsite	1	2	1	3	2	3	12
Upper Patsy Marley	3	1	2	3	2	2	13
Emma Hill	3	1	1	3	3	2	13

High Value = 3 Moderate Value = 2 Low Value = 1

- **Educational and Scientific Opportunities**

The unique properties of lower montane and sub-alpine wetlands in Utah offer important opportunities for public awareness and scientific investigation. Since these areas anchor upper watershed ecosystems, their importance to man must be emphasized. Some educational opportunities exist in Albion Basin for both educational and scientific investigation activities:

- Sub-basin restoration/enhancement of areas modified by construction, permanent facilities, or intensive human use. Such activities are well adapted for volunteer groups or interest groups desiring to participate in a mountain, rather than urban restoration experience.

- Interpretive signing of popular trails, describing values typically ignored by the hundreds of casual hikers which visit Albion Basin each year. Such signing may help to prevent damage to very sensitive areas of high ecologic significance.

- Outdoor classroom activities for students of all ages who have little awareness or familiarity with mountain wetlands.

- Further research and assessment of food chain support systems, patterns of interspersion and dependence, and inventory of both aquatic and terrestrial life forms.

FUNCTIONAL VALUE RATINGS OF ALBION BASIN WETLANDS

Ratings for wetlands in the Basin are derived from the sum of the qualitative indexes developed for each functional value.

1. Groundwater Discharge

The rating is derived from a numerical value reflecting annual estimated surface discharge to Little Cottonwood Creek in acre-feet. For example, the surface discharge estimated for Patsy Marley Hill is 1,269 acre-feet, with a rating value fraction of 12. The rating for North Rustler is based on 94 acre-feet, or .9, a similar relative fraction of the estimated discharge.

2. Groundwater Recharge

Uses the same fraction method as in groundwater discharge.

3. Flood Storage

This index is based on the percentages of wetlands in the Basin compared to total sub-watershed acreage, as developed by Novitski (1979).

4. Streambank Anchoring/Dissipation of Erosion

This value is derived from a fraction of the sum of indices which include erosion/instability hazard, erosive energy, and frictional resistance.

5. Sediment Trapping, Nutrient & Metal Retention

Derived from a fraction of total index values for sediment source, accretion rate, trapping rate, and pollutant retention.

6. Food Chain Support

Based on a the sum of relative values, high-moderate-low, derived from Kusler's (1983) six ecosystem interactions.

7. Fishery & Wildlife Habitat

As described before, fishery habitat is physically restricted within the Basin and was not rated. Wildlife habitat is based on a fraction of the total indices for avian/small mammals and large mammals potentially using the area by habitat type and linear edge effect.

8. Passive Recreation & Heritage Value

These ratings are based on high-moderate-low values derived from Larson's (1976) six wetland recreational value criteria.

FUNCTIONAL VALUE TOTALS

The table below summarizes the total relative values estimated for each wetland rangesite:

WETLAND RANGESITE	FUNCTIONAL VALUE								
	1	2	3	4	5	6	7	8	Total
Patsy Marley Hill	12	8	8	23	38	13	119	20	241
West Albion Basin	10	7	13	24	158	18	314	34	578
Albion Meadows	2	1	7	3	19	10	4	29	75
Albion Loop	14	9	3	2	27	13	9	23	100
East Albion Basin	14	9	3	12	70	12	24	37	181
Greely Bowl	6	4	15	2	21	7	3	26	84
Lower Greely	6	4	15	13	40	17	100	22	217
North Rustler	1	.6	15	6	.5	10	4	22	59
Creek Townsite	.7	.5	40	7	.9	13	21	21	104
Upper Patsy Marley	12	8	8	6	.8	13	8	23	79
Emma Hill	8	5	1	4	.03	7	7	22	54

WETLAND RANKING

Based on total estimated points of the eight functional value indices, the following ranking can be considered in evaluating future management actions for Albion Basin wetlands:

WETLAND RANGESITE	TOTAL FUNCTIONAL VALUE FRACTION
1. West Albion Basin	57
2. Lower Patsy Marley Hill	24
3. Lower Greely	21
4. East Albion Basin	18
5. Creek Townsite	10
6. Albion Loop	10
7. Greely Bowl	8
8. Upper Patsy Marley Hill	7
9. Albion Meadows	7
10. North Rustler	5
11. Emma Hill	5

PREDOMINANT LAND USE AND OWNERSHIP

The dominant land use in Albion Basin is forested watershed, administered by the U.S. Forest Service. Within the 2,340 acre sub-watershed area, about 200 acres is privately owned. About half of the private holdings are in the upper portion of Albion Basin, with the remaining half located in the vicinity of the Creek Townsite, Emma Hill, and Patsy Marley Hill.

o Private Residential Use and Development Potential

The majority of the private land is zoned FR-1 for single family detached residential lots. This zone applies to all existing plats including the Cecret Lake, Albion Alps, Albion Basin, Patsy Marley, and Grizzly Gulch subdivisions. Although only about 20 of the 80 residential lots of record have been developed, there is potential for additional activity on sixty remaining lots, if water is made available. The availability of water is controlled by Salt Lake City corporation.

If water is made available to owners of recorded lots, an additional 60 lots in the upper Basin, and an unknown number of lots on Patsy Marley Hill, could impact natural resource values in the Basin. Construction runoff and runoff from impermeable surfaces such as roofs, roads, and garages will increase pollutants to Little Cottonwood Creek. Although State Anti-degradation policy requires no new point discharges--treated or otherwise--creation of new non-point sources of pollution will occur. These sources are required to be managed to the maximum extent feasible. What constitutes "maximum extent" or "feasible" is typically dictated by economic trade-offs.

o Alta Lift Company and U.S. Forest Service Management

The entire sub-basin is managed as a year-round recreational resort by the U.S. Forest Service and its lessee, Alta Ski Lift Company. The upper basin alone receives, conservatively estimated by the Forest Service, about 16,000 annual summer visits. About 6,000 of the visits occur within the Albion Loop campground. The remaining 10,000 visits are attracted by Cecret Lake and Catherine's Pass trails.[24] Winter visitation is extremely high, with about 900,000 visits per year in Little Cottonwood Canyon, about half of which occurs at the Alta Ski Resort.[25]

Alta Lift Company has a well-recognized and responsible record in the area of natural resource management. The relationship between the Forest Service and Lift Company has produced a quality level of stewardship throughout the Basin, which provides critically important municipal watershed values. The Lift Company has been a leader in native high altitude revegetation techniques, and has initiated a tree replacement program as part of its operation, including a modest nursery for conifer propagation.