Overview of Environmental and Hydrogeologic Conditions at Dutch Harbor, Alaska

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U.S. GEOLOGICAL SURVEY

Open-File Report 95-411

Prepared in cooperation with the

FEDERAL AVIATION ADMINISTRATION

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By Kathleen J. Lemke *and* Ann M. Vanderpool

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Anchorage, Alaska
1995

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
Gordon P. Eaton, Director

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Denver, CO 80225-0425

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CONVERSION FACTORS

Multiply	By	To obtain
millimeter (mm)	0.03937	inch
meter (m)	3.281	foot
kilometer (km)	0.6214	mile
square kilometer (km^2)	0.3861	square mile
kilometer per hour (kph)	0.6214	mile per hour
liter per day (L/d)	0.2642	gallon per day
hectare (ha)	2.471	acre

In this report, temperature is reported in degrees Celsius (°C), which can be converted to degrees Fahrenheit (°F) by the following equation:

$$°F = 1.8\ (°C) + 32$$

VERTICAL DATUM

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929—A geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Overview of Environmental and Hydrogeologic Conditions at Dutch Harbor, Alaska

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Abstract

The Aleutian Island village of Dutch Harbor, Alaska, has mild winters, cool summers, and abundant rainfall. Bedrock in the area is altered sedimentary and volcanic rock that is fractured and faulted. Numerous lakes and streams are in the area and ground water is plentiful. The water supply for the village of Dutch Harbor is trucked from nearby Unalaska which obtains its water from lakes, streams, and shallow ground water. The FAA facilities are located near the north side of the village of Dutch Harbor. Fuel spills and disposal of hazardous materials may affect ground and surface water in the vicinity of these facilities.

INTRODUCTION

The Federal Aviation Administration (FAA) owns and (or) operates airway support and navigational facilities throughout Alaska. Fuels and potentially hazardous materials such as solvents, polychlorinated biphenyls, and pesticides may have been used and (or) disposed of at many of these sites. To determine if environmentally hazardous substances have been spilled or disposed of at any of these sites, the FAA is conducting environmental studies mandated by the Comprehensive Environmental Response, Compensation, and Liability Act and the Resource Conservation and Recovery Act. To complete these more comprehensive environmental studies, the FAA requires information on the hydrology and geology of areas surrounding the facilities. This report is the product of compilation, review, and summary of existing hydrologic and geologic data by the U.S. Geological Survey, in cooperation with the FAA, and provides such information for the FAA facilities and nearby areas at Dutch Harbor, Alaska. Also presented in this report is a brief description of the FAA facility history and physical setting of the region surrounding Dutch Harbor.

BACKGROUND

Location

The Dutch Harbor FAA facilities are located near the fishing village of Dutch Harbor at lat 53° 54' N., long 166° 32' W., about 1,200 km west-southwest of Anchorage (fig. 1). Dutch Harbor is on the southeast side of Amaknak Island which is in Unalaska Bay and is connected to Unalaska Island and the city of Unalaska by a 200-meter-long road bridge. Unalaska Island is part of the Aleutian Island chain.

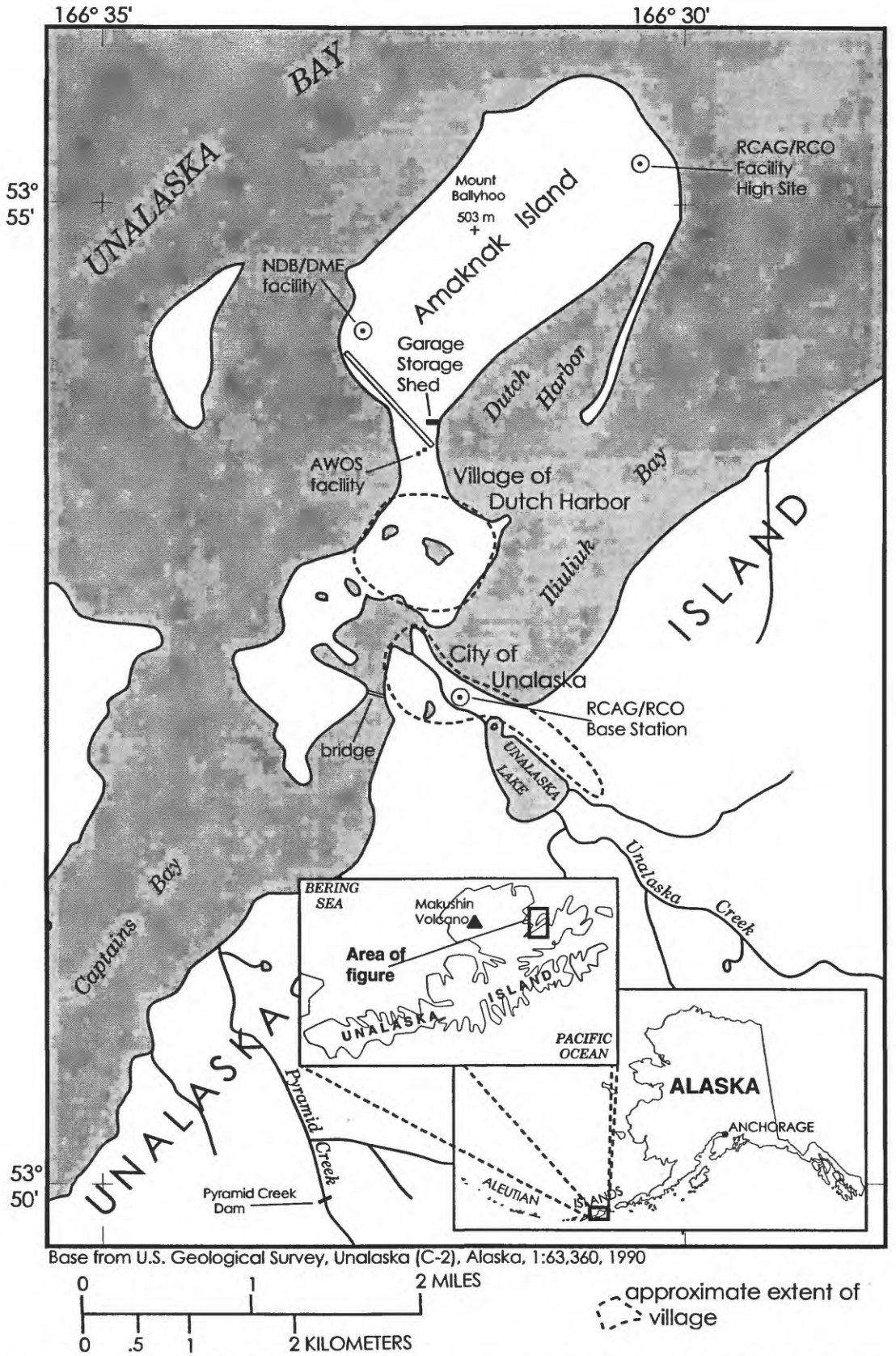

Figure 1. Location of Dutch Harbor, Alaska and Federal Aviation Administration facilities.

Facility History

The Dutch Harbor FAA facilities have been in operation since 1976 (Ecology and Environment, Inc., 1992). The FAA facilities comprise six sites on Amaknak Island and one site in Unalaska (fig. 1). A storage building is adjacent to the Dutch Harbor airstrip, the Nondirectional Beacon/Distance Measuring Equipment (NBD/DME) facility is north-northeast of the Dutch Harbor airstrip, the Remote Center Air/Ground Communications facility/Remote Communications Outlet (RCAG/RCO) High Site is near the northern end of Amaknak Island, the Automated Weather Observation Station (AWOS) facility is at the southwest corner of the airstrip at Dutch Harbor, the Runway End Identification Lights (REIL) facility is at the southeast end of runway 30, Visual Approach Slope Indicator (VASI) facilities are on the southeast end of runway 30 and at the northwest end of runway 12 at the Dutch Harbor Airport, and the RCAG/RCO base station is in the city of Unalaska (Ecology and Environment, Inc., 1992). A detailed description of FAA facilities near Dutch Harbor and a listing of suspected sources of contamination can be found in an environmental compliance investigation report by Ecology and Environment, Inc. (1992).

The FAA maintains a temporary rotating maintenance staff at the Dutch Harbor facilities, which have no permanent employees. The only year-round access to the FAA facilities and Dutch Harbor is by aircraft or boat. In 1990, the population of Unalaska was 3,089 (U.S. Census Bureau, 1991); however, the 1990 census did not include a separate listing for Dutch Harbor.

PHYSICAL SETTING

Climate

Dutch Harbor has a maritime climate, characterized by high humidity, frequent cloudiness and precipitation, and strong surface winds (Hartman and Johnson, 1984). The mean annual temperature is 4.8 °C with monthly mean temperatures ranging from -0.2 °C in February to 11.9 °C in August (table 1). These temperatures place Dutch Harbor, like most of the Aleutian Island chain, outside of the permafrost region (Ferrians, 1965). On the average, more than 90 days each year have greater than 2.5 mm of rain and more than 54 days each year have greater than 25 mm of snowfall. Total mean annual precipitation is 1,475 mm (Leslie, 1989). Fog occurs about 30 days out of the year and is more frequent in the summer than in the winter. Winds average 18 kph and extreme winds may reach 130 kph (Selkregg, 1976).

Table 1. Mean monthly temperature, precipitation, and snowfall for the period 1922 to 1987, Dutch Harbor.

[Modified from Leslie (1989); °C, degree Celsius; mm, millimeter; >, more than]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Temperature (°C)													
Mean maximum	2.6	2.2	3.2	5.1	7.7	10.7	13.8	15.2	12.2	8.2	5.3	3.3	7.4
(Record maximum 26.7 °C, September 1939)													
Mean minimum	-2.1	-2.7	-2.3	-0.4	2.1	5.1	7.6	8.7	6.7	3.2	0.3	-1.3	4.4
(Record minimum -22.2 °C, January 1986)													
Mean	0.3	-0.2	0.4	2.4	4.9	7.9	10.7	11.9	9.4	5.7	2.8	1.0	4.8
Precipitation (mm)													
Mean total	168	168	119	104	107	72	39	60	132	182	156	165	1475
Mean No. wet days (> 2.5 mm rain)	8.2	12.3	10.0	6.1	4.7	5.0	4.2	5.2	9.8	7.5	8.8	10.5	92.4
Mean No. snow days (> 25 mm snowfall)	10.0	16.5	12.5	6.0	0.0	0.0	0.0	0.0	0.0	0.3	2.5	6.3	54.8
Mean snowfall[1] (mm)	381	490	287	163	2	0	0	0	0	5	114	305	1748

[1] Moisture content of the snowfall is included in precipitation totals.

Vegetation

The vegetation near Dutch Harbor is characterized as either alpine tundra or moist tundra (Viereck and Little, 1972). The well-drained alpine tundra occurs at higher elevations on the island and is dominated by low heath shrubs, prostrate willows, and dwarf herbs (Viereck and Little, 1972). The moist tundra occupies lower elevation areas and consists of tall grass meadows, low heath shrubs, mosses, lichens, and tufted hair grass (Viereck and Little, 1972).

Physiography

Dutch Harbor is in the Aleutian Island physiographic section of the Alaska-Aleutian province (Wahrhaftig, 1965). Similar to other Aleutian Islands, Unalaska Island results from the ongoing convergence of tectonic plates and is mostly volcanic in origin. Makushin Volcano (elevation, 2,036 m) and an associated hydrothermal field are about 25 km west of Dutch Harbor on the northern part of Unalaska Island (fig. 1). The steep volcano slopes are drained by small swift streams, some of which run over porous rock and flow only during heavy rains. Lakes commonly occur in ice-carved basins (Wahrhaftig, 1965).

Many of the FAA facilities at Dutch Harbor lie at less than 12 m elevation in an area that is otherwise dominated by fiords and high sea cliffs. On the nearby mountainous island of Unalaska, the south-facing cliffs are steeper than the north-facing cliffs. Both glaciated U-shaped valleys and postglacial V-shaped ravines occur across Unalaska Island (Drewes and others, 1961).

Bedrock Geology

Site-specific geologic information for the vicinity of the Dutch Harbor FAA facilities is scarce. Drewes and others (1961) mapped Unalaska Island at a large scale and reported that Amaknak Island was composed of andesite and basalt extrusive rocks having intruded dikes of similar composition. Deep fracture and fault systems are prominent regionally (Motyka and others, 1993). A reconnaissance visit by USGS staff to the Dutch Harbor area found that the bedrock is dominated by hydrothermally altered volcanic rocks that are intruded by numerous dikes and veins (Frederic Wilson, U.S. Geological Survey, written commun., 1992). Some altered tuffs also are present, as well as a few outcrops of coarse sandstone. Nearby (approximately 15 km south of Dutch Harbor) emplacement of granitic to dioritic intrusive bodies caused the hydrothermal alteration of these rocks (Drewes and others, 1961; McLean and others, 1984). The erosional resistance of the volcanic rocks causes the steep cliffs on the perimeter of Amaknak Island.

Surficial Geology

Surficial deposits near Dutch Harbor generally are composed of mechanically disintegrated rock and various tephra deposits (Drewes and others, 1961). On steep slopes, abundant moisture causes these deposits to creep. No permafrost exists in the immediate area. On the slope behind the Dutch Harbor airstrip, surficial deposits consist of at least 0.5 m of till overlain by 1.3 m of developed soil containing ash and lapilli layers. Soils here generally contain more clay towards the bottom. The till, also exposed in road cuts, is stony with a matrix of clay and silt (Drewes and others, 1961, p. 648-651). North of Dutch Harbor, on the cliffs of Amaknak Island, talus cones are common. About 1 km southeast of Unalaska, the bedrock is at a greater depth than that near Dutch Harbor. The till here is overlain by 1.4 m of developed soils and colluvium (Drewes and others, 1961).

HYDROLOGY

Surface Water

Unalaska Island is surrounded by the Bering Sea on the north and the Pacific Ocean on the south (fig. 1). Rivers and streams draining into the Pacific Ocean generally flow in steep-walled valleys and are short and steep. In contrast, the valleys on the Bering Sea side of the Island are flat-floored U-shaped glacial troughs with streams originating in cirques and meandering through unconsolidated sediments (U.S. Army Corps of Engineers, 1984). Many of the numerous rivers and streams on Unalaska Island are unnamed and have not been assessed for flow or water quality.

Streams near the Dutch Harbor FAA facilities on Amaknak Island originate from the uplands near Mt. Ballyhoo and drain into Dutch Harbor, Captains Bay, and Unalaska Bay (fig. 1). On the east side of the island, several small streams flow directly into Dutch Harbor. No perennial streams exist near these six facilities. Several lakes near Dutch Harbor are indicated on topographic maps of the area (Unalaska [C-2] Alaska); however, hydrologic data for the lakes and streams were not

found. The nearest long-term stream-gaging station is at a distance of about 800 km on the north Gulf of Alaska coast and thus provides little insight to hydrologic conditions near Dutch Harbor (U.S. Army Corps of Engineers, 1984; U.S. Geological Survey, 1995).

Pyramid Creek and Unalaska Creek are at distances of 2 and 3 km respectively from the Dutch Harbor FAA facilities (fig. 1). Pyramid Creek is a source of domestic water for Unalaska and is diverted at the Pyramid Creek Dam (U.S. Army Corps of Engineers, 1984). The drainage basin area above Pyramid Creek Dam is about 7 km^2. Two small unnamed lakes within the basin have surface areas of 4 and 8 ha respectively (U.S. Army Corps of Engineers, 1984). Unalaska Creek flows into Unalaska Lake about 3.2 km southeast of the FAA facilities in Dutch Harbor and about 1.6 km southeast from the Unalaska RCAG/RCO Base Station. Two surface-water reservoirs within the Unalaska Creek drainage basin and the reservoir above Pyramid Creek Dam are used to provide water to residents and commercial users on the island. The water usage from the reservoirs is about 1.1×10^7 L/d (Ecology and Environment, Inc., 1992). The two reservoirs in Unalaska Creek are about 2 km south of Unalaska on the east and west forks of Unalaska Creek. A third reservoir, Icey Creek Reservoir, is about 5 km inland in the Pyramid Creek valley (Ecology and Environment, Inc., 1992; Tryck, Nyman, and Hayes, Inc., 1988).

The U.S. Army Corps of Engineers (1993) indicates that flood hazard is low for the city of Unalaska and the village of Dutch Harbor. When flooding does occur, it commonly results from heavy rains in the area. Flooding occurred in 1940, 1985, and 1991 (U.S. Army Corps of Engineers, 1993). Local tsunamis are possible along the coastline both from large earthquakes and eruptions of Makushin Volcano on Unalaska Island; however, the probability of these events is difficult to define (U.S. Army Corps of Engineers, 1993).

Ground Water

Ground water in the Dutch Harbor area generally flows through the unconsolidated sediments away from the mountains toward the coast. Ground water also occurs in secondary openings such as fractures and joints in the underlying volcanic bedrock. However, no data are available to indicate potential water yields from bedrock. Drillers' logs for two wells in Unalaska indicate that ground water is about 150 to 170 m below ground surface (Ecology and Environment, Inc., 1992). Information on miscellaneous ground-water analyses from wells on Unalaska Island was found in a search of USGS paper files (Appendix 1).

Drinking Water

Local ground water is not used for drinking water at the Dutch Harbor FAA facilities (Ecology and Environment, Inc., 1992). Drinking water is trucked to the facilities from the city of Unalaska public supply. The Unalaska Department of Public Works municipal water system supplies drinking water for Dutch Harbor and Unalaska (Ecology and Environment, 1992). The system is supplied by municipal wells and reservoirs (Ecology and Environment, 1992). The wells supply about 1.7×10^7 L/d of water to the total system, which has an output of about 2.7×10^7 to 3.0×10^7 L/d of water (Ecology and Environment, Inc., 1992).

SUMMARY

The FAA facilities near Dutch Harbor are located on Amaknak and Unalaska Islands. The maritime climate of this area is mild and humid. Bedrock of hydrothermally altered volcanic breccias and altered tuffs is overlain by surficial deposits of glacial sediments and till. The area is characterized by numerous lakes, ponds, and streams and is surrounded by alpine or moist tundra. The potential exists for tsunamis; however, hazards for flooding near the FAA facilities are low and the greatest flood hazard is due to heavy rains. Drinking water for the Dutch Harbor FAA facilities is transported to the site from the public supply in Unalaska which is not at risk from spills at the FAA sites.

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APPENDIX 1

Ground water analyses for the Unalaska area

C-369

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

File No. _____

Name _____

CROSS REFERENCE

Letter dated _____, from _____

Re:

SEE ALSO FOR PREVIOUS CHEMICAL ANALYSES DATA

Reply dated _____

See file _____

Name _____

U.S. GOVERNMENT PRINTING OFFICE 16—76682-1

Geological Survey
FORM 9-1657

UNITED STATES DEPARTMENT OF THE INTERIOR
Ground Water Analysis

Water Resources Division

State _____ (1–2) County _____ (3–4) Latitude ° ' " N, S (5–10 11) Longitude ° ' " (12–18) Seq. No. (19) Date coll. M D Y (20–25) 07 11 69

Local well No.[a] Unalaska Owner[b] ACS Well Collected by Teagna Lab. Anal. _____ Project No. ACS

WBF _____ Appearance Wc clear Wa _____ Lab. No. 12805-69-835 Sampling depth (26–29) Type[c] _____ (30)

Kx10⁶ T 9010 R KCl 334 (31–35) 3.8

pH 7.0 (36–38) Temperature °F (39–41)

SiO_2 ff _____ ml (42–44) 5.0 Abs .196

	ml	ppm	epm
Ca		2.4 (45–49)	.12
Mg		0.4 (50–53)	.03
Subtotal cations (Ca, Mg)		3.8	0.15
Na		2.9 (54–58)	0.13
K		0.5 (59–61)	0.01
Subtotal cations (Ca, Mg, Na, K)			0.29
HCO_3	0.36 ml (3.4)	7 (62–65)	0.11
CO_3	ml	(66–67)	

	ml	ppm	epm
SO_4	f ml	0.2 (68–72)	0
Cl	ml	5.7 (73–78)	0.16
	mg		
Mg · $AgNO_3$			
Source of data[d] (79)		Card Q (80) Q	
F	ml Abs	0.0 (26–28)	0.00
NO_3	2 ml Abs .006	0.0 0.1 (29–32)	0.00
PO_4	f Abs	(33–35)	
	Abs %		
HPO_4	% H_2PO_4		
Total anions			0.27
B	f ml Abs	(36–38)	
Al	ml	(39–41)	
Abs (Al + Fe)			

Remarks and explanation on other side

	ml	ppm	epm
Fe	f ml	4.8	
Total	ml Abs .067 (42)	.06 (45)	
Dissol.	ml Abs		
Mn	f ml	0.11	
Total	ml Abs (46–49)		
Dissol.	ml Abs		
Cu	ml	(50–52)	
Pb	ml	(53–54)	
Zn	ml	(55–57)	
Subtotal cations (Al, Fe, Mn, Cu, Pb, Zn)			
Subtotal cations (Ca, Mg, Na, K)			
Total cations			

Dissolved solids
Residue at 180° _____ ml (58–63)
Dish No. _____
Calculated _____ (64–69) 21

Hardness 5.7
Ca, Mg _____ ml (70–73) 7.5
Noncarbonate _____ (74–77) 1.8

Color (78–79) Card R (80) R

	County	Lat.	Long.	Seq. No.	Date	Samp. depth	c

marks:

Br _____ ml (26-28)

I _____ ml (29-31)

Alk. as $CaCO_3$ 6 (32-35)

Free CO_2 (36-38)

SAR (39-41)

RSC (42-44)

Organics

MBAS (ABS) _____ ml (45-47)

(48-50)

(51-54)

Radiochemical

Alpha (pc/l) (55-57)

Beta (pc/l) (58-60)

Ra (pc/l) (61-63)

U (ug/l) (64-66)

Other data (67-79)[e]

a Master card A (21-34)
b Master card A (52-66)
c Type:
1. Pumped
2. Bucket
3. Forest
4. Spigot
5. Bailer
6. Special
d Source of data:
1. USGS
2. UPHS
3. State Health
4. State
5. Industrial
6. Private
7. Educational

e Indicate constituent and card columns.

Chemist STAFF Checked by HH

Date began _____ Date ~~transmitted~~ finished 8-25-69

Punched by _____ Verified _____

Card S 80 S

ACW Well - Unalaska

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

9-268 q

Laboratory Number	18805					
Date of collection	7-11-69					
Silica (SiO_2)	5.0					
Iron (Fe)	.06					
Manganese (Mn)	0.11					
Calcium (Ca)	2.4					
Magnesium (Mg)	0.4					
Sodium (Na)	2.9					
Potassium (K)	0.6					
Bicarbonate (HCO_3)	7.0					
Carbonate (CO_3)	0.00					
Sulfate (SO_4)	0.2					
Chloride (Cl)	3.7					
Fluoride (F)	0.0					
Nitrate (NO_3)	000.1					
Dissolved solids Calculated	21					
Residue on evaporation at 180°C						
Hardness as $CaCO_3$	7.5					
Noncarbonate hardness as $CaCO_3$	1.0					
Alkalinity as $CaCO_3$	6					
Specific conductance (micromhos at 25°C)	30					
pH	7.0					
Color	-					

18805 - ACW Well at Unalaska, Coll. by Teague, clear appearance.

GROUND WATER — PM — LAB. NO. 8436 (65-Y)

County :
Sample No. :
Inv. :
W.O.No. :
GW Basin : UNALASKA ACS
Loc. :

Loc.No:
Region:

Samp. Pt. : TAP

Pumptime :
Temp. : 40 °F.
Agency :
Remarks :

Disch. :
Coll. : 4-23-65 PST

WELL DATA
Type :
Depth : Ft.
Cased : Ft.
Gravel packed:
Use : DOM.
Owner :
Remarks : fairly clear

Drilled:
Dia. : In.
Perf. :

SILICA 10 ml
A 0.545 mg 0.1
Factor 18.35
A sample 0.380
SiO_2 ppm 7.0

IRON(dis) 25 ml
A 0.530 mg .05
Factor 3.774
A sample 0.010
Fe ppm 0.04

IRON(total) 25 ml
A 0.530 mg .05
Factor 3.774
A sample 0.035
Fe ppm 0.13

CALCIUM 100 ml
1.05
0.00
1.05
F 4.0
Ca ppm 4.2

MAGNESIUM
epm TH 0.34
epm Ca 0.21
epm Mg 0.13
Mg ppm 1.6

ALKALINITY
HCO_3 14 100 ml CO_3 0
1.40
0.00
1.40

SODIUM 0 dil
Sample 66 %T
Curve 0*10
Na ppm 6.2

POTASSIUM 0 dil
Sample 18 %T
K ppm 0.6

TOTAL ALKALINITY as CO_3 7
as HCO_3 14 as $CaCO_3$ 11

SULFATE 10 ml
0.55
0.00
0.55
0.05
0.50
SO_4 ppm 4.8

CHLORIDE 100 ml
~~1 ml = 0.5 mg~~ Cl
3.50
0.00
3.50
0.10
3.40
Cl ppm 12

FLUORIDE 10 ml
A Sample
~~Corr ml~~ - 0
A ~~mg~~ Std
F ppm 0.0

NITRATE 10 ml
ml Ag_2SO_4 0.0
A 1.400 mg 0.5
Factor 21.43
A sample 0.030
NO_3 ppm 0.6

BORON ml
A mg
Factor
A sample
B ppm —

SUM 44
T/A ft 0.06
DISSOLVED SOLIDS ml
D.S. ppm —

HARDNESS 100 ml as $CaCO_3$
1.10
0.00
1.10
Total 11
HCO_3 (0.82) 11
Non-Carb 6

% Na 43
SPECIFIC CONDUCTANCE
R(KCl) 334
R sample 5140
Micromhos at 25°C 65

pH 6.8
COLOR 5°
TURB —
% E -3.8

epm		epm	
0.21	Ca	0.00	CO_3
0.13	Mg	0.23	HCO_3
		0.10	SO_4
0.27	Na	0.34	Cl
0.02	K	0.00	F
		0.01	NO_3
0.63	Sum	0.68	Sum

Δ 5
Σ 131

CO_2 .14
.252
3.5 ppm

Palmer 1958 GPO 976283

DATE STARTED 5-18-65 CHEMIST
DATE COMPLETED 5-20-65 CHECKED

36

ALUMINUM ____ ml

A ____ mg ____ Appar. Al ____

Asample ____ Fe X .12 − ____

Factor ____ Mn X .04 − ____

F X .05 + ____

Al ppm [ ]

MANGANESE (qual.) 1 ml

A ____ mg ____

Asample ____

Factor ____ Mn ppm [0.01]

CHROMIUM ____ ml

A ____ mg ____

Asample ____

Factor ____ Cr ppm [ ]

____ ml

A ____ mg ____

Asample ____

Factor ____ ppm [ ]

COPPER ____ ml

A ____ mg ____

Asample ____ Factor ____

Acolor ____

Acorr. ____ Cu ppm [ ]

LEAD ____ ml

A ____ mg ____

Asample ____

Factor ____ Pb ppm [ ]

ZINC ____ ml

A ____ mg ____

Asample ____

Factor ____ Zn ppm [ ]

ARSENIC ____ ml

A ____ mg ____

Asample ____

Factor ____ As ppm [ ]

____ ml

A ____ mg ____

Asample ____

Factor ____ ppm [ ]

ANALYSIS NOTES

Lab. No. K2332-69-363
ACS

Source Waukesha ACS

Location Waukesha City Water Supply

___¼ ___¼ ___¼ Sec.___ T.___ R.___ ___Merid. Field/Office No.___

Date coll. 2-24-69 Time ___

Coll. by 1Sgt William P. Teague

Field detns: Temp. (°C) 40°F pH ___

Sp. cond. (μmhos) ___ Eh ___

Appearance clear

Remarks: faucet ACS house

Well Type ___ Use ___

Depth (ft.) unknown Cased to (ft.) ___

Diam. (in.) ___ Date drilled ___

Water level (ft.) ___

Discharge ___

W. B. F. ___

Owner ___

Percent Sodium	
SAR	
Free CO_2	
Copper (Cu)	
Zinc (Zn)	

Analyst Angela - Negrini

MAR 17 1969

Date started 3-11-69 Date completed ___

Checked by ___ ACF ___

ACS Station
Unalaska, Alaska

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

9-268 q

Laboratory Number	8436					
Date of collection	April 23, 1965					
Silica (SiO_2)	7.0					
Iron (Fe) (dis)	0.04					
Iron (Fe) (Total)	0.13					
Manganese (Mn)	0.01					
Calcium (Ca)	4.2					
Magnesium (Mg)	1.6					
Sodium (Na)	6.2					
Potassium (K)	0.6					
Bicarbonate (HCO_3)	14					
Carbonate (CO_3)	0					
Sulfate (SO_4)	4.8					
Chloride (Cl)	12					
Fluoride (F)	0.0					
Nitrate (NO_3)	0.6					
Carbon Dioxide (CO_2)	3.5					
Dissolved solids						
Calculated	44					
Residue on evaporation at 180°C						
Hardness as $CaCO_3$	17					
Noncarbonate hardness as $CaCO_3$	6					
Alkalinity as $CaCO_3$	11					
Specific conductance (micromhos at 25°C)	65					
pH	6.8					
Color	5					

8436 - ACS Station, Unalaska, Alaska, water coll. at tap, 40°F, domestic use, water fairly clear at collection.

(21)

ANALYSIS NOTES

	mg/l	me/l
SiO_2 10 ml Dil ____ ABS .275	6 5	
Al ____ ml Dil ____ ABS ____		
For Al, Fe, Mn Total ☐ in soln. ☐		
Fe Dil ____ ABS 0.020	0 7	
Mn Dil ____ ABS ____	0 0 0	0.30
Ca Dil ____ Scale ____	4 2	.21
Mg Dil ____ Scale ____	1 1	.09
Sr Dil ____ Scale ____		
Na Dil ____ Percent Trans. ____ Scale ____	8 1	0.35
K Dil ____ Percent Trans. ____ Scale ____	1 5	.04
Li Dil ____ Scale ____		
Total Cations	69	
Dissolved solids (residue on evap. at 180°C) ____ ml Dish No. ____		
Dissolved Solids (calc.)	4 4	

	mg/l	me/l
HCO_3 ____ ml 0.60 ml H_2SO_4 pH 7.8	1 2	0.20
CO_3 ____ ml ____ ml H_2SO_4		
Total Alkalinity as CO_3 6		
SO_4 10 ml 3.4 ml $BaCl_2$ 0	0 0	.07 ~~.00~~
Cl ____ ml Dil ____ ml $Hg(NO_3)_2$ ____	1 3	.37 ~~.69~~
F 10 ml Dil ____ ABS 2.000	0 0	00
NO_3 2 ml Dil ____ ABS 1.010	3	00
PO_4 ____ ml Dil ____ ABS ____		
Total anions	64	

Specific conductance (μmhos at 25°)
T 20.2 °C
R_{KCL} 356 R_{sample} 435 — 8 2

Total Hardness 0.25 ml — 1 5

Hardness as $CaCO_3$ (calc.) — 1 0

Noncarbonate (calc.) — 5

Color — 5

Difference, me/l .05

Percent difference 3.8

Lab. No. 12332-69-363

ACS

4.89
2.29
2.60
.56

(9)

Unalaska - ACS

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Analyses by Geological Survey, United States Department of the Interior

9-268 q (parts per million) (milligrams per liter)

Laboratory Number	18138					
Date of collection	8-24-69					
Silica (SiO_2)	6.5					
Iron (Fe)	.07					
Manganese (Mn)	0.00					
Calcium (Ca)	4.2					
Magnesium (Mg)	1.1					
Sodium (Na)	8.1					
Potassium (K)	1.5					
Bicarbonate (HCO_3)	12					
Carbonate (CO_3)						
Sulfate (SO_4)	5.4					
Chloride (Cl)	13					
Fluoride (F)	0.0					
Nitrate (NO_3)	.3					
Dissolved solids						
Calculated	44					
Residue on evaporation at 180°C						
Hardness as $CaCO_3$	15					
Noncarbonate hardness as $CaCO_3$	5					
Alkalinity as $CaCO_3$	10					
Specific conductance (micromhos at 25°C)	82					
pH	7.0					
Color	5					

18138 - Unalaska - ACS, city water supply. Collected by T/Sgt. W. P. Teague from faucet in ACS house. Clear, temp 40.

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER RESOURCES DIVISION

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

9-268 q

Laboratory Number	10341					
Date of collection	7/13/67					
Silica (SiO_2)	4.6					
Iron (Fe)	0.38					
Manganese (Mn). qualitative	0.00					
Carbon Dioxide (CO_2)	1.3					
Calcium (Ca)	5.0					
Magnesium (Mg)	0.8					
Sodium (Na)	4.4					
Potassium (K)	0.1					
Bicarbonate (HCO_3)	13					
Carbonate (CO_3)	0					
Sulfate (SO_4)	5.0					
Chloride (Cl)	4.7					
Fluoride (F)	0.0					
Nitrate (NO_3)	0.0					
Dissolved solids						
Calculated	33					
Residue on evaporation at 180°C						
Hardness as $CaCO_3$	16					
Noncarbonate hardness as $CaCO_3$	5					
Alkalinity as $CaCO_3$	11					
Specific conductance (micromhos at 25°C)	55					
pH	7.2					
Color	0					

10341-Gualala, scurvy mountain stream, point of collection, A. C. S. Station appearance clear, collected by K. C. Haskell, (no other information)

[redacted]

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

9-268 q

[redacted]	9749					
Date of collection	[redacted]					
Silica (SiO_2)	6.8					
Iron (Fe)	[redacted]					
Manganese (Mn)	[redacted]					
[redacted] (CO2)	0.3					
Calcium (Ca)	[redacted]					
Magnesium (Mg)	[redacted]					
Sodium (Na)	[redacted]					
Potassium (K)	[redacted]					
Bicarbonate (HCO_3)	16					
Carbonate (CO_3)	[redacted]					
Sulfate (SO_4)	[redacted]					
Chloride (Cl)	[redacted]					
Fluoride (F)	[redacted]					
Nitrate (NO_3)	[redacted]					
Dissolved solids						
Calculated	33					
Residue on evaporation at 180°C						
Hardness as $CaCO_3$	14					
Noncarbonate hardness as $CaCO_3$	1					
Alkalinity as $CaCO_3$	13					
Specific conductance (micromhos at 25°C)	65					
pH	[redacted]					
Color	[redacted]					

9749 - [redacted], Unalaska, Alaska. Collected by Sgt. Kenneth C. Haskell, Clear Appearance.

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

9-268 q

Laboratory Number	8546					
Date of collection	7/26/65					
Silica (SiO_2)	4.1					
Iron (Fe) (dis)	0.00					
Iron (Fe) (total)	0.04					
Manganese (Mn)	0.02					
Calcium (Ca)	0.0					
Magnesium (Mg)	2.9					
Sodium (Na)	3.8					
Potassium (K)	0.2					
Bicarbonate (HCO_3)	6					
Carbonate (CO_3)	0					
Sulfate (SO_4)	2.4					
Chloride (Cl)	10					
Fluoride (F)	0.0					
Nitrate (NO_3)	0.0					
Carbon Dioxide (CO_2)	1.0					
Dissolved solids						
Calculated	26					
Residue on evaporation at 180°C						
Hardness as $CaCO_3$	12					
Noncarbonate hardness as $CaCO_3$	7					
Alkalinity as $CaCO_3$	5					
Specific conductance (micromhos at 25°C)	28					
pH	7.0					
Color	5					

8546 - Unalaska ACS Site, gravity flow from reservoir, ACS Bldg., sediment.

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

9-268 q

Laboratory Number	12805					
Date of collection	7-11-69					
Silica (SiO_2)	5.0					
Iron (Fe)	.06					
Manganese (Mn)	0.11					
Calcium (Ca)	2.4					
Magnesium (Mg)	0.4					
Sodium (Na)	2.9					
Potassium (K)	0.5					
Bicarbonate (HCO_3)	7.0					
Carbonate (CO_3)	0.00					
Sulfate (SO_4)	0.2					
Chloride (Cl)	5.7					
Fluoride (F)	0.0					
Nitrate (NO_3)	000.1					
Dissolved solids						
Calculated	21					
Residue on evaporation at 180°C						
Hardness as $CaCO_3$	7.5					
Noncarbonate hardness as $CaCO_3$	1.8					
Alkalinity as $CaCO_3$	6					
Specific conductance (micromhos at 25°C)	38					
pH	7.0					
Color	-					

12805 - ACW Well at Unalaska, Coll. by Teague, clear appearance.

Unalaska - ACS

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Analyses by Geological Survey, United States Department of the Interior

9-268 q (parts per million) (milligrams per liter)

Laboratory Number	18338					
Date of collection	8-24-69					
Silica (SiO_2)	6.5					
Iron (Fe)	.07					
Manganese (Mn)	0.00					
Calcium (Ca)	4.8					
Magnesium (Mg)	1.1					
Sodium (Na)	8.1					
Potassium (K)	1.5					
Bicarbonate (HCO_3)	12					
Carbonate (CO_3)						
Sulfate (SO_4)	3.4					
Chloride (Cl)	13					
Fluoride (F)	0.0					
Nitrate (NO_3)	.3					
Dissolved solids						
Calculated	44					
Residue on evaporation at 180°C						
Hardness as $CaCO_3$	15					
Noncarbonate hardness as $CaCO_3$	5					
Alkalinity as $CaCO_3$	10					
Specific conductance (micromhos at 25°C)	~~0.2~~ 82					
pH	7.0					
Color	5					

18338 - Unalaska - ACS, city water supply. Collected by T/Sgt. W. P. Teague from faucet in ACS house. Clear, temp 40.

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER RESOURCES DIVISION

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

9-268 q

Laboratory Number	10341					
Date of collection	7/13/67					
Silica (SiO_2)	4.6					
Iron (Fe)	0.38					
Manganese (Mn). qualitative	0.00					
Carbon Dioxide (CO_2)	2.3					
Calcium (Ca)	5.0					
Magnesium (Mg)	0.8					
Sodium (Na)	4.6					
Potassium (K)	0.1					
Bicarbonate (HCO_3)	23					
Carbonate (CO_3)	0					
Sulfate (SO_4)	1.0					
Chloride (Cl)	6.7					
Fluoride (F)	0.0					
Nitrate (NO_3)	0.0					
Dissolved solids						
Calculated	33					
Residue on evaporation at 180°C						
Hardness as $CaCO_3$	16					
Noncarbonate hardness as $CaCO_3$	5					
Alkalinity as $CaCO_3$	11					
Specific conductance (micromhos at 25°C)	55					
pH	7.2					
Color	0					

10341-Unalaska, source mountain stream, point of collection, A. C. S. Station approximate climax, collected by E. C. Mandell, (no other information)

[redacted]

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

9-268 q

[redacted]	9740					
Date of collection	[redacted]					
Silica (SiO_2)	8.0					
Iron (Fe)	0.02					
Manganese (Mn)	0.01					
[redacted]	0.3					
Calcium (Ca)	4.0					
Magnesium (Mg)	1.0					
Sodium (Na)	4.2					
Potassium (K)	0.00					
Bicarbonate (HCO_3)	16					
Carbonate (CO_3)	0.00					
Sulfate (SO_4)	1.9					
Chloride (Cl)	6.0					
Fluoride (F)	0.2					
Nitrate (NO_3)	0.1					
Dissolved solids						
Calculated	33					
Residue on evaporation at 180°C						
Hardness as $CaCO_3$	14					
Noncarbonate hardness as $CaCO_3$	1					
Alkalinity as $CaCO_3$	13					
Specific conductance (micromhos at 25°C)	65					
pH	8.0					
Color	0.0					

9740 - [redacted]. Collected by [redacted]. Clear Appearance.

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

9-268 q

Laboratory Number	8546					
Date of collection	7/26/65					
Silica (SiO_2)	4.1					
Iron (Fe) (dis)	0.00					
Iron (Fe) (total)	0.04					
Manganese (Mn)	0.02					
Calcium (Ca)	0.0					
Magnesium (Mg)	2.9					
Sodium (Na)	3.8					
Potassium (K)	0.2					
Bicarbonate (HCO_3)	6					
Carbonate (CO_3)	0					
Sulfate (SO_4)	2.4					
Chloride (Cl)	10					
Fluoride (F)	0.0					
Nitrate (NO_3)	0.0					
Carbon dioxide (CO_2)	1.8					
Dissolved solids						
Calculated	26					
Residue on evaporation at 180°C						
Hardness as $CaCO_3$	12					
Noncarbonate hardness as $CaCO_3$	7					
Alkalinity as $CaCO_3$	5					
Specific conductance (micromhos at 25°C)	28					
pH	7.0					
Color	5					

8546 - Unalaska ACS Site, gravity flow from reservoir, ACS Bldg., sediment.

ACS Station
Unalaska, Alaska

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER RESOURCES DIVISION

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

9-268 q

Laboratory Number	8436					
Date of collection	April 23, 1965					
Silica (SiO_2)	7.0					
Iron (Fe) (dis)	0.04					
Iron (Fe) (Total)	0.13					
Manganese (Mn)	0.01					
Calcium (Ca)	4.2					
Magnesium (Mg)	1.6					
Sodium (Na)	6.2					
Potassium (K)	0.6					
Bicarbonate (HCO_3)	14					
Carbonate (CO_3)	0					
Sulfate (SO_4)	4.8					
Chloride (Cl)	12					
Fluoride (F)	0.0					
Nitrate (NO_3)	0.6					
Carbon Dioxide (CO_2)	3.5					
Dissolved solids						
Calculated	44					
Residue on evaporation at 180°C						
Hardness as $CaCO_3$	17					
Noncarbonate hardness as $CaCO_3$	6					
Alkalinity as $CaCO_3$	11					
Specific conductance (micromhos at 25°C)	65					
pH	6.8					
Color	5					

8436 - ACS Station, Unalaska, Alaska, water coll. at tap, 40°F, domestic use, water fairly clear at collection.