

H10970

NOAA FORM 76-35A

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE

DESCRIPTIVE REPORT

Type of Survey Hydrographic

Field No. RA-05-01-00

Registry No. H-10970

LOCALITY

State Washington

General Locality Puget Sound

Sublocality Lake Washington Ship Canal

2000

CHIEF OF PARTY

Commander D.R. Herlihy, NOAA

LIBRARY & ARCHIVES

DATE

HYDROGRAPHIC TITLE SHEET

H-10970

INSTRUCTIONS · The hydrographic sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the office.

FIELD NO.

RA-05-01-00

State Washington

General Locality Puget Sound

Sublocality Lake Washington Ship Canal

Scale 1:5,000

Date of Survey March 13-14, 2000

Instructions Date na

Project No. S-N907-RA

Vessel RA-1(2121), RA6(2126)

Chief of Party Commander D.R. Herily, NOAA

Surveyed by RAINIER Personnel

Soundings taken by echo sounder, hand lead, pole KNUDSON 320M, RESON 8101 MB

Graphic record scaled by RAINIER Personnel

Graphic record checked by RAINIER Personnel

evaluation by R. Shipley Automated plot by HP 750C & HP 755CM

Verification by E. Domingo, R. Shipley

Soundings in Feet at Washington Lake Low Water Datum

REMARKS: All times are UTC. UTM Projection (zone 10)

Revisions and annotations appearing as endnotes were generated during office processing.

All separates are filed with the hydrographic data.

As a result, page numbering may be interrupted or non-sequential.

Descriptive Report to Accompany Hydrographic Survey H10970

Project OPR-S-N907-RA-00
Lake Washington Ship Canal
Scale 1:5000
March 2000

NOAA Ship RAINIER

Chief of Party: Commander Daniel R. Herlihy, NOAA

A. AREA SURVEYED

This hydrographic survey was completed as specified by the Draft Standing Project Instructions dated April 6, 1998. Hydrographic Survey Letter Instructions were not provided for this survey. This project responds to a request from the United States Navy to determine if a 27-foot draft vessel (USS Ingram) could transit into Lake Washington. A copy of this request is included in Appendix V.¹ The survey was conducted to provide full-bottom multibeam coverage of the Lake Washington Ship Canal.

The survey area is located in Seattle, Washington and covers the Lake Washington Ship Canal, which runs from Salmon Bay through Lake Union, Portage Bay, and Union Bay to Lake Washington. The survey covers approximately 0.65 square nautical miles. The survey's northern limit is latitude 47°39'54.10"N and the southern limit is latitude 47°37'37.31"N. The survey's western limit is longitude 122°23'40.20"W and the eastern limit is longitude 122°16'29.06"W.

Data acquisition was conducted during the period March 13-14, 2000 (DN 73 to 74).

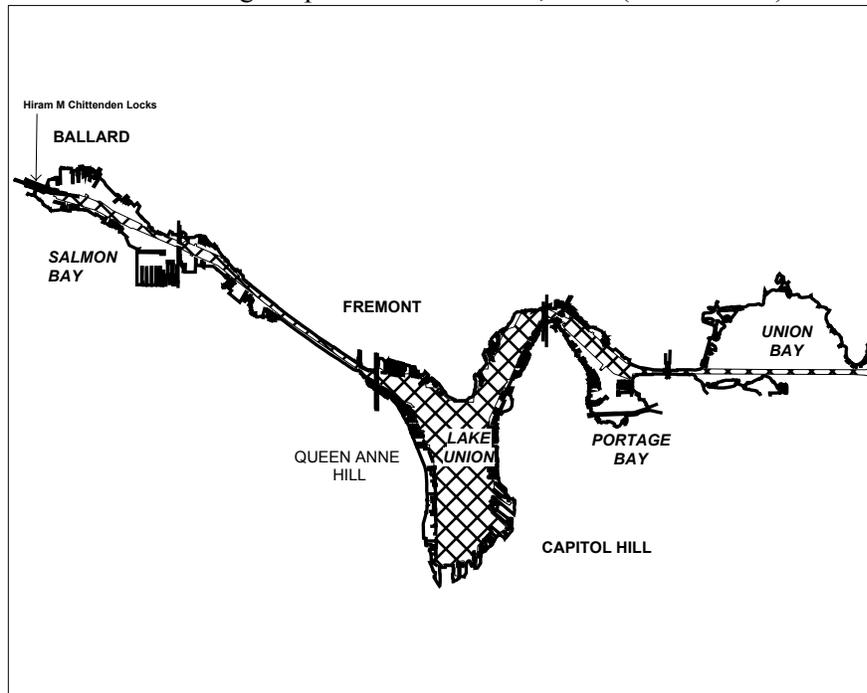


Figure 1: H10970 Survey Limits

B. DATA ACQUISITION AND PROCESSING

A complete description of data acquisition and processing systems, survey vessels, quality control procedures, and data processing methods used during the acquisition of data for OPR-S-N907-RA are discussed in the following sections.

B1. Equipment and Vessels

Data were acquired by RAINIER's survey launches (vessel numbers 2121 and 2126). Vessels 2121 and 2126 were used to acquire shallow-water multibeam soundings and sound velocity profiles. No unusual vessel configurations or problems were encountered on this project.²

Launch Vertical-Beam Echo Sounder (VBES) - VN 2121 and 2126

All RAINIER launches are equipped with a Knudsen Engineering Limited 320M, which is a dual frequency (100 kHz, 24 kHz) digital recording vertical-beam echo sounder with an analog paper record. The beamwidths for the high and low frequency are 7° and 25° respectively. Although VBES data were not processed for this project, VBES data were acquired concurrently with launch multibeam data and compared to nadir beams of multibeam in real-time during data acquisition to assure multibeam data quality. Digital VBES depth data were also used by Isis to assist the Reson 8101 in filtering depth fliers in real-time.

Launch Shallow-Water Multibeam (SWMB) - VN 2121 and 2126

Vessels 2121 and 2126 are equipped with a hull-mounted Reson SeaBat 8101, with option 033, Angle-Independent Imagery, and option 040, Extended Range Projector. The SeaBat 8101 is a 240 kHz multibeam system that measures relative water depths across a 150° swath, consisting of 101 individual 1.5° x 1.5° beams. This system was used to obtain full-bottom coverage in depths generally from 4 meters to 25 meters, with range scale values ranging from 75 meters to 125 meters, depending upon the depth of water and across-track slope.

Side Scan Sonar

Side Scan Sonar (SSS) equipment was not used on this project. However, it should be noted that the Reson Seabat 8101 system provides a low-resolution digital SSS record of the multibeam swath. This SSS imagery is primarily used during processing of the multibeam depth data to aid in determining whether anomalous soundings are true features or noise.

Positioning Equipment

Vessels 2121 and 2126 are equipped with a TSS POS/MV Position and Orientation Sensor to measure and calculate position. The POS/MV is a GPS-aided inertial navigation system, which provides a blended position solution derived from both an Inertial Motion Unit (IMU) and an integrated GPS receiver. The IMU and GPS receivers are complementary sensors, and data from one are used to filter and constrain errors from the other, resulting in higher position accuracy and fewer errors than either system alone. Position accuracy is displayed in real-time by the POS/MV software and was monitored to ensure that positioning accuracy requirements as outlined in the NOS Hydrographic Surveys Specifications and Deliverables were not exceeded. In addition, the POS/MV software displays HDOP and number of satellites used in position computation. Data acquisition was generally halted when an HDOP of 2.5 was exceeded or the number of satellites available dropped below four. However, because positional accuracy

can be maintained by the POS/MV through short GPS outages with the help of the IMU, data acquisition was not halted during short periods of time when the HDOP was exceeded and/or the number of satellites used fell below stated parameters.

Software

Shallow-water multibeam (SWMB) echo sounder data, along with position and attitude data from the POS/MV, were acquired using Triton-Elics' ISIS software version 4.54, and processed using Universal Systems Limited's CARIS HIPS software version 4.3.2, running on a Silicon Graphics Inc. Origin 2100 with the Irix 6.5.2 operating system.

Coastal Oceanographic's HYPACK MAX was utilized for vessel navigation and line tracking during acquisition of shallow-water multibeam (SWMB) data.

Final soundings were saved in MapInfo format and will be submitted with the digital data.

Raw sound velocity data were processed using VelocWin 5.03 supplied by the NOS Hydrographic Systems and Technology Programs N/CS11 (HSTP). VelocWin 5.03 uses raw salinity, temperature, and pressure measurements to create a sound velocity profile.

A complete list of software and versions is included in Appendix V.³

B2. Data Processing and Quality Control

Shallow-water Multibeam Data

Shallow-water multibeam data were monitored in real-time using the 2-D and 3-D data display windows in Isis and the on-screen display for the Reson SeaBat 8101 sonar processor. Adjustable user parameters are range scale, power, gain, and pulse width. These parameters were adjusted as necessary to ensure the best data quality. Additionally, vessel speed was adjusted as necessary, and in accordance with the NOS Specifications and Deliverables and Draft Standing Project Instructions to ensure the required along-track coverage for object detection.

Following acquisition, shallow-water multibeam data were initially reviewed with the CARIS Hydrographic Data Cleaning System (HDCS) program SwathEdit. All soundings were reviewed, ping-by-ping, and obvious depth fliers were identified and manually flagged as "rejected". Vessel positioning and attitude data from each system were similarly displayed and manually cleaned. Fliers or gaps in positioning and attitude data were rejected and interpolated for small periods in time and outright rejected for larger periods in time in which the characteristic of the curve was ambiguous. All soundings beyond a maximum angle of 60° off-nadir were rejected in accordance with the Draft Standing Project Instructions to reduce the noise and refraction errors possible in these outer beams.

After review and cleaning in SwathEdit, depth, position and attitude data were merged, using the HDCS program HDCS LineMerge, with sound velocity⁴, vessel offset⁵, and dynamic draft correctors⁶ to compute the corrected depth and position of each sounding. All soundings were then again reviewed, and spatially referenced in HDCS Subset Mode. Data were compared with adjacent lines and crosslines, for systematic errors such as sound velocity errors. Questionable soundings were also compared with adjacent or overlapping data for confirmation or further rejection. Depth fliers and noisy data, which were not rejected in SwathEdit, were rejected in Subset Mode.

A 3-meter sun-illuminated Digital Terrain Model (DTM) image was created to demonstrate coverage and

to further check for systematic errors such as sound velocity, or attitude and/or timing errors.

A statistical analysis of all SWMB data was performed using the CARIS Quality Control Report (QCR) function. SWMB crosslines were compared with mainscheme soundings, beam-by-beam, to statistically determine the accuracy of each beam. Beams not meeting accuracy requirements as described in the NOS Hydrographic Surveys Specifications and Deliverables were further filtered and rejected. Results from the survey's QCR can be found in Appendix V.⁷ Crosslines were only run in areas of regular and even bathymetry in order to utilize the lowest variance in the analysis and to eliminate possible skew of the results due to irregular bathymetry.

To produce the final reduced data set represented by the final field sheet, all non-rejected soundings having passed all other quality-assurance checks were imported into a CARIS "workfile" by selecting shoal-biased "line-by-line" binning using a 3-meter cell size. The resultant thinned data were then imported into HPS and combined with heights of point features. The processed soundings were excessed in HPS ZoomEdit using a 3.5-millimeter character size, ensuring that the largest spacing between selected soundings would not exceed 5 millimeters at survey scale. Final selected soundings were saved and plotted in MapInfo at a 2-millimeter character size.

Data processing flow diagrams are included in Appendix V⁸ of this report.

Crosslines

SWMB crosslines totaled 4.37 nautical miles, comprising 10.5% of SWMB hydrography. The Quality Control Report (CARIS HIPS) for the checkline file averaged 93.5%, with a depth tolerance factor of 0.0075 and 99.5%, with a depth tolerance factor of 0.013, which conform to International Hydrographic Organization Special Order and Order 1 specifications, respectively, as detailed in Special Publication S-44, Edition 4. See Appendix V⁹ for the detailed reports.

Junctions

There are no contemporary survey junctions with H10970.¹⁰

Data Quality Factors

No unusual conditions were encountered during the survey that affected the expected accuracy and quality of survey data.¹¹

B3. Corrections to Echo Soundings

Sound Velocity

Sound velocity profiles were acquired with Sea-Bird Electronic's SEACAT SBE19 Conductivity, Temperature, and Depth (CTD) profiler (S/N 2543). Raw conductivity, temperature, and pressure data were processed using the program VelocWin version 5.03, which generates sound velocity profiles for CARIS and sound velocity corrector tables for HPS. Sound velocity correctors were applied to SWMB soundings in CARIS. The calibration report and dates are included in Section III of the *Separates to be Included with Survey Data*.¹²

The speed of sound through water was determined by a minimum of one cast every four hours of SWMB acquisition in accordance with the Draft Standing Project Instructions and NOS Specifications and Deliverables for Hydrographic Surveys. Casts were conducted more frequently when changing survey

areas, or when it was felt that conditions, such as a change in weather, would warrant additional sound velocity profiles.

Vessel Offsets and Dynamic Draft Correctors

The following table shows when the vessel offsets and dynamic draft correctors used for this survey were last determined:

Vessel No.	Date of Static Draft and Transducer Offset Measurements	Method of Settlement and Squat Measurement	Date of Settlement and Squat Measurement	Location of Settlement and Squat Measurement
2121	March 1999	OTF*	March 1999	Port Angeles, WA
2126	March 1999	OTF*	March 1999	Port Angeles, WA

*OTF: "On-the-fly" GPS techniques

Sensor offset and dynamic draft values were applied to SWMB data in CARIS during post-processing. These values are stored in CARIS Vessel Configuration Files (VCFs). Vessel offset diagrams and dynamic draft tables are included in Section V¹³ of the *Separates to be Included with Survey Data*. The VCFs themselves are included with the digital HDCS data.

Heave, Pitch, Roll and Heading, Including Biases and Navigation Timing Errors

SWMB launches (VN 2121 and 2126) utilized a TSS POS/MV Model 320 Position and Orientation System – Marine Vessel (POS/MV), which provides accurate navigation and attitude data to correct for the effects of heave, pitch, roll and heading. The POS generates attitude data in three axes (roll, pitch and heading) to an accuracy of 0.05° or better. Heave measurements supplied by the POS/MV maintain an accuracy of 5% of the measured vertical displacement for movements that have a period of up to 10 seconds. The POS/MV delivers heading measurements by two distinct methods. First, the Dynamic Heading Alignment determines the vessels heading by using the data supplied by the Internal Measurement Unit (IMU) and GPS receivers to achieve heading that is, at best, accurate to within 0.25°. This method suffers from drift but is relatively unaffected by noise. Second, the GPS Azimuth Measurement System (GAMS) determines the geographic vector between two GPS antennas fixed to the vessel by comparing the phase of satellite signals they receive. The error from this method is largely due to noise, but exhibits no drift. The POS/MV uses the advantages of each method to compensate for the disadvantages of the other to arrive at an optimal accuracy of 0.05°. Serial numbers are located in Appendix V.¹⁴

Heave, roll, pitch, and navigation latency biases were determined during Patch Tests conducted off Shilshole Bay, WA on March 6, 2000 for vessels 2121 and 2126. SWMB vessel offsets, dynamic draft correctors, and system bias values are contained in CARIS Vessel Configuration Files (VCFs) and were created using the program "VCFEDIT" in CARIS. These offsets and biases are applied to the sounding data during processing in CARIS. The VCFs and Patch Test data are included with the digital HDCS data.

C. VERTICAL AND HORIZONTAL CONTROL

Horizontal Control

The horizontal datum for this project is the North American Datum of 1983 (NAD83). Differential GPS (DGPS) was the sole method of positioning. Differential corrections from the U.S. Coast Guard beacon at Whidbey Island (ID# 888) were utilized during this survey.

Vertical Control

The vertical datum for this project was not provided. No water level correctors were applied to the soundings.¹⁵

The Pacific Hydrographic Branch will obtain and apply lake level data¹⁶ to the survey data during final processing.¹⁷

D. RESULTS AND RECOMMENDATIONS

D.1 Automated Wreck and Obstruction Information System (AWOIS) Investigations

There were no AWOIS items assigned to this project.

D.2 Chart Comparison

One chart is affected by this survey:

Chart	Scale	Edition Number	Date	Datum
18447	1:10,000	27 th	April 1, 2004	NAD83

Depths from chart 18447 agree well with the current survey, generally within one to two feet. Notable differences are discussed below. All of the items discussed were covered with 100% shallow-water multibeam.

In the vicinity of a charted 28-foot sounding, the present survey revealed depths of 36¹⁸ feet (Pos. #82549) and 38¹⁹ feet (Pos. #82407) at 47°38'30.180"N, 122°20'27.214"W (549505.8 E, 5276690.2 N) and 47°38'31.112"N, 122°20'27.571"W (549498.1 E, 5276718.9 N), respectively.²⁰

In the vicinity of a charted 36-foot sounding, the present survey revealed a depth of 30²¹ feet (Pos. #112171) at 47°38'41.267"N, 122°20'16.821"W (549719.7 E, 5277034.3 N).

In the vicinity of a charted 33-foot sounding, the present survey revealed two depths of 30²² feet (Pos. #317640 and Pos. #322460) at 47°38'57.417"N, 122°19'40.488"W (550473.4 E, 5277539.4 N) and 47°38'57.664"N, 122°19'41.352"W (550455.3 E, 5277546.9 N), respectively.

In the vicinity of a charted 46-foot sounding, the present survey revealed depths of 39²³ feet (Pos. #344710) and 42²⁴ feet (Pos. #344810) at 47°38'05.039"N, 122°19'49.901"W (550291.0 E, 5275920.7 N) and 47°38'05.634"N, 122°19'50.372"W (550281.0 E, 5275939.0 N), respectively.

In the vicinity of a charted 25-foot sounding, the present survey revealed a depth of 17²⁵ feet (Pos. #397550) at 47°38'39.144"N, 122°19'59.377"W (550084.2 E, 5276971.9 N).

In the vicinity of a charted 11-foot sounding, the present survey revealed a depth of 9²⁶ feet (Pos. #397703) at 47°38'38.990"N, 122°20'03.420"W (549999.9 E, 5276966.4 N).

In the vicinity of a charted pile with the labeling "*Subm pile (cov 19ft)*" and a charted wreck, the present survey revealed a depth of 20²⁷ feet (Pos. #325664) at 47°38'58.128"N, 122°19'42.511"W (550431.0 E, 5277561.0 N).²⁸

The hydrographer recommends updating the Lake Washington Ship Canal tabulated controlling depths of the channels with the following depths observed in this survey:

Chart 18447 depths:²⁹

Name of Channel	Left Outside Quarter (feet)	Middle Half of Channel (feet)	Right Outside Quarter (feet)
Large Lock to Lake Union	24.0	26.6	23.8
Portage Bay Reach	17.8	26.7	22.9
Montlake Cut	18.7	30.1	20.9
Union Bay Reach	20.2	28.4	16.7

Survey H10970 depths:³⁰

Name of Channel	Left Outside Quarter (feet)	Middle Half of Channel (feet)	Right Outside Quarter (feet)
Large Lock to Lake Union	24-26	29-32	24-26
Portage Bay Reach	18-21	28-31	18-23
Montlake Cut	16-19	30-32	16-19
Union Bay Reach	As charted	30-34	25-29

The survey revealed a shoalest depth of 27³¹ feet (Pos. #47665) at 47°39'23.955"N, 122°22'04.600"W (547460.0 E, 5278333.4 N) in the Large Lock to Lake Union Channel.

The survey revealed a shoalest depth of 28³² feet (Pos. #253043) at 47°38'49.659"N, 122°16'35.205"W (554340.8 E, 5277334.7) in Union Bay Reach.

Final sounding comparisons will be made at Pacific Hydrographic Branch after application of lake level data.

D.3 Shoreline

No remote sensing source shoreline data were supplied for this project. Features and shoreline shown on the 27th edition of chart 18447 were digitized in MapInfo by RAINIER personnel and displayed in Hypack for field verification. Some charted shoreline and features were compared with existing shoreline and features. Disprovals of charted piles and new piers were found in the Large Lock to Lake Union channel. However, the detached positions obtained were not within accuracy standards. These items are not included with this survey due to problems with positioning and inadequate detail of these features.³³

The hydrographer recommends conducting limited shoreline verification for this survey.³⁴

D.4 Dangers to Navigation

No dangers to navigation were found.³⁵

D.5 Aids to Navigation

All aids to navigation within the survey limits were found to be correctly charted and serve their intended purpose.³⁶

E. APPROVAL

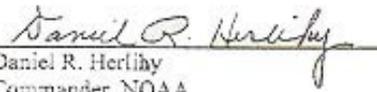
As Chief of Party, I have ensured that standard field surveying and processing procedures were followed in producing this examination in accordance with the Hydrographic Manual, Fourth Edition; the Hydrographic Survey Guidelines; the Field Procedures Manual, and the NOS Hydrographic Surveys Specifications and Deliverables, as updated for 2000.

The digital data and supporting records have been reviewed by me, are considered complete and adequate for charting purposes, and are approved. All records are forwarded for final review and processing to N/CS34, Pacific Hydrographic Branch

Survey H10970 is complete and adequate to supersede charted soundings in their common areas. The hydrographer recommends conducting limited shoreline verification for this survey.³⁷

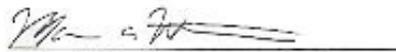
No supplemental reports have been created relating to this survey.

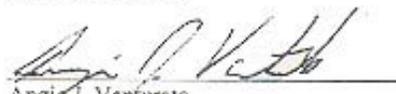
proved and Forwarded:


Daniel R. Herlihy
Commander, NOAA
Commanding Officer

In addition, the following individuals were also responsible for overseeing data acquisition and processing of this survey:

Survey Sheet Managers:


Mark A. Wetzler
Lieutenant, NOAA


Angie J. Venturato
Ensign, NOAA

Field Operations Officer:


Edward J. Van Den Ameele
Lieutenant, NOAA

¹ Filed with the hydrographic data

² Concur

³ Filed with the hydrographic data

⁴ Filed with the hydrographic data

⁵ Filed with the hydrographic data

⁶ Filed with the hydrographic data

⁷ Filed with the hydrographic data

⁸ Filed with the hydrographic data

⁹ Filed with the hydrographic data

¹⁰ Concur

¹¹ Concur

¹² Filed with the hydrographic data

¹³ Filed with the hydrographic data

¹⁴ Filed with the hydrographic data

¹⁵ Concur

¹⁶ Approved Water Levels and Datums dated July 19, 1991 is attached.

¹⁷ Lake Union and the ship canals are not tidal. The Corps of Engineers water level gauge for the Hiram M. Chittenden Locks was used for the vertical datum determination for this survey. The soundings are referenced to mean lower low water which is 20 feet above the plane of MLLW in Puget Sound. The smooth sheet tide correctors were determined by subtracting 20 feet from the water level observations at the Chittenden Locks gauge. The difference between the referenced MLLW and the observed readings for the days of hydro was .3 feet (3.6 inches). This value was applied as the smooth sheet tide corrector.

¹⁸ PHB Revision--Strikethrough ~~36~~ and replace with 35

¹⁹ PHB Revision--Strikethrough ~~38~~ and replace with 37

²⁰ Source of 28 sounding unknown. Chart using current soundings

²¹ PHB Revision--Strikethrough ~~30~~ and replace with 29. Chart 29 foot sounding.

²² PHB Revision--Strikethrough ~~30~~ and replace with 29

²³ PHB Revision--Strikethrough ~~39~~ and replace with 38

²⁴ PHB Revision--Strikethrough ~~42~~ and replace with 41

²⁵ PHB Revision--Strikethrough ~~17~~ and replace with 16

²⁶ PHB Revision--Strikethrough ~~9~~ and replace with 8

²⁷ PHB Revision--Strikethrough ~~20~~ and replace with 19. It is recommended that the charted submerged pile at latitude 47/38/58.28N, longitude 122/19/42.83W be removed and the survey position be charted. The associated note, *Subm pile (cov 19 ft)* should be retained as charted. It is also recommended that the charted wreck at latitude 47/38/57.71N, longitude 122/19/43.03W, be removed and replaced with a submerged wreck with a least depth of 26 feet at latitude 47/38/57.62N, longitude 122/19/42.32W.

²⁸ The charted wreck at latitude 47/37/55.87N, longitude 122/20/6.17W was investigated and found to have a new least depth of 26 feet at MLLW. It is recommended that the charted wrecks' depth of 28 feet be changed to the current survey depth.

²⁹ Do Not Concur with tabulations. Advise MCD to review lake level applied survey data and any other current resources to retabulate.

³⁰ Do Not Concur. Refer to endnote 28.

³¹ Do Not Concur. Refer to endnote 28.

³² Do Not Concur. Refer to endnote 28.

³³ Concur

³⁴ Concur

³⁵ One danger to navigation was discovered during office processing and reported to the USCG on February 1, 2002 is attached to this report.

³⁶ Concur

³⁷ Concur

Danger to Navigation Report

Hydrographic Survey Registry Number: H10970

Survey Title: State: Washington
Locality: Lake Washington Ship Canal
Sub-locality: Union Bay Reach

Project Number: S-N907-RA

Survey Dates: March 13-14, 2000

Depths are reduced to Mean Lower Low Water using verified tides.
Positions are based on the NAD83 horizontal datum.

CHARTS AFFECTED:

<u>Chart</u>	<u>Scale</u>	<u>Edition</u>	<u>Date</u>
18447	1:10,000	26 th	Jan 25, 1997

DANGERS:

<u>Feature</u>	<u>Depth</u>	<u>Latitude</u>	<u>Longitude</u>
sounding	27 ft	47/38/49.7 N	122/16/35.2 W

COMMENTS:

A shoal sounding of 27 feet within the Union Bay Reach Channel in a controlling depth of 30 feet.

Questions concerning this report should be directed to the Chief, Pacific Hydrographic Branch at (206) 526-6836.

H10970dton1.txt

47/38/49.7 122/16/35.2 27 sounding in feet

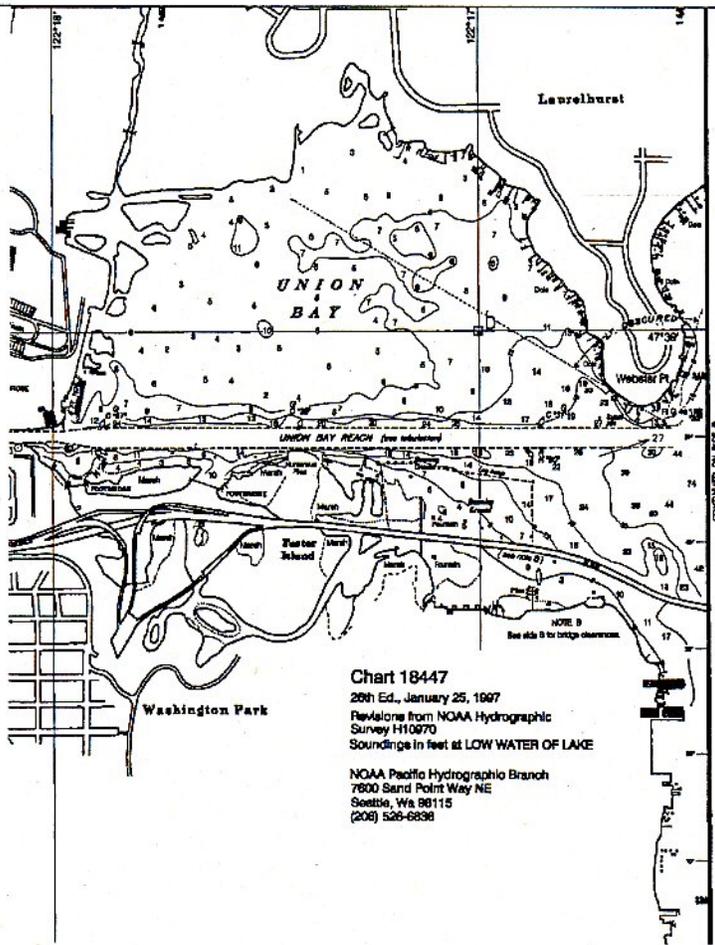


Chart 18447
28th Ed., January 25, 1997
Revisions from NOAA Hydrographic
Survey H10970
Soundings in feet at LOW WATER OF LAKE

NOAA Pacific Hydrographic Branch
7600 Sand Point Way NE
Seattle, Wa 98115
(206) 526-6836



**UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration**

NATIONAL OCEAN SERVICE
Rockville, Maryland 20852

ORIGINAL

July 19, 1991

MEMORANDUM FOR: Dennis Hill
Pacific Hydrographic Section
Chief, Hydrographic Unit

FROM: Briah K. Connor *Briah K. Connor*
Tidal Datums Quality Assurance Section,
Chief, Hydrographic and Marine Boundary Unit

SUBJECT: Approved Water levels and datums for Hydrography
Project S-N933-DA-1991 Lake Washington, Washington

Lake Washington is not Tidal. The chart datum for Lake Washington is "Washington Lake Low Water Datum (WLLWD)", which is 20 feet above "Hiram M. Chittenden Locks Datum (HCLD)". Neither WLLWD or HCLD are tidal datums, both are fixed datums. This is based on documentation from the U.S. Army COE and verified by telephone on 7/17/91 with Lawrence Signani and Larry Markle of the Seattle COE Office. They also verified that the water level gauge and staff at the Hiram M. Chittenden Locks, which were used for water level control of February 1991 survey, are relative to HCLD. Therefore, to refer the hydrographic soundings from the February 1991 survey in Lake Washington to chart datum, subtract 20 feet from the water level observations at the Chittenden Locks gauge. These corrections are to be applied to the hydrographic soundings. It is recommended that vertical datum information on NOAA Nautical Chart #18447, LAKE WASHINGTON SHIP CANAL AND LAKE WASHINGTON be corrected as indicated:

"SOUNDINGS IN FEET"

Below the Locks: at Mean Lower Low Water

**above the locks: at WASHINGTON LAKE LOW WATER DATUM which
is 20 FEET above HIRAM M. CHITTENDEN LOCKS DATUM**

"HEIGHTS"

**Vertical clearances above the locks are referenced to
MEAN LAKE LEVEL which is 21 FEET above
HIRAM M. CHITTENDEN LOCKS DATUM**

**Vertical clearances for the bridge and cable at the
Burlington Northern R.R. Bridge (47°40', 122°24') are
referenced to LAKE WASHINGTON ORDINARY HIGH WATER
which is 21.85 FEET above HIRAM M. CHITTENDEN LOCKS DATUM**



APPROVAL SHEET
H10970

Initial Approvals:

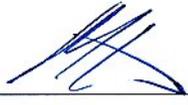
The survey and associated records have been inspected with regard to survey coverage, delineation of the depth curves, development of critical depths, cartographic symbolization, and verification or disproof of charted data. The survey records and digital data comply with NOS requirements except where noted in the Descriptive Report and are adequate to supersede prior surveys and nautical charts in the common area.



Date: 11/20/04

Russ Davies
Cartographer
Pacific Hydrographic Branch

I have reviewed the smooth sheet, accompanying data, and reports. This survey and accompanying digital data meet or exceed NOS requirements and standards for products in support of nautical charting except where noted in the Descriptive Report.

 , LCDR/NOAA

Date: 30 Nov 2004

Donald W. Haines
LCDR, NOAA
Chief, Pacific Hydrographic Branch

