Figure 2.—View of the Black River in about 1900 showing the natural drainage from the south end of Lake Washington. The upstream channel, abandoned after the lake lowering, was mostly filled for commercial development, and only a remnant of the lower river course remains today.

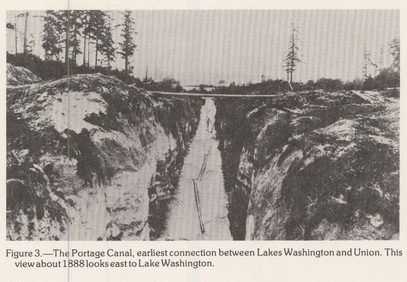


Figure 3.—The Portage Canal, earliest connection between Lakes Washington and Union. This view about 1888 looks east to Lake Washington.

Figure 4.—Beginning of the water-level adjustment between Lake Washington and Lake Union in 1916. This view is the releasing of Portage Bay water into the Portage (or Montlake) Cut prior to lowering Lake Washington. Houseboats along the west shore of Portage Bay are visible in the distance.

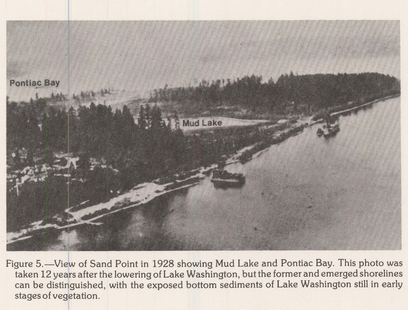
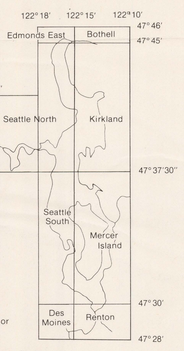


Figure 5.—View of Sand Point in 1928 showing Mud Lake and Pontiac Bay. This photo was taken 12 years after the lowering of Lake Washington, but the former and emerged shorelines can be distinguished, with the exposed bottom sediments of Lake Washington still in early stages of vegetation.

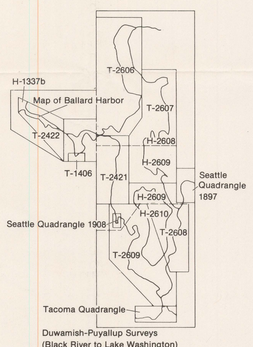
Photographs courtesy of the Historical Society of Seattle and King County, Museum of History and Industry.



Quadrangle	Edition date	Photo revision date(s)
Edmonds East	1953	1968, 1973
Bothell	1953	1968, 1973
Shilshole Bay	1949	1968, 1973*
Seattle North	1949	1968
Kirkland	1950	1968, 1973
Seattle South	1949	1968, 1973
Mercer Island	1950	1968, 1973
Des Moines	1949	1968, 1973
Renton	1949	1968

*This was a photo inspection. No major culture or drainage changes were observed.

INDEX OF 1:24,000 SCALE U.S. GEOLOGICAL SURVEY MAPS USED TO COMPILE THE LARGE BASE MAP



Field sheet[1]	Name	Year surveyed (with dates if referenced)	Agency[2]	Topographer (if listed)	Original scale
H-1337b	Du Wamish Bay (Reference for MLLW line)	1875	USC & GS	--	1:10,000
--	Map of Ballard Harbor (Reference for MLLW line)	1893-4	USCE	--	1:4,800
T-1406	Du Wamish Bay	1875	USC & GS	J.S. Lawson	1:10,000
T-2421	Seattle Bay and City (City Front and Head of Bay)	1899 Aug.-Sept.-Oct.	USC & GS	J.J. Gilbert	1:10,000
T-2422	Seattle Bay and City (Shilshole Bay to Alki Point)	1899 Aug.-Sept.-Oct.	USC & GS	J.J. Gilbert	1:10,000
T-2606	Lake Washington - Northern Sheet	1902	USC & GS	O.B. French	1:10,000
T-2607	East Shore of Lake Washington Juanita Bay to Meydenbauer Bay	1902	USC & GS	O.B. French	1:10,000
T-2608	East Shore of Lake Washington Meydenbauer Bay to May Creek	1902	USC & GS	O.B. French	1:10,000
T-2609	Lake Washington - Southern Sheet	1902	USC & GS	O.B. French	1:10,000
H-2608	Lake Washington - Northern Part	1902 Sept. 25–Oct. 24	USC & GS	O.B. French	1:10,000
H-2609	Lake,Washington - Middle Part	1902 Oct. 14–Nov. 8	USC & GS	O.B. French	1:10,000
H-2610	Lake Washington - Southern Part	1902 Oct. 27–Nov. 20	USC & GS	O.B. French	1:10,000
--	Tacoma Quadrangle	1900	USGS	H. Gannett	1:25,000
--	Seattle Quadrangle	1897	USGS	H. Gannett	1:25,000
--	Seattle Quadrangle	1908	USGS	R. McKee	1:62,500
--	Duwamish-Puyallup Surveys (Black River to Lake Washington)	1907	USCE	--	1:4,800
--	Duwamish-Puyallup Surveys (Black River Junction)	1907	USCE	--	1:4,800

[1]USC & GS field sheets prefixed with "T" are topographic surveys; those prefixed with "H" are hydrographic surveys.

[2]Agency abbreviations: USC & GS, U.S. Coast and Geodetic Survey (now National Ocean Survey); USGS, U.S. Geological Survey; USCE, U.S. Army Corp of Engineers.

INDEX OF HISTORICAL SURVEYS AND MAPS USED IN THE MAP COMPILATION

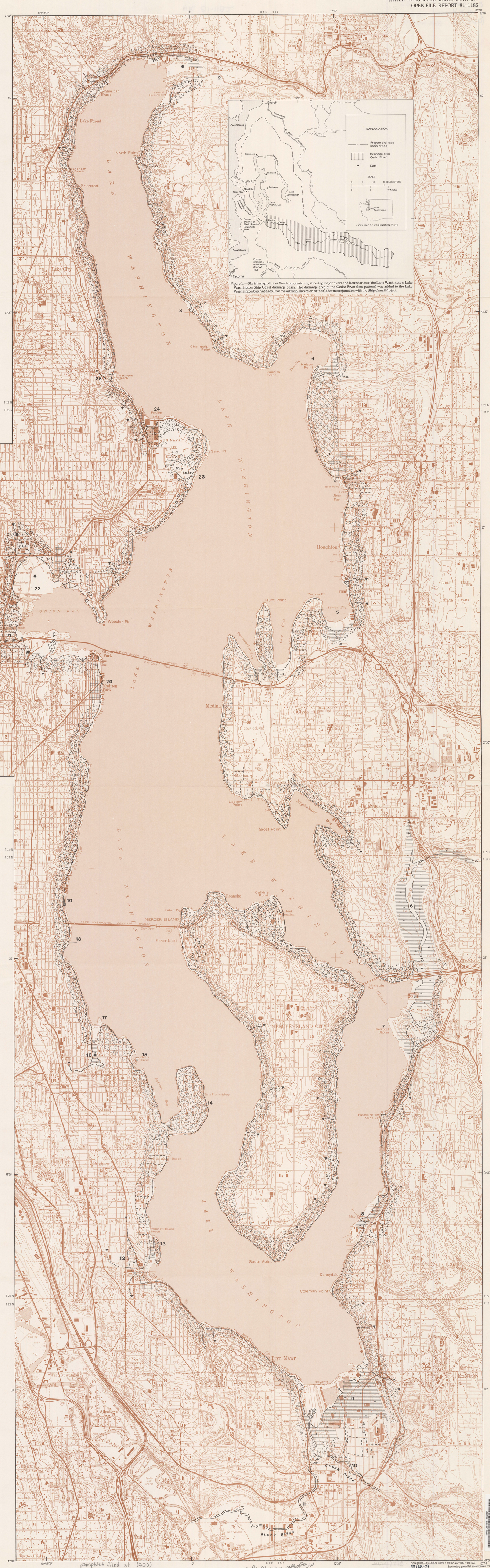


Figure 1.—Sketch map of Lake Washington vicinity showing major rivers and boundaries of the Lake Washington-Lake Washington Ship Canal drainage basin. The drainage area of the Cedar River (line pattern) was added to the Lake Washington basin as a result of the artificial diversion of the Cedar in conjunction with the Ship Canal Project.

EXPLANATION

Symbols for historical map	Features	Symbols for present-day map	Remarks
	Shoreline		Corresponds to the line of mean high water level (saltwater) or mean lake level.
	Mean lower low-water line	(Not shown)	
	Streams	Intermittent, Perennial	The historical mapping made no distinction between intermittent and perennial streams. Streams indexed with solid, inverted triangles are historical channels that have been filled, diverted to sewers, or significantly modified. Open triangles indicate historical streams that today enter the lakes or bays in a near-natural state.
	Wetland		The historical wetlands were freshwater marsh except in Salmon Bay, where salt and brackish marsh existed.
	Forested upland	(Not shown)	The historical forest vegetation was predominantly a mixture of Douglas fir, western red cedar, and western hemlock.
	Grassland	(Not shown)	The historical grasslands included land that was logged prior to the surveys but not then developed for agricultural or urban use.
	Agricultural land	(Not shown)	Limits of land cleared for agricultural use. The polygons represent plots of different ownership or fields for different crops.
	Urban land	(Now shown as streets, buildings, or structures)	
	Shoreline structures		Piers, wharves, warehouses, and mills extending from the shoreline.
	Solid-waste disposal sites	(Not shown)	Sites of filled or modified land where the filling has included general waste and demolition waste (Sources: Wilson, 1975; Phelps, 1978, p. 208).

Numbers refer to areas of historical interest described below.

Base from U.S. Geological Survey: Edmonds East, Bothell, 1953; Shilshole Bay, Seattle North, Duwamish Head, Seattle South; Renton, Vashon, Des Monies, 1949; Mercer Island and Kirkland, 1950

COVERSION TABLE

The following factors are provided for conversion of traditional units used in this report to metric units.

Multiply	*By*	*To obtain*
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.6093	kilometer (km)
acre	0.4047	hectare (ha)
square mile (mi^2)	2.59	square kilometer (km^2)
cubic foot per second (ft^3/s)	0.028317	cubic meter per second (m^3/s)

SHORELINE AND HYDROLOGIC CHANGES OF LAKE WASHINGTON AND THE ROUTE OF LAKE WASHINGTON SHIP CANAL

The text that accompanies this map summarizes Lake Washington and the route of Lake Washington Ship Canal in its present-day setting, the natural conditions preceding the canal project, and a brief history of the project. Also discussed are several planning implications derived from the historical and present-day comparison.

The completion of the Lake Washington Ship Canal in 1917 signaled the beginning of major changes to the shoreline and hydrology of the lakes and bays. Many other changes followed, mainly resulting from the urban growth of the area, but the canal project was unparalleled in its effects.

Except for parts of the Lake Union shoreline, all the shoreline in the lakes and bays has been altered from the natural condition; either cut or filled, raised or lowered. For this report, 30 locations have been selected on the lake and canal perimeters (see map) and brief accounts are given below of significant historical changes to the shoreline or hydrologic conditions at these sites.

1 Kenmore Shoreline and Sammamish River Mouth

Most wetlands and former lake bottom in this vicinity have been zoned for commerical and industrial land use, major landfill, and shoreline modification. The river mouth is periodically dredged to maintain small-craft navigation. In the past, dredge spoil was used to fill neighboring wetlands, but this practice has ceased.

2 Sammamish River

Historically also called Squak Slough, the river in its natural state was a slow, meandering stream bordered by willow-lined marsh and navigable by small, flat-bottomed steamers. Lowering of Lake Washington lowered the base level of the river, thus increasing its gradient and making it too narrow and shallow for navigation. The stronger current reportedly proved ideal for cutthroat trout. However, the channel was later dredged for small-craft passage, which resulted in major destruction of fish-spawning grounds (Ajwani, 1956, p. 4, 56). By 1966, the entire river channel had been widened, deepened, and straightened for the reduction of flooding of adjacent farmlands (U.S. Army Corps of Engineers, 1973, p. 19). At the river mouth, the curved southern channel was the natural channel after Lake Washington was lowered, and this reach has been given the name Squawk Slough (different spelling).

3 Lake Washington submerged forest

One of three known submerged forests in the lake (the other two are on the west and southeast sides of Mercer Island), this site includes trees on a landslide terrace about 100 ft below the present water surface. The slide event has been dated at about 1,100 years ago, and related evidence suggests a lake level then of 12 to 20 feet lower than at present (McDonald, 1956, p. 11). After lake lowering in 1916, the treetops were near the surface and were a navigational hazard. Between 1916–1918 the trees were removed with grapples or the standing tips blown off with dynamited charges to a depth of no less than 30 ft (McKnight, 1923, p. 57).

4 Juanita Bay and Nelson Point

The shallow slope of this bayhead resulted in sustantial shoreline recession when the lake was lowered. Nelson Point was originally the end of a spit built about 1,100 ft into the bay by north-flowing longshore sediment. This former spit remains today as a prominent ridge between lakefront residential property and a park on the former wetlands.

5 Yarrow Bay

Of the three sizable bays in this vicinity, presently (1981) only the bayhead and wetlands of Yarrow Bay have not been filled for land development.

6 Mercer Slough

Underlying this slough and once-extensive adjacent wetlands is the largest peat body in King County, locally as deep as 70 ft (Rigg, 1958, p. 70; Shannon and Wilson, 1963, unpublished data). The natural slough was a wide waterway extending almost to Wilburton, but it drained substantially with lake lowering and is now mostly an artificial channel. Wetlands that fringed the former north end of the slough have largely been filled and developed commercially. Across the central part of this low area 48 acres have been developed as the Bellefields Nature Park which simulates the once natural wetlands habitat.

7 Newport Shores

The outer edge of the former wetlands was about where the shoreline stood after lake lowering. Additional land was built during the most extensive finger-fill development on the lake shore. This type of development involves the dredging of parallel channels for boat moorage and use of the dredged material to create land for channel-side housing. Because of restricted flushing and circulation, water quality in these channels may be subject to degradation (Horowitz, 1978, p. 44).

8 May Creek Delta

Evidence of prehistoric lower lake levels were revealed here with the artificial lake lowering in 1916. In-place forest remnants were scattered across the former lake bottom, and also remains of Indian campfires were found arranged along a possible former shoreline (Carter, 1917, p. 15).

9 Former Renton wetlands

Wetlands once dominated the extreme southern end of the lake, occupying 296 acres on the 1902 U.S. Coast and Geodetic Survey map and possibly were more extensive, before the southern fringe was cleared and drained for agricultural use. Slag from the Renton coal mines was a major fill material for the former wetland which is now used for commerce and industry (McDonald, 1955, p. 10).

10 Cedar River

The Cedar River historically joined the Black River south of Lake Washington. Near its mouth, the main channel of the Cedar was migrating southward in a manner perceived as a threat to the early town of Renton. Anticipating the lake lowering, residents of the Cedar River flood plain organized a commercial waterway district in 1911. They contracted for excavation of a channelway in 1912 to stabilize the river's course and permanently divert the Cedar into Lake Washington.

11 Black River

The Black River was the natural drainageway from Lake Washington (fig. 2) and also received most flow of the Cedar River. Archeological excavations have revealed evidence of the rapid migration of Black River meanders. The excavations also show that massive volumes of sediment were deposited as single events in historical time, likely related to the early logging and increased land erosion in the Cedar valley (James Chatters, Office of Public Archeology, oral commun., May 1980). The diversion of the Cedar River in 1912 and the lowering of Lake Washington in 1916 left the upper Black River channel abandoned. Migrating fish had to adopt a new route to the lake via the locks and the canal. The former Black River channel has been largely filled for commercial and industrial land. Only the western extreme of the channel remains today, occupied by a small, sluggish stream of local drainage.

12 Dunlap Slough

This former shallow slough went dry with the lowering of the lake. The area now is predominantly residential land and a school play field.

13 Pritchard Island

Prior to lake lowering this was a true island separated from the west lakeshore by a shallow channel and marsh. The lake lowering exposed the channel and marsh bottom and the rich organic soil which the Atlantic Nursery of the Seattle Park System now utilizes.

14 Bailey Peninsula

The present-day wooded shoreline of this pensinsular park is a reflection of the once-natural setting that dominated the lakeshore. When the lake formerly fluctuated to high water levels, the peninsula periodically became an island with the low-lying connection becoming submerged. Artificial filling of this isthmus began in 1911 and, with the lowered lake level, it became a broad meadow (Sherwood, 1960).

15 Ohler's Island

This island literally emerged from the receding lake waters, where prior bathymetric surveys had indicated a marsh shoal of soft mud. North of the island, a small spit formerly extended from the north shore of the bay, near where a small wetlands habitat has developed. The island presently is part of a marina facility.

16 Wetmore Slough

The mill town of Columbia City was established on the shore of Wetmore Slough and anticipated the dredging and development of the slough as a lake port. The lowered lake level ended such prospects, by draining much of this inlet and leaving only a small stream at the southern end and an embayment at the northern end. By the mid 1920's, the stream had become part of the municipal sewer system, and in 1937 the north end was artificially filled during improvement of the lakeshore boulevard. The low area of the former slough was used as a solid-waste disposal site into the 1960s. A play field presently occupies the landfill surface (Sherwood, 1960).

17 Stanley S. Sayres Memorial Park

Before lake lowering, the outer end of this peninsula was a shoal separated from shore by a channel 7.5 ft deep (U.S. Coast and Geodetic Survey, 1902). Lowering of the lake exposed the entire peninsula. It was later artificially filled and otherwise modified for park development.

18 The pollution and recovery of Lake Washington

Until 1901, the City of Seattle obtained part of its municipal water from Lake Washington. A trestle carried steel pipe into the lake to draw water from a depth 30–40 ft below the surface. Some lakeside communities obtained limited drinking water from the lake until 1965. However, from the time of early settlement until the 1930s, the lake also was used as a dump for raw sewage from the surrounding communities. By 1941, secondary sewage-treatment plants had been built to serve nearshore communities but the effluent was still discharged into the lake. The resultant nutrient enrichment of Lake Washington produced excessive algal growth; the water gradually became a murky greenish brown. by the late 1950s, beaches were regularly closed to swimmers because of polluted water. In a historic effort of community concern and cooperation, an area-wide sewage system was designed and implemented, such that by 1968 all sewage was diverted around the lake for treatment and subsequent discharge into Puget Sound. The scope of this project and the obvious improvement of Lake Washington water quality have attracted international recognition.

19 Site of 1898 landslide

The glacial processes that shaped Lake Washington were also responsible for building the adjacent higher land, much of which slopes steeply to the lakeshore. Landslides on these steep slopes have been a process of dramatic natural change to the lake shoreline. An 1898 slide involving about 75 acres significantly altered the shoreline immediately north of the present Mercer Island floating bridge (McDonald, 1956, p. 10).

20 Lake Washington sedimentary record

Bottom-sediment cores from off Madison Park show that the buildup of sediment in the lake increased beginning about 1880 and continued at a high rate into the 1920s. This accelerated deposition possibly corresponds to early deforestation and land clearing around the lake, and later road-building, all of which undoubtedly increased land erosion and inflow of sediment to the lake (Spyridakis and Barnes, 1978, p. 10–11). The 1916 lowering of the lake-water level is recorded in bottom sediments throughout the lake. The band of newly exposed lake-bottom sediments was eroded from the emerged shorelands and deposited back into the basin, and now appeaars as a distinct silt band in the bottom sediments (Edmondson and Allison, 1970, p. 141). This band generally occurs 4.7–7.0 in., below the top of the sediment cores, but slightly deeper near the Cedar River mouth (Spyridakis and Barnes, 1978, p. 9).

21 Portage Canal

This canal was excavated in 1885 for transporting logs from Lake Washington to Lake Union (fig. 3). The west end of the canal forked into a lock for lowering logs into Portage Bay and a gated flume for chuting logs into the bay. The two facilities were alternately used depending on the size of the logs or the amount of water-level difference between Lake Union and Washington. A remnant of this canal is visible along the south side of the Seattle and King County Museum of History and Industry. The Portage Canal route was not used in the Ship Canal construction because the route of the Portage Cut (also called Montlake Cut) provided better navigational channel alinement.

22 Union Bay

Because of the shallow nature of this bay, the lake lowering resulted in substantial shoreline recession and wetland draining, but landfill also has been a significant factor in modifying Union Bay. Prior to 1911, a rubbish dump was located in the marsh area at the extreme north end of the bay. After lake lowering, the north-central bay was filled and modified by a major municipal solid-waste-disposal facility (Montlake Dump), which was operational into the late 1960s. The stream formerly entering the bayhead, once the natural drainage from Green Lake, was diverted to city sewers in 1911.

23 Mud Lake

This lake was once a popular fishing and picnic site (fig. 5). A small stream from the east end of Mud Lake connected it to Lake Washington. After the Lake Washington lowering, Mud Lake and surrounding marsh were reduced in size. The smaller lake existed until it was earth-filled in 1939–40 for expansion of the main runway of the Sand Point U.S. Naval Air Station. The southeast part of this peninsula presently (1981) is being developed as a city park, and plans include excavation to recreate Mud Lake and simulate the once-natural setting (Jones and Jones, 1975, p. 4–8, 21).

24 Pontiac Bay

Though the waters off the northwest corner of Sand Point are labeled Pontiac Bay on present-day maps and charts, the name properly refers to the former natural embayment that no longer exists (fig. 5). The bay was first reduced in size by lake lowering, and then was earth-filled in the early 1930s during initial development of the Naval Air Station (Jones and Jones, 1975, p. 4).

25 Thornton Creek

The lowering of Lake Washington's water level forced tributary streams to form new channels across the exposed lake bottom to reach the new shoreline. Lower Thornton Creek is an example of dramatic decrease in gradient and velocity as the steam crosses the floor of a former shallow embayment. The stream is also one example of a drainage severely affected by urban activities and land uses. For example, since a tributary basin of Thorton Creek was paved for a large commercial development, the stream has been noticeably more flood-prone. Also, the stream channel has locally been degraded by unregulated dumping, and once received a large gasoline spill that ignited and sent 20-foot-high flames down the channel along the top of the water surface (Seattle Post-Intelligencer, March 12, 1979, p. A11). In Thorton Creek, as in several other streams surrounding the lake, efforts are underway to improve conditions so as to reestablish salmon migration and spawning.

26 Lake Union

The present water level of Lake Union approximates the water level prior to construction of the Ship Canal. Changes to the lake's shoreline since that time have nearly all been-from landfill. The naturally steep slope along most of the lake's shoreline encouraged filling below the slopes for waterfront development. The southern end of the lake, already shallow, was filled to boat-mooring depths. The weight of fill material along the southwest shore possibly pushed up a small mud island that emerged in May 1962. The feature remains today as a shoal of minimum 3-foot depth.

As with Lake Washington, Lake Union has also had historical changes to the lakeshore resulting from landslides, and a clean-up effort to eliminate sewage and waste discharge. In the late 1880s, a large landslide from southeast Queen Anne Hill slid into the lake's southwest corner (Johnson, 1975, p. 28). A project to stop waste-water discharge from entering Lake Union was begun in 1965, and efforts continue today to end storm-sewer overflows from entering the lake.

27 Lake Union's outflow

The natural outflow from Lake Union was through a channel that extended westward to Salmon Bay and was the route of salmon migration into the lake. By 1884, about 15 years prior to completion of the historical mapping, the original stream had been straightened and widened to facilitate log transport from Lake Union to Salmon Bay.

28 Salmon Bay

With completion of the lock and dam, Salmon Bay was permanently flooded to a level 9.7 ft above the natural mean high water, and transformed from a saltwater to a fresh-water bay. In anticipation of this flooding, the streets and buildings along much of the waterfront were raised so as not to be inundated by the higher water level. Subsequent landfill has brought the shoreline of most of the bay to about the map location of the mean high water line of the original tidal inlet. A former small island in the inlet, named Pest Island (used as a quarantine-detention site), was partially excavated for the canal. The part of the island not removed was submerged by the raising of the bay level, and later became the footing (foundation) for the south bascule of the Ballard Bridge (Wandrey, 1945, p. 21).

29 Saltwater intrusion into the Ship Canal and Lake Washington

After completion of the canal and locks, saltwater was found to enter Salmon Bay during lockage operations. The invading saltwater moved up-canal, and entered the deeper part of Lake Union, which was becoming a trap for the dense salty water. Bacterial production of hydrogen sulfide soon became an odorous problem in Lake Union. In extremely dry seasons, the saltwater rose high enough to overtop a sill that separates Lake Union from Lake Washington and enter the larger lake. During the summer of 1952, a season of exceptionally low precipitation and runoff, enough saltwater entered Lake Washington to almost prevent the usual top-to-bottom mixing of the lake water the following winter (Seckel, 1953, p. 58–60). Construction of the saltwater barrier above the large locks in 1967 has largely stopped the intrusion problem. However, seasonal water levels in the lake-canal system coinciding with increased summer lockages creates a situation in which saltwater intrusion could still be a problem.

30 Salmon Bay entrance

Two spits formerly intruded into the entrance to Salmon Bay, one on either side of a constricted tidal channel. The spits were removed during the Ship Canal dredging and channel alinement.

Dredging of an earlier channel from deep water in Puget Sound into Salmon Bay, reaching the wharves at Ballard, had been completed by 1901 under the direction of the U.S. Army Corps of Engineers. The channel east of "The Narrows" (present site of the lock facilities) provided approximately 10 ft of water depth at extreme low water. This made it easier for vessels to tow logs into the mills at Ballard and carry out lumber and shingles for export.

SCALE 1:24 000

1 MILE

7000 FEET

1 KILOMETER

CONTOUR INTERVAL 20 AND 25 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
THE AVERAGE RANGE OF TIDE IS APPROXIMATELY 11 FEET

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