CONCRETE FLOATING BRIDGES

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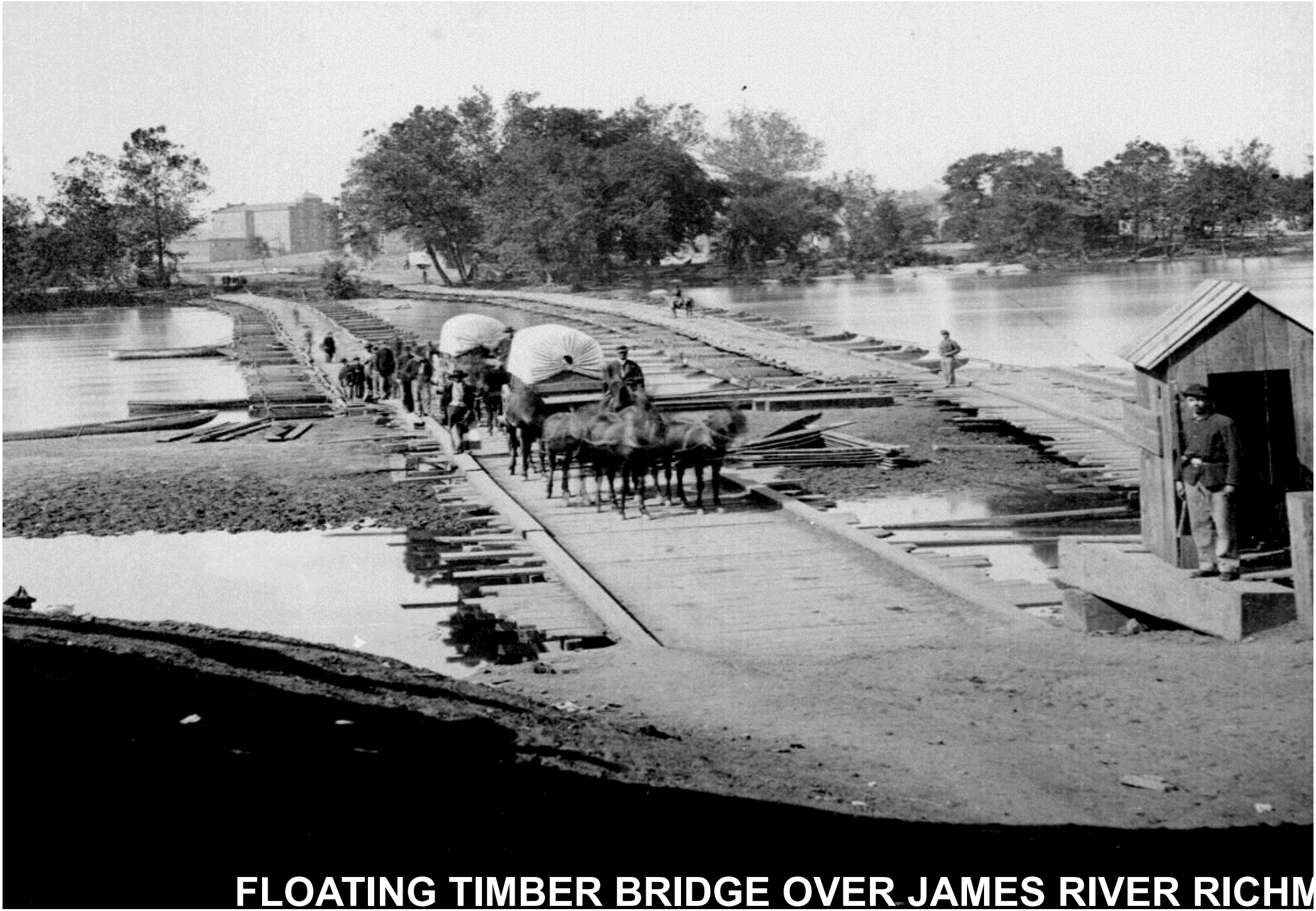
WSDOT Bridge Engineer for Design of Existing LVM Floating Bridge

Concrete in Historic Structures

ACI 2013 Spring Convention – Minneapolis, MN



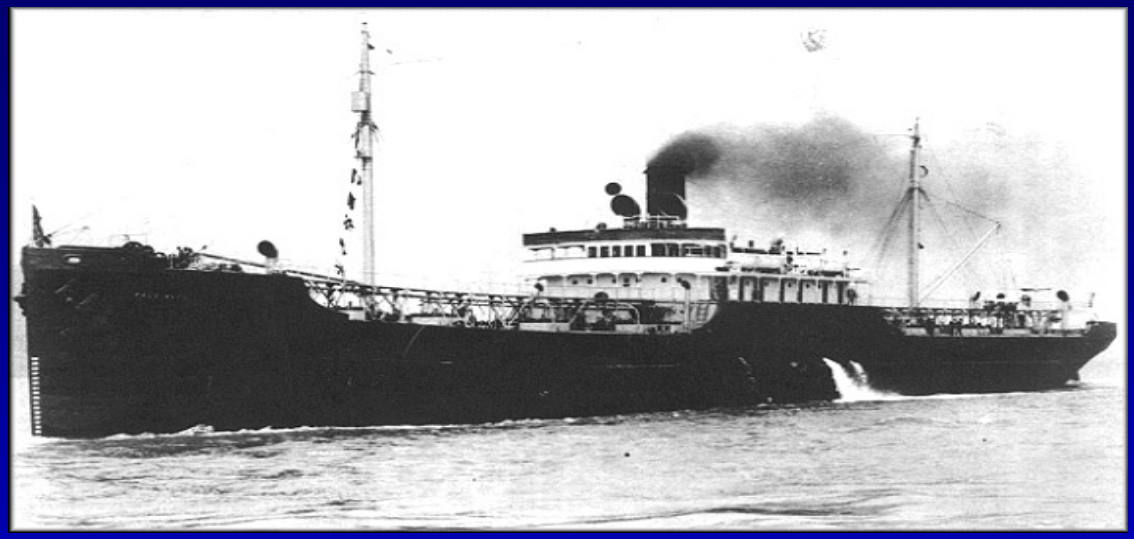
FLOATING TIMBER BRIDGE OVER JAMES RIVER RICHM

ATA BRIDGE, GOLDEN HORN, ISTANBUL, TURKEY, FIRST BUILT 1845
REPLACED WITH BASCULE STEEL BRIDGE, 1992

FLOATING BRIDGES WORLDWIDE

図-付1.1.6　海外の浮体橋位置図

CONCRETE SHIPS



WW I – 12 SHIPS

SS PALO ALTO

419 x 54 x 35 ft

WW II – 24 SHIPS

SS ARTHUR NEWELL TALBOT

336 x 54 x 35 ft

SO WHY NOT CONCRETE FLOATING BRIDGES?

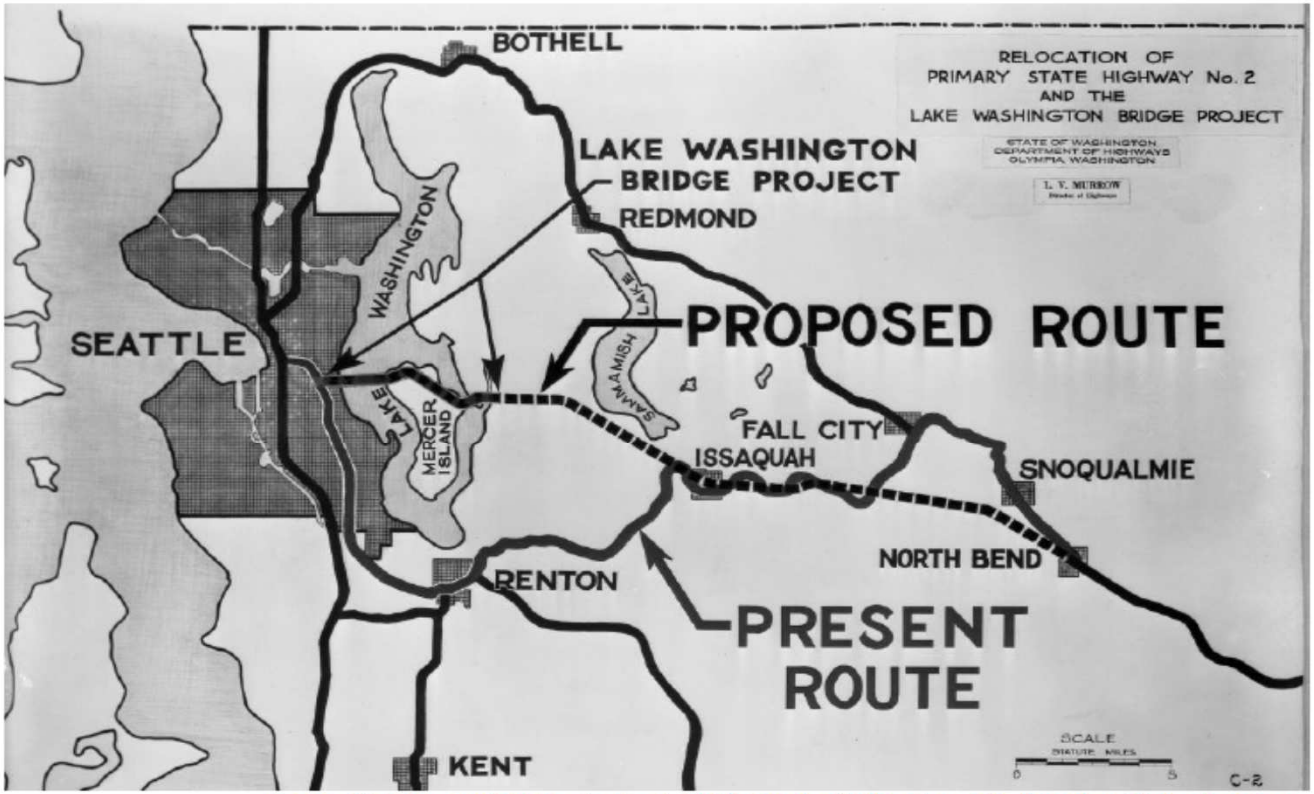
CONCRETE FLOATING BRIDGES

THE WORLD'S FIRST CONCRETE FLOATING BRIDGE

SEATTLE, WA, OPENED, JULY 2, 1940

SEATTLE'S PROBLEM

HOW TO CONNECT EAST TO THE REST OF WASHINGTON AND THE NATION WITH LAKE WASHINGTON IN THE WAY?



Lacey V. Murrow Bridge Project, DOT Photo Collection, Washington State Archives.

Figure 1: Vicinity Map (Circa 1935)

THE ENGINEERING CHALLENGES

SIZE: LAKE WASHINGTON IS 1.5 MILES WIDE BETWEEN SEATTLE ON THE WEST AND MERCER ISLAND ON THE EAST.

DEPTH AND SOILS; THE LAKE IS A FJORD 200FT DEEP WITH 200FT OF SOFT SOIL ON THE LAKE BOTTOM

SHIPPING; THE LAKE HAD TO REMAIN OPEN TO SHIPS UP TO 10,000 TONS

STORMS; LAKE WAVES UP 9FT DEVELOP FOR THE 10 MILE MAXIMUM STORM FETCH FOR WINDS BLOWING FROM THE SOUTHEAST

THE INNOVATOR – HOMER HADLEY

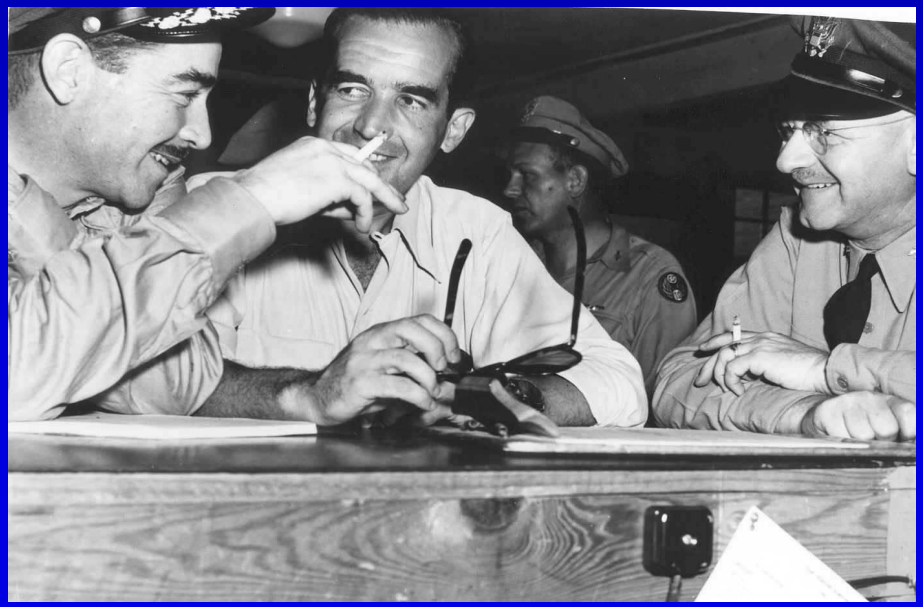
IN 1921 HOMER HADLEY WAS 36, AND SPEAKING AT AN ASCE MEETING ON SEATTLE'S PROBLEM WHEN HE FIRST PROPOSED A CONCRETE FLOATING BRIDGE IN 1921 . HOMER WORKED FOR THE SEATTLE SCHOOL DISTRICT AND HAD WORKED PREVIOUSLY BUILDING CONCRETE SHIPS IN THE PHILADELPHIA SHIPYARDS DURING WWI.

HIS PROPOSAL WAS FOR A BRIDGE MADE FROM INTERCONNECTED CONCRETE BARGES.

HOMER BECAME THE PCA NORTHWEST REGIONAL ENGINEER LATE IN 1921 AND CONTINUED TO PUSH THE CONCRETE BRIDGE CONCEPT AS A PRIVATE TOLL BRIDGE FROM 1921 THROUGH 1937 WHEN THE WASHINGTON STATE TOLL BRIDGE AUTHORITY (WTAB) WAS CREATED.

THE SKIPPER – LACEY V. MURROW

LACEY V. MURROW WAS VERY CAPABLE AND VERY PERSUASIVE. HE WAS THE DIRECTOR OF HIGHWAYS IN WASHINGTON STATE FROM 1933 TO 1940 AND WAS MADE CHIEF ENGINEER OF THE WTBA WHEN IT WAS CREATED IN 1937. UNDER HIS DIRECTION THE WTBA CREATED TWO MAJOR BRIDGES –THE ORIGINAL TACOMA NARROWS BRIDGE AND THE LAKE WASHINGTON FLOATING BRIDGE.



HE RESIGNED HIS POSITION AT THE WTBA TWO MONTHS BEFORE THE NARROWS BRIDGE FAILURE AND ENTERED THE AIR FORCE. HE RETIRED AS A BRIGADIER GENERAL AND SERVED EXTENSIVELY IN COMBAT IN WW II AND THE KOREAN WAR. HE IS BURIED IN ARLINGTON CEMENTERY.

LACEY V ON LEFT AND HIS YOUNGEST BROTHER EDWARD R MURROW ,CENTER, IN EUROPE IN WW II.

THE BIRTH OF THE FIRST CONCRETE FLOATING BRIDGE

HADLEY INTRODUCED THE CONCEPT OF A CONCRETE FLOATING BRIDGE TO MURROW THREE MONTHS AFTER MURROW BECAME HEAD OF THE WTBA. MURROW PROMPTLY ENDORSED THE CONCEPT. PRELIMINARY DESIGN WAS COMPLETED 4 MONTHS LATER , CONSTRUCTION STARTED 10 MONTHS LATER, AND THE BRIDGE WAS OPENED 18 MONTHS LATER.

PRIOR TO THE FORMATION OF THE WTBA THERE HAD BEEN A SEATTLE TOLL BRIDGE AUTHORITY (STBA) WHICH HAD ENDORSED A $3.5 MILLION CONCEPT TO BUILD A STEEL TRUSS CANTILEVER BRIDGE ACROSS THE NARROWEST CHANNEL FROM SEATTLE TO THE MIDDLE OF MERCER ISLAND.

THE STBA CONSIDERED THE CONCRETE PONTOON BRIDGE BUT DISCARDED IT WITH NEWSPAPERS LABELING IT AS “SCOWS CHAINED TOGETHER.” ENVIRONMENTALISTS DEEMED IT A DESECRATION OF THE LAKE, PREDCITING IT WOULD RUIN PROPERTY VALUES AND SINK WITHIN FIVE YEARS. AFTER BRIDGE COMPLETION NEWSPAPERS DECLARED IT ‘’UTTERLY AMAZING” AND “THE EIGHTH WONDER OF THE STRUCTURAL WORLD.”

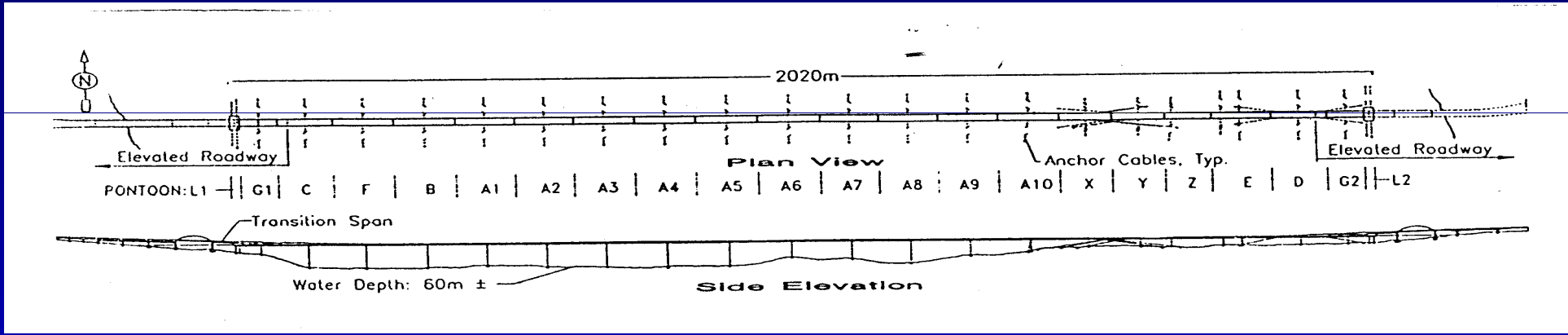
WHY A FLOATING BRIDGE?

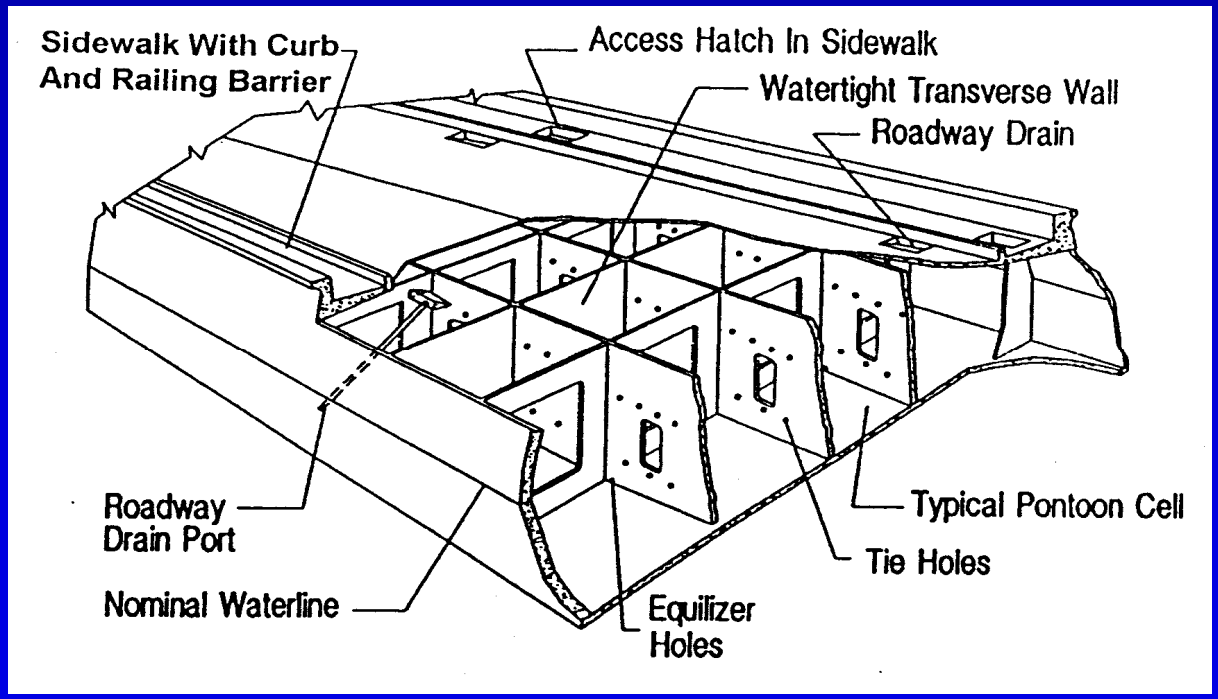
1. LOCATION – MOST DIRECT ROUTE
   - GREAT DEPTH TO FIRM FOUNDATION MADE TOWER CONSTRUCTION VERY CHALLENGING
   – WELL REGULATED LAKE HEIGHT AND LITTLE CURRENT MADE WATER TO LAND TRANSITIONS EASY
2. SCHEDULE – COULD BE BUILT WITHIN TWO YEARS
3. ESTIMATED 1935 COST S –
   $7-10 MILLION FOR FLOATING BRIDGE
   $35-50 MILLION FOR A SUSPENSION BRIDGE
   $$50-100 MILLION FOR A TUNNEL

WHY CONCRETE?

DEAD LOAD OF CONCRETE PROVIDES MORE INERTIA THAN FOR A STEEL OR WOOD FLOATING BRIDGE AND THEREFORE MORE RESISTANCE TO ROUGH WEATHER CONDITIONS

OVERALL LAYOUT -1940 BRIDGE





KEY FEATURES

CELLULAR PONTOONS WITH INTEGRAL ROADWAY

EACH PONTOON ANCHORED TRANSVERSELY

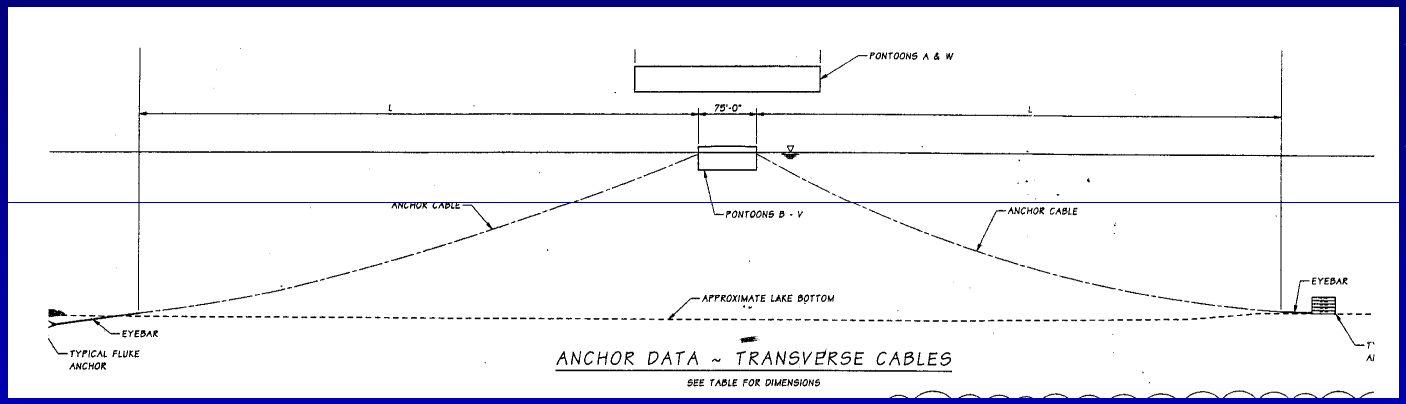
OPENING SPAN FOR SHIPS

TRANSITION SPANS TO LAND

19 PONTOONS BOLTED TOGETHER

CRITICAL PONTOON ELEMENTS

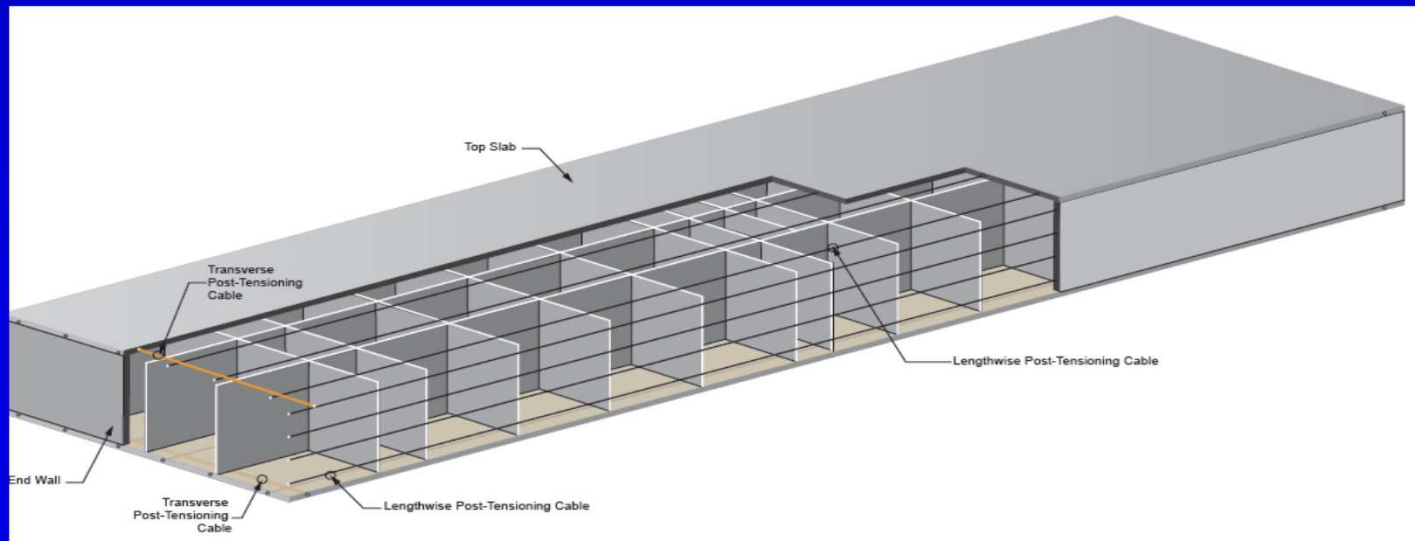
ANCHOR SYSTEM



ANCHOR OFFSET ≈ 700FT

ANCHOR TENSION ≈ 120 K

CELLULAR INTERIOR – FOR IN 1940 & 2012
LONGITUDINAL PT & TRANSVERSE PT – NONE 1940
AVG. STRESS ABOUT 2 KSI - 2012



PONTOON DIMENSIONS

1940

359 FT LONG X 59 FT WIDE X 14.67 FT DEEP

2012

359.75 FT LONG X 75FT W X 33FT DEEP

CONCRETE FLOATING BRIDGES
CONSTRUCTION OF PONTOON DRY DOCK

Property of University of Washington Libraries, Special Collections Division

SINGLE PONTOON DRY DOCK
HARBOR ISLAND, ELLIOT BAY, SEATTLE
MAY 1939

DRY DOCK FOR FOUR LARGE PONTOONS, ABERDEEN, WA
FEBRUARY 2012

THE ENGINEER – LACEY V. MURROW

1939

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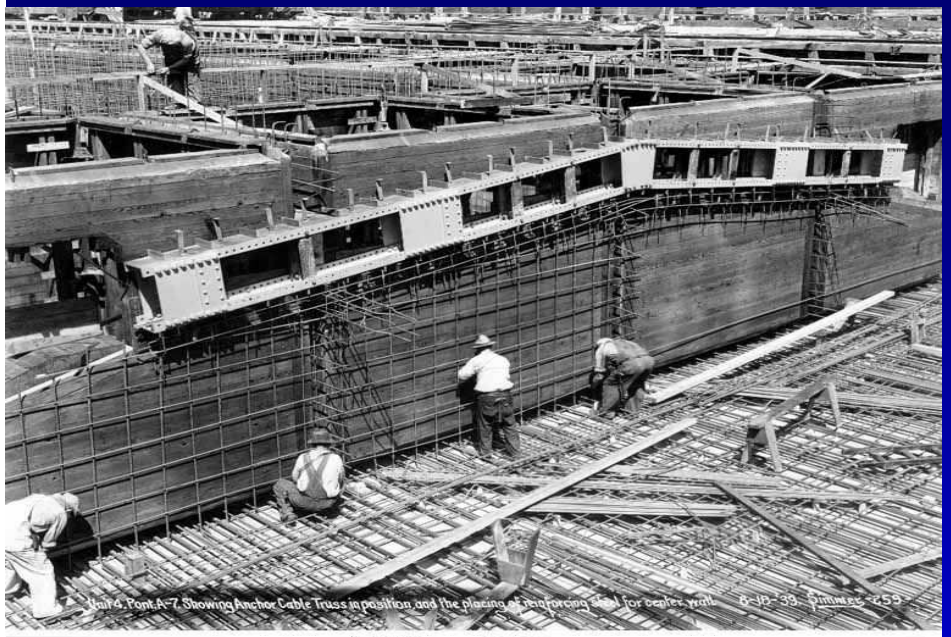
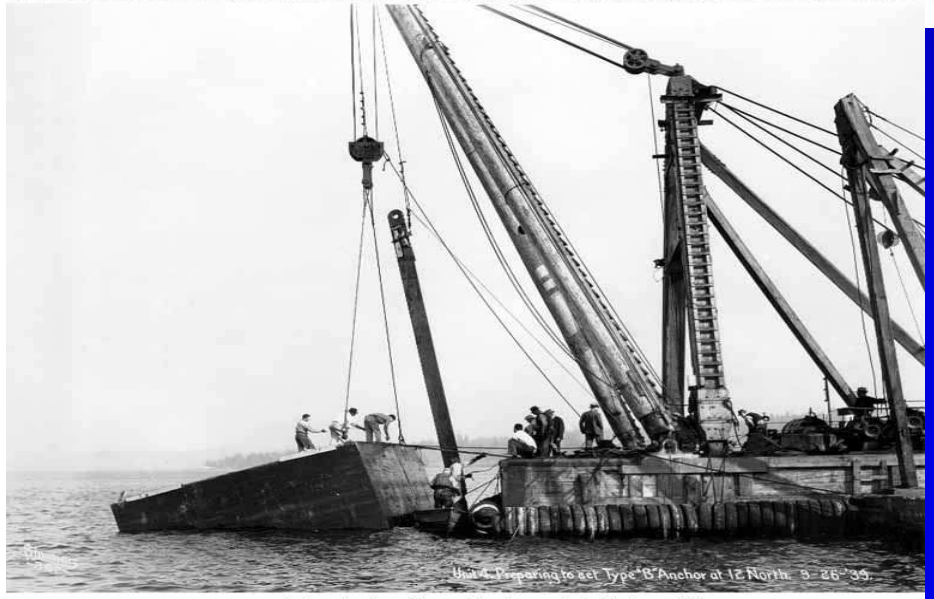
2012

ANCHOR GALLERY AND ANCHORS





FLOAT OUT OF FIRST PONTOON

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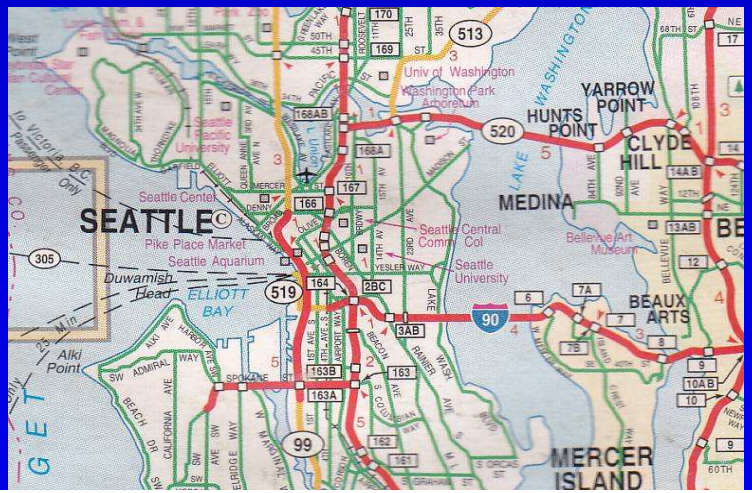
FIRST PONTOON MAY 1939
ELLIOTT BAY SEATTLE



FIRST SR 520 PONTOON- JULY 2012

THE CONTROLLING FACTOR

PASSAGE THROUGH THE LOCKS BETWEEN PUGET SOUND AND LAKE WASHINGTON

1939

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2012

PONTOONS TOWED INTO LAKE

1939

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2012

ASSEMBLY ON THE LAKE

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THE OPENING SPAN

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OPENING DAY, JULY 2, 1940

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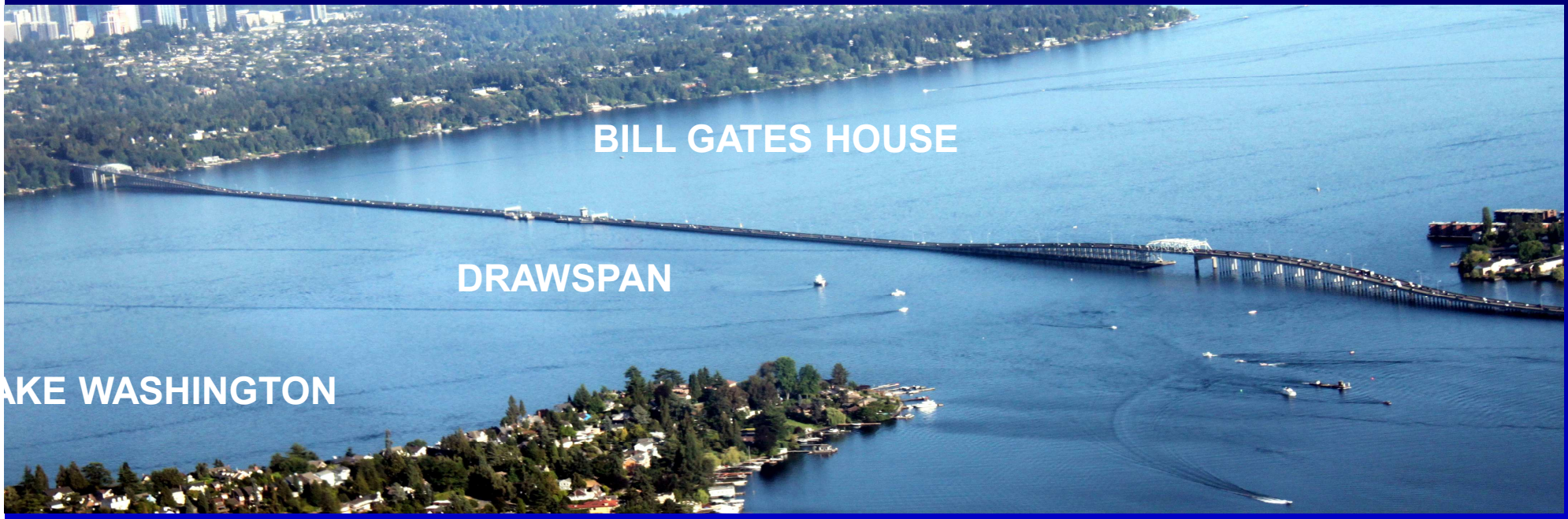
TODAY'S WASHINGTON STATE FLOATING BRIDGES

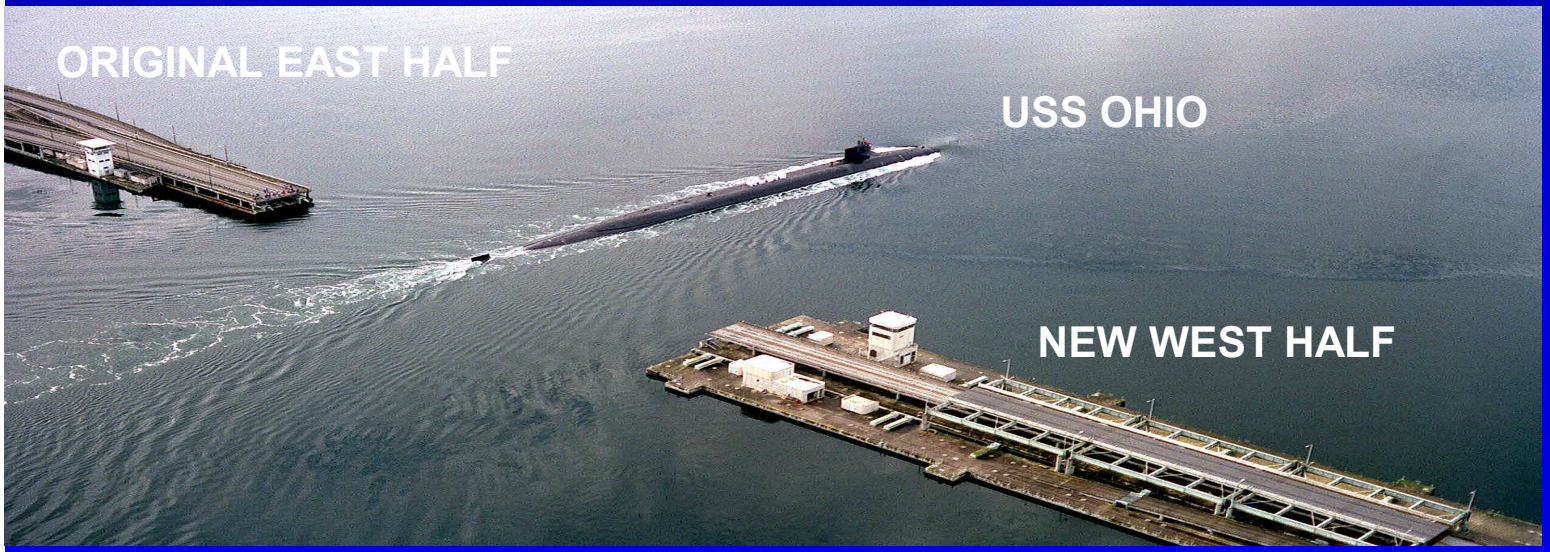


SR 520 EVERGREEN POINT BRIDGE

TOTAL LENGTH = 12,404 FT
FLOATING LENGTH = 7,578 FT

BRIDGE REGULARLY SUBJECT TO STRONG WINTER STORMS

TODAY'S WASHINGTON STATE FLOATING BRIDGES



TOTAL LENGTH = 7,866FT

FLOATING LENGTH = 6521 FT

HOOD CANAL FLOATING BRIDGE

TODAY'S WASHINGTON STATE FLOATING BRIDGES

I-90 BRIDGES LOOKING EAST. HOMER HADLEY ON LEFT AND LACEY V. MURROW ON RIGHT

TOTAL LENGTH =9,559 FT; FLOATING LENGTH = 6,620 FT