Low Low Water in Puget Sound vs. Mean Sea Level

What do the flood event gauge readings at Sedro-Woolley really mean?

Back in 1928

In drafting the historical chapter of past flood control/reduction efforts I reviewed the over 80 plus studies dating back to 1875. In 1928 the Corps published the following table

38. Flood heights and discharges at Sedro-Woolley (25 miles above the mouth, drainage area 2,970 square miles) were as follows:

Date	Gauge Height[1]		Discharge	Run-off	Accuracy
			Cubic feet per second	*Second feet per square mile*	*Per cent*
About 1815	63.5	33.5	400,000	134	15
About 1856	60.0	30.0	350,000	101	15
Nov. 16, 1896	54.8	24.8	185,000	62	15
Nov. 19, 1897	54.9	24.9	190,000	64	15
Nov. 16, 1906	54.7	24.7	180,000	61	15
Nov. 30, 1909	56.5	26.5	220,000	74	10
Dec. 30, 1917	54.1	24.1	195,000	66	10
Dec. 13, 1921	54.3	24.3	210,000	71	10

[1]Zero of gauge set at elevation of extreme low water in Puget Sound

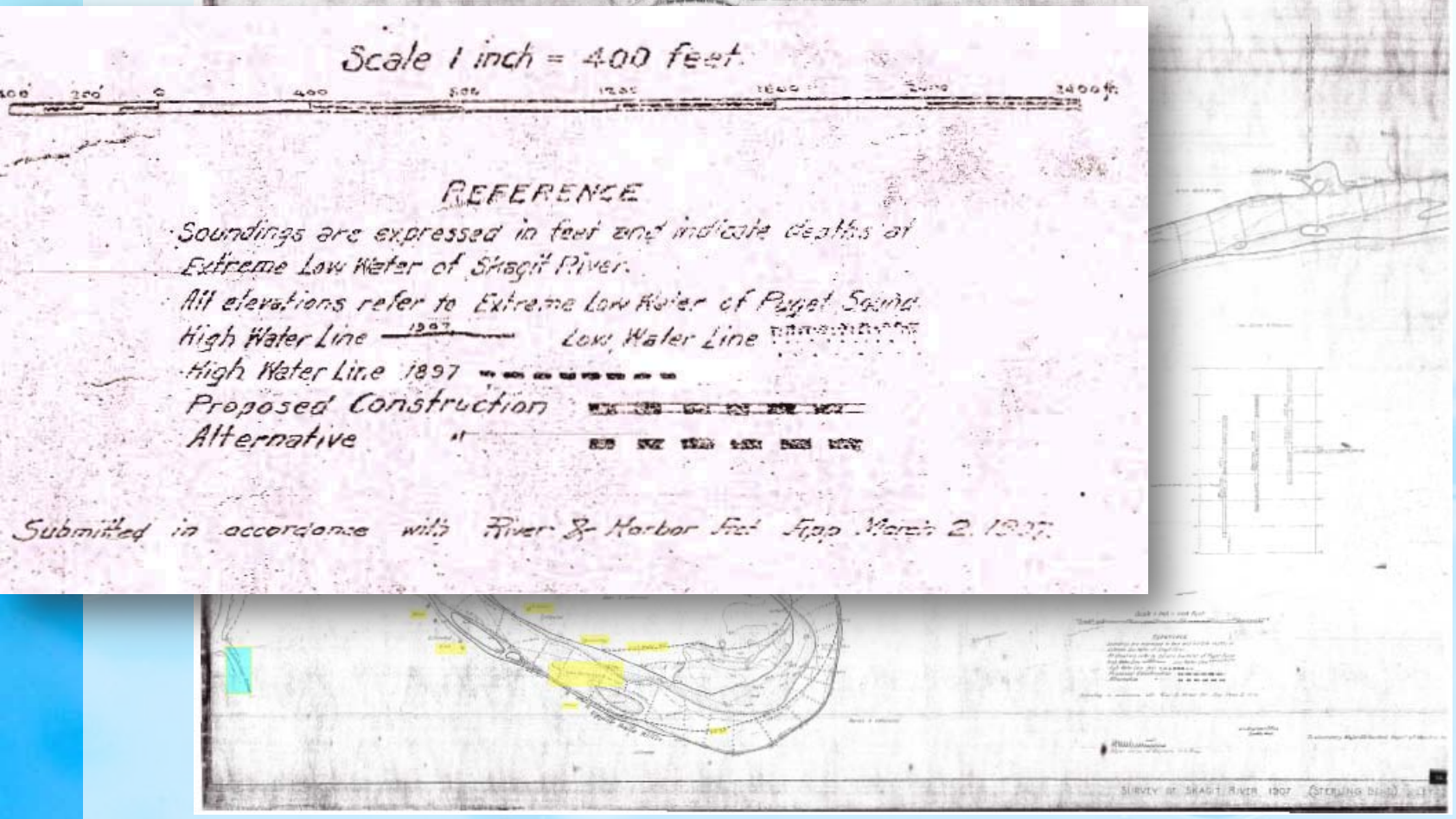
(***Source***: USACE Preliminary Examination of Skagit River May 9, 1928)

Two Problems With the Numbers

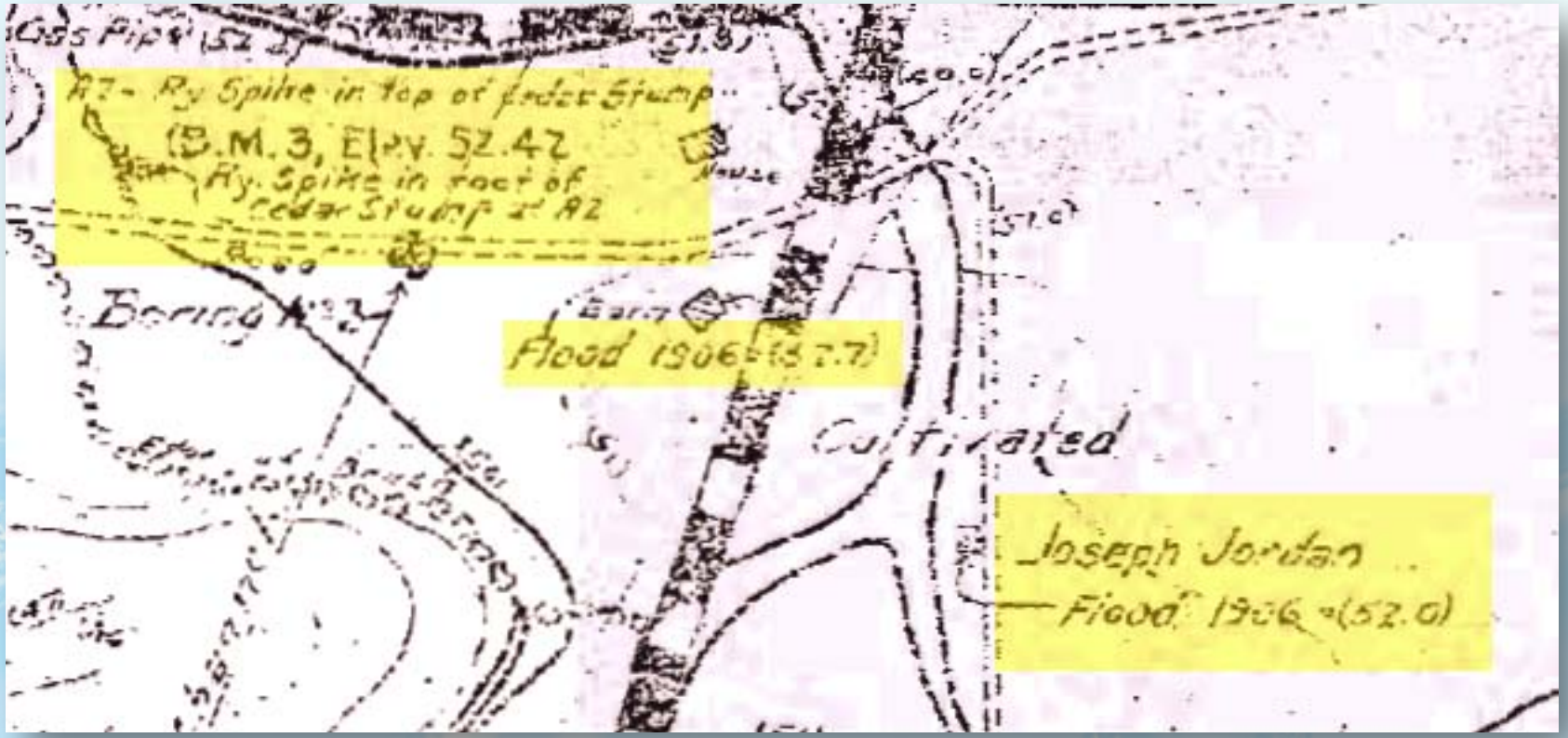
1. The figures published are the same figures that Stewart used in his 1923 "Draft" report except that the Corps added 30 feet to Stewarts gage readings but those were based on Low Low Water in Puget Sound.

2. Low Low Water is NOT the same as Mean Sea Level.

BACK TO 1907


Scale 1 inch = 400 feet
REFERENCE
Soundings are expressed in feet and indicate depths at Extreme Low Water of Skagit River.
All elevations refer to Extreme Low Water of Puget Sound
High Water Line 1907
Low Water Line
High Water Line 1897
Proposed Construction
Alternative
Submitted in accordance with River & Harbor Act App. March 2, 1907.

2,890 FEET BELOW S-W RAILROAD BRIDGE



In 1961 Stewart-Bodhaine, USGS Published the Following

28. *Skagit River near Sedro Woolley, Wash.*

Location.—Lat 48°29'05", long 122°14'30", in NW¼ sec. 36, T. 35 N., R. 4 E., at Northern Pacific Railway bridge, three-quarters of a mile downstream from entrance to Beatty Slough, and 1½ miles south of Sedro Woolley.

Drainage area.—3,000 sq mi, approximately, of which 400 sq mi is in Canada.

Gage.—Staff or chain gages. Datum of gage is extreme low sea level in Puget Sound (levels by Corps of Engineers), which is 8.93 ft below mean sea level, unadjusted.

Stage-discharge relation.—Defined by current-meter measurements below 91,000 cfs and extended by logarithmic plotting.

The difference between Low Low Water/Extreme Low Sea Level in Puget Sound and Mean Sea Level.

Spot the Similarities

1961 Stewart-Bodhaine:

Skagit River at S-W

Nov. 16, 1896	54.8
Nov. 19, 1897	54.9
Nov. 16, 1906	54.7
June 11, 1908	47.8
Nov. 18, 1908	52.0
Nov. 30, 1909	56.5
Nov. 21, 1910	52.1
Nov. 19, 1911	48.4
June 3, 1913	46.4
Jan. 7, 1914	49.6
Apr. 3, 1915	45.4
June 18, 1916	46.5
June 16, 1917	44.4
Dec. 30, 1917	54.1
Dec. 4, 1918	47.0
Dec. 13, 1921	54.3
Dec. 25, 1922	45.2

1928 Corps:

Skagit River at S-W

Date	Gauge Height[1]	
About 1815	63.5	33.5
About 1856	60.0	30.0
Nov. 16, 1896	54.8	24.8
Nov. 19, 1897	54.9	24.9
Nov. 16, 1906	54.7	24.7
Nov. 30, 1909	56.5	26.5
Dec. 30, 1917	54.1	24.1
Dec. 13, 1921	54.3	24.3

Subtracting 8.93 feet From Published Figures

Skagit River near Sedro-Woolley, Wash

Minus 8.93 feet Extreme Low Water to get to Mean Sea Level

1815	54.7	400,000
1856	51.1	300,000
November 16, 1896	45.9	185,000
November 19, 1897	46.0	190,000
November 16, 1906	45.8	180,000
November 30, 1909	47.6	220,000
December 30, 1917	45.2	195,000
December 13, 1921	45.4	210,000

Which Means When Considering…

August 2009 Corps Historical Flood Estimates Accounting for Dam Storage

Skagit River near Sedro-Woolley, Wash

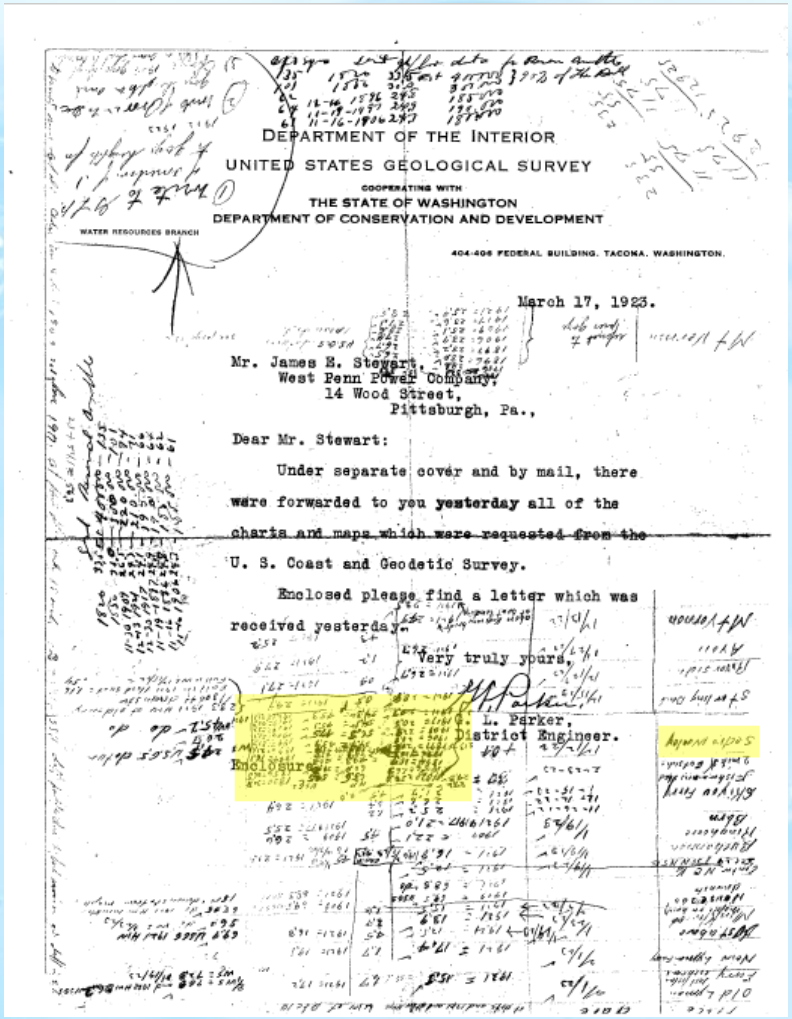
Minus Approx. 3 feet Due to Ross/Upper Baker Dam Storage or roughly 50,000 cfs[1]

1815	51.7	350,000
1856	48.1	250,000
November 16, 1896	42.9	135,000
November 19, 1897	43.0	140,000
November 16, 1906	42.8	130,000
November 30, 1909	44.6	170,000
December 30, 1917	42.2	145,000
December 13, 1921	42.4	160,000

The 2003 flood event registered 42.02 (Mean Sea Level) on the Sedro-Woolley gage. In 2006 it registered 42.2.

SOURCE: Army Corps of Engineers Seattle District August 2009 Feasibility Scoping Meeting Read-Ahead Report: http://www.SkagitRiverHistory.com/Corps Docs/2009-08-19 SKAGIT FSM Read-Ahead Final.pdf

Stewart's Handwritten Calculations



DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
COOPERATING WITH
THE STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
WATER RESOURCES BRANCH
404-406 FEDERAL BUILDING, TACOMA, WASHINGTON.

March 17, 1923.

Mr. James E. Stewart,
West Penn Power Company,
14 Wood Street,
Pittsburgh, Pa.,

Dear Mr. Stewart:

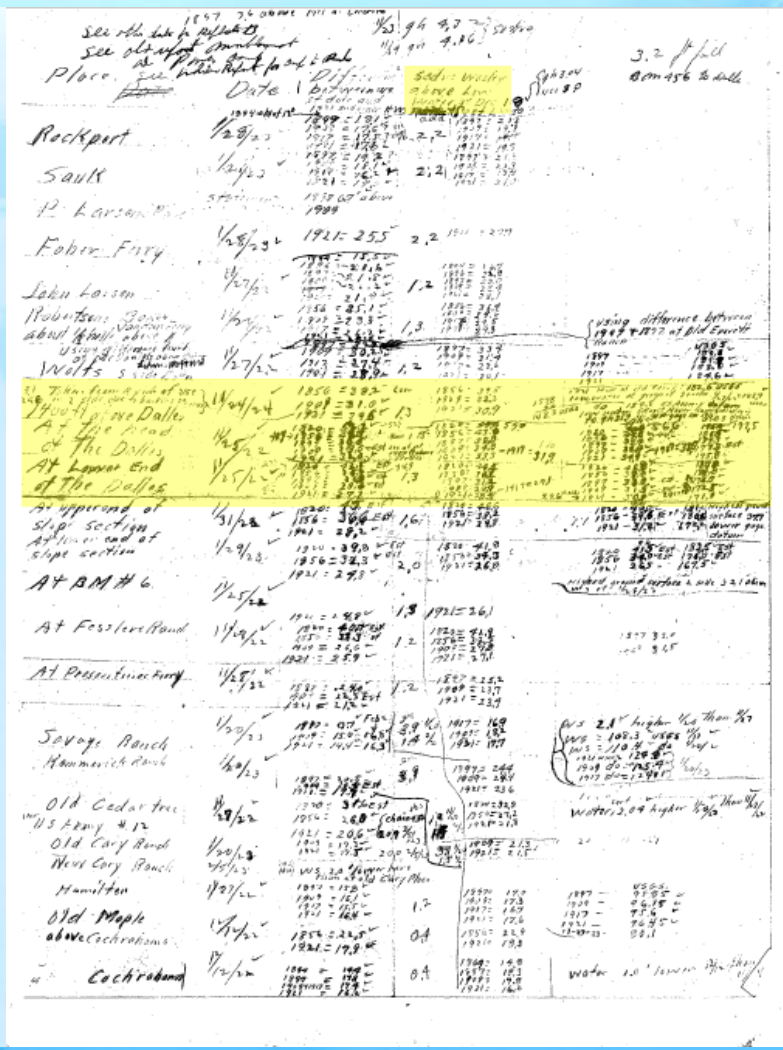
Under separate cover and by mail, there were forwarded to you yesterday all of the charts and maps which were requested from the U. S. Coast and Geodetic Survey.

Enclosed please find a letter which was received yesterday.

Very truly yours,

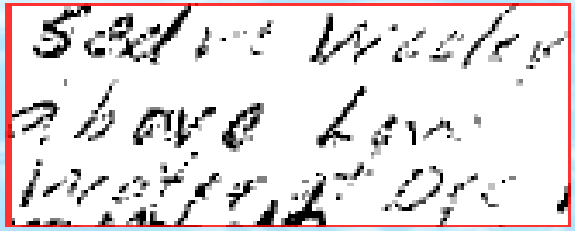
M. L. Parker,
District Engineer.

Enclosure

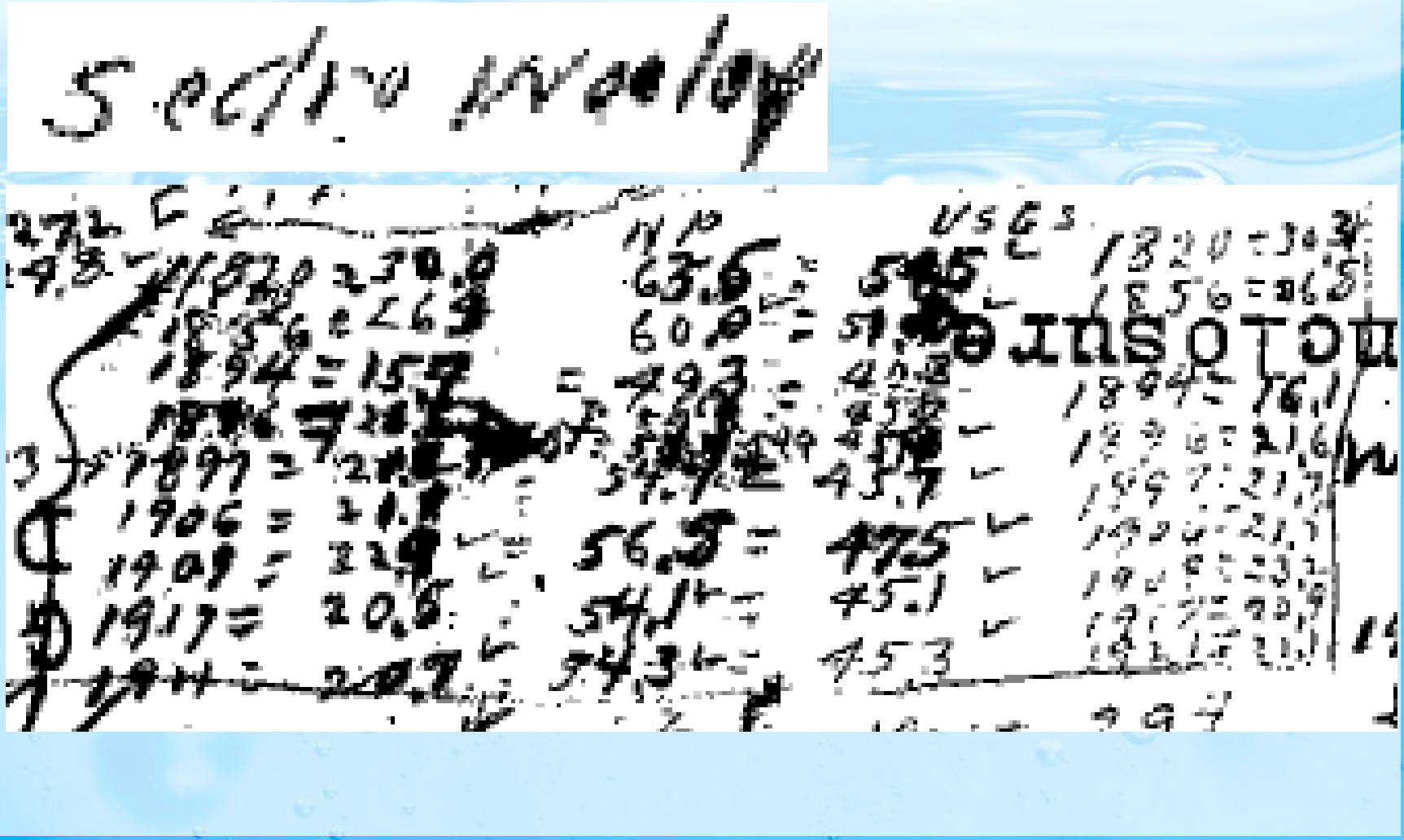


Rockport
Sauk
Faber Ferry
Jake Larsen
Robertson
Wolfs
At the Dalles
At the Road
At The Dalles
At Lower End of The Dalles
At BM #6
At Fosterville Road
At Prosserville Ferry
Savage Ranch
Old Cedar tree
Old Cary Ranch
New Cary Ranch
Hamilton
Old Maple
above Cochrahans
Cochrahans

So what datum did James E. Stewart use in his 1922 survey?



Page 1 of Stewart's Notes Showing Sedro-Woolley Calculations

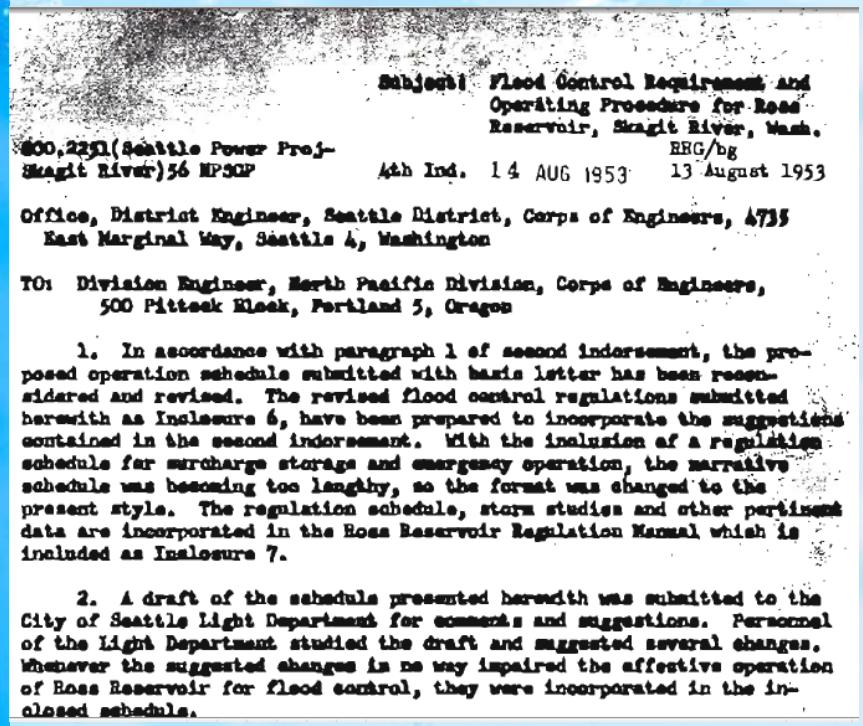


Which Leads Us To the Question

Why is this all so important?

The Consequence

Corps Seattle District Letter to Corps HQ Portland, Re: Flood Storage Behind Ross Dam, 13 August 1953



Subject: Flood Control Requirement and Operating Procedure for Ross Reservoir, Skagit River, Wash.

800.2251(Seattle Power Proj-Skagit River)56 NPSCP

4th Ind. 14 AUG 1953

RHG/bg 13 August 1953

Office, District Engineer, Seattle District, Corps of Engineers, 4735 East Marginal Way, Seattle 4, Washington

TO: Division Engineer, North Pacific Division, Corps of Engineers, 500 Pittock Block, Portland 5, Oregon

1. In accordance with paragraph 1 of second indorsement, the proposed operation schedule submitted with basis letter has been reconsidered and revised. The revised flood control regulations submitted herewith as Inclosure 6, have been prepared to incorporate the suggestions contained in the second indorsement. With the inclusion of a regulation schedule for surcharge storage and emergency operation, the narrative schedule was becoming too lengthy, so the format was changed to the present style. The regulation schedule, storm studies and other pertinent data are incorporated in the Ross Reservoir Regulation Manual which is included as Inclosure 7.

2. A draft of the schedule presented herewith was submitted to the City of Seattle Light Department for comments and suggestions. Personnel of the Light Department studied the draft and suggested several changes. Whenever the suggested changes in no way impaired the effective operation of Ross Reservoir for flood control, they were incorporated in the inclosed schedule.

The next step was to determine the amount of storage required at Ross Reservoir to provide the maximum crest reduction at Sedro Woolley. All discharges of more than 65,000 second-feet at either Sedro Woolley (**1908 through 1923**) and Concrete (**1924 to date**) **occurring in October, November, and December were studied.**

We have been told repeatedly that Stewart's Sedro-Woolley figures are not reliable, yet the Corps used those figures instead of the Concrete figures for the Stewart floods but used Concrete for all the rest of the floods.