US Army Corps of Engineers®

Portland-Vancouver Harbor Information Package

Third Edition

Reservoir Regulation and
Water Quality Section

October 2014

Abstract

Planners, engineers, and residents of the Portland-Vancouver Harbor area have established a need for thorough and consistent information pertaining to the hydrology of the harbor. The hydrology of the harbor is very complex. Harbor stage (water level) is influenced by three primary factors: (1) upstream reservoir regulation; (2) natural streamflows on the Columbia River, Willamette River, and local tributaries; and (3) tidal effects (especially at stages below 12 feet). Two stations in the harbor provide a sufficiently long and representative database to derive useful statistics for stage. These stations are the Willamette River at Portland and the Columbia River at Vancouver. Both stations show peak daily and monthly stages during two periods: the winter as a result of high Willamette River streamflow and the late spring as a result of high Columbia River streamflow. Minimum daily and monthly stages occur in the summer and fall at both stations.

Acknowledgment

The U.S. Army Corps of Engineers, Portland District, developed the Portland-Vancouver Harbor Information Package in cooperation with the U.S. Geological Survey and the National Weather Service. Valuable assistance was provided by the following individuals: Richard Cassidy, Doug Speers, Ron Mason, and Ralph Almeria of the U.S. Army Corps of Engineers; Lawrence E. Hubbard and Suzanne Miller of the U.S. Geological Survey; and Chuck Orwig of the National Weather Service. Their efforts have resulted in completion of a report which otherwise would have not been possible.

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Portland-Vancouver Harbor Information Package

1. Introduction. In response to a growing demand for hydrologic information for the Portland-Vancouver Harbor area, the U.S. Army Corps of Engineers has developed this harbor information package. The purpose of this package is to provide current, thorough, and consistent information pertaining to the hydrology of the harbor.

Contents of the harbor information package include the following: a general description of the Portland-Vancouver Harbor; a description of the principal gauging stations; a summary of the data extremes and variability for the period of record; and a hydrologic analysis of the Portland-Vancouver Harbor. Appendixes in this report are as follows:

a. Glossary of Hydrologic Terms Used in the Portland-Vancouver Harbor Area.
b. Principal Agencies and Responsibilities Related to the Portland-Vancouver Harbor Area.
c. Inventory of River Stations Providing Portland-Vancouver Harbor Information.
d. Summary of Extreme Readings of Stage and Discharge in the Portland-Vancouver Harbor Area.
e. References.

2. General Description of the Portland-Vancouver Harbor Area. The Portland-Vancouver Harbor is considered in this report to be the waters in close proximity to metropolitan Portland and Vancouver. In general, this area is bounded on the south at river mile (RM) 25 on the Willamette River below Willamette Falls at Oregon City; on the west below the confluence of the Willamette and Columbia Rivers at RM 100 on the Columbia River; and on the east at RM 110 also on the Columbia River (see Figure 1).

Because of the harbor's low elevation and proximity to the coast, tidal effects on river stage are significant. Harbor stage is also influenced by the regulation of upstream water storage projects as well as natural streamflows on both the Columbia and Willamette Rivers. These effects are discussed further in paragraph 5, Hydrologic Analysis.

A large number of hydrologic terms are commonly used in engineering and planning applications concerning the Portland-Vancouver Harbor. These terms and their definitions are provided in Appendix A. Hydrologic data pertaining to the Portland-Vancouver Harbor are collected and used by many agencies. The principal agencies involved in this activity and their respective responsibilities are described in Appendix B.

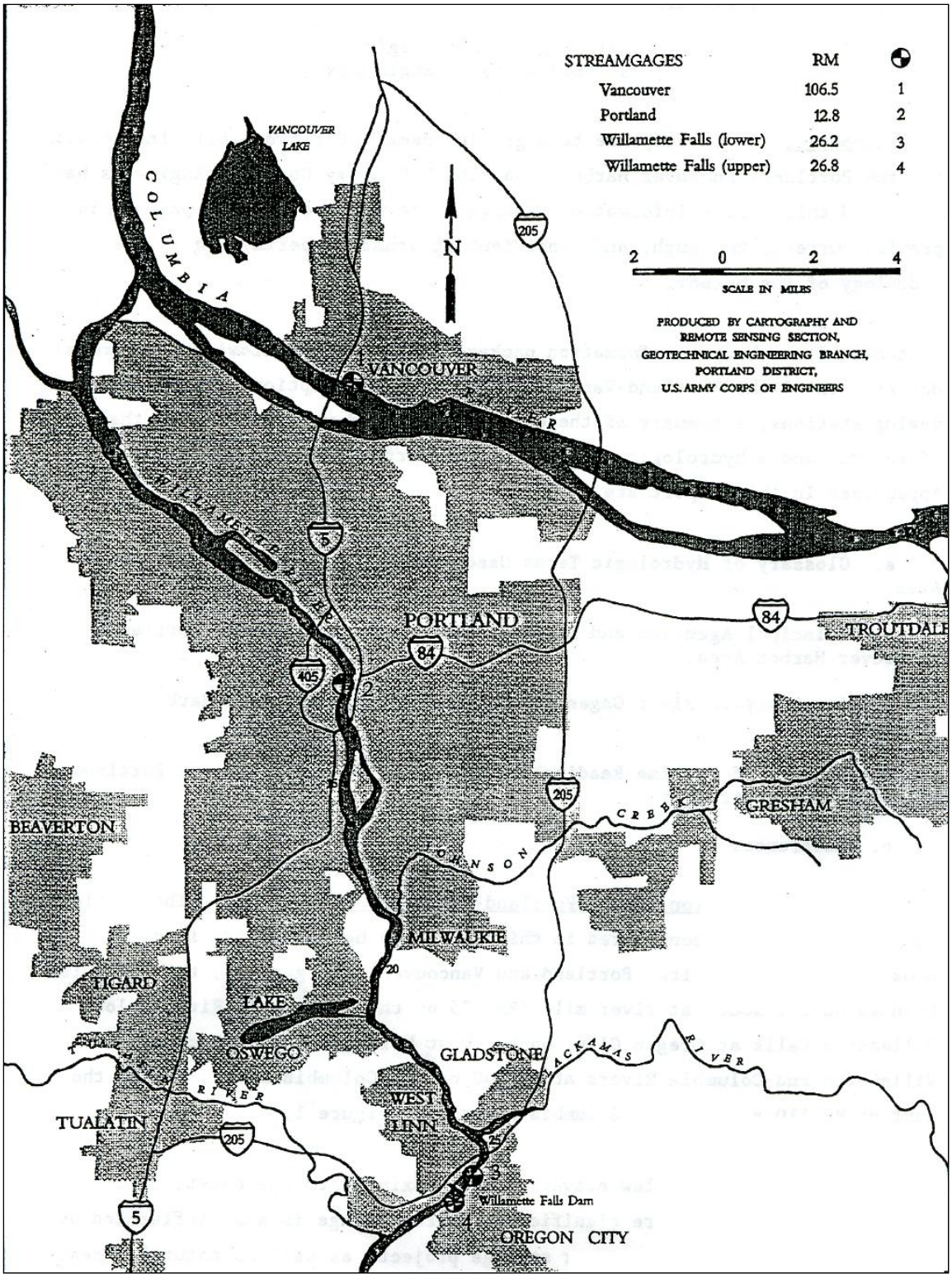

Figure 1. Portland - Vancouver Harbor Area.

3. Principal Gauging Stations. Stage and flow data are available for the Portland-Vancouver Harbor. Stage data (elevation in feet above sea level or another datum) are collected at Vancouver on the north and upstream side of the I-5 bridge for the Columbia River. Stage data are collected at Portland on the west side, middle section of the Morrison Street Bridge, for the Willamette River. The datum at the Vancouver station is 1.82 feet (a stage reading of 0 is 1.82 feet above sea level, or more appropriately the National Geodetic Vertical Datum of 1929 [NGVD29]). The datum at the Portland station is 1.55 feet, NGVD29.

The National Ocean Service collects stage data at Astoria, Oregon. Stage data are collected by the Port of Portland at Astoria, Oregon; Beaver, Oregon; Skamokawa, Washington; Wauna, Oregon; Longview, Washington; St. Helens, Oregon; and the Port of Vancouver, Washington. With the exception of Vancouver, these stations are downstream of the Portland-Vancouver Harbor and are, therefore, not discussed further in this report.

The most reliable measurement of discharge along the lower Columbia River is at The Dalles. Columbia River discharge data below Bonneville Dam is not available because of tidal influences. Discharge data, however, is available for the tidally influenced Willamette River at Portland. This data is acquired through use of a special type of stream gauge (acoustic velocity meter and velocity index recorder) capable of measuring discharge in a tidal area.

A summary of the gauges providing information relevant to the Portland-Vancouver Harbor and downstream is provided in Appendix C.

4. Period of Record, Data Extremes, and Variability of Data. The period of record, extreme readings, and variability of data for the Portland, Vancouver, and The Dalles gauges are discussed in the following paragraphs.

a. Period of Record.
   1) Vancouver, Washington – Columbia River. The period of record used for stage data at Vancouver is from water year 1902 to the present. Daily discharge data is not available except for a short period between 1965 and 1969. The most relevant stage data (used for this report) uses a period of record beginning in water year 1973, the year all Columbia River flood control projects were completed, operating, and reflecting present conditions. Daily stage data collected by the Corps of Engineers at Vancouver has previously been unpublished. The USGS has streamflow data from October 1963 through June 1970. USGS began operating the stage only site in February 1998.
   2) Portland, Oregon – Willamette River. Stage data at Portland has been measured continuously since water year 1879. The station was equipped with an acoustic velocity meter with a water stage and velocity index recorder from 1972 through 1994 and returned to a flow station again in October 2003. Daily discharge data (from stage) collected by the United States Geological

Survey (USGS) at Portland was published by the USGS annually from water year 1973 to water year 1994.

3) The Dalles – Columbia River. Period of record for daily stage and discharge is from water year 1879 to the present. Daily discharge data (from stage) collected by the USGS at The Dalles has been published by the USGS intermittently since water year 1879 and annually since water year 1969.

b. Data Extremes. Maximum and minimum stage measurements are available for the Columbia River at Vancouver from water year 1902 to the present; at The Dalles from water years 1879 through 2002; and at the Willamette River at Portland from water year 1879 to the present. Maximum and minimum discharge measurements are available for the Willamette River at Portland since water year 1973 and for the Columbia River at The Dalles since water year 1879. Extreme readings for these stations are provided in Appendix D.

c. Reliability of Data. Mean daily and monthly statistics based on daily high and low values may differ slightly from values derived from a continuous record. In addition, missing stage data at Portland and Vancouver occurred for short periods of time. Due to the close relationship between stage at Vancouver and stage at Portland, data from Portland was periodically used to provide missing Vancouver values, and vice versa, after correcting for their differences in datum. During these periods of missing or inadequate data, which represent between 1 to 2 percent of the total data for both Portland and Vancouver periods of record, no extreme values were established and, therefore, the statistics reported in this report do not significantly change. Overall reliability of the data used in this report is considered good.

5. **Hydrologic Analysis**.

a. General. The hydrology of the Portland-Vancouver Harbor area is very complex. Hydrologic conditions are influenced by three primary variables:

1) Upstream reservoir regulation on the Columbia and Willamette Rivers.
2) Natural streamflows on the Columbia River, Willamette River, and local tributaries such as the Sandy, Washougal, and Clackamas Rivers.
3) Tidal effects.

Each of these three variables will seasonally influence harbor stage to a greater or lesser degree. For example, upstream reservoir regulation on the Columbia and Willamette Rivers has resulted in reducing peak winter and spring stages and correspondingly increasing late summer and fall stages. Natural streamflows have a strong influence on stages during extreme events when reservoir regulation cannot completely control downstream streamflow, be it high or low. Tidal effects are noticed at harbor stages less than 12 feet, and are pronounced at stages less than 5 feet which are common in the summer and fall. The combined effect of these three interacting variables is what makes the hydrology of the harbor complex.

A definite slope exists in the harbor area at different times of the year. During the winter period, with high flows coming out of the Willamette River, the Portland Harbor stage tends to be 0.2 to 0.5 feet greater than Vancouver. Conversely, in the spring when the Columbia River flows are high, the Vancouver stage tends to be a few tenths higher than Portland.

Occasionally harbor stages can change substantially due to heavy rain in the harbor area. In February of 1982 an intense rain event hit northern Oregon and southern Washington causing an increase of 3 to 4 feet in the harbor area over a 12-hour period.

The harbor area is especially sensitive to harbor stages below 0.0 feet on the Portland-Vancouver gauges. At such times special river statements are made by the National Weather Service (NWS) to apprise harbor interests of the magnitude and timing of stages occurring below 0.0 feet. These low water conditions are especially critical during summer and fall weekends when both commercial and pleasure boats using the harbor area may hit sand bars in unexpected locations.

b. Definition of Hydrologic Terms. Data from two principal stations in the harbor area, Columbia River at Vancouver and Willamette River at Portland, were examined to help describe the hydrologic behavior of the harbor. Vancouver and Portland stage data for water years 1973 through 2013 were collected as daily high and low values. For purposes of this report, five hydrologic terms were utilized and are defined as follows:
    1) Mean Daily Stage – the arithmetic mean of the maximum and minimum daily stage.
    2) Monthly Mean Stage – the arithmetic mean of all mean daily stages for a particular month.
    3) Minimum and Maximum Monthly Stage – the lowest and highest monthly mean stage.
    4) Mean Monthly Stage – the arithmetic mean of all monthly mean stages.
    5) Minimum and Maximum Extreme Stage – the lowest and highest instantaneous stage values to occur by month.

For example on a given day in August of 1989, the Vancouver maximum stage was 4.2 feet and the minimum stage was 1.8 feet, resulting in a mean daily stage of 3.0 feet. At the end of the month the arithmetic mean of the 31 “mean daily stages” would become the “monthly mean stage” for August of 1989. At the end of the century, the “mean monthly stage” for August would be equal to the arithmetic mean of all August “monthly mean stages” for each year of record. The lowest monthly mean stage and the highest monthly mean stage for the month of August in the period of record are considered to be the minimum and maximum monthly stages, respectively. The “minimum extreme stage” for all the months of August within the period of record would be the lowest stage to ever occur, even if for only a few hours. The same is true for the “maximum extreme stage”.

c. Columbia River Stage at Vancouver. Figure 2 and Table 1 show minimum, mean, and maximum monthly stage at Vancouver for the period of record water years 1973 through 2013. Maximum monthly stages usually occur during the winter (December through February) and the spring (March through June). A notable maximum monthly stage value of 26.8 feet occurred in February of 1996, coinciding with a period of flooding on the Willamette and Columbia Rivers. Maximum monthly stage values of 15.7 feet in March of 1983 and 18.9 feet in June of 1997 occurred in the spring, corresponding to periods of extremely high spring flows on the Columbia River. During these periods of high stages and high discharges, tidal effects are relatively minor.

A minimum monthly stage as low as 1.1 feet during July of 2001 has been observed. Minimum monthly stages shown on Figure 2 occur between July and September. Tidal effects have a pronounced influence on monthly river stages in the summer and fall.

Figure 3 and Table 2 show minimum and maximum daily stage. Notable values include the September 2001 minimum stage of 0.0 feet and the February 1996 maximum stage of 27.2 feet. During mid to late summer the daily stage at Vancouver typically varies as much as 3 feet because of tidal influences.

Daily stage values are not significantly influenced by tides above a stage of about 12 feet. However, below a stage of 12 feet an increasingly greater tidal effect occurs. Tidal influences are more pronounced during the summer and fall, the low water period on both the Columbia and Willamette Rivers. Daily fluctuations of several feet from the mean daily stage are common, particularly when mean daily stage is less than 5 feet. Mean daily stages equal to or less than 2.8 feet have occurred in every month of the calendar year.

Table 1. Minimum, Mean, and Maximum Monthly Stage at Vancouver, Washington, Water Years 1973 through 2013 (Gauge zero equals 1.82 feet, NGVD)

Month	Minimum Monthly Stage (feet)	Mean Monthly Stage* (feet)	Maximum Monthly Stage (feet)
October	1.2	3.1	6.9
November	1.9	4.5	17.1
December	2.0	6.4	18.2
January	2.3	7.0	23.3
February	2.1	6.6	**26.8**
March	2.0	6.5	**15.7**
April	1.6	6.8	17.6
May	2.3	8.3	17.9
June	1.5	8.4	**18.9**
July	**1.1**	5.0	9.7
August	1.1	3.5	6.4
September	1.2	2.5	5.9

*using weighted average

Table 2. Minimum and Maximum Daily Stage at Vancouver, Washington, Water Years 1973 through 2013 (Gauge zero equals 1.82 feet, NGVD)

Month	Minimum Daily Stage (feet)	Maximum Daily Stage (feet)
October	0.0	7.7
November	0.3	17.5
December	1.2	18.5
January	1.6	23.3
February	1.2	**27.2**
March	1.0	15.7
April	1.1	17.8
May	1.4	17.9
June	0.4	21.1
July	0.1	17.8
August	0.0	7.5
September	**0.0**	7.3

Figure 4 and Table 3 show minimum and maximum extreme stage. Notable values include the July 2001 and September 1973 minimum stages of –0.7 feet and the February 1996 maximum extreme stage of 27.2 feet. The minimum extreme stages coincided with extremely low flows on the Columbia and Willamette Rivers and a low tide. The maximum extreme stage occurred as a result of a major flood on the Willamette River producing a peak discharge of 420,000 cubic feet per second. A discharge of 283,000 cubic feet per second was recorded during another major flood event in January of 1974.

Table 3. Minimum and Maximum Extreme Stage at Vancouver, Washington, Water Years 1973 through 2013 (Gauge zero equals 1.82 feet, NGVD)

Month	Minimum Extreme Stage (feet)	Maximum Extreme Stage (feet)
October	-0.6	7.7
November	-0.6	17.5
December	0.7	18.5
January	0.7	23.4
February	0.8	**27.2**
March	0.9	15.8
April	0.4	17.8
May	1.0	17.9
June	0.0	21.1
July	**-0.7**	17.9
August	0.0	8.1
September	**-0.7**	7.9

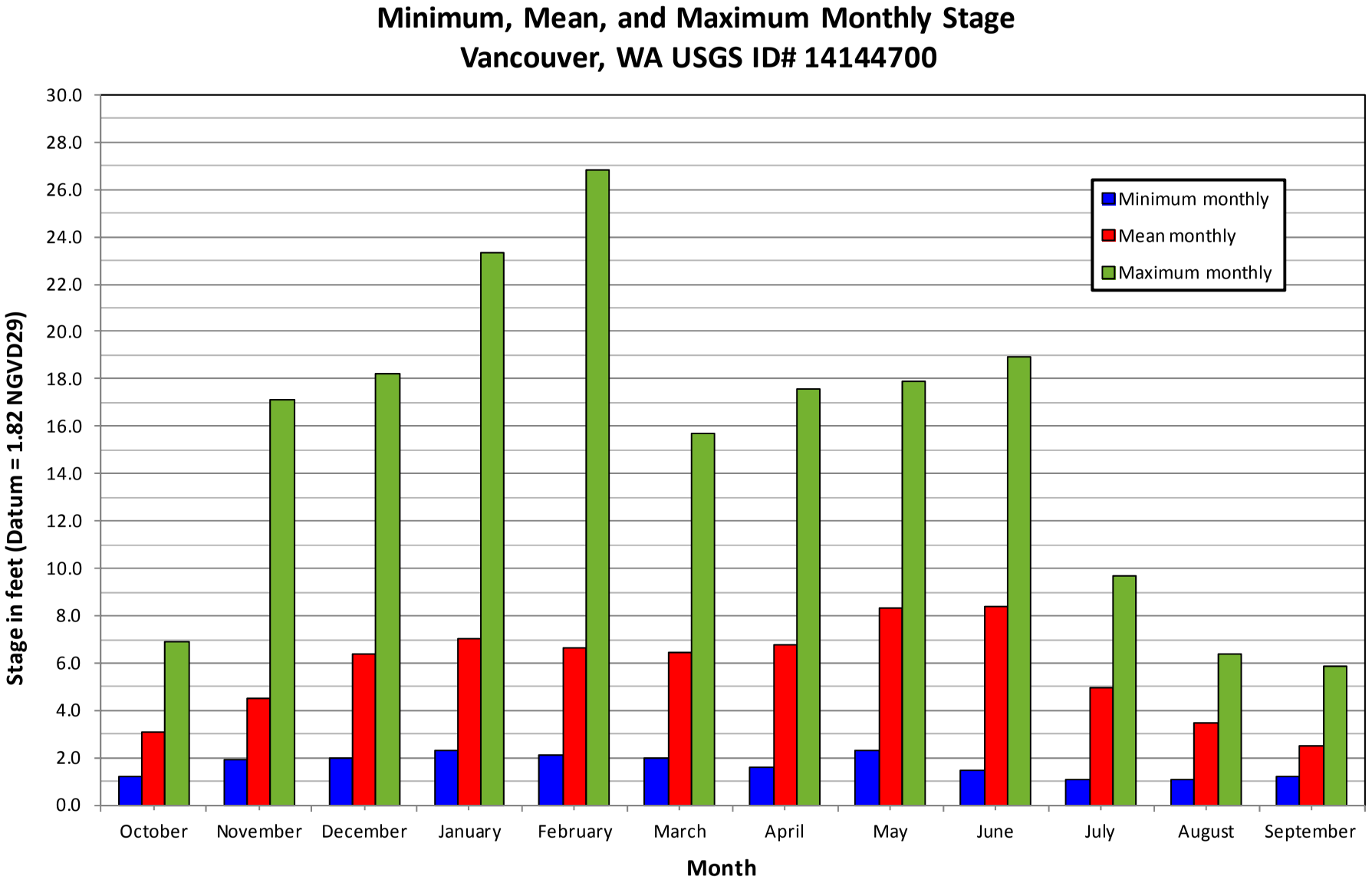

Figure 2. Minimum, Mean, and Maximum Monthly Stage at Vancouver, Washington, Water Years 1973 through 2013.

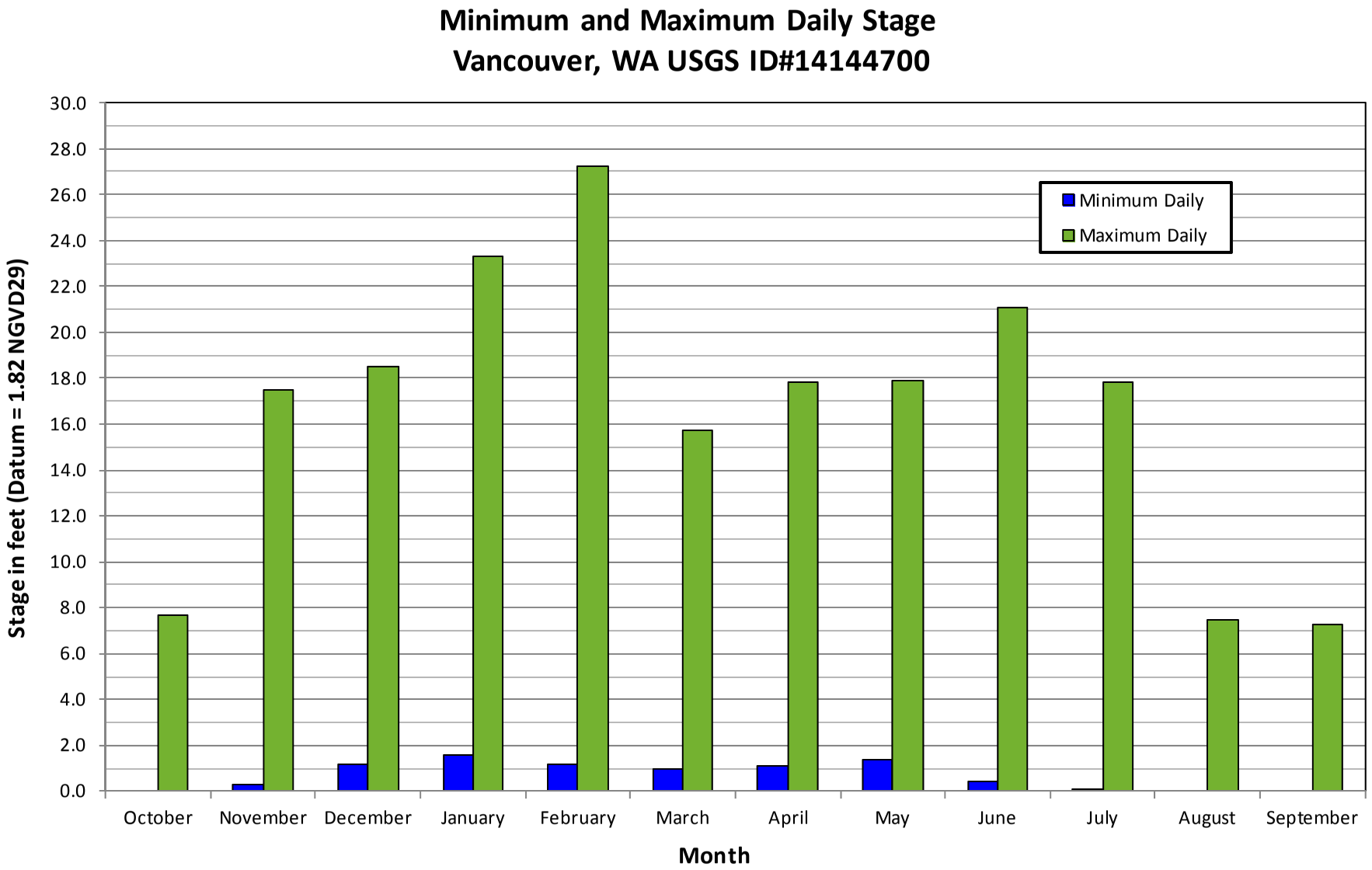

Figure 3. Minimum and Maximum Daily Stage at Vancouver, Washington, Water Years 1973 through 2013.

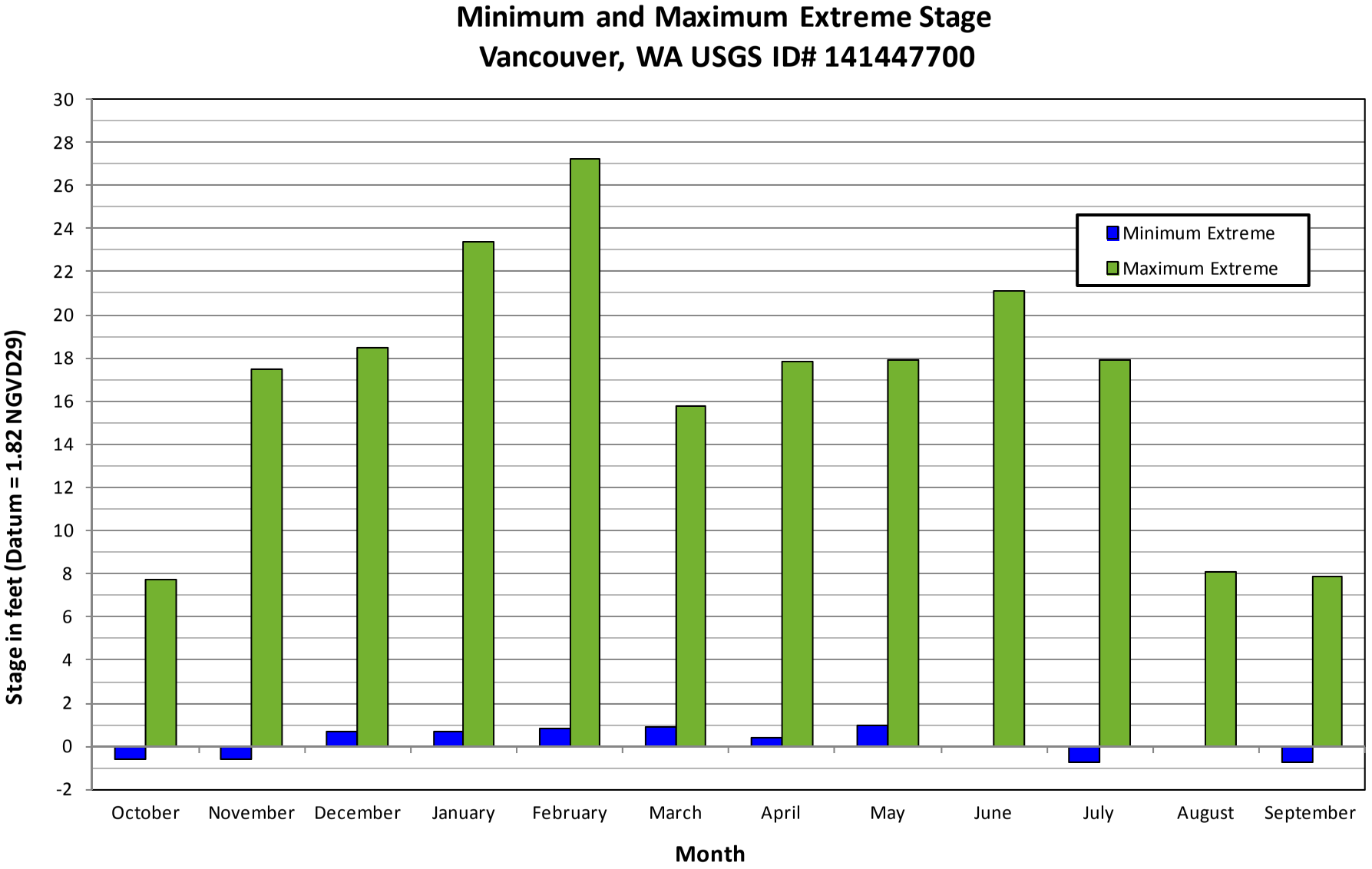

Figure 4. Minimum and Maximum Extreme Stage at Vancouver, Washington, Water Years 1973 through 2013.

d. Willamette River Stage at Portland. Willamette River stage data for water years 1973 through 2013 was collected at Portland as daily high and daily low values, the arithmetic mean of which was considered to be mean daily stage. Figure 5 and Table 4 show minimum, mean, and maximum monthly stage for the period of record water years 1973 through 2013. Maximum monthly stages in the Willamette River at Portland usually occur during the winter (December through February) and the spring (March through June). Notable maximum monthly stages of 27.2 feet in February 1996 and 18.5 feet in June of 1997 indicate the effects that large runoff years on the Columbia River have on stage at Portland.

Minimum monthly stages usually occur between July and October. A minimum monthly stage of 1.1 feet occurred in July of 2001. Normally, August and September are the months when minimum monthly stages are most likely to occur in the Portland Harbor. As experienced in Vancouver, tidal effects strongly influenced monthly river stages in the Portland Harbor during the summer and fall.

Figure 6 and Table 5 show minimum and maximum daily stage. Notable maximum daily values include the February 1996 maximum stage of 28.5 feet. Notable minimum daily values include the November 2000 stage of 0.6 feet. Mean daily stages equal to or less than 2.8 feet have occurred in every month of the calendar year. The daily stage at Portland between August and October typically varies by several feet. As experienced at Vancouver, tidal effects are pronounced for stages below 5 feet, moderate effects from 5 to 12 feet, and diminished effect above a stage of 12 feet.

Table 4. Minimum, Mean, and Maximum Monthly Stage at Portland, Oregon, Water Years 1973 through 2013 (Gauge zero equals 1.55 feet, NGVD)

Month	Minimum Monthly Stage (feet)	Mean Monthly Stage* (feet)	Maximum Monthly Stage (feet)
October	1.4	3.0	7.2
November	1.6	4.7	17.5
December	2.2	6.5	16.6
January	2.6	7.1	22.7
February	2.5	6.7	**27.2**
March	2.6	6.6	14.3
April	2.0	6.8	17.4
May	1.1	8.0	17.4
June	2.0	8.2	**18.5**
July	**1.1**	4.9	9.6
August	1.2	3.6	6.6
September	1.1	3.1	6.1

*using weighted average

Table 5. Minimum and Maximum Daily Stage at Portland, Oregon, Water Years 1973 through 2013 (Gauge zero equals 1.55 feet, NGVD)

Month	Minimum Daily Stage (feet)	Maximum Daily Stage (feet)
October	0.0	7.3
November	**0.6**	12.7
December	1.2	18.6
January	1.5	23.8
February	1.3	**28.5**
March	1.3	15.9
April	0.9	17.6
May	1.2	17.9
June	0.5	20.0
July	0.0	17.4
August	0.1	7.9
September	0.0	7.6

Figure 7 and Table 6 show minimum and maximum extreme stage. Notable values include the November 1979 minimum extreme stage of –0.5 feet and the February 1996 maximum extreme stage of 28.5 feet. The minimum extreme stage coincided with extremely low flows on the Columbia and Willamette Rivers and a low tide. The maximum extreme stage occurred as a result of extremely high flows on the Willamette River.

Table 6. Minimum and Maximum Extreme Stage at Portland, Oregon, Water Years 1973 through 2013 (Gauge zero equals 1.55 feet, NGVD)

Month	Minimum Extreme Stage (feet)	Maximum Extreme Stage (feet)
October	-0.4	7.4
November	**-0.5**	13.3
December	1.1	18.9
January	0.6	24.1
February	0.8	**28.5**
March	0.1	17.6
April	0.5	17.6
May	1.3	17.9
June	0.6	20.0
July	-0.5	17.4
August	0.0	8.8
September	-0.6	9.8

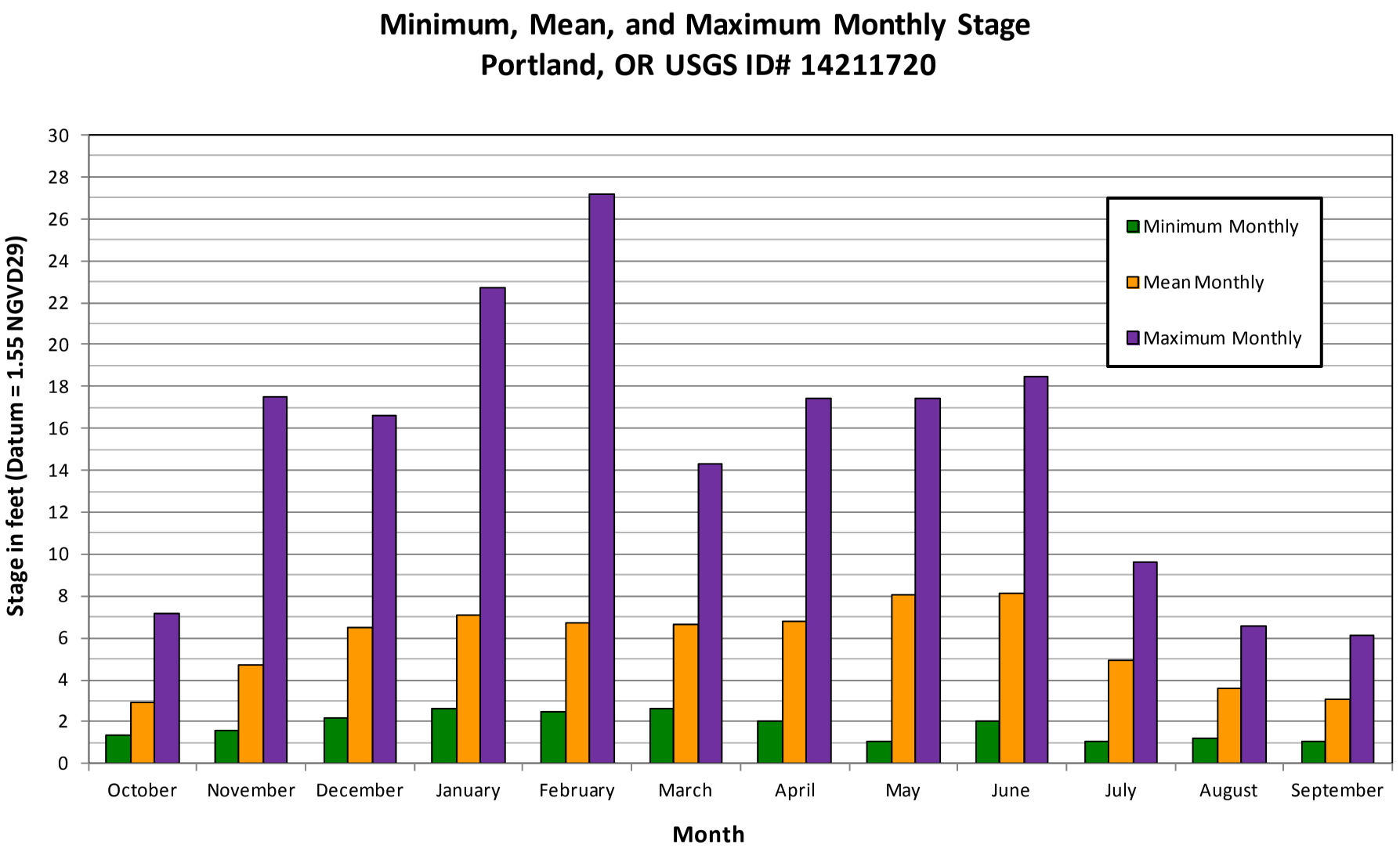

Figure 5. Minimum, Mean, and Maximum Monthly Stage at Portland, Oregon, Water Years 1973 through 2013.

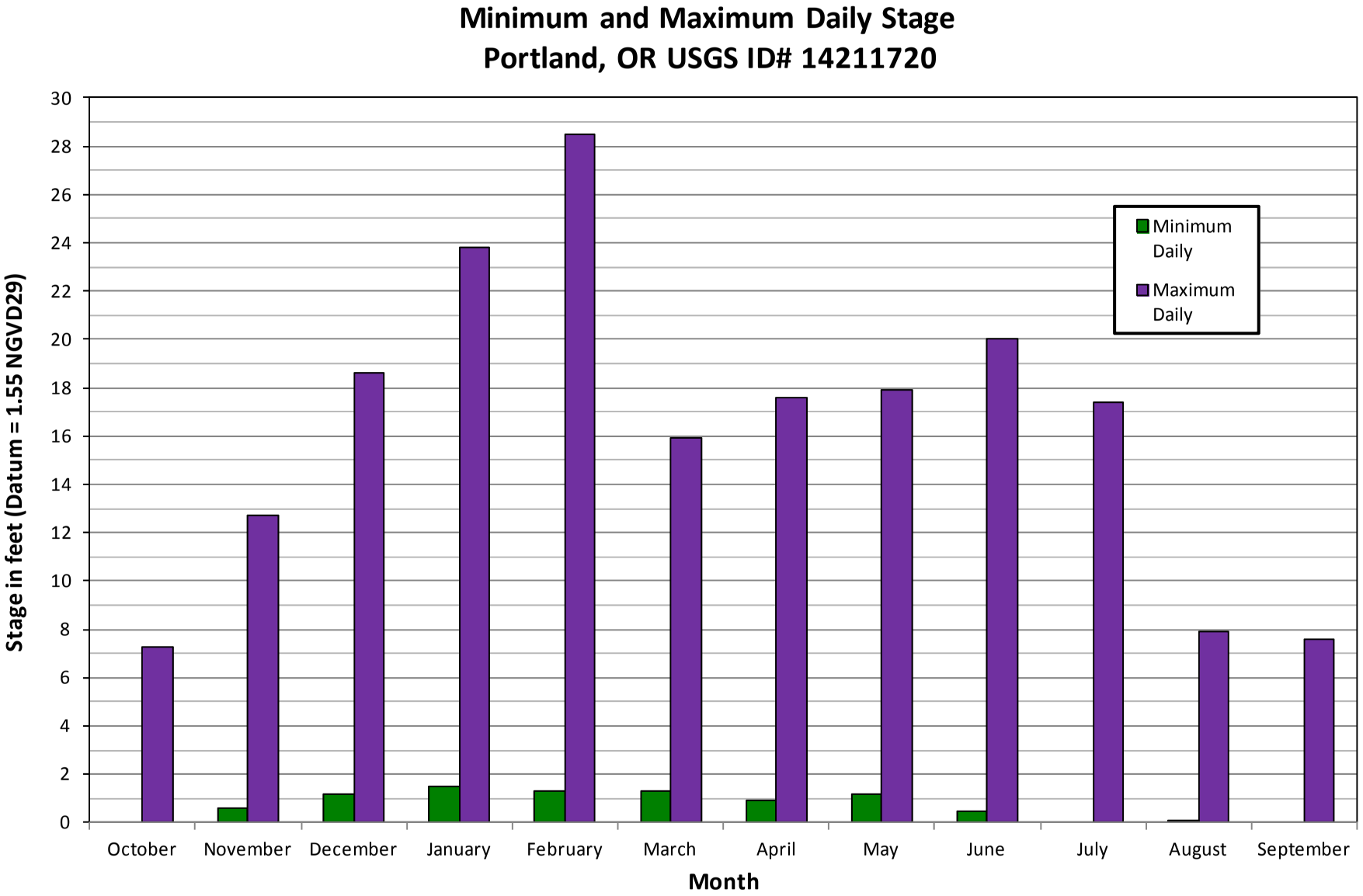

Figure 6. Minimum and Maximum Daily Stage at Portland, Oregon, Water Years 1973 through 2013.

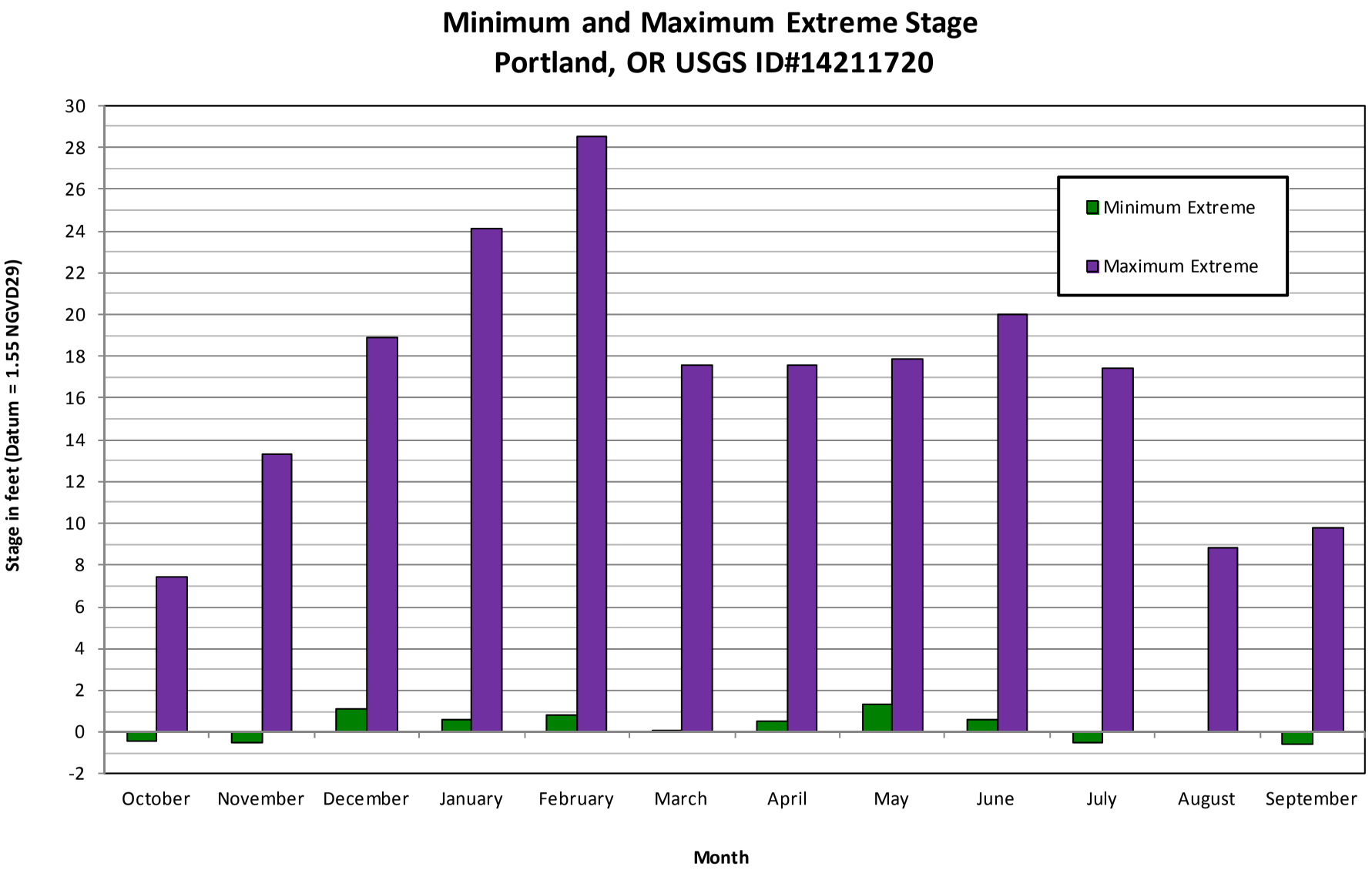

Figure 7. Minimum and Maximum Extreme Stage at Portland, Oregon, Water Years 1973 through 2013.

6. Summary. The hydrology of the Portland-Vancouver Harbor area is very complex. Hydrologic conditions are influenced by three primary variables:

a. Upstream reservoir regulation on the Columbia and Willamette Rivers.
b. Natural streamflows on the Columbia River, Willamette River, and local tributaries.
c. Tidal effects.

As these variables interact a wide range of conditions can occur. Engineering design in the harbor area should, therefore, use all available hydrologic data and consider both mean and extreme conditions described in this and other reports.

Appendix A

Glossary of Hydrologic Terms Used in the Portland-Vancouver Harbor Area

1. **River Mile**. Distance in miles beginning at the mouth of a river.
2. **River Stage**. Height of a river measured from mean sea level (equivalent to NGVD) or relative to a specific elevation called a "datum".
3. **Bankfull Stage**. A given stage determined by the U.S. Army Corps of Engineers and used to schedule releases from reservoirs. Normally, bankfull stage is below flood stage.
4. **Flood Stage**. A river stage established by the National Weather Service (NWS) above which flood damages might occur. Flood stage is generally above bankfull stage, but below major flood stage.
5. **Major Flood Stage**. A river stage established by the U.S. Army Corps of Engineers above which major flood damage is expected to occur. Major flood stage is generally above flood stage.
6. **Columbia River Datum (CRD)**. Plane of reference from which river stage is measured on the Columbia River from the lower Columbia River up to Bonneville Dam, and on the Willamette River up to Willamette Falls. Equals 1.82 feet above mean sea level (equivalent to NGVD) at Vancouver, Washington.
7. **Portland River Datum (PRD)**. Plane of reference from which river stage is measured on the Willamette River at Portland. Equals 1.55 feet above mean sea level (equivalent to NGVD) at the Morrison Street Bridge, Portland gauge.
8. **National Geodetic Vertical Datum (NGVD) of 1929**. Replaced mean sea level.
9. **Daily Discharge**. Average streamflow measured at a station expressed in units of cubic feet per second (cfs).
10. **Mean Daily Stage**. The arithmetic mean of the maximum and minimum daily stage.
11. **Monthly Mean Stage**. Arithmetic mean of all daily stages for a particular month.
12. **Minimum and Maximum Monthly Stage**. The lowest and highest monthly mean stage.
13. **Mean Monthly Stage**. Arithmetic mean of all monthly mean stages for a given time period.
14. **Minimum and Maximum Extreme Stage (by month)**. The lowest and highest instantaneous stage values to occur during a particular month.
15. **Acoustic Velocity Meter and Velocity Index Recorder**. Instruments that measure stream velocity at stations where conventional stage recorders would not suffice, notably in tidally influenced areas.
16. **Strip Chart Water Level Recorder**. Continuously records water level (stage) on a paper chart.
17. **Limited Automated Remote Collector (LARC)**. A device which records and temporarily stores stage data. LARCs are interrogated by master computers to retrieve and make use of stored data. The NWS has installed a LARC at the Vancouver station.
18. **Ordinary High Water**. Water level (in feet) established by field observation of seasonally high river levels by the U.S. Army Corps of Engineers. Ordinary high water designates the jurisdictional limits of the structures and/or work affecting all

navigable rivers including the Columbia and the Willamette Rivers. Ordinary high water in both stage and elevation for the Columbia and Willamette Rivers is provided by river mile in Tables A-1 and A-2.

19. **Ordinary Low Water**. Water level (in feet) established by field observation of seasonally low river levels by the U.S. Army Corps of Engineers; used to designate a lower boundary of river stage. Due to its inexact nature, ordinary low water is no longer used by the Corps for regulatory purposes, but may appear in past records.

Table A-1. Ordinary High Water for the Columbia River, River Miles 100 to 110.

River Mile	Ordinary High Water (Stage in feet)	Ordinary High Water (Elevation NGVD)
100	15.1	16.4
101	15.1	16.5
102	15.2	16.6
103	15.2	16.7
104	15.4	17.0
105	15.6	17.3
106	15.8	17.6
107	16.0	17.9
108	16.1	18.1
109	16.3	18.4
110	16.5	18.7

Table A-2. Ordinary High Water for the Willamette River, River Miles 0 to 26 (Mouth to Willamette Falls Locks).

River Mile	Ordinary High Water (Stage in feet)	Ordinary High Water (Elevation NGVD)
0	15.2	16.6
1	15.1	16.6
2	15.0	16.6
3	14.9	16.6
4	14.9	16.6
5	14.9	16.6
6	14.9	16.6
7	14.9	16.6
8	14.8	16.6
9	14.8	16.6
10	14.8	16.6
11	14.8	16.6
12	14.7	16.6
13	14.7	16.6
14	14.8	16.7
15	14.9	16.8
16	14.9	16.8
17	15.0	16.9
18	16.1	18.0
19	17.1	19.0
20	18.1	20.0
21	19.5	21.4
22	20.8	22.8
23	22.1	24.2
24	23.4	25.6
25	24.4	26.7
26	26.2	28.6

Appendix B

Principal Agencies and Responsibilities Related to the Portland-Vancouver Harbor Area

1. U.S. Army Corps of Engineers, North Pacific Division

a. Address:

Water Management Division (503) 808-3931
P.O. Box 2870, Portland, Oregon 97208-2870

b. Responsibilities:
   1) Upstream reservoir regulation of water storage projects on the Columbia River.
   2) Liaison maintained with Bonneville Power Administration (BPA) and the National Weather Service (NWS).

2. U.S. Army Corps of Engineers, Portland District

a. Address:

Reservoir Regulation and Water Quality Branch	(503) 808-4886
Program Management Branch	(503) 808-4703
Channels and Harbors Project	(503) 808-4340
Regulatory	(503) 808-4371
Environmental Resources Branch	(503) 808-4767

P.O. Box 2946, Portland, Oregon 97208-2946

b. Responsibilities:
   1) Upstream reservoir regulation of water storage projects on the Willamette River.
   2) Daily maximum and minimum stage data collected at Vancouver (I-5 gauge, 1947 through the present) by the Hydraulics and Hydrology Branch. Special hydrologic studies performed as needed.
   3) Mapping of 100-year floodplain performed by the Planning Branch. Explanation of the origin and use of these maps.
   4) Navigation improvements and channel mapping performed by the Navigation Branch. Channel depths and profiles for selected Willamette and Columbia River reaches.
   5) Permits issued for wetland and riverine development by the Regulatory and Environmental Resource Branch. Interpretations of Corps methods and riverine regulations.

3. National Weather Service, Weather Forecast Office

a. Address:

National Weather Service Forecast Office (503) 326-2340
5241 NE 122nd Ave., Portland, Oregon 97230-1089

b. Responsibilities:
   1) Flood watches and warnings issued.
   2) Public information is made available through two telephone recordings a day, 365 days a year. These recordings provide:
      a) Eight fifteen a.m. recording:
         - Seven a.m. stage reading for Morrison Street Bridge on the Willamette River and for the Vancouver (I-5) gauge on the Columbia River.
         - Gives high and low stage range for previous 24-hours.
         - Two-day stage forecast for Portland-Vancouver area.
         - Phone line has ring-through feature for data other than that recorded. Available from 8:15 a.m. to 2 p.m.
      b) Two p.m. recording:
         - Gives 1 p.m. stage reading for Morrison Street Bridge and Vancouver (I-5) gauges.
         - Updates the two-day stage forecast.
   3) National Weather Service processes daily-telemetered stage and precipitation data collected throughout the state.

4. National Weather Service, Northwest River Forecast Center (NWRFC)

a. Address:

Northwest River Forecast Center (503) 326-7401
5241 NE 122nd Ave., Portland, OR 97230-1089

b. Responsibilities:
   1) Forecasts river stage on Willamette and Columbia Rivers.
   2) Collects and stores Columbia River stage data from the Port of Portland gauges.

5. U.S. Geological Survey (USGS)

a. Address:

Oregon Water Science Center (503) 251-3200
2130 SW 5th Avenue, Portland, OR 97201

b. Responsibilities:
   1) Research on special hydrologic problems.
   2) Data collection for water management:
      a) Willamette River at Portland (Morrison Street Bridge) discharge and stage data recorded.
      b) Stage data collected just above and below Willamette Falls since November 1976.
      c) Columbia River at The Dalles discharge and stage data recorded.

6. Port of Portland

a. Address:

Port of Portland (503) 415-6000
7200 N.E. Airport Way Portland, OR 97218

b. Responsibilities:
   1) Collection of real time stage data on the Columbia River which includes:
      a) Operation of seven gauges between Hammond and Port of Vancouver.
      b) Data collection every six minutes. Stored as hourly data in the National Weather Service's database in cooperation with the Port of Portland.
      c) Data is used for planning and shipping loads associated with transit in the harbor.
   2) Uses 3-day and 6-day forecasts produced by the Northwest River Forecast Center and reformats them for use by harbor and shipping interests.
   3) Keeps records of existing waterfront facilities.

7. Bonneville Power Administration (BPA)

a. Address:

Bonneville Power Administration (503) 230-3000
P.O. Box 3621, Portland, OR 97208-3621

b. Responsibilities: Marketing agency for federal power generation in the Pacific Northwest. Releases from upstream reservoirs in the Columbia River Basin are significantly affected by power generation requirements determined by BPA.

8. U.S. Coast Guard (USCG)

a. Address:

Marine Safety Office (503) 240-9317
6767 N Basin Street, Portland, Oregon 97217-3992

b. Responsibilities:
   1) Navigation related
      a) Designate anchorage locations.
      b) Review dredge and disposal permits.
      c) Safety.
   2) Other functions
      a) Search and rescue.
      b) Buoy installation and maintenance.
      c) Marking of navigable channels.
      d) Law enforcement.
      e) Environmental protection.

9. <u>Department of Commerce – National Ocean Services</u>

a. Address:

Northwest Ocean Service Center (206) 526-4277
7600 Sand Point Way NE, Seattle, Washington 98115

b. Responsibilities: Publish tide tables including Astoria, Oregon, near the mouth of the Columbia River.

Appendix C

Inventory of River Gauges Providing Portland-Vancouver Harbor Information

Name: Vancouver (Interstate 5 Bridge) – Columbia River
Parameter: Stage
USGS No.: 14144700
Owner/Operator: National Weather Service (NWS)/U.S. Army Corps of Engineers, Portland District
Location: Columbia River, near right bank, in control house of I-5 bridge at south edge of Vancouver, 5.0 mi upstream from Willamette River at mile 106.5.
Description: USGS records show the station was established in 1954 by NWS. Station consists of a LARC established by the NWS in tandem with a Corps of Engineers strip chart water level recorder. The NWS currently interrogates the LARC on an hourly basis. Datum of the Vancouver Station is 1.82 feet, NGVD29. The Corps of Engineers stores the strip charts and maintains a daily high and daily low database. USGS has streamflow data from October 1963 through June 1970. Operation of the stage only site began in February 1998 by USGS.

Name: Portland – Willamette River
Parameter: Stage/Discharge
USGS No.: 14211720
Owner/Operator: U.S. Geological Survey (USGS)
Location: Willamette River in pier at east end of drawspan, on upstream side of Morrison Bridge, in Portland at mile 12.8.
Description: Staff gauge operating continuously since 1896. A stage recorder was installed in 1958. The station was equipped with an acoustic velocity meter (measures streamflow velocity using acoustics) with a water stage and velocity index recorder from 1972 to 1994. Datum of the Portland – Willamette River Station is 1.55 feet, NGVD29.

Name: The Dalles – Columbia River
Parameter: Stage/Discharge
USGS No.: 14105700
Owner/Operator: U.S. Geological Survey (USGS)
Location: Columbia River, The Dalles, Oregon, on left bank, 0.3 mi downstream from Mill Creek, 2.6 river miles below The Dalles Dam, The Dalles, Oregon, River Mile 188.9
Description: Period record of stage and daily discharge is 1878 to the present. It is presently equipped with an acoustic velocity meter with water stage and velocity index recorder.

Name: Astoria – Columbia River
Parameter: Stage
NOAA No.: 9439094
Owner/Operator: National Oceanic and Atmospheric Administration (NOAA) – National Ocean Service
Location: Columbia River, Tongue Point, Astoria, Oregon

Description: Station established in 1853. Data collected as time and height differences during high and low water. Data is published annually. Period of record is 1896 to the present.

Name: Columbia River Level Reporting and Forecasting System
Parameter: Stage
Port of Portland No.: Gauges referenced by location
Owner/Operator: Port of Portland
Location: Astoria, Oregon; Beaver, Oregon; Skamokawa, Washington; Wauna, Oregon; Longview, Washington; St. Helens, Oregon; and Port of Vancouver, Washington
Description: The Port of Portland operates six stage gauges with telemetry on the Columbia River below Vancouver. The data is used primarily as a navigation aid. A permanent record of this data is available through the Port of Portland or the Northwest River Forecast Center. The period of record is from September of 1986 to the present. There is no longer a station at Hammond, Oregon on the Columbia River.

Appendix D

Summary of Extreme Readings of Stage and Discharge in the Portland-Vancouver Harbor Area

1. **Vancouver (I-5) – Columbia River**

   a. Water year 1902 to the present:

Maximum Stage	31.0 feet	13, 14 June 1948
Minimum Stage	-1.2 feet	9 November 1929
	-1.2 feet	29 December 1930
	-1.2 feet	4 November 1935

   b. Water year 1973 to the present:

Maximum Stage	27.2 feet	9 February 1996
Minimum Stage	-0.84 feet	21 September 2003

2. Portland – Willamette River

   a. Water year 1879 to the present:

Maximum Stage	33.0 feet	7 June 1894
Minimum Stage	-2.2 feet	8 December 1890 (ice affected)
	-0.8 feet	22 October 1939 (no ice effects)
	-0.8 feet	13 October 1952 (no ice effects)

   b. Water year 1973 to the present:

Maximum Discharge	420,000 cfs	9 February 1996
Maximum Stage	28.5 feet	10 February 1996
Minimum Discharge	4,200 cfs	10 July 1978
Minimum Stage	-0.6 feet	21 September 2003

3. The Dalles – Columbia River

   a. Water year 1879 to the present:

Maximum Discharge	1,240,000 cfs	6 June 1894
Maximum Stage	106.5	
Minimum Discharge	12,100 cfs	16 April 1968
Minimum Stage	N/A	

   b. Water year 1973 to the present:

Maximum Discharge	619,000 cfs	20 June 1972
Maximum Stage	N/A	
Minimum Discharge	41,500 cfs	7 March 2011
Minimum Stage	N/A	

Appendix E

References

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4. United States Geological Survey. "Water Resources Data, Water Year 2011." Water Data Report WDR-US-2011, site 14105700. Portland, Oregon. 2012

5. United States Geological Survey. "Water Resources Data, Water Year 2013." Water Data Report WDR-US-2013, site 14144700. Portland, Oregon. 2014.

6. United States Army Corps of Engineers, Portland District. Hand written records of stage readings at Vancouver, Washington, on the Columbia River.

7. Port of Portland Stage Data. Personal correspondence, 1988.

8. USGS Stage Data. Personal correspondence, 2014.

9. USACE, Portland District. Records of stage readings at Vancouver, Washington, on the Columbia River and at Portland, Oregon, on the Willamette River.