12. PROJECT OPERATION AND RESOURCE UTILIZATION

Project operation and resource utilization was developed with two types of models that both model reservoir operation and hydroelectric generation. The models differ significantly in the generating resources included in each model and the time period of simulation.

The first model is a production costing model called PROMOD, which determines the economic hourly dispatch of the various Railbelt resources as required to meet the Railbelt electricity load at various locations. The PROMOD data set as developed for this study includes all the Railbelt generating resources of all types and operates for one year on an hourly basis with long-term average inflows to Watana Reservoir. That modeling work is described in Section 5.

The second model, discussed in this section, is a reservoir operation and hydroelectric power study model. The only generating resource included is Susitna-Watana Hydro, so it does not simulate complete power generation within the interconnected Railbelt electrical system. The model operates for 61 continuous years on an hourly basis. It models the generation of a fixed portion of the total Railbelt load, or a remaining portion of the Railbelt load after considering generation from individual resources developed in the PROMOD simulation. An example of Susitna-Watana Hydro hourly generation for a year as developed in a PROMOD simulation run is shown on Figure 12-1. PROMOD results differ from the hydroelectric power study model results presented below because PROMOD focuses on hourly generation that minimizes production costs whereas the hydroelectric power study model maximizes generation from Susitna-Watana Hydro to meet pre-assigned hourly loads.

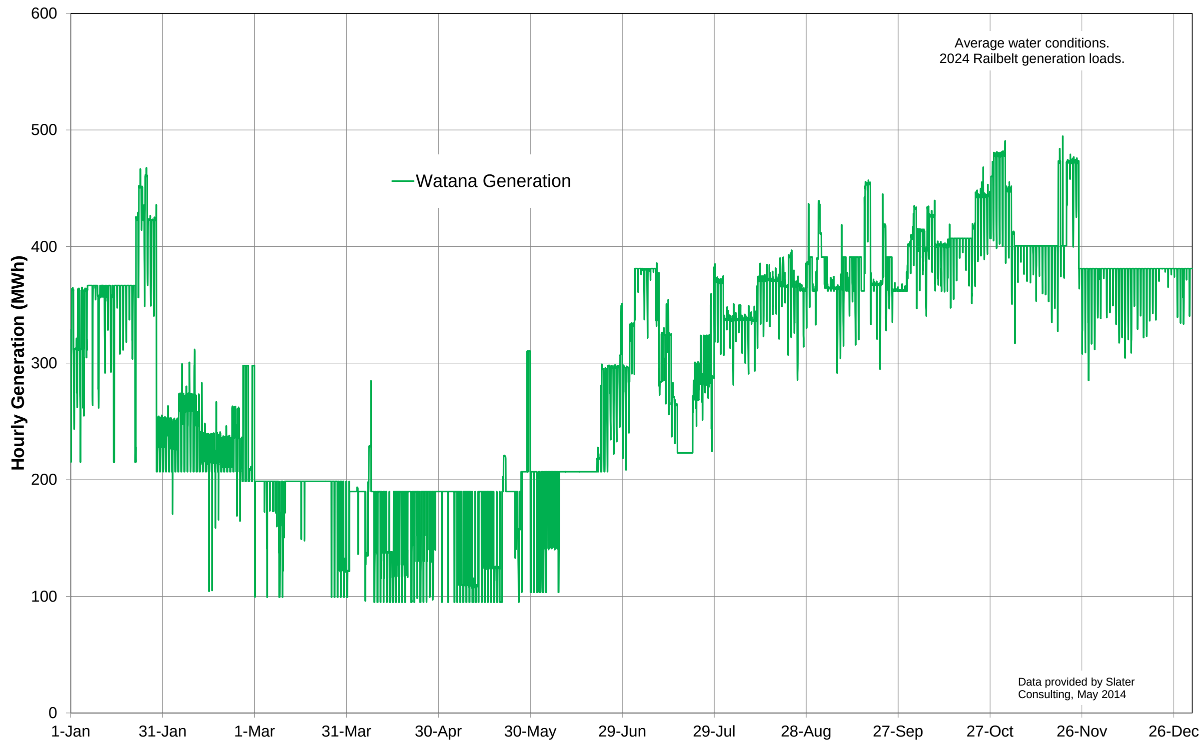

Figure 12-1. Susitna-Watana Hourly Generation as Developed by PROMOD for Average Water Conditions

12.1. Proposed Project Operation

12.1.1. Background

Project operating flexibility is important to the Railbelt utilities that will be utilizing the power output from the Project. As noted above, PROMOD simulations encompass the entire Alaska Railbelt connected electrical system, to determine how to maximize the benefits of the Susitna-Watana Project within the integrated system.

It is expected that based on this modeling work, and with consideration of potential environmental needs, AEA will most likely propose to operate the project in some form of an intermediate load following mode such that total energy is maximized while shaping monthly generation to be proportional to Railbelt utility total load requirements. The following discussion of flows and power operation is based on this premise. It is an update to the discussion of planned project operations included in Section 3.5 of the December 2011 Pre-Application Document (PAD). The modeling performed since December 2011 reflects further refinements in project development plans that have been made since that time, including the decision to establish the normal maximum reservoir level at El. 2050 ft. and to increase the maximum annual drawdown from 150 ft. to 200 ft. to maximize annual power generation while providing greater flexibility for environmental flow releases.

Reservoir storage capability is vital to the project's intended function – to provide critical winter generation capacity by regulating the flows of the Susitna River – and to serve as a major long-term power generating resource for the region. The requirement for substantial storage clearly identified in all the previous studies of the Susitna River, documented in Section 3, provides for capture and storage of spring snowmelt for later release through the powerhouse during the winter months. This capability also serves to ensure that seasonal flow releases can be provided to both protect environmental habitat and enhance river recreational opportunities downstream of the Project. In contrast a run-of-river hydro project on the Susitna (or any river), without storage and release capability cannot provide these important system, environmental and/or recreational benefits. Therefore, the Susitna-Watana Project is proposed as a storage-type resource in order to maximize overall regional benefits.

Further engineering and environmental studies, system modeling and collaboration with Railbelt utilities and other stakeholders will continue to be carried out up to submittal of the Federal Energy Regulatory Commission (FERC) License Application to more clearly define the expected integration into the Railbelt system.

12.1.2. Environmental Flows

Minimum flow requirements in the Susitna River downstream of the proposed Watana Dam are potentially significant to project operation, but have not yet been established. An acceptable flow regime will be determined through the continuing FERC licensing studies and through collaboration with licensing participants.

Initial model runs were made using the Case E-VI from the Susitna 1985 FERC License Application. Those criteria specified a minimum wintertime flow of 2,000 cubic feet per second (cfs) at Gold Creek, and a minimum summertime flow of varying amounts up to 9,000 cfs.

At this time, for planning purposes, AEA is considering a minimum winter flow of not less than 3,000 cfs at Gold Creek. The modified minimum daily flows at Gold Creek are shown on Figure 12.1-1. For reference, the average monthly natural flows at Gold Creek are also shown on Figure 12.1-1. The reservoir operation and power study model runs also included a provision to potentially limit releases at Watana Dam to the natural inflow, although this would be an infrequently controlling condition with the minimum daily flows at Gold Creek as shown on Figure 12.1-1.

After the Project is constructed, downstream flows at the project site are expected to vary on a seasonal, weekly, and daily basis. In addition to the flows discharged through the powerhouse for generation purposes, flow augmentation, when required, would also be undertaken by making releases through the low-level outlets (if the powerhouse is not operational).

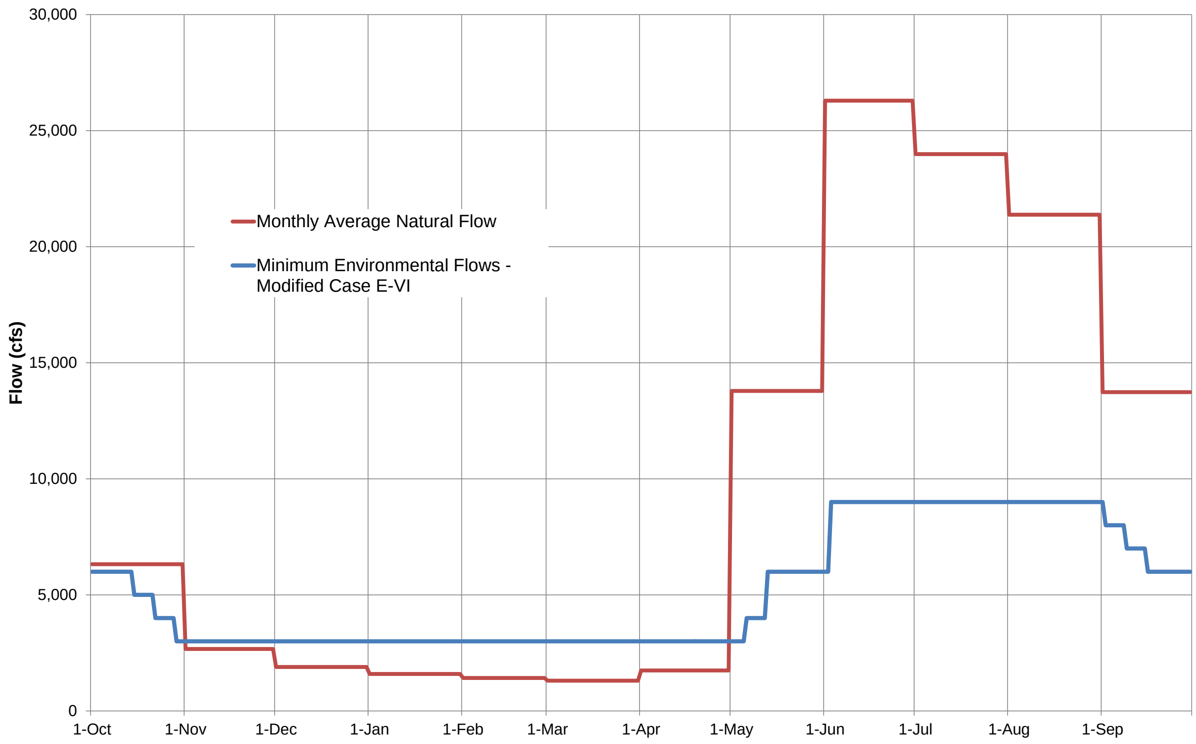

Figure 12.1-1. Minimum Environmental Flows and Average Natural Monthly Flows at Gold Creek

12.1.3. Reservoir Operation

12.1.3.1. Reservoir Operation Model

A reservoir operation model developed by MWH was used to develop the results presented in this report. The U.S. Army Corps of Engineers Reservoir System Simulation Model HEC-ResSim was also used for preliminary runs. The two reservoir operation models are functionally similar, but each has significant advantages. HEC-ResSim is a free, publicly available model. Execution times in the MWH reservoir operation model are several times faster than for HEC-ResSim, and the MWH model can be programmed to simulate unique or complex operation requirements including dry water year rule curves and inflow forecasting. Both models determine energy generation, reservoir levels, and outflows at the dam. The MWH model does not include riverine flow routing capabilities. The remaining description in this section applies to the MWH reservoir operation model.

The model is a water balance type of reservoir operation model that accounts for flow through the project reservoir, penstocks, and powerhouse on an hourly basis for a continuous period of 61 years. The model is written in FORTRAN and uses a number of text input and output files.

The operation model input includes (1) daily inflows to the reservoir; (2) daily local inflows between Watana Dam and the USGS gaging station at Gold Creek; (3) general model input parameters that describe the physical and operating rules and characteristics of the reservoir; (4) Susitna-Watana powerhouse characteristics, which contains the preliminary turbine efficiencies as a function of flow and head, preliminary generator efficiencies as a function of output, and limiting maximums of the units; (5) the Railbelt electricity load for each hour of the year from which the generation requirements at Susitna-Watana are developed; and (6) minimum flow requirements at Gold Creek for each day of the year.

The operation model produces tabular text output along with files that are designed to facilitate graphical presentation in a spreadsheet. The tabular text output is separated into monthly, daily, and hourly summary files. In the monthly tables, the entire 61-year period of operation is summarized into one table for each parameter. In the daily tables, one year of operation is summarized in a table. For the hourly tables, one month of output is summarized in each table for each parameter. The tabular text output is extensive and includes the following parameters:

- Inflows to the reservoir and natural local inflows between Watana Dam and the USGS gaging station at Gold Creek
- Generation from each turbine and total for the project
- Net head on the units
- Turbine-generator efficiencies for each unit
- Water surface elevation and water storage in the reservoir
- Reservoir elevation frequency for each month of the year
- Ranked monthly energy output for each month of the year (a measure of generation reliability)
- November through April total generation for a specified reliability
- Flow through each turbine and total powerhouse flow
- Total release to the river at Watana Dam
- Non-powerhouse flow (low-level outlet plus spillway flow)
- Flow at Gold Creek, which is the instream flow location
- Water balance at the reservoir as a means of checking model computations

Separate monthly, daily, and hourly output files are also created in a linear, comma-separated value format (.CSV) that imports easily into a spreadsheet for the purpose of creating graphical presentations.

12.1.3.2. Dry Year Rule Curve

Placing the same electricity generation requirements on the project in every year would mean that either the active storage in the reservoir would be empty at times (causing generation to be abruptly greatly reduced or stopped), or the electricity generation requirements would be relatively low, controlled by the driest sequence of years. It would be preferable to reduce generation in a controlled manner for part of the year in about 15 percent of the years. Railbelt thermal generation could be increased in the dry years to compensate. To facilitate the controlled reduction of generation in unusually dry years, a preliminary dry year rule curve was developed. The dry year rule curve reduces generation when the reservoir level falls below the rule curve for any given day of the year, and increases the reduction up to a specified maximum as the distance of the reservoir level below the rule curve becomes greater. Reduction in generation at Susitna-Watana was limited to a maximum of 32 percent in any hour of the year compared to the same hour of the year in full generation years.

12.1.3.3. Forecasting

Because a substantial portion of the total inflow to Watana Reservoir results from snowmelt, the opportunity exists to forecast spring and early summer inflow based on snowpack data that could potentially be collected in the watershed tributary to Watana Dam. In average to high snowpack years, generation could be increased beginning in March once the snowpack level was established. In low snowpack years, there would be no generation increases. Because a snowpack measurement network does not currently exist in the Watana watershed, historic March through June total inflows were used as a proxy for a snowpack inflow forecast. Based on the preliminary inflow forecast method, generation was increased beginning in March in 70 percent of the years. Generation was increased by a variable monthly amount that tended to result in monthly generation that was in proportion to monthly Railbelt generation needs. It is expected that this preliminary forecasting methodology can be improved. One potential forecasting improvement would be a wet water year rule curve that increased generation when reservoir levels were relatively high at a given time of year.

12.1.3.4. Reservoir Levels

As shown on Figure 12.1-2, the Watana Reservoir maximum normal operating level would be at El. 2050 ft. and the minimum operating level would be at El. 1850 ft. The active (live) storage between El. 1850 ft. and El. 2050 ft. is 3,380,000 acre-ft. The total reservoir storage to El. 2050 ft., including the dead storage below El. 1850 ft., is 5,170,000 acre-ft.

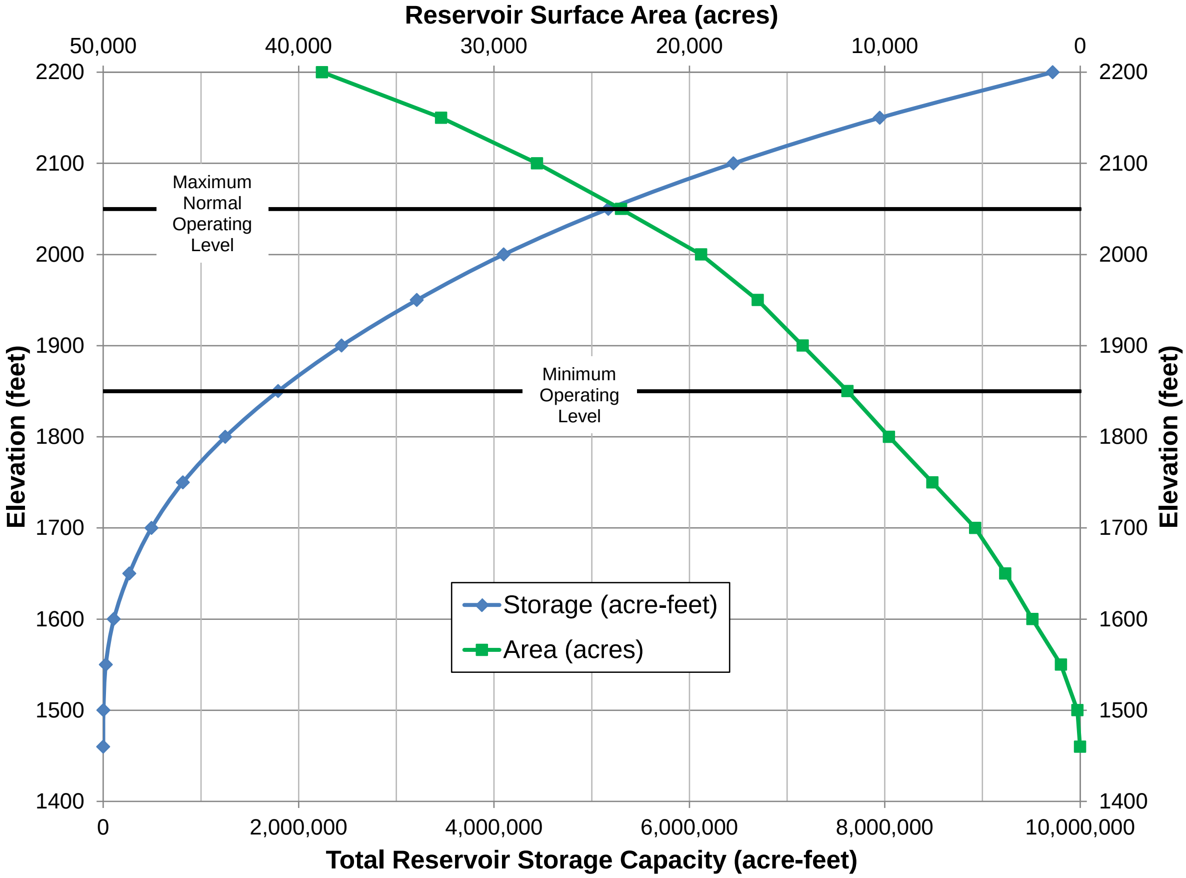

Figure 12.1-2. Watana Reservoir Elevation-Area-Capacity Table

To accomplish efficient dispatch, the project reservoir would be drafted annually by an average of about 120 ft. to 150 ft., if the Susitna-Watana Project was being operated to deliver maximum potential generation with high reliability. A maximum drawdown of 200 ft. (to El. 1850 ft.) would be possible and could occur. A more refined future operating plan that incorporated coordination of Railbelt resources could prevent Watana Reservoir from ever reaching El. 1850 ft.

Figure 12.1-3 presents the modeled daily reservoir elevations for the 61-year period of modeled reservoir operations. As indicated by this model, the reservoir would have been filled to El. 2050 ft. in about 80 percent of the years, but at times the reservoir would have remained unfilled for two or more years. The more recent period of record, from 1978 to the present, would have had notably fewer extreme drawdowns – with none reaching El. 1850 ft. This is, at least in part, because there was a seasonal shift in flows that generally increased flows in the low flow season, reduced flows in the high flow season, and advanced the sharp rise in inflows in April. All of these events would effectively have moved the inflows more "in phase" with the generation required to satisfy electricity demands.

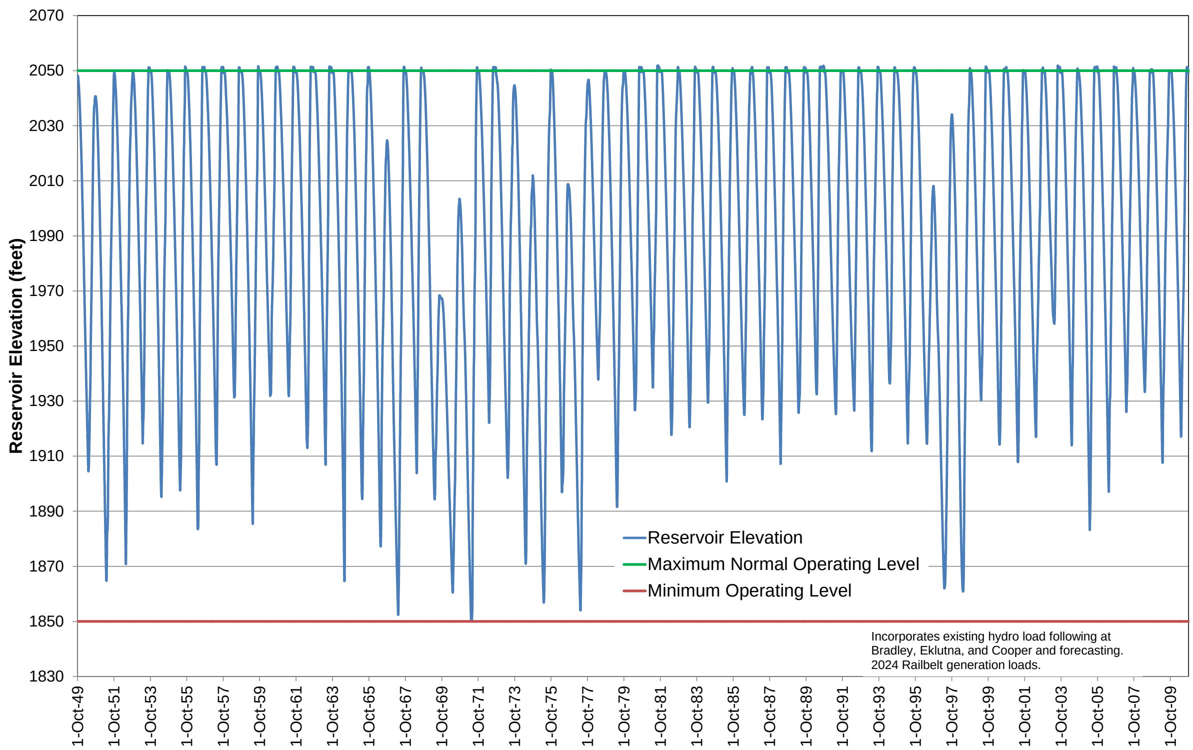

Figure 12.1-3. Daily Reservoir Elevations (feet)

12.1.3.5. Tailwater Rating Curve

A tailwater rating curve, as shown on Figure 12.1-4, is used to determine the static head on the units. For a reservoir level at the normal maximum operating level at El. 2050 ft., the available static head is about 589 ft.

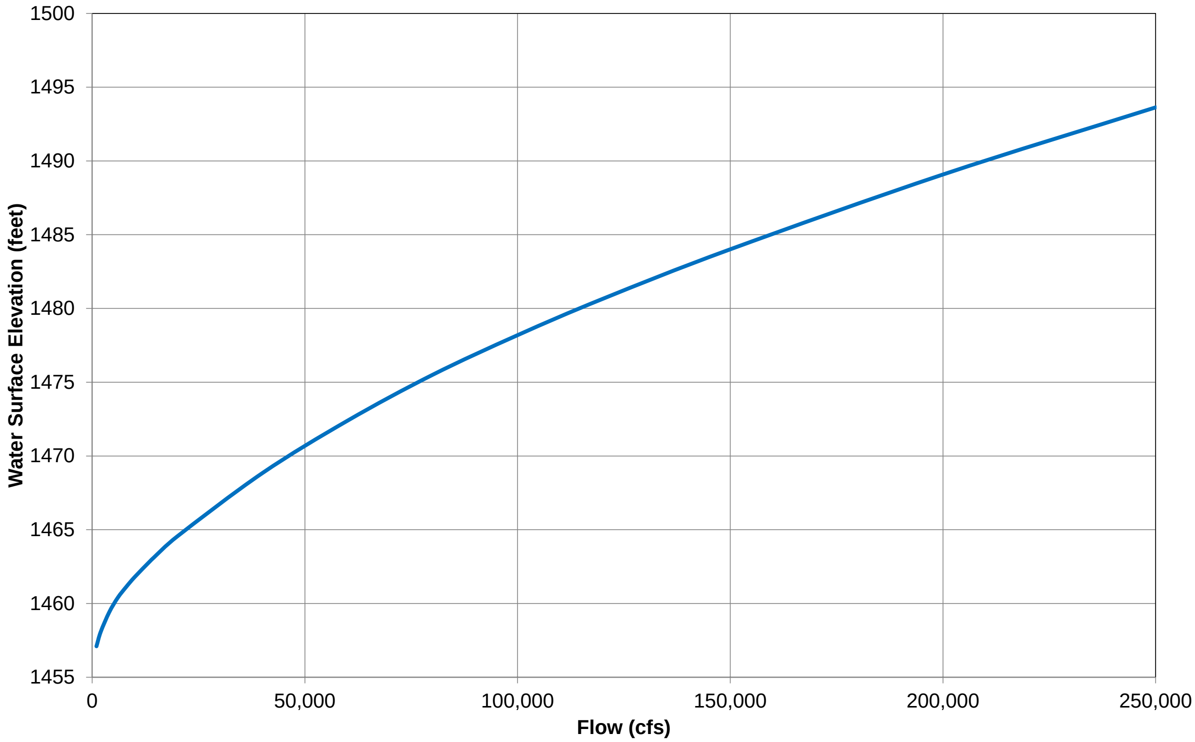

Figure 12.1-4. Tailwater Rating Curve

12.1.3.6. Operational Objectives

The 1985 FERC License Application envisioned the Alaska Power Authority Susitna-Watana Hydroelectric Project as a load-following project. The degree to which the project will be designed to carry system load swings is still under study and a definite operating plan for the project will not be developed until prior to submittal of the FERC license application. In the meantime, alternative operating scenarios have been developed. One operating scenario, designated as maximum load following, assumed that the Susitna-Watana powerhouse would provide the entire load variability of the Railbelt. This is conservative, in that other hydro on the system – though much smaller capacity – could be used to assume some of the load-following. Under the currently assumed operating mode there would be diurnal variations in powerhouse discharge as the generating units are used to meet hourly and daily Railbelt electrical load fluctuations, satisfy assumed downstream environmental flow requirements, and prevent spill, therefore optimizing power generation within the constraints of the Railbelt system. As noted above, this mode of operation was used as one premise for the initial model runs for the current studies. These model runs reflected the anticipated maximum variations that could occur from load-following, but operations due to infrequent, sudden starts and stops of other Railbelt units could potentially result in greater variations.

However, system modeling results demonstrate that the Susitna-Watana Project will not need to carry the full hourly load deviations.

For the current model runs, the primary operating objectives of the project were assumed to be similar to those described in the PAD, except that other system hydro would provide the primary means of peak generation, and include the following:

- Maximize power generation with high reliability during the months of November through April.
- Generate power as necessary to meet modified Case E-VI.
- Maximize power generation during the months of May through October – i.e., minimizing spills – without reducing the power generation during the November through April period.
- Shape generation according to Railbelt area power requirements, to the extent possible with environmental needs, and considering other generating unit availability on the interconnected grid.

Continuing system modeling in conjunction with project operations model runs are examining variations from this Base Case scenario, and results will be presented to and discussed with stakeholders during the licensing study process with the goal of including the final selected operating plan in the FERC License Application.

Ultimately, the Railbelt system modeling results from the ongoing work described previously will be used to confirm the anticipated system requirements over the economic life of the project to help AEA and the utilities jointly determine the most economical dispatch arrangements. Generally speaking this work involves critical analysis of the operating mode of the largest power plants expected to be on line in the system in future years, including Susitna-Watana, to determine how best to achieve long-term system reliability, and minimize investment and thus future regional electricity costs.

12.1.4. Operating Scenario

Results are presented in this section for the intermediate load following scenario (ILF-1). The Bradley Lake, Eklutna Lake, and Cooper Lake hydroelectric plants (other hydro on the system) were assumed to operate in a peaking mode to reduce the amount of load following that would be necessary at Susitna-Watana. No load following was assumed to occur at the gas-fired generation plants. Emergency load variations are excluded.

Flow releases would be made through the powerhouse or through low level outlet works during the rare occasions when the power plant is off line during emergency outages. Flow discharges through the powerhouse under this operating plan would range from the minimum required instream flow release (yet to be determined) to a high of about 14,000 cfs (based on the 618 MW nominal power plant turbine capacity at maximum water level) during times of maximum power generation. Based on preliminary studies, daily power generation during a peak winter month (January) would average about 8,250 megawatt hour (MWh) and powerhouse discharges would average approximately 8,360 cfs during that time.

For efficient operation of the whole interconnected Railbelt system, powerhouse discharges are expected to vary over a 24-hour period during the peak winter months. It is difficult to characterize typical powerhouse operations before production modeling simulation of the Railbelt is complete. However, to provide a preliminary indication of powerhouse discharge variability under the relatively conservative assumption of the Susitna-Watana powerhouse providing the entire load variability of the Railbelt during a typical January, simulation model runs have been performed using those criteria. Under that scenario, typical 24-hour powerhouse discharges would range from a low of about 7,000 cfs to a high of about 9,050 cfs. Powerhouse discharges could be as high as about 13,000 cfs for short periods of time during the day to meet load spikes or emergency conditions. The daily flow variation may be constrained because of environmental requirements.

Once the Susitna-Watana Project is in operation, reservoir storage and release patterns will seasonally shift some of the normal Susitna River flow from the high flow summer months to the cooler winter months, which will result in less variability in flow over the course of the year and changes to typical downstream river stages.

Figure 12.1-5 illustrates the intermediate load following operation for the 15 month period from July 1, 1984 through September 30, 1985. This period was selected as an average water period for the concurrent Susitna-Watana environmental studies. Hourly outflows at Watana Dam (blue line) and hourly flows at Gold Creek (purple line) are plotted against the flow scale on the left side of the plot, as are daily average reservoir inflows (red line). The reservoir elevation (green line) is plotted against the right vertical axis. The results presented on the figure include use of the dry year rule curve and preliminary forecasting.

Monthly average results for the 61-year period of operation for the intermediate load following case are presented in the following tables, which incorporate the dry year rule curve and preliminary forecasting:

- Table 12.1-1. Monthly Average Reservoir Elevations (feet)
- Table 12.1-2. Monthly Susitna-Watana Powerhouse Flow (cfs)
- Table 12.1-3. Monthly Total Release to River at Watana Dam (cfs)
- Table 12.1-4. Monthly Flows at Gold Creek (cfs)

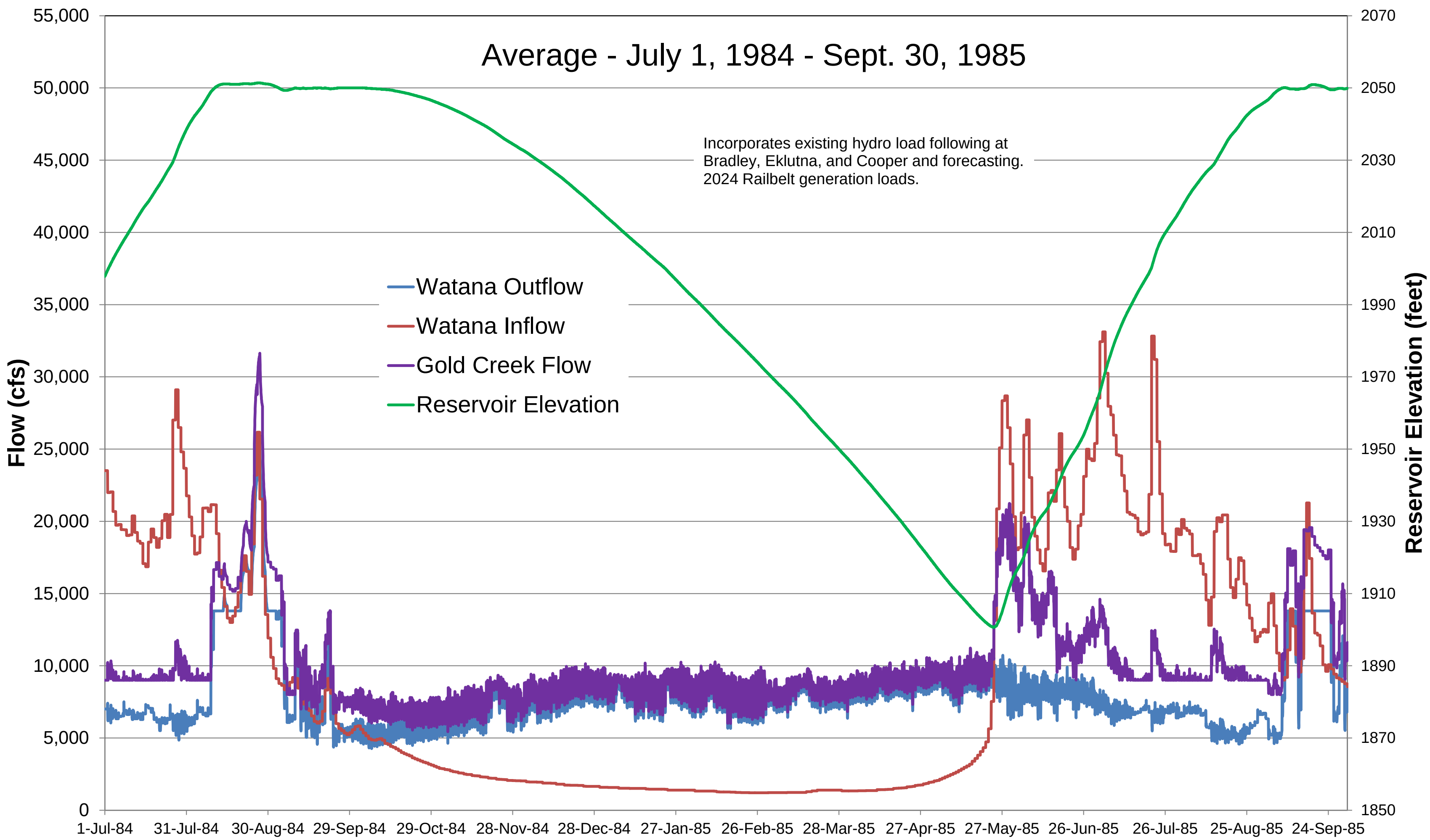

Figure 12.1-5. Intermediate Hourly Load Following Operation for an Average Water Year

Table 12.1-1. Monthly Average Reservoir Elevations (feet)

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1950	2046.3	2036.7	2019.3	1995.8	1970.3	1944.4	1919.9	1909.5	1939.4	1981.5	2024.8	2039.4	1985.7
1951	2037.6	2023.7	2002.2	1974.6	1943.6	1911.7	1879.7	1876.1	1914.1	1956.6	1996.0	2034.7	1962.7
1952	2048.1	2038.8	2022.3	2000.9	1977.4	1951.4	1920.6	1884.5	1907.6	1968.2	2016.8	2039.6	1981.4
1953	2048.8	2043.1	2027.8	2006.5	1983.1	1958.0	1929.2	1927.2	1972.6	2010.4	2042.8	2050.6	2000.2
1954	2049.0	2039.0	2021.5	1999.0	1974.7	1947.9	1916.2	1903.3	1941.2	1982.9	2023.8	2049.2	1987.4
1955	2048.6	2039.9	2024.1	2003.5	1981.1	1956.8	1928.2	1903.0	1929.5	1993.3	2033.9	2050.4	1991.1
1956	2048.3	2037.7	2019.4	1995.9	1970.4	1942.7	1909.6	1890.8	1946.1	2009.6	2049.9	2050.8	1989.5
1957	2049.1	2040.9	2025.8	2005.3	1983.5	1959.9	1932.2	1912.0	1961.6	2006.0	2041.5	2051.1	1997.5
1958	2049.9	2045.0	2032.9	2015.2	1995.1	1973.4	1948.7	1934.7	1971.1	2010.2	2047.9	2049.9	2006.3
1959	2048.1	2038.0	2020.0	1997.8	1973.9	1947.5	1916.2	1895.6	1932.3	1977.3	2021.5	2050.5	1985.0
1960	2048.8	2040.1	2024.6	2004.4	1982.4	1961.1	1941.0	1939.1	1971.5	2001.7	2044.3	2051.1	2001.0
1961	2049.5	2041.8	2027.3	2008.8	1989.0	1967.6	1944.9	1939.8	1975.3	2024.3	2050.7	2049.8	2005.9
1962	2048.3	2039.1	2023.4	2003.2	1981.4	1958.0	1931.4	1916.7	1974.3	2042.4	2051.3	2050.3	2001.8
1963	2049.5	2042.3	2027.4	2007.2	1985.6	1962.4	1934.7	1918.5	1967.4	2024.2	2051.3	2050.3	2001.9
1964	2049.4	2040.5	2023.3	2000.8	1976.5	1949.9	1918.1	1879.8	1946.9	2020.2	2047.0	2049.9	1992.0
1965	2049.2	2040.6	2024.3	2001.7	1977.6	1951.8	1922.2	1898.7	1933.4	1988.1	2031.2	2049.6	1989.2
1966	2048.1	2037.0	2018.9	1996.0	1971.4	1944.9	1914.0	1883.8	1920.0	1961.9	1998.6	2020.7	1976.4
1967	2021.4	2005.3	1981.1	1949.2	1919.6	1893.4	1868.9	1861.3	1913.9	1966.6	2026.4	2050.5	1955.0
1968	2048.5	2038.4	2021.9	2001.3	1979.7	1957.2	1931.4	1913.0	1962.7	2019.4	2049.0	2049.8	1997.9
1969	2046.5	2034.6	2015.1	1989.9	1962.4	1935.1	1909.5	1899.2	1922.0	1949.5	1967.2	1967.4	1966.6
1970	1965.8	1957.3	1942.7	1924.8	1906.2	1889.2	1871.2	1867.1	1895.2	1938.5	1983.4	2001.6	1928.7
1971	1998.0	1982.3	1961.0	1943.4	1919.1	1893.2	1868.7	1851.6	1890.2	1959.6	2019.6	2050.0	1944.9
1972	2049.2	2041.4	2026.6	2007.3	1986.8	1965.2	1940.1	1931.7	1990.8	2040.6	2051.2	2049.8	2006.9
1973	2045.9	2036.3	2018.3	1995.0	1970.0	1945.3	1921.8	1905.8	1942.6	1993.1	2021.4	2043.3	1986.7
1974	2041.6	2028.3	2007.8	1981.2	1951.8	1921.9	1892.0	1878.6	1924.6	1957.0	1987.7	2006.6	1965.0
1975	2007.5	1989.4	1964.0	1943.7	1919.5	1893.6	1869.6	1864.0	1920.1	1980.7	2021.8	2041.9	1951.5
1976	2049.6	2041.3	2023.2	2000.0	1975.4	1948.8	1917.6	1900.0	1928.4	1962.2	1997.1	2008.2	1979.4
1977	2001.9	1985.1	1962.5	1943.9	1919.7	1893.8	1869.9	1860.2	1920.8	1983.2	2019.8	2037.8	1950.1
1978	2045.9	2040.1	2025.7	2006.4	1985.4	1965.4	1947.4	1946.0	1971.6	2009.9	2040.3	2049.5	2003.0
1979	2047.9	2038.5	2021.5	1999.3	1975.6	1950.0	1920.0	1896.9	1934.7	1982.3	2030.5	2046.5	1987.1
1980	2049.6	2043.9	2030.7	2011.4	1990.7	1968.8	1943.7	1929.7	1963.1	2020.6	2051.1	2050.1	2004.6
1981	2049.9	2044.5	2030.5	2011.7	1992.7	1971.9	1948.4	1946.8	1977.1	2020.3	2051.5	2050.4	2008.1
1982	2049.9	2044.0	2028.7	2008.7	1987.4	1964.4	1938.0	1922.1	1956.0	2000.5	2034.4	2048.0	1998.6
1983	2049.3	2040.5	2024.8	2005.5	1984.9	1963.4	1938.2	1926.0	1960.8	2002.7	2039.3	2050.1	1998.9
1984	2049.8	2043.6	2029.0	2010.2	1990.9	1971.0	1948.5	1935.3	1967.9	2018.3	2049.2	2049.9	2005.4
1985	2048.7	2039.9	2024.5	2004.2	1982.4	1959.4	1933.3	1908.7	1939.3	1993.5	2033.1	2049.7	1993.2
1986	2049.2	2040.2	2023.7	2002.3	1979.5	1957.6	1937.3	1929.7	1963.7	2003.5	2034.8	2049.3	1997.7
1987	2050.0	2044.0	2029.0	2008.8	1987.5	1965.2	1939.9	1927.8	1958.3	2003.8	2047.7	2050.2	2001.1
1988	2049.2	2041.2	2024.3	2002.8	1980.2	1956.5	1929.0	1919.0	1964.8	2018.2	2048.5	2050.3	1998.8
1989	2049.5	2042.2	2026.6	2006.6	1985.8	1964.0	1939.3	1929.7	1962.6	2008.2	2045.1	2050.5	2001.0
1990	2049.5	2042.7	2026.8	2006.4	1985.1	1963.1	1939.9	1951.0	2017.6	2050.7	2051.2	2051.3	2011.5
1991	2049.1	2039.6	2023.6	2003.3	1981.6	1961.3	1942.5	1928.4	1957.7	2009.1	2039.2	2049.8	1998.9
1992	2049.0	2039.3	2023.2	2002.9	1981.4	1961.2	1943.7	1930.4	1958.3	2009.0	2047.0	2050.0	1999.8
1993	2047.5	2037.5	2021.2	2000.1	1977.8	1954.1	1927.1	1923.2	1970.7	2002.9	2033.0	2050.6	1995.6
1994	2049.7	2043.8	2029.5	2010.8	1990.8	1969.5	1945.9	1941.8	1979.6	2029.4	2050.1	2049.9	2007.7
1995	2047.3	2037.5	2021.3	2000.3	1977.9	1954.3	1928.1	1927.4	1957.1	2007.9	2043.6	2050.9	1996.3
1996	2049.0	2040.6	2023.6	2001.3	1977.6	1954.7	1933.6	1917.7	1934.6	1959.2	1986.3	2005.4	1982.0
1997	2002.8	1984.2	1961.0	1943.5	1919.5	1894.7	1872.1	1864.4	1891.6	1939.4	1994.5	2029.0	1941.5
1998	2031.2	2016.6	1995.1	1967.0	1935.2	1902.5	1873.2	1863.3	1908.9	1964.3	2013.0	2040.8	1959.4
1999	2049.5	2042.3	2026.9	2006.7	1984.8	1963.7	1943.9	1935.0	1965.7	2010.6	2047.9	2050.0	2002.4
2000	2049.5	2042.1	2026.8	2006.4	1984.6	1961.6	1935.1	1917.1	1953.3	2016.1	2048.4	2050.2	1999.4
2001	2049.7	2042.3	2027.0	2006.9	1985.5	1962.8	1936.6	1912.3	1949.4	1996.4	2035.4	2049.9	1996.3
2002	2048.2	2038.5	2022.0	2000.4	1977.3	1955.0	1934.2	1923.3	1953.2	1982.6	2017.5	2047.6	1991.8
2003	2050.1	2047.6	2036.0	2017.7	1998.7	1981.8	1965.6	1959.8	1990.6	2037.7	2051.1	2050.3	2015.7
2004	2049.2	2040.5	2024.0	2002.6	1979.6	1954.8	1926.6	1934.5	1981.6	2019.9	2044.8	2049.4	2000.8
2005	2044.6	2031.6	2012.7	1989.0	1963.0	1934.1	1899.4	1905.3	1973.5	2033.3	2051.2	2051.2	1991.0
2006	2049.7	2041.0	2023.6	2001.7	1978.5	1954.0	1925.8	1906.2	1939.9	1985.9	2028.8	2050.2	1990.5
2007	2049.2	2041.2	2026.0	2006.4	1985.8	1964.0	1939.2	1934.7	1965.6	1997.8	2031.5	2048.5	1999.3
2008	2048.4	2039.3	2025.1	2005.6	1983.7	1962.5	1943.6	1939.9	1970.8	2009.9	2046.7	2049.9	2002.3
2009	2049.0	2038.3	2019.6	1996.6	1972.4	1946.3	1917.5	1933.2	1972.4	2006.1	2032.2	2049.6	1994.6
2010	2049.7	2042.3	2026.5	2005.5	1983.2	1959.5	1932.6	1929.5	1964.0	2003.7	2044.3	2050.6	1999.4
Average	2043.3	2034.0	2017.2	1996.0	1973.0	1949.2	1923.6	1912.2	1950.7	1997.8	2032.1	2043.7	1989.5
Maximum	2050.1	2047.6	2036.0	2017.7	1998.7	1981.8	1965.6	1959.8	2017.6	2050.7	2051.5	2051.3	2015.7
Minimum	1965.8	1957.3	1942.7	1924.8	1906.2	1889.2	1868.7	1851.6	1890.2	1938.5	1967.2	1967.4	1928.7

Table 12.1-2. Monthly Susitna-Watana Powerhouse Flow (cfs)

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1950	5,909	7,234	8,263	8,682	8,747	7,310	6,674	6,144	5,820	5,235	5,559	5,388	6,736
1951	6,093	7,564	8,812	9,440	9,799	8,357	7,873	6,918	6,211	5,462	5,686	4,982	7,252
1952	5,868	7,180	8,170	8,522	8,500	8,393	9,296	10,436	9,888	7,591	6,011	5,408	7,934
1953	6,018	7,075	8,016	8,339	8,311	8,181	8,939	8,546	7,455	6,410	7,498	12,452	8,092
1954	6,103	7,174	8,195	8,576	8,588	8,518	9,488	9,537	8,423	7,145	5,525	8,442	7,967
1955	5,858	7,151	8,125	8,438	8,375	8,223	8,977	9,517	8,903	6,865	6,864	11,440	8,217
1956	5,954	7,210	8,259	8,679	8,742	8,711	9,788	10,151	8,306	6,456	11,970	13,585	8,978
1957	5,892	7,128	8,076	8,378	8,306	8,128	8,817	9,133	7,780	6,527	7,264	13,800	8,257
1958	7,375	7,034	7,868	8,074	7,953	7,738	8,215	8,238	7,495	6,421	10,577	6,083	7,760
1959	5,869	7,201	8,242	8,619	8,620	8,533	9,489	9,900	8,754	7,317	6,312	11,385	8,342
1960	6,713	7,146	8,113	8,408	8,331	6,802	6,069	5,379	6,142	5,410	8,613	13,800	7,563
1961	7,394	7,105	8,031	8,271	8,129	7,908	8,341	8,088	7,375	6,165	12,620	10,459	8,326
1962	6,390	7,173	8,140	8,448	8,365	8,181	8,849	8,931	7,471	9,319	13,800	11,837	8,914
1963	6,270	7,092	8,028	8,315	8,234	8,056	8,717	8,887	7,599	7,163	13,800	11,171	8,614
1964	6,284	7,137	8,143	8,526	8,533	8,444	9,402	10,643	8,548	6,557	9,479	7,440	8,261
1965	6,047	7,136	8,118	8,494	8,493	8,378	9,227	9,732	8,718	7,009	6,124	11,451	8,232
1966	7,867	7,228	8,274	8,675	8,706	8,631	9,586	10,472	9,315	7,704	6,081	5,754	8,189
1967	6,469	8,084	9,588	10,042	7,947	6,903	5,638	7,239	9,570	7,586	6,659	11,639	8,108
1968	5,902	7,191	8,182	8,508	8,423	8,210	8,849	9,103	7,738	6,241	10,889	7,362	8,050
1969	5,903	7,284	8,393	8,883	9,039	7,603	7,006	6,455	7,334	7,777	6,451	4,280	7,193
1970	3,676	4,442	5,102	5,300	5,259	4,398	4,782	5,856	6,544	5,961	5,748	5,650	5,225
1971	7,070	8,824	6,675	6,800	7,479	6,691	5,596	3,920	8,693	7,826	6,030	10,342	7,146
1972	6,164	7,117	8,050	8,314	8,196	7,974	8,517	8,373	6,949	8,166	13,800	11,580	8,604
1973	5,914	7,247	8,293	8,708	8,756	7,282	6,617	6,242	5,507	5,821	5,623	5,239	6,761
1974	6,007	7,445	8,626	9,188	9,456	8,028	7,601	7,165	6,007	5,820	6,108	5,526	7,237
1975	6,821	8,583	7,956	6,960	7,824	7,101	5,720	7,741	9,305	7,223	5,880	6,873	7,325
1976	7,123	7,118	8,146	8,550	8,566	8,485	9,427	9,668	8,916	7,738	6,245	6,116	8,005
1977	6,966	8,728	7,561	7,189	7,961	7,207	5,776	7,260	9,330	7,139	5,856	5,640	7,210
1978	5,915	7,146	8,078	8,343	8,243	6,681	5,902	5,213	5,524	5,366	6,130	6,224	6,554
1979	5,873	7,188	8,195	8,571	8,561	8,443	9,321	9,823	8,668	7,179	5,717	6,200	7,805
1980	6,660	7,063	7,932	8,191	8,079	7,868	8,383	8,412	7,725	6,294	13,800	10,939	8,448
1981	6,992	7,047	7,935	8,184	8,023	7,777	8,221	7,868	7,306	6,849	13,800	11,611	8,471
1982	5,943	7,054	7,988	8,272	8,176	8,001	8,593	8,714	7,935	6,649	6,978	9,544	7,813
1983	6,136	7,137	8,105	8,372	8,258	8,031	8,585	8,563	7,797	6,955	7,619	10,786	8,021
1984	7,468	7,063	7,980	8,225	8,070	7,803	8,218	8,228	7,590	6,468	11,833	7,623	8,052
1985	5,857	7,151	8,115	8,414	8,331	8,143	8,773	9,267	8,493	6,935	5,967	10,309	7,969
1986	6,359	7,143	8,130	8,477	8,431	6,905	6,169	5,598	6,689	7,592	5,978	9,188	7,211
1987	9,698	7,057	7,981	8,270	8,174	7,974	8,520	8,488	7,863	6,601	10,457	10,444	8,463
1988	5,846	7,121	8,122	8,460	8,405	8,235	8,944	8,859	7,680	6,233	10,641	10,810	8,275
1989	7,133	7,095	8,053	8,337	8,230	8,010	8,545	8,416	7,743	6,471	9,123	13,035	8,342
1990	7,363	7,082	8,045	8,343	8,253	8,038	8,523	7,755	6,267	12,779	13,800	13,800	9,181
1991	7,309	7,158	8,135	8,444	8,358	6,798	6,029	5,619	5,085	5,431	6,017	10,107	7,030
1992	6,275	7,166	8,142	8,455	8,367	6,799	6,000	5,568	5,162	4,857	10,055	8,583	7,113
1993	5,881	7,215	8,205	8,550	8,490	8,307	9,023	8,711	7,496	6,599	5,874	12,774	8,079
1994	8,395	7,059	7,966	8,212	8,077	7,854	8,308	8,006	7,263	5,986	12,313	7,773	8,106
1995	5,886	7,215	8,201	8,543	8,483	8,298	8,985	8,533	7,892	6,485	7,420	13,800	8,298
1996	6,742	7,138	8,136	8,509	8,495	6,991	6,273	5,899	6,201	6,191	6,056	5,544	6,840
1997	6,940	8,759	6,676	6,825	7,836	6,738	5,367	5,746	6,552	5,825	5,248	5,078	6,455
1998	6,238	7,756	9,060	9,744	10,175	8,724	6,128	5,168	6,298	5,462	5,157	6,103	7,150
1999	7,508	7,094	8,043	8,334	8,261	6,729	5,993	5,462	5,138	5,181	10,511	9,580	7,316
2000	6,472	7,097	8,045	8,344	8,267	8,079	8,702	8,910	8,031	6,293	9,822	11,211	8,267
2001	7,836	7,093	8,039	8,327	8,239	8,047	8,646	9,103	8,170	6,773	5,683	8,590	7,873
2002	5,867	7,188	8,179	8,537	8,505	6,982	6,254	5,762	6,031	5,838	5,427	8,655	6,921
2003	9,255	7,024	7,782	8,003	7,862	6,252	5,467	4,908	4,847	7,379	13,800	10,251	7,744
2004	7,829	7,136	8,125	8,465	8,426	8,285	9,045	8,312	7,187	6,185	8,600	5,997	7,799
2005	5,942	7,362	8,463	8,910	9,016	9,051	10,288	9,523	7,451	6,673	13,800	13,800	9,186
2006	8,083	7,126	8,134	8,497	8,462	8,305	9,077	9,403	8,466	7,064	7,137	10,269	8,330
2007	9,472	7,122	8,068	8,343	8,231	8,010	8,547	8,259	7,642	6,737	5,773	8,652	7,901
2008	5,945	7,167	8,098	8,367	8,299	6,762	6,001	5,351	5,253	5,325	9,662	12,107	7,351
2009	5,882	7,194	8,253	8,653	8,671	8,578	9,437	8,345	7,453	6,517	5,888	8,780	7,793
2010	6,512	7,093	8,054	8,370	8,310	8,133	8,803	8,466	7,692	6,594	8,332	12,222	8,206
Average	6,614	7,238	8,064	8,364	8,356	7,771	7,907	7,868	7,421	6,686	8,320	9,271	7,817
Maximum	9,698	8,824	9,588	10,042	10,175	9,051	10,288	10,643	9,888	12,779	13,800	13,800	9,186
Minimum	3,676	4,442	5,102	5,300	5,259	4,398	4,782	3,920	4,847	4,857	5,157	4,280	5,225

Table 12.1-3. Monthly Total Release to River at Watana Dam (cfs)

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1950	5,909	7,234	8,263	8,682	8,747	7,310	6,674	6,144	5,820	5,235	5,559	5,388	6,736
1951	6,093	7,564	8,812	9,440	9,799	8,357	7,873	6,918	6,211	5,462	5,686	4,982	7,252
1952	5,868	7,180	8,170	8,522	8,500	8,393	9,296	10,436	9,888	7,591	6,011	5,408	7,934
1953	6,018	7,075	8,016	8,339	8,311	8,181	8,939	8,546	7,455	6,410	8,026	13,038	8,185
1954	6,103	7,174	8,195	8,576	8,588	8,518	9,488	9,537	8,423	7,145	5,525	8,442	7,967
1955	5,858	7,151	8,125	8,438	8,375	8,223	8,977	9,517	8,903	6,865	8,708	12,266	8,442
1956	5,954	7,210	8,259	8,679	8,742	8,711	9,788	10,151	8,306	6,456	15,778	15,649	9,471
1957	5,892	7,128	8,076	8,378	8,306	8,128	8,817	9,133	7,780	6,527	7,706	16,425	8,510
1958	7,375	7,034	7,868	8,074	7,953	7,738	8,215	8,238	7,495	6,421	11,330	6,083	7,824
1959	5,869	7,201	8,242	8,619	8,620	8,533	9,489	9,900	8,754	7,317	7,315	14,664	8,697
1960	6,713	7,146	8,113	8,408	8,331	6,802	6,069	5,379	6,142	5,410	10,065	17,305	7,974
1961	7,394	7,105	8,031	8,271	8,129	7,908	8,341	8,088	7,375	6,165	17,152	10,459	8,710
1962	6,390	7,173	8,140	8,448	8,365	8,181	8,849	8,931	7,471	12,627	19,931	13,285	9,835
1963	6,270	7,092	8,028	8,315	8,234	8,056	8,717	8,887	7,599	7,598	21,066	11,281	9,277
1964	6,284	7,137	8,143	8,526	8,533	8,444	9,402	10,643	8,548	6,557	9,479	7,440	8,261
1965	6,047	7,136	8,118	8,494	8,493	8,378	9,227	9,732	8,718	7,009	6,124	13,676	8,415
1966	7,867	7,228	8,274	8,675	8,706	8,631	9,586	10,472	9,315	7,704	6,081	5,754	8,189
1967	6,469	8,084	9,588	10,042	7,947	6,903	5,638	7,239	9,570	7,586	6,707	14,143	8,318
1968	5,902	7,191	8,182	8,508	8,423	8,210	8,849	9,103	7,738	6,241	10,890	7,362	8,050
1969	5,903	7,284	8,393	8,883	9,039	7,603	7,006	6,455	7,334	7,777	6,451	4,280	7,193
1970	3,676	4,442	5,102	5,300	5,259	4,398	4,782	5,856	6,544	5,961	5,748	5,650	5,225
1971	7,070	8,824	6,675	6,800	7,479	6,691	5,596	3,920	8,693	7,826	6,030	10,741	7,179
1972	6,164	7,117	8,050	8,314	8,196	7,974	8,517	8,373	6,949	8,812	17,780	11,801	9,015
1973	5,914	7,247	8,293	8,708	8,756	7,282	6,617	6,242	5,507	5,821	5,623	5,239	6,761
1974	6,007	7,445	8,626	9,188	9,456	8,028	7,601	7,165	6,007	5,820	6,108	5,526	7,237
1975	6,821	8,583	7,956	6,960	7,824	7,101	5,720	7,741	9,305	7,223	5,880	6,873	7,325
1976	7,123	7,118	8,146	8,550	8,566	8,485	9,427	9,668	8,916	7,738	6,245	6,116	8,005
1977	6,966	8,728	7,561	7,189	7,961	7,207	5,776	7,260	9,330	7,139	5,856	5,640	7,210
1978	5,915	7,146	8,078	8,343	8,243	6,681	5,902	5,213	5,524	5,366	6,130	6,224	6,554
1979	5,873	7,188	8,195	8,571	8,561	8,443	9,321	9,823	8,668	7,179	5,717	6,200	7,805
1980	6,660	7,063	7,932	8,191	8,079	7,868	8,383	8,412	7,725	6,294	18,000	11,182	8,824
1981	6,992	7,047	7,935	8,184	8,023	7,777	8,221	7,868	7,306	7,368	30,571	12,198	9,987
1982	5,943	7,054	7,988	8,272	8,176	8,001	8,593	8,714	7,935	6,649	6,978	10,848	7,920
1983	6,136	7,137	8,105	8,372	8,258	8,031	8,585	8,563	7,797	6,955	9,382	11,619	8,239
1984	7,468	7,063	7,980	8,225	8,070	7,803	8,218	8,228	7,590	6,468	13,370	7,623	8,182
1985	5,857	7,151	8,115	8,414	8,331	8,143	8,773	9,267	8,493	6,935	5,967	10,309	7,969
1986	6,359	7,143	8,130	8,477	8,431	6,905	6,169	5,598	6,689	7,592	5,978	9,188	7,211
1987	10,635	7,057	7,981	8,270	8,174	7,974	8,520	8,488	7,863	6,601	11,393	10,972	8,665
1988	5,846	7,121	8,122	8,460	8,405	8,235	8,944	8,859	7,680	6,233	11,535	11,829	8,434
1989	7,133	7,095	8,053	8,337	8,230	8,010	8,545	8,416	7,743	6,471	10,062	13,091	8,426
1990	7,363	7,082	8,045	8,343	8,253	8,038	8,523	7,755	6,267	17,041	19,618	22,092	10,719
1991	7,309	7,158	8,135	8,444	8,358	6,798	6,029	5,619	5,085	5,431	6,017	10,107	7,030
1992	6,275	7,166	8,142	8,455	8,367	6,799	6,000	5,568	5,162	4,857	10,867	8,583	7,182
1993	5,881	7,215	8,205	8,550	8,490	8,307	9,023	8,711	7,496	6,599	5,874	15,704	8,320
1994	8,395	7,059	7,966	8,212	8,077	7,854	8,308	8,006	7,263	5,986	13,265	7,773	8,187
1995	5,886	7,215	8,201	8,543	8,483	8,298	8,985	8,533	7,892	6,485	7,420	15,617	8,447
1996	6,742	7,138	8,136	8,509	8,495	6,991	6,273	5,899	6,201	6,191	6,056	5,544	6,840
1997	6,940	8,759	6,676	6,825	7,836	6,738	5,367	5,746	6,552	5,825	5,248	5,078	6,455
1998	6,238	7,756	9,060	9,744	10,175	8,724	6,128	5,168	6,298	5,462	5,157	6,178	7,156
1999	7,508	7,094	8,043	8,334	8,261	6,729	5,993	5,462	5,138	5,181	14,268	9,580	7,635
2000	6,472	7,097	8,045	8,344	8,267	8,079	8,702	8,910	8,031	6,293	9,822	12,260	8,354
2001	7,836	7,093	8,039	8,327	8,239	8,047	8,646	9,103	8,170	6,773	5,683	8,590	7,873
2002	5,867	7,188	8,179	8,537	8,505	6,982	6,254	5,762	6,031	5,838	5,427	8,740	6,928
2003	9,431	7,024	7,782	8,003	7,862	6,252	5,467	4,908	4,847	10,938	17,584	11,591	8,493
2004	7,829	7,136	8,125	8,465	8,426	8,285	9,045	8,312	7,187	6,185	8,600	5,997	7,799
2005	5,942	7,362	8,463	8,910	9,016	9,051	10,288	9,523	7,451	6,805	18,170	18,885	9,986
2006	8,115	7,126	8,134	8,497	8,462	8,305	9,077	9,403	8,466	7,064	9,104	10,659	8,532
2007	9,740	7,122	8,068	8,343	8,231	8,010	8,547	8,259	7,642	6,737	5,773	8,653	7,924
2008	5,945	7,167	8,098	8,367	8,299	6,762	6,001	5,351	5,253	5,325	9,662	12,107	7,351
2009	5,882	7,194	8,253	8,653	8,671	8,578	9,437	8,345	7,453	6,517	5,888	8,780	7,793
2010	6,512	7,093	8,054	8,370	8,310	8,133	8,803	8,466	7,692	6,594	8,672	13,801	8,365
Average	6,637	7,238	8,064	8,364	8,356	7,771	7,907	7,868	7,421	6,896	9,641	10,041	8,013
Maximum	10,635	8,824	9,588	10,042	10,175	9,051	10,288	10,643	9,888	17,041	30,571	22,092	10,719
Minimum	3,676	4,442	5,102	5,300	5,259	4,398	4,782	3,920	4,847	4,857	5,157	4,280	5,225

Table 12.1-4. Monthly Flows at Gold Creek (cfs)

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1950	7,080	7,739	8,552	8,893	8,909	7,461	6,854	8,206	9,240	9,156	9,033	6,913	8,169
1951	6,828	7,827	9,036	9,637	9,968	8,510	8,194	9,421	9,828	9,384	9,125	8,674	8,863
1952	6,910	7,713	8,548	8,842	8,705	8,574	9,485	11,421	15,439	12,149	9,663	7,980	9,621
1953	7,523	7,748	8,356	8,563	8,480	8,350	9,259	11,916	12,152	9,940	11,622	15,745	9,970
1954	7,153	7,590	8,496	8,839	8,793	8,680	9,737	12,566	12,782	10,710	10,061	10,756	9,682
1955	6,869	7,689	8,529	8,796	8,657	8,447	9,221	11,199	14,007	11,602	13,248	14,809	10,256
1956	6,888	7,588	8,522	8,880	8,941	8,904	9,983	13,237	14,114	11,743	20,000	18,859	11,480
1957	6,978	7,720	8,499	8,718	8,607	8,372	9,061	11,559	12,953	10,564	11,294	19,884	10,343
1958	8,885	7,790	8,497	8,464	8,218	7,972	8,523	10,533	11,924	10,389	15,283	7,478	9,513
1959	6,779	7,626	8,545	8,910	8,885	8,734	9,742	12,694	12,795	11,628	12,822	17,645	10,566
1960	7,929	7,701	8,545	8,776	8,623	7,045	6,332	8,164	8,902	9,389	14,148	20,884	9,698
1961	8,827	7,688	8,556	8,752	8,479	8,269	8,858	11,812	14,044	10,897	19,777	13,685	10,820
1962	7,669	7,610	8,480	8,739	8,608	8,404	9,092	10,187	14,724	15,036	23,599	16,429	11,568
1963	7,433	7,383	8,319	8,606	8,549	8,172	8,770	12,616	12,939	13,231	23,729	12,800	11,072
1964	7,546	7,598	8,442	8,722	8,718	8,582	9,538	11,371	16,286	9,421	11,870	9,487	9,797
1965	7,579	7,567	8,258	8,591	8,580	8,471	9,355	11,754	13,223	11,615	9,848	16,803	10,132
1966	9,851	7,761	8,702	9,015	9,021	8,946	10,023	13,023	16,327	11,414	10,521	8,291	10,247
1967	7,362	8,482	9,966	10,440	8,316	7,213	5,955	10,164	14,369	12,397	13,223	17,340	10,441
1968	6,783	7,610	8,532	8,871	8,763	8,550	9,182	12,455	13,584	10,577	13,913	9,014	9,828
1969	6,590	7,559	8,521	8,988	9,154	7,733	7,254	8,190	8,875	9,035	7,558	5,113	7,878
1970	4,397	4,636	5,259	5,488	5,424	4,549	4,876	7,700	10,777	10,212	9,462	7,547	6,701
1971	8,590	9,734	7,278	7,145	7,737	6,924	5,865	4,808	14,014	10,650	10,490	12,994	8,842
1972	7,032	7,624	8,603	8,882	8,734	8,431	8,921	14,290	13,952	11,761	19,559	13,248	10,937
1973	6,827	7,691	8,587	8,952	9,000	7,487	6,827	7,736	10,336	9,026	9,158	6,894	8,207
1974	6,721	7,751	8,838	9,368	9,616	8,179	7,803	9,984	9,146	9,118	8,973	7,722	8,599
1975	7,535	8,923	8,277	7,264	8,120	7,383	6,039	10,435	14,830	11,975	9,059	9,755	9,133
1976	8,547	7,512	8,366	8,750	8,761	8,670	9,703	11,930	13,126	11,053	9,697	7,395	9,465
1977	7,708	9,245	8,032	7,554	8,285	7,508	6,112	9,497	15,931	11,104	9,221	7,909	9,006
1978	7,312	7,824	8,584	8,745	8,577	7,002	6,242	7,356	8,862	9,024	9,021	7,801	8,029
1979	6,800	7,684	8,531	8,853	8,821	8,687	9,612	12,262	12,929	12,123	9,286	8,152	9,482
1980	8,011	7,862	8,407	8,540	8,374	8,150	8,716	10,631	13,405	12,211	20,958	13,467	10,746
1981	8,084	7,572	8,060	8,339	8,406	8,101	8,620	10,003	9,869	13,706	37,901	14,319	11,964
1982	7,706	7,846	8,270	8,573	8,558	8,376	9,180	11,220	12,595	10,329	9,050	14,652	9,691
1983	7,875	7,638	8,570	8,840	8,645	8,294	8,920	11,837	11,703	9,332	13,019	14,011	9,893
1984	8,887	7,560	8,300	8,491	8,299	8,006	8,415	10,359	11,451	9,303	16,346	9,705	9,608
1985	7,270	7,860	8,710	8,874	8,701	8,571	9,234	11,998	13,600	10,149	9,454	14,245	9,884
1986	8,230	7,777	8,634	8,927	8,861	7,261	6,571	7,944	8,878	9,035	9,023	11,491	8,549
1987	12,895	7,721	8,369	8,593	8,478	8,275	8,924	10,806	11,843	11,726	15,180	13,348	10,531
1988	6,956	7,607	8,442	8,773	8,706	8,536	9,262	11,895	12,766	10,662	14,957	14,284	10,242
1989	8,544	7,679	8,451	8,735	8,589	8,369	8,966	10,865	12,351	10,568	13,956	15,828	10,245
1990	8,836	7,662	8,413	8,695	8,593	8,407	9,327	12,164	12,069	21,115	23,723	26,736	13,004
1991	8,582	7,638	8,567	8,822	8,717	7,122	6,352	6,733	9,501	9,124	9,226	12,323	8,553
1992	7,362	7,644	8,574	8,846	8,726	7,171	6,415	6,687	9,180	9,263	14,552	10,426	8,741
1993	6,714	7,748	8,610	8,921	8,840	8,634	9,518	12,339	11,558	9,987	9,160	19,403	10,109
1994	10,193	7,701	8,460	8,620	8,433	8,159	8,925	10,603	12,625	9,636	16,524	9,477	9,962
1995	6,747	7,757	8,616	8,912	8,827	8,638	9,537	11,641	12,151	10,883	10,649	18,975	10,270
1996	7,946	7,656	8,426	8,762	8,737	7,215	6,545	7,109	8,986	9,028	9,074	7,432	8,076
1997	7,631	9,152	7,035	7,174	8,175	7,065	5,726	7,521	9,912	10,094	9,581	7,538	8,049
1998	7,006	8,119	9,401	10,073	10,498	9,037	6,505	6,928	10,594	9,972	9,142	9,070	8,852
1999	8,961	7,700	8,469	8,689	8,589	7,035	6,317	7,179	9,185	9,202	18,771	11,661	9,326
2000	7,776	7,715	8,452	8,696	8,608	8,409	9,070	11,010	13,572	11,498	12,747	15,041	10,217
2001	9,354	7,704	8,463	8,687	8,584	8,382	8,993	10,743	13,455	10,604	9,472	10,465	9,577
2002	6,783	7,701	8,556	8,847	8,791	7,246	6,522	7,795	8,953	9,026	9,529	11,613	8,441
2003	11,410	8,037	8,288	8,334	8,302	6,555	5,891	6,373	9,051	15,999	21,252	13,995	10,319
2004	9,311	7,626	8,486	8,761	8,685	8,505	9,572	12,397	11,559	9,708	11,724	7,198	9,472
2005	6,578	7,708	8,785	9,200	9,268	9,264	10,787	14,139	13,319	11,406	21,985	22,849	12,114
2006	9,621	7,549	8,434	8,779	8,742	8,579	9,384	12,141	12,492	11,075	14,490	12,869	10,357
2007	11,610	7,730	8,523	8,745	8,610	8,358	8,993	11,284	11,088	10,493	9,151	11,062	9,645
2008	6,891	7,790	8,646	8,733	8,570	7,036	6,334	7,479	8,935	9,154	13,108	14,693	8,945
2009	6,918	7,505	8,516	8,933	8,934	8,849	10,282	12,327	11,461	9,907	9,128	11,019	9,480
2010	7,830	7,638	8,420	8,665	8,582	8,396	9,169	11,889	11,191	11,311	12,177	16,595	10,157
Average	7,860	7,758	8,436	8,682	8,647	8,036	8,252	10,369	11,995	10,850	13,267	12,521	9,727
Maximum	12,895	9,734	9,966	10,440	10,498	9,264	10,787	14,290	16,327	21,115	37,901	26,736	13,004
Minimum	4,397	4,636	5,259	5,488	5,424	4,549	4,876	4,808	8,862	9,024	7,558	5,113	6,701

12.2. Project Generation

Monthly project generation potential is summarized on Table 12.2-1, which shows a long-term average annual energy generation capability of 2,760 GWh (or 2,800 GWh when rounded to two significant figures). The generation values represent generator output without deductions for outages and assume that all potential generation is usable. The generation results presented in this section are for a powerhouse with a total generating output of 606 MW at the normal maximum operating level (equivalent to a turbine capacity of 618 MW) and including a preliminary inflow forecasting operation. Various alternative conditions (the amount of load following, the installed capacity, the inclusion of forecasting) within reasonable ranges have relatively small effects on the estimated total amount of annual generation. It is expected that further refinements in project operation plans will be made by AEA in future phases of project development.

Figure 12.2-1 is a plot of the annual generation for the 61-year period of simulated operation. For a hydroelectric project that is dependent on variable natural inflows, annual generation is relatively uniform. Multi-year dry periods result in the lowest annual generation values.

An objective of project operation was to shape the monthly potential generation in a manner that is similar to the Railbelt monthly electricity load. Because the natural reservoir inflows have a very high seasonal variability, including having the lowest inflows in the winter when electricity demand is highest, utilization of reservoir storage is the primary method of shaping seasonal generation to correspond to the Railbelt's needs. Figure 12.2-2 shows that Susitna-Watana generation can be shaped to closely correspond to monthly Railbelt generation demand. Further improvement could be made with more detailed inflow forecasting methods.

Figure 12.2-3 is an hourly generation duration curve for the 61-year period of simulated operation. In the simulated operation, generation reaches a maximum of about 600 MW (606 MW generator output; 600 MW transformer output) during periods when the reservoir reaches or exceeds the maximum normal operating level at El. 2050 ft. Additional operating refinements would be expected to reduce the percentage of time the powerhouse operates at its maximum capability.

Figure 12.2-4 is a plot of hourly Susitna-Watana generation for the 15 month period of simulation from July 1, 1984 through September 30, 1985, which is the selected average water period for Susitna-Watana environmental studies that are in-progress. The intermediate load following operation is apparent by the repeated daily fluctuations in generation.

Table 12.2-1. Susitna-Watana Powerhouse Generation Potential (GWh)

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1950	196	228	262	266	231	200	168	156	154	154	177	169	2,360
1951	200	233	273	278	242	213	179	160	154	154	174	153	2,413
1952	195	227	261	263	228	235	235	246	240	217	191	170	2,708
1953	201	225	258	260	225	232	230	226	209	202	245	394	2,907
1954	204	227	261	264	229	237	237	238	223	212	176	270	2,776
1955	195	227	260	262	226	232	231	237	229	209	222	363	2,893
1956	198	227	262	266	231	239	240	244	221	203	390	429	3,149
1957	196	226	259	260	225	231	229	233	213	204	237	435	2,949
1958	245	225	255	254	219	225	221	222	209	202	345	196	2,817
1959	195	227	262	265	229	237	237	241	227	214	201	361	2,897
1960	224	226	260	261	225	194	161	146	175	166	279	435	2,751
1961	246	226	258	258	222	228	222	220	208	199	411	335	3,032
1962	213	227	260	262	226	232	229	231	210	305	450	376	3,220
1963	209	226	258	259	224	230	228	231	211	230	450	355	3,109
1964	210	226	260	263	228	236	236	246	225	210	312	240	2,892
1965	202	226	260	263	228	235	234	239	227	210	198	362	2,884
1966	260	228	263	266	231	238	238	246	234	218	188	178	2,786
1967	207	243	285	278	187	168	124	160	237	217	213	369	2,687
1968	197	227	261	263	227	232	229	233	213	200	356	236	2,873
1969	196	229	265	269	234	203	171	159	184	215	186	118	2,430
1970	104	119	139	139	119	103	105	131	155	162	172	169	1,617
1971	216	255	190	186	174	163	123	83	204	221	191	329	2,336
1972	206	226	258	259	223	229	225	224	203	268	450	366	3,137
1973	196	228	263	266	231	199	167	157	146	178	178	165	2,374
1974	198	231	269	274	239	209	178	167	154	166	185	166	2,435
1975	213	251	229	190	184	172	127	173	234	213	188	217	2,391
1976	237	226	260	264	229	236	236	239	229	219	192	186	2,753
1977	215	254	217	197	187	175	128	159	234	212	187	178	2,342
1978	196	226	259	260	224	193	159	143	155	167	202	200	2,384
1979	195	227	261	264	229	236	235	240	226	212	185	199	2,710
1980	222	225	256	257	221	227	223	224	213	201	450	347	3,067
1981	234	225	256	257	220	225	221	217	207	219	450	368	3,099
1982	199	225	257	258	223	229	226	228	216	206	227	302	2,795
1983	205	226	259	260	224	230	226	226	214	215	248	343	2,877
1984	248	225	257	257	221	226	221	222	211	207	387	245	2,926
1985	195	226	260	261	225	231	228	235	224	211	194	328	2,818
1986	212	226	260	262	227	195	162	149	185	234	196	293	2,601
1987	319	225	257	258	223	229	225	225	215	205	340	332	3,053
1988	195	226	260	262	226	233	230	230	212	199	347	343	2,964
1989	237	226	258	260	224	229	225	224	213	203	296	412	3,008
1990	245	225	258	260	224	230	225	215	193	417	450	435	3,377
1991	242	227	260	262	226	194	161	149	138	169	197	323	2,547
1992	209	227	260	262	226	194	160	149	140	148	326	273	2,574
1993	196	228	261	264	228	234	232	228	209	205	191	403	2,878
1994	279	225	257	257	221	227	222	219	207	194	402	248	2,957
1995	196	228	261	264	228	234	231	226	215	203	244	435	2,963
1996	224	226	260	263	228	196	163	153	162	177	183	166	2,401
1997	214	254	190	186	184	164	119	128	154	159	158	155	2,067
1998	203	237	277	281	246	218	137	114	154	156	160	191	2,374
1999	248	226	258	259	224	193	160	147	141	160	341	306	2,664
2000	216	226	258	260	224	230	227	231	217	200	322	357	2,969
2001	260	226	258	259	224	230	227	233	219	208	185	274	2,802
2002	195	227	261	263	228	196	163	151	165	175	170	273	2,468
2003	306	226	253	253	218	187	152	138	138	237	450	325	2,881
2004	260	226	260	262	227	233	232	223	205	198	282	191	2,799
2005	197	230	266	270	234	244	244	237	209	217	450	435	3,234
2006	267	226	260	263	227	234	232	236	223	211	229	327	2,935
2007	312	226	259	260	224	229	225	222	211	207	187	275	2,839
2008	198	227	259	260	225	193	160	145	147	164	314	384	2,678
2009	196	227	262	265	230	238	236	224	209	204	191	282	2,765
2010	218	226	258	260	225	231	229	225	212	205	272	386	2,947
Average	218	227	255	256	221	216	201	200	199	204	268	293	2,760
Maximum	319	255	285	281	246	244	244	246	240	417	450	435	3,377
Minimum	104	119	139	139	119	103	105	83	138	148	158	118	1,617

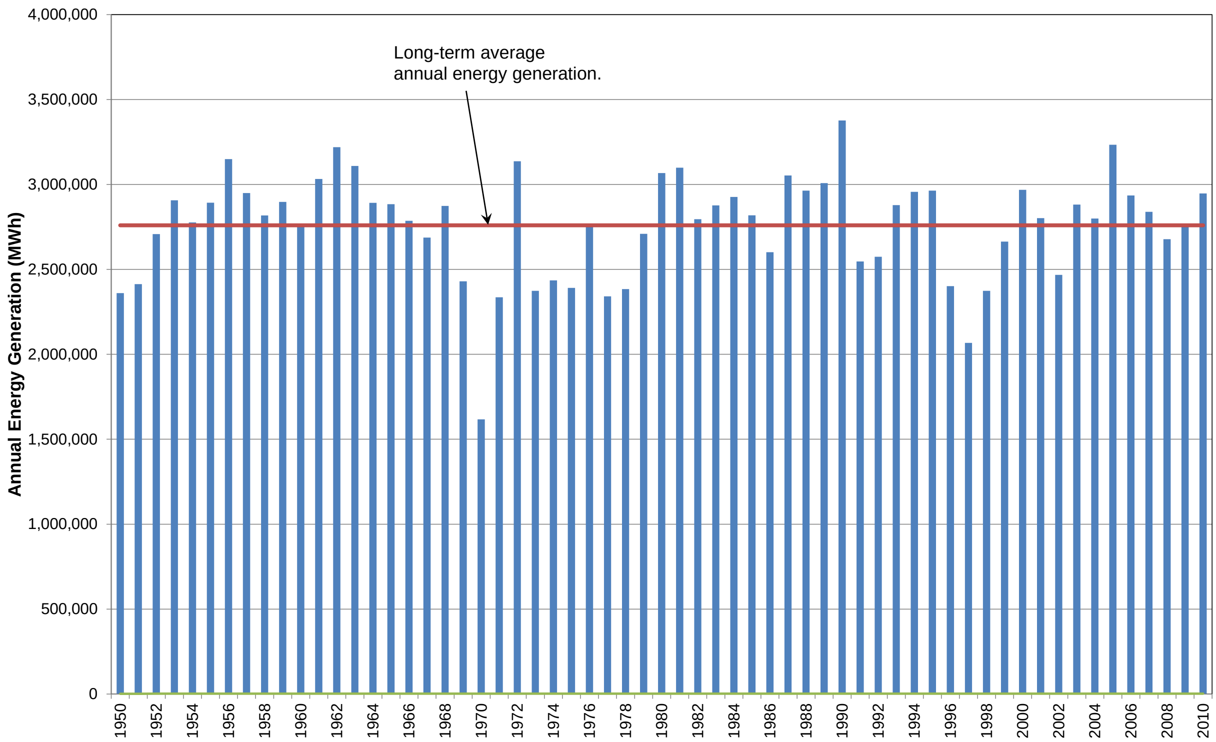

Figure 12.2-1. Annual Average Generation Potential (MWh)

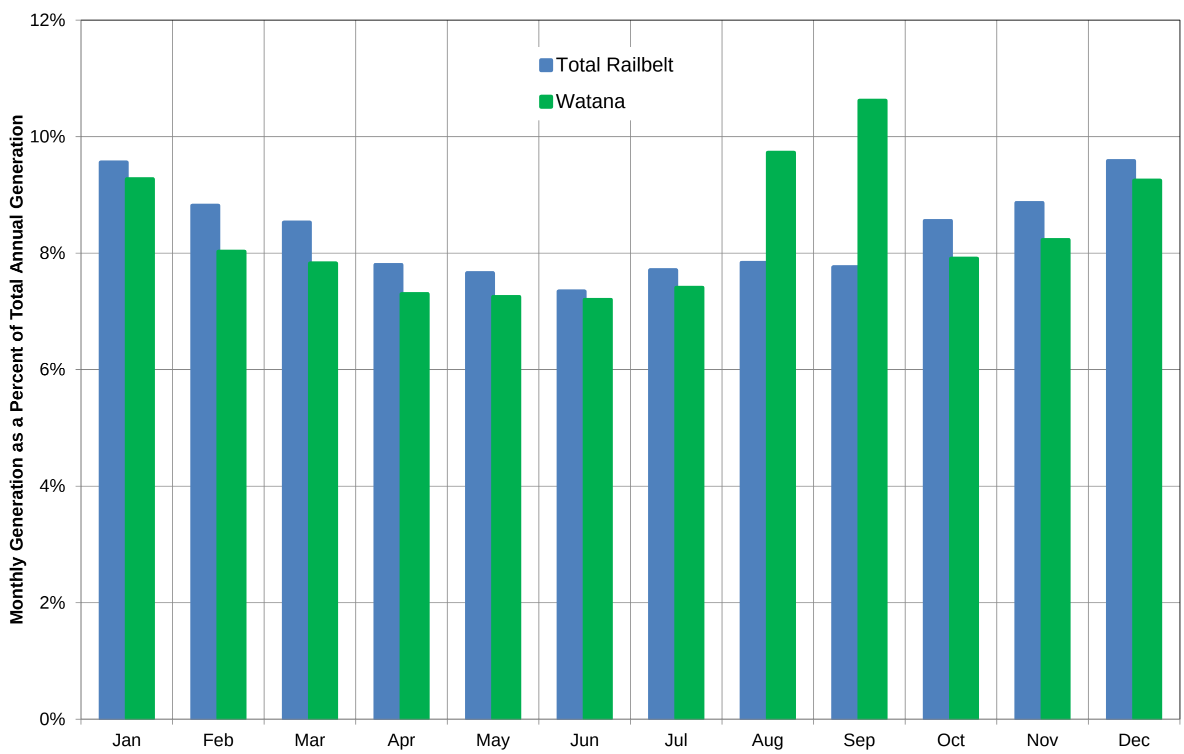

Figure 12.2-2. Comparison of Susitna-Watana and Total Railbelt Monthly Generation Pattern

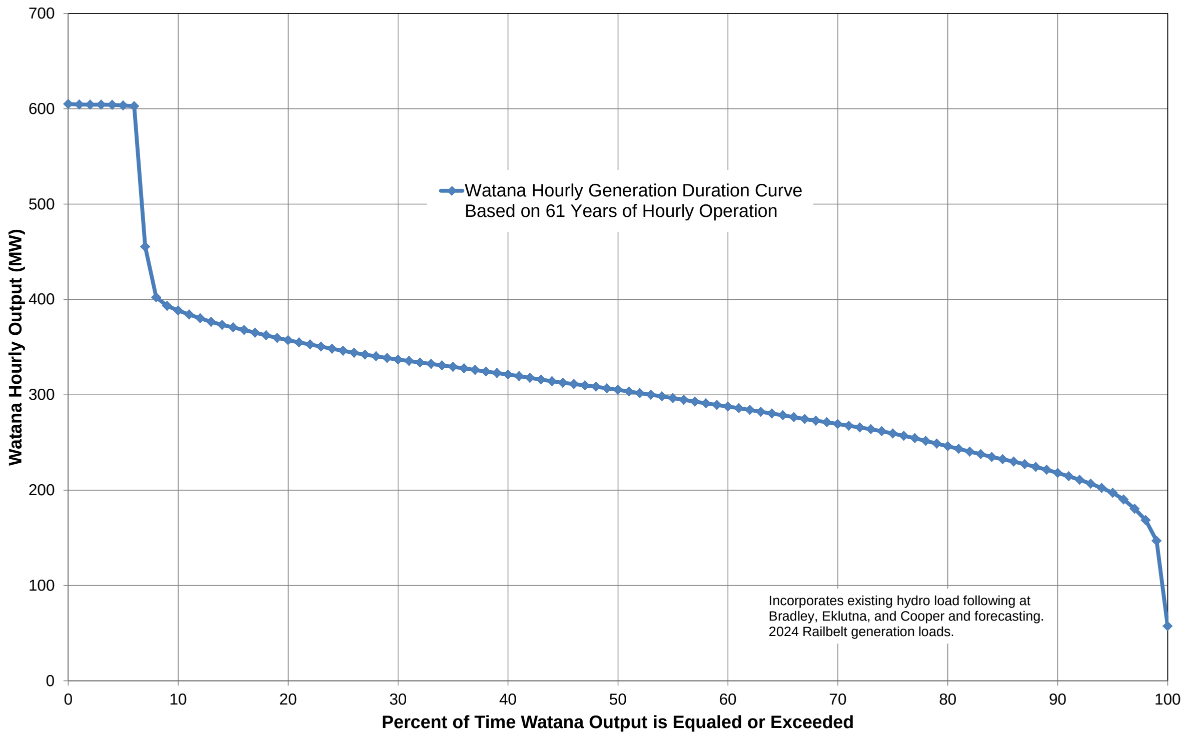

Figure 12.2-3. Modeled Susitna-Watana Powerhouse Hourly Generation Duration Curve

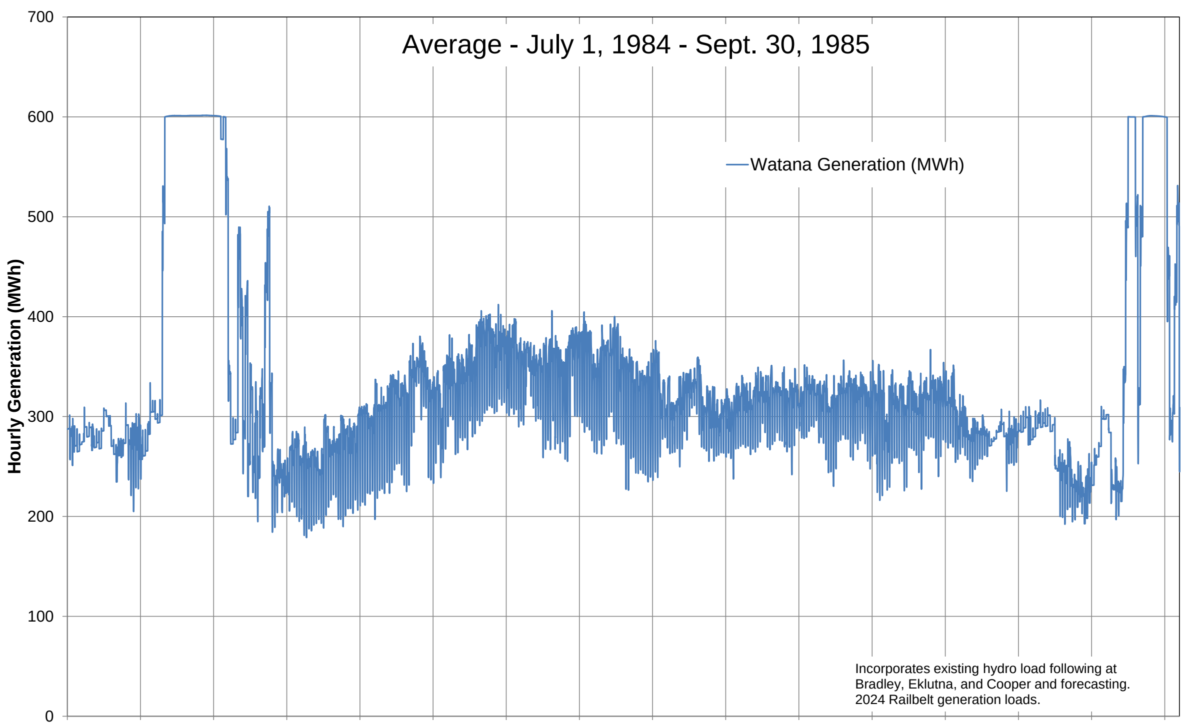

Figure 12.2-4. Modeled Hourly Susitna-Watana Generation for an Average Water Year

12.3. Downstream River Flows and Depths

Reservoir operations of the project will result in a seasonal shift of flows at Gold Creek as depicted on Figure 12.3-1 for long-term average monthly flows. Historical Susitna River average flows would be decreased under post-project conditions for the ice-free season from June through September. Based on the monthly average flows, a brief initial comparison of pre-project and post-project river depths at Gold Creek is provided in this section.

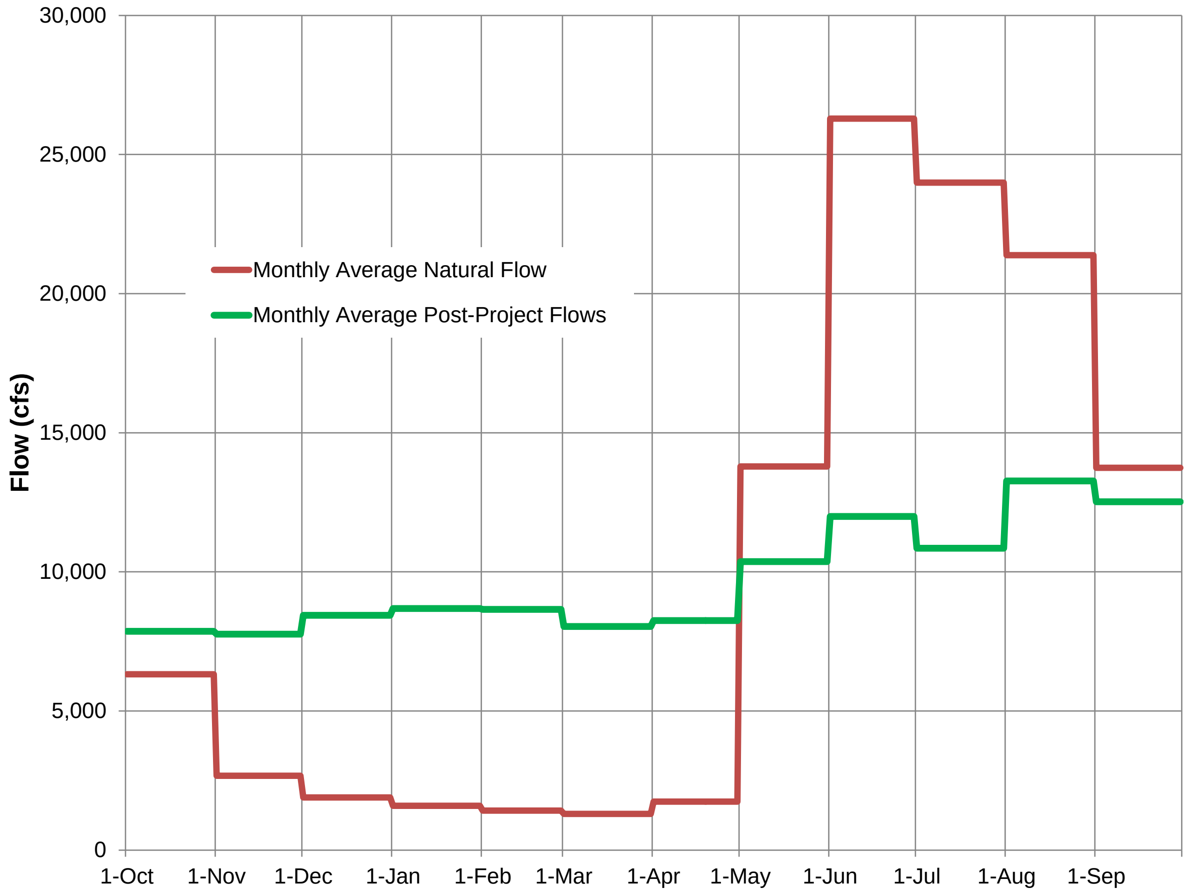

Figure 12.3-1. Monthly Average Natural and Modeled Post-Project Flows in the Susitna River at Gold Creek

The USGS regularly measures flows at cross-sections near Gold Creek to provide data for gaging station 15292000. The USGS provided cross-sectional data is shown on Figure 12.3-2 (with exaggerated vertical scale) for the flow measurement of 18,800 cfs that was made on August 15, 2013, along with the maximum and minimum water levels recorded on that day. For the purposes of this analysis, the river depth will be taken as the average of the deepest 50 ft. width. At the measured flow of 18,800 cfs, the indicated average depth in the deepest 50 ft. width of channel would be 12.4 ft.

Figure 12.3-3 provides a comparison of hourly average flow stages at Gold Creek for the August 15, 2013 day of flow measurement and a day (May 26, 1985) from the simulated intermediate load following case (ILF-1) that had a similar flow. The recorded average flow at Gold Creek on August 15, 2013 was 18,900 cfs and the simulated average flow on May 26, 1985 was 18,800 cfs.

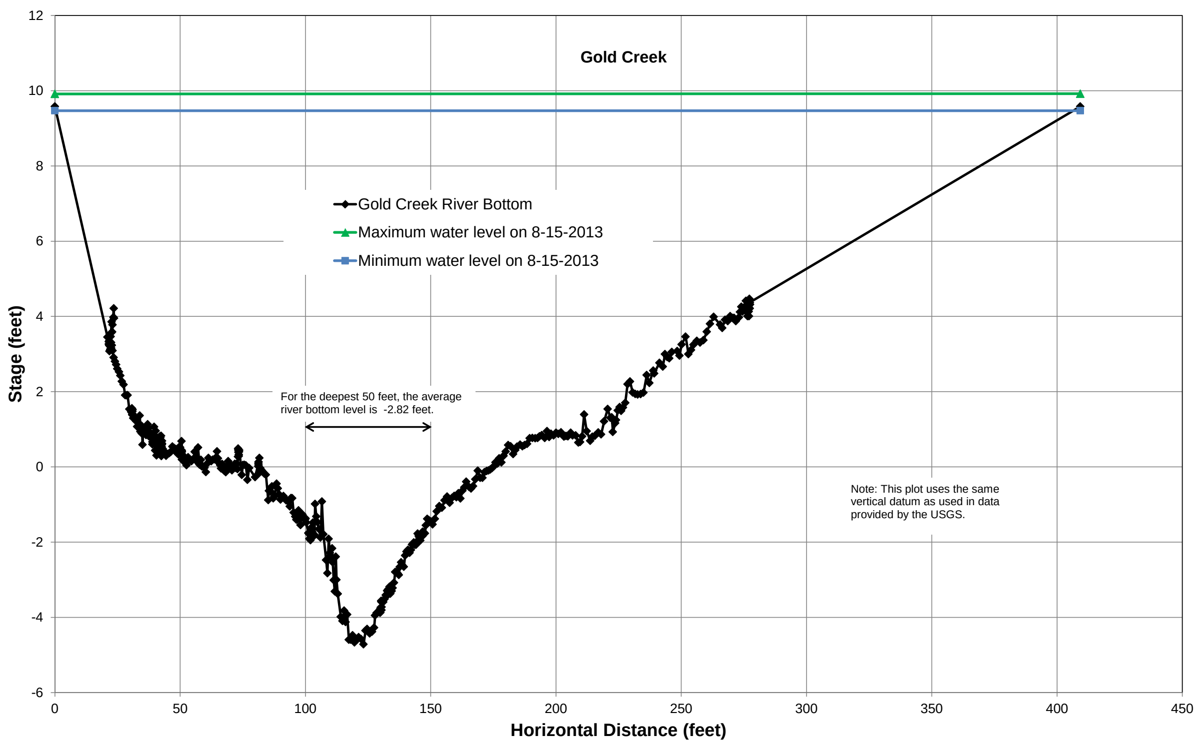

Figure 12.3-2. USGS Surveyed Cross-Section at Gold Creek

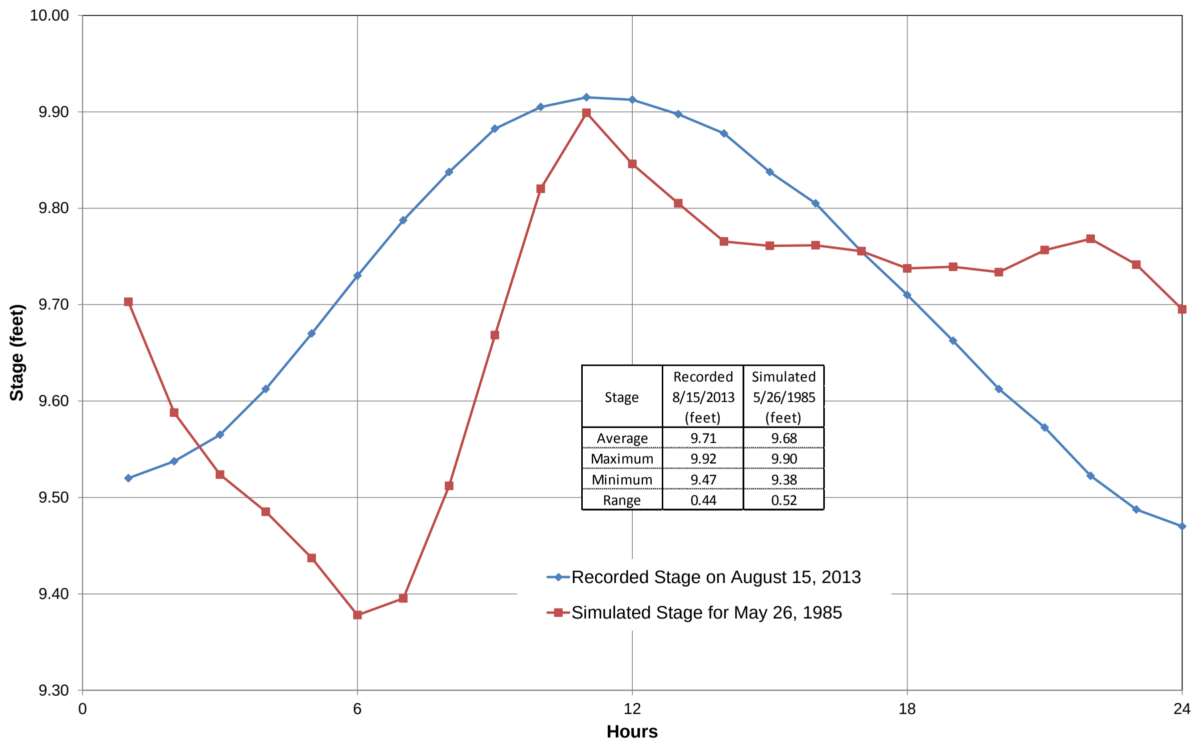

Figure 12.3-3. Recorded and Simulated Susitna River at Gold Creek Stage Comparison

Data provided in the previous two figures are for example days with comparable flow rates at one location. Flow and water level conditions will vary from day to day and from location to location. Table 12.3-1 provides the depths for pre-project and post-project average monthly flows at Gold Creek. The maximum depth reduction shown in Table 12.3-1 would be from 13.32 ft. to 11.05 ft. in June, which is a difference of 2.27 ft.

Table 12.3-1. Ice-Free Season Monthly Average Flows and Depths at Gold Creek

Month	Pre-Project Conditions			Post-Project Conditions		
	Flow (cfs)	Stage (feet)	Depth (feet)	Flow (cfs)	Stage (feet)	Depth (feet)
June	26,292	10.50	13.32	11,995	8.23	11.05
July	23,988	10.22	13.04	10,850	8.01	10.83
August	21,382	9.88	12.70	13,267	8.48	11.30
September	13,737	8.57	11.39	12,521	8.34	11.16