

E. R. O.

Report on
Annual Volume



STATE OF IDAHO
OFFICE OF THE ATTORNEY GENERAL
LAWRENCE G. WASDEN

May 7, 2007

Shelley Keen
Idaho Department of Water Resources
P.O. Box 83720
Boise, ID 83720-0098

Re: Transmittal of Analysis of the Annual Diversion Requirement for Water Right
Permit 63-09341

Dear Mr. Keen:

Please find enclosed an original copy of the analysis performed by ERO Resources Corporation regarding the diversion measurements of the Capitol Mall Complex geothermal heating system. If you have any questions, please do not hesitate to contact me at (208) 334-4549.

Sincerely,

A handwritten signature in black ink, appearing to read "D. Stanish", with a horizontal line underneath.

DAVID I. STANISH
Deputy Attorney General
Natural Resources Division

DIS/olv
Enclosure

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**ANALYSIS OF THE
ANNUAL DIVERSION REQUIREMENT
FOR WATER RIGHT PERMIT 63-9341**

Prepared for –

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May 3, 2007

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ANALYSIS OF THE ANNUAL DIVERSION REQUIREMENT FOR WATER RIGHT PERMIT 63-9341

MAY 3, 2007

Water right permit 63-9341 in the name of the State of Idaho Department of Administration is for year-round space heating within the Capitol Mall Complex and was issued on June 10, 1980. Proof of beneficial use was timely filed on May 6, 1985 and a field examination was conducted by IDWR on July 23, 1987. The field exam report was completed on January 13, 1988 with a recommendation for licensing of 1.79 cfs and 1,031 afa (336 million gallons per year) for diversion rate and volume respectively.

This permit is for the diversion of geothermal water from the Boise Front Low Temperature Geothermal Resource Ground Water Management Area. A moratorium on further development in the management area was established on June 10, 1988. The moratorium did not limit development under this permit since proof of beneficial use was filed prior to the moratorium order but it has limited development under other geothermal rights from the resource. As a result, no water right licenses for heating have been issued in the management area since its establishment.

The annual volume of water use under this permit was reevaluated by IDWR in 1995. The resulting Open File Report titled "Production History For The State Of Idaho Capitol Mall Geothermal System 1983-1994" by Kenneth W. Neely estimated the annual volume of geothermal water diverted under this permit to be 613.8 afa (200 million gallons per year) for 1993. The volume included a 10% increase in the calculated volume as an adjustment due to data Mr. Neely believed to be inaccurate or were missing. As a result of Mr. Neely's analysis, the diversion rate proposed to be licensed has increased to 2.19 cfs.

In 2007 Mr. Neely revisited his analysis of the 1993 diversion data for the Capitol Mall Geothermal System. Since his analysis in 1995, Mr. Neely has devised techniques for estimating values for missing or suspect geothermal diversion data. Mr. Neely applied his techniques to the 1993 Capitol Mall Geothermal System diversion data and recalculated the probable 1993 diversion volume to be 613.5 afa (199.9 million gallons per year). IDWR has declined to include an adjustment in the proposed volume for the remaining limitations acknowledged in Mr. Neely's 2007 reanalysis.

The questions remaining to be answered are 1) what is the extent of beneficial use developed during the permit period, 2) should the extent of beneficial use for heating of human inhabited areas be limited only to the system capacity, 3) should the extent of beneficial use be based upon the most heating intensive year of record at any time, not just during the permit period, or 4) should the extent of beneficial use be based upon a statistically likely heating intensive year even if that year has never before occurred? Based upon an answer to these questions, what is the extent of beneficial use of geothermal water by the Capitol Mall Geothermal System that should be licensed and how does that amount compare to 1993?

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The National Weather Service uses the statistic heating degree day (HDD) to provide a relative measure of the space heating required during a given day or year as compared to any other day or year. HDD is computed as the departure of the mean daily temperature less than 65°F. HDD data are available for the Boise Air Terminal weather station from 1940 through February 2007. Temperatures at the Boise Air Terminal will be different than temperatures at the Capitol Mall but the data from the Boise Air Terminal weather station should be suitable as a reference station for comparing the difference in temperature during different periods at the State Capitol Mall Complex.

For the year 1993 Boise Air Terminal weather station recorded 6,278 HDD. For the periods 1984, 1985 and from May 7, 1984 through May 6, 1985 the HDD for the Boise Air Terminal weather station are 6,961, 7,603 and 7,056, respectively.¹

The relationships from IDWR Administrator's Memorandum No. 23 can be used to compare the volume of water required in any year for which the HDDs are known to the volume of water diverted in 1993 as calculated by Mr. Neely. From Memorandum No. 23, design heat load is estimated by the equation:

$$E = [e \times \Delta T_d] \times A \quad (1)$$

Where: E = Design heat load in BTU/hr
e = Insulation efficiency of building(s) being heated
 ΔT_d = Design temperature difference for heating load (assume 70°F – 4°F for Boise)
A = Area being heated in square feet.

In this equation, if the design temperature difference (ΔT_d) were replaced by the HDD temperature amount (T_{HDD}), the result would be the average BTU/hr to heat an area A for a day rather than the design heat load for that area.

Also from Memorandum No. 23, the temperature drop of the geothermal water across the system is estimated by:

$$\Delta T_s = 0.3 \times (S - t) \quad (2)$$

Where: ΔT_s = The temperature drop of the geothermal water across the heating system
S = Geothermal water source temperature °F
t = Temperature required by the system °F

Finally, Memorandum No. 23 shows the flow rate for the geothermal water can be estimated by the equation:

¹ The data from the Boise Air Terminal weather station for the period 1940 through February 2007 are included on a CD accompanying this report.

$$W = \frac{Q}{500 \times \Delta T_s} \quad (3)$$

Where: W = Geothermal water flow rate in gallons per minute
 Q = Heat load in BTU/hr (E from above)²
 ΔT_s = The temperature drop of the geothermal water across the heating system

Substituting equation (1) into equation (3) and substituting T_{HDD} for ΔT_d equation (3) becomes:

$$W = \frac{[e \times T_{HDD}] \times A}{500 \times \Delta T_s} \quad (4)$$

Where equation (4) yields the gallons per minute needed to heat an area A , T_{HDD} degree days for a day.

If this equation were multiplied by 1,440 the result would be the volume of geothermal water in gallons per day to heat area A , T_{HDD} degree days for a day. Likewise, if T_{HDD} were the total degree days for a year the result would be the gallons of geothermal water to heat area A for a year.

Making these substitutions results in:

$$W_{AV} = \frac{[e \times T_{HDDY}] \times A \times 2.88}{\Delta T_s} \quad (5)$$

Where: W_{AV} = The annual volume of geothermal water to heat area A in gallons
 T_{HDDY} = Total heating degree days for one year °F

Substituting the 1993 values of diversion volume and HDD into equation (5) results in a combined value for e , A times 2.88 divided by ΔT_s of 31,841 $((199.9 \times 10^6)/6278)$. The heated area, building efficiency and temperature drop across the system must be assumed to remain the same between 1984 and 1993 to relate the diversion volume in 1993 to the diversion volume in earlier years.³

² Q is normally used to refer to a flow rate of water. In this case, to be consistent with IDWR Administrator's Memorandum No. 23, Q refers to heat load in BTU/hr and is the same as E from equation (1).

³ Although there appears to be a small decline in the temperature of the geothermal water from 1983 to 1994, both 1984 and 1985 show fluctuations that deviate from a uniform decline. A separate evaluation of the effects these fluctuations had on the geothermal water requirements in 1984 and 1985, if any, appears to be beyond the scope of this report.

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Using equation (5) and the constant 31,841 the total volume of geothermal water required to heat the Capital Mall Complex for various periods is shown in the table below. This table is provided to aid IDWR in issuing a license for water right permit number 63-9341.

Year	HDD	Million Gallons	AFA
1993	6,278	199.9	613.5
1984	6,961	221.6	680.1
1985	7,603	242.1	743.0
5/7/84 - 5/6/85	7,056	224.7	689.6

The volume of water that is normally licensed for irrigation purposes is based upon a selected reoccurrence interval of the irrigation requirement for the most water consumptive crop grown in the area. The volume of water licensed is not based upon either the actual crop raised or the water requirement for that crop during the permit development period. A similar approach could be used to develop a standard for the volume of water for geothermal heating of areas occupied by humans.

One possible standard is to recommend the volume of water needed to provide heat during the most heating intensive, highest HDD, year of record (i.e., 1985). As with irrigation, it would not matter whether the highest demand year occurred during the permit period so long as the system is capable of delivering the volume of water recommended.

Another possible standard is to recommend the quantity of water for the year that is statistically likely to occur based upon the available HDD record. The HDD record for the Boise Air Terminal weather station has a mean of 5,700 HDD and a standard deviation of 469.2 HDD. Typically, the mean ± 4 standard deviations of a sample data set is assumed to include 99.94% of the population. In this case, the mean $+4$ standard deviations ($5,700 + 4(469.2)$) equals 7,576.8 HDD, slightly less than the actual 7,603 HDD from 1985.

Borse Air Terminal
Weather Station
1940-2007