IN THE OFFICE OF THE STATE ENGINEER

IN THE MATTER OF APPLICATIONS 47166,) 47167 AND 47168 FILED TO APPROPRIATE) THE PUBLIC WATERS OF AN) UNDERGROUND SOURCE IN BRADY'S HOT) SPRINGS AREA, CHURCHILL COUNTY,) NEVADA.)

RULING

GENERAL

Application 47166 was filed on August 18, 1983, by Munson Geothermal, Inc., to appropriate 5.0 c.f.s. of water from an underground source for industrial and domestic purposes within Section 12, T.22N., R.26E., M.D.B.&M. The point of diversion is described as being within the NW1/4 NE1/4 Section 12, T.22N., R.26E., M.D.B.&M.[1]

Application 47167 was filed on August 18, 1983, by Munson Geothermal, Inc., to appropriate 5.0 c.f.s. of water from an underground source for industrial and domestic purposes within Section 12, T.22N., R.26E., M.D.B.&M. The point of diversion is described as being within the SW1/4 NE1/4 Section 12, T.22N., R.26E., M.D.B.&M.[1]

Application 47168 was filed on August 18, 1983, by Munson Geothermal, Inc., to appropriate 5.0 c.f.s. of water from an underground source for industrial and domestic purposes within Section 12, T.22N., R.26E., M.D.B.&M. The point of diversion is described as being within the SE1/4 SW1/4 Section 12, T.22N., R.26E., M.D.B.&M.[1]

Applications 47166, 47167 and 47168 were timely protested by Geothermal Food Processors, Inc., on the following grounds:[1]

> "Nevada water laws provide protection of prior rights for water users. Geothermal Food Processors, Inc., (GFP) has acquired prior rights to the water and has valid permits to appropriate additional water. Geothermal fluid is used by GFP to heat air which is used for drying vegetables. The granting of Application No. 47168,

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[1] Public record in the office of the State Engineer under Applications 47166, 47167 and 47168.

together with Application Nos. 47166 and 47167, will interfere with GFP's rights by depriving it of sufficient water to carry on its current and anticipated operations.

Cooled geothermal fluid, the only water available at the site, is used for cleaning the raw vegetables as they enter the drying process. GFP is concerned that the drilling of test holes and wells near the plant site will contaminate the geothermal fluid which is ultimately used to clean the vegetables prior to drying.

GFP has expended several million dollars to develop the geothermal food processing plant. The development of geothermal energy by GFP as an alternate source of energy has been and will continue to be of great benefit to the State of Nevada. The granting of Application No. 47168, together with Application Nos. 47166 and 47167, will jeopardize the continued operation of the processing plant and the jobs of the employees employed at the processing plant.

GFP is undertaking extensive studies for establishing additional uses of geothermal resources at the site for food processing and development. The additional uses of geothermal resources that may be developed from such research has the potential of further benefiting the State of Nevada and its citizens. The granting of Application No. 47168, together with Application Nos. 47166 and 47167, will jeopardize this research and development program.

Preliminary pumping studies indicate that the potential drawdown of the geothermal resource as a result of sustained pumping, over and above the permits held by Protestant, will cause the geothermal resource to be mined to an elevation which will make it uneconomical for Protestant to extract such resource for the

purpose of continuing its present food drying operation."

The protestant requested that Applications 47166, 47167 and 47168 be denied.

Under the remarks secton (Item No. 12) on Applications 47166, 47167 and 47168, the applicant indicated these filings were made to provide production and cooling water for a geothermal power plant and associated uses.

A public administrative hearing was held before the State Engineer on October 28, 29 and November 4, 1985, to receive additional evidence and testimony in the matter of protested Applications 47166, 47167 and 47168.

FINDINGS OF FACT

I.

Application 47167 was withdrawn by counsel for Munson Geothermal, Inc., (hereinafter "MGI") during the opening remarks at the administrative hearing on October 28, 1985. The estimates made by MGI for total combined withdrawal and for total consumption proposed by the subject three (3) applications were, therefore, reduced by 1/3.[2]

II.

Geothermal Food Processors, Inc., (hereinafter "GFP") is the owner of record of seven (7) well permits on five (5) wells. Proof of beneficial use has been filed on Permits 29511, Certificate 10559, and on Permit 29512, Certificate 10560, for a diversion rate of 1.56 c.f.s. each and a total consumption of 473.31 acre-feet each for the period of June 1st to October 31st of each year. Permits 44643, 44644, 44645, 44646 and 44647 allow a diversion rate of 5.0 c.f.s. each and a consumptive use of 181.0 acre-feet each annually with the remaining 95% of water withdrawn to be returned to the source as a condition of the permits. Permits 29511 and 44646 cover the same well, commonly known as Brady No. 5. Permits 29512 and 44646 cover the well known as Brady No. 8. Permits 44643,

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[2] Transcript of public administrative hearing before the State Engineer, October 28, 1985, pp. 8 - 9 (hereinafter "Transcript", date and page).

44644 and 44645 are filed on three (3) other existing wells. Permits 44643 through 44647, inclusive, are presently in good standing with proof of beneficial use due on March 1, 1988. These five (5) wells are located within the SE1/4 NW1/4 Section 12, T.22N., R.26E., M.D.B.&M.[3]

III.

Protestant, GFP, presented testimony indicating significant declines in water levels in the GFP well known as Grace No. 1 (Permit 44643), that would result over a 15 to 20 year period under various pumping conditions. Protestant entered into the record a mathematical model of the geothermal system at Brady's Hot Springs Area that was used to simulate drawdowns at Grace No. 1, under certain pumping conditions, utilizing both the GFP and MGI wells. This model utilized equations developed by Theis for confined aquifers.[4]

Protestant's use of the methods developed by Theis, to predict aquifer response to long term pumping required certain assumptions be made concerning aquifer characteristics.[5] Protestant's witness testified that the transmissivity and storativity values used in the model were good estimates and are within the correct order of magnitude.[6] However, the witness further testifed that a number of other assumptions made when utilizing the Theis ideal aquifer system do not apply at Brady's.[7] One of these assumptions is that the aquifer must be infinite in areal extent or at least infinite acting[8] so that the expanding cone of depression developed upon pumping does not

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[3] Permit 29511, Certificate 10599; Permit 29512, Certificate 10560; Permits 44643, 44644, 44645, 44646 and 44647 are public record in the office of the State Engineer.

[4] Transcript, October 28, 1985, pp. 110 - 118. Protestant's Exhibit "G".

[5] Transcript, October 28, 1985, p. 119.

[6] Transcript, October 29, 1985, pp. 107-108, 112, 162.

[7] Transcript, October 29, 1985, pp. 119 - 120.

[8] Transcript, October 29, 1985, pp. 119, 124.

encounter any boundaries, either recharge boundaries or impermeable boundaries.[9] Protestant's witness testified that this assumption does not apply at Brady's due to the existence of the Brady Fault which will create a boundary effect when the cone of influence created by pumpage encounters the fault.[10] Protestant's witness then emphasized that the model presents an order of magnitude effect from producing wells at Brady's, and that if the hydraulic conditions in the field are less favorable than those assumed for the use of the Theis model, the resulting impacts will be proportionately greater.[11] The State Engineer finds that the utilization of the Theis equations, which were designed for a confined aquifer, is inappropriate for the Brady's Hot Springs area and as further set forth in the following findings.

IV.

A number of exhibits on the geology and on reservoir analyses generated from pumping tests conducted at Brady's were offered and received into evidence at the hearing.[12] Testimony on behalf of both MGI and GFP made repeated references to a report on well testing at Brady's, prepared by GeothermEx, Inc., in April 1981 which is the most recent reservoir analysis to date. This report states that the test results "indicated a complex, fault recharged system with fairly high transmissivity and storativity", and further described "this reservoir as a large reservoir fed by hot fluid moving up from depth along a fault".[13] The report emphasized that, since no impermeable boundaries[14] were encountered during the test together with the fact that

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[9] Transcript, October 29, 1985, p. 126.

[10] Transcript, October 29, 1985, pp. 124, 127.

[11] Transcript, October 29, 1985, pp. 130 - 131.

[12] See Index of Exhibits, Transcript, October 28, 1985, pp. 3 - 4.

[13] Applicant/Protestant Joint Exhibit No. 4, GeothermEx Report, p. 23.

[14] Applicant/Protestant Joint Exhibit No. 4, GeothermEx Report, p. 23.

the water levels in most of the wells at the end of the recovery period were within a few feet of the original level before production ever started, despite substantial volumes of fluid produced from the reservoir just prior to and during the test,[15] that it was reasonable to describe the reservoir as large.[16]

GeothermEx noted an "indication of recharge from Brady's fault" in two observation wells during the latter part of the flow test,[17] and that the temperature of the water produced gradually increased during the test.[18] GeothermEx further explained "...that heating up of the water may have been due partly to the recharge of hotter fluid from Brady's Fault".[19]

Due to the limitations involved in this particular test program,[20] GeothermEx was unable to use certain analytical techniques in their report. Future water level declines were, therefore, described by GeothermEx in terms of straight-line extrapolations taken from the actual drawdown rates during the test.[21] The report then qualified the large predicted drawdown noting the actual water level declines "will be far less" for several reasons, two of which are noted here:

> "2. It is most likely that, as pressure declines, recharge from Brady's Fault will be more significant and will help arrest water level decline.

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[15] Applicant/Protestant Joint Exhibit No. 4, GeothermEx Report, p. 24.

[16] Applicant/Protestant Joint Exhibit No. 4, GeothermEx Report, p. 25.

[17] Applicant/Protestant Joint Exhibit No. 4, GeothermEx Report, p. 23, Figures 6, 10, 11 and 13.

[18] Applicant/Protestant Joint Exhibit No. 4, GeothermEx Report, p. 23.

[19] Applicant/Protestant Joint Exhibit No. 4, GeothermEx Report, p. 23.

[20] Applicant/Protestant Joint Exhibit No. 4, GeothermEx Report, p. 5.

[21] Applicant/Protestant Joint Exhibit No. 4, GeothermEx Report, pp. 23 - 24.

3. Injection of waste water in the reservoir can arrest the water level decline very effectively."[22]

These conclusions appear to be technically sound.

V.

Applicant MGI presented testimony that included a review of a pumping test analysis conducted in 1977 and prepared by J. M. Rudisill. It is noted in Figure 4 of the Rudisill Report that about 150 hours into the test the water level changes in the observation well flattened out and remained relatively constant through the remainder of the test.[23] The State Engineer agrees that this represents a constant pressure boundary that exists somewhere in the reservoir "...which is no doubt the fault itself, that is really going to govern the water level changes we'd expect to see with time in the reservoir".[24] One of the four conclusions reached by Rudisill from the test was:

"(3) From the drawdown curves..., it appeared that the shallow reservoir being drawn upon is being fed by a deep, vast reservoir (probably deep circulating up the Brady Thermal Fault) which would cause the pressure decline of the field to slow greatly over time. The build-up behavior of the wells confirmed the recharging ability of the system...."[25] (Emphasis added.)

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[22] Applicant/Protestant Joint Exhibit No. 4, GeothermEx Report, p. 24. See also pp. 19 - 20.

[23] Transcript, October 29, 1985, pp. 279 - 280.

[24] Transcript, October 29, 1985, p. 280.

[25] Applicant/Protestant Exhibit No. 6, Rudisill Report, pp. 2 - 3.

The fault allows access to a large, vast reservoir[26] and when pressure declines are created (by pumpage) in the shallow aquifer itself, the fault is allowed to feed additional fluid to the system.[27] Applicant's witness also confirmed the interpretation of the data by GeothermEx that a constant pressure boundary will be controlling water level declines in the system.[28]

VI.

Applicant's witness testified that, given the data that exists for the system at Brady's, it is not appropriate to use the Theis formula to predict long-term drawdowns and one could not make that extrapolation with a very high level of confidence from data generated during a relatively short-term test.[29] Applicant's witness concluded that the data shows that the "reservoir is connected and obviously there will be some effect between the wells when production begins", but that there is "no way to quantify the numbers right now".[30] Applicant's witness emphasized that the best possible strategy[31] to pursue in these "dynamic", fault fed systems is to flow wells for a long period of time and have monitor wells associated with the producing wells and base the development strategy on how the system responds with real time.[32] The State Engineer agrees.

Protestant's expert witness testifed, under cross examination, that if one were to "assume that the fault is a constant head boundary, there is minimum drawdown, much less than that (Theis model) because it will act as a nonfluctuating source...".[33]

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[26] Transcript, October, 29, 1985, p. 270.

[27] Transcript, October 29, 1985, p. 266.

[28] Transcript, October 29, 1985, pp. 295 - 296.

[29] Transcript, October 29, 1985, p. 296.

[30] Transcript, October 29, 1985, p. 309.

[31] Transcript, October 29, 1985, pp. 273 - 274.

[32] Transcript, October 29, 1985, p. 274.

Protestant's use of the Theis model to predict drawdowns did not take into account any recharge effects of injection wells.[34]

CONCLUSIONS

I.

The State Engineer has jurisdiction of the parties and the subject matter of this action and determination.[35]

II.

The State Engineer is prohibited by law from granting a permit under an application to appropriate the public waters where:[36]

A. There is no unappropriated water at the proposed source, or

B. The proposed use conflicts with existing rights, or

C. The proposed use threatens to prove detrimental to the public interest.

III.

Evidence and testimony presented at the hearing and other data and information available to the State Engineer supports the concept that the hydrology of Brady's consists of a relatively shallow series of semi-confined aquifers bisected by a large northeast trending fault. This fault is actually feeding thermal water from depth and along its length up and into the shallow aquifers. The Brady Thermal Fault acts as a constant pressure head or recharge boundary in the aquifer system and, as pressure declines occur in the aquifer system, additional fluid is allowed to flow in the direction of this increased gradient. The rate of recharge may continue to increase up to a complete balance with the rate of production.

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[33] Transcript, October 28, 1985, p. 156.

[34] Transcript, October 28, 1985, p. 131.

[35] NRS 533.025, 533.030 and 533.325.

[36] NRS 533.370, subsection 3.

IV.

The fact that the Brady Fault exists as a recharge boundary was not addressed by protestant's testimony nor was it accounted for in their use of a mathematical model to predict drawdowns resulting from long term pumpage. Evidence and testimony available to the State Engineer support the technical conclusion that the drawdowns predicted by the Theis equations should be far less due to the recharge boundary condition.

V.

The relatively shallow aquifer system itself may appear limited, but being hydraulically interconnected with a large fault along its length and along its height or depth allows access to a vast reservoir of geothermal water.

VI.

Even if the Brady Thermal Fault does not supply a recharge rate to exactly balance the production rate, it will provide at least partial recharge so that the rate of water level decline will be greatly reduced with time and with proximity to the recharge boundary. The extent and limit of the recharge can be quantified with effective monitoring of pressure, temperature and water level responses.

VII.

Since the Brady Fault is feeding thermal water under pressure and from great depth, it is likely that the fluids produced from the reservoir will remain constant or, at the most, be subject to reasonable long term temperature effects.

VIII.

Protestant's used the logic that, if hydraulic conditions in the field are less favorable than those assumed for the use of the Theis model, the resulting impacts will be proportionately greater. Conversely, the evidence supports the existence of a recharge boundary at Brady's which creates a much more favorable field condition than assumed for the Theis model and should result in proportionately smaller impacts.

IX.

Injection of used geothermal fluids can provide reservoir pressure support through artificially recharging the reservoir at times and in areas necessary to protect minimum needed water levels in production wells of all users of the resources.

X.

The recharging ability of the system at Brady's, together with the judicious placement and utilization of injection wells and with all other evidence available to the State Engineer, supports the conclusion that the proposed use under Applications 47166 and 47168 will not conflict with existing rights nor threaten to prove detrimental to the public interest. To insure protection of existing rights, the State Engineer will require that all data on pressure/water level and temperature responses during development and production of applicant's wells be submitted to the State Engineer on a timely basis.

RULING

The protests to the granting of Applications 47166 and 47168 are herewith overruled based on the record of evidence that the proposed use will not conflict with existing rights nor threaten to prove detrimental to the public interest. Permits will be issued under applications 47166 and 47168 upon receipt of statutory permit fees, subject to the following terms and conditions:

1. Subject to all existing rights on the source.

2. A resource management and monitoring plan will be submitted to the State Engineer for approval prior to any withdrawal and use of the geothermal fluids.

3. All spent fluids will be reinjected into the same aquifer as they are withdrawn.

4. Consumptive use will be limited to 20% of the fluids withdrawn.

5. All data on pressure, temperature and water level responses will be submitted to the State Engineer on a semi-annual basis.

6. The combined withdrawal of fluids under Applications 47166 and 47168 shall be limited to 2467 acre-feet.

7. All energy generated by the approval of these permits is subject to recapture for use within the State of Nevada under the provisions of NRS 533.372(1).

8. The State Engineer reserves the right to further regulate the withdrawal of geothermal fluids under the subject permits upon a demonstration of unreasonable adverse effect on existing rights.

Respectfully submitted,

PETER G. MORROS
State Engineer

PGM/TKG/bl

Dated this 20th day of

December, 1985.