TECHNICAL MEMORANDUM

To File TOWN OF SILVER CITY/AIRPORT WELLS March 1, 2011

From Dave M. Romero, P.H.

Subject HYDROLOGIC EFFECTS OF WELLFIELD USE IN AREA OF GRANT COUNTY AIRPORT

Introduction

The Town of Silver City (the Town) provides water to approximately 20,000 residents in the Town and to the local water associations of Pinos Altos, Tyrone, Rosedale and the Arenas Valley. The principal aquifer that supplies the Town water system is the Gila Group aquifer, as described by Hawley and others (2000, Plate 1). Over the last five years, the Town has diverted an average of 2,700 acre feet per year (AFY) from its wells to meet municipal water demand. Water routed through the Town distribution system is returned to the wastewater treatment plant (WWTP), which discharges approximately 1,400 AFY, of which 755 AFY is released to San Vicente Arroyo southeast of the Town. On December 27, 2010, the Town authorized Balleau Groundwater, Inc. (BGW) to quantitatively assess the hydrologic effects to the regional aquifer system from diverting groundwater in the area of the Airport wells. This document provides the findings of that assessment.

The Town's water supply is provided by wells located a few miles southwest of Town. The wells are known as Frank's wellfield, the Woodward wellfield, the Gabby Hayes well and the Anderson well (Figure 1). The Town is interested in developing groundwater in the area of the Grant County Airport to facilitate and regionally expand its municipal water system to potentially include the towns of Santa Clara, Bayard and Hurley. The Town currently has a New Mexico Office of the State Engineer (OSE) permit (M-2846) for diversion of 193.2 AFY from two undrilled wells in the area of the Grant County Airport (hereafter the airport well site).

Other wells in the area of the Grant County Airport are prospective for diverting water to supply a regional water system and the Town is considering potential options. For example the Stark wellfield (OSE permit M-5068 et al) is located about four miles southeast of the Airport wells. Specific details of the Stark well infrastructure are uncertain, but the wells are connected to a pipeline that routes water north toward the Town of Hurley. Figure 1 shows a general locality map of the Town, the existing Town wells, the Airport well sites and the Stark wellfield.

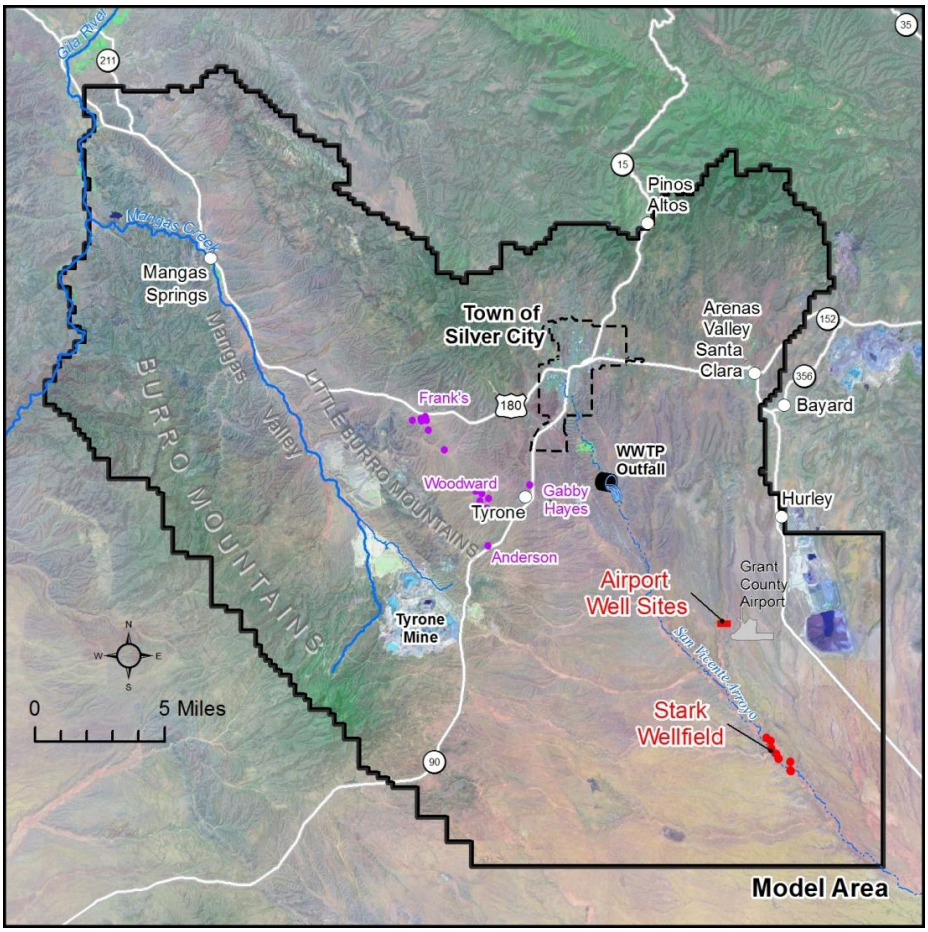

Figure 1. Locality map.

The Town is considering applying for administrative return flow credit with the OSE for use in conjunction with diverting water from the airport wells, or potentially from other wells in the airport area. A recent study conducted by the Town (BGW, 2010) indicates potential for

return flow credit in the amount of 99 percent of the quantity discharged into San Vicente Arroyo from the Town's WWTP.

The analysis below considers three options, one in which groundwater is developed from the location of the Airport wells, a second in which the water supply is diverted from the Stark wellfield, and a third with groundwater developed from both wellfields combined. If the Town plans to move forward in a setting similar to that described above, there are a number of factors to consider that are beyond the scope of this document with regard to regional water system expansion, OSE approval of return-flow credit and potential use of wells under other ownership. However, for planning purposes we have analyzed three scenarios that depict development of groundwater in the area of the Grant County Airport to provide context for the change to the hydrologic system that can be reasonably expected to occur if groundwater is developed in that area.

Technical Approach

BGW developed a model (the model) of the aquifer system in the region of the Mangas Trench (Trauger, 1972, p. 22) that accounts for the groundwater diversions from the Town wellfields and for regional water use of others. The OSE has developed two earlier versions of groundwater flow models in the same general area; Hathaway (1986) and Johnson (2000) each developed two-dimensional models to assess hydrologic effects from proposed transfers of groundwater rights. The model used herein builds on the previous work of the OSE. It is a three-dimensional model to account for deep municipal well pumping and shallow recharge to the water table. The model provides a mathematical simulation method for examining the change in aquifer conditions resulting from historical groundwater development and for estimating the magnitude of water-level change caused by specific water uses. The model is based on the U.S. Geological Survey (USGS) MODFLOW 2000 program (Harbaugh and others, 2000). The model was calibrated to approximately match water-level trends observed in the areas of the existing Town wells. Documentation of the model is under development. The model area is shown on Figure 1. The model is in a form suitable for the analysis described herein.

Analysis of Groundwater Development

In regard to the Town's interest in developing groundwater in the area of the Grant County Airport, we analyzed three example scenarios of well use: 1) groundwater diverted at the site of the permitted airport well site, 2) groundwater diverted at the site of the Stark wellfield and 3) groundwater diverted from both the airport and Stark wellfield sites combined. Each scenario accounts for return flow associated with effluent discharge to San Vicente Arroyo from the Town's WWTP. A new OSE permit for groundwater use could reasonably involve annual well diversions in an amount equal to the quantity of water that is returned to the Gila Group aquifer by the Town at the site of the WWTP. Over the last five years, we estimate that the average recharge to the Gila Group aquifer from the Town's WWTP is about 750 AFY (BGW, 2010). Accordingly, each scenario represents a groundwater diversion in the amount of 750 AFY and a corresponding return flow to the aquifer of 750 AFY, over a future 40-year period. The actual quantity of return flow that will occur in the future is dependent on the actual quantity of the Town's future water demand and on plans for water re-use, which are uncertain. For planning purposes, we analyze the future change to regional water levels from both return flow and groundwater pumping in the constant amount of 750 AFY as an exercise of return flow credits.

Diversion from Airport Wells

The airport well site is shown on Figure 1. The two wells are currently undrilled; we simulated two wells drilled to a depth of approximately 1,000 feet. The wells are permitted to divert up to 193.2 AFY, but approved return flow credit would allow increased diversions. The analysis quantifies the hydrologic effect of additional pumping (750 AFY) above existing permits in conjunction with return flow credit (i.e. approval of return flow credit in the amount of 750 AFY would allow diversions up to 943.2 AFY). The projected change to water levels, after 40 years of pumping and return flow operations, is shown on Figure 2.

The red contours on Figure 2 represent the 40-year drawdown associated with diverting 750 AFY from the airport wells (375 AFY per well); the blue contours represent the water-level rise from 750 AFY of return flow. The results indicate that about one mile from the airport wells,

drawdown is up to about 15 feet; at distances greater than one mile, drawdown is less than 15 feet. Diverting 750 AFY from the airport wells causes about two feet of drawdown at the site of the Stark wellfield, which is about four miles away. The Apache wellfield, about two miles east of the airport well site, is the nearest water use permitted for commercial and industrial purposes; drawdown in that area is less than five feet. Water-level rise from return flow in the area of San Vicente Arroyo is on the order of 20 feet near the WWTP.

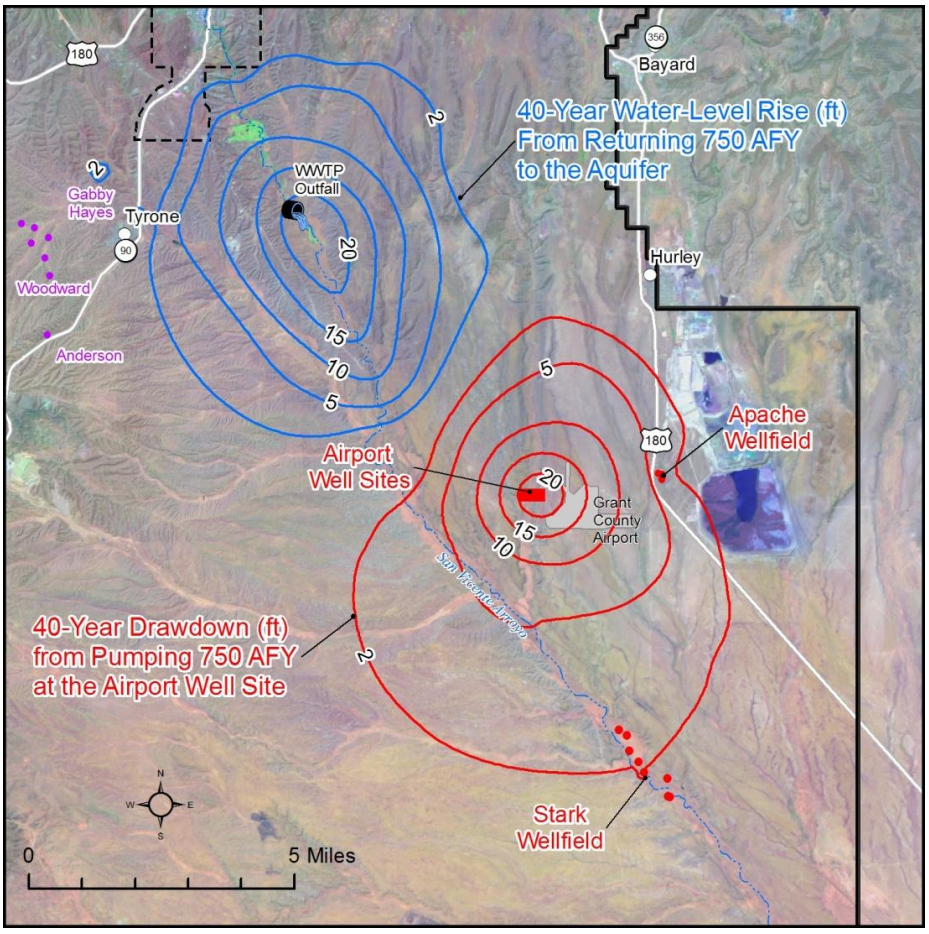

Figure 2. Water-level change from airport well use.

Diversion from Stark Wellfield

The example scenario for analyzing water-level changes from diverting 750 AFY from the Stark wellfield is the same as the scenario above, except for diverting the water from the Stark wellfield instead of from the airport well site. The Stark wellfield has eight wells; four were

drilled in the mid-1940s and four were drilled in the mid-1960s. Specific details of the Stark wellfield are shown on Table 1 (attached). Well depths vary from 375 to 512 feet. The wells are authorized for use under a June 4, 1974 Court Order of the Sixth Judicial District in and for Luna County, No. 6326, Subfile No. 766. The wellfield is authorized for use up to 2,581 AFY in any one year but not to exceed 12,000 acre feet in any five year period. The Court Order places caps on individual well diversions of 300 gallons per minute (gpm) on all of the wells, except for Well 8 which can divert up to 400 gpm. The total diversion from all wells combined cannot exceed 1,600 gpm. As shown on Table 1, the Court Order also assigns priority dates to well diversions. For the analysis herein, additional pumping of 750 AFY at the Stark wellfield is expected to be under a new permit that relates to return flow from the Town's WWTP. The 1974 Court Order imposes restrictions on well use; however, Stark wellfield operations under the new example permit could reasonably be administered alongside the framework of well operations authorized under the Order. For example, any well diversions in excess of the well

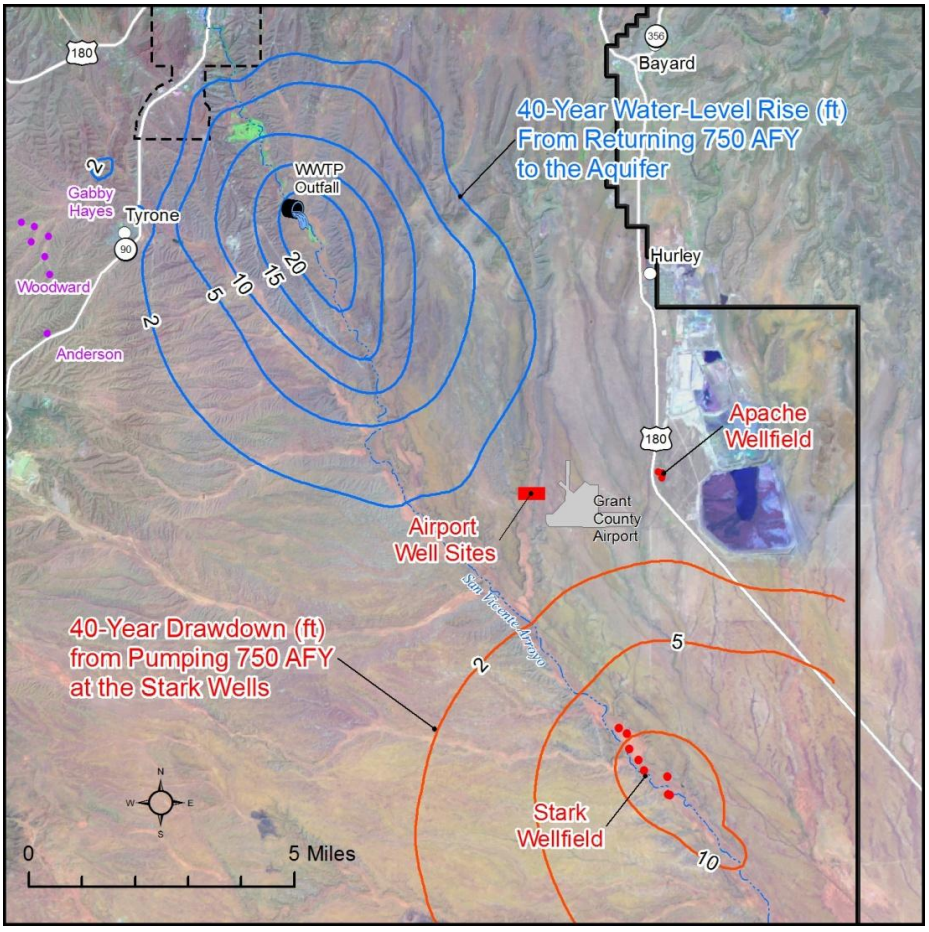

Figure 3. Water-level change from Stark wellfield use.

use specified under the Court Order could be associated with use under the new permit. Another option is to install a meter on the water line associated with municipal use and to administer water routed through that line under the new permit. The projected change to water levels, after 40 years of pumping and return flow operations, is shown on Figure 3.

The diversion of 750 AFY from the Stark wellfield is equally distributed amongst all eight wells. After 40 years of pumping, the well diversion causes less than two feet of drawdown in the area of the airport wells and the Apache wellfield.

Diversion from Airport Wells and Stark Wellfield

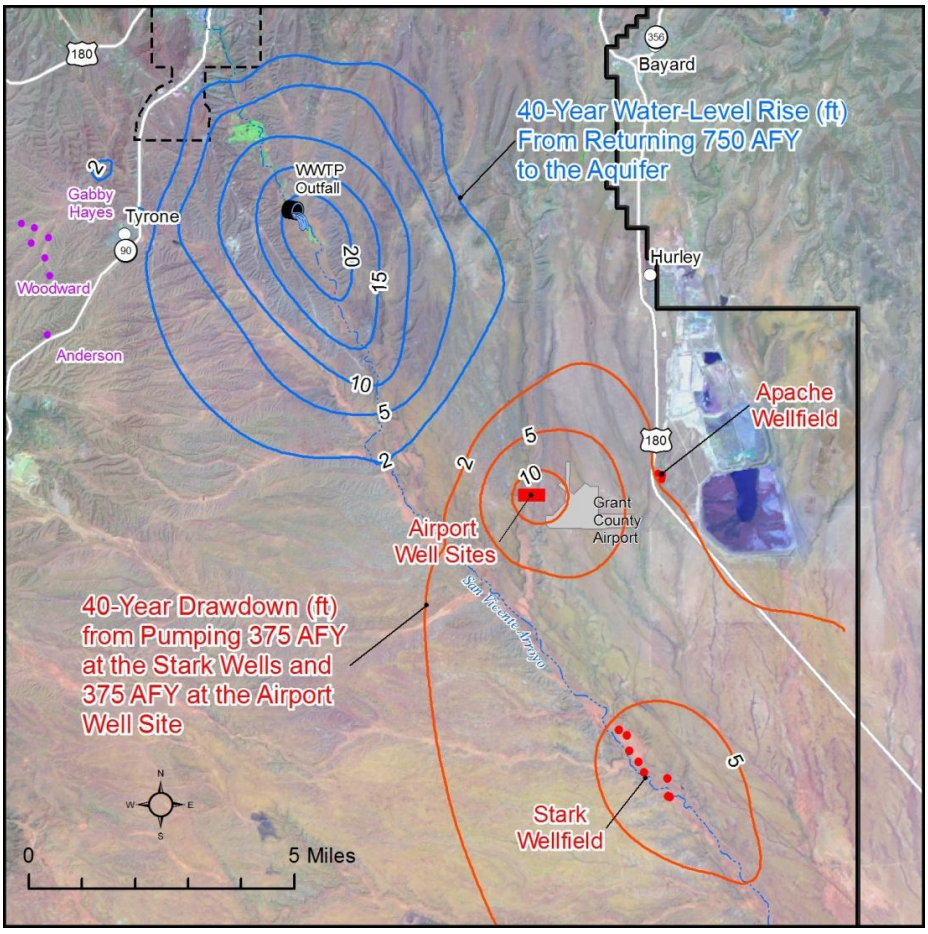

Figure 4. Water-level change from airport and Stark wellfield use combined.

The third well pumping scenario is the same as the two scenarios described above, except the groundwater pumping is distributed as 375 AFY to the airport wells and 375 AFY to the Stark wellfield; the pumping is distributed equally between the wells at each site. The results after 40 years of groundwater withdrawal are shown on Figure 4.

Commentary on Analysis

The analysis herein is an assessment of the isolated effect of pumping 750 AFY from the area of the Grant County Airport in conjunction with the same quantity of return flow to the Gila Group aquifer from the Town's WWTP. For planning purposes, the results provide insight to the quantity of water-level changes that can reasonably be expected to occur if groundwater is developed in this area. Climate variability and water operations at other wells can also influence water levels in the study area. The analysis herein isolates the water-level changes associated with new groundwater development in conjunction with return flow credit; it does not include water-level changes from other water operations or climate variability.

If the Town were to move forward with plans similar to the scenarios described in this report, then the groundwater diversion would be a new water operation; the return flow to the Gila Group aquifer, however, is currently ongoing and it has occurred since the 1940s[1] when the Town began discharging effluent to San Vicente Arroyo. The analysis of water-level rise associated with return flow in this report accounts for return flow credit that may be approved for use in the future. Return flow has occurred for the last 60 years or so; however, the Town has not received administrative credit for return flow operations during that time. If the analysis herein accounted for historical return flow operations, then the magnitude of water-level rise depicted in Figures 2, 3 and 4 would be greater, and the drawdown from well pumping would be on the order of a few feet smaller.

Historical records of well diversions at the Stark wellfield are available. The OSE (Johnson, 2002) compiled information from consultant reports (Hargis & Montgomery, 1983) that indicate instantaneous rates of diversion from 1952 to 1981 that range from 0.35 to 3.11

[1] Trauger (1972, p. 61) reports that the Town has discharged effluent to San Vicente Arroyo for many years, but the discharge increased markedly in about 1945 when Frank's wellfield was developed.

cubic feet per second. Records of annual use from 1983 to 2000 on file at the District III OSE in Deming, NM indicate that wellfield diversions ranged from 872 to 1,878 AFY with an average rate of 1,272 AFY (Johnson, 2002, Table 5). Historical groundwater diversions from the Stark wellfield indicate that it is feasible for wells to produce groundwater on the order of a couple of thousand AFY. Table 1 also lists specific capacity information for Stark wells 1, 2 and 4. Specific capacity is on the order of a few gpm per foot based on well production rates that range from 370 to 600 gpm, which is adequate for municipal well production as it is compatible with individual well yields from the Town's existing municipal wells.

Conclusions

1. The Town of Silver City is considering options for development of groundwater in the area of Grant County Airport. Development of 750 acre feet per year from the site of the Town's existing airport well permit (two wells adjacent to the airport) causes less than 15 feet of drawdown to aquifer water levels located over a mile distant from the well site after 40 years of pumping. At the nearest wellfield permitted for commercial and industrial use (the Apache wellfield), drawdown is projected to be less than five feet. Approximately four miles southeast of the airport wells in the area of the Stark wellfield, 40-year drawdown effects are on the order of two feet.

2. In the area of Grant County Airport, groundwater has been diverted at rates up to about 2,000 acre feet per year. The average Stark wellfield diversion from 1983 to 2000 was 1,272 acre feet per year. Individual well yields at three Stark wells are reported to be on the order of hundreds of gallons per minute. These factors indicate that groundwater development in the area of Grant County Airport is feasible.

Attachments: Table 1

References

Balleau Groundwater, Inc., 2006, Supplement on Water Use and Wellfield Service – A 40-Year Water Plan for the Town of Silver City, New Mexico: Consultant Report to the Town of Silver City dated April 25, 2006.

Balleau Groundwater, Inc., 2010, Effluent Percolation into the Gila Group Aquifer near Silver City, New Mexico: Consultant Report to the Town of Silver City dated November 12, 2010.

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Hathaway, D.L., 1986, Hydrogeologic Evaluation of Proposed Transfer of Water from the Gila River to Tyrone by the Phelps Dodge Corporation: New Mexico Office of the State Engineer.

Hargis & Montgomery, Inc., 1983, Regional Groundwater Flow Model, San Vicente Basin, Grant and Luna Counties, New Mexico: Consultant Report to Kennecott Minerals Company, memorandum dated July 29, 1983.

Hawley, J.W., Hibbs, B.J., Kennedy, J.F., Creel, B.J., Remmenga, M.D., Johnson, M., Lee, M.M. and Dinterman, Phil, 2000, Trans-International Boundary Aquifers in Southwestern New Mexico: Technical Completion Report, Interagency contract number X-996350-01-3, New Mexico Water Resources Research Institute. Prepared for the U.S. Environmental Protection Agency – Region 6 and the International Boundary and Water Commission – U.S. Section.

Johnson, M.S., 2000, Hydrologic Evaluation of Application GSF-1745 into GSF-1014 for Permit to Change Location of Well and Place or Purpose of Use in the Gila-San Francisco Underground Water Basin Grant County, New Mexico: New Mexico Office of the State Engineer Hydrology Report 00-3.

Johnson, M.S., 2002, Modifications to the OSE Silver City Ground-Water flow Model: Draft Memorandum, New Mexico Office of the State Engineer, Hydrology Bureau, To: Gila River Alternatives Analysis File, Through: Tom Morrison, Hydrology Bureau Chief, memorandum dated February 6, 2002.

Trauger, F.D., 1972, Water Resources and General Geology of Grant County, New Mexico: New Mexico State Bureau of Mines and Mineral Resources Hydrologic Report 2.

AIRPORT WELLS

TABLE 1. SUMMARY OF STARK WELLFIELD INFORMATION

Well ID	OSE File No.	Location			Year Completed	Total Depth (ft)	Casing Diameter (in)	Screened Interval (ft)	Depth to Water (ft)	Depth to Water (yr)	Pump	Specific Capacity[C] (gpm/ft)	Maximum Diversion Rate (gpm)	Data Source[D]
		NM PLSS (Twn.Rng.Sec.QQQ)[A]	NAD83 New Mexico West[B] X (ft)	Y (ft)										
Stark Well 1	M-5068	20S.12W.19.123	2,633,002	566,456	1947	375	16		87	1963	100-hp turbine			1
							16 - 8	Cased 160'	64	1952		2.5 - 3.4		2
													300	3
Stark Well 2	M-5068-S	20S.13W.13.121	2,628,085	573,068	1947	512	14	95 - 297	94.3	1960	100-hp turbine			1
								Cased 305'	91	1954		3.0		2
													300	3
Stark Well 3	M-5068-S-2	20S.12W.19.141	2,633,174	566,377	1947	415			76	1962	100-hp turbine			1
							16	Cased 140'	59.4	1947				2
									63	1952				2
									81.2	1955				2
													300	3
Stark Well 4	M-5068-S-3	20S.12W.18.343	2,632,931	568,218	1947	400	14	65 - 295	71	1960	100-hp turbine			1
							18 - 14		64	1952		2.7		2
													300	3
Stark Well 5	M-5068-S-4	20S.13W.13.213	2,628,920	572,479	1963?	500	16	90 - 310	92	1963	75-hp submersible			1
													300	3
Stark Well 6	M-5068-S-5	20S.13W.13.233	2,629,143	570,992	1963	500	16	82 - 354	--	--	125-hp submersible			1
													300	3
Stark Well 7	M-5068-S-6	20S.13W.13.421	2,630,063	569,848	1964	450	16	88 - 403	90	1964	75-hp submersible			1
													300	3
Stark Well 8	M-5068-S-7	20S.13W.13.442	2,630,595	568,837	1964	450	16	78 - 403	80	1964	75-hp submersible			1
													400	3

Notes: (from June 4, 1974 Order of the District Court of the Sixth Judicial District in and for the County of Luna, No. 6326, Subfile No. 766)

The total rate of diversion from all wells combined shall not exceed 1600 gpm.

The total amount of water diverted shall not exceed 2581 acre feet (AF) in any one year and not exceed 12,000 AF in any five year period.

Priority:

September 1947, for 300 gpm not to exceed average annual amount of 484 AF.

October 1947, for 300 gpm not to exceed average annual amount of 484 AF.

November 1947, for 300 gpm not to exceed average annual amount of 484 AF.

July 1952, for 300 gpm not to exceed average annual amount of 484 AF.

September 16, 1963, for 300 gpm not to exceed average annual amount of 484 AF.

October 1, 1963, for 100 gpm not to exceed average annual amount of 161 AF.

[A]Quarter sections are listed largest to smallest (1=NW, 2=NE, 3=SW, 4=SE).

[B]Coordinates estimated from NM PLSS locations and well sites apparent on year 2009 National Agriculture Imagery Program (NAIP) aerial photography provided by ESRI (www.esri.com).

[C]Specific capacity at Stark Well 1 is based on pumping 450 and 580 gpm with drawdown of 132 and 232 feet. Stark Well 2 had 124 feet of drawdown while pumping 370 gpm; Stark Well 4 had 223 feet of drawdown from pumping 600 gpm.

[D]Data Source explanation:

1 = Dinwiddle, G.A., Mourant, W.A., and Basler, J.A., 1966, Municipal Water Supplies and Uses, Southwestern New Mexico: New Mexico State Engineer Technical Report 29D.

2 = Trauger, F.D., 1972, Water Resources and General Geology of Grant County, New Mexico: New Mexico State Bureau of Mines and Mineral Resources Hydrologic Report 2.

3 = New Mexico Office of the State Engineer WATERS database (http://www.ose.state.nm.us/waters_db_index.html), data accessed December 29, 2010).