

# Update of Groundwater Pumping Effects Simulation, 2012

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Co-Ops

COPY TO:

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## Introduction and Background

In February of 2012, Phil Nowlin representing the Las Campanas Water and Sewer Cooperatives (Las Campanas), requested that CH2M HILL complete an analysis of effects of Las Campanas groundwater pumping on local surface water bodies including the Rio Grande and its tributaries. Under New Mexico Water Law, groundwater pumping effects on surface water bodies must be offset with surface water rights or through a dedicated return flow plan.

As part of an agreement with Sangre de Cristo Water, Las Campanas has had access to groundwater pumped from the Buckman wellfield since 1991. As part of this agreement, Las Campanas has provided and continues to provide offsets to groundwater pumping effects associated with the amount of water they use. Note that because of the distance of the Buckman wells from surface water bodies as well as the associated hydrogeology, effects do not occur on an instantaneous basis (e.g. 100 ac-ft of pumping does not result in 100 ac-ft of effect in the same year.) This results in a lag time of occurrence of effects on the river. Likewise the offset needs any given year are likely due in part to historical pumping.

Groundwater pumping effects on surface water bodies also vary with the pumping location, pumping amount, and time period from which pumping occurs. Las Campanas' agreement with Sangre de Cristo specifies that the pumping effects be assessed using the proportional pumping of Buckman Wells 3, 4, 5, and 6. For example, if Las Campanas used 500 ac-ft of groundwater in a given year and 20 percent of the total production of wells 3, 4, 5, and 6 came from well 4, effects are assessed as if Las Campanas pumped 20 percent, or 100 ac-ft, from well 4.

## Methods

The New Mexico Office of the State Engineer (OSE) uses a superposition model (OSE Model) developed by Barroll (2005) to assess pumping effects from the Buckman wellfield. As developed, the OSE Model includes packages that read the output from MODFLOW and isolate the effects on the Rio Grande and its tributaries. More specifically, the effects on the Rio Grande, Pojoaque, and Tesuque are output. Las Campanas pumping from 1991 through 2011 was input into the model as shown in Table 1. For each year the rate was input to the model by well, proportioned as shown in Table 1. Pumping was equally split between model layers 1 and 2.

TABLE 1  
**Las Campanas Pumping and Buckman Wellfield Proportion**

| Year | Pumping<br>(ac-ft) | Proportion (Well No.) |      |      |      |
|------|--------------------|-----------------------|------|------|------|
|      |                    | 3                     | 4    | 5    | 6    |
| 1991 | 19                 | 0.10                  | 0.37 | 0.06 | 0.47 |
| 1992 | 284                | 0.06                  | 0.27 | 0.03 | 0.65 |
| 1993 | 451                | 0.05                  | 0.30 | 0.07 | 0.58 |
| 1994 | 395                | 0.06                  | 0.32 | 0.12 | 0.50 |
| 1995 | 444                | 0.14                  | 0.31 | 0.15 | 0.40 |
| 1996 | 515                | 0.23                  | 0.24 | 0.17 | 0.37 |
| 1997 | 501                | 0.22                  | 0.22 | 0.07 | 0.49 |
| 1998 | 660                | 0.23                  | 0.20 | 0.06 | 0.52 |
| 1999 | 896                | 0.24                  | 0.20 | 0.00 | 0.56 |
| 2000 | 940                | 0.31                  | 0.16 | 0.00 | 0.54 |
| 2001 | 949                | 0.24                  | 0.19 | 0.00 | 0.57 |
| 2002 | 757                | 0.17                  | 0.22 | 0.11 | 0.51 |
| 2003 | 894                | 0.16                  | 0.18 | 0.11 | 0.55 |
| 2004 | 529                | 0.05                  | 0.26 | 0.00 | 0.69 |
| 2005 | 462                | 0.11                  | 0.52 | 0.00 | 0.37 |
| 2006 | 521                | 0.13                  | 0.32 | 0.00 | 0.55 |
| 2007 | 495                | 0.16                  | 0.49 | 0.00 | 0.35 |
| 2008 | 505                | 0.10                  | 0.80 | 0.06 | 0.04 |
| 2009 | 477                | 0.07                  | 0.36 | 0.08 | 0.49 |
| 2010 | 393                | 0.21                  | 0.23 | 0.06 | 0.50 |
| 2011 | 275                | 0.13                  | 0.29 | 0.00 | 0.57 |
| 2012 | 0                  | 0.05                  | 0.25 | 0.00 | 0.69 |

Note: Because water supply from 2012 on is from the Buckman Direct Diversion, future groundwater pumping is simulated as "0"

# Results

Figure 1 presents the residual effects on the Rio Grande and its tributaries due to pumping associated with Las Campanas. As can be seen, the effects diminish rapidly once pumping ceases in 2012, dropping from about 210 acre-feet to 40 acre-feet by 2050 and less than 20 acre-feet by 2100. Table 2 shows the annual effects from 1991 to 2100.

FIGURE 1. LAS CAMPANAS OFFSET REQUIREMENTS FROM HISTORICAL PUMPING

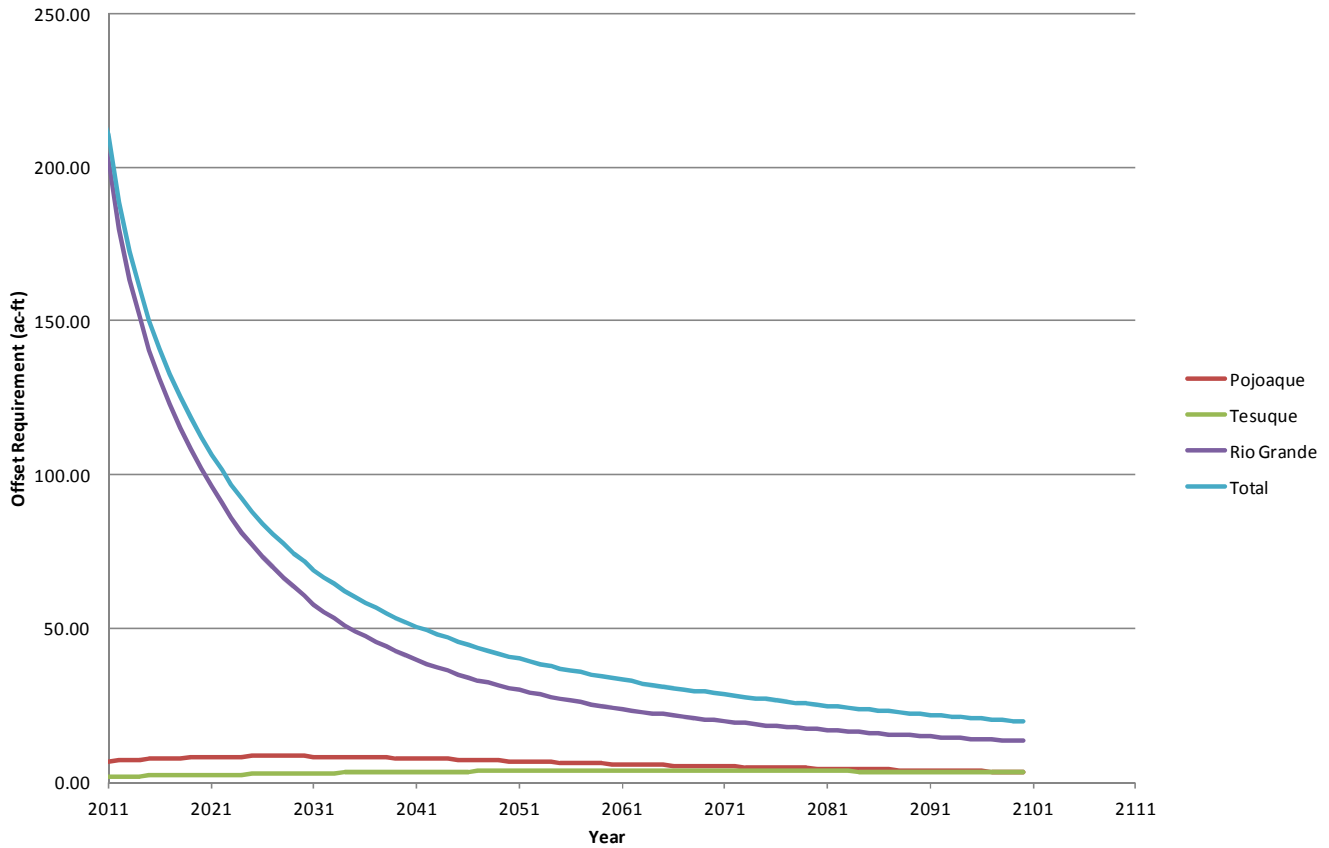


TABLE 2  
Effects of Las Campanas Pumping on Surface Water Bodies

|      | Pojoaque (ac-ft) | Tesuque (ac-ft) | Rio Grande (ac-ft) | Total (ac-ft) |
|------|------------------|-----------------|--------------------|---------------|
| 1991 | 0.01             | 0.00            | 1.08               | 1.09          |
| 1992 | 0.14             | 0.04            | 14.92              | 15.09         |
| 1993 | 0.38             | 0.11            | 33.86              | 34.35         |
| 1994 | 0.62             | 0.19            | 45.49              | 46.31         |
| 1995 | 0.86             | 0.27            | 58.89              | 60.02         |
| 1996 | 1.11             | 0.36            | 74.77              | 76.23         |
| 1997 | 1.37             | 0.44            | 86.81              | 88.62         |
| 1998 | 1.71             | 0.53            | 105.74             | 107.98        |

**TABLE 2**  
**Effects of Las Campanas Pumping on Surface Water Bodies**

|             | <b>Pojoaque<br/>(ac-ft)</b> | <b>Tesuque<br/>(ac-ft)</b> | <b>Rio Grande<br/>(ac-ft)</b> | <b>Total<br/>(ac-ft)</b> |
|-------------|-----------------------------|----------------------------|-------------------------------|--------------------------|
| <b>1999</b> | 2.18                        | 0.65                       | 135.32                        | 138.15                   |
| <b>2000</b> | 2.72                        | 0.78                       | 162.71                        | 166.21                   |
| <b>2001</b> | 3.27                        | 0.93                       | 184.15                        | 188.35                   |
| <b>2002</b> | 3.73                        | 1.06                       | 189.92                        | 194.71                   |
| <b>2003</b> | 4.21                        | 1.20                       | 202.34                        | 207.75                   |
| <b>2004</b> | 4.59                        | 1.31                       | 196.43                        | 202.33                   |
| <b>2005</b> | 4.87                        | 1.39                       | 199.12                        | 205.38                   |
| <b>2006</b> | 5.18                        | 1.47                       | 202.19                        | 208.84                   |
| <b>2007</b> | 5.50                        | 1.55                       | 209.47                        | 216.52                   |
| <b>2008</b> | 5.82                        | 1.62                       | 222.58                        | 230.02                   |
| <b>2009</b> | 6.18                        | 1.70                       | 218.70                        | 226.58                   |
| <b>2010</b> | 6.53                        | 1.79                       | 212.39                        | 220.71                   |
| <b>2011</b> | 6.83                        | 1.86                       | 202.03                        | 210.72                   |
| <b>2012</b> | 6.99                        | 1.91                       | 179.75                        | 188.65                   |
| <b>2013</b> | 7.11                        | 1.94                       | 163.54                        | 172.60                   |
| <b>2014</b> | 7.24                        | 1.97                       | 151.14                        | 160.35                   |
| <b>2015</b> | 7.38                        | 2.01                       | 140.66                        | 150.04                   |
| <b>2016</b> | 7.52                        | 2.05                       | 131.35                        | 140.91                   |
| <b>2017</b> | 7.66                        | 2.09                       | 122.95                        | 132.70                   |
| <b>2018</b> | 7.79                        | 2.14                       | 115.31                        | 125.24                   |
| <b>2019</b> | 7.92                        | 2.19                       | 108.33                        | 118.44                   |
| <b>2020</b> | 8.03                        | 2.24                       | 101.94                        | 112.20                   |
| <b>2021</b> | 8.12                        | 2.29                       | 96.09                         | 106.51                   |
| <b>2022</b> | 8.21                        | 2.35                       | 90.73                         | 101.29                   |
| <b>2023</b> | 8.27                        | 2.40                       | 85.81                         | 96.48                    |
| <b>2024</b> | 8.32                        | 2.46                       | 81.27                         | 92.05                    |
| <b>2025</b> | 8.36                        | 2.51                       | 77.10                         | 87.98                    |
| <b>2026</b> | 8.39                        | 2.57                       | 73.25                         | 84.21                    |
| <b>2027</b> | 8.40                        | 2.63                       | 69.70                         | 80.73                    |
| <b>2028</b> | 8.40                        | 2.68                       | 66.41                         | 77.49                    |
| <b>2029</b> | 8.39                        | 2.74                       | 63.37                         | 74.49                    |
| <b>2030</b> | 8.36                        | 2.79                       | 60.55                         | 71.70                    |

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|             | <b>Pojoaque<br/>(ac-ft)</b> | <b>Tesuque<br/>(ac-ft)</b> | <b>Rio Grande<br/>(ac-ft)</b> | <b>Total<br/>(ac-ft)</b> |
|-------------|-----------------------------|----------------------------|-------------------------------|--------------------------|
| <b>2031</b> | 8.33                        | 2.84                       | 57.93                         | 69.10                    |
| <b>2032</b> | 8.29                        | 2.90                       | 55.49                         | 66.67                    |
| <b>2033</b> | 8.24                        | 2.95                       | 53.22                         | 64.41                    |
| <b>2034</b> | 8.19                        | 3.00                       | 51.11                         | 62.29                    |
| <b>2035</b> | 8.13                        | 3.05                       | 49.14                         | 60.31                    |
| <b>2036</b> | 8.06                        | 3.09                       | 47.29                         | 58.44                    |
| <b>2037</b> | 7.99                        | 3.14                       | 45.56                         | 56.69                    |
| <b>2038</b> | 7.91                        | 3.18                       | 43.95                         | 55.04                    |
| <b>2039</b> | 7.83                        | 3.22                       | 42.44                         | 53.49                    |
| <b>2040</b> | 7.75                        | 3.26                       | 41.01                         | 52.02                    |
| <b>2041</b> | 7.66                        | 3.30                       | 39.67                         | 50.63                    |
| <b>2042</b> | 7.57                        | 3.33                       | 38.41                         | 49.32                    |
| <b>2043</b> | 7.48                        | 3.37                       | 37.23                         | 48.08                    |
| <b>2044</b> | 7.39                        | 3.40                       | 36.10                         | 46.89                    |
| <b>2045</b> | 7.29                        | 3.43                       | 35.05                         | 45.77                    |
| <b>2046</b> | 7.20                        | 3.46                       | 34.05                         | 44.71                    |
| <b>2047</b> | 7.11                        | 3.49                       | 33.10                         | 43.69                    |
| <b>2048</b> | 7.01                        | 3.51                       | 32.20                         | 42.72                    |
| <b>2049</b> | 6.91                        | 3.53                       | 31.35                         | 41.80                    |
| <b>2050</b> | 6.82                        | 3.55                       | 30.54                         | 40.91                    |
| <b>2051</b> | 6.72                        | 3.57                       | 29.77                         | 40.07                    |
| <b>2052</b> | 6.63                        | 3.59                       | 29.04                         | 39.26                    |
| <b>2053</b> | 6.54                        | 3.60                       | 28.34                         | 38.48                    |
| <b>2054</b> | 6.44                        | 3.62                       | 27.68                         | 37.74                    |
| <b>2055</b> | 6.35                        | 3.63                       | 27.05                         | 37.02                    |
| <b>2056</b> | 6.26                        | 3.64                       | 26.44                         | 36.34                    |
| <b>2057</b> | 6.17                        | 3.65                       | 25.86                         | 35.67                    |
| <b>2058</b> | 6.07                        | 3.66                       | 25.30                         | 35.04                    |
| <b>2059</b> | 5.99                        | 3.66                       | 24.77                         | 34.42                    |
| <b>2060</b> | 5.90                        | 3.67                       | 24.26                         | 33.83                    |
| <b>2061</b> | 5.81                        | 3.67                       | 23.77                         | 33.25                    |
| <b>2062</b> | 5.72                        | 3.67                       | 23.31                         | 32.70                    |

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**Effects of Las Campanas Pumping on Surface Water Bodies**

|      | Pojoaque<br>(ac-ft) | Tesuque<br>(ac-ft) | Rio Grande<br>(ac-ft) | Total<br>(ac-ft) |
|------|---------------------|--------------------|-----------------------|------------------|
| 2063 | 5.64                | 3.67               | 22.85                 | 32.17            |
| 2064 | 5.56                | 3.67               | 22.42                 | 31.65            |
| 2065 | 5.47                | 3.67               | 22.00                 | 31.14            |
| 2066 | 5.39                | 3.67               | 21.60                 | 30.66            |
| 2067 | 5.31                | 3.66               | 21.21                 | 30.18            |
| 2068 | 5.23                | 3.66               | 20.84                 | 29.73            |
| 2069 | 5.16                | 3.65               | 20.48                 | 29.28            |
| 2070 | 5.08                | 3.64               | 20.13                 | 28.85            |
| 2071 | 5.00                | 3.63               | 19.79                 | 28.43            |
| 2072 | 4.93                | 3.62               | 19.46                 | 28.02            |
| 2073 | 4.86                | 3.61               | 19.15                 | 27.62            |
| 2074 | 4.79                | 3.60               | 18.84                 | 27.23            |
| 2075 | 4.72                | 3.59               | 18.55                 | 26.86            |
| 2076 | 4.65                | 3.58               | 18.26                 | 26.49            |
| 2077 | 4.58                | 3.57               | 17.98                 | 26.13            |
| 2078 | 4.51                | 3.55               | 17.71                 | 25.78            |
| 2079 | 4.45                | 3.54               | 17.45                 | 25.43            |
| 2080 | 4.39                | 3.52               | 17.19                 | 25.10            |
| 2081 | 4.32                | 3.51               | 16.94                 | 24.77            |
| 2082 | 4.26                | 3.49               | 16.70                 | 24.45            |
| 2083 | 4.20                | 3.47               | 16.47                 | 24.14            |
| 2084 | 4.14                | 3.46               | 16.24                 | 23.84            |
| 2085 | 4.08                | 3.44               | 16.02                 | 23.54            |
| 2086 | 4.03                | 3.42               | 15.80                 | 23.25            |
| 2087 | 3.97                | 3.40               | 15.59                 | 22.96            |
| 2088 | 3.91                | 3.39               | 15.38                 | 22.68            |
| 2089 | 3.86                | 3.37               | 15.18                 | 22.41            |
| 2090 | 3.81                | 3.35               | 14.99                 | 22.14            |
| 2091 | 3.75                | 3.33               | 14.80                 | 21.88            |
| 2092 | 3.70                | 3.31               | 14.61                 | 21.62            |
| 2093 | 3.65                | 3.29               | 14.43                 | 21.37            |
| 2094 | 3.60                | 3.27               | 14.25                 | 21.12            |

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|             | Pojoaque<br>(ac-ft) | Tesuque<br>(ac-ft) | Rio Grande<br>(ac-ft) | Total<br>(ac-ft) |
|-------------|---------------------|--------------------|-----------------------|------------------|
| <b>2095</b> | 3.55                | 3.25               | 14.08                 | 20.88            |
| <b>2096</b> | 3.51                | 3.23               | 13.90                 | 20.64            |
| <b>2097</b> | 3.46                | 3.21               | 13.74                 | 20.41            |
| <b>2098</b> | 3.41                | 3.19               | 13.58                 | 20.18            |
| <b>2099</b> | 3.37                | 3.17               | 13.42                 | 19.95            |
| <b>2100</b> | 3.33                | 3.14               | 13.26                 | 19.73            |

## Golf and Residential Use

Table 3 presents the historical Las Campanas groundwater pumping for golf and residential. In total 72 percent of all Las Campanas groundwater production was for irrigation of the golf courses with 28 percent for residential and commercial use.

TABLE 3  
*Historical Las Campanas Pumping Data*

|               | <b>Golf</b>  | <b>Residential</b> | <b>Total</b>  |
|---------------|--------------|--------------------|---------------|
| 1991          | 14           | 5                  | 19            |
| 1992          | 274          | 10                 | 284           |
| 1993          | 437          | 13                 | 450           |
| 1994          | 360          | 35                 | 395           |
| 1995          | 397          | 47                 | 444           |
| 1996          | 512          | 3                  | 515           |
| 1997          | 345          | 156                | 500           |
| 1998          | 535          | 125                | 660           |
| 1999          | 719          | 177                | 895           |
| 2000          | 672          | 268                | 939           |
| 2001          | 744          | 204                | 948           |
| 2002          | 545          | 212                | 757           |
| 2003          | 753          | 141                | 893           |
| 2004          | 289          | 240                | 529           |
| 2005          | 223          | 239                | 462           |
| 2006          | 285          | 236                | 521           |
| 2007          | 244          | 251                | 495           |
| 2008          | 250          | 255                | 505           |
| 2009          | 189          | 288                | 477           |
| 2010          | 117          | 276                | 393           |
| 2011          | 228          | 46                 | 275           |
| <b>TOTALS</b> | <b>8,131</b> | <b>3,224</b>       | <b>11,355</b> |



## References

Barroll, P., 2005. Memo to Tom Morrison, OSE Hydrology Bureau Chief, titled Santa Fe Model: Resolution of Discrepancy between Superposition and Calibrated Versions of the Model.