TECHNICAL MEMORANDUM #2

LUHDORFF & SCALMANINI CONSULTING ENGINEERS

Water Demand and Supply Evaluation for the Blue Lake Springs Mutual Water Company – Water Master Plan

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This technical memorandum presents an assessment of current and future water demand and well source capacity required for the Blue Lake Springs Mutual Water Company (BLSMWC) water system assessment as part of the Water Master Plan. This technical memorandum is the second of a series of memorandums which, when combined, will constitute the complete Water Master Plan analysis.

Documents provided by BLSMWC and used in reference for this analysis are as follows:

- Well production and water level data (1988 – present)
- Daily Consumption Records (2001-01, 2003-06, 2008-11)
- Customer water meter records
- LSCE Technical Memorandum #1 – Project Development
- BLSMWC 1990 Water Master Plan (Psomas)
- BLSMWC - CDPH Permit Amendment 2007
- BLSMWC - CDPH Inspection Reports (2003-2005, 2012)
- CCWD – 2010 Urban Water Management Plan
- DWR Water Facts (April 2004)
- USGS Water Resources Investigation Report 83-4262

1.0 WATER DEMAND ANALYSIS

Defining current and future water demand requirements is central to the evaluation of the BLSMWC's water facilities, including assessing the adequacy of groundwater production and treatment facilities to reliably meet current and projected water requirements. In addition, a component of the master plan is to utilize a computer hydraulic model of the water distribution system to assess the ability of facilities to adequately deliver, store and distribute water at current and future levels of service. The distribution system hydraulic model will require the water demand factors presented in this memorandum. The water demand projections presented in this memorandum are the basis for effective capital improvement planning, budgeting and scheduling that will be presented in the Water Master Plan.

1.1 Blue Lake Springs Development – Existing and Future Water Services

BLSMWC serves water to the Blue Lake Springs subdivision. The subdivision consists of 2,024 lots divided into twelve development units (identified as Units 1-5 and 7-13). Unit 6 was never developed and was not included in the final subdivision maps. Every lot in Blue Lake Springs has a water service lateral; however, not all lots have been improved with a residential dwelling unit and a connection to the water service lateral. As of the date of this memorandum, there are 1,712 improved lots that have water service connections. There remain 312 unimproved lots that represent the basis for future growth within the water system. Current and future water services are summarized in Table 1 (below).

Of the existing 1,712 water service connections, only two are for commercial uses and 1,710 serve residential dwelling units. One of the commercial connections serves water to the Home Owners Association office building and the other serves water to the golf course restrooms and a maintenance building. There are no service connections used for dedicated irrigation (i.e., there are no common landscape areas, parks or greenbelts). Additionally, there are no public agencies served by the water system, such as schools, government buildings, fire houses, etc. There are also water demands not associated with service connections, such as with water company operational demands (i.e., hydrant flushing and water treatment plant building domestic uses) and unaccounted water system losses (i.e., mainline leakage, etc.). BLSMWC historically has been unmetered (flat-rate billing), and only in recent years has commenced installation of customer meters. There are currently 255 metered service connections (two of which are the commercial connections noted above).

A majority of homes in Blue Lake Springs are occupied on a part-time basis as vacation homes. The community population varies from approximately 650 permanent residents (typically in the winter months) to as many as 5,500 permanent and seasonal (typically in the summer months). The water company estimates that approximately 300 residential units are used full-time and the balance used as vacation homes. The estimate of full-time residences is based on the number of customers whose billing addresses are located in Arnold; those customers with non-local billing addresses are assumed to be vacation residences. The number has been confirmed by fire safety inspections performed by Ebbetts Pass Fire District. Customer meter records, if available, could be used to determine the mix of part-time and full-time residences; however, as stated above the system is largely unmetered. Furthermore, it is not possible to determine the future use of vacation homes. Therefore, the future growth of the system will be assumed to follow the same proportions of full-time and part-time residences, noted above. Table 1 (below) provides the assumed mix of permanent (full-time) and vacation (part-time) homes in the existing and future BLSMWC water system.

Table 1
Current and Future Service Connections

Service Connection Type	Current [1]	Growth [2]	Build-Out [3]
Full-time (Permanent) Residences	300	55	355
Part-time (Vacation) Residences	1,410	257	1,667
Total Residential Services	1,710	312	2,022
Commercial Services	2	0	2
Irrigation Services	0	0	0
Public Authority Services	0	0	0
Total Service Connections	1,712	312	2,024

NOTES:
1) Per BLSMWC records there are 1,712 water service customers. BLSMWC estimates that currently 300 customers are full-time residences with the balance used as vacation residences.
2) Growth is based on the remaining 312 unimproved residential lots within BLSMWC. The proportion of full-time residences and part-time residences is assumed to be the same for future growth.
3) There are a total of 2,024 lots within the BLSMWC subdivision, which is the build-out.

It should be noted that while the BLSMWC Articles of Incorporation allocated 3,000 shares, or one share per lot, the BLSMWC service area currently only includes 2,024 lots (or shares) and there are no current plans to expand beyond the existing service area boundary. Furthermore, the subdivision was originally planned with four additional units (Units 6, 14, 15 and 16), but those units were not included in the BLSMWC service area and all homes in those units are served by Calaveras County Water District.

1.2 Historic Water Use

BLSMWC has records of daily, monthly and annual water production for the entire system and for water delivered to each pressure zone. The available production data is compiled from operator daily readings of output flows (production) from the water treatment plant and water supplied by Calaveras County Water District (CCWD) from two inter-ties. BLSMWC can also calculate water usage in each pressure zone based upon daily readings of zone meters and storage tank levels. It should be noted that daily water usage records in the system includes all water used by the system such as regular customer water demands and system losses (i.e. operational water and pipeline leakage). Thus, water demand projections based on this data are conservative. Furthermore, since the system is largely unmetered (i.e. flat rate billing) there is no way to compare water production to customer water use to estimate water losses.

The records of historical annual water use and number of service connections are depicted in Figure 1 (see attached) for the period of 1989 to 2012. As shown on Figure 1, BLSMWC added service connections at an average rate of 10 connections per year (or a growth rate of approximately 0.6 percent), with most service connections added prior to 1996. There was a higher rate of connections added between 2001 and 2007, but very few after 2007.

The historic BLSMWC water use (Figure 1) showed no long-term patterns of growth or decline between the years 1993 and 2007. Water use in 1993 was 65 million gallons per year (MGY) and in 2007 was 69 MGY, with an average annual water use of 71 MGY prior to 2007. There were some years of higher than normal water use, with a peak of 81 MGY in 2001. From 2007 to 2011 annual water use steadily declined from 69 MGY to 51 MGY. In 2012 there was a slight increase to 53 MGY, but current water use remains far less than it was historically between 1993 and 2007.

Though there is no direct evidence, water usage decreases post-2007 are likely a result of: 1) a mainline replacement program that eliminated thousands of feet of leaking and aged mainlines; and 2) less vacation home use due to national and local economic decline. The former is a permanent reduction in water demand, whereas the latter is temporary and it is assumed that water use will return to historic levels with a recovering economy. As noted above, because the system is largely unmetered (i.e., flat rate billing), there is no customer water meter data available that could be used to quantify the effects that these events had on water usage. For the purposes of this planning document, the higher average water use observed in earlier years is considered conservative and is used as the basis of projecting current and future water demand requirements of the system.

1.3 Current and Projected Annual Water Requirements

A number of water demand projection methods are available for planning and design of water supply and distribution systems. The method most applicable to BLSMWC is the *Per-Service Method* that uses unit consumption values (e.g., million gallons per year per service connection). This method assumes that: (1) the future development and the associated water demand will be directly related to the number of service connections in the system; and, (2) the ratio of each type of service (i.e., residential, commercial, etc.) will remain constant over the planning period. For BLSMWC water system, this method may be appropriate because the system consists predominantly of residential services and all future connections will be residential. This method also assumes that the proportion of full-time to part-time homes will remain at the current rate of approximately 17.5 percent.

A previous water master plan, completed for BLSMWC in 1990, estimated the build-out water demand using a variant of the *Per-Service Method*. The water demand was reported as 318 gallons per day (GPD) per connection on the maximum day demand (i.e., the day of maximum use in a given year). Since BLSMWC consists of mostly vacation homes, it would be expected that annual water use would vary per connection due to varying use of vacation homes throughout the year. However, the 1990 report used the maximum day water as the basis of water use per connection, which would be appropriate considering maximum day demand coincides with, and is a result of, seasonal use of vacation homes.

As discussed above, the higher water use observed prior to 2007 will be used as the basis for determining current and future water requirements. The average annual production (prior to 2007) was approximately 71 MGY. The average water use *Per-Service* was 121 GPD per connection. Although the service connections in the system have increased over time, water demand has actually declined. As discussed above, it is assumed that water demand (and vacation home use) may return to historic levels and must be planned for accordingly. Therefore, this *Per-Service* water use factor is applied using the current number of service connections to calculate the average day demand (ADD). At the current number of service connections (1,712) the ADD for BLSMWC is approximately 0.21 million gallons per day (MGD), or an average flow of 144 gallons per minute (gpm). At full build-out of 2,024 service connections, the projected ADD is approximately 0.24 MGD, or a projected annual water use of 89 MGY.

1.4 Daily Water Demand and Peaking Factors

With the average daily water demand as a basis, maximum-day and peak-hour factors required for source capacity sizing (maximum day demand) and for storage and distribution system analysis (peak hour demand) can be determined. Fire flow requirements are also needed for storage and distribution analysis, but those are specified by the local fire protection district, independent of peaking factors related to regular water use within the system.

The California Department of Public Health Waterworks Standards (Title 22) requires at all times for a public water system to possess sufficient water source capacity to meet the maximum day demand. Per Title 22 the maximum day demand (MDD) must be determined from a minimum of 10 years of data, and utilize actual daily usage records, if available, to ascertain MDD.

For the BLSMWC system, daily usage records are available back to 2000. In the period of record, the highest maximum daily water use was 0.47 MGD recorded on September 2, 2001. The maximum daily water use varied between 0.34 to 0.47 MGD and typically occurred during the vacation season months July through September. As noted above, annual water demand was higher prior to 2007; the same is true for historic maximum day demands. Prior to 2007, the average MDD was 0.44 MGD. Since 2007, MDD has been consistently below 0.4 mg. There were also two anomalous days of maximum water usage that were attributed to system losses. A daily usage of 0.56 MGD in December 2004 corresponded with a mainline break when approximately 0.27 million gallons was lost. A recorded value of 0.53 MGD in September 2003 was related with an uncontrolled tank overflow event of nearly 0.2 million gallons. Both of these events were anomalies and not considered regular water demand.

The current MDD of the system is based on the historical average MDD (prior to 2007) of 0.44 MGD. The average MDD *Per-Service* water use is 266 GPD per connection. Note this is slightly lower than the per-service water use estimate provided in the previous water master plan (318 GPD per connection). At the current number of service connections (1,712), the MDD of the system is estimated to be 0.46 MGD (assuming vacation home use returns to previous levels). The ratio of MDD (0.46 MGD) to ADD (0.21 MGD) produces a peaking factor of 2.2.

The peak hour demand (PHD) is the estimated peak flow that occurs during the day of maximum demand (usually for a period of 4 to 5 hours). Certain factors specific to each system affect the peak hour demand, such as irrigation timers and residential use patterns, which can be measured and represented by a system's diurnal curve if hourly data are available. In the absence of that information, Title 22 permits the use of a factor of 1.5 multiplied by the average flow of the maximum day, which is a factor derived from extensive statewide studies comparing diurnal peaking factors. Using the Title 22 approach, the calculated peak hour demand is 474 gpm (1.5 times 316 gpm, which is the average flow during the MDD of 0.46 MGD. The ratio of PHD (474 gpm) to ADD (144 gpm) produces a peaking factor of 3.3.

Applying the MDD and PHD peaking factors established above, the estimated water demand factors at build-out will be: ADD = 0.24 MGD (or 170 gpm); MDD = 0.54 MGD (or 375 gpm); and, PHD = 560 gpm. The adequate sizing of the water system facilities will also consider the MDD plus fire flow for the purposes of capacity, tank and distribution sizing with the fire flow requirements from the Ebbetts Pass Fire District presented in a forthcoming memorandum on water distribution system analyses. Table 2 (below) presents the summary of existing and future daily average, maximum and peak hour water demands.

Table 2
Existing and Future Water Demand

	Average Day Demand (ADD) [1]		**Maximum Day Demand (MDD) [2]**		**Peak Hour Demand (PHD) [3]**
Level of Service	**MGD**	**gpm**	**MGD**	**gpm**	**gpm**
Existing (1,712 connections)	0.21	144	0.46	316	474
Build-out (2,024 connections)	0.24	170	0.54	375	560

Notes:

1) ADD = 121 GPD per Service Connection
2) MDD = ADD x 2.2 (or 266 GPD per Service Connection)
3) PHD = ADD x 3.3

Figure 2 (attached) depicts the relationship between water demand and the number of service connections. The figure shows water demand in terms of ADD, MDD and PHD at current service levels (1,712 service connections) and projected future service levels (2,024 service connections). The figure also shows the current source capacity in relation to current and future service levels, which is discussed in more detail in Section 2, below.

1.5 Water Supply from Calaveras County Water District

As indicated above, BLSMWC has inter-ties with the Calaveras County Water District in the Ebbetts Pass water system. The connection is classified as an emergency backup supply to augment the water sources during times of emergencies, such as due to loss of a well.

In previous years, BLSMWC relied on supply from CCWD to provide a significant fraction of regular service in the system. BLSMWC previously considered annexation to CCWD due to capacity issues with the water supply wells, but the option was deemed infeasible due to the cost of CCWD connection fees and requirements to upgrade all facilities to CCWD design standards. BLSMWC currently has expressed objectives to develop additional groundwater supplies to maintain its own levels of regular service.

CCWD reported water supplied to BLSMWC in the CCWD 2011 Urban Water Management Plan. According to that plan, CCWD states that supplemental water is provided to three private water systems in the area: Fly In Acres, Snowshoe Springs, and Blue Lake Springs Mutual Water Companies. CCWD states that it has supplied up to half of the BLSMWC water demand at times, and that CCWD has sufficient water supplies to meet the future water demands of all three private water systems if annexation were to occur. For now, the CCWD-BLSMWC connection is considered a wholesale connection for emergency purposes.

2.0 WATER SUPPLY ASSESSMENT

2.1 Hydrogeologic Setting and Groundwater Occurrence

Groundwater in the Arnold area is encountered in shallow alluvial deposits, in bedrock formations, and at the surface emanating from springs. Shallow sources are generally inadequate for drinking water supply due to limited available drawdown for pumping and they are typically directly under the influence of surface water, such as streams. The groundwater source for the BLSMWC system is produced from wells completed in bedrock formations at depths of 200 feet and greater. Bedrock in the Sierra region is also referred to as hard rock. Groundwater that occurs in hard rock is transmitted through fractures created by tectonic forces. The yields of hard rock wells are influenced by the size and extent of fractures and fracture networks encountered in the borehole.

Because of the nature of fracture networks, hard rock sources are often poorly correlated between wells. Wells in close proximity and completed at similar depths may or may not exhibit mutual pumping interference due to the randomness of encountering connected fractures in well boreholes. In contrast, alluvial aquifer systems, such as the San Joaquin Valley and Sacramento Valley Groundwater Basins, have characteristics that permit delineation of lateral and vertical extent, estimation of storage capacity, and reliable correlation of properties based on borehole geophysical measurements and well interference testing.

The California Department of Water Resources (DWR) does not delineate groundwater basins in hard rock settings and indicates that exploration may be trial-and-error and predictions of yield and sustainability difficult. Source capacity determined under Title 22 California Water Works Standards requires discount factors for bedrock well tests because of these uncertainties.

There is limited literature on hard rock wells and groundwater occurrence in the state's mountainous regions. DWR reports that about half of hard rock wells have yields of 10 gpm or less (DWR, 2004). A USGS survey of hard rock wells in Nevada County (Page, et. al., 1984) found little correlation of yield to depth, other than lower yields below about 215 feet, and average reported yields on driller's logs of 18 gpm. From experience, hard rock wells typically have low specific capacities with values of 0.1 to 1 gpm per foot of drawdown (gpm/ft). By contrast, specific capacities of alluvial aquifer wells may be 10 to 100 gpm/ft.

Well data for the Arnold area is essentially non-existent outside of BLSMWC water system records. This is due to the fact that groundwater is not a significant source of supply in the area with Arnold and other towns served by the Calaveras County Water District (CCWD) water system. The Blue Lake Springs subdivision originally used shallow supply wells located near the clubhouse, but this source was reportedly problematic because of its shallow nature and pumping interference with nearby golf course supply wells. BLSMWC also drilled numerous exploratory boreholes within and around the subdivision, but found no significant groundwater occurrence. In 1986, White Pines Lake Wells 1 and 2 were drilled with Well 3 added in 2001 and in contrast to typical hard rock wells, all three wells have relatively high yields (240 to 280 gpm) and high specific capacities (5 to 10 gpm/ft).

2.2 Existing Supply Wells and Yields

The current BLSMWC source of supply consists of three hard rock wells drilled next to White Pines Lake. The wells were drilled and equipped through a combination grant and loan from CCWD and are owned jointly by CCWD and BLSMWC with the latter responsible for operations and maintenance. Wells 1 and 2 were the primary wells up to 2001 when Well 3 was added as a supplemental source. Currently, Wells 2 and 3 are active and Well 1 is classified as a standby source and used for water level monitoring.

The White Pines Lake wells are completed in hard rock at depths to 225 feet below ground surface (bgs). Well 1 was deepened in 2012, but encountered no additional water-bearing fractures. Each well has surface and sanitary seals consisting of cemented casings set at 70 to 130 feet. Wells 1 and 2 are open hole completions below the surface casings and Well 3 has an inner liner and formation stabilizer installed in the open hole. Well profiles are included in the appendix of this memorandum.

When first installed, Wells 1 and 2 exhibited yields of 240 gpm each. Mutual interference was evident when the wells were run simultaneously. In the late 1990s, yield of the wells reportedly declined and led to the installation of Well 3. A fourth well was drilled north of Well 3, but yielded no water. Based on the most recent CDPH inspection report, Well 2 and 3 are currently rated at 70 and 280 gpm, respectively. As discussed below, water levels in the wells declined to the point that they could not be used in late August 2013.

2.3 Well Production and Water Levels

2.3.1 Well Production

Production from the White Pines Lake wells has been variable since they were bought online in the late 1980s. From 1988 to 1990, production averaged over 100 million gallons per year (MGY) and ranged from 123 to 85.5 MGY as a significant portion of supply was used by CCWD. During this period, usage by BLSMWC ranged between 65 and 70 MGY. In the period 1991 to 2001, average water production was 71 MGY and used solely for the BLSMWC system.

From 2001 to 2010, the BLSMWC supply was supplemented by CCWD deliveries through an inter-tie between the systems. The use of CCWD water arose over concerns that the well supply was declining. During this period, average well production was 44 MGY with a low of 23.5 MGY in 2007. Water usage during this time averaged 72.5 MGY with the difference between production and usage made up by CCWD deliveries. Water usage declined after 2007, likely due to the 2007-09 drought as well as other factors discussed above (i.e., mainline replacements and the economic downturn), and was 53.4 million gallons in 2012.

In 2011 and 2012, with the exception of a small quantity from CCWD in 2011, all water used by the subdivision was provided by the White Pines Lake wells. In 2011 and 2012, production was 47.5 MGY and 53.2 MGY, respectively. Figure 1 shows the well production and BLSMWC total water usage history along with number of cabin connections. Multi-year drought periods in 1987-92 and 2007-09 are highlighted for reference and discussed below.

2.3.2 Water Levels

Water levels in wells are a key to assessing both the condition of a well and whether there is sufficient margin for pumping drawdown during operation. Water levels also reflect the available groundwater storage in the aquifer. Water levels have been indirectly monitored by BLSMWC via pressure transducers set at the top of the well pump assemblies. The pressure transducers respond to the height of water, or head, above the instrument setting depth with measurements recorded continuously on a chart. With the setting depth, the transducer data can be converted to groundwater depth in the well, or feet below ground surface (bgs).

Figure 3 shows water production from the White Pines Lake wells and seasonal groundwater levels since the wells were brought online. The shallowest seasonal level (i.e., the highest water level recovery) occurs in the spring when demand is low and in response to recharge in the wet winter months. The deepest levels are those in the late summer, usually around Labor Day, which is the last high use period of the season for the BLSMWC system. From Figure 3, it can be seen that water level recoveries in the spring consistently reached ground surface through 1997. In 1998, water levels recovered to 30 feet bgs and then at progressively deeper levels in subsequent years. Then in two out of three years, water levels recovered to ground surface from 2004 to 2006. After that period to 2010, water level recoveries ranged from about 40 to 60 feet bgs. In all years up to this point, the deepest water levels in the late summer ranged between 100 to 150 feet bgs. At this level there is sufficient margin for running Wells 2 and 3 as the pumps are set at approximately 180 and 200 feet, respectively.

In 2011 and 2012, spring water levels showed a marked decline from previous years, recovering to between 105 and 115 feet bgs. The levels in late summer also declined with just enough margin in 2012 to continue to operate through early September after which water demand drops significantly with the end of the vacation season. A detailed view of the 2012-13 period is shown on Figures 4a, 4b, and 4c. This series shows water levels from a transducer installed in Well 1, which is situated between Wells 2 and 3 (note that this level is somewhat shallower than the levels from the charts for Wells 2 and 3 used to construct Figure 3). The transducer data from Well 1 provides a continuous record with the exception of several weeks in the summer 2012 when the well was deepened.

Figure 4a indicates that the spring recovery in 2013 was 12.5 feet deeper than the preceding year (89 feet versus 76.5 feet). Figure 4b shows that in 2012, the water level was stable in late August and through the Labor Day weekend and there was sufficient water level margin above the pump in Well 3 to operate efficiently. By late 2013, the water level data from Well 1 transducer declined more steeply at the end of June and by late August, both Wells 2 and 3 had been taken off line and system deliveries from CCWD were taken through the inter-tie. When the wells were brought back on line in late September, water levels were relatively stable at about 120 feet bgs. The higher level is due to recovery when the wells were off line and a result of decreased demand.

Figure 4c shows that the steep water level decline in July 2013 corresponded to increased production compared to the same period the year before. In July 2013, water production was 7.8 million gallons, up from 6.8 million gallons in July 2012. Along with the decline in spring water level recoveries, the increase in 2013 water usage was a direct factor leading to use of supplemental water from CCWD in late August 2013.

2.4 Recharge and Available Groundwater Supply

Spring water levels are an indicator of recharge and groundwater replenishment. A balance in recharge and pumping must be achieved over the long-term for the source of supply to be characterized as sustainable. As noted in the preceding section, spring water level recoveries in the White Pines Lake wells changed after 1997 when the depth to groundwater in the White Pines Lake wells did not reach the ground surface for the first time. In 2012 and 2013, the spring water level recovery fell further to 100 feet bgs in 2012. As groundwater level reflects storage in the aquifer system, the decline in spring water levels indicates a change in available supply at the start of the high demand period from April to September.

Recharge occurs with precipitation, snowpack, and runoff. The Sierra snowpack provides water storage in winter months and a source of supply via runoff in summer months when demand is highest. A balance between pumping and recharge may not be achieved in every water year type and groundwater levels may decline over several dry years, but then recover in normal to wet years. The seasonal fluctuations in water levels for the White Pines Lake wells, shown in Figure 3, shows a balance in pumping and recharge from 1988 through 2006, even with the declines in between 1997 and 2006. This is because the spring water levels in 2004-05 and 2006-07 matched historical levels. Even at the lower levels observed in 2007 to 2011, there were no constraints in meeting high summer demand with Wells 2 and 3. In contrast, the subsequent deeper level observed in the spring 2013, along with increased usage during July (by 1 million gallons compared to the previous year), led to shutting off the wells and taking CCWD water deliveries for several weeks in late August and September.

To relate observed water level recoveries to recharge, we examined snowpack patterns from various weather stations near Arnold (precipitation data reflect similar trends). Figures 5a and 5b show cumulative departure from mean snow depth in the Arnold vicinity (Bloods Creek station). Figure 5a shows cumulative departure from average snow depth from 1978 to present, with multi-year droughts in 1987-92 and 2007-2009 highlighted. Figure 5b superimposes the seasonal water level history for the White Pines Lake wells on the departure curve. Examination of Figures 5a and 5b does not show a strong correlation between snowpack and water levels except in recent years when it appears that the 2007-09 drought followed by dry years in 2012 and 2013 led to the lack of water level recovery in 2012 and 2013.

While the declining spring water level recoveries in recent years may be attributed to low recharge, the relationship does not appear to hold for the period between 1988 and 2000 when water levels recovered during all water year types including the earliest years when water production was higher due to CCWD usage (see Figure 2). This may be explained by the very high departure in the snow depth above the mean, which peaked in the mid-1980s. Here, as observed throughout the Sierras and the state, a very high cumulative departure from average precipitation and snow depth may have provided high levels of storage in hard rock aquifers. Subsequent pumping from the White Pines Lake wells (even at over 100 million gallons per year in the late 1980s) did not deplete storage through the 1987-92 drought. Considering the record since 1978, it is noted that the cumulative departure shown in Figures 5a and 5b was several times that in subsequent wet years making the mid-1980s anomalous.

From the above, the availability of supply for the White Pines Lake wells is a function of significant climate variations with the lack of water level recovery in the past two years having a direct effect on BLSMWC well operations by late summer. Such a condition should be expected to worsen if dry conditions continue. This working hypothesis is a reason that BLSMWC should seek to develop well sites that draw groundwater from expanded recharge areas.

2.5 Source Capacity

Source capacity for wells is defined under Title 22 California Water Works Standards. For hard rock wells, as cited previously, discount factors are applied to pump tests to account for uncertainty of the resource. At present, the rated capacities of active Wells 2 and 3 are 70 gpm and 280 gpm, respectively, for a total source capacity of 350 gpm. In addition, BLSMWC has a backup source of supply from the inter-ties with CCWD. CCWD stated in its 2010 Urban Water Management Plan that it has sufficient capacity to serve all of BLSMWC water requirements from these inter-ties.

Based on historical well production and water levels, and the increased pumping and water level decline observed in summer 2013, it may be concluded that the White Pines Lake wells, while having a satisfactory rated capacity, cannot provide their rated capacity in multiple dry years without more stringent conservation (to prevent the high usage in July 2013), or developing additional well sources, or both. Once groundwater source capacity is sufficient in all water year types, additional well capacity in the event a primary source is out of service for an extended time may be desired, noting that CCWD inter-tie provides a short-term emergency supply.

3.0 ADEQUACY OF SOURCE CAPACITY

3.1 Source Capacity versus Demand

A comparison of source capacity and water demand is depicted on Figure 2. In accordance with the California Waterworks Standards (Title 22), water systems shall at all times possess sufficient source capacity to meet the maximum day demand (MDD) of the system. As indicated in the previous section, the rated source capacity of the BLSMWC wells is 350 gpm. As depicted on Figure 2, the source capacity is adequate for the current MDD of 316 gpm, but additional source capacity is required to meet the build-out MDD of 375 gpm. Additional source capacity will be required once the system exceeds 1,895 service connections.

It is good engineering practice for systems that rely only on groundwater to have the ability to meet the system’s MDD with the highest capacity well offline. In other words, systems that have only well sources must have a backup source in order to reliably meet required levels of service at all times. There are also regulatory requirements set forth in Title 22 that address this.

As noted in the previous section, while the wells did not meet the system requirements in the late summer 2013 due to lack of recharge in the preceding winter, BLSMWC utilized the backup emergency source of supply (i.e. CCWD inter-tie) to meet its water requirements. The inter-tie with CCWD is considered a backup source that is to be used when there are interruptions to regular well source capacity, which satisfies good engineering practice and also meets the Title 22 requirements for providing a backup source.

Although BLSMWC can meet its current water requirements through a combination of well source capacity and emergency connections, BLSMWC has a stated goal of meeting source capacity requirements using its own well sources. As BLSMWC seeks to expand groundwater source capacity in the near term, there is possible use of CCWD water if the 2013-14 winter is manifested as a third consecutive dry year. While this is a concern of water agencies throughout the state, the lack of tools to quantify the relationship between pumping and recharge in hard rock settings likely requires even higher source capacity margins to ensure that the supply is sufficient in multiple dry years.

BLSMWC has identified candidate sites and is conducting drilling exploration and testing to achieve this objective. It should be noted that the testing conducted to date is not designed to comply with Title 22 recommendations for source capacity testing for two reasons: 1) there is no ability to conduct long duration (e.g. 10-day) testing due to discharge limitations; and, 2) CDPH does not require source capacity testing for the system at present.

3.2 Recommendations for Groundwater Exploration

BLSMWC seeks to conduct exploration drilling to assess and develop new well sources to supplement the White Pines Lake wells. Based on the analysis presented in this memorandum, the objective of groundwater exploration is to provide sufficient supply during multiple dry years. Recent work included compiling and ranking candidate sites and results of drilling at three locations for which access and testing agreements were obtained.

3.2.1 Criteria for Sites

Over the past year, BLSMWC has identified and assessed nearly 20 sites using the following criteria:

- Site is compatible for use as a water supply source in a public water system (examples of compatible sites are open spaces at schools or parks);
- Site can satisfy control zone and minimum offsets from contamination sources;
- Site can satisfy CEQA and DWSAP requirements;
- Feasible and reasonable cost to connect to power utility;
- Reasonable cost to connect to the BLS mainline;
- Site must be sufficiently large for handling pump test water;
- A purchase option can be obtained that allows feasibility testing (e.g., test hole drilling).

As related to source capacity testing, a main constraint in the Arnold area is the lack of access to a permitted storm system to handle test water. As a result, test water has been discharged to land, which requires 24-hour monitoring and has limited tests to about a day.

3.2.2 Lucia and Borad Sites

Drilling at the Lucia and Borad sites encountered water-bearing fractures in hard rock formations. Subsequent testing indicated favorable water quality, but the yields were low, about 50 gpm, as compared to the White Pines Lake wells. The specific capacities in the Borad and Lucia were less than 1 gpm/ft, or about one tenth that for the White Pines Lake wells. As shown in Figure 6, which simulates drawdown at 50 gpm using interpreted fracture properties at each site, there is significantly greater drawdown associated with pumping at Lucia and Borad compared to White Pines Lake wells. Noting that another boring on CCWD property near the Moose Lodge encountered no water bearing fractures, exploration drilling and testing to date have been more consistent with hard rock settings described by DWR (2004) and in the Nevada County survey by Page (1984). As a result, conditions at White Pines Lake appear to be anomalously favorable. Therefore, development of additional sources should be based on the expectation that yields will be up to 50 gpm with higher drawdowns than experienced at White Pines Lake.

3.3 Surface Water and Conjunctive Use

Although BLSMWC seeks to be independent from CCWD other than for short-term emergency use, a key strategy to address dry-year shortages throughout the state is conjunctive use of groundwater and surface water. In most cases this involves using surface water in wet to normal years to supplement and reduce groundwater pumping, thus permitting groundwater levels to recover. Then, in dry years when surface water is scarcer, a greater fraction of groundwater that has been stored in the aquifer system may be pumped. For BLSMWC, such an approach is complicated by difficulty in quantifying aquifer conditions and identifying the sources of recharge in a hard rock setting. Nevertheless, future planning should recognize that climate change projections by DWR and others indicate that snowpack and precipitation patterns throughout the Sierra Nevada region will change in a manner that adversely affects groundwater recharge and storage.

We look forward to discussing this memorandum with you upon your review.

Enclosures

Figure 1 – Historic Water Production and Usage
Figure 2 – Water Requirements – Current and Build-out
Figure 3 – Well Production and Seasonal Water Levels
Figure 4a – Comparison of Spring Water Levels in 2012 and 2013
Figure 4b – Comparison of Late Summer Levels in 2012 and 2013
Figure 4c – Water Production versus Water Levels
Figure 5a – Conjunctive Departure from Mean Snow Depth (inches)
Figure 5b – Cumulative Departure from Mean Snow Depth and Seasonal Water Levels
Figure 6 – Simulated Drawdown Comparison

Appendix: Well Profiles