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Pine Strawberry Water Improvement District (PSWID)
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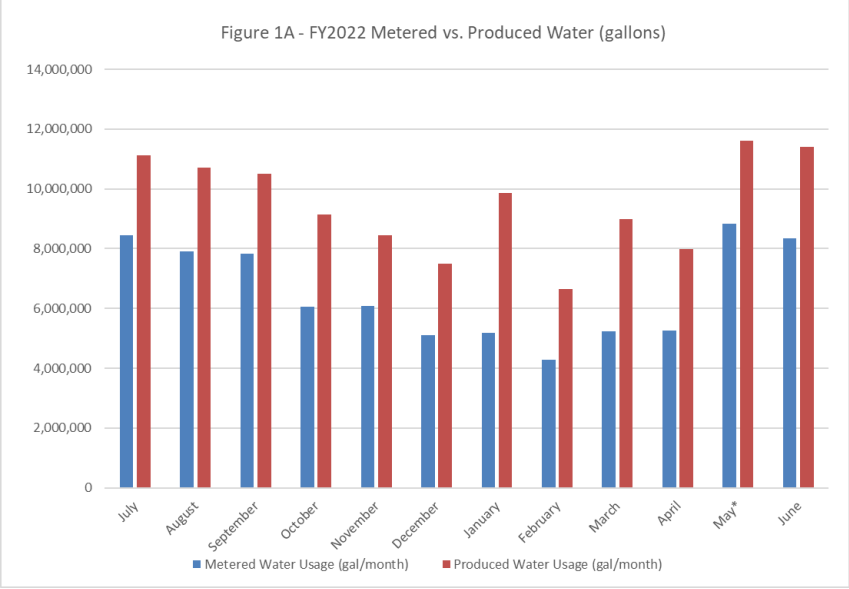
**Subject:** **Technical Memorandum – Source/Demand Analysis & Recommendations (FY2022)**

## INTRODUCTION

The Pine-Strawberry Water Improvement District (PSWID) operates the Pine and Strawberry water systems. In recent years, the District has become increasingly concerned about the systems ability to meet the demand of customers and have issued a "Will Serve Letter Moratorium" in March of 2021. The District has embarked on a significant Capital Improvement Program (CIP) that include water main replacements to reduce leaks/water losses and development of new water sources (wells) to meet demands. The District has requested an updated technical memorandum for FY2022 to perform a source versus demand analysis and recommended actions for the Board of Directors to consider. In response to this request Sunrise Engineering has, using information provided by PSWID, performed an analysis of the systems historical water use, evaluate existing well capacity, apply industry standard design criteria and provide recommend actions to navigate through the deficiencies identified.

## HISTORICAL WATER DEMAND ANALYSIS

The District provided the system water use data for FY2022 to be used as part of this analysis [4]. This included both water produced data (from the system wells) and meter reading data. The District does not record "real-time" data. Figure 1A – FY2022 Metered vs. Produced Water shows the differences between the two indicating the system experiences significant losses due to leaks, breaks and unmetered connections. On average the system experienced 32% in annual losses for FY2022. This is more than double than the 16% average for public water systems [1].



In order to understand the water usage (indoor and outdoor) experienced by the system the FY2022 water meter reading data provided by PSWID was analyzed on a monthly basis. The peak month for demands occurred in May 2022. The meter reading data does not include the water losses experienced by the system; therefore, the "true" demand experienced by the system (what the water sources need to produce) should include a loss factor applied to these measured demands. Based on the average losses calculated above this loss factor should be 1.32 for FY2022. A summary of the demands and calculations for Average Daily Demand (ADD) and Maximum Month Demand (MMD) are shown in Figure 2A – PSWID Monthly Water Demand (FY2022).

*Figure 2A – PSWID Monthly Water Demand (FY2022)*

| FY2022 USAGE | | Total System Metered Water Usage Summary by Month | | | | |
|---|---|---|---|---|---|---|
| Month | Days per Month | Number of Accounts | Metered Water Usage (gal/month) | Metered Water Usage (gal/day) | Metered Water Usage (gal/min) | Metered Water Usage (gal/conn/day) |
| **July** | 31 | 3,260 | 8,453,713 | 272,700 | 189 | 84 |
| **August** | 31 | 3,248 | 7,914,850 | 255,318 | 177 | 79 |
| **September** | 30 | 3,245 | 7,835,531 | 261,184 | 181 | 80 |
| **October** | 31 | 3,238 | 6,052,302 | 195,236 | 136 | 60 |
| **November** | 30 | 3,246 | 6,091,620 | 203,054 | 141 | 63 |
| **December** | 31 | 3,251 | 5,097,574 | 164,438 | 114 | 51 |
| **January** | 31 | 3,243 | 5,176,410 | 166,981 | 116 | 51 |
| **February** | 28 | 3,241 | 4,284,221 | 153,008 | 106 | 47 |
| **March** | 31 | 3,258 | 5,232,188 | 168,780 | 117 | 52 |
| **April** | 30 | 3,252 | 5,258,804 | 175,293 | 122 | 54 |
| **May*** | 31 | 3,252 | 8,833,603 | 284,955 | 198 | 88 |
| **June** | 30 | 3,259 | 8,343,024 | 278,101 | 193 | 85 |
| *Peak Month | **Average** | **3,249** | **6,547,820** | **214,921** | **149** | **66** |

| | Without Loss Factor | With Loss Factor | |
|---|---|---|---|
| **Annual Average Daily Demand (ADD)** | **214,921** | **282,763** | **gal/day** |
| **Annual Average Daily Demand (ADD)** | **149** | **196** | **gpm** |
| | | | |
| **Maximum Month Demand (MMD)** | **284,955** | **374,904** | **gal/day** |
| **Maximum Month Demand (MMD)** | **198** | **260** | **gpm** |

The District has a unique water demand profile because the system experiences high water demand over the weekends as compared to the weekdays due to the presence of vacation rentals and weekend homes. The demand variation is especially more dramatic during major holiday weekends such as Memorial Day, Independence Day, and Labor Day. During multiple interviews with the operators of PSWID, it was re-iterated that the system experiences roughly twice the demands during the weekends (Saturday and Sunday) when compared to the weekdays. This is likely even more acute (more than twice the demand) during holiday weekends. As evidence of this, the nearby community of Payson experiences a similar demand of 2.5 times average daily demand [2].

For the purposes of this technical memorandum and until the District measures "real-time" data (multiple data points) during these holiday weekends a Maximum Day Demand (MDD) factor range of 2.0 to 2.5, applied to the ADD, will be used to estimate the largest volume of water delivered to the system in a single day. MDD is what the water supply (wells and transmission lines) should be designed to handle. A summary of the demands and calculations for Maximum Day Demand (MDD) are shown in Figure 3A – PSWID Maximum Day Demand (MDD) FY2022. An MDD peaking factor of 2.0 to 2.5 falls within industry standards as evidenced Table 2-1 of the PSWID Water System Master Plan completed by CH2MHill in 2014 [5].

*Figure 3A – PSWID Maximum Day Demand (MDD) FY2022*

| | | | |
|---|---|---|---|
| **Maximum Day Demand Factor** | **2.0** | **Estimate Weekend Demand** | |
| | **Without Loss Factor** | **With Loss Factor** | |
| **Maximum Day Demand (MDD)** | **429,842** | **565,527** | **gal/day** |
| **Maximum Day Demand (MDD)** | **298** | **392** | **gpm** |
| | | | |
| **Maximum Day Demand Factor** | **2.5** | **Estimate Holiday Weekend Demand** | |
| | **Without Loss Factor** | **With Loss Factor** | |
| **Maximum Day Demand (MDD)** | **537,303** | **706,908** | **gal/day** |
| **Maximum Day Demand (MDD)** | **373** | **490** | **gpm** |

Based on these estimated calculations, with a loss factor, the District's system should include enough water source (well capacity) for 566,000 gallons per day or 392 gallons per minute at an MDD Factor of 2.0 and 707,000 gallons per day or approximately 490 gallons per minute at an MDD Factor of 2.5 for FY2022 if there is no reduction in demand or water loss within the system. In FY2022 the system averaged approximately 3,249 connections. Based on this MDD Average (FY2022), each connection represents approximately 174 gallons per day or 0.12 gallons per minute of source usage at an MDD Factor of 2.0 and 217 gallons per day or 0.15 gallons per minute of source usage at an MDD Factor of 2.5.

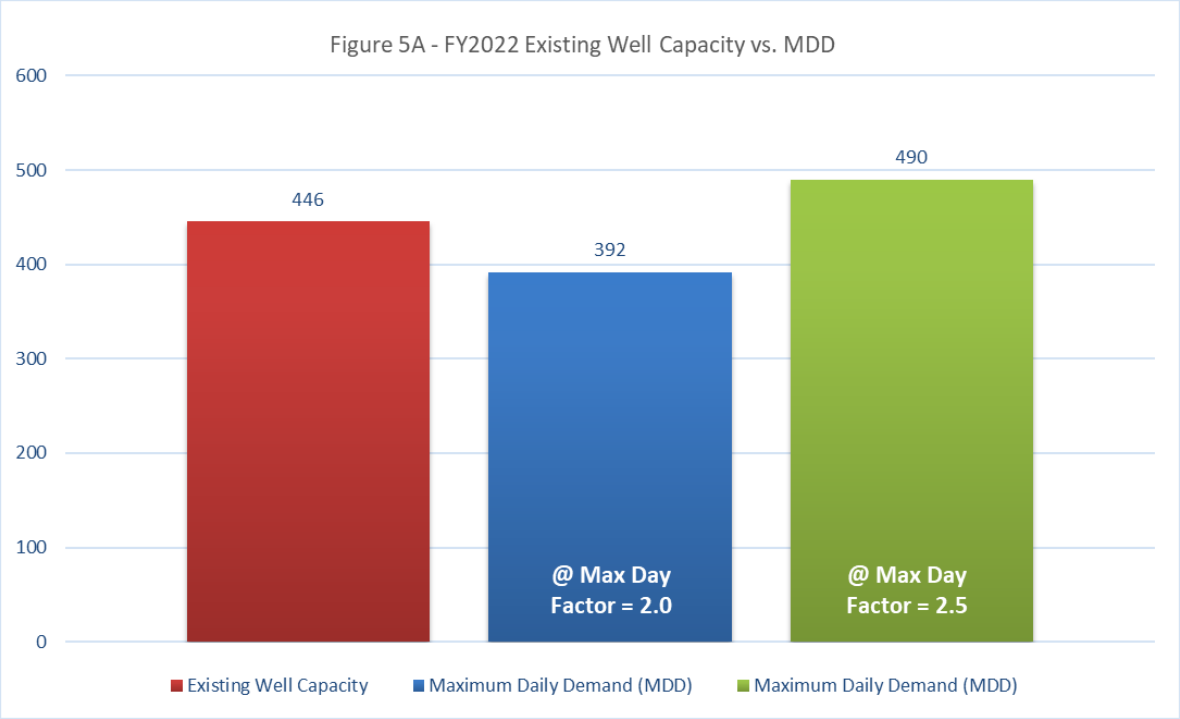
## EXISTING SOURCE AVAILABILITY

The District currently owns/operates 22 water production wells within the distribution system [3]. Some of these wells are owned by entities, other than the District, but deliver water through a "Water Share Agreement" (WSA). Many of these wells are shallow, small producing wells that are subject to fluctuating groundwater levels that impact their ability to deliver water to the system. A summary of the District's current well capacity is shown in Figure 4 – PSWID Current Well Capacity (FY2022).

*Figure 4 – PSWID Current Well Capacity (FY2022)*

| # | Site Name | Registration Number | Depth (FT) | Current Well Capacity (GPM) | | | NOTES |
|---|---|---|---|---|---|---|---|
| 1 | B (WSA) | 55-571532 | 200 | 18 | | | Water share agreement (WSA). |
| 2 | BT-1 (Brookview Terrace 1) | 55-613695 | 200 | 15 | | | Currently operational. |
| 3 | BT-2 (Brookview Terrace 2) | 55-613688 | 170 | 16 | | | Currently operational. |
| 4 | CT (Canyon Tanks Well) | 55-519445 | 190 | 6 | | | Currently operational. |
| 5 | J1 (WSA) | 55-586130 | 400 | 30 | | | Water share agreement (WSA). |
| 6 | J2 (WSA) | 55-586129 | 400 | 28 | | | Water share agreement (WSA). |
| 7 | M (WSA) | 55-561197 | 440 | 23 | | | Currently operational. |
| 8 | MRW1 (Milk Ranch 1) | 55-210454 | 1050 | 19 | | | Currently operational. |
| 9 | MRW2 (Milk Ranch 2) | 55-210454 | 802 | 18 | | | Currently operational. |
| 10 | MRW3 (Milk Ranch 3) | 55-221551 | 800 | 85 | | | Highest production well within PSWID |
| 11 | P-1 (Portal 1 - Field Office) | 55-603958 | 233 | 18 | | | Currently operational. |
| 12 | PW-3 (Portal 3) | 55-603963 | 480 | 21 | | | Currently operational. |
| 13 | SH-1 (Strawberry Hollow 1) | 55-635796 | 252 | 15 | | | Currently offline for winter. (WSA) |
| 14 | SH-3 (Strawberry Hollow 3) | 55-587628 | 1320 | 15 | | | Currently operational. |
| 15 | SR-5 (Strawberry Ranch 5) | 55-635779 | 400 | 12 | | | Currently operational. |
| 16 | STDWID 2 WSA | 55-547869 | 200 | 7 | | | Water share agreement. |
| 17 | STDWID1 (WSA) | 55-542283 | 500 | 24 | | | Water share agreement. |
| 18 | SV-1 (Strawberry View 1) | 55-635774 | 400 | 28 | | | Currently operational. |
| 19 | TF (Tank Farms) | 55-807338 | 755 | 22 | | | Currently operational. |
| 20 | W (WSA) Strawberry | 55-588181 | 400 | 11 | | | Currently offline for winter. (WSA) |
| 21 | PW-2 (Portal 2) | 55-603961 | 280 | 12 | | | Currently operational. |
| 22 | SH-2 (Strawberry Hollow 2) | 55-635775 | 280 | 3 | | | Currently offline for winter. (WSA) |
| | | **TOTAL (GPM)** | | **446** | **GPM** | | |
| | | **TOTAL (GPD)** | | **642,240** | **GPD** | | |

In summary, the District currently has 446 gallons per minute capacity (642,240 gallons per day) of source capacity of the system. This capacity does not meet the requirements of the FY2022 Maximum Day Demand (MDD). It is important to note that the gallons per day calculation is based on the wells running for 24 hours straight. Figure 5A – FY2022 Existing Well Capacity vs. MDD, expressed in gallons per minute (gpm) illustrates a slight surplus at a MDD Factor of 2.0 and deficit at a MDD Factor of 2.5 for FY2022, to meet current demands.




## DESIGN CRITERIA GUIDANCE

When evaluating a systems capability to provide necessary source water it is good engineering practice to not only consider the ability to meet the MDD, but also have provisions for redundancy and a safety factor. Wells often need to be serviced, break down or in the case of drought the water levels in the wells drop below the ability to pump. Water supply systems often use what is called "Firm Capacity" to accomplish these provisions.

Firm Capacity is where the "available capacity" of a system, in this instance the well production, is limited to the total capacity of all the well production, less the largest well is out of service. In the case of PSWID, Milk Ranch #3 is the largest producing well at 85 gallons per minute. This assumes that the Pine and Strawberry systems are connected and water can be moved between each system. Currently, the PSWID does not meet this "Firm Capacity" criterion and there is no margin/safety factor/redundancy. If the Milk Ranch #3 well is inoperable, even for a short period of time, especially in the summer months, the District would struggle to provide enough source capacity to the system. Figure 6A – FY2022 "Firm Capacity" vs. MDD, expressed in gallons per minute (gpm) illustrates deficits to meet current demands. Figure 7A – FY2022 PSWID Current Well Capacity vs. Maximum Day Demand (MDD) summarizes both the existing and "firm" capacity of the wells within the system against the system demands.

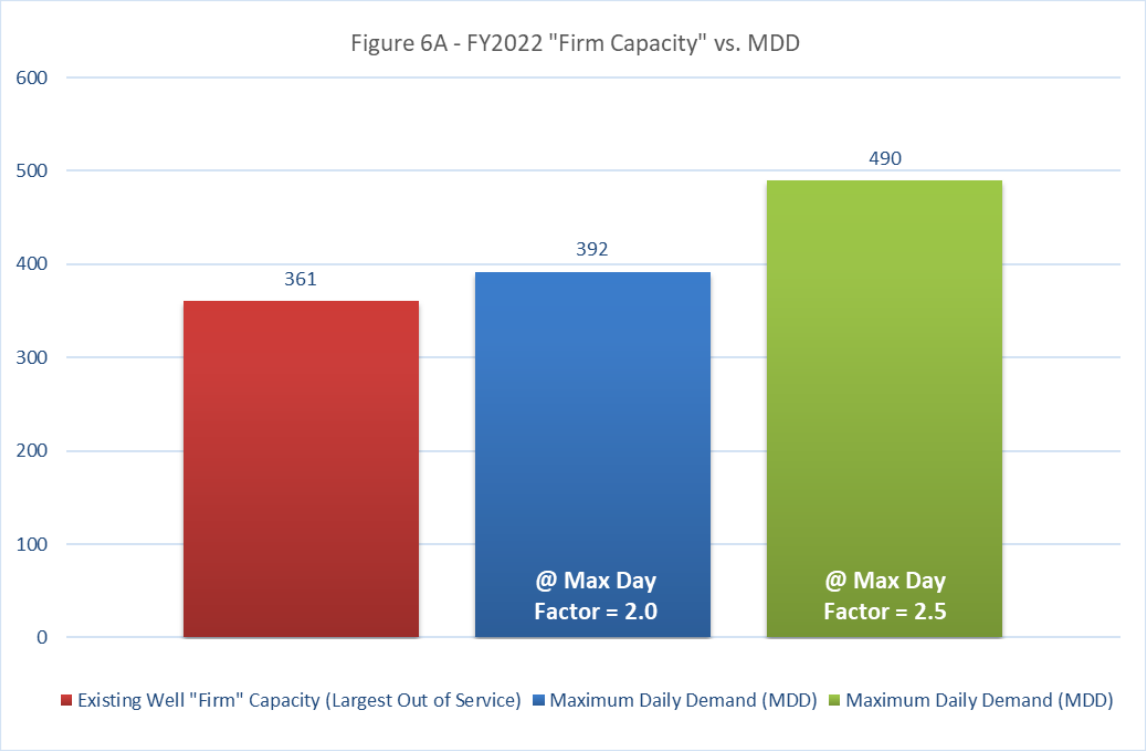



*Figure 7A – FY2022 PSWID Current Well Capacity vs. Maximum Day Demand (MDD)*

| Max Day Factor | Units | Maximum Daily Demand (MDD) | Existing Well Capacity | Surplus/(Deficit) | Existing Well "Firm" Capacity (Largest Out of Service) | Surplus/(Deficit) |
|---|---|---|---|---|---|---|
| **2.0** | GPM | 392 | 446 | 54 | 361 | (31) |
| | GPD | 565527 | 642240 | 76713 | 519840 | (45687) |
| | | | | | | |
| **2.5** | GPM | 490 | 446 | (44) | 361 | (129) |
| | GPD | 706908 | 642240 | (64668) | 519840 | (187068) |
| | | | | | | |

In summary, the PSWID sources (wells) do not currently meet the maximum daily demand (MDD) for "Firm Capacity" or "Existing Capacity". This is a condition where the District should work diligently to develop additional water sources to remedy the shortfall for both existing users and provide for additional growth. This technical memorandum highly recommends that the District focus on developing "Firm Capacity" to meet the system demands.

## RECOMMENDATIONS

Based on the analysis performed above, we have developed some action items for the PSWID to consider moving forward. These recommendations are presented in priority from highest to lowest.

**Recommendation #1A – Develop More Source:** The District should develop additional sources (wells) for the system to meet "Firm Capacity" for current demands and include a provision for future development/connections. Currently, the District is developing an additional well within the Strawberry system. It is unlikely, that this well alone will make-up the current deficit. Based on this probability, the District should invest in additional well(s) improvements to increase source capacity in the system. This could be accomplished with a new (deeper) well location(s) to possibly accomplish higher yields.

**Recommendation #1B – "Real Time" Data:** The data used to develop this analysis is based on monthly usage provided by the District. Due to this fact the Max Day Demand factor used is an estimate based on industry standards and information from a nearby community (Town of Payson). If the District were to compile more "real time" (daily) usage and/or source production data, especially during the summer months, it would enable the better approximation of a Max Day Demand factor for the PSWID system, specifically. This factor could be higher or lower than the one used in this technical memorandum. A higher factor would require more source, a lower factor would require less source to be developed but would ultimately reflect actual PSWID demand conditions.

**Recommendation #2 – Fix Distribution System Leaks:** The water losses within the distribution system are above average and are due to leaks and unmetered connections. The leaks in the system act as an additional "demand" on the system. If these leaks can be repaired, it effectively reduces the amount of additional source (wells) that will need to be developed. It is important to note that if a large portion of the water losses within the system are unmetered connections, they will not reduce the demand to the system. The District is currently working to replace many existing older, leaking mains within the distribution system. Water demand should be monitored throughout the year, as construction on these distribution system improvements are completed, and compared with previous year demands to monitor how much of an impact is being realized from repairing leaky portions of system.

**Recommendation #3 – Water Conservation Education:** One way of potentially reducing demand is education to make the community more aware of the need for water conservation. The District should investigate implementing opportunities developed by the Water Enhancement Committee to conserve water. This could include signs throughout the community, workshops, mailers/emails with education pieces to deliver this message to the users within the system.

**Recommendation #4 – Reduce/Restrict Outdoor Watering:** The PSWID currently allows outdoor watering. There is no tracking mechanism in place now to know, even approximately, what percentage of the total water demand is for outdoor uses. One strategy to reduce demand would be to short and/or long term eliminate this option and restrict water use to indoor needs only. In the short term, this will reduce the demand while the District develops new sources of water. If this option is implemented long-term/permanently, water demand should be monitored throughout the year to determine how much of a reduction occurs from eliminating outdoor uses. If the outdoor use elimination shows marked decrease in demands the District would not have to develop additional source to meet these demands. This will likely be an unpopular recommendation with connections that currently conduct outdoor watering.

**Recommendation #5 – More Aggressive Tiered Water Rates:** The last recommendation for the District to consider would be more aggressive tiered water rates based on consumption. This could be used to curtail demand on the system because as more water used by each connection, the more expensive the water bills will be for customers. Some customers will make changes, others will not. Due to the nature of second homes and weekend rented properties an aggressive tiered water rate may not have as large an impact to reduce demand and will place more burden on the full time residents within the community.

In closing, the findings of this technical memorandum indicates that the PSWID system requires more source to meet the "Firm Capacity" criteria for both existing demands and future connections to the system. In addition, the District can implement strategies to reduce demand within the system to off-set the amount of additional source required. The District should carefully consider and implement some or all of the recommendations outlined in this memorandum that work best for the District and their users.

## REFERENCES


[1] EPA – Water Audits and Water Loss Control for Public Water Systems

[2] Water Master Plan for Water Works System Serving the Town of Payson (2011)

[3] Pine-Strawberry FY2022 well inventory data (PSWID Data)

[4] Pine-Strawberry FY2022 water meter and well production data (PSWID Data)

[5] Pine-Strawberry WID – Water System Master Plan 2014 (CH2MHill) – Excerpt below:

As noted, since no real-time data are available, a MDD PF of 2 is recommended based on discussions with District Staff, data from surrounding communities, and industry standards. Due to the same real-time data constraint, hourly flow data was not available for analysis to develop the peak hour demand (PHD) PF. Therefore, a PHD factor of 3 (PHD to ADD) is recommended, based on the peaking factors of surrounding communities (Payson's MDD:ADD was 2.5 as noted in Appendix A) and industry standards. A summary of several industry references regarding ranges of peaking factors for MDD and PHD are noted in Table 2-1 below:

TABLE 2-1
**Peaking Factor Summary from Reference Material**

| Reference | MDD: ADD Ratio | PHD:ADD Ratio |
|---|---|---|
| Water Distribution Modeling[2] | 1.2—3.0 | 3.0—6.0 |
| Water Distribution Systems Handbook[3] | 1.5—3.5 | 2.0—7.0 |
| Davis' Handbook of Applied Hydraulics[4] | 1.5—3.0 | 2.0—4.0 |

[2] Walski, Thomas M. et al., *Water Distribution Modeling*, First Edition, June 2001. ISBN: 0-09657580-4-4.

[3] Mays, Larry W., *Water Distribution Systems Handbook*, 2000, page 3.9.

[4] Velon, J.P., and T.J. Johnson, "Water Distribution and Treatment." *Davis' Handbook of Applied Hydraulics*, 4th Edition, McGraw-Hill, New York, 1993.


## DEFINITIONS

Average Daily Demand (ADD): The total volume of water delivered to the system over a year divided by 365 days. The average use in a single day is gallons per day and/or gallons per minute over 24 hours.

Maximum Month Demand (MMD): The gallons per day and/or gallons per minute over 24 hours average during the month with the highest water demand.

Maximum Daily Demand (MDD): The largest volume of water delivered to the system in a single day expressed in gallons per day and/or gallons per minute over 24 hours. The water supply (wells, treatment plants and transmission lines) should be designed to handle the maximum day demand.

Firm Capacity: The available capacity of a system or process with the largest unit out of service.