Madison Water Utility
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Report: **Consider Setting a Range of Revised Water System Demands Based On Proposed Conservation Goals And Establishing Other System Evaluation Criteria Used in the Distribution System Hydraulic Model**

Legistar No. 11715

Date: Friday, August 22, 2008

To: Madison Water Utility Board

From: Al Larson P.E.
Principal Engineer

Purpose:

A series of engineering evaluation criteria is used in the distribution system computer model to identify system deficiencies. These criteria are based on sound professional engineering practice, regulatory requirements, industry standards, and Madison standards. With the adoption of the Public Participation SOP and the Utility Sustainability Plan, there is a need to itemize criteria used in system evaluation. Using the established evaluation criteria, the distribution system hydraulic system computer model will be used to evaluate and determine project justification and need. This memo will layout the basic assumptions, projections, and criteria used in that system and project analysis.

Definitions

Average Day Demand: Total annual water demand divided by 365 days.
Maximum Day Demand: Highest 24 hour demand within any calendar year. Highest single day demand that typically occurs in July.
Maximum 10-Day Demand: Highest demand of a 10-day period during the year.
Pressure Range Goals: Ideal pressure range delivered to the customer in all conditions.
Storage Capacity Requirements: Volume of storage needed to meet operational and emergency needs.
Fire Flow Requirements: Rate of flow available and length of supply needed to provide the desired level of fire protection in the system. Fire flow requirements are dependent upon property zoning and fire department needs and requirements.
Water Supply Capacity: Capacity of the system to meet demands and maintain reservoir levels during high demand conditions with wells down for maintenance.

Criteria

Average Day Demand: Average day demand is based on historical usage by customer class in conjunction with projected development and population trends. Historical water sales for Madison Water Utility since 1960 as reported in the Utility PSC annual report are presented in attached Figure 1. Stated conservation goals of 20% reduction in residential water use by the year 2020 have been applied to the demand projections established in the 2006 Master Plan and are presented in Figure 2 and Table 1 along with current Master Plan water projections. In reference to the 20% reduction in demand stated as a conservation goal, the 2006 Master Plan growth rates have been reduced 20% and this is proposed to be the upper range of the demands. **Recommendation:** For the purposes of system evaluation, it is recommended that the Utility establish a range of demand projections between the adjusted 2006 Master Plan projections (upper limit) and the conservation goals (lower limit) as indicated in Figure 2 and Table 1. This recommendation would base system analysis on a range of demands that would be lower than current 2006 Master Plan projections. System performance will be evaluated between the upper and lower ranges as noted. It is further recommended that these water demand projections be routinely updated every 3 to 5 years to more accurately reflect actual conditions and development trends.

Table 1

Projected Total Average Day Water Demands (mgd)

	2006 Master Plan	**Adjusted Master Plan (Upper Range)**	**Revised w/conservation (Lower Range)**
2005	33.21	**33.21**	**33.21**
2010	34.60	**34.41**	**32.94**
2015	36.03	**35.61**	**32.76**
2020	37.74	**36.81**	**32.64**
2025	39.20	**38.01**	**33.88**
2030	41.06	**39.49**	**35.40**
2035	42.91	**40.97**	**36.92**
2040	44.77	**42.46**	**38.43**
2045	46.62	**43.94**	**39.95**
2050	48.48	**45.42**	**41.47**
2055	50.33	**46.91**	**42.99**
2060	52.18	**48.39**	**44.51**

Maximum Day Demand: Maximum day demand is based on historical demand patterns within the service area. Maximum day is used as a worst case scenario evaluation of the system. The system is designed to handle the maximum day with key components of the system out of service. **Recommendation:** It is recommended that maximum day demand will be pressure zone specific and will be per the Master Plan ratios itemized in Table 2.

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Historic Water Demand
Figure 1
August 2008

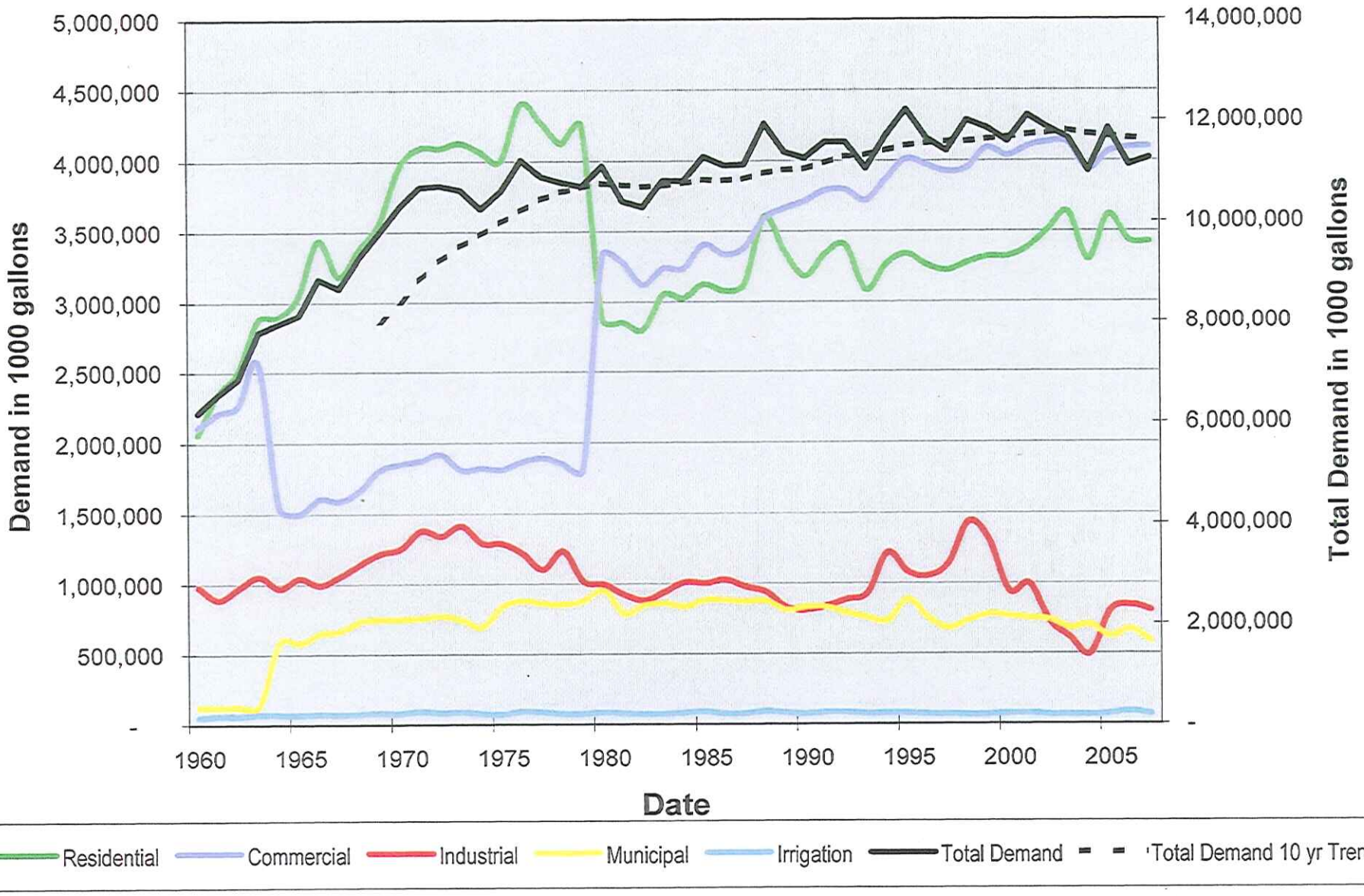

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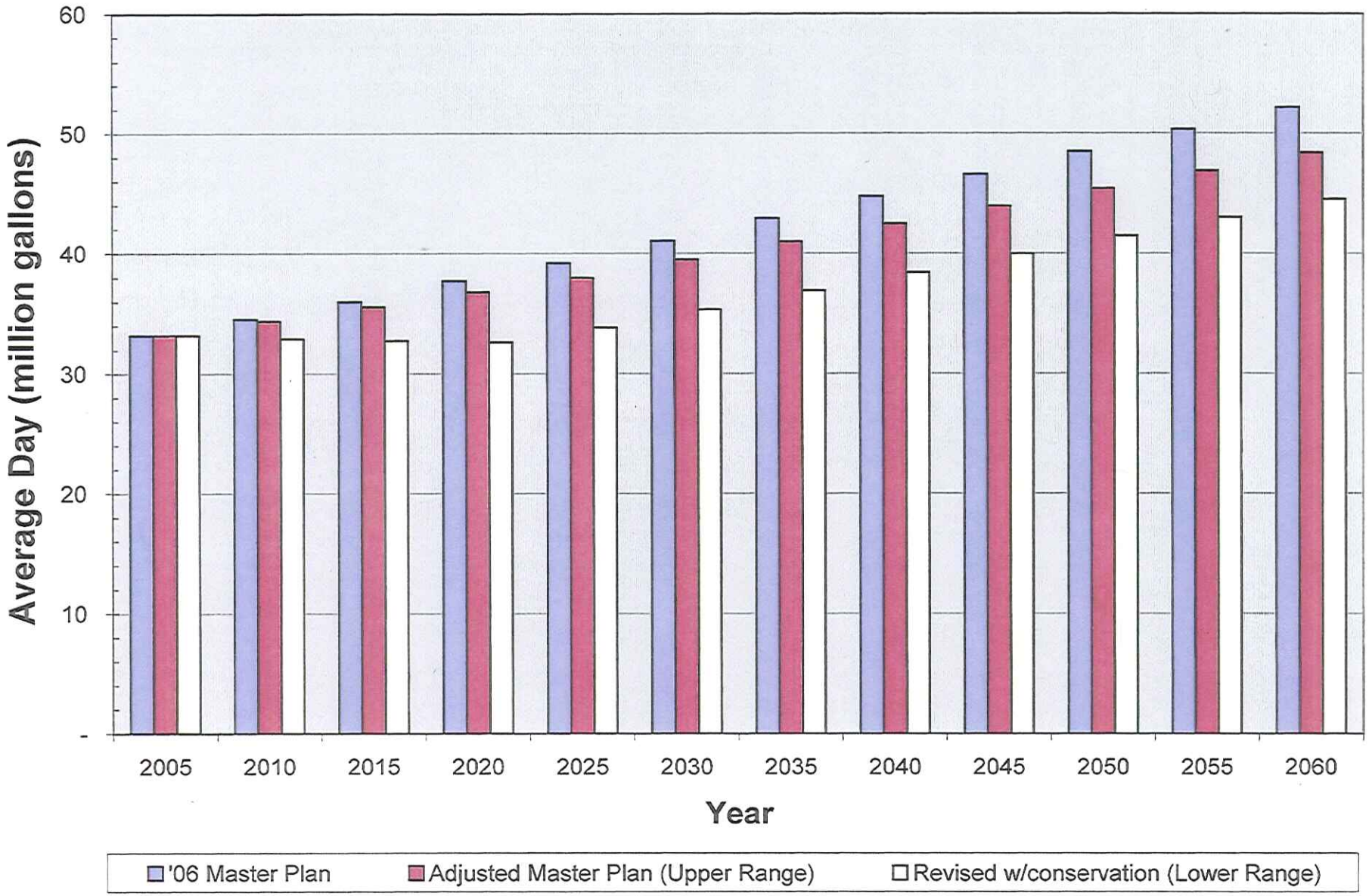
Figure 2

Average Day Water Demand Projections



Revised zone water demand projections based on the reduced average day projections and the projected conservation demands are listed in Table 3.

Table 2

Max Day and Max Hour Ratios by Zone

	2010		*2025*	
Service Zone	**MD:AD**	**MH:MD**	**MD:AD**	**MH:MD**
123	2.42	2.16	2.33	2.14
4	1.81	1.39	1.79	1.38
5	3.27	2.18	3.27	2.20
6 East	1.74	1.39	1.72	1.38
6 West	1.51	1.27	1.50	1.27
7	2.05	2.11	2.04	2.10
8	2.06	2.11	1.96	2.09
9	2.72	2.16	2.63	2.16
10	3.03	2.17	2.56	2.15
11	3.36	2.19	2.78	2.18
12			6.00	2.17

Table 3 - (Table ES-4 - Revised)

Revised Projected Max Day Demands (mgd) by Service Zone

	2010 Design Year				*2025 Design Year*			
Service Zone	**Lower Range Average**	**Lower Range Max Day**	**Upper Range Average**	**Upper Range Max Day**	**Lower Range Average**	**Lower Range Max Day**	**Upper Range Average**	**Upper Range Max Day**
123	1.58	3.82	1.65	4.00	1.62	3.78	1.82	4.24
4	1.09	1.98	1.14	2.07	1.13	2.02	1.26	2.26
5	0.14	0.47	0.15	0.49	0.15	0.48	0.16	0.54
6 East	8.41	14.62	8.79	15.28	8.65	14.90	9.70	16.71
6 West	14.04	21.16	14.67	22.11	14.44	21.62	16.20	24.25
7	3.59	7.34	3.75	7.66	3.69	7.52	4.14	8.44
8	2.91	5.99	3.04	6.26	2.99	5.87	3.36	6.58
9	0.70	1.91	0.74	2.00	0.72	1.91	0.81	2.14
10	0.33	1.01	0.35	1.05	0.34	0.88	0.38	0.98
11	0.13	0.45	0.14	0.47	0.14	0.38	0.15	0.43
12	-	-	-	-	-	-	0.01	0.06
Totals	**32.94**	**58.75**	**34.41**	**61.38**	**33.88**	**59.35**	**38.01**	**66.62**

Maximum 10-Day Demand: Maximum 10-day demand is considered to be a significant stress period on a water supply system. The ability of a system to provide adequate supply, sustain pressures, and maintain reservoir levels during the maximum 10-day demand period is critical to sustaining adequate levels of service. This extended period high demand criteria can be used to evaluate supply capacity issues and reservoir recovery. **Recommendation:** Table 4 indicates upper and lower design projections for the maximum 10-day period in the years 2010 and 2025 by pressure zone based on the revised demand projections.

Table 4

Max Month Demands by Service Zone

	2010 Design Year		*2025 Design Year*	
Service Zone	**Lower Max 10-Day Average**	**Upper Max 10-Day Average**	**Lower Max 10-Day Average**	**Upper Max 10-Day Average**
123	3.33	3.48	3.29	3.69
4	1.72	1.80	1.76	1.97
5	0.41	0.42	0.42	0.47
6 East	12.74	13.31	12.98	14.55
6 West	18.43	19.25	18.83	21.12
7	6.39	6.67	6.55	7.35
8	5.22	5.45	5.11	5.73
9	1.67	1.74	1.66	1.86
10	0.88	0.92	0.76	0.86
11	0.39	0.41	0.33	0.37
12	-	-	-	0.05
Totals	**51.17**	**53.46**	**51.69**	**58.03**

Pressure Range Goals: Providing adequate pressures to the consumer tap is required and expected for good system operation. Minimum pressures of 35 psi during normal operating conditions and 20 psi during fire flow events are required by the DNR and the PSC. The National Plumbing Code recommends a maximum pressure of 80 psi and good practice sets a maximum pressure goal of 90 psi. Maintaining adequate pressures at the tap are also necessary to minimize the risk of cross connections and the resulting water quality impacts such an event would have. **Recommendation:** It is recommended for system evaluation that the pressure goals for the system be a range of 40 to 90 psi for normal operation during the maximum day and that the pressure at any point in the system be sustained above 20 psi during a fire flow event. It is recognized that exceptions to these goals will be required in some areas due to topography and system configuration. Areas where it is not feasible or economically reasonable to meet the stated goals will be evaluated on a case-by-case basis.

Storage Requirements: System storage is a critical component of the water distribution system and provides supply dampening capacity during daily operation, provides water supply during emergency conditions such as power outages, and provides water for fire protection and public safety. Storage capacity is comprised of three components, equalizing storage, fire flow reserves, and emergency storage. Equalizing storage provides supply to the system when demand exceeds pump capacity. It is based on the maximum day demand and the available pumping capacity and generally equals 15 to 25% of the maximum day. Fire flow reserves are based on fire code requirements and will range from 120,000 to 630,000 gallons in the various pressure zones. Emergency storage has been established to be 12 hours of supply on the average day. Actual storage capacity requirements are determined pressure zone by pressure zone.

Fire Flow Requirements: Requirements for the Madison system will be as established in the 2006 Master Plan.

Table 5-2 from the Master Plan
Required Fire Flow and Duration

Fire Flow rate, gpm	Duration, hours
Up to 2,500 gpm	2
2,501 to 3,500 gpm	3
Greater than 3,501 gpm	4

Table 5-3 from the Master Plan
Design Fire Flow Goals and Storage Volumes

Land Use Category	Fire Flow Goal gpm	Fire Duration hrs	Fire Reserve Volume (MG)
LDR – Low Density Residential NPA – Neighborhood Planning Area TND – Traditional Neighborhood Development	1,000	2	0.12
MDR – Medium Density Residential NMU – Neighborhood Mixed Use	2,000	2	0.24
HDR – High Density Use CMU – Community Mixed Use GC – General Commercial	2,500	2	0.30
RMU – Regional Mixed Use RC – Regional Commercial E – Employment SI – Special Institutional D – Downtown C – Campus AP – Airport I – Industrial	3,500	3	0.63

Water Supply Capacity: Required well capacity is established in the master plan under two requirements. In all cases, as a minimum, it must be assumed that the largest source in the

zone is out of service due to a power outage or a mechanical failure. In Madison's system, the main pressure zone covers such a large area containing 16 operating wells that it is divided into two zones, 6E and 6W. For analysis to ensure reliability of supply in Zone 6 and other zones fed from Zone 6, each of the two halves of Zone 6 will be analyzed with two wells out of service. The required supply capacity is therefore:

1. With one or two wells out of service and applying maximum day demands, the supply system (the wells) shall have sufficient capacity to refill system reservoirs within a 24-hour period.
2. The supply system will be designed such that the wells will operate 21 hours per day during the annual peak 10-day period. The well system will be able to provide the required water supply and refill reservoirs during the maximum 10-day period with one or two of the largest wells out of service.
3. The supply system will be designed such that with one or two wells out of service on the maximum day, the system can meet max day demands and refill reservoirs with the wells operating 24-hours per day.

Typical Scenario Analysis Development:

The following will be considered as typical analysis scenarios. This list is not exhaustive and other scenarios will be used as necessary to fully evaluate system performance.

1. Winter day conditions with wells down for maintenance
    a. Maintain target pressures
    b. Maintain reservoir levels
2. Average day conditions with wells down for maintenance
    a. Maintain target pressures
    b. Maintain reservoir levels
3. Maximum day conditions with wells down for maintenance
    a. Maintain target pressures
    b. Refill reservoir within 24 hours
4. Maximum 10-day conditions with wells down for maintenance
    a. Maintain target pressures
    b. Refill reservoir within 24 hours
5. Fire flows
    a. Max day conditions with wells down for maintenance
    b. Maintain pressures above 20 psi at all points in the system
    c. Refill reservoirs within 24 to 48 hours max
6. Design Years
    a. 2010
    b. 2025
    c. Buildout or 2060