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Appendix F

Noise Assessment Report

2825 LAFAYETTE STREET DATA CENTER ENVIRONMENTAL NOISE AND VIBRATION ASSESSMENT

Santa Clara, California

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INTRODUCTION

This report summarizes the assessment of environmental noise and vibration impacts resulting from the construction and operation of the Data Center project proposed at 2825 Lafayette Street in Santa Clara, California. The site currently contains two office buildings and is bound to the south by an existing Digital Realty Data Center; to the north by Central Expressway; to the east by a Union Pacific Railroad line; and to the west by Lafayette Street. The project proposes to demolish the two existing buildings and construct a 2- to 3-story 552,500 square foot data center building and a substation on the site. A surface parking lot will provide 284 parking spaces on the site.

The report is divided into two sections: 1) The Setting Section provides a brief description of the fundamentals of environmental noise, summarizes applicable regulatory criteria, and discusses the results of the ambient noise monitoring survey completed to document existing noise conditions; and 2) the Impacts and Mitigation Measures Section describes the significance criteria used to evaluate project impacts, provides a discussion of each project impact, and presents mitigation measures, where necessary, to mitigate impacts to a less-than-significant level.

SETTING

Fundamentals of Environmental Noise

Noise may be defined as unwanted sound. Noise is usually objectionable because it is disturbing or annoying. The objectionable nature of sound could be caused by its *pitch* or its *loudness*. *Pitch* is the height or depth of a tone or sound, depending on the relative rapidity (*frequency*) of the vibrations by which it is produced. Higher pitched signals sound louder to humans than sounds with a lower pitch. *Loudness* is intensity of sound waves combined with the reception characteristics of the ear. Intensity may be compared with the height of an ocean wave in that it is a measure of the amplitude of the sound wave.

In addition to the concepts of pitch and loudness, there are several noise measurement scales which are used to describe noise in a particular location. A *decibel (dB)* is a unit of measurement which indicates the relative amplitude of a sound. The zero on the decibel scale is based on the lowest sound level that the healthy, unimpaired human ear can detect. Sound levels in decibels are calculated on a logarithmic basis. An increase of 10 decibels represents a ten-fold increase in acoustic energy, while 20 decibels is 100 times more intense, 30 decibels is 1,000 times more intense, etc. There is a relationship between the subjective noisiness or loudness of a sound and its intensity. Each 10 decibel increase in sound level is perceived as approximately a doubling of loudness over a fairly wide range of intensities. Technical terms are defined in Table 1.

There are several methods of characterizing sound. The most common in California is the *A-weighted sound level (dBA).* This scale gives greater weight to the frequencies of sound to which the human ear is most sensitive. Representative outdoor and indoor noise levels in units of dBA are shown in Table 2. Because sound levels can vary markedly over a short period of time, a method for describing either the average character of the sound or the statistical behavior of the variations must be utilized. Most commonly, environmental sounds are described in terms of an average level that has the same acoustical energy as the summation of all the time-varying events. This *energy-equivalent sound/noise descriptor* is called L_{eq}. The most common averaging period is hourly, but L_{eq} can describe any series of noise events of arbitrary duration.

The scientific instrument used to measure noise is the sound level meter. Sound level meters can accurately measure environmental noise levels to within about plus or minus 1 dBA. Various computer models are used to predict environmental noise levels from sources, such as roadways and airports. The accuracy of the predicted models depends upon the distance the receptor is from the noise source. Close to the noise source, the models are accurate to within about plus or minus 1 to 2 dBA.

Since the sensitivity to noise increases during the evening and at night -- because excessive noise interferes with the ability to sleep -- 24-hour descriptors have been developed that incorporate artificial noise penalties added to quiet-time noise events. The *Community Noise Equivalent Level* (*CNEL*) is a measure of the cumulative noise exposure in a community, with a 5 dB penalty added to evening (7:00 pm - 10:00 pm) and a 10 dB addition to nocturnal (10:00 pm - 7:00 am) noise levels. The *Day/Night Average Sound Level* (*DNL* or L_{dn}) is essentially the same as CNEL, with the exception that the evening time period is dropped and all occurrences during this three-hour period are grouped into the daytime period.

Effects of Noise

The thresholds for speech interference indoors are about 45 dBA if the noise is steady and above 55 dBA if the noise is fluctuating. Outdoors the thresholds are about 15 dBA higher. Steady noises of sufficient intensity (above 35 dBA) and fluctuating noise levels above about 45 dBA have been shown to affect sleep. Typically, the highest steady traffic noise level during the daytime is about equal to the L_{dn}/CNEL and nighttime levels are 10 dBA lower. The standard is designed for sleep and speech protection and most jurisdictions apply the same criterion for all residential uses. Typical structural attenuation is 12 to 17 dBA with open windows. With closed windows in good condition, the noise attenuation factor is around 20 dBA for an older structure and 25 dBA for a newer dwelling. Sleep and speech interference is therefore possible when exterior noise levels are about 57 to 62 dBA L_{dn}/CNEL with open windows and 65 to 70 dBA L_{dn}/CNEL if the windows are closed. Levels of 55 to 60 dBA are common along collector streets and secondary arterials, while 65 to 70 dBA is a typical value for a primary/major arterial. Levels of 75 to 80 dBA are normal noise levels at the first row of development outside a freeway right-of-way. In order to achieve an acceptable interior noise environment, bedrooms facing secondary roadways need to be able to have their windows closed, and those facing major roadways and freeways typically need special glass windows.

TABLE 1 Definition of Acoustical Terms Used in this Report

Term	Definition
Decibel, dB	A unit describing, the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for air is 20 micro Pascals.
Sound Pressure Level	Sound pressure is the sound force per unit area, usually expressed in micro Pascals (or 20 micro Newtons per square meter), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 square meter. The sound pressure level is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the pressures exerted by the sound to a reference sound pressure (e. g., 20 micro Pascals). Sound pressure level is the quantity that is directly measured by a sound level meter.
Frequency, Hz	The number of complete pressure fluctuations per second above and below atmospheric pressure. Normal human hearing is between 20 Hz and 20,000 Hz. Infrasonic sounds are below 20 Hz and Ultrasonic sounds are above 20,000 Hz.
A-Weighted Sound Level, dBA	The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise.
Equivalent Noise Level, L_{eq}	The average A-weighted noise level during the measurement period.
L_{max}, L_{min}	The maximum and minimum A-weighted noise level during the measurement period.
L_{01}, L_{10}, L_{50}, L_{90}	The A-weighted noise levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Day/Night Noise Level, L_{dn} or DNL	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 p.m. and 7:00 a.m.
Community Noise Equivalent Level, CNEL	The average A-weighted noise level during a 24-hour day, obtained after addition of 5 decibels in the evening from 7:00 p.m.to 10:00 p.m. and after addition of 10 decibels to sound levels measured in the night between 10:00 p.m. and 7:00 a.m.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Intrusive	That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.

Source: Handbook of Acoustical Measurements and Noise Control, Harris, 1998.

TABLE 2 Typical Noise Levels in the Environment

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	110 dBA	Rock band
Jet fly-over at 1,000 feet		
	100 dBA	
Gas lawn mower at 3 feet		
	90 dBA	
Diesel truck at 50 feet at 50 mph		Food blender at 3 feet
	80 dBA	Garbage disposal at 3 feet
Noisy urban area, daytime		
Gas lawn mower, 100 feet	70 dBA	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	60 dBA	
		Large business office
Quiet urban daytime	50 dBA	Dishwasher in next room
Quiet urban nighttime	40 dBA	Theater, large conference room
Quiet suburban nighttime		
	30 dBA	Library
Quiet rural nighttime		Bedroom at night, concert hall (background)
	20 dBA	
		Broadcast/recording studio
	10 dBA	
	0 dBA	

Source: Technical Noise Supplement (TeNS), California Department of Transportation, September 2013.

Fundamentals of Groundborne Vibration

Ground vibration consists of rapidly fluctuating motions or waves with an average motion of zero. Several different methods are typically used to quantify vibration amplitude. One method is the Peak Particle Velocity (PPV). The PPV is defined as the maximum instantaneous positive or negative peak of the vibration wave. In this report, a PPV descriptor with units of mm/sec or in/sec is used to evaluate construction generated vibration for building damage and human complaints. Table 3 displays the reactions of people and the effects on buildings that continuous or frequent intermittent vibration levels produce. The guidelines in Table 3 represent syntheses of vibration criteria for human response and potential damage to buildings resulting from construction vibration.

Construction activities can cause vibration that varies in intensity depending on several factors. The use of pile driving and vibratory compaction equipment typically generates the highest construction related groundborne vibration levels. Because of the impulsive nature of such activities, the use of the PPV descriptor has been routinely used to measure and assess groundborne vibration and almost exclusively to assess the potential of vibration to cause damage and the degree of annoyance for humans.

The two primary concerns with construction-induced vibration, the potential to damage a structure and the potential to interfere with the enjoyment of life, are evaluated against different vibration limits. Human perception to vibration varies with the individual and is a function of physical setting and the type of vibration. Persons exposed to elevated ambient vibration levels, such as people in an urban environment, may tolerate a higher vibration level.

Structural damage can be classified as cosmetic only, such as paint flaking or minimal extension of cracks in building surfaces; minor, including limited surface cracking; or major, that may threaten the structural integrity of the building. Safe vibration limits that can be applied to assess the potential for damaging a structure vary by researcher. The damage criteria presented in Table 3 include several categories for ancient, fragile, and historic structures, the types of structures most at risk to damage. Most buildings are included within the categories ranging from "Historic and some old buildings" to "Modern industrial/commercial buildings". Construction-induced vibration that can be detrimental to the building is very rare and has only been observed in instances where the structure is at a high state of disrepair and the construction activity occurs immediately adjacent to the structure.

The annoyance levels shown in Table 3 should be interpreted with care since vibration may be found to be annoying at lower levels than those shown, depending on the level of activity or the sensitivity of the individual. To sensitive individuals, vibrations approaching the threshold of perception can be annoying. Low-level vibrations frequently cause irritating secondary vibration, such as a slight rattling of windows, doors, or stacked dishes. The rattling sound can give rise to exaggerated vibration complaints, even though there is very little risk of actual structural damage.

TABLE 3 Reaction of People and Damage to Buildings from Continuous or Frequent Intermittent Vibration Levels

Velocity Level, PPV (in/sec)	Human Reaction	Effect on Buildings
0.01	Barely perceptible	No effect
0.04	Distinctly perceptible	Vibration unlikely to cause damage of any type to any structure
0.08	Distinctly perceptible to strongly perceptible	Recommended upper level of the vibration to which ruins and ancient monuments should be subjected
0.1	Strongly perceptible	Threshold at which there is a risk of damage to fragile buildings with no risk of damage to most buildings
0.25	Strongly perceptible to severe	Threshold at which there is a risk of damage to historic and some old buildings.
0.3	Strongly perceptible to severe	Threshold at which there is a risk of damage to older residential structures
0.5	Severe - Vibrations considered unpleasant	Threshold at which there is a risk of damage to new residential and modern commercial/industrial structures

Source: Transportation and Construction Vibration Guidance Manual, California Department of Transportation, September 2013.

Regulatory Background - Noise

The State of California and the City of Santa Clara have established regulatory criteria that are applicable in this assessment. The State of California Environmental Quality Act (CEQA) Guidelines, Appendix G, are used to assess the potential significance of impacts pursuant to local General Plan policies, Municipal Code standards, or the applicable standards of other agencies. A summary of the applicable regulatory criteria is provided below.

State CEQA Guidelines. The CEQA contains guidelines to evaluate the significance of effects of environmental noise attributable to a proposed project. Under CEQA, noise impacts would be considered significant if the project would result in:

(a) Generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies;

(b) Generation of excessive groundborne vibration or groundborne noise levels;

(c) For a project located within the vicinity of a private airstrip or an airport land use plan or where such a plan has not been adopted within two miles of a public airport or public use airport, if the project would expose people residing or working in the project area to excessive noise levels.

2016 California Green Building Standards Code (Cal Green Code). The State of California established exterior sound transmission control standards for new non-residential buildings as set forth in the 2016 California Green Building Standards Code (Section 5.507.4.1 and 5.507.4.2). Section 5.507 states that either the prescriptive (Section 5.507.4.1) or the performance method

(Section 5.507.4.2) shall be used to determine environmental control at indoor areas. The prescriptive method is very conservative and not practical in most cases; however, the performance method can be quantitatively verified using exterior-to-interior calculations. For the purposes of this report, the performance method is utilized to determine consistency with the Cal Green Code. Both of the sections that pertain to this project are as follows:

> **5.507.4.1 Exterior noise transmission, prescriptive method.** Wall and roof-ceiling assemblies making up the building envelope that are exposed to the noise source shall meet a composite STC rating of at least 50 or a composite OITC rating of no less than 40, with exterior windows of a minimum STC of 40 or OITC of 30 when the building falls within the 65 dBA L_{dn} noise contour of a freeway or expressway, railroad, industrial source or fixed-guideway noise source, as determined by the local general plan noise element.

> **5.507.4.2 Performance method.** For buildings located within the 65 dBA L_{dn} noise contour of a freeway or expressway, railroad, industrial source or fixed-guideway noise source, wall and roof-ceiling assemblies making up the building envelope and exposed to the noise source shall be constructed to provide an interior noise environment attributable to exterior sources that does not exceed an hourly equivalent noise level ($L_{eq\ (1\text{-}hr)}$) of 50 dBA in occupied areas during any hour of operation.

The performance method, which establishes the acceptable interior noise level, is the method typically used when applying these standards.

Santa Clara County Airport Land Use Commission Comprehensive Land Use Plan. The Comprehensive Land Use Plan adopted by the Santa Clara County Airport Land Use Commission (ALUC) contains standards for projects within the vicinity of San José International Airport which are relevant to this project:

4.3.2 Noise Compatibility

> The objective of noise compatibility criteria is to minimize the number of people exposed to frequent and/or high levels of aircraft noise.

4.3.2.1 Policies

N-1 The Community Noise Equivalent Level (CNEL) method of representing noise levels shall be used to determine if a specific land use is consistent with the CLUP.

N-2 In addition to the other policies herein, the Noise Compatibility Policies presented in Table 4-1 shall be used to determine if a specific land use is consistent with this CLUP.

N-3 Noise impacts shall be evaluated according to the Aircraft Noise Contours presented on Figure 5.

N-6 Noise level compatibility standards for other types of land uses shall be applied in the same manner as the above residential noise level criteria. Table 4-1 presents acceptable noise levels for other land uses in the vicinity of the Airport.

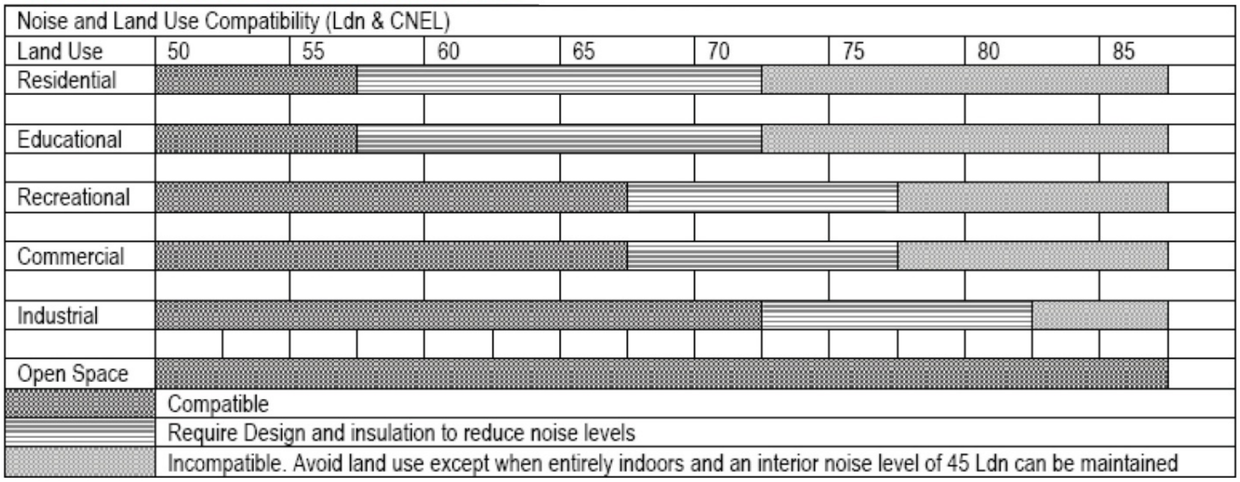
Table 4 – 1 NOISE COMPATIBILITY POLICIES

LAND USE CATEGORY	CNEL					
	55-60	60-65	65-70	70-75	75-80	80-85
Residential – low density Single-family, duplex, mobile homes	*	**	***	****	****	****
Residential – multi-family, condominiums, townhouses	*	**	***	****	****	****
Transient lodging - motels, hotels	*	*	**	****	****	****
Schools, libraries, indoor religious assemblies, hospitals, nursing homes	*	***	****	****	****	****
Auditoriums, concert halls, amphitheaters	*	***	***	****	****	****
Sports arena, outdoor spectator sports, parking	*	*	*	**	***	****
Playgrounds, neighborhood parks	*	*	***	****	****	****
Golf courses, riding stables, water recreation, cemeteries	*	*	*	**	***	****
Office buildings, business commercial and professional, retail	*	*	**	***	****	****
Industrial, manufacturing, utilities, agriculture	*	*	*	***	***	****
* Generally Acceptable	Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements. Mobile homes may not be acceptable in these areas. Some outdoor activities might be adversely affected.					
** Conditionally Acceptable	New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features included in the design. Outdoor activities may be adversely affected. Residential: Conventional construction, but with closed windows and fresh air supply systems or air conditioning will normally suffice.					
*** Generally Unacceptable	New construction or development should be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design. Outdoor activities are likely to be adversely affected.					
**** Unacceptable	New construction or development shall not be undertaken.					

Source: Based on General Plan Guidelines, Appendix C (2003), Figure 2 and Santa Clara County ALUC 1992 Land Use Plan, Table 1.

City of Santa Clara General Plan. The City of Santa Clara's General Plan identifies noise and land use compatibility standards for various land uses and establishes policies to control noise within the community. Table 5.10-2 from the General Plan shows acceptable noise levels for various land uses. Industrial land uses are considered compatible in noise environments of 70 dBA L_{dn}/CNEL or less. The guidelines state that where the exterior noise levels are greater than 70 dBA L_{dn}/CNEL and less than 80 dBA L_{dn}/CNEL, the design of the project should include measures to reduce interior noise to acceptable levels. Exterior noise levels exceeding 80 dBA L_{dn}/CNEL at industrial land uses are considered incompatible. Industrial land uses proposed in noise environments exceeding 80 dBA L_{dn}/CNEL should generally be avoided, except when the use is entirely indoors and where interior noise levels can be maintained at 45 dBA L_{dn}/CNEL or less.

TABLE 5.10-2: GENERAL PLAN NOISE STANDARDS



Applicable goals and policies presented in the General Plan are as follows:

5.10.6-G1 Noise sources restricted to minimize impacts in the community.

5.10.6-G2 Sensitive uses protected from noise intrusion.

5.10.6-G3 Land use, development and design approvals that take noise levels into consideration.

5.10.6-P1 Review all land use and development proposals for consistency with the General Plan compatibility standards and acceptable noise exposure levels defined on Table 5.10-1.

5.10.6-P2 Incorporate noise attenuation measures for all projects that have noise exposure levels greater than General Plan "normally acceptable" levels, as defined on Table 5.10-1.

5.10.6-P3 New development should include noise control techniques to reduce noise to acceptable levels, including site layout (setbacks, separation and shielding), building treatments (mechanical ventilation system, sound-rated windows, solid core doors and baffling) and structural measures (earthen berms and sound walls).

5.10.6-P4 Encourage the control of noise at the source through site design, building design, landscaping, hours of operation and other techniques.

5.10.6-P5 Require noise-generating uses near residential neighborhoods to include solid walls and heavy landscaping along common property lines, and to place compressors and mechanical equipment in sound-proof enclosures.

5.10.6-P6 Discourage noise sensitive uses, such as residences, hospitals, schools, libraries, and rest homes, from areas with high noise levels, and discourage high noise generating uses from areas adjacent to sensitive uses.

5.10.6-P7 Implement measures to reduce interior noise levels and restrict outdoor activities in areas subject to aircraft noise in order to make Office/Research and Development uses compatible with the Norman Y. Mineta International Airport land use restrictions.

City of Santa Clara Municipal Code. The City's Municipal Code establishes noise level performance standards for fixed sources of noise. Section 9.10.40 of the Municipal Code limits noise levels at multi-family residences to 55 dBA during daytime hours (7:00 a.m. to 10:00 p.m.) and 50 dBA at night (10:00 p.m. to 7:00 a.m.). Noise levels at light industrial land uses are limited to 70 dBA. If the measured ambient noise level at any given location differs from those levels set forth above, the allowable noise exposure standard shall be adjusted in five dBA increments in each category as appropriate to encompass or reflect the ambient noise level.

The noise limits are not applicable to the performance of emergency work, including the operation of emergency generators and pumps or other equipment necessary to provide services during an emergency, licensed outdoor events, City-owned electric, water, and sewer utility system facilities, construction activities occurring within allowable hours, permitted fireworks displays, or permitted heliports.

Construction activities are not permitted within 300 feet of residentially zoned property except within the hours of 7:00 a.m. and 6:00 p.m. on weekdays and 9:00 a.m. and 6:00 p.m. on Saturdays. No construction is permitted on Sundays or holidays.

The City Code does not define the acoustical time descriptor such as L_{eq} (the average noise level) or L_{max} (the maximum instantaneous noise level) that is associated with the above limits. A reasonable interpretation of the City Code would identify the ambient base noise level criteria as an average or median noise level (L_{eq}/L_{50}).

Existing Noise Environment

A noise monitoring survey was performed between Wednesday, May 29, 2019 and Friday, May 31, 2019 to quantify and characterize ambient noise levels at the site and in the surrounding area. The survey included one long-term measurement (LT-1) and four short-term measurements (ST-1, ST-2, ST-3, and ST-4), as shown in Figure 1. The predominant sources of noise in the project vicinity included traffic on Central Expressway, aircraft associated with Norman Y. Mineta San José International Airport, mechanical noise from the surrounding industrial sites, and railroad train operations. The daily trends in noise levels at LT-1 are shown in Figure 2. The results for short-term measurements are summarized in Table 4.

FIGURE 1 Noise Measurement Locations

Long-term measurement LT-1 was made in the southeast corner of the site approximately 175 feet west of the railroad tracks and 535 feet south of Central Expressway. Hourly average noise levels at this location typically ranged from 65 to 69 dBA L_{eq} during daytime hours and 50 to 69 dBA L_{eq} during nighttime hours, affected primarily by the timing of train operations and frequency of aircraft overflights. The community noise equivalent level on Thursday, May 30, 2019 was 70 dBA CNEL.

Short-term measurement ST-1 was made at a distance of approximately 125 feet south of the Central Expressway center line. This location was selected to quantify noise generated by traffic along the expressway and aircraft noise from Norman Y. Mineta San Jose International Airport. During the measurement, three jet takeoffs produced noise levels ranging from 78 and 85 dBA L_{max}. Traffic to the north provided a steady noise level between 58 and 62 dBA. The 10-minute average noise level measured at ST-1 was 69 dBA L_{eq}.

ST-2 was made between two existing buildings on the site and was located approximately 150 feet north of the southernmost property line of the site. Noise at ST-2 was characterized primarily by mechanical equipment with other sources of noise including forklift operations at the 651 Walsh Avenue site to the south, workers conversing, and aircraft. Two jet takeoffs produced noise levels of 66 dBA and 71 dBA L_{max}. The average noise level measured at ST-2 was 57 dBA L_{eq}.

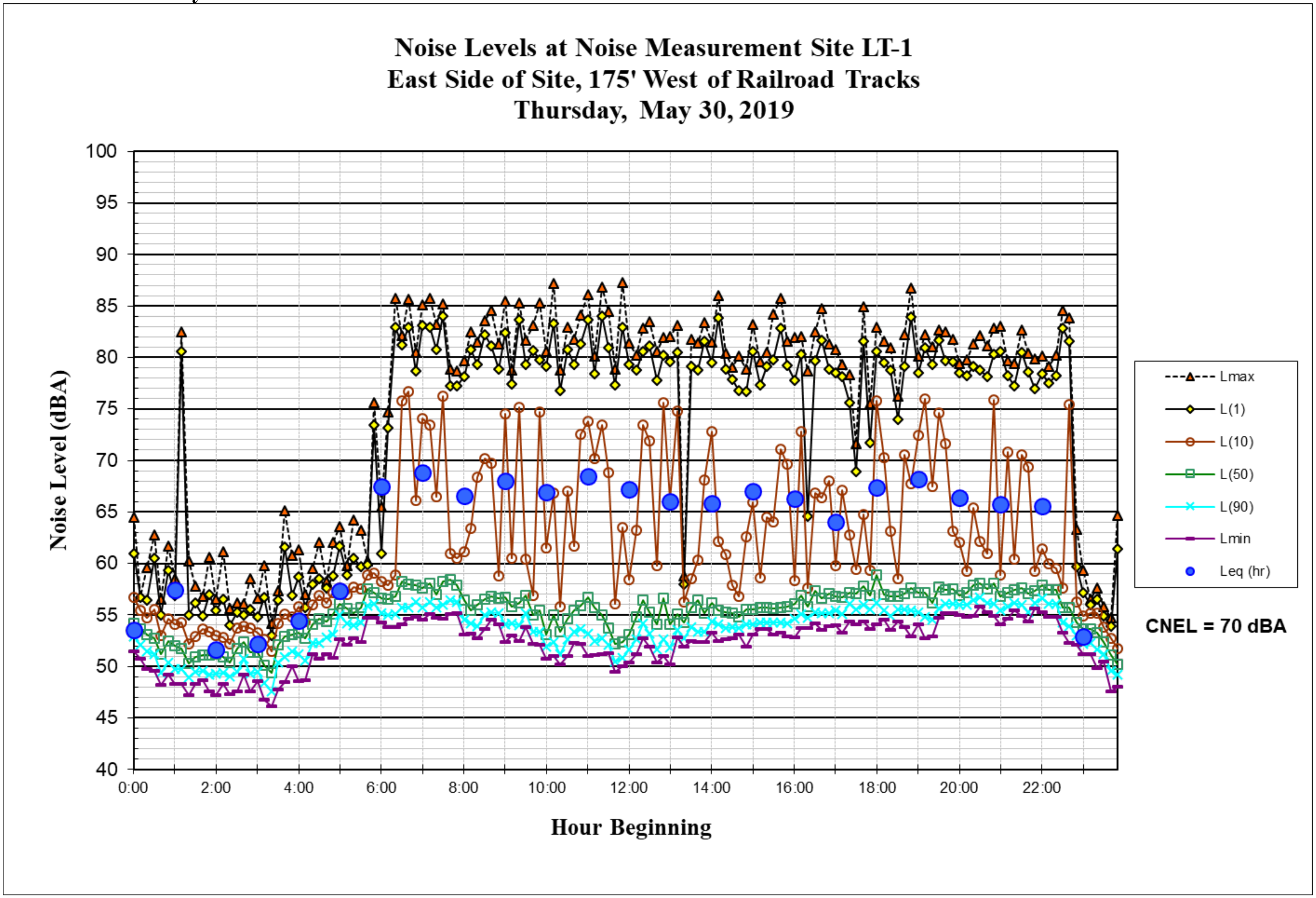
ST-3 was made along the southern property line of the project site, approximately 90 feet south of rooftop mechanical equipment and approximately 480 feet east of Lafayette Street. Rooftop mechanical equipment, traffic on Lafayette Street, and noise from the Owens Corning industrial site contributed to the ambient noise environment at the measurement location. Levels were steady throughout the measurement yielding an average noise level of 62 dBA L_{eq}.

ST-4 was made on the western side of the property, approximately 110 feet east of the center line of Lafayette Street. The noise environment was primarily characterized by the noise emitted from Owens Corning industrial site to the west, which produced a steady noise level of 66 to 67 dBA. Intermittent traffic noise on Lafayette Street generated noise levels up to 77 dBA L_{max}. The average noise level measured at ST-4 was 68 dBA L_{eq}.

TABLE 4 Summary of Short-Term Noise Measurements (dBA)

ID	Location (Date, Start Time)	Measured Noise Levels, dBA				Primary noise source
		L_{10}	L_{50}	L_{90}	L_{eq}	
ST-1	Northeast corner of site, 125 feet south of Central Expressway center line. (5/29/19, 11:30 a.m. to 11:40 a.m.)	69	62	58	69	Jet takeoffs, traffic from Central Expressway
ST-2	Between buildings, 150 feet north of southern property line. (5/29/19, 11:50 a.m. to 12:00 p.m.)	60	54	52	57	Mechanical equipment, jet takeoffs
ST-3	Along southern property line, 480 feet east of Lafayette Street. (5/29/19, 12:03 p.m. to 12:07 p.m.)	64	61	60	62	Industrial plant, mechanical equipment
ST-4	Parking lot on western side of property, 110 feet east of Lafayette Street center line. (5/29/19, 12:11 p.m. to 12:15 p.m.)	70	67	66	68	Industrial plant, traffic

FIGURE 2 Daily Trend in Noise Levels at LT-1



GENERAL PLAN CONSISTENCY ANALYSIS

The impacts of site constraints such as exposure of the proposed project to excessive levels of noise and vibration are not considered under CEQA. This section addresses Noise and Land Use Compatibility for consistency with the policies set forth in the City's General Plan.

Noise and Land Use Compatibility

The applicable Santa Clara General Plan policies were presented in detail in the Regulatory Background section and are summarized below for the proposed project:

- For non-residential land uses, the Cal Green Code requires interior noise levels to be maintained at 50 dBA $L_{eq(1\text{-}hr)}$ or less during hours of operation in noise sensitive spaces such as offices.

- The Santa Clara Municipal Code requires that exterior noise levels at industrial land uses be maintained at or below 70 dBA.

The proposed land use is categorized as heavy industrial and is not considered sensitive to noise. There are no noise sensitive exterior or interior areas on the project site. Small office areas are provided for clients to visit the facility, but the usage of these spaces is not anticipated to be a regular occurrence.

Noise levels at the exterior façades of the data center building would be 64 to 70 dBA CNEL. Therefore, the exterior environment would be considered compatible with City's 70 dBA CNEL compatibility threshold for industrial land uses.

Hourly average noise levels during peak periods are anticipated to be 62 to 68 dBA $L_{eq(1\text{-}hr)}$. The building will be provided with forced-air mechanical ventilation, allowing occupants the option of closing windows to control noise. Standard industrial building construction with windows closed provides approximately 25 dBA of noise reduction in interior spaces. As a result, interior hourly average noise levels from exterior environmental noise sources would typically be 37 to 43 dBA $L_{eq(1\text{-}hr)}$. For the occasions in which interior spaces are utilized as offices, noise levels would comply with the Cal Green Code's 50 dBA $L_{eq(1\text{-}hr)}$ limit.

NOISE IMPACTS AND MITIGATION MEASURES

This section describes the significance criteria used to evaluate project impacts under CEQA, provides a discussion of each project impact, and presents mitigation measures, where necessary, to provide a compatible project in relation to adjacent noise sources and land uses.

Significance Criteria

The following criteria were used to evaluate the significance of environmental noise and vibration resulting from the project:

1. **Temporary or Permanent Noise Increases in Excess of Established Standards.** A significant impact would be identified if project construction or operations would result in a substantial temporary or permanent increase in ambient noise levels at sensitive receivers in excess of the local noise standards contained in the Santa Clara General Plan or Municipal Code, as follows:

    - Operational Noise in Excess of Standards. A significant noise impact would be identified if the project would expose persons to or generate noise levels that would exceed applicable noise standards presented in the General Plan or Municipal Code.

    - Permanent Noise Increase. A significant impact would be identified if traffic generated by the project or project improvements/operations would substantially increase noise levels at sensitive receivers in the vicinity. A substantial increase would occur if: a) the noise level increase is 5 dBA CNEL or greater where the future noise level is compatible in terms of noise and land use compatibility, or b) the noise level increase is 3 dBA CNEL or greater where the future noise level exceeds the compatibility threshold.

    - Temporary Noise Increase. A significant temporary noise impact would be identified if construction would occur outside of the hours specified in the Municipal Code or if construction noise levels were to exceed the City's construction noise limits at adjacent noise sensitive land uses. Construction activities are not permitted within 300 feet of residentially zoned property except within the hours of 7:00 a.m. and 6:00 p.m. on weekdays and 9:00 a.m. and 6:00 p.m. on Saturdays. No construction is permitted on Sundays or holidays.

2. **Generation of Excessive Groundborne Vibration.** A significant impact would be identified if the construction of the project would generate excessive vibration levels. Groundborne vibration levels exceeding 0.3 in/sec PPV would be considered excessive as such levels would have the potential to result in cosmetic damage to buildings of normal construction (see Table 3).

3. **Excessive Aircraft Noise Levels.** A significant impact would be identified if the project would expose people residing or working in the project area to excessive noise levels from aircraft. Aircraft noise levels of 70 dBA CNEL or less would be considered compatible with industrial land uses (see Table 4-1).

Impact 1: **Temporary or Permanent Noise Increases in Excess of Established Standards.** Project construction and operations would not result in a substantial temporary or permanent noise level increase at existing noise-sensitive land uses in the project vicinity. **This is a less-than-significant impact.**

a. Permanent Noise Increases from On-Site Operational Noise

The City's Municipal Code establishes noise level performance standards for fixed sources of noise. Section 9.10.40 of the Municipal Code limits noise levels to 55 dBA during daytime hours (7:00 a.m. to 10:00 p.m.) and 50 dBA at night (10:00 p.m. to 7:00 a.m.) at residences and public parks, 65 dBA during daytime hours and 60 dBA at night at commercial/office uses, 70 dBA at light industrial land uses, and 75 dBA at heavy industrial uses. The allowable noise exposure standards may be adjusted to reflect the ambient noise level. A reasonable interpretation of the City Code would identify the ambient base noise level criteria as an average or median noise level (L_{eq}/L_{50}).

The Municipal Code states that noise limits set forth in the code are not applicable to the performance of emergency work, including the operation of emergency generators and pumps or other equipment necessary to provide services during an emergency. However, the City has applied the noise limits to testing of the standby generators for previous data center buildings in the City.

An acoustical study was conducted by Aercoustics Engineering Limited (Aercoustics) to calculate noise levels generated by project operations, including proposed cooling equipment and emergency generators.[1] All cooling equipment is proposed to be located on the rooftops, surrounded by 3.5 m (11 foot) tall screen walls. The generator yard will be located on the south side of the new building and shielded by a 3.6 m (12 foot) screen wall. The following noise producing equipment was analyzed in the Aercoustics report. Sound power levels for the equipment are provided in Table 5.

- 93 Air-Cooled Chillers (ACCs) Motivair MLC-FC 930
- 45 3000 kW Generators in enclosures rated for 80 dBA @ 23 feet
- 37 Rooftop Units (RTUs) Aaon RN-018
- 22 Make up Air Units (MAUs) Aaon RN-020
- Exhaust Fans (EFs) excluded from study due to negligible impact

TABLE 5 Sound Power Levels of Proposed Equipment[1]

Equipment	Sound Power Level, dBA
RTU Radiated[a]	91
MAU Radiated[a]	93
Air-Cooled Chiller	100
3000 kW Genset Inlet	92
3000 kW Genset Casing	104
3000 kW Genset Discharge	105
3000 kW Genset Exhaust[b]	136

[a] Data approximated based on provided supply and return fan data.
[b] Levels do not include the effects of a muffler; however, all calculations included a Silex Critical Grade Silencer, Model JC-12.

Testing would occur during daytime hours only. Table 6 shows the proposed generator testing schedule for the site. As indicated in Table 6, only one generator would be tested at any given time. Considering the proposal of 45 generators for the site, this would be equivalent to 11 hours and 15 minutes of testing per month for the monthly readiness test, 7 hours and 30 minutes of testing per month for the quarterly test, 7 hours and 30 minutes of testing per month for the semi-annual test, and 45 minutes per month for the pull the plug test. Assuming 20 workdays per month,

[1] Environmental Noise Study, Project 19115.00, Proposed Data Center 2825 Lafayette, Aercoustics Engineering Ltd., August 2, 2019.

this would be an average of 1 hour and 20 minutes of testing per work day to complete the testing of all generators.

TABLE 6 Proposed Generator Testing Schedule

Scenario	Typical Test Time, minutes	# of Engines Run Concurrently	Comments	Load
Monthly Readiness Test	15	1	Max of 10 engines tested per day	**1%**
Quarterly Test	30	1	Max of 10 engines tested per day	**1%**
Semi-Annual Test	60	1	Max of 10 engines tested per day	**1%**
Pull the Plug Test (5-year cycle)	60	1	Max of 4 engines tested per day	**100%**
The typical load range for the above tests is 1 to 70%. Engines are not run concurrently for any of these tests.				

The site is bordered on all sides by heavy industrial uses, which would not be considered noise sensitive. The nearest noise sensitive land use is Memorial Cross Park (R11), located about 2,200 feet to the southeast, adjacent to Norman Y. Mineta San José International Airport. Office uses are located about 2,200 feet to the southwest (R10). The closest residences are located about 4,200 feet to the south and 3,800 feet to the north of the project site and are well shielded by intervening structures.

Aercoustics calculated noise from the rooftop equipment and emergency generators using the CadnaA noise prediction software, following the ISO 9613 prediction standard. Three scenarios were analyzed; 1) "Cooling Only", which included all rooftop equipment operating simultaneously with no generators operating, 2) "Single Generator", where the maximum sound level from a single generator at the specific location is shown, and 3) "All Generators" where all equipment is operating at full capacity, which would only occur during a complete power failure and not during testing (see Table 6). The results of this analysis are shown in Figures 1 to 6 in Appendix A and in Table 7, with and without the inclusion of rooftop screens.

The assumptions used in the modeling are described in detail in the Aercoustics Report. Notably, receivers were modeled at a height of 4.5 m (14.75 feet). A receiver height of 5-feet, representative of ear height of an adult standing on the ground, is more commonly used in Santa Clara and other Bay Area cities. Use of a second story receiver height would be expected to result in higher noise exposure, as less shielding would be realized at this height. Additionally, the effects of topography were neglected in the analysis and all chillers were assumed to be operating at 100% load; again, conservative assumptions (see Table 6). Although not indicated in the Aercoustics Report, review of the figures indicates that shielding from off-site structures was not taken into account in the modeling (See Figures in Appendix A); this may be because these structures were not input into the model or because less shielding is realized with use of the higher receiver height. In either case, at least 20 dBA of additional noise reduction would be anticipated at distant receivers with the consideration of shielding.

TABLE 7 Calculated Sound Pressure Levels at Receiver Locations

Receiver	No Roof Screening, dBA			With Roof Screening, dBA			Noise Limit, dBA[b]
	Cooling Only	Single Generator	All Generators[c]	Cooling Only	Single Generator	All Generators[c]	
R01	63	63	63	56	56	56	70
R02	61	61	61	55	55	56	70
R03	63	63	63	57	57	57	70
R04	70	70	70	60	60	60	75
R05	63	63	65	56	56	61	70
R06	64	64	73	56	59	73	75
R07	62	64	69	56	60	68	75
R08	67	67	74	59	59	74	75
R09	68	68	74	59	60	74	75
R10	55	55	60	47	48	59	65[a]
R11	**56**	**56**	59	47	48	**57**	55

[a] Although the Aercoustics Report identifies this as a residential or park land use, it is actually representative of the City of Santa Clara Public Works Corporation Yard. Therefore, the commercial/office limits were applied. There are no residential land uses near this location.
[b] Testing would occur during daytime hours only; therefore, the nighttime limits do not apply.
[c] As described above, the "All Generator" scenario would occur during a complete power failure and not during testing; therefore, the limits do not apply.

As indicated in Table 7, with the conservative assumptions used in the Aercoustics noise analysis, noise levels would exceed the City's limits only at Memorial Cross Park (R11). Noise levels at the remaining land uses would be below the Code limits.

Given the conservative assumptions in the Aercoustics Report, noise levels at Memorial Cross Park (R11) would exceed the Code limits by about 1 dBA during testing without roof screening and would meet the limits with rooftop screening. With more realistic assumptions, such as shielding from intervening structures or the use of a ground floor receptor for the park, noise levels are anticipated to be considerably lower and would easily meet the City's Municipal Code noise limit. Additionally, the City's Municipal Code allows for the adjustment of the standard to account for ambient noise levels at the receiving use. Memorial Cross Park is located within the 65 dBA CNEL 2019 contour for the Norman Y. Mineta San José International Airport[2] and adjacent to De La Cruz Boulevard, a six-lane arterial roadway. As a result, ambient daytime noise levels of 65 dBA L_{eq} could be expected, 9 dBA higher than the conservatively calculated noise levels generated by Project operations without screening under "Cooling Only" and "Single Generator" scenarios. Given ambient conditions, Project operations would not be audible at Memorial Cross Park with or without rooftop screening. During a complete power failure with "All Generators" operating, which would be exempt from the Code limits, noise levels would still not be audible above ambient noise levels at the park.

The noise exposure levels are below the City's allowable exterior levels. This is a **less-than-significant** impact.

[2] Noise exposure maps are available at https://www.flysanjose.com/noise/noise-reports.

Mitigation Measures 1a: None required.

b. Permanent Noise Increases from Project Traffic

Neither the City of Santa Clara nor the State of California define the traffic noise level increase that is considered substantial. A significant impact would occur if the permanent noise level increase due to project-generated traffic was 3 dBA CNEL or greater at noise-sensitive receptors for existing levels exceeding 55 dBA CNEL or was 5 dBA CNEL or greater for existing levels at or below 55 dBA CNEL. For reference, a 3 dBA CNEL noise increase would be expected if the project would double existing traffic volumes along a roadway and a 5 dBA CNEL noise increase would be expected if the project would triple existing traffic volumes along a roadway.

The project site is surrounded primarily by non-noise sensitive industrial land uses. The nearest noise sensitive land use is Memorial Cross Park, located about 2,200 feet to the southeast, adjacent to Norman Y. Mineta San José International Airport. Office uses are located about 2,200 feet to the southwest. With the exception of a few employees, the data center would not generate traffic. A surface parking lot will provide 284 parking spaces on the site. These spaces are required to meet the City's parking requirements but will be largely unoccupied. Therefore, there would be no measurable increase in the CNEL along local roadways in the vicinity of the project. This is a **less-than-significant** impact.

Mitigation Measure 1b: None required.

c. Temporary Noise Increases from Project Construction

Construction activities are not permitted within 300 feet of residentially zoned property except within the hours of 7:00 a.m. and 6:00 p.m. on weekdays and 9:00 a.m. and 6:00 p.m. on Saturdays. No construction is permitted on Sundays or holidays.

Construction activities for individual projects are typically carried out in stages. During each stage of construction, there would be a different mix of equipment operating, and noise levels would vary by stage and vary within stages, based on the amount of equipment in operation and the location at which the equipment is operating. Typical construction noise levels at a distance of 50 feet are shown in Tables 8 and 9. Table 8 shows the average noise level ranges, by construction phase, and Table 9 shows the maximum noise level ranges for different construction equipment.

TABLE 8 Typical Ranges of Construction Noise Levels at 50 Feet, L_{eq} (dBA)

	Domestic Housing		Office Building, Hotel, Hospital, School, Public Works		Industrial Parking Garage, Religious Amusement & Recreations, Store, Service Station		Public Works Roads & Highways, Sewers, and Trenches	
	I	**II**	**I**	**II**	**I**	**II**	**I**	**II**
Ground Clearing	83	83	84	84	84	83	84	84
Excavation	88	75	89	79	89	71	88	78
Foundations	81	81	78	78	77	77	88	88
Erection	81	65	87	75	84	72	79	78
Finishing	88	72	89	75	89	74	84	84
I - All pertinent equipment present at site. **II** - Minimum required equipment present at site.								

Source: U.S.E.P.A., Legal Compilation on Noise, Vol. 1, p. 2-104, 1973.

TABLE 9 Construction Equipment 50-foot Noise Emission Limits

Equipment Category	L_{max} Level (dBA)1,2	Impact/Continuous
Arc Welder	73	Continuous
Auger Drill Rig	85	Continuous
Backhoe	80	Continuous
Bar Bender	80	Continuous
Boring Jack Power Unit	80	Continuous
Chain Saw	85	Continuous
Compressor[3]	70	Continuous
Compressor (other)	80	Continuous
Concrete Mixer	85	Continuous
Concrete Pump	82	Continuous
Concrete Saw	90	Continuous
Concrete Vibrator	80	Continuous
Crane	85	Continuous
Dozer	85	Continuous
Excavator	85	Continuous
Front End Loader	80	Continuous
Generator	82	Continuous
Generator (25 KVA or less)	70	Continuous
Gradall	85	Continuous
Grader	85	Continuous
Grinder Saw	85	Continuous
Horizontal Boring Hydro Jack	80	Continuous
Hydra Break Ram	90	Impact
Impact Pile Driver	105	Impact
Insitu Soil Sampling Rig	84	Continuous
Jackhammer	85	Impact
Mounted Impact Hammer (hoe ram)	90	Impact
Paver	85	Continuous
Pneumatic Tools	85	Continuous
Pumps	77	Continuous
Rock Drill	85	Continuous
Scraper	85	Continuous
Slurry Trenching Machine	82	Continuous
Soil Mix Drill Rig	80	Continuous
Street Sweeper	80	Continuous
Tractor	84	Continuous
Truck (dump, delivery)	84	Continuous
Vacuum Excavator Truck (vac-truck)	85	Continuous
Vibratory Compactor	80	Continuous
Vibratory Pile Driver	95	Continuous
All other equipment with engines larger than 5 HP	85	Continuous

Notes:

1 Measured at 50 feet from the construction equipment, with a “slow” (1 sec.) time constant.

2 Noise limits apply to total noise emitted from equipment and associated components operating at full power while engaged in its intended operation.

3 Portable Air Compressor rated at 75 cfm or greater and that operates at greater than 50 psi.

Source: Mitigation of Nighttime Construction Noise, Vibrations and Other Nuisances, National Cooperative Highway Research Program, 1999.

Construction activities would include demolition, site preparation, grading and excavation, trenching, building (exterior), interior/ architectural coating and paving. Pile driving, which has the highest potential of generating noise impacts, may be used for construction of the building foundation. Hourly average noise levels due to construction activities during busy construction periods outdoors would typically range from about 75 to 88 dBA L_{eq} at a distance of 50 feet. Impact pile driving would generate maximum noise levels of up to about 101 dBA L_{max} at a distance of 50 feet, with an hourly average noise level of 95 dBA L_{eq}. Construction-generated noise levels drop off at a rate of about 6 dBA per doubling of the distance between the source and receptor. Shielding from intervening structures or buildings would be anticipated to provide 10 to 20 dBA or more of additional noise reduction.

There are no residences located within 300 feet of the site. The closest residences are located about 4,200 feet to the south and 3,800 feet to the north of the project site and are well shielded by intervening structures. Not taking shielding into account, typical construction activities would be anticipated to generate noise levels in the range of 37 to 50 dBA L_{eq} at a distance of 3,800 to 4,200 feet, and pile driving would be anticipated to generate noise levels of 61 dBA L_{max} and 55 dBA L_{eq}. Given the substantial shielding between residences and the project site, at least 20 dBA of additional reduction would be anticipated, resulting in construction noise levels that are well below ambient levels and likely inaudible at the closest residences. This is a **less-than-significant** impact.

Mitigation Measure 1c: None required.

Impact 2: Generation of Excessive Groundborne Vibration due to Construction. Construction-related vibration levels are not anticipated to exceed 0.5 in/sec PPV at the nearest structures. **This is a less-than-significant impact.**

The City of Santa Clara does not specify a construction vibration limit. For structural damage, the California Department of Transportation recommends a vibration limit of 0.5 in/sec PPV for buildings structurally sound and designed to modern engineering standards, 0.3 in/sec PPV for buildings that are found to be structurally sound but where structural damage is a major concern, and a conservative limit of 0.25 in/sec PPV for historic and some old buildings (see Table 3). The 0.5 in/sec PPV vibration limit would be applicable to properties in the vicinity of the project site.

Construction activities would include demolition, site preparation, grading and excavation, trenching, building (exterior), interior/ architectural coating and paving. Pile driving may be used for construction of the building foundation. Impact pile driving, if used, has the potential of generating the highest ground vibration levels and is of primary concern to structural damage. Other project construction activities, such as drilling, the use of jackhammers, rock drills and other high-power or vibratory tools, and rolling stock equipment (tracked vehicles, compactors, etc.) may also potentially generate substantial vibration in the immediate vicinity. Erection of the building structure is not anticipated to be a source of substantial vibration with the exception of sporadic events such as dropping of heavy objects, which should be avoided to the extent possible.

The closest structures to the project site are industrial buildings, located 100 to 160 feet from the site property line. Table 10 presents typical vibration levels that could be expected from construction equipment at a reference distance of 25 feet and at distances of 100 and 160 feet, representative of the closest industrial structures to the project site.

TABLE 10 Vibration Source Levels for Construction Equipment

Equipment		PPV at 25 ft. (in/sec)	PPV at 100 ft. (in/sec)[1]	PPV at 160 ft. (in/sec)[1]
Pile Driver (Impact)	upper range	1.158	0.252	0.150
	typical	0.644	0.140	0.084
Pile Driver (Sonic)	upper range	0.734	0.160	0.095
	typical	0.17	0.037	0.022
Clam shovel drop		0.202	0.044	0.026
Hydromill (slurry wall)	in soil	0.008	0.002	0.001
	in rock	0.017	0.004	0.002
Vibratory Roller		0.210	0.046	0.027
Hoe Ram		0.089	0.019	0.012
Large bulldozer		0.089	0.019	0.012
Caisson drilling		0.089	0.019	0.012
Loaded trucks		0.076	0.017	0.010
Jackhammer		0.035	0.008	0.005
Small bulldozer		0.003	0.001	0.000

Source: Transit Noise and Vibration Impact Assessment, United States Department of Transportation, Office of Planning and Environment, Federal Transit Administration, October 2018 as modified by Illingworth & Rodkin, Inc., October 2019.

[1]These levels calculated assuming normal propagation conditions, using a standard equation of *PPVeqmt-PPVref * (25/D) 1.5*, from FTA, May 2006.

As indicated in Table 5, vibration levels at the nearest industrial building, located 100 feet south of the site property line, would be well below 0.5 in/sec PPV from all construction activity, including potential pile driving. Vibration levels would be lower in more distant locations. This is a **less-than-significant** impact.

Mitigation Measure 2: None required.

Impact 3: Excessive Aircraft Noise Levels. The proposed project would be located in a compatible noise environment with respect to noise generated by Norman Y. Mineta San José International Airport. **This is a less-than-significant impact**.

Norman Y. Mineta San José International Airport is located approximately 800 feet east of the project site. Based on the 2027 noise contours shown in the Norman Y. Mineta San José International Airport Master Plan Update Project Report (2010), the project site has an airport noise exposure of about 70 dBA CNEL. This noise level would be considered compatible with industrial use. This is a **less-than-significant impact**.

Mitigation Measure 3: None required.

Appendix G

Water Use Analyses

City of Santa Clara
Water Supply Assessment (WSA) Form

Site Name:	
Address:	2825 Lafayette Street
Date:	02 March 2020

Person Completing WSA Form

Name:	Chad Mendell
Affiliation:	ESD (Design Team, Lead Consultant)
Phone Number:	(312) 456-2387
Email:	cmendell@esdglobal.com

1) Describe Summary of Work:

Two existing two-store office buildings are being demolished and are being replaced one three-story data center building. The data center building will have a small office component and will primarily be 'white space' for computer equipment.

2) Fill out the following table for Existing Site:

If no existing development, write "N/A"

Existing Development				
Use	**sq ft.**	**Water Type (Potable, Recycled)**	**Demolition or Remaining**	**Notes**
Residential				
Irrigation	63,150	Reclaimed		
Office Space	305,000	Potable		
Retail Space				
Industrial				
All Other[1]				
Total Demolition	162,700			
Total Remaining	0			

[1]Other uses include (but not limited to): fountains, pools, water features, athletic fields, parking lot, etc.

3) Fill out the following table for Proposed Development:

Proposed Development				
Use	**sq ft.**	**Water Type**	**Earliest Completion Date**	**Notes** (i.e. Different addresses to be used at project site)
e.g. Office Space	***300,000***	***Potable***	***June 2014***	***2 - 150,000 sq. ft. buildings***
e.g. Irrigation	***95,300***	***Recycled***		
Residential				
Irrigation	206,450	Reclaimed	First Completion 1Q22; Full Completion 2Q27	
Office Space	71,405	Potable	First Completion 1Q22; Full Completion 2Q27	
Retail Space				
Industrial				
All Other[1]	504,715	Potable	First Completion 1Q22; Full Completion 2Q27	Data Center
Total Proposed	576,120	Outdoor Area Not Included in Total		

4) Totals

Total Development After Project Completion: **(Total Remaining + Proposed)**	576,120 SqFt

5) If any additional notes, please indicate below:
(i.e. Projected Water Demand)

2022: 11.84 acre-ft/year; 295 gpm	2025: 47.37 acre-ft/year; 1,024 gpm
2023: 23.68 acre-ft/year; 512 gpm	2026: 59.76 acre-ft/year; 1,271 gpm
2024: 35.53 acre-ft/year; 768 gpm	2027: 65.24 acre-ft/year; 1,407 gpm

Technical Memo

Client Company	Digital Realty (DLR)	ESD Project #	C190280-001
Client Contact / Phone #	Joe Hubbard / 469.385.2632	Date	2020.02.28
Author / Phone #	Michael Streich / 312.580.0515		
Project Name	2825 Lafayette Entitlement		
Location	2825 Lafayette, Santa Clara, California		

Subject
Projected Water Consumption for Proposed New 2825 Lafayette Data Center & Office Building

SUMMARY

The annual water consumption of the proposed new data center and office building located at 2825 Lafayette **will be limited to 67.0 acre-ft/yr**. The 67.0 acre-ft/yr. of water will be consumed by the plumbing and mechanical systems. Of the consumed domestic water, approximately 18.3 acre-ft/yr. will be blowdown.

The peak water demand of the facility based on the project's design ambient temperature of 102.5 deg F DB is 1,407 gallons/minute. The peak blowdown at this design ambient temperature is 365 gallons/minute.

The peak water demand of the facility based on the maximum ambient temperature for a typical meteorological year (TMY3) is 1,157 gallons/minute. The peak blowdown at the maximum ambient temperature for the typical meteorological year is 307 gallons/minute.

TMY, as defined by the National Renewable Energy Laboratory (https://nsrdb.nrel.gov/tmy), is a data set available through the National Solar Radiation Database which includes one year of hourly weather data that represents the median weather data over a duration of time. The TMY3 data set is the most recent weather data set available for designers to use. The TMY3 data sets are based on data collected from 1991 to 2005. The TMY2 data sets (outdated) are based on data collected from 1961-1990. TMY data sets are often used for computer energy simulations and performance comparisons of mechanical system topologies.

The weather data indicates that a peak demand of 1,407 gallons/minute will happen extremely infrequently, if ever (the TMY3 data set indicates there are no bin hours over 96 deg F DB). This demand could only occur in a situation where the entire facility is operating at 100% of the design building capacity on a day where the ambient temperature lies outside of the TMY3 temperatures. The owner's data center portfolio indicates a typical utilization under 70% of the designed building capacity. This is important to note as the load on the mechanical plant decreases, the evaporative heat rejection consumption also decreases.

BACKGROUND

2825 Lafayette is a proposed 576,120 sq.-ft proposed data center and office building. 504,715 sq.-ft is proposed data center and 71,405 sq.-ft is proposed office building. A water supply assessment is required for facilities which meet the following regulatory criteria:

- A residential development having more than 500 units
- A hotel or motel development having more than 500 rooms
- A commercial office building employing 1,000 people or having more than 250,000 sq.-ft of floor space
- An industrial, manufacturing or industrial park planned to house more than 1,000 employees or having more than 650,000 sq.-ft of floor space
- A mixed-use project that contains one or more of the criteria above
- Any project that has a water demand equal to or greater than the amount of water required by a 500 dwelling unit development

A 500 dwelling unit development based on the current residential water demand factor equates to 67.8 acre-ft/yr. of water consumption. This water consumption rate relates to the proposed 2825 Lafayette facility through the following building services:

- Plumbing (toilets, sinks, pantries, janitor closets, hose bibbs, etc.)
- Mechanical (humidification, chilled water plant evaporation)

The purpose of this memo is to detail the annual and peak water consumption of the proposed facility at 2825 Lafayette.

SUMMARY OF WATER USES

Plumbing System Water Uses

Domestic

Based on preliminary assumptions on the PBB layout and past project experience with the building owner, there is an estimated a peak domestic water demand of 12 GPM and an estimated yearly consumption of 47,000 gallons (**0.15 acre-ft/yr.**).

Hose Bibbs

Water usage from hose bibbs is hard to estimate accurately as it is very operator dependent. For this analysis we have studied cleaning the condensing coils on the roof for 8 hours, once a month, twelve times a year, or 115,000 gallons per year (**0.35 acre-ft/yr.**).

Mechanical System Water Uses

Humidification

Based on the proposed data hall sizes, typical operating conditions, annual average weather data and past project experience with the building owner, there is an estimated the annual humidification load to be 1,507,148 gallons (**4.63 acre-ft/yr.**). As the design progresses alternate humidification systems and control sequences will be evaluated to decrease this annual consumption.

Evaporative Heat Rejection

There are two important design criteria for the proposed evaporative mechanical plant:

1. Peak water consumption - for this study, it is assumed that all the installed evaporative air-cooled chillers are operational. Operating all the installed equipment is the most energy efficient mode of operation for the plant. With all equipment operational under design load and design ambient conditions, the equipment will operate at 75%.

    a. There are two peak water demand conditions of interest for this facility:

        i. Design ambient temperature of 105 deg F DB: **1,355 gallons/minute demand (1,407 gallons/minute including humidification and domestic water consumption)**

        ii. Maximum ambient temperature for the typical meteorological year (TMY3) of 96.1 deg F DB: **1,105 gallons/minute demand (1,177 gallons/minute including humidification, hose bibbs and domestic water consumption)**

    These peak ambient conditions are of significance because these values directly relate to the quantity of water evaporated by the mechanical system (an increase in ambient dry-bulb and wet-bulb temperature yields an increase in water evaporated by the system) and thus indicate the maximum anticipated demand on the water utility serving the facility. While interpreting these data points it is important to note the relationship between ambient temperature conditions vs the total water demand in relation to the anticipated time at the ambient temperature condition.

Ambient Dry-Bulb (°F DB)	Coincident Wet-Bulb (°F WB)	Hours	Domestic Water Consumption + Blowdown (GPM)	Hose Bibb Consumption (GPM)	Humidification Consumption + Blowdown (GPM)	Evaporation (Heat Rejection System) (GPM)	Blowdown (Heat Rejection System) (GPM)	Total Demand (GPM)
102.5	67	1	12	0	40	1,042	313	1,407
97.5	65.3	1	12	20	40	850	255	1,177
92.5	64.1	9	12	20	40	682	205	959
87.5	63.7	37	12	20	40	530	159	761
82.5	63.6	188	12	20	40	394	118	584
77.5	62.6	291	12	20	40	282	85	439

    This data indicates that a peak mechanical heat rejection demand of 1,355 gallons/minute will happen extremely infrequently, if ever (the 102.5°F and the 97.5°F ambient dry-bulb data points do not exist in the TMY3 data set) and would only occur in a situation where the entire facility is operating at 100% of the design building capacity on a day where the ambient temperature lies outside of the TMY3 temperatures. The owner's data center portfolio indicates a typical utilization under 70% of the designed building capacity. This is important to note because as the load on the mechanical plant decreases, the evaporative heat rejection consumption decreases.

2. Total annual water consumption - **The total annual water consumption of the evaporative heat rejection plant will be limited to ensure the total annual consumption of the building is under 67.8 acre-feet/year.** Based on the projected

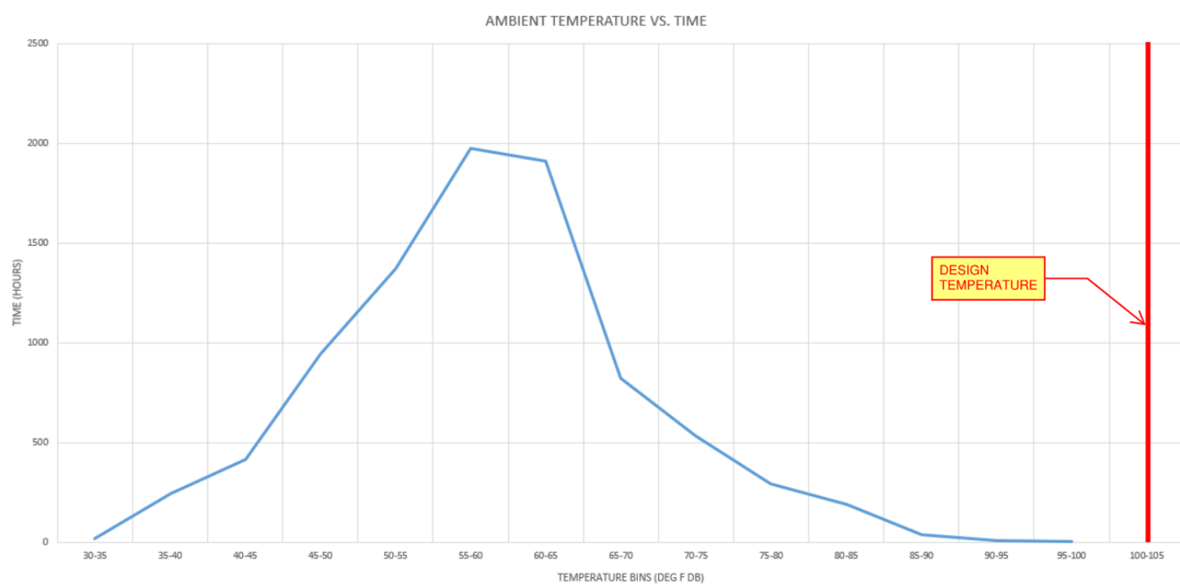
domestic water consumption, projected hose bibb water consumption and humidification system water consumption it is anticipated that the evaporative heat rejection plant will be allowed to consume a **maximum of 65.13 acre-ft/yr**. The evaporative portion of the mechanical plant will be limited through the control system which will be capable of enabling and disabling the evaporative media based on the ambient temperature. See the water consumption control theory section below for more details on how the ambient temperature setpoint impact water consumption.

WATER CONSUMPTION CONTROL THEORY

The amount of water consumed by the mechanical plant can be controlled through an ambient temperature setpoint. When the ambient temperature is above the setpoint, the adiabatic system on the air-cooled chillers will be enabled. When the ambient temperature is below the setpoint, the adiabatic system on the air-cooled chillers will be disabled. The higher the ambient temperature setpoint, the greater the reduction in water consumption and annual runtime of adiabatic system. The chart below confirms this relationship.

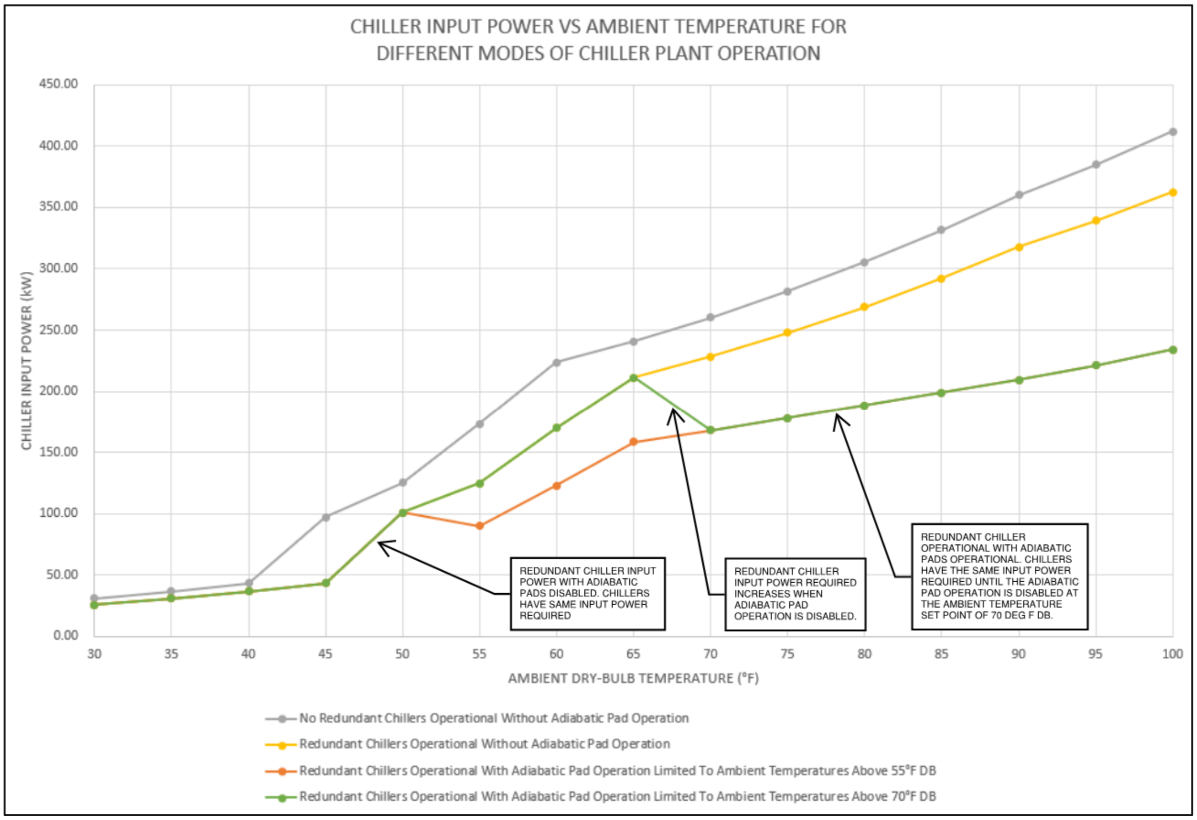
For example:

- If the ambient temperature setpoint is 100 deg F DB, the adiabatic system would not be enabled based on the TMY3 data set.
- If the ambient temperature setpoint is 30 deg F DB, the adiabatic system would never be disabled based on the TMY3 data set.
- If the ambient temperature setpoint is 70 deg F DB, the adiabatic system would operate for 1,183 hours based on the TMY3 data set.



IMPACT OF LIMITING WATER CONSUMPTION ON ENERGY EFFICIENCY

The adiabatic pads provided on the air-cooled chillers pre-cool the ambient inlet air to the chiller. By reducing the ambient inlet air temperature to the chiller, the chiller's required input power is also reduced. The consumption of water and ability to run the redundant equipment allows for a more energy efficient mechanical system as detailed by the chart.



CALCULATING WATER CONSUMPTION

Working with the proposed equipment vendor, the efficiency of the adiabatic pads and the chiller's required condenser airflow rate to reject the design load were determined. Utilizing the TMY3 bin data set (which includes 8760 hours of weather data) it is possible to vary the adiabatic pad set point and determine the amount of water consumed by the plant (when the building is fully loaded, and the chilled water plant is completely built out). The results of this study are listed in the table below.

Chiller Adiabatic Transition On/Off Setpoint (°F DB)	Calculated Water Consumption (Evaporation + Blowdown) (Acre-Feet)	Hours of Adiabatic System Operation at Setpoint
95	0.16	2
90	0.82	11
85	2.98	48
80	11.51	236
75	24.88	588
70	47.19	1183
65	71.99	1882
60	131.44	3793
55	189.52	5995
50	223.14	7399
45	235.30	8133
40	239.46	8501
35	241.04	8743
30	241.16	8760

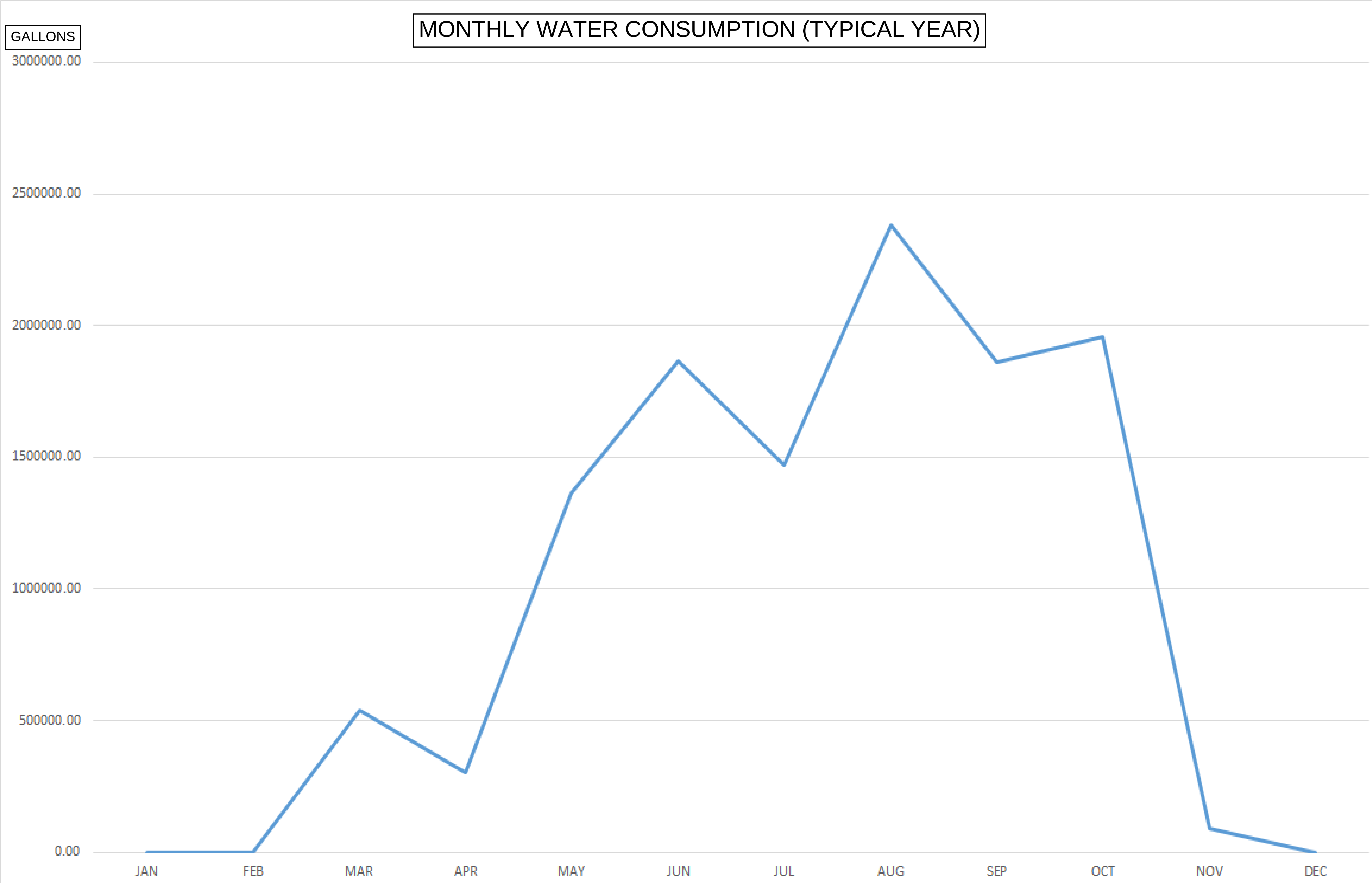
ANTICIPATED WATER DEMAND AND ANNUAL RAMP SCHEDULE

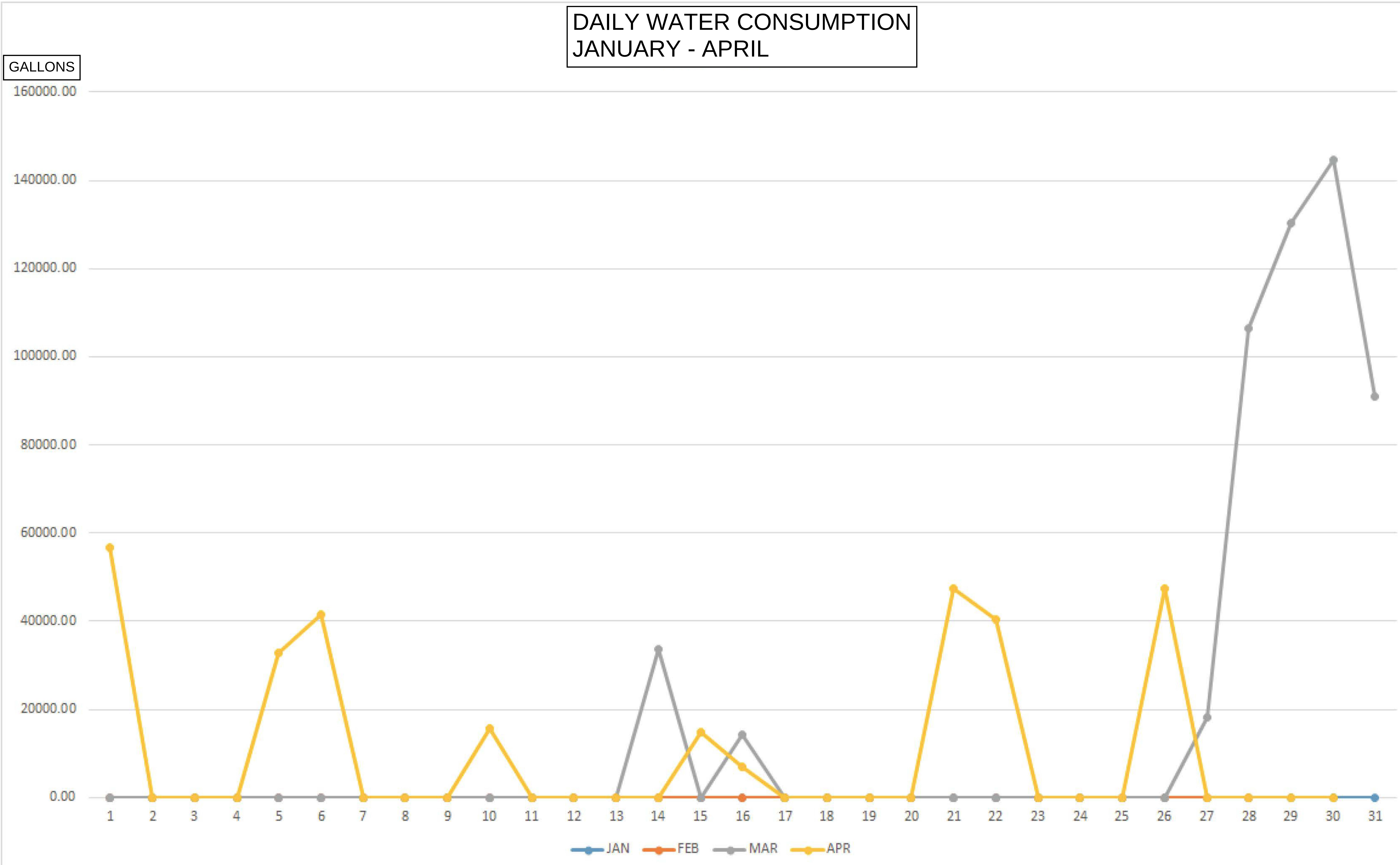
The peak water demand and total annual water consumption values listed in the section above will not be present when the facility is initially built. Based on past experiences with the owner, it is expected that two data halls will be built out and operated every year. As such, it is estimated that the facility will not require the anticipated total peak water demand of 1,407 GPM until 2027. See the anticipated water demand and annual ramp table below.

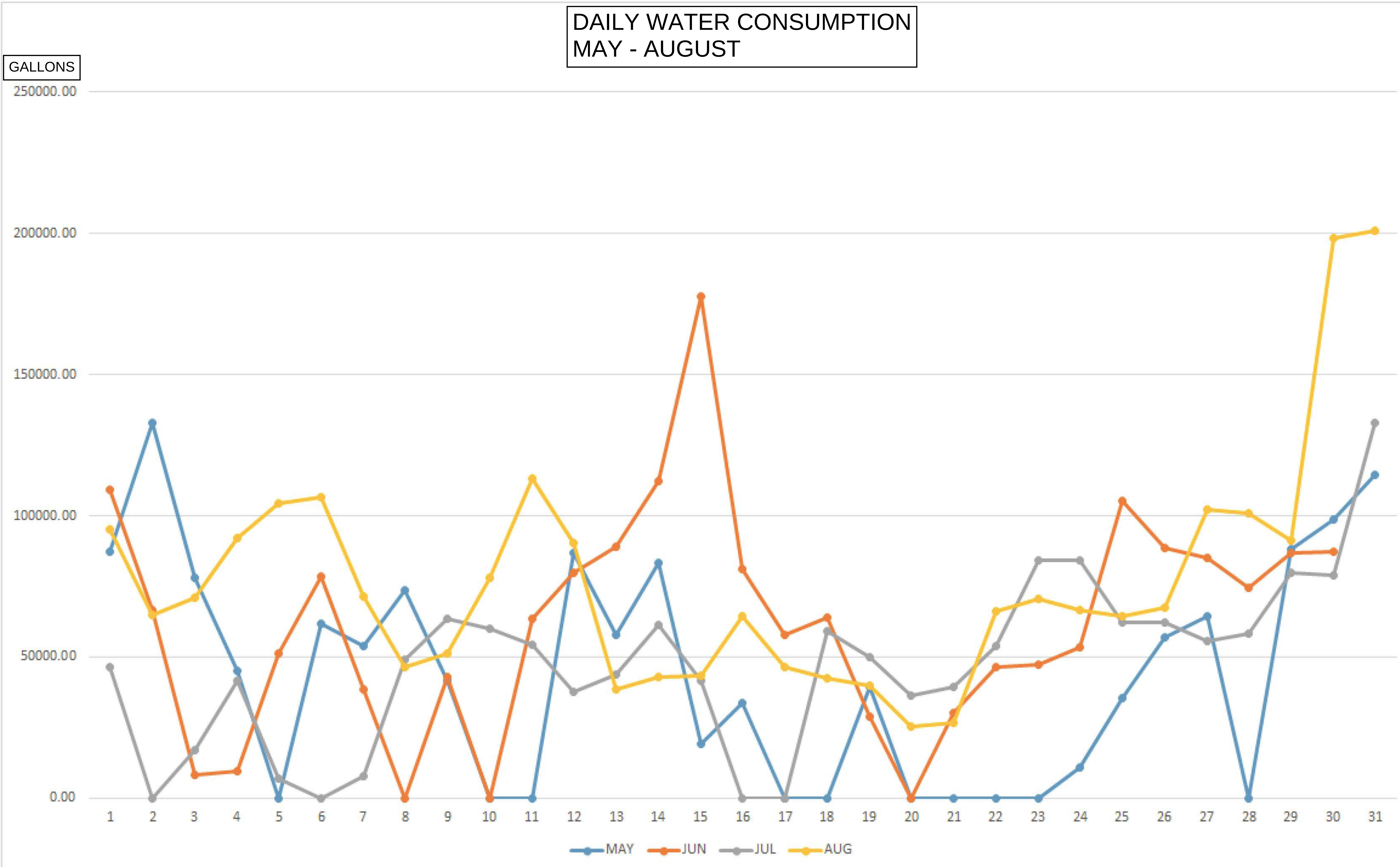
Year	Number of Data Halls Online	Adiabatic Transition On/Off Setpoint (°F DB)	Anticipated Total Peak Water Demand (GPM)	Anticipated Total Peak Blowdown (GPM)	Annual Water Consumption (Acre-Ft/Yr.)	Annual Water Blowdown (Acre-Ft/Yr.)
2022	2	67	255.82	66.36	11.84	3.32
2023	4	67	511.64	132.73	23.68	6.65
2024	6	67	767.45	199.09	35.53	9.98
2025	8	67	1,023.27	265.45	47.37	13.31
2026	10	67	1,279.09	331.82	59.21	16.64
2027	11	67	1407	365	65.13	18.3

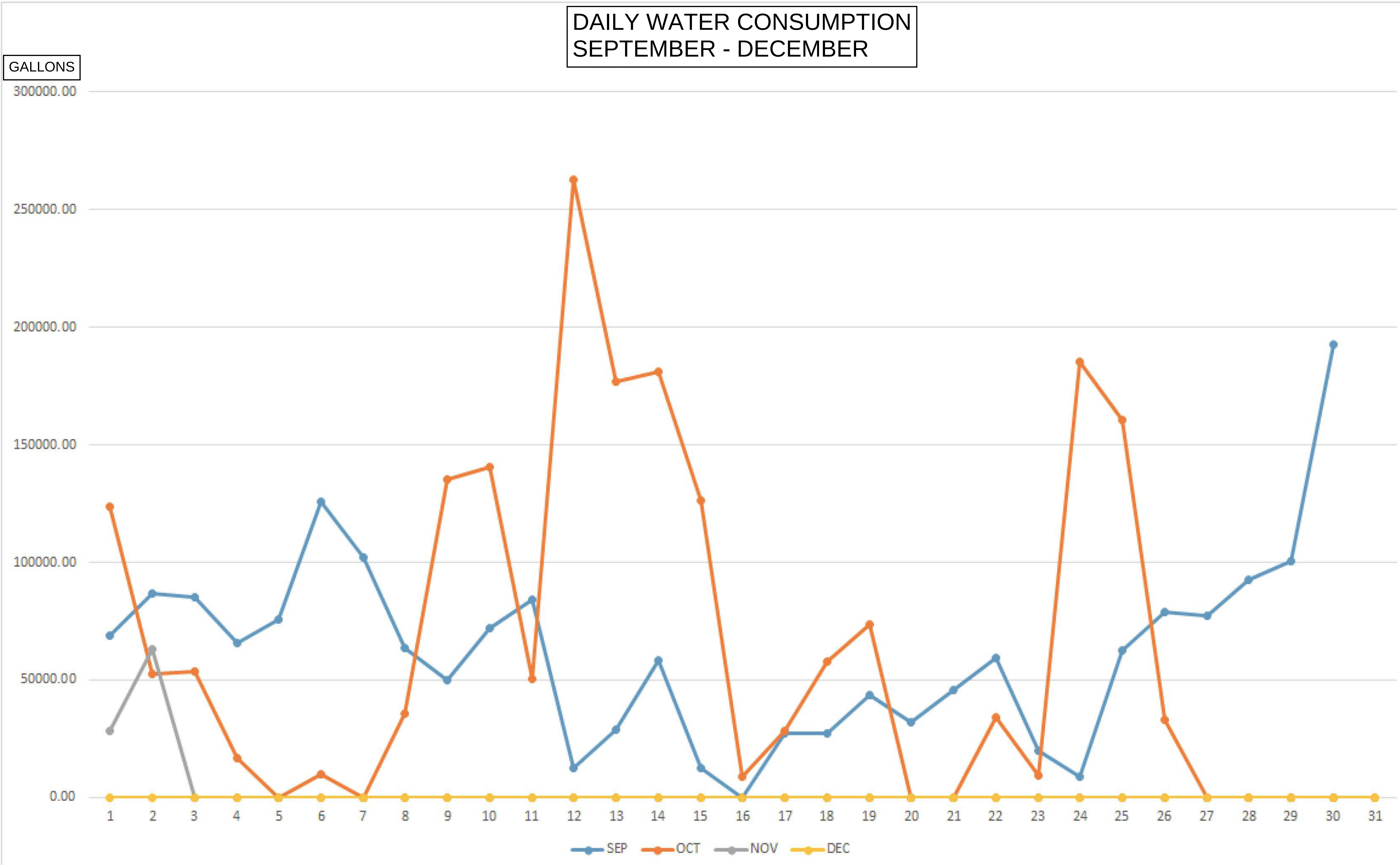
*Mechanical evaporative heat rejection plant water consumption is limited to prohibit exceeding the 67.8 acre-feet/year limit by managing the adiabatic transition setpoint.

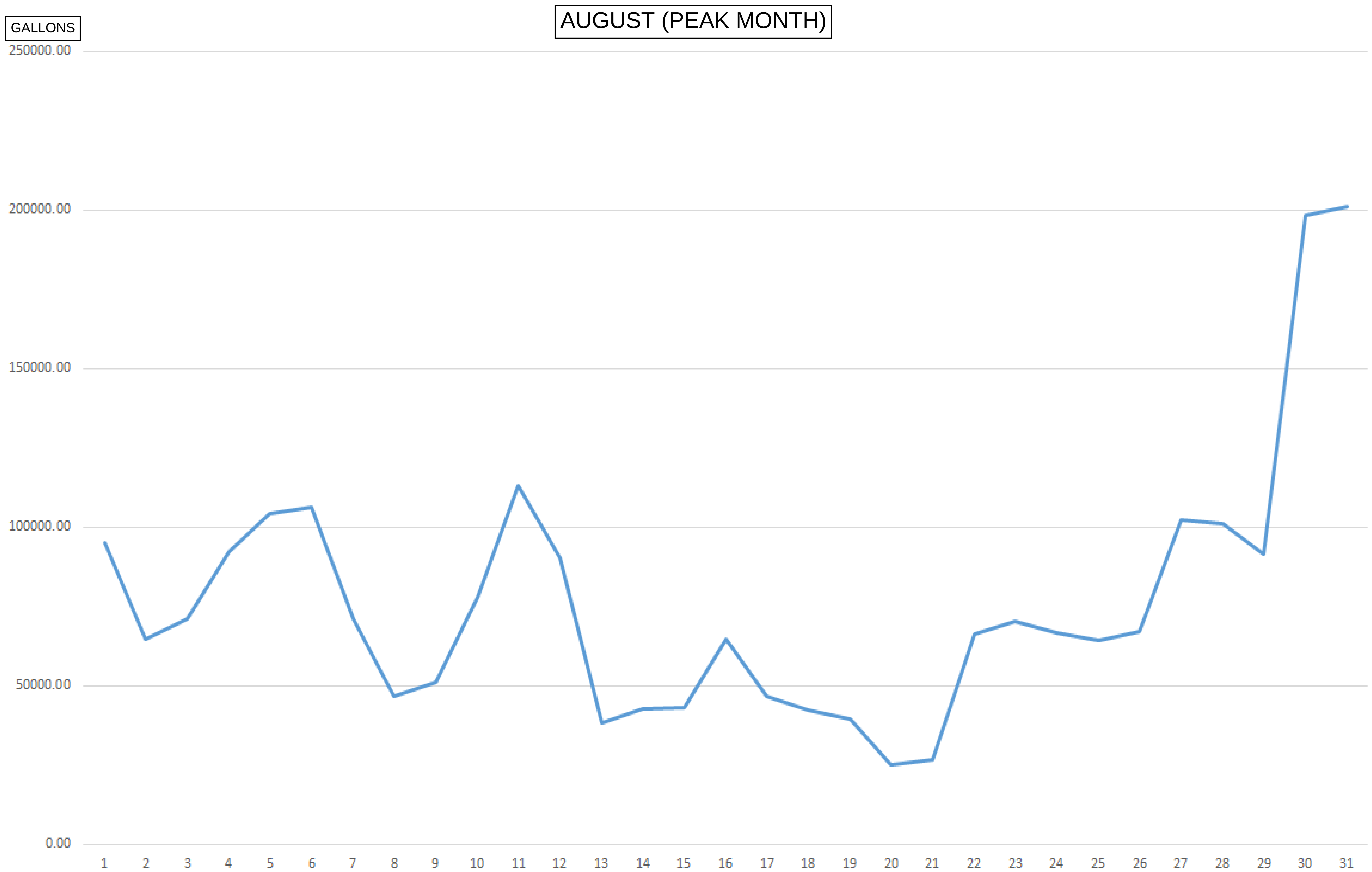
**Values in table above are based on TMY3 weather data. Anticipated peak demand of 1,454.6 GPM is based on the design ambient temperature, which is higher than the data points included in the TMY3 weather data.


MONTHLY WATER CONSUMPTION (TYPICAL YEAR)
GALLONS
3000000.00
2500000.00
2000000.00
1500000.00
1000000.00
500000.00
0.00
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


DAILY WATER CONSUMPTION
JANUARY - APRIL
GALLONS
160000.00
140000.00
120000.00
100000.00
80000.00
60000.00
40000.00
20000.00
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
JAN
FEB
MAR
APR


DAILY WATER CONSUMPTION
MAY - AUGUST
GALLONS
250000.00
200000.00
150000.00
100000.00
50000.00
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
MAY
JUN
JUL
AUG


DAILY WATER CONSUMPTION
SEPTEMBER - DECEMBER
GALLONS
300000.00
250000.00
200000.00
150000.00
100000.00
50000.00
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
SEP
OCT
NOV
DEC


AUGUST (PEAK MONTH)
GALLONS
250000.00
200000.00
150000.00
100000.00
50000.00
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
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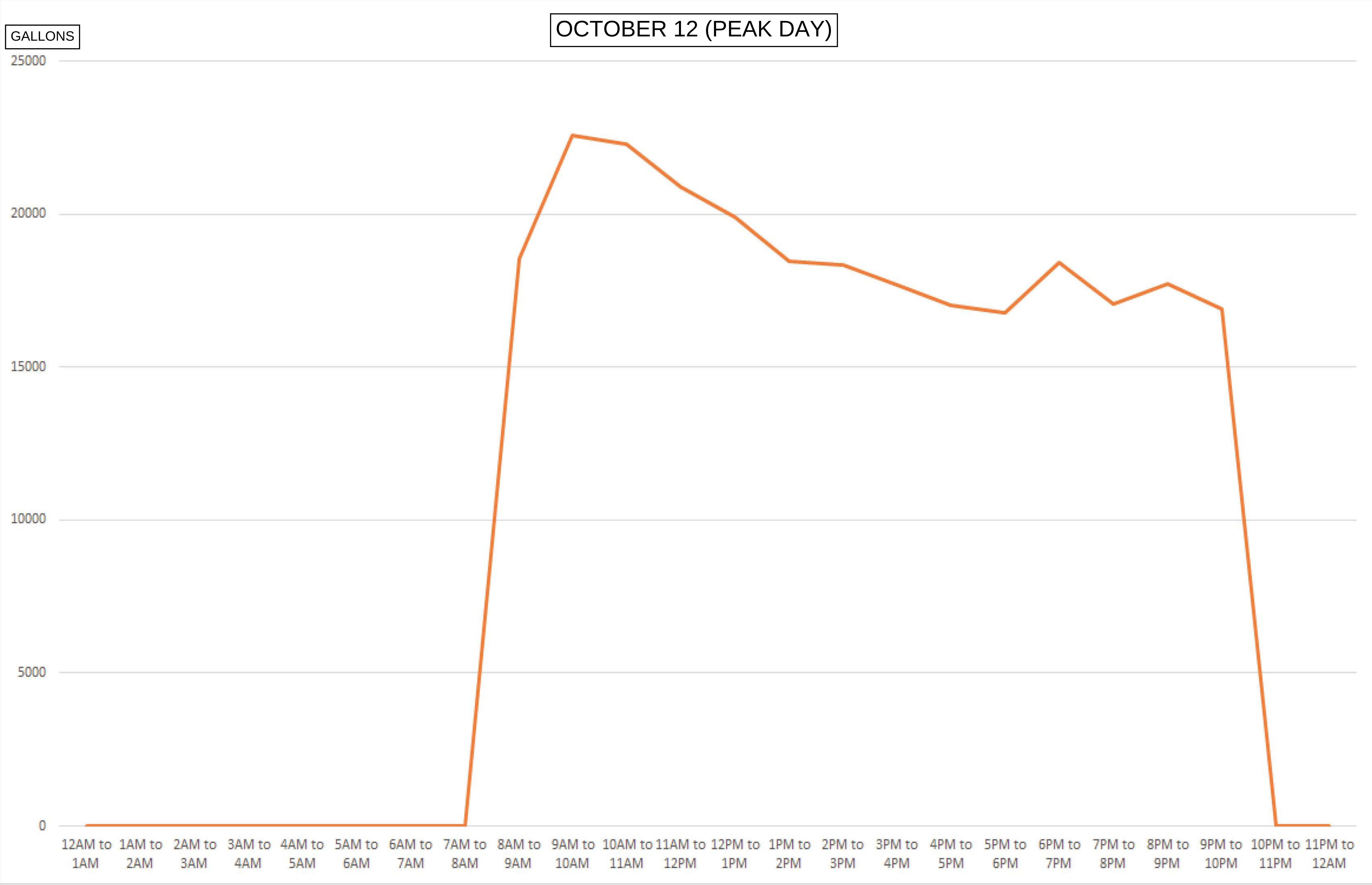
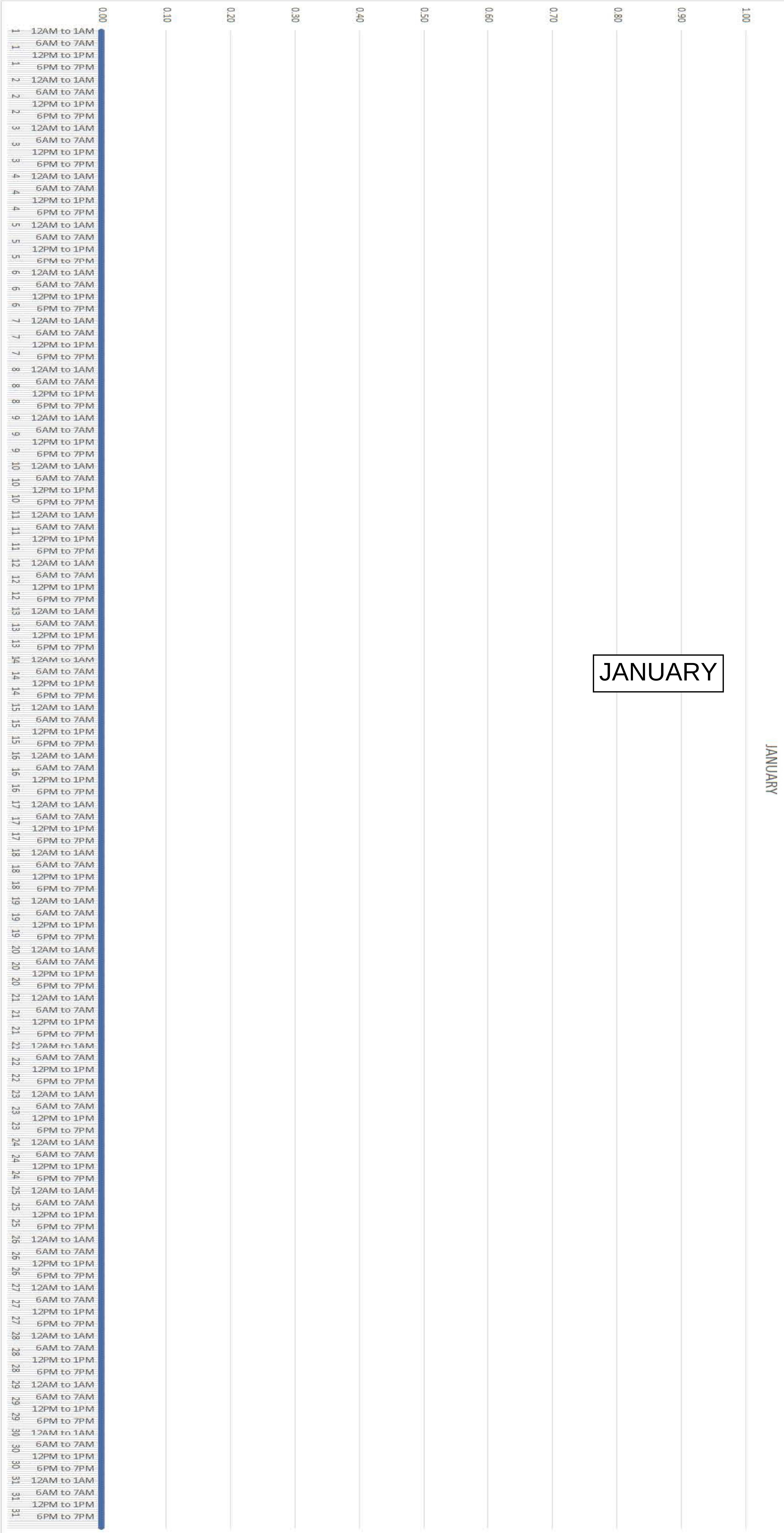
26
27
28
29
30
31



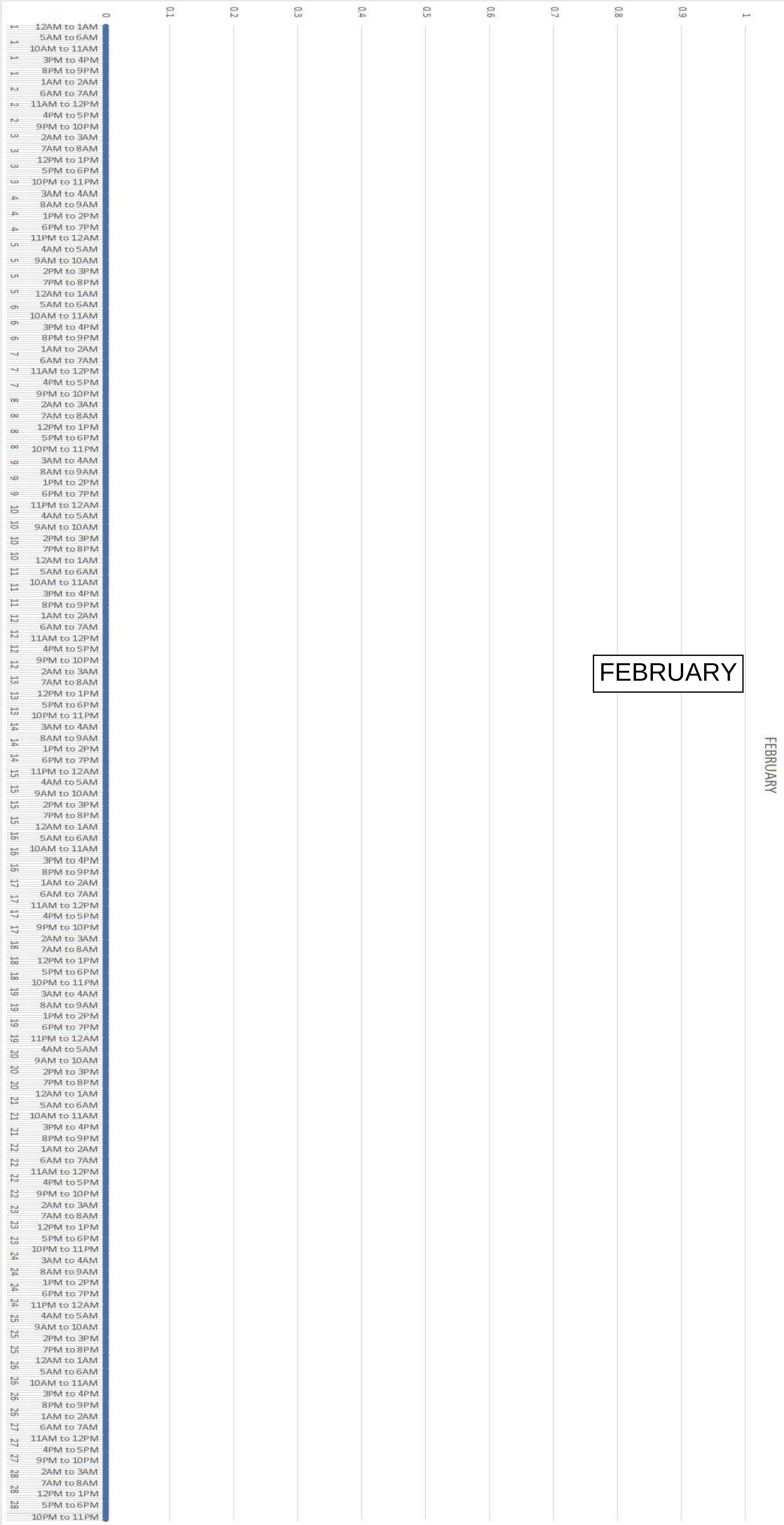
OCTOBER 12 (PEAK DAY)
GALLONS
25000
20000
15000
10000
5000
0
12AM to 1AM
1AM to 2AM
2AM to 3AM
3AM to 4AM
4AM to 5AM
5AM to 6AM
6AM to 7AM
7AM to 8AM
8AM to 9AM
9AM to 10AM
10AM to 11AM
11AM to 12PM
12PM to 1PM
1PM to 2PM
2PM to 3PM
3PM to 4PM
4PM to 5PM
5PM to 6PM
6PM to 7PM
7PM to 8PM
8PM to 9PM
9PM to 10PM
10PM to 11PM
11PM to 12AM

GALLONS

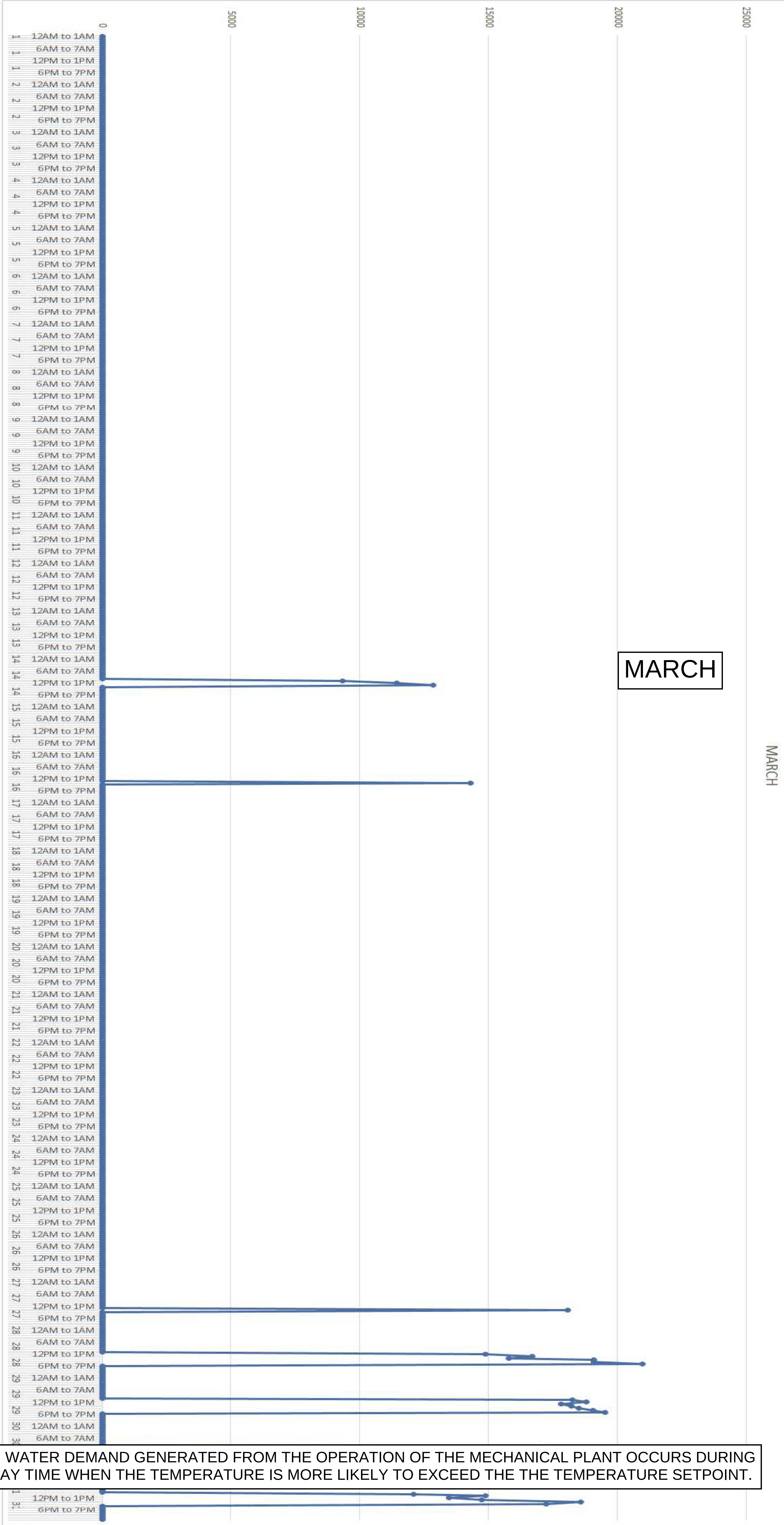
JANUARY



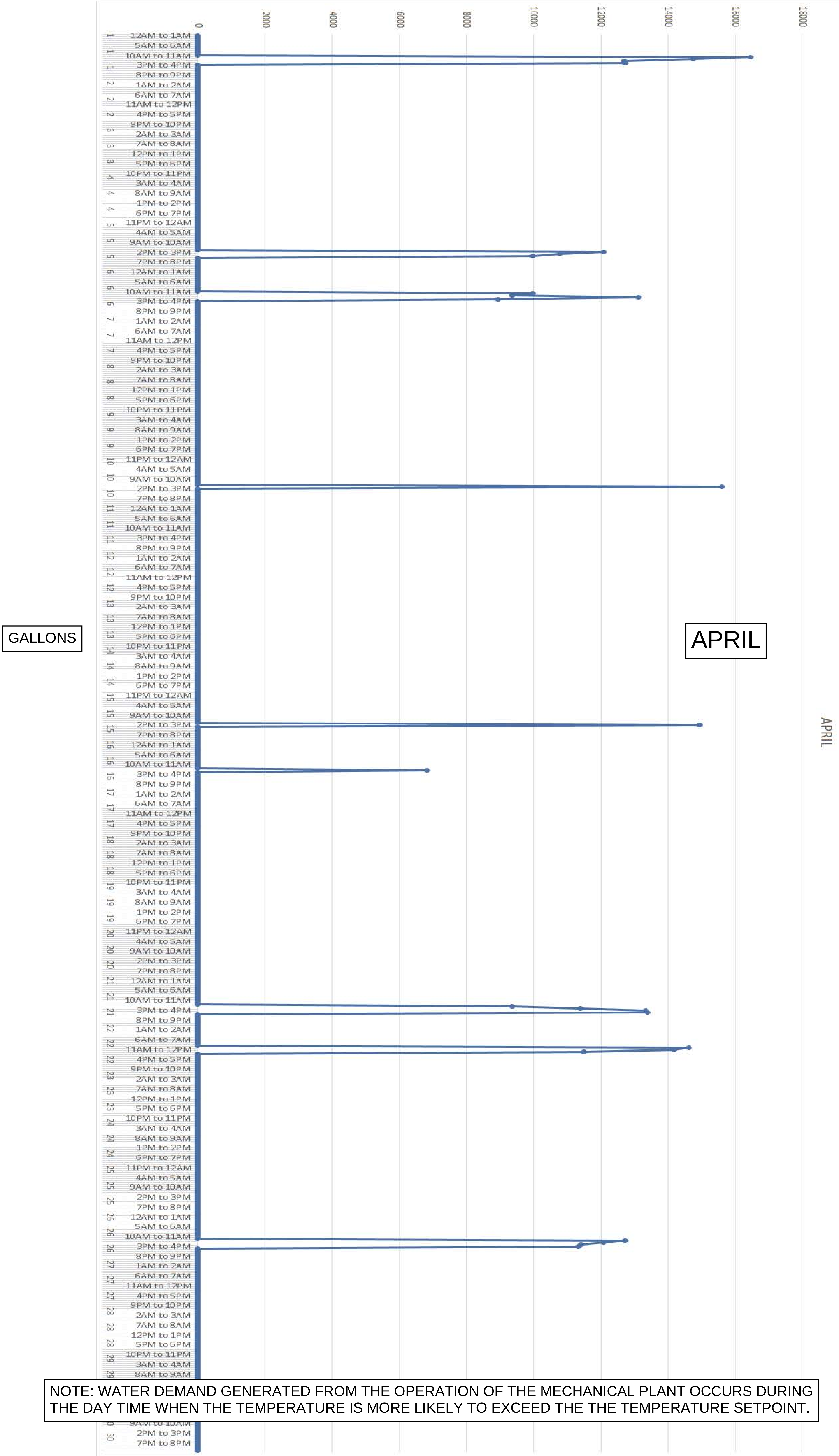
GALLONS



GALLONS

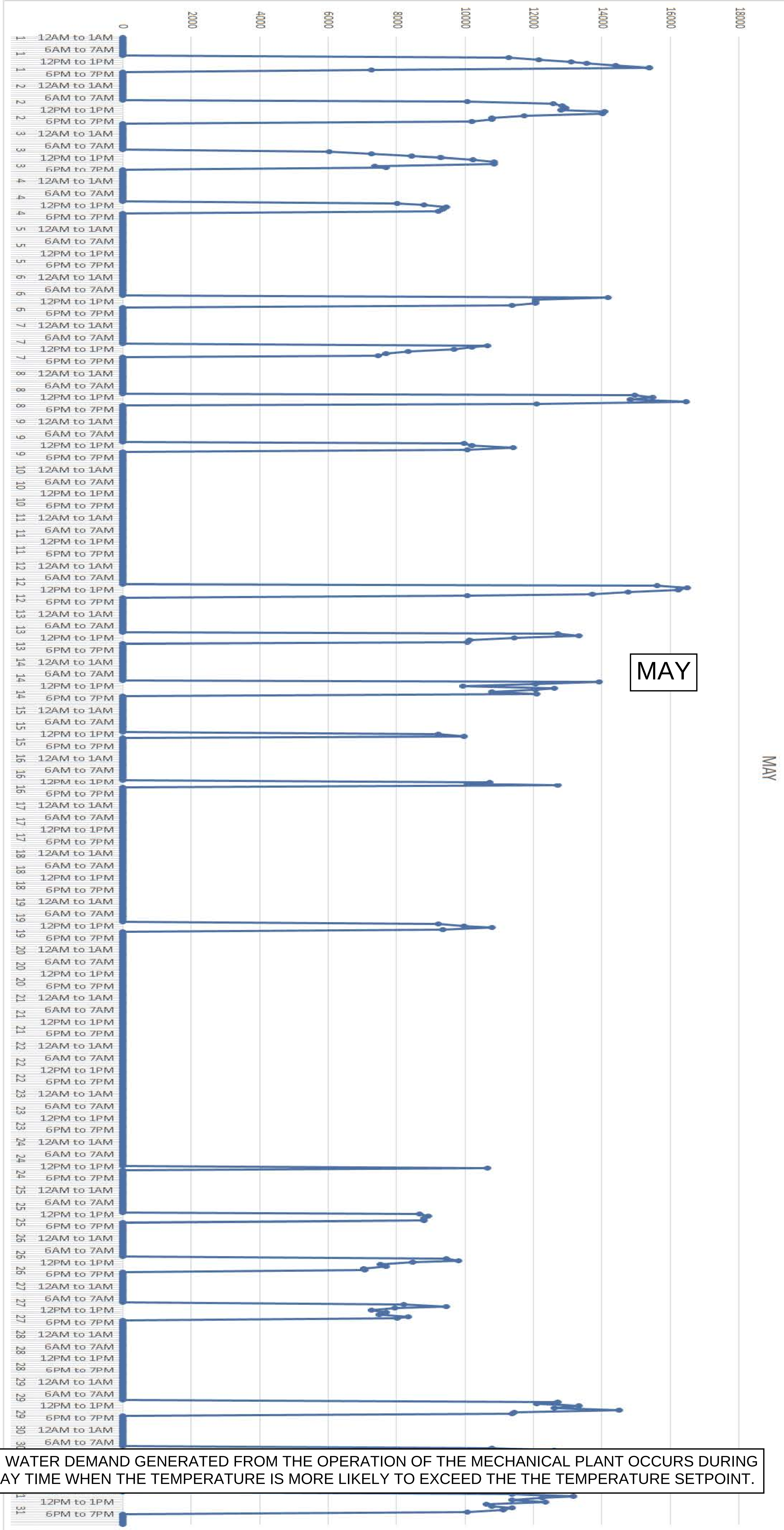


NOTE: WATER DEMAND GENERATED FROM THE OPERATION OF THE MECHANICAL PLANT OCCURS DURING THE DAY TIME WHEN THE TEMPERATURE IS MORE LIKELY TO EXCEED THE THE TEMPERATURE SETPOINT.



NOTE: WATER DEMAND GENERATED FROM THE OPERATION OF THE MECHANICAL PLANT OCCURS DURING THE DAY TIME WHEN THE TEMPERATURE IS MORE LIKELY TO EXCEED THE THE TEMPERATURE SETPOINT.

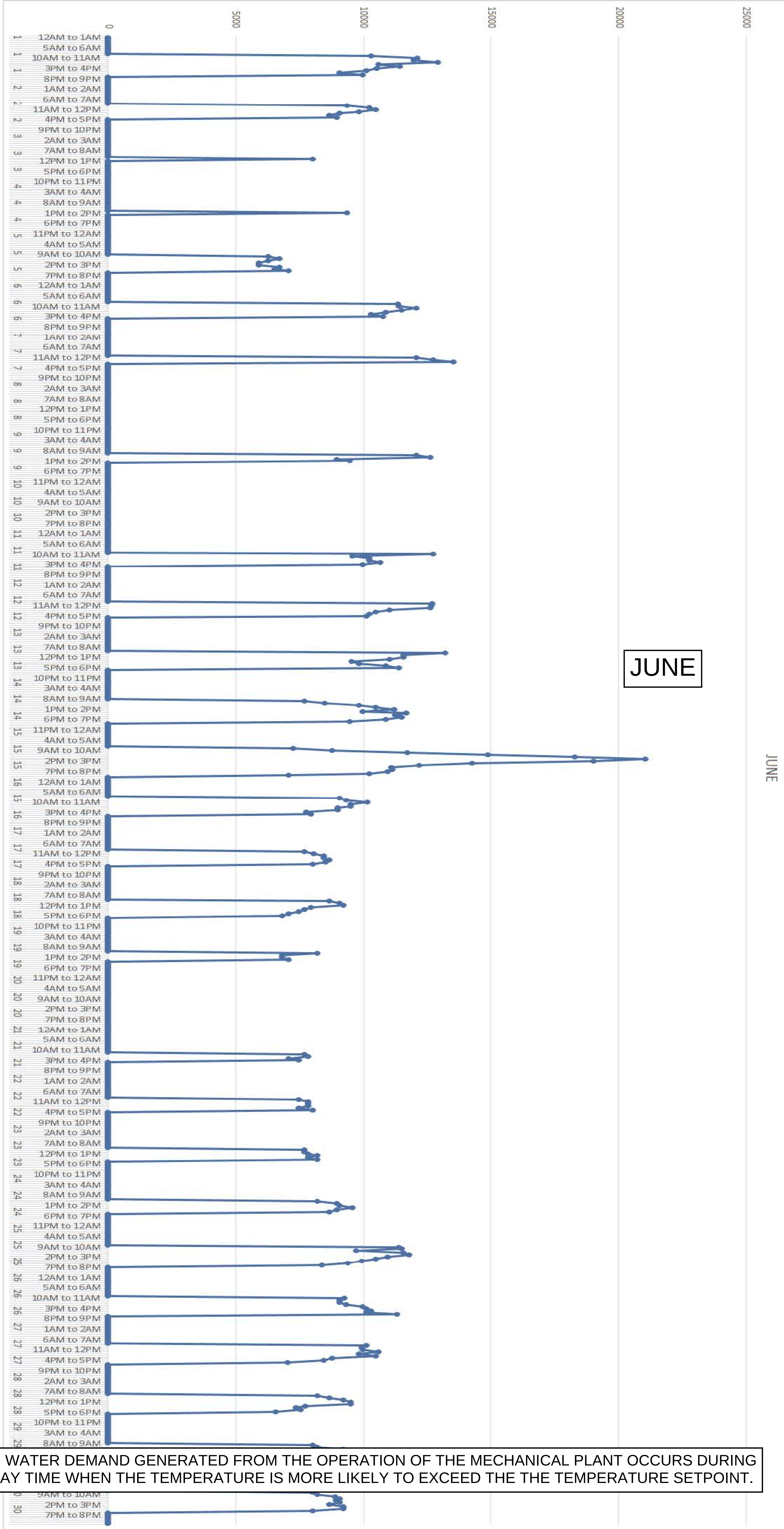
GALLONS



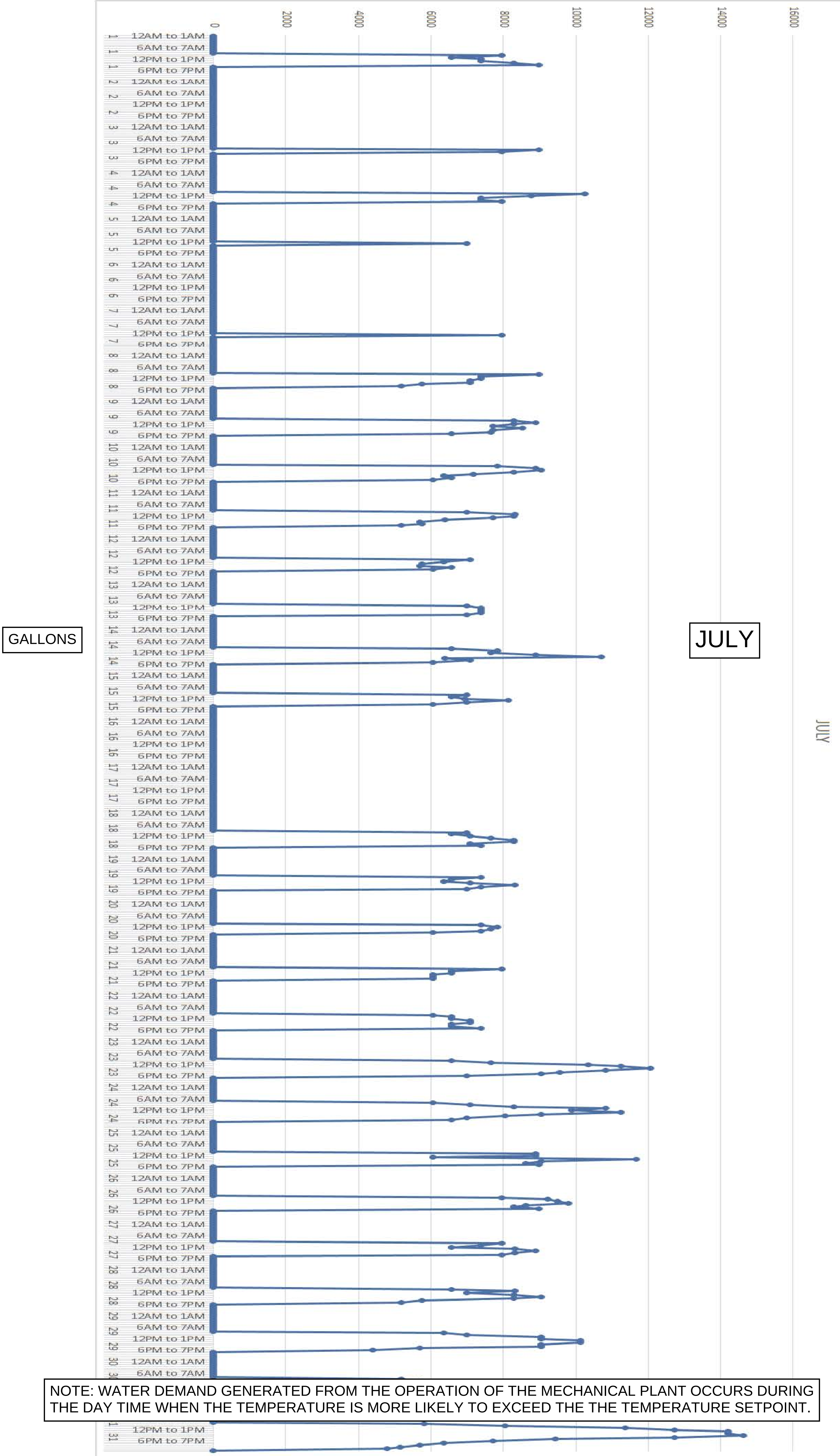
NOTE: WATER DEMAND GENERATED FROM THE OPERATION OF THE MECHANICAL PLANT OCCURS DURING THE DAY TIME WHEN THE TEMPERATURE IS MORE LIKELY TO EXCEED THE THE TEMPERATURE SETPOINT.

GALLONS

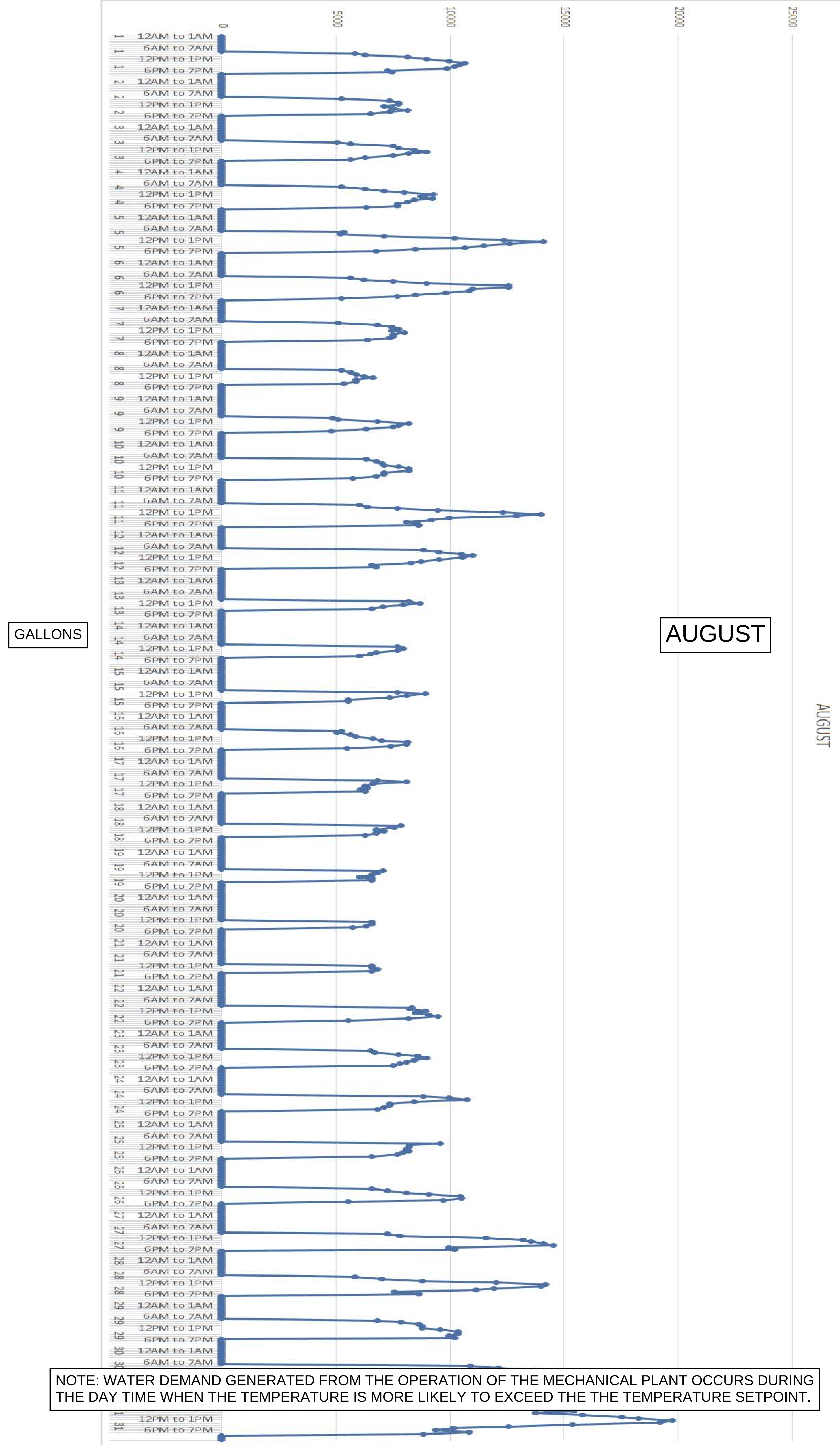
JUNE



NOTE: WATER DEMAND GENERATED FROM THE OPERATION OF THE MECHANICAL PLANT OCCURS DURING THE DAY TIME WHEN THE TEMPERATURE IS MORE LIKELY TO EXCEED THE THE TEMPERATURE SETPOINT.



NOTE: WATER DEMAND GENERATED FROM THE OPERATION OF THE MECHANICAL PLANT OCCURS DURING THE DAY TIME WHEN THE TEMPERATURE IS MORE LIKELY TO EXCEED THE THE TEMPERATURE SETPOINT.

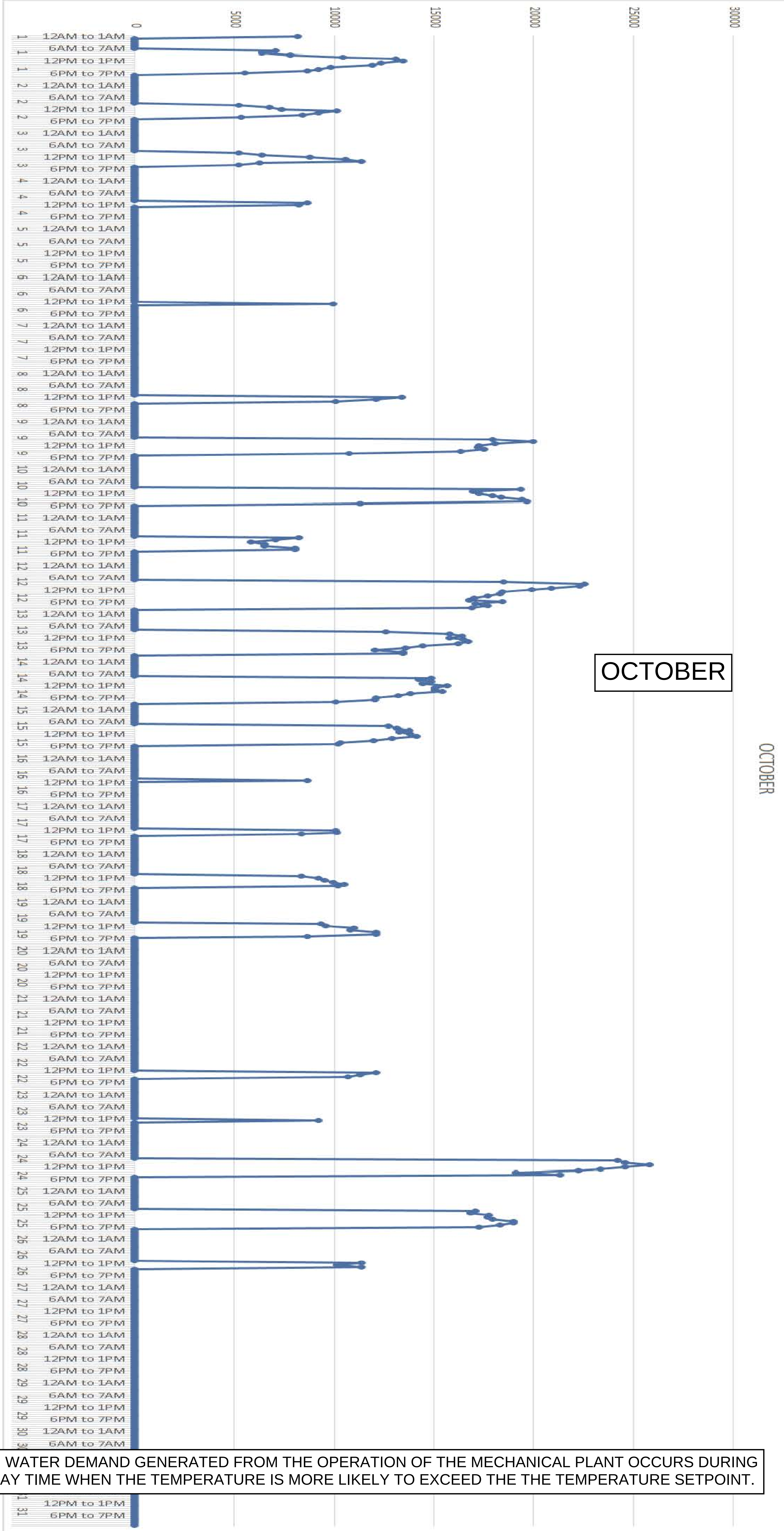


NOTE: WATER DEMAND GENERATED FROM THE OPERATION OF THE MECHANICAL PLANT OCCURS DURING THE DAY TIME WHEN THE TEMPERATURE IS MORE LIKELY TO EXCEED THE THE TEMPERATURE SETPOINT.

NOTE: WATER DEMAND GENERATED FROM THE OPERATION OF THE MECHANICAL PLANT OCCURS DURING THE DAY TIME WHEN THE TEMPERATURE IS MORE LIKELY TO EXCEED THE THE TEMPERATURE SETPOINT.

GALLONS

OCTOBER



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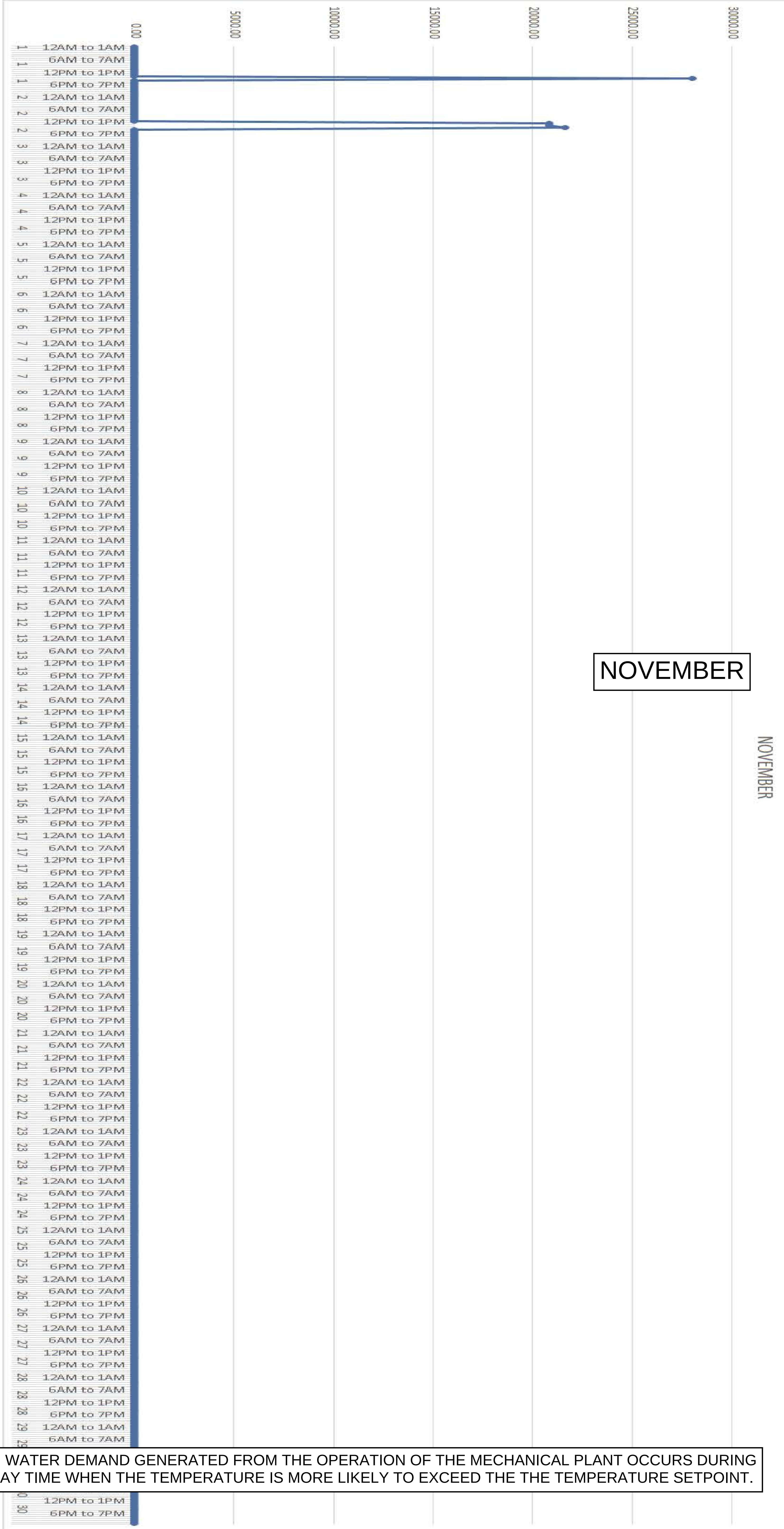
GALLONS



NOVEMBER

NOTE: WATER DEMAND GENERATED FROM THE OPERATION OF THE MECHANICAL PLANT OCCURS DURING THE DAY TIME WHEN THE TEMPERATURE IS MORE LIKELY TO EXCEED THE THE TEMPERATURE SETPOINT.

GALLONS

DECEMBER