WATER CONSERVATION PLAN

LAKE HAVASU CITY, ARIZONA

2020 UPDATE

Approved by Lake Havasu City Council on December 10, 2019

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1.0 DESCRIPTION OF DISTRICT

1.1 LOCATION

Lake Havasu City, located in Mohave County, is situated along the eastern bank of the Colorado River in the west central area of the State of Arizona. The City lies at the western foothills of the Mohave Mountains. The general location of the City is shown on Figure 1.1.

1.2 HISTORY

Lake Havasu City was conceived as a master planned community in 1963 by Mr. Robert McCulloch, who emphasized a recreational and retirement residential-type development. This theme was augmented by attention to creating a strong employment base. At that time, the City encompassed approximately 26 square miles. Initial growth of the City was spurred by the manufacturing industry; however, the recreational, construction and retirement industries eventually became the primary economic base with growth. The City was incorporated in October 1978 and now encompasses approximately 42 square miles. Land to the north, east, and south of the City remains as unincorporated land of Mohave County.

1.3 SIZE OF POPULATION

Population estimates between decadal censuses for the City of Lake Havasu, obtained from the State of Arizona Office of Economic Opportunity, State Demographer's Office (SDO), are generated by working with the U.S. Bureau of Census. The SDO releases population estimates near the end of each calendar year using assumptions based on experience, education, and knowledge of solid demographic methodology (Table 1-1). The 2018 population estimate for Lake Havasu City was 55,600. Population estimates form the basis of one type of calculation projecting water consumption into the future.

The SDO methodology for population does not account for seasonal population variations. Winter visitors in Lake Havasu City spend between 4 to 6 months in the warmer climate only to leave for the summer. During this period, the city's population grows between 50-75%. Some have second homes and others use recreational vehicles, but still draw on the water supply. On the other hand, many other homes in Lake Havasu City are vacation homes of residents from Southern California and elsewhere. These factors account for an estimated 70%-75% full-time residency during particular times of the year. The implication is that the population estimates from the state may differ from reality by a significant margin. If the part time occupancy ever shifted to full-time residency, then the water demand will increase proportionately.

[1] web site: https://population.az.gov

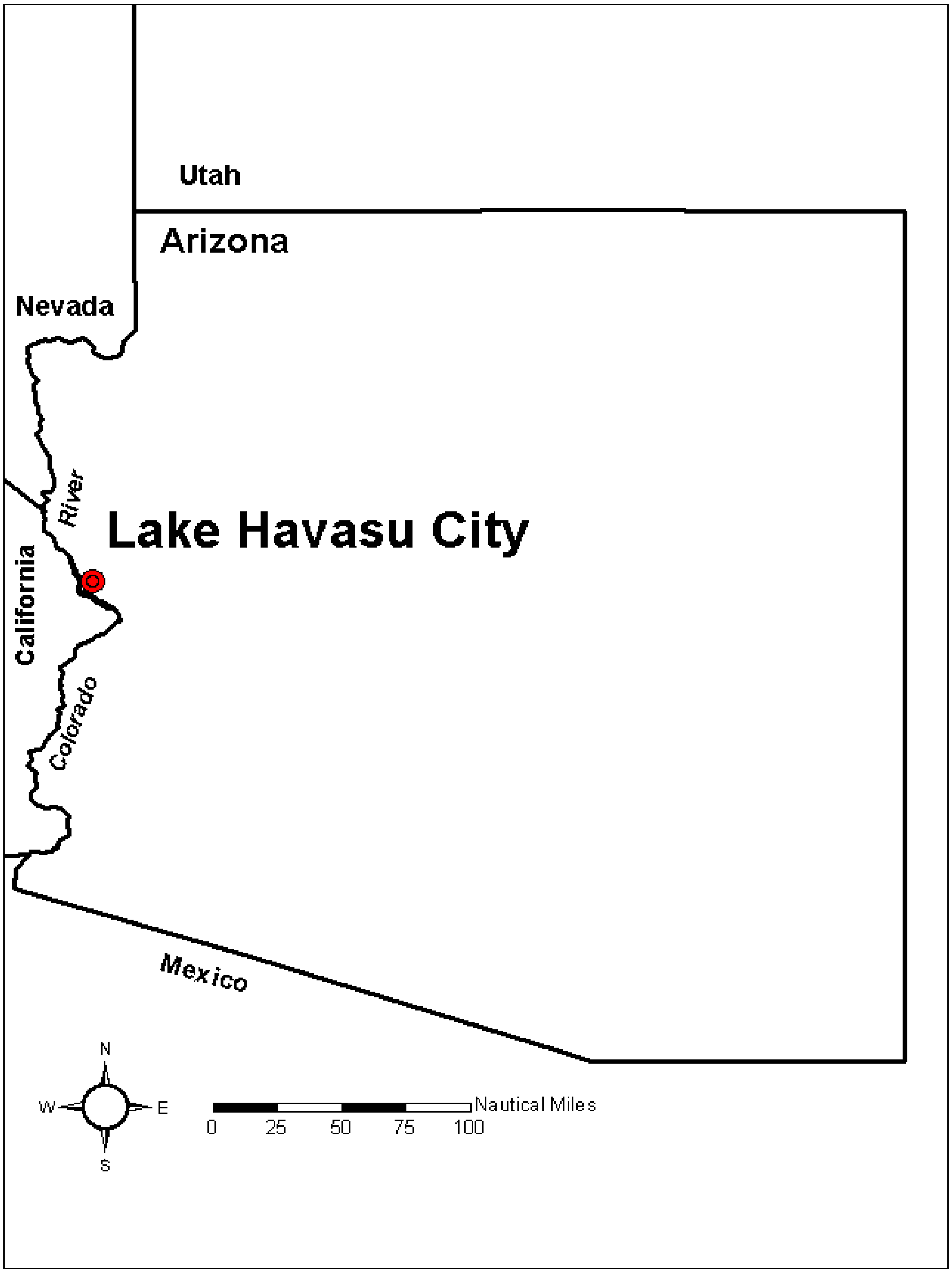

FIGURE 1-1: LOCATION MAP OF LAKE HAVASU CITY

TABLE 1-1: LAKE HAVASU CITY GROWTH RATES – 1980 TO 2019

5-Year Period	5-Year Population Increase	5-Year Population Growth (percent)	Average Yearly Population Growth Rate (percent)
1980-1985	2,260	14	2.8
1985-1990	7,010	38.3	7.7
1990-1995	10965	43.3	8.7
1995-2000	7,915	21.8	4.4
2000-2005	9,235	20.9	4.2
2005-2010	-966	-1.8	-0.4
2010-2015	1,114	2.1	0.4
2015-2018*	2017	3.7	1.2

Source: Arizona Office of Economic Opportunity * Three year calculation.

1.3.1 POPULATION PROJECTIONS

The references used in the development of the population projections are as follows:

- Arizona Department of Administration - https://population.az.gov/population-projections
- Lake Havasu City Phase I (1996) and Phase II (1998) Comprehensive Wastewater Plan
- Draft Lake Havasu City General Plan (2015)
- Lake Havasu City Comprehensive Water Master Plan Update (2018)

The SDO has also published post-recession population projections to 2050 for all population centers in Arizona, including Lake Havasu City. Slow economic growth rate has been realized since 2012 and is expected to continue indefinitely. Based on the 1998 Phase II Comprehensive Wastewater Master Plan, the build out population is approximately 96,000 people. Build out is a timeless description for the ultimate population projected. According to the statistical analysis of the logistic growth of Lake Havasu City provided in the 1998 Wastewater Master Plan, the year 2060 best describes the period for build out with the available data. That estimate is probably outdated with the interruption of the great recession. The SDO projections for Lake Havasu City show a population of approximately 60,500 by 2050. However, this is likely underestimated as Lake Havasu City's current population (~55,600) was originally estimated to have not been achieved until 2029. Build out planning and population projections are based on the existing Water Service Area (Figure 1.2), which is significantly larger than the City limits, approximately 56 square miles. Updated population projections for Lake Havasu City are shown in Table 1-2.

The Arizona Department of Water Resources (ADWR) conducted a water demand and supply assessment for members of the Mohave County Water Authority (2015), which included three levels of population growth projections to 2050 for Lake Havasu City, three projected water demand scenarios to 2050 (see Section 3.1), and calculated estimated shortage volumes to the City when Shortages are declared on the Lower Colorado River over the same time period (see Section 8.0).

Their "medium range" series population projection is taken from the SDO calculations, but their "low range" and "high range" series are calculated in-house to represent variations in the City's potential growth and associated water demand.

TABLE 1-2: PROJECTED POPULATION ESTIMATES FOR LAKE HAVASU CITY 2020 TO 2050*

Year	Projected Population Estimate*
2020	53,314
2025	54,651
2030	55,871
2035	57,092
2040	58,246
2045	59,314
2050	60,436

*Information from 2016 Arizona Department of Administration – Employment and Population Statistics.

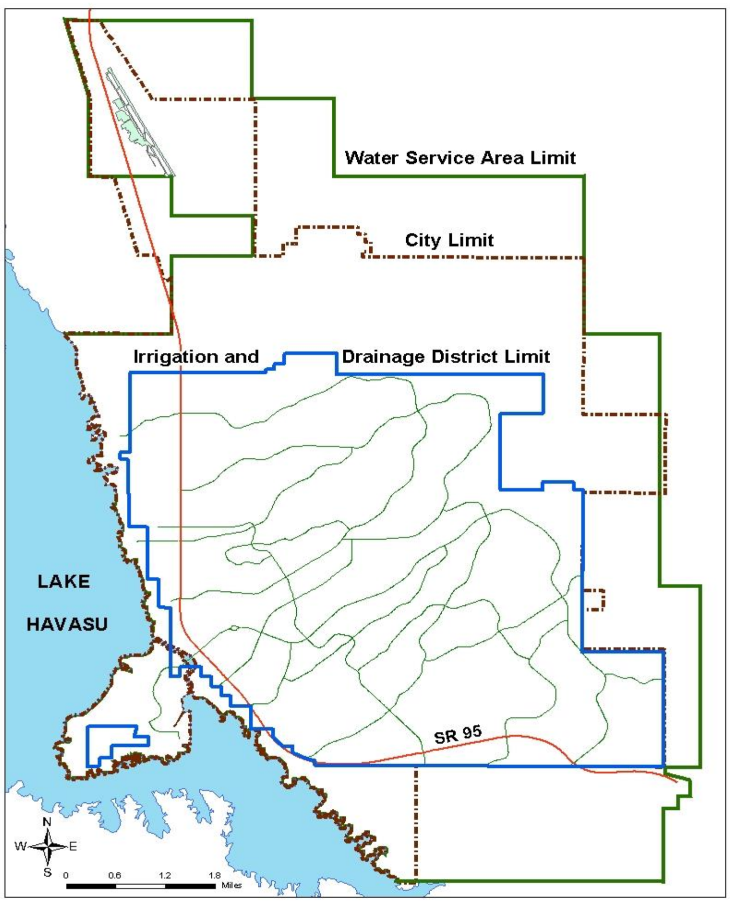

FIGURE 1-2: BOUNDARIES FOR LAKE HAVASU CITY'S IRRIGATION AND DRAINAGE DISTRICT, CITY LIMIT AND EXPANDED WATER SERVICE AREA

1.4 NATURAL SETTING

1.4.1 CLIMATE/WEATHER

Lake Havasu City is located in the Lower Colorado River topographic trough and within the transition zone between the Sonoran and Mojave deserts. The region experiences over 300 days of sunshine with low humidity most of the year, except during the Arizona monsoonal season from July through September. Although normal temperatures range from 78° to 120° Fahrenheit (°F) in the summer and from 37°F to 68°F in the winter, this area is known for its temperature extremes. Lake Havasu City holds the record for the hottest day for a city in the Western Hemisphere at 128°F and the 30-year overall average temperature of 75°F is almost equal that of Death Valley National Park. In any single year, the City has experienced as many as 145 days over 100°F and 86 days over 110°F along with up to 32 days with overnight lows above 90°F.

Coupled with the high temperatures, the region experiences low precipitation volumes, all as rainfall. Rainfall data for the last 40 years indicate an average annual precipitation of 4.15 inches, including years in which less than 2 inches of rain were recorded. Precipitation usually occurs during the winter months (January to March) from cold fronts and during the summer monsoon season (late July to early September) from scattered convective thunderstorms. The evapotranspiration rates are very high during the summers and annual calculated volume losses exceed 7 feet, perpetuating a deficit in plant water requirements. Since the area lacks significant precipitation rates, native vegetation is sparse, consisting of creosote, bur sage, paloverde, brittlebush, acacia, mesquite, ocotillo, cacti of many types and annual flowering weeds and grasses.

1.4.2 TOPOGRAPHY/SOILS

Lake Havasu City is surrounded by three metamorphic core mountain ranges; the Chemehuevi and Whipple Mountains to the west on the California side of Lake Havasu/Colorado River and the Mohave Mountains east of the city, which top 5000 feet above mean sea level (amsl). Foothills to all mountains consist of volcanic lava and ash deposits that have been extensively eroded. The city is built on top of coalesced alluvial fan deposits dissected by many braided, ephemeral stream beds and the local topography consists of a series of northeast-southwest trending ridges between the dry washes. The alluvial fan deposits, including those exposed in the washes contain sand and larger clasts whose composition reflects the adjacent metamorphic and volcanic sources. Elevations in the City range from approximately 450 feet above sea level at Lake Havasu to 1,700 feet near the mountain foothills. The ground surface uniformly slopes downward at a 4 percent grade from the easterly limits of the City to Lake Havasu. Surface runoff is interrupted by streets and directed to a system of improved arroyos, washes and drains. The Mohave Mountains located 6 miles east of the City limits are the boundary of the drainage area.

As described in the Soil Conservation Manual for Mohave County, the predominant soil classification in Lake Havasu City is the Laveen-Carrizo-Antho association. This association consists of nearly level to moderately sloping soils on dissected high terraces and alluvial fans. Soil development is minimal in almost all locations and organic debris accumulations are very low due to the widely spaced plant growth.

Slopes are dominantly 0 to 8 percent but include short slopes up to 50 percent. The soils are formed in both old and recent mixed alluvium and this association comprises about 4 percent of the county. Laveen soils make up about 40 percent of this association; Carrizo soils, 25 percent; and Antho soils, 25 percent. Cavelt, Rillito, Gilman, Vint and Brios soils and Riverwash make up the remaining 10 percent.

Laveen soils have pale brown loam surface layers 10 to 15 inches thick over brown loam substrata that contains many soft to hard masses of lime down to 60 inches or more. Local areas are alkali (sodic) or saline-alkali. These soils are on ridges of dissected terraces with dominant slopes of 0 to 5 percent although there are some short side slopes that range up to 50 percent. Carrizo soils have very pale brown loamy fine sand surface layers up to 6 inches thick over stratified very gravelly coarse sand substrata that extends to a depth of 60 inches or more. These soils have slopes of 0 to 8 percent. Local areas are gravelly to very gravelly on the surface. The Antho soils have brown or light yellowish brown sandy loam or gravelly sandy loam surface layers and stratified sandy loam, fine sandy loam, or gravelly sandy loam substrata with thin layers of silt loam, loamy sand, or gravelly loamy sand to a depth of 60 inches or more. These soils have slopes of 0 to 5 percent. Carrizo and Antho soils are subject to brief flooding in local areas.

Within Lake Havasu City, the soils support home sites, commercial and industrial buildings, and recreational usage along the Colorado River outside the city limits. The soils in this association are also used for rangeland with limited seasonal grazing and wildlife habitat.

1.5 CULTURAL RESOURCES

A survey of cultural resources was conducted for Lake Havasu City in 1991 as part of an environmental assessment of the area. The original report was a Class I Archaeological Document prepared by a subcontract of Willdan Associates and the results of this survey were summarized in a later report, “Colorado River Water Allocation, Lake Havasu City, Arizona, Final Environmental Assessment, June 1992”. For cultural resources, the Willdan report noted that the desert environment of the area today is different than the paleo-environment before human habitation, approximately 10,000 to 12,000 years ago. The earlier environment was wetter and warmer with different vegetation, pine trees and some grassland to support big game animals. Mohave Indians were considered the primary inhabitants of the area. The general chronological time periods are: (1) Big Game Hunting, (2) Post Big Game Hunting/the San Dieguito Traditions, (3) The Amargosa Tradition, and (4) Post Amargosa Tradition. Historic land occupations include Spanish exploration in the 16th Century, the mission culture, Mexican outpost establishment and Americans, early in the 19th Century after the Mexican-American War.

The Willdan report stated that the City is located in the lower Sonoran Life Zone, described as Sonoran Desert Scrub, Lower Colorado River Subdivision biome. The Mohave Mountains east of the City contain a growing herd of desert bighorn sheep and some mule deer, and although conditions exist for support, there do not appear to be any of the threatened desert tortoises in the area. Other endangered species in the area include the peregrine falcon, bald eagle, southwest willow flycatcher, Yuma clapper rail, razorback sucker, and bony-tail chub.

The Willdan report also stated that twenty-two cultural resource surveys have been conducted within or near Lake Havasu City, although no studies have been conducted within the boundaries of the Lake Havasu Irrigation and Drainage District (I.D.D.). Sixteen (16) archaeological sites have been reported in the service area with little variation in the type of site found. The majority of features are described as rock rings, rock circles, or sleeping circles, with some intaglios, cairns, and lithic scatters. In some cases trails are noted.

The Willdan report noted that all sites identified in the cultural resource surveys were found in areas below 1,000 feet in elevation, with the majority of the surveys conducted near the river along or near the shore line. The Willdan report recommended that the areas below an elevation of 1,000 feet be considered sensitive for cultural remains including historic materials, that the areas above 1,000 feet be considered sensitive until proven otherwise, and that intensive archaeological surveys to identify and, if necessary, evaluate cultural materials precede any proposed activity in areas above 1,000 feet. The Willdan report also suggested, based on their current data, that the areas below elevations of 1,000 feet above sea level are probably more sensitive for archaeological sites, while the more rugged areas are less likely to yield such remains. The inland areas are likely to yield more trails, isolated finds, and possible repetition of rock feature sites, although densities could not be predicted.

1.6 ZONING

1.6.1 CLASSIFICATIONS

Lake Havasu City has established a Zoning Ordinance and an Official Zoning Map. The zoning classifications used by Lake Havasu City are summarized below:

- Single-Family Dwelling Zone (R-l)
- Two-Family Dwelling Zone (R-2)
- Multi-Family Residence Zone (R-3 & R-4)
- Condominium Area (R-5)
- Residential Agricultural Area (R-A)
- Residential Estates (R-E)
- Residential Mobile Home Area (R-MH)
- Light-Agricultural Area (A-1)
- Commercial Area (C-1)

- General Commercial Area (C-2)
- Commercial – Residential (C-R)
- Commercial – Commercial Health District (CHD)
- Mixed Use – Channel Riverwalk (CRW)
- Mixed Use – Uptown McCulloch Mainstreet (UMS)
- Mixed Use – Mixed Use (MU)
- Professional Office Area (C-O)
- Land Use Regulations Industrial Park (M-1P)
- Heavy Manufacturing Area (M-2)
- Golf Course Area (G-C)
- Public Facilities (P-1)

These zoning classifications define permitted uses, conditional uses, and property development standards for the entire area contained within the City limits.

1.6.2 EXISTING LAND USES

Existing management plans for Lake Havasu City establish land use categories within the City's Water Service Area. The major land uses within the City are residential, commercial/industrial, recreation/resort, and undeveloped. The residential element is dispersed throughout the entire City. The commercial and industrial element is concentrated in narrow strips that parallel the main traffic routes: Highway 95, Lake Havasu Avenue, North Kiowa Boulevard, and McCulloch Boulevard. The recreation and resort element encompasses the Lake shoreline and the Island, and includes the golf course facilities in the southwestern portion of the City. Undeveloped is the final element, which is located in the northern and eastern parts of the City. Existing land uses and respective acreages as of March 2010 are summarized in Table 1-3. Developed and undeveloped acreage is shown for each category. Acreage of developed land is based on visual inspections of aerial photography in 2005 coupled with electronic tracking of development conducted from 2005 to the present.

1.6.3 FUTURE LAND USES

The anticipated changes in the existing land uses are outlined in the Lake Havasu City General Plan Update prepared in 2015, and the 2007 City’s Water Master Plan Update. The City's land use plan was predetermined in the 1960s. As indicated in the City’s planning documents, substantial land absorption will be accounted for by completing development of areas already planned for commerce, industry and residences. In addition, four specific plans were developed to address the variations in growth patterns for sub-areas within the City:

- North Havasu Specific Plan
- Island Specific Plan
- Shoreline Specific Plan
- Havasu Foothills Specific Area Plan

A master plan has been developed for SARA Park, which will consider effluent use for irrigation. Based on the general goals and strategies outlined in the above-listed management plans, defined lots and acreage per zone designation have been identified. The number of lots developed as of 2013 are shown in Table 1-4. These land use estimates are based on a build out population of approximately 96,000 people, discussed in Section 1.3.1

In addition to the above land use categories, a Mountain Preserve Protection Area has been designated to keep the foothills of the Mohave Mountains as open space. These areas are mostly designated low density rural residential.

TABLE 1-3: 2019 LAND USE LOTS AND ACREAGE BY ZONE AND PERCENTAGE DEVELOPED

Buildable Lots						
Zone	**No. of Lots**	**No. of Dev. Lots**	**% Dev.**	**Total Acres**	**Acres Dev**	**% Acres Dev**
R-1	25,764	23,216	90%	8,286	7,220	87%
R-2	1,941	1,696	87%	570	474	83%
R-3	978	791	81%	338	229	68%
R-1/PD	1	1	100%	8	8	100%
R-3/PD	978	791	81%	338	229	68%
R-E	1,809	1,461	81%	1,073	843	79%
R-E/PD	372	205	55%	83	33	40%
R-A	132	102	77%	240	199	83%
R-M	1,484	1,333	90%	241	198	82%
R-M/PD	1,175	1,106	94%	153	106	69%
RMH	524	488	93%	96	84	88%
R-UMS	310	264	85%	54	39	72%
R-CHD	508	441	87%	44	30	68%
R-SGD	377	269	71%	151	106	70%
Total	**35,413**	**31,403**	**89%**	**11,353**	**9,584**	**84%**
MU-CRW	302	299	99%	135	134	99%
MU-CRW/PD	6	5	83%	13	12	92%
MU-G	2	0	0%	14	0	0%
MU-N	228	185	81%	111	102	92%
MU-N/PD	38	28	74%	49	22	45%
MU-UMS	274	206	75%	86	67	78%
MU-UMS/PD	9	5	56%	16	14	88%
Total	**859**	**728**	**85%**	**424**	**351**	**83%**

TABLE 1-3 CONTINUED: 2019 LAND USE LOTS AND ACREAGE BY ZONE AND PERCENTAGE DEVELOPED

Buildable Lots						
Zone	No. of Lots	No. of Dev. Lots	% Dev.	Total Acres	Acres Dev	% Acres Dev
C-2	677	542	80%	311	236	76%
C-1/NKO	133	41	31%	88	58	66%
C-1/PD	14	12	86%	23	22	96%
C-2/PD	708	680	96%	252	169	67%
C-CHD	143	128	90%	118	111	94%
C-SGD	202	109	54%	68	38	56%
A-P	44	25	57%	8,604	7,130	83%
GC	12	9	75%	359	354	99%
I	12	0	0%	163	10	6%
I-B	11	10	91%	637	634	100%
I-B/PD	6	1	17%	35	28	80%
LI	1,390	1,284	92%	606	424	70%
LI/PD	433	110	25%	148	19	13%
P-1	54	23	43%	2,043	1,550	76%
Total	**4,154**	**3,155**	**76%**	**13,604**	**10,930**	**80%**

*Undeveloped is defined as less than $10,000 improvement value

2.0 WATER SUPPLY

2.1 WATER SOURCE

The principal water source for Lake Havasu City is contracted, 4th priority Colorado River water entitlements that total 28,581.7 acre-feet/year (ac-ft/yr). This amount is a combination of 19,180 ac-ft/yr through an amended Bureau of Reclamation (Reclamation) contract (#14-06-W-203) and 6,000 ac-ft/yr subcontracted (#95-101) with the Mohave County Water Authority (MCWA). The MCWA subcontract was a result of a 1995 split in the federal entitlement provided to Kingman, Arizona, who could not economically utilize the water. An additional 3,500 ac-ft was withheld from that allocation by the Department of the Interior for potential use in Indian water rights settlements. Ultimately, that water was not needed for that purpose and in 2010 and again in 2015, parts of that allocation became available to the MCWA members. Lake Havasu City purchased 1,250 ac-ft. Additionally, 2,139 ac-ft of 4th priority Colorado River water was secured in 2009 by the City through another MCWA subcontract. This water was part of a much larger, complex acquisition of agricultural water by the MCWA from farmers in the Cibola area of La Paz County, Arizona. The portion of this transaction contracted to the MCWA was re-designated from agricultural to municipal and industrial use. Approximately 1,600 ac-ft of the water kept its original designation and was assigned to La Paz County and to the Bureau of Reclamation's Multispecies Conservation Program. As subcontracted to the City, the water may only be used during a declared Colorado River water shortage or when the City's annual water demand has exceeded its entitlement. Further, a 12.7 ac-ft 4th priority allocation was transferred to the City in 2012 from a developer planning to construct a small marina on Lake Havasu. This water is exclusively reserved to compensate for lake surface evaporation due to the enlargement of the lake's surface area.

The City's practice of reusing treated wastewater (effluent) for landscape and turf irrigation has lessened the pressure to use treated Colorado River water, thus lowering the City's annual allocation requests. Approximately 1,850 ac-ft of effluent was sold in 2018 to irrigation customers, nearly 60% of the City's total annual generated effluent (3170 ac-ft). Effluent will play a larger water management role in the future as the City moves to convert public potable water irrigation systems to effluent (see Section 5).

Reserved water supplies beyond the Cibola water acquisition include long-term storage credits firmed with the Arizona Water Banking Authority (AWBA) through subcontracts with the Mohave County Water Authority for 126,019 acre-feet of stored water to be accessed when the Secretary of the Interior has declared a water shortage on the Colorado River. This account will be available to the City until 2096. An additional 950 ac-ft of long-term storage credits were secured in 2003 by the City from the Central Arizona Water Conservation District through the MCWA.

Given the existing land use planning adopted by the City for the existing water service area, the current per capita consumptive use (189.3 gallons per capita per day (GPCD) based on the assumed baseline water demand of 10 MGD, and an estimated population of 55,600 in 2018) and the population and water demand projections, the allocation of 28,581.7 ac-ft/yr should be sufficient to meet the City's water demands through to build-out population under normal Colorado River supply conditions (see section 3.1).

2.1.1 COLORADO RIVER WATER DIVERSION POINTS

Lake Havasu City primarily diverts water from a 25 MGD capacity, sixteen foot inside diameter, horizontal collector well (HCW) located at London Bridge Beach on Pittsburg Island. This well has the capability of producing up to 32 MGD over short, high demand periods. Nine conventional production wells located in two well fields on the northwest side of the City (7 wells) and on Pittsburg Island (2 wells) are kept in reserve for emergency use (Table 2-1). They are run periodically to keep them lubricated and fully developed. Four production wells in the South Well Field and one irrigation well in Rotary Park were decommissioned and pumps removed in 2007.

TABLE 2-1: LAKE HAVASU CITY MUNICIPAL WATER WELLS COORDINATES, DEPTHS, AND ARIZONA DEPARTMENT OF WATER RESOURCES REGISTRATION NUMBERS

Well	Longitude	Latitude	Depth	Arizona Dept. of Water Resources 55-registration #
Horizontal Collector Well	114º 20' 54"	34º 27' 54"	103	55-571246
LHC Well#2	114º 21' 5"	34º 28' 6"	163	55-606030
LHC Well#9	114º 20' 57"	34º 28' 6"	175	55-527469
LHC Well#18	114º 21' 36"	34º 30' 27"	450	55-513061
LHC Well#15	114º 21' 36"	34º 30' 24"	550	55-606040
LHC Well#14	114º 21' 36"	34º 30' 19"	509	55-606039
LHC Well#13	114º 21' 36"	34º 30' 12"	429	55-606038
LHC Well#10	114º 21' 36"	34º 30' 5"	550	55-606035
LHC Well#11	114º 21' 36"	34º 30' 4"	439	55-606036
LHC Well#12	114º 21' 36"	34º 30' 1"	553	55-606037
Queens Bay Well	114º 20' 37"	34º 28' 99"	80	55-511667
Memorial Gardens Cemetery Well	114º 21' 40"	34º 30' 50"	N/A	55-807341
South Intake	114º 20' 11"	34º 27' 31"	N/A	N/A

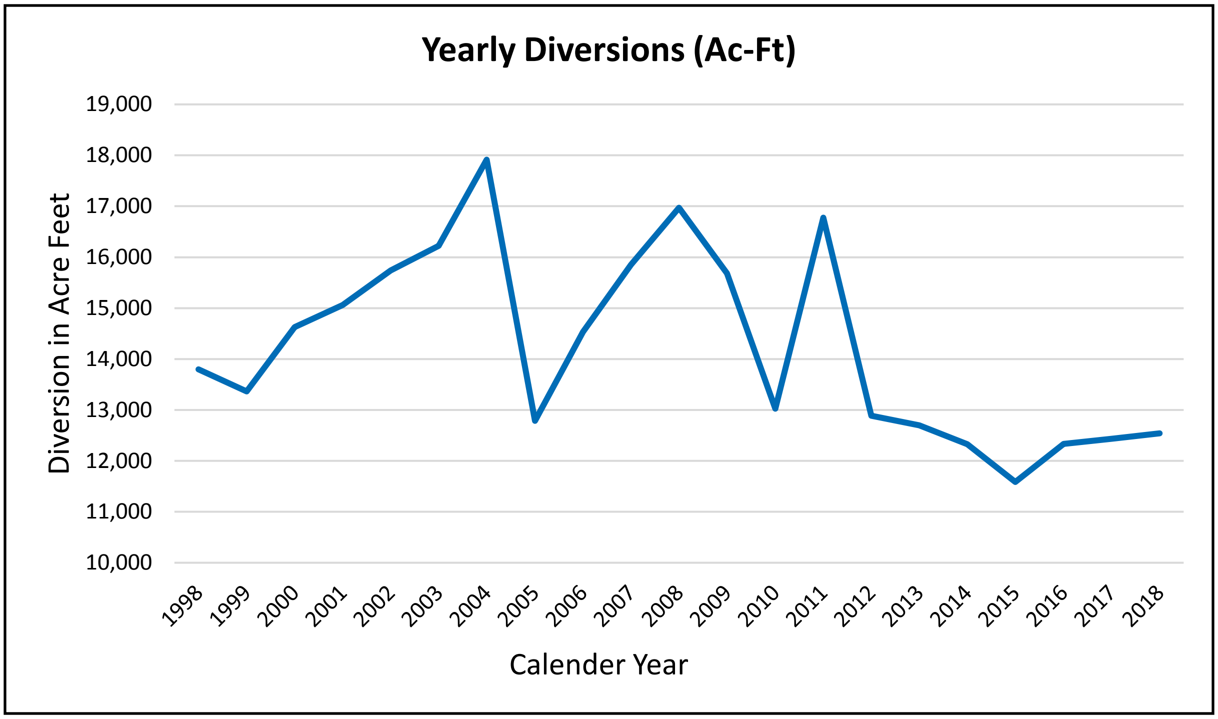

FIGURE 2-1: LAKE HAVASU CITY'S COLORADO RIVER ANNUAL DIVERSIONS FROM 1998 TO 2018.

*THE 2005 DIVERSION REFLECTS AN UNUSUALLY WET WINTER/SPRING PERIOD AND THE 2008/2009 DIVERSIONS ARE PROBABLY HIGHER THAN WHAT WAS REALLY PUMPED DUE TO METER INACCURACY ISSUES AT THE ENTRANCE TO THE CITY'S WATER TREATMENT PLANT. THOSE ISSUES WERE ADDRESSED IN 2010.

All wells penetrate the Colorado River Aquifer, which is hydrologically connected to the Colorado River/Lake Havasu. Two private water wells for landscape irrigation are included in the City's accounting of its annual allocation. These wells were established early in the City's history and provide untreated water to a golf course and to a cemetery lawn. Raw lake water is seasonally withdrawn through a surface water intake (called the South Intake), approximately 300 feet from shore and 15 feet below the water surface, to supplement effluent from the City's Mulberry Wastewater Treatment Plant (WWTP). The mix of effluent and lake water is then pumped to the 36-hole London Bridge Golf Course for irrigation. The South Intake has typically provided between 1.0 and- 1.5 million gallons per day (mgd) of raw source water during the summer months for golf course irrigation.

2.1.2 EFFLUENT

Lake Havasu City is currently being served by three wastewater treatment plants. The Island WWTP, located on Pittsburgh Island, has an ultimate design capacity of 2.5 mgd. Approximately 50 percent of the treated effluent from the Island Plant is reused; the balance is disposed in percolation/evaporation ponds. The Mulberry WWTP, located just east of the intersection of Arizona State Route 95 and Mulberry Avenue, has an ultimate design capacity of 2.2 mgd and virtually 100 percent of the treated effluent from the Mulberry WWTP is reused for golf course irrigation. The third and newest wastewater treatment plant, known as the North Regional WWTP, currently has a 3.5 MGD capacity, but can be expanded to an ultimate capacity of 14.0 mgd. This plant contains advanced ultra-filtration membrane technology to filter out particulates, bacteria and viruses down to 0.04 microns. Some of this effluent is injected into the subsurface through vadose zone wells for storage and the rest to either a golf course or to the Island WWTP percolation ponds (see Section 5 – Effluent Reuse).

2.2 WATER UTILITY

Lake Havasu City owns and operates a functional water distribution system including wells, treatment plant, booster stations, transmission and distribution lines and storage facilities, most of which were constructed in the 1960s and the 2000s. The service area includes most of the area within the City limits plus an expanded water service area that is approximately one section wider than the City limits to the north, east and south. The Service Area comprises approximately 56 square miles. However, not all of the residents of Lake Havasu City are within its water service area. Approximately 555 acres of the northwest part of the City and approximately 3000 acres outside the city limit in Mohave County are included in the EPCOR Water Company water service area, a private water provider. EPCOR has a separate 4th priority Colorado River diversion contract with Reclamation.

2.2.1 WATER PRODUCTION AND TREATMENT

Water pumped from all municipal wells is transported via a 48 inch diameter pipeline to the City's water treatment plant. Incoming water is metered and aerated before treatment with ferric chloride to precipitate arsenic. Water is then fed through sand filter beds containing bacteria that utilize and remove manganese, iron and other elements from the water. Water then enters an ultraviolet radiant system and then into a chlorine basin for final disinfection before sent into the distribution system. Water used in the treatment process is separated from the solid contents and re-circulated through the plant again. Water is sent out of the facility through a high-service pump station into one of two major distribution lines, one serving the south and central part of the city and the other serving the north part of the city. The current capacity of the treatment plant is 26 MGD with the potential to expand to 32 MGD. Lake Havasu City's 2018 Water Master Plan determined that the 26 MGD capacity is currently sufficient to meet the City's needs, and it is estimated no capacity expansions will be required until 2040.

Even so, the City is embarking on an exploratory program to find a second horizontal collector well location, which will allow for more flexible water source management, and either the water treatment plant will be expanded or a second water treatment plant will be constructed to accommodate this additional water source.

2.2.2 DISTRIBUTION

The two main distribution lines from the water treatment plant connect with four major transmission systems, the north airport, north, south, and the central transmission systems, each of which convey water through a series of pump stations out to the distribution system in the various pressure zones. The sizes of the transmission mains are 30 inches to the north part of the City and 36 inches to the central and southern parts of the City.

Lake Havasu City owns, operates and maintains 15 booster pumping stations (including the south intake, which pumps water from the lake up to the Mulberry WWTP commingling pond and then up to the golf courses) serving seven pressure zones throughout the City (Figure 2-2). Each booster station is controlled by radio signals communicated from the controlling reservoir for that booster station.

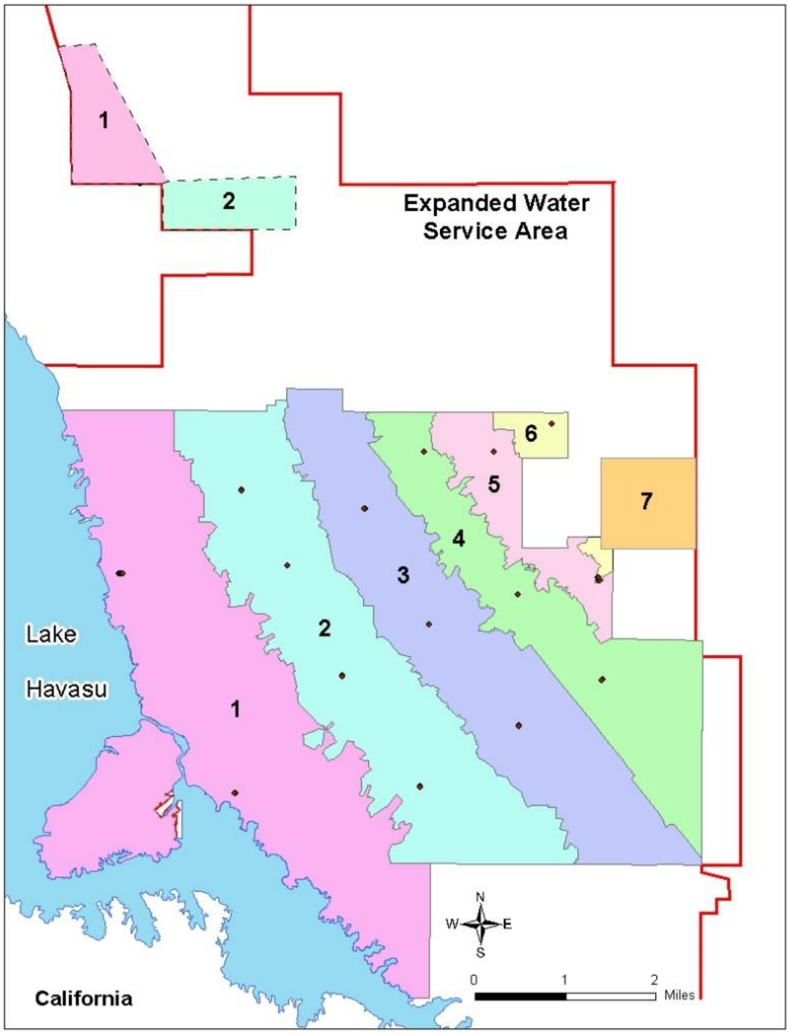

FIGURE 2-2: WATER PRESSURE ZONES (1-7) AND PUMP STATIONS (DOTS) IN LAKE HAVASU CITY FOR WATER DISTRIBUTION REFLECTING THE CITY'S 2-4^{O} SOUTHWEST SLOPING TOPOGRAPHY

*Water from one series of pump stations is forced to the next pressure zone and gravity fed to customers. As a result, the tops of each pressure zone have much lower pressure (24-50 psi) than the bottoms of each pressure zone (up to 170 psi).

The controlling reservoir is the reservoir receiving water from the booster station. The high service pump station at the water treatment plant takes suction directly from the treated water clear-well located on-site, and pumps to Zone 1. All other booster stations utilize the storage reservoir adjacent to it as the suction supply and pump to the next pressure zone. Water is gravity fed from the storage tanks creating highly varied pressure conditions in the rest of the distribution system. Top of zone pressure ranges from 24 – 50 psi and bottom of zone pressures are up to 170 psi, requiring customers to have pressure regulators installed.

2.2.3 STORAGE

Water storage facilities in Lake Havasu City are used to equalize pumping rates into the distribution system and to provide a reserve of water for firefighting and emergency purposes. As the volume of water in a storage reservoir fluctuates during the day, the minimum amount of water stored in the reservoir is considered to be the effective quantity available for firefighting and emergency use. The City's continuing goal is to have reservoir storage capacity capable of meeting the following three storage requirements:

- ***Operational Storage*** – Operational storage is provided to balance out the daily demand fluctuations so that extreme demand variations will not be imposed on the sources of supply. A volume of water should be stored during periods of less than average water use sufficient to allow water to be returned to the system to meet the increased demands during periods of high water use. This volume of water is also referred to as equalizing storage and allows the sizing of water production facilities to be based on the maximum day demand rather than the peak hour demand. No specific criteria are established to determine the exact amount of operational storage required for a water supply system, although a conservative value used is 20 to 25 percent of one maximum day's water usage. In the 2018 Water Master Plan Update prepared for Lake Havasu City, the volume requirement for operational storage was set at 20 percent of one maximum day's water use.

- ***Fire Flow Storage*** – Fire storage provides a readily available source of water for firefighting. In the event of a major fire on a day of maximum water use, water production facilities may not be able to meet the fire demand and domestic demand concurrently. The amount of water to be stored for this purpose is determined by the land use in the area served by that system. Lake Havasu City Fire Department follows the flow guidelines issued in the International Fire Code Commentary by the International Code Council. Recommended flow rates are based on building type and size and are presented in Table 2-2. In the 2018 Master Plan Update, it was recommended that fire storage be provided for the largest fire flow and duration in each pressure zone, respectively. Fire storage is assumed to be shared amongst multiple tanks in a pressure zone.

- ***Emergency Storage*** – Emergency storage provides a source of water to allow for a continued supply during power outages, mechanical failures, transmission line failures, and scheduled maintenance of facilities. In the 2018 Water Master Plan Update, it was determined that emergency storage set at 100% average day demand would be sufficient in the distribution system under the 2019 storage criteria. The amount of emergency storage is an owner option based on an assessment of risk and the desired degree of system dependability.

Lake Havasu City typically stores 18.8 MG in 27 storage tanks, including the 2.5 million gallon clear-well at the new water treatment plant. This is not full capacity, which is 23.155 MG, but an operational storage to allow for fluctuations in supply/demand. Two tanks are hydropneumatic tanks that are used for providing pressure in Zones 6 and 6A; these tanks are 5,000 gallons each and are considered negligible in terms of storage capacity. The existing reservoir capacity by pressure zone is summarized in Table 2-3. All existing storage tanks, except the 0.15 MG-bolted steel tanks, are of welded steel construction.

2.2.4 WATER MEASUREMENT/ACCOUNTING

Municipal water provided to all water service area customers is metered upon entry onto the customer's property. Meter readers visually inspect meter condition and record water usage monthly at each meter. The readings are forwarded to the City's Finance Department, which issues invoices to the users. Lake Havasu City's 2019 annual consumption by user class and the number of water accounts as of April 2019 are shown in Table 2-4 (also Figure 3-2), which also indicates that approximately 86 percent of all of Lake Havasu City's water accounts are of the residential type. Residential accounts consume approximately 74% of the City's total water usage compared with approximately 7 percent of the total for commercial accounts. Residential consumption not only includes residential/multi-family water use, but also 40% of the irrigation meter category type. Unmetered water listed in Table 2-4 is water used for hydrant flushing, fire control, and other city related activities.

2.2.5 WATER PRICING/BILLIING

Current water pricing structure is established by City Code and outlined in Lake Havasu City Operating Policy and Procedure 5.100.99 of the Rules and Regulations of the Lake Havasu Irrigation and Drainage District. These rates have been in effect since August 1, 2009. In addition to the actual usage billed to each customer every month, a fee is charged for administrative costs associated with the account, and is based on the size of the service meter. The monthly meter charges for all types or classes of service are given in Table 2-5 and the quantitative charges for the amount of water used on a monthly basis are given in Table 2-6. Since 2009, the residential rate structure has been $1.35 per 100 cu ft. for the first 1300 cu. ft., and rates incrementally rise from that volume (Table 2-6). The structure is to help encourage citizens to use less water and reward those who do.

2.2.6 OPERATION AND MAINTENANCE PROGRAM

The City currently has documented an extensive maintenance plan for the water system. A rigorous well and booster station maintenance schedule has been established, as well as monitoring and maintenance of reservoirs, flushing of distribution system lines originating from citizen complaints, chlorination facilities, hydropneumatic systems and visual inspections of transmission line routes.

Also, water meter installation and service/main line repairs have been documented in the City's Operation and Maintenance Records.

TABLE 2-2: MINIMUM REQUIRED FIRE FLOW AND FLOW DURATION FOR BUILDINGS

FIRE-FLOW CALCULATION AREA (square feet)					Fire Flow (gallons per minute)[c]	FLOW DURATION (hours)
Type IA and IB[b]	Type IIA and IIIA[b]	Type IV and V-A[b]	Type IIB and IIIB[b]	Type V-B[b]		
0-22,700	0-12,700	0-8,200	0-5,900	0-3,600	1,500	2
22,701-30,200	12,701-17,000	8,201-10,900	5,901-7,900	3,601-4,800	1,750	
30,201-38,700	17,001-21,800	10,901-12,901	7,901-9,800	4,801-6,200	2,000	
38,701-48,300	21,801-24,200	12,901-17,400	9,801-12,600	62,01-7,700	2,250	
48,301-59,000	24,201-33,200	17,401-21,300	12,601-15,400	7,701-9,400	2,500	
59,001-70,900	33,201-39,700	21,301-25,500	15,401-18,400	9,401-11,300	2,750	
70,901-83,700	39,701-47,100	25-501-30,100	18,401-21,800	11,301-13,400	3,000	3
83,701-97,700	47,101-54,900	30,101-35,200	21,801-25,900	13,401-15,600	3,250	
97,701-112,700	54,901-63,400	35,201-40,600	25,901-29,300	15,601-18,000	3,500	
112,701-128,700	63,401-72,400	40,601-46,400	29,301-33,500	18,001-20,600	3,750	
128,701-145,900	72,401-82,100	46,401-52,500	33,501-37,900	12,601-23,300	4,000	4
145,901-164,200	82,101-92,400	52,501-59,100	37,901-42,700	23,301-26,300	4,250	
164,201-183,400	92,401-103,100	59,101-66,000	42,701-47,700	26,301-29,300	4,500	
183,401-203,700	103,101-114,600	66,001-73,300	47,701-53,300	29,301-32,600	4,750	
203,701-225,200	114,601-126,700	73,301-81,100	53,301-58,600	32,601-36,000	5,000	
225,201-247,700	126,701-139,400	81,101-89,200	58,601-65,400	36,001-39,600	5,250	
247,701-271,200	139,401-152,600	89,201-97,700	65,401-70,600	39,601-43,400	5,500	
271,201-295,900	152,601-166-500	97,701-106,500	70,601-77,000	43,401-47,400	5,750	
295,901-Greater	166-501-Greater	106,501-115,800	77,001-83,700	47,401-51,500	6,000	
-	-	115,801-125,500	83,701-90,600	51,501-55,700	6,250	
-	-	125,501-135,500	90,601-97,900	55,701-60,200	6,500	
-	-	135,501-145,800	97,901-106,800	60,201-64,800	6,750	
-	-	145,801-156,700	106,801-113,200	64,801-69,600	7,000	
-	-	156,701-167,900	113,201-121,300	69,601-74,600	7,250	
-	-	167,901-179,400	121,301-129,600	74,601-79,800	7,500	
-	-	179,401-191,400	129,601-138,300	79,801-85,100	7,750	
-	-	191,401- Greater	138,301-Greater	85,101-Greater	8,000	

For SI: 1 square foot = 0.0929 m^2, 1 gallon per minute = 3.785 L/m, 1 pound per square inch = 6.895 kPa.
a. The minimum required fire flow shall be permitted to be reduced by 25 percent for Group R.
b. Types of construction are based on the *International Building Code.*
c. Measured at 20 psi.

TABLE 2-3: EXISTING STORAGE CAPACITY

Pressure Zone	Location	Tank Sizes	Capacity (million gallons)
North System	Station 1A	1 @ 1.00 MG	1.00 MG
	Station 1B	2 @ 1.00 MG	2.00 MG
	Station 2A	2 @ 1.00 MG	2.00 MG
	Station 3A	1 @ 1.00 MG, 1 @ 0.25 MG	1.25 MG
	Station 4A	1 @ 1.00 MG, 1 @ 0.25 MG	1.25 MG
	Station 5A	1 @ 0.005 MG	0.005 MG
	Pneumatic Tank	1 @ 0.005 MG	0.005MG
	North Airport	1 @ 2.00 MG	2.00MG
Total Storage for North System			**9.51 MG**
Central System	Station 1	1 @ 1.00 MG, 1 @ 0.25 MG	1.25 MG
	Station 2	1 @ 1.00 MG, 1 @ 0.25 MG	1.25 MG
	Station 3	1 @ 0.50 MG, 1 @ 0.25 MG	0.75 MG
	Station 4	1 @ 1.00 MG, 1 @ 0.25 MG	1.25 MG
	Pneumatic Tank	1 @ 0.005MG	0.005 MG
Total Storage for Central System			**4.505 MG**
South System	Station 1C	2 @ 1.00 MG	2.00 MG
	Station 2C	2 @ 1.00 MG	2.00 MG
	Station 3C	2 @ 1.00 MG	2.00 MG
Total Storage for South System			**6.00 MG**
Water Treatment Plant			2.5 MG
Lake Havasu City Airport Fire Pump System			0.15 MG
Total Water Full Storage			**23.155 MG**

TABLE 2-4: WATER CONSUMPTION AND NUMBER OF ACCOUNTS BY USER CLASS IN APRIL, 2019

User Type	Number Accounts April, 2019	2019 Water Consumption By User Class YTD (Cubic Feet)	Per Account (Cubic Feet)	Percent Of Total
Residential	27,685	298,535,602	10,783	59.07%
Residential – Multi Family	1,455	42,008,537	28,872	8.31%
Commercial	933	34,455,453	36,930	6.82%
Restaurants and Hotels	145	14,024,318	96,719	2.77%
Schools	31	2,988,946	96,418	0.59%
Industrial	14	4,640,798	331,486	0.92%
Construction	71	3,676,771	51,786	0.73%
Golf Course – South Intake	1	1,722,468	1,722,468	0.34%
Irrigation	1,818	79,984,668	43,996	15.83%
Well Water	2	22,224,756	11,112,378	4.40%
Unmetered Water Use		1,157,742		0.23%
Totals	**32,155**	**505,420,059**		**100.0%**
Total Acre Feet Pumped		**12,296**		**100.0%**
Total Acre Feet Metered		**11,603**		**94.4%**
Total Acre Feet Unaccounted		**694**		**5.6%**

TABLE 2-5: WATER RATES BASED ON DIAMETER OF SERVICE LINE

Size of Service	In-District Monthly Base Charge	Out of District Monthly Base Charge
Up to ¾ inch	$5.16	$6.45
1 inch	$8.17	$10.21
1 ½ inch	$16.69	$20.86
2 inch	$28.17	$35.21
3 inch	$52.66	$65.83
4 inch	$97.09	$121.36
6 inch	$198.95	$248.69
8 inch	$283.91	$354.89

TABLE 2-6: 2009 WATER RATE STRUCTURE BASED ON QUANTITY CONSUMED

WATER RATES

Single Family Residential

Quantity Used	In District Charge Per 100 Cubic Feet	Out of District Charge Per 100 Cubic Feet
0 – 1,300 cubic feet	$1.35	$1.69
1,301 – 2,500 cubic feet	$1.76	$2.20
2,501 – 5,000 cubic feet	$2.16	$2.70
Over 5,001 cubic feet	$2.70	$3.38

Multi-Family Residential

Quantity Used	In District Charge Per 100 Cubic Feet	Out of District Charge Per 100 Cubic Feet
0 – 2,600 cubic feet	$1.35	$1.69
2,601 – 5,000 cubic feet	$1.76	$2.20
5,001 – 200,000 cubic feet	$2.16	$2.70
Over 200,000 cubic feet	$2.70	$3.38

Commercial/Industrial

Quantity Used	In District Charge Per 100 Cubic Feet	Out of District Charge Per 100 Cubic Feet
0 – 31,500 cubic feet	$1.76	$2.20
31,501 – 340,000 cubic feet	$2.16	$2.70
Over 340,000 cubic feet	$2.70	$3.38

TABLE 2-6 CONTINUED: 2009 WATER RATE STRUCTURE BASED ON QUANTITY CONSUMED

IRRIGATION RATES

Single Family Residential

Quantity Used	In District Charge Per 100 Cubic Feet	Out of District Charge Per 100 Cubic Feet
0 – 1,200 cubic feet	$1.76	$2.20
1,201 – 3,700 cubic feet	$2.16	$2.70
Over 3,700 cubic feet	$2.70	$3.38

Other

Quantity Used	In District Charge Per 100 Cubic Feet	Out of District Charge Per 100 Cubic Feet
0 – 16,000 cubic feet	$1.76	$2.20
16,001 – 89,000 cubic feet	$2.16	$2.70
Over 89,000 cubic feet	$2.70	$3.38

RV Parks

Quantity Used	In District Charge Per 100 Cubic Feet	Out of District Charge Per 100 Cubic Feet
0 – 39,000 cubic feet	$1.35	$1.69
39,001 – 86,000 cubic feet	$1.76	$2.20
86,001 – 150,000 cubic feet	$2.16	$2.70
Over 150,000 cubic feet	$2.70	$3.38

Hydrants

Quantity Used	In District Charge Per 100 Cubic Feet	Out of District Charge Per 100 Cubic Feet
All	$2.70	$3.38

2.3 QUALITY OF WATER SUPPLY

As mentioned in section 1.8.1, Lake Havasu City's sole raw water source is from the Colorado River and its hydraulically connected Colorado River Aquifer through a series of groundwater wells and one direct lake intake. All drinking water is diverted from the wells, primarily from the City's horizontal collector well, and pumped through a water treatment facility capable of removing arsenic, manganese and iron. The water is also subjected to ultraviolet radiation and chlorine disinfection to destroy microorganisms at the water treatment facility. A compliance schedule monitoring specific elements, compounds and biologic components is in place through Arizona Department of Environmental Quality regulations (Table 2-7).

TABLE 2-7: CONSTITUENTS MONITORED WITH FREQUENCY SCHEDULES FOR COMPLIANCE WITH SAFE DRINKING WATER STANDARDS REGULATED BY THE ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

Constituent	Sampling Frequency	Maximum Concentration Load	Next Scheduled Sample Event
DO, Alkalinity, NH3, Hardness, Calcium, TDS, and pH,	Twice per week	2nd; TDS-500mg/l & pH – 6.5-8.5	Every week
Lead and Copper	3 years	0.015mg/l, 1.3 mg/l	08/02/20
Volatile Organic Compounds	6 years		08/02/20
Maximum Residual	Monthly	various	Every month
Trihalomethane	Quarterly	0.08 mg/l	Each yearly quarter
Haloacetic Acid	Quarterly	0.60 mg/l	Each yearly quarter
IOC's 141.23	3 years		01/02/20
SOC-PCB-Aroclor	3 years		01/02/20
Asbestos	9 years		01/02/23
Total coliform	Monthly	None	Every month
Nitrate	Annual	10 mg/l	01/01/20
Nitrite	9 years		01/01/23
Sulfate	No Schedule	2nd; 250 mg/l	n/a
Fluoride	No Schedule	4.0 mg/l	n/a
Chloride	No Schedule	2nd ; 250 mg/l	n/a
Arsenic	Quarterly	0.01 mg/l	Each yearly quarter
Iron	Weekly	2nd ; 0.3 mg/l	Weekly
Manganese	Weekly	2nd ; 0.05 mg/l	Weekly
Radionuclide; Ra 226 & 228	6 years	5 pCi/L	01/01/20

*2nd – Secondary MCL goals

2.3.1 GROUNDWATER

Colorado River Aquifer water quality is determined by sampling municipal wells and monitoring wells within the Lake Havasu Basin at varying intervals depending whether the constituent is under compliance through the Safe Drinking Water Act, through Aquifer Protection Permits issued by the ADEQ for wastewater disposal, or for non-compliance water quality studies.

The water is generally classified as sodium chloride type with a significant sulfate component (Table 2-8). Groundwater from wells located approximately two miles from Lake Havasu tends to be more chloride rich and groundwater close to the lake contains more sulfate, calcium and magnesium.

Chloride, pH, manganese, sulfate, and total dissolved solid (TDS) values in groundwater within the basin can occur above the respective secondary MCLs. Chloride and sulfate concentrations have been detected as high as 1,258 mg/l and 972 mg/l, respectively, but the typical ranges are exemplified in Table 2-8. Multiple field recordings of groundwater pH, when collecting water samples, average from 7.5 to 9.7. TDS was detected at concentrations ranging from 204 to 1,770 mg/L, with higher TDS values from wells less than one mile from the lake. Manganese was detected at concentrations ranging from <0.01 to 1.44 mg/l in the Lake Havasu City municipal wells, but is consistently below 0.3 mg/l from the horizontal collector well. Lake Havasu City's new water treatment plant, which biologically removes essentially all the manganese from the influent water pumped from the horizontal collector well has removed the impetus of periodic flushing of "black" water at street hydrants around the city.

TABLE 2-8: AVERAGE CONCENTRATIONS OF MAJOR CONSTITUENTS IN GROUNDWATER FROM THE LAKE HAVASU BASIN

Well	TDS	Hardness	Ca^{+2}	Na^{+}	Mg^{+2}	SO_4^{-2}	Cl^{-}	HCO_3^{-}	NO_3^{-}	F^{-}
HCW	780	340	85	140	32	280	140	170	0.8	0.72
Well #12	760	360	82	150	38	270	180	150	0.6	0.74
NP-2	770	n/a	35	237	3.1	144	262	97	2.0	5.65
MW-3	610	96	30	170	5.2	80	85	169	4.6	8.29

*The City's main drinking water source, the horizontal collector well (HCW) and one reserve municipal well, well #12, are compared with two monitoring wells located about 1.5 to 2.5 miles from the lake, one near the center of the city (MW-3) and the other outside the developed area (NP-2).

Fluoride and nitrate concentrations at several sample locations within the basin occur at concentrations above their respective maximum contaminant levels (MCL). The MCL for fluoride is 4.0 mg/l and concentrations of this analyte range up to 8.4 mg/l. Most of the high concentrations are in groundwater traveling through felsic volcanic rocks of the Mohave Mountains foothills that leach this constituent. The groundwater emanates from confined aquifer conditions to mix with groundwater of the Colorado River Aquifer such that the concentrations decrease westward, away from the foothills and towards Lake Havasu. Fluoride in municipal water wells is below 2.0 mg/l, the secondary MCL for fluoride.

The MCL for nitrate is 10.0 mg/l and concentrations of this analyte occur up to 26 mg/l in monitoring wells within the developed areas of the city, particularly in a zone between 1000 feet from the Lake Havasu eastern shoreline and approximately one mile from the shoreline. However, within 1000 feet of the shoreline, where all municipal water wells occur, nitrate concentrations are generally below 3 mg/l.

A groundwater model indicates that oscillations in Lake Havasu's level, which occur on several scales (i.e. diurnal, monthly, seasonal), cause an intermixing transition zone between groundwater unaffected by these oscillations and the lake body. This transition dilutes nitrate concentrations in westward flowing groundwater that comingles with infiltrating lake water. Nitrates are presumably sourced from thousands of septic tanks that once occupied almost all of the residential parcels in the city. Nitrate concentrations in the Colorado River Aquifer outside of the developed portion of the city are less than 2 mg/l.

Lake Havasu City finished its nine year wastewater expansion program in 2011, which decommissioned over 22,000 septic tanks, eliminating much of the nitrate sources. However, a very flat groundwater gradient coupled with the paucity of precipitation for recharging the aquifer keep the residual nitrate in the aquifer from quickly flushing through the system. A nitrate monitoring program was instituted in 2005. To date, several locations have experienced decreasing nitrate concentration, but other locations have maintained or slightly increased nitrate concentration.

2.3.2 SURFACE WATER

Surface water and groundwater quality data from federal, state, regional, commercial and academic sources for the Lower Colorado River, including Lake Havasu, are available from the Southern Nevada Water Authority's water quality database. This compilation is the result of a seven year agreement (ending in 2016) between the Colorado River Regional Sewer Coalition, a group of local and regional sewer and water providers using Colorado River water (Lake Havasu City is a member), and the Lower Colorado River Region of the Bureau of Reclamation. Data will be mapped according to GPS location and displayed in a number of ways, including using a GIS interface map.

Water quality information for Lake Havasu has been collected by the Metropolitan Water Company of Southern California, by the Arizona Department of Environmental Quality, The U.S. Bureau of Reclamation, The Central Arizona Project, and the Chemehuevi Indian Tribe. Whereas none of the available information indicates that the surface water contains any regulated constituents greater than their designated maximum concentration load as set by the U.S. Environmental Protection Agency, water quality may be impacted from several sources. Nutrient loading through near river/reservoir septic tank effluent and agricultural fertilized fields provides nitrate-nitrogen for uptake in aquatic photosynthetic organisms. Nutrient loading has helped with significant increases in aquatic plant populations, particularly spiny naiad and various types of algae, which have nuisance and maintenance issues. Increased phytoplankton has helped quagga mussel populations expand. Added sediment loading from side ephemeral washes may also bring in nutrient supplies for bacterial growth, particularly *E. coli* during the warm summer months. Other potential concerns on the lower Colorado River include hexavalent chromium plumes migrating to the system, uranium tailings from active and inactive mines on the Colorado Plateau, hydrocarbons from recreational water vehicles, and pharmaceutical and other endocrine disruptive compounds.

2.3.2.1 INORGANIC CONSTITUENTS

Because the Colorado River Aquifer (CRA) is in direct hydraulic connection with the surface water of the Colorado River, the inorganic constituents in surface water should be similar to the groundwater where the municipal wells are located. However, groundwater is also percolating from the Mohave Mountains, mixing with the CRA and the sand and gravel sediments also contain leaching constituents, which together, increases the manganese, arsenic, iron, and fluoride content of the groundwater (see Section 2.1.1).

2.3.2.2 ORGANIC CONSTITUENTS

Certain organic compounds capable of producing adverse health effects can be found in some surface waters, usually in small quantities. Chlorinated organic compounds, specifically chlorinated hydrocarbons, may be the most significant organic compounds in drinking water in terms of potential health risk. Reactions between naturally occurring organic materials such as humic and fulvic acids (precursors), and chlorine used for disinfection are likely sources of chlorinated organics, particularly trihalomethanes (THMs). The formation of trihalomethanes is dependent on time and the concentrations of organics, chlorine, and bromine. With chlorine added as a disinfectant as the water is pumped into the system, THM formation occurs primarily after the water has entered the distribution system.

Two tests which serve as indicators for THM formation are trihalomethane formation potential (THMFP) and total organic carbon (TOC). Based on the data obtained on these parameters from sampling in the HCW, it appears that THM formation in the distribution system, after treatment, would be well below the current MCL of 100 parts per billion (ppb).

Pharmaceutical and other endocrine disruptive compounds have been detected in Lake Havasu and in the Colorado River. They were also analyzed from HCW and water treatment plant samples. Constituents analyzed consist of those thought to be very persistent in the environment or of interest to researchers for their potential influence on bacteria. Of the 30 plus constituents analyzed, up to seventeen compounds were detected in the surface water and six from the HCW (Table 2-9). Furthermore, Colorado River samples collected by the Bureau of Reclamation in 2014 have detected trace levels of many more emerging contaminants, including cyanotoxins in Lake Havasu.

2.3.2.3 MICROBIOLOGICAL PARAMETERS

Microbiological organisms that are commonly found in surface water supplies include bacteria, viruses, and protozoa. To achieve 4-log (99.99 percent) removal of viruses and 3-log (99.9 percent) removal of giardia cysts, disinfection, filtration, and adequate disinfectant contact time must be provided as part of the surface water treatment process. Microscopic particulate analysis results did not indicate the presence of giardia, coccidian, or total coliform in water samples collected from the HCW.

TABLE 2-9: PHARMACEUTICALS AND OTHER ORGANIC ENDOCRINE DISRUPTIVE COMPOUNDS ANALYZED AND DETECTED IN LAKE HAVASU, IN THE COLORADO RIVER, FROM THE CITY'S HORIZONTAL COLLECTOR WELL (HCW) AND FROM THE CITY'S WATER TREATMENT PLANT (WTP) BETWEEN 2007 AND 2008

Compound	Compound Use	Colorado River	Lake Havasu	HCW Average	WTP Average
Albuterol	Bronchodilator	102.1	NT	NT	NT
Atenolol	Heart regulator	2.2	1.7	ND	ND
Caffeine	Stimulant	7.4	12.4	ND	ND
Carbamazepine	Anticonvulsant	4.0	3.1	18.4	14.6
Microcystin	Natural heptotoxin	Sub ug/L	Up to 22 ug/L	ND	ND
Dilantin	Antiepileptic	4.0	3.9	4.52	4.3
Gemfibrozil	Lowers lipid levels	0.5	0.4	ND	ND
Ibuprofen	Anti-inflammatory	ND	1.6	ND	ND
Meprobamate	Tranquilizer	10.9	10.7	1.78	1.1
Primidone	Anticonvulsant	3.1	3.0	14.4	15.2
Sulfamethoxazole	Antibiotic	12.5	9.5	21.2	ND
Triclosan	Chlorinated aromatic	2.1	ND	ND	ND
Trimethoprim	Antibiotic	0.4	0.4	ND	ND
Methamphetamine	Illicit psychotic	14.0	ND	ND	ND
MDMA (ecstasy)	illicit psychotic	30.0	2.0	ND	ND
Atrazine	Herbicide	1.3	1.2	0.608	0.6
DEET	Insecticide	16.8	8.4	ND	ND
Sucralose	Artificial sweetener	447	NT	NT	NT
TCEP	Reducing agent	11.9	8.1	ND	ND
TCPP	Flame retardant	147.0	120.0	ND	ND

* ND = not detected; NT – not tested. All values are in ng/l (parts per trillion) unless otherwise noted.

3.0 HISTORIC AND PROJECTED WATER DEMANDS AND WATER SYSTEM DEFICIENCIES

3.1 WATER DEMAND

Well water measured through a meter at the City's water treatment plant and lake water measured through the City's South Intake lake diversion, are both reported in acre-feet per month (ac-ft/mo) from 2015 to 2019 (Table 3-1). Highest water consumption occurs from May through September, which correlates with a combination of recreational impacts and the higher water demands of the summer season. The average amount of water pumped during this period ranges from 1,000 to 1,300 acre-feet per month; November through April, consumption is between approximately 700 to 1,000 ac-ft/mo (Table 3-2). Metered diversions reported at the end of each month do not necessarily equate with volume of water consumed. Billed consumption is determined through individual customer meters read and reported at different times of a given month, so within certain months, the volume used can actually be slightly larger than the volume diverted. However, over a year's time, the billed consumption should be close to the diversion volume minus unaccounted water losses, which can compose from 7% to 12% of the total water diverted.

Water usage is also typically reported by combining billed consumption with population estimates from the SDO to calculate a per capita consumption given in GPCD. This unit is an easy way to compare a water provider's total demand through time and a way to compare with other water providers, yet a per capita approach is most valid when considering individual use. Lake Havasu City's total water demand and residential water use has continued to remain relatively stable with no significant changes in the past five years even with increases in population (Figure 3-1) due to a combination of water conservation measures and the association of monthly sewer charges with winter water consumption. The billed per capita consumption of Lake Havasu City has decreased from 250 GPCD since 1998 to 189 GPCD in 2018. Residential per capita use, which includes water volumes from single and multi-family residential irrigation meters, has also decreased to 138 GPCD in 2018. These accounts composed 67.3% of Lake Havasu City's total water use in 2018 (Figure 3-2). The other 32.7% consumption came from businesses, schools, park irrigation, and industry, which would not accurately reflect a per capita consumption based on population.

Projecting the City's water needs into the future given population projections is not straightforward. Revised population projections from the SDO mentioned in Section 1.3.1 have improved the culpability of developing water use projections. However, these are just projections and do not account for swings in the general economy and possible demographic changes (e.g. mean age of the population, supporting businesses and housing status). The last point comments on the current housing situation. Many people living permanently outside of Arizona have bought vacation homes in the city.

City staff estimate that between 20% and 30% of the homes in the water service area are vacant at any given time, which of course precludes accurate population counts at any given time regardless of the population estimates from the state. The frequency of occupation of these homes ranges from periodic weekend visits by people who live within 6-7 hours' drive of the city to six plus month stays from visitors escaping northern latitude winter weather. Many of these homes have active water accounts, which are sparsely utilized most of the calendar year, with the possible exception of landscape irrigation. If demographics change in the future to where people begin to occupy these homes permanently, then the per capita consumption would probably be affected without the city necessarily experiencing significant growth or new construction.

The decreasing water consumption trends for the City are also influenced by the way the City calculates fixed monthly sewer charges to residential customers. The calculation is based on the average water usage during 4 months that starts in mid-November and goes to early April. This "winter water averaging" process throws out the highest usage month and averages the other three. The mean per month volume is compared to a corresponding monthly sewer rate table, that is fixed starting with the May water bills and continues at this rate the rest of the year. Residents are encouraged to conserve on water to get the lowest sewer charge possible. This fee structure has been in place since the inception of the sewer expansion program in 2002 and could continue until loans used to pay for sewer construction costs have been settled (up to 25 years from 2020). If a different funding mechanism replaces the current one that does not depend on water usage, then the incentive to conserve during the winter may decrease.

With demographic changes, housing vacancy rates and sewer fee concerns in mind, none of which can be reliably quantified to be included in water demand projections, several water demand projection scenarios have been produced; all except one are population based. ADWR produced high, medium, and low series demand projections based on high, medium, and low series Lake Havasu City population projections and a per capita consumption rate of 275 GPCD in their Mohave County Water Authority Demand and Supply Assessment report. One is based on the revised population estimates and growth projections developed by the Arizona Department of Administration (Figure 3-3a) and the other takes population considerations out of the equation. The second set is based on water consumption trends and is forecasted using an exponential growth expression (Figure 3-3b). In each case, the projections indicate that the City should have enough water for increasing demand under normal water supply conditions and keeping per capita consumption at respectable levels. Note, however, that the population projections end at 2050 with a population well under the estimated build-out population of 96,000 stated in the City's 2015 General Plan. Since these projections do not consider the above issues or account for changes in estimated population growth in the city, they will have to be revised as needed to reflect changes in the community that would affect the water consumption rate.

The dashed “Shortages” lines in both figures indicate expected declines in the City’s entitlement due to federally declared Colorado River water Shortages. The Shortages, which are discussed in Section 4, have three initial tiers, beyond which federal and state water agencies will have to revise how to manage the Colorado River. The entitlement reduction estimates are based on modeling results from the Arizona Department of Water Resources.Lake Havasu City’s 4th priority status thrusts the city to the forefront of future water supply uncertainty as the City’s entitlement will be among the first to be affected (see Section 4).

TABLE 3-1: MONTHLY WATER DIVERSIONS FROM 2015 TO 2018

Acre-feet Pumped				
Month	**2015**	**2016**	**2017**	**2018**
January	792	741	734	859
February	728	794	706	804
March	857	1,013	895	922
April	908	965	942	1,009
May	991	1,093	1,039	1,138
June	1,105	1,298	1,170	1,205
July	1,184	1,340	1,329	1,263
August	1,206	1,220	1,251	1,327
September	1,147	1,101	1,189	1,220
October	1,001	1,049	1,158	1,040
November	862	905	1,132	921
December	806	814	892	837
Yearly Total	11,587	12,333	12,437	12,545
% Change	-6.38	6.05	0.84	0.86
Water Accounts	30,720	31,110	31,594	32,091
% Change	1.28	1.25	1.53	1.55
AC-FT per Account	0.38	0.40	0.39	0.39
Allocation	28,582	28,582	28,582	28,582
Remaining allocation	16,995	16,249	16,145	16,037
% Residential Use	67.6	67.8	66.5	67.7
Population estimates	53,583	53,796	54,801	55,600
Billed Consumption	10,660	10,899	11,355	11,792
City Wide per Capita Use in gallons	178	181	186	189

TABLE 3-2: AVERAGE MONTHLY WATER CONSUMPTION (AC-FT) IN LAKE HAVASU CITY FROM 2015 TO 2018

Month	Billed Consumption (ac-ft)
January	697
February	683
March	701
April	790
May	870
June	986
July	1,087
August	1,130
September	1,262
October	1,089
November	922
December	965

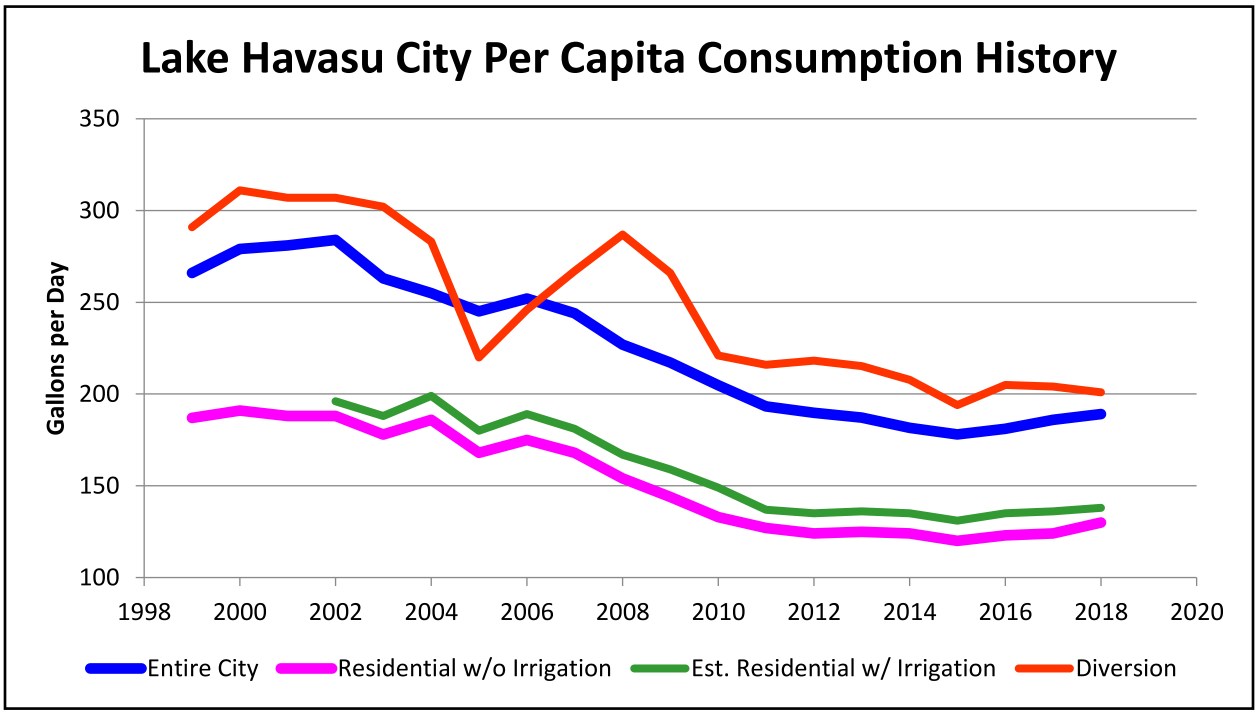

FIGURE 3-1: CITY WIDE AND RESIDENTIAL WATER CONSUMPTION PER CAPITA (GPCD) FROM 1998 TO 2018

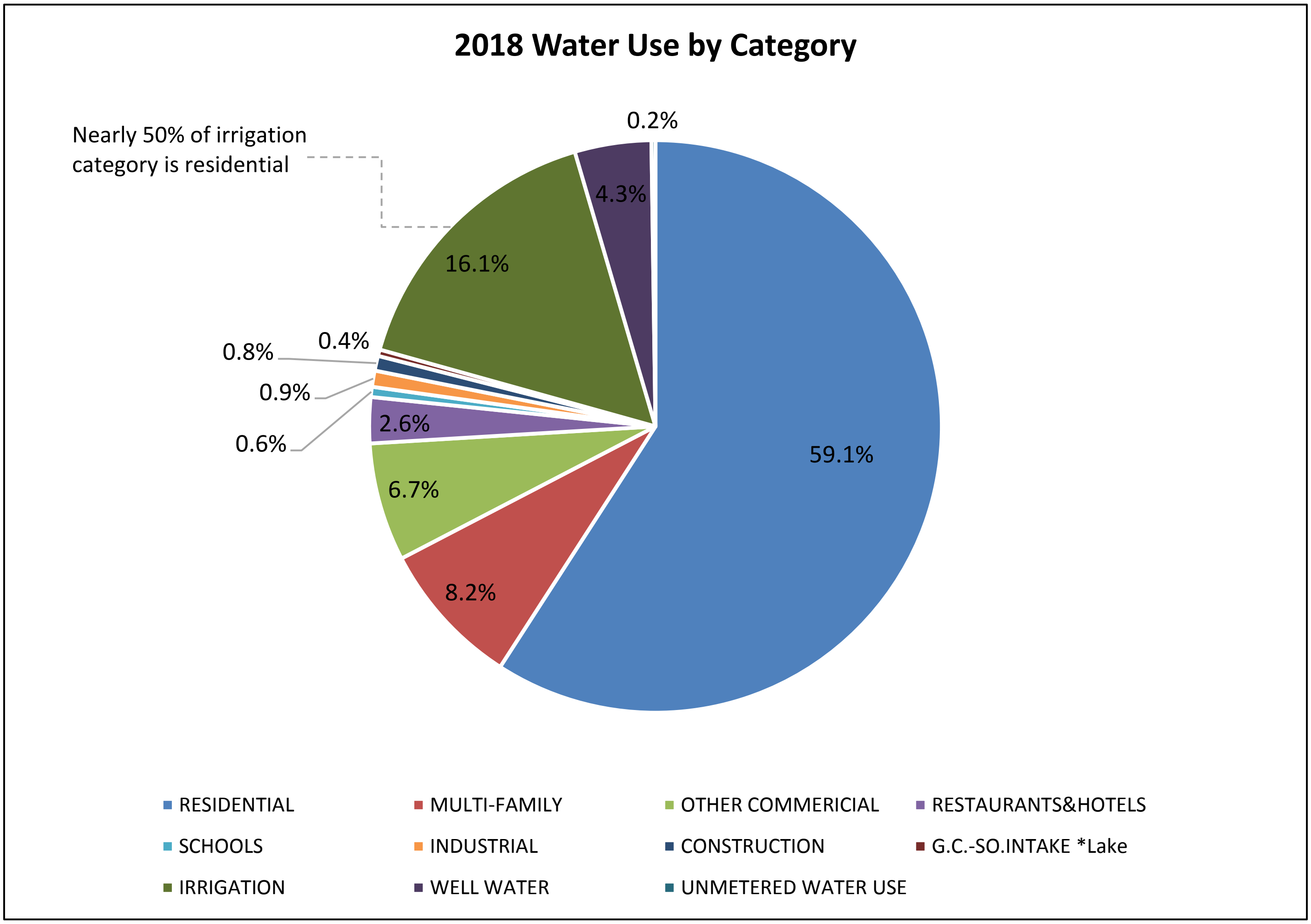

FIGURE 3-2: DISTRIBUTION OF TOTAL WATER CONSUMPTION IN LAKE HAVASU CITY FOR 2018

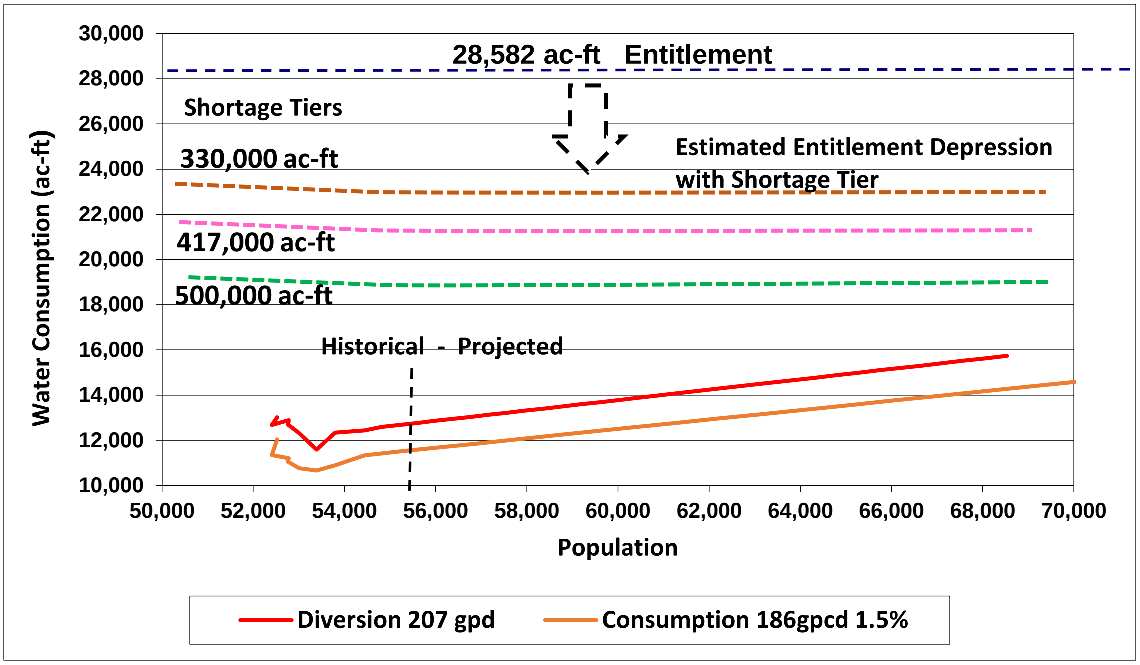

FIGURE 3-3A: LAKE HAVASU CITY PROJECTED WATER DEMANDS BASED ON POPULATION TRENDS MODIFIED FROM SDO PROJECTIONS AND 1.5% POPULATION GROWTH CONSUMPTION RATES

*Shortage estimates are based on percent reductions from the City's entitlement and increasing allocations for all Colorado River contract holders.

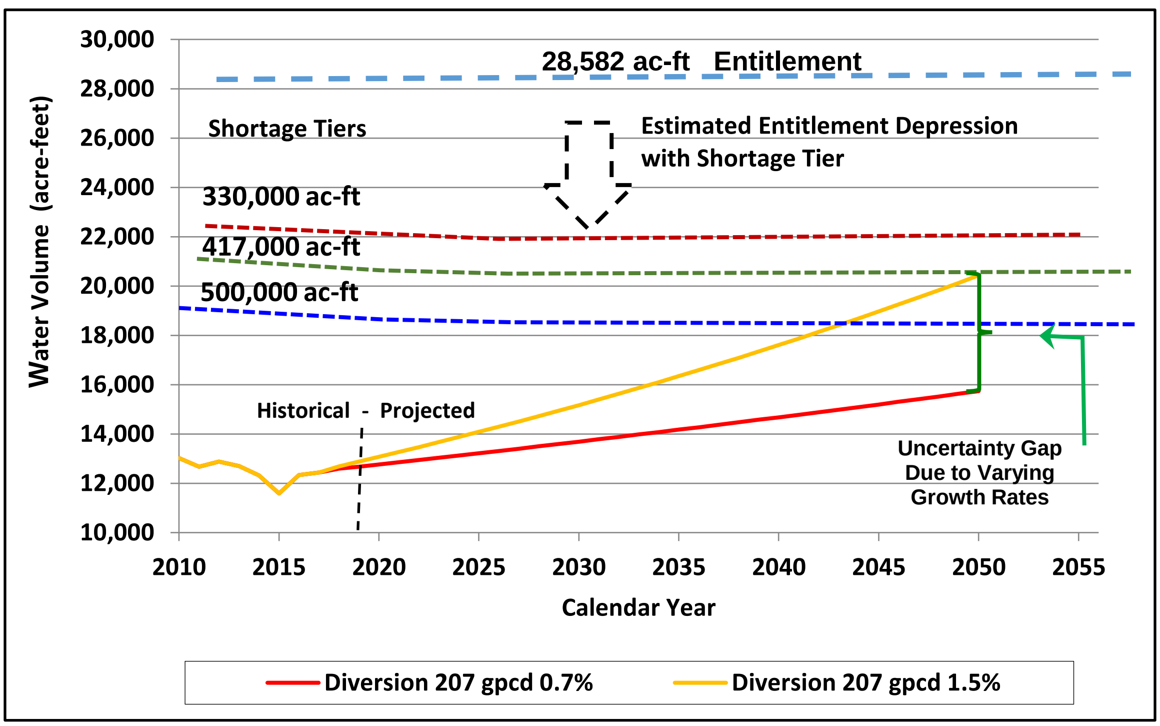

FIGURE 3-3B: NON-POPULATION BASED WATER DIVERSION PROJECTIONS FOR LAKE HAVASU CITY BASED ON INCREASING LINEAR AND EXPONENTIAL DEMAND FROM 2015 TO 2050

3.1.1 OVERALL 2018-2019 WATER BUDGET SUMMARY

SUPPLY		
Colorado River water entitlement (2019)	28,572.7 ac ft/yr	
Effluent (2014 total generated)	4,408 ac ft/yr	(3.94 MGD)
TOTAL	**32,980.7 ac ft/yr**	
DEMAND		
Well Water †	11,793 ac ft/yr	
Raw Lake Water*	43 ac ft/yr	(0.04 mgd)
Effluent (Reused in 2018)	1,543 ac ft/yr	(1.38 mgd)
TOTAL DEMAND	**13,379 ac ft/yr** (41% of total water supply)	

† Demand well number does not include distribution system unmetered losses.
* Water can be pumped from the South Intake in the lake to supply the London Bridge Golf Course

3.1.2. WATER USE CLASSIFICATIONS

Water consumption in Lake Havasu City is categorized into eleven classes through the City's accounting and billing process (Figure 3-2 and Table 2-4). Although the chart shows two residential classes (single and multi-family), there is another residential component hidden within the irrigation class. Irrigation is a combination of non-residential use and those residential customers with irrigation meters separate from their domestic water meter. The number of residential irrigation meters has been steady since the completion of the wastewater expansion program. Those with irrigation meters can water their landscape during the winter months without worrying about how that would affect their monthly sewer charges since the water does not drain into the sewer system. About 45-50% of the irrigation volume is residential use. All consumption categories will be addressed concerning water conservation in the next five years, yet reducing residential consumption will remain a primary focus.

3.2 DEFICIENCIES

Whereas recent water acquisitions (2,319 ac-ft from Cibola water transfer to the MCWA in 2008 and 1,250 ac-ft from the Kingman entitlement in 2010 and 2015) may sustain water supply needs to the City's build out population under normal water supply conditions, the Lake Havasu City 2018 Water Master Plan Update indicates there are infrastructure augmentation and upgrades that will be necessary to deliver the City's entire entitlement to customers. These modifications range from source water volume increases through to distribution and storage expansion and alteration.

As an example, the City is currently investigating to either construct a second horizontal collector well or several new conventional wells to help with increased withdrawal volumes and to build some redundancy into the water source system in case of system failures at the first collector well site. The bulk of the recommended infrastructure changes; however, will occur in water pressure zones two through five, coinciding with projections of where the largest population increases will occur.

3.2.1 SUPPLY AND TREATMENT

The City's current maximum daily water supply is 45.2 mgd, 24.9 mgd from the horizontal collector well and 20.3 mgd from the reserve municipal wells (if needed). On the other hand, the maximum daily water treatment capacity at the City's water treatment plant is 26 mgd. While the City's 2018 average daily treatment production was 9.5 mgd, the City's 2018 Water Master Plan Update projects a maximum daily water demand of 19.3 mgd by 2040. Although the City should continue to monitor demands and maximum day use in the event the City experiences more rapid growth, it is predicted that no capacity expansions will be required at the City's water treatment plant by 2040.

3.2.2 STORAGE

The 2007 Water Master Plan Update indicated that the City would need to have 34.5 MG of water storage capacity, including 2.25 MG emergency reserve and 24.69 MG fire reserve, to adequately serve the community at build-out population. The City has a current storage capacity of 23.2 MG, with multiple storage tanks sites in each of the seven water pressure zones serving the adjacent topographically lower pressure zone (Table 2-3). Additional storage tanks therefore may be needed within each pressure zone, except Pressure Zone 1 as the residential development in this area is at capacity. However, these estimates from the 2007 Water Master Plan Update are pre-recession suggestions, and may now differ. The 2018 Master Plan Update did not reference the maximum storage capacity needed at build out population to update these estimated suggestions.

Water pump stations at storage tank sites to get water upslope to the above water pressure zone storage tank sites are in need of major upgrades as many are at least 35 years old. Specific recommendations in the 2007 Water Master Plan Update are laid out in project form for upgrade implementation. The City has been renovating the reservoir stations and has expanded the capacity of a few of the stations.

3.2.3 DISTRIBUTION AND METERING

The 2018 Water Master Plan Update study identified that beyond the obvious need for future water mainlines with population growth, there are various deficiencies within the distribution system, including undersized transmission and water mainlines, insufficient fire flow to certain areas and water pressure issues, both low and high.

Suggestions to correct these deficiencies are site specific, which may include modifying pressure boundaries and adding new water mains to supplement low pressure areas.

All city water distribution lines are metered at the point of use, and no deficiencies were identified on the 2007 Water Master Plan, yet thousands of the residential meters and many commercial meters are over 15-20 years old. As meters wear out over time and read lower than the passed volume, the City has established a meter replacement program. Meters that are replaced have a port for the attachment of an optional transmitter that can send meter data to a central receiver for downloading, thus automating water meter reading. This practice would be especially useful during winter water use averaging when monthly sewer charges are determined for each customer.

4.0 COLORADO RIVER SHORTAGES

With the continuation of drought in the southwest United States, the Colorado River and Lakes Mead and Powell in particular, are losing storage capacity. A Record of Decision was issued through the Bureau of Reclamation by the Department of Interior in 2007, which established the Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lakes Powell and Mead management program. This 20-year program was developed to balance the water storage in both reservoirs and to establish criteria from which the Secretary of the Interior could declare a reduction in water deliveries (Shortage) downstream from Lake Mead. Any Shortage to the lower basin will primarily affect 4th priority contracts in Arizona. Lake Mead's water elevation is used as the benchmark for knowing when to declare a Shortage. When the lake's elevation reaches 1075 feet amsl, a 383,000 ac-ft Shortage is automatically declared. This declaration will actually be made several months (by August of the previous year) prior to the calendar year that it is implemented, based on projections of lake elevation made by Reclamation. If the lake elevation should reach 1050 feet amsl, 500,000 ac-ft would be held back and if the lake elevation reaches 1025 feet amsl, a 600,000 ac-ft shortage will be declared. Further drops in lake elevation will prompt a conference between Reclamation and the affected states for negotiation of options, which could include implementing a second tier of Shortages that effectively bars all water deliveries to 4th priority users in Arizona such as Lake Havasu City. In June of 2016, Lake Mead's elevation was 1071.64 feet amsl, the lowest water level since the reservoir began filling in the 1930's. The lake elevation began to rise again in July and has been above 1075 feet since August 2016. Reclamation's May 2019 24-month projections indicates that the January elevation of Lake Mead will be above 1075 in 2020 and 2021, yet these predictions depend on weather conditions and can drastically change.

Entities directly affected by the reduced water supply during a Shortage outside of Arizona include Nevada, which will take 3.3% of the Shortage volume, and possibly Mexico, which has an agreement (Minute 323, the successor of Minute 319) with the United States to take a shortage of 50,000 ac-ft during the first Shortage tier and more in successive tiers. Assuming Mexico is involved in the reductions, then for a tier one Shortage, Arizona 4th priority contracts would expect 320,000 ac-ft reduced. Two and three tier Arizona Shortage volumes are 400,000 ac-ft and 480,000 ac-ft, respectively.

California's Colorado River entitlement and Arizona's priority one through three contracts will not be affected by the Shortages described above. Once higher priority Arizona allocations are satisfied, Reclamation will calculate the percent reductions to the 4th priority entitlements. These calculations will be based on the percent water volume attached to each entity's entitlement compared to Arizona's total 4th priority apportionment and to the total apportionment of 4th priority mainstream contracts (those entities actually adjacent to the river system versus the Central Arizona Project (CAP). An intrastate Shortage agreement was reached in 2006 between CAP, Arizona Department of Water Resources (ADWR) and the 4th priority on-river entitlements in which water reductions from mainstream contracts will be made from their respective entitlements, not from their previous year's annual allocation.

The agreement has been formalized in letters from ADWR's Director to Arizona's governor and to Reclamation's Lower Colorado Regional Director and in a joint letter from MCWA and the Central Arizona Water Conservation District. This agreement should be honored throughout the Colorado River Interim Guidelines period, which ends in 2026. There is no guarantee, however, that the Arizona agreement will not be legally challenged or will be extended, even if the federal management program is continued beyond 2026. The 2015 ADWR MCWA Demand and Supply Assessment assumes that another shortage strategy known as the 80P1050, which is intended to keep Lake Mead at the 1050 ft amsl elevation 80% of the time and above 1000 feet amsl 100% of the time, will be invoked during shortages after 2026. This shortage policy calls for a pro rata deduction from the City's annual allocation. The pro rata refers to all 4th priority Arizona contracts, including the Central Arizona Project. In this situation, direct reductions may be taken from the contractor's previous year's allocation, guaranteeing "wet water" shortages. The ADWR report indicates that annual volume reductions between 6,000 and 8,000 ac-ft may be realized between 2033 and 2050.

Lake Havasu City's 2018 entitlement of 28,581.7 ac-ft is ~1.7% of the total 2018 fourth priority water available to Arizona and is 17.4% of the total 4th priority water entitled to the mainstream users. An example of the expected impacts of a declared Shortage to the City's entitlement is shown in Table 4-1. Based on Arizona's 2014 Colorado River consumption totals, approximately 5,354 ac-ft will be reduced from the City's entitlement if Mexico also takes a reduction during the first tier Shortage. If Mexico's entitlement is not reduced, then the reduction to Lake Havasu City would be approximately 6,197 ac-ft. The calculations used in the example assume full use of mainstream contracts. This was used based on the intrastate agreement to reduce water volumes from contract entitlements. The timing of a Shortage will affect the reduction volume as more contract holders utilize their full allocation. Reclamation, ADWR, and CAP have produced models predicting the probability of when Shortages might occur. All models show a marked probability increase to between 40% and 60% starting in 2020 and continuing at that level indefinitely.

The Lake Havasu City Council passed a resolution in 2010 to include a strategic plan within this water conservation plan to mitigate water shortages whether declared by the Federal government or from emergency situations. The plan is discussed in Section 8.

The Lower Colorado River Drought Contingency Plan (DCP) passed in 2019 has added a new component to conserve water behind Lake Mead and portion a voluntary 192,000 ac-ft decrease in allocation to Arizona when Lake Mead's level is below 1,100 amsl. This cut is included even when the Interim Guidelines for shortage declaration are invoked (i.e. when Lake Mead is below 1075' amsl). The 4th Priority river contracts in Arizona are not included in the voluntary cutbacks under the DCP, so this does affect Lake Havasu City's situation with respect to shortage declarations.

TABLE 4-1: ESTIMATED ENTITLEMENT REDUCTIONS TO LAKE HAVASU CITY IN ACRE-FEET WITH PROGRESSIVE COLORADO RIVER SHORTAGE VOLUMES

	For 1st Tier		For 2nd Tier		For 3rd Tier	
	if Mexico	if no Mexico	if Mexico	if no Mexico	if Mexico	if no Mexico
2018 P1-3 Consumption Demand	1,195,073	1,195,073	1,195,073	1,195,073	1,195,073	1,195,073
2018 P4 Available Water	1,604,927	1,604,927	1,604,927	1,604,927	1,604,927	1,604,927
P4 Mainstream Full Use Shortage %	0.096	0.096	0.096	0.096	0.096	0.096
P4 Available after Shortage Reduction	1,274,927	1,224,927	1,187,927	1,117,927	1,104,927	979,927
P4 Mainstream Shortage Reduced Supply	122,393	117,593	114,041	107,321	106,073	94,073
Shortage to LHC	6,675	6,947	7,164	7,612	7,702	8,684
Resulting LHC Entitlement	21,907	21,635	21,418	20,970	20,880	19,898
Water to CAP	1,152,534	1,107,334	1,073,886	1,010,606	998,854	885,854

*Range of reductions is based on assuming total 4th Priority (P4) mainstream demand (164,652 ac-ft). Note: Only half that value used in 2018. P1-3 is Arizona Priority 1 through 3 contracts. “If no Mexico” means Mexico does not take part in the Shortage, which means Nevada and Arizona take larger reductions.

5.0 EFFLUENT REUSE

5.1 EFFLUENT REUSE

Approximately one-half of the treated wastewater (effluent) generated from the three existing wastewater treatment plants is currently being used for irrigation with the balance of the effluent going to either percolation ponds located on the Island or to vadose injection wells. Effluent produced at the 2.5 MGD Island wastewater treatment plant (IWWTP) is currently pumped through a reuse system to four users on Pittsburgh Island. These users include the Nautical Estates Condominiums, the Lake Havasu Marina, the Islander R.V. Park, and a football/soccer field maintained by the City. In each case, the effluent is used for landscape or turf irrigation. The treatment process includes standard aeration and denitrification processes, but also includes tertiary ultraviolet treatment to obtain A+ classified effluent (highest effluent quality level set by the Arizona Department of Environmental Quality). Any excess effluent is disposed in percolation ponds on site, which percolates a short distance underground before surfacing under Lake Havasu.

Effluent from the 2.2 MGD Mulberry wastewater treatment plant (MWWTP) also obtains Class A+ quality through the same technology as the IWWTP. The effluent has historically been seasonally mixed with water from Lake Havasu through the City's South Intake diversion point to both meet irrigation demand and improve effluent water quality in terms of total dissolved solids. The blended water is then pumped to the London Bridge West Golf Course where approximately half of the water is used for irrigation. The remainder of the water is pumped through an 8-inch line to the London Bridge East Golf Course where it is also used for irrigation. Effluent generated by the MWWTP not disposed into the commingling pond is sent to the IWWTP percolation ponds.

Effluent generated at the 3.5 MGD North Regional wastewater treatment plant (NRWWTP) is either sent to the Refuge Golf Course, which lies outside the city limit and outside the City's water service area, is injected into the subsurface via vadose injection wells, or is sent to the IWWTP percolation ponds. The NRWWTP uses ultra-filtration membrane technology on top of the standard processes previously mentioned, which not only improves the Class A+ quality water, but also minimizes particulate clogging of perforated screens in each vadose well. The NRWWTP is planned for expansion up to 15 MGD, in 3.5MGD phases, as demand warrants.

Long-term wastewater management and reclaimed water reuse issues and goals addressed in the 1998 Phase II Comprehensive Wastewater Plan are undergoing revision with the development of an updated wastewater master plan and effluent reuse plan. The City has constructed an interconnecting infrastructure system to flexibly convey wastewater and effluent given particular situations. Any of the three wastewater plants may receive influent from any part of the city and effluent may be separately delivered from one wastewater plant to another to supplement customer deliveries. Two effluent pipelines were installed in the early 2000's to potential customers, but have not been activated.

One to a private cemetery, probably will not be used in the near future as the cemetery has its own water well that is more economical than buying effluent. The other line near the MWWTP will be utilized in the near future to pump effluent to park sites and the new campus of Arizona State University (ASU).

The main goal of effluent reuse is to maximize the replacement of Colorado River raw and potable water irrigation. Treated effluent represents an opportunity to reduce water demand on a gallon for gallon basis. Converting turf and landscape irrigation areas now using potable water to effluent is a high priority for the City. The City generates effluent approximately 4400 ac-ft of effluent annually or about 3.9 MGD and reuses 35-40% of that amount (Figure 5-1). The percentage of effluent reused on a month to month basis depends on the season and local weather conditions (Figure 5-2). A 2014 Reclaimed Water Management study by the City identified the most cost-effective locations to convert to effluent sourced irrigation. Most sites are near an existing effluent distribution pipeline (active and inactive) and all have a reasonable water demand that can be supplied year round from the City's three wastewater treatment plants (Table 5-1). The study prioritized parts of the city in which to initiate these conversions (Figure 5-3). The first priority area includes Rotary Municipal Park, London Bridge Beach, Arizona State Route 95 landscaping, and Grand Island Park on the Island. The second priority area includes the currently unused effluent line near MWWTP to Cypress and Jack Hardie parks and ASU. Effluent purple pipelines for delivery and irrigation were installed in Rotary Park, London Beach Park, Grand Island Park, and Cypress Park since 2016, yet to date, effluent delivery infrastructure from the wastewater treatment plants is incomplete. Delivery of effluent to most schools and other parks upslope may need further investigation to find an economically feasible solution. The City will also require sewer connections for future development outside the current sewer expansion program area, which will further increase available year-round effluent.

Lake Havasu City has utilized its Lake Havasu intake pump (South Intake) to supplement effluent in the city's Mulberry Wastewater Treatment Plant commingling pond. The blended lake water-effluent mix is pumped to a local 36-hole golf course. As more effluent became available with the completion of the City's sewer expansion program, less raw water has been needed from the South Intake (Figure 5-4). The City and the company who owns the golf course have had recent discussions to decrease their irrigation (and thus effluent) demand by removing excess turf and perhaps even a percentage of fairway turf. This proposal has several benefits beyond decreasing water demand, including decreased fertilizing, which may help with groundwater quality (there are high nitrates present in the aquifer down gradient from the golf course), will decrease or could eliminate the need for the South Intake supplemental water supply, and low operation costs to the golf course. The goal is to eventually discontinue use of the South Intake when enough effluent becomes available and when all feasible potable water irrigators have been converted to effluent. The South Intake pump station was overhauled in 2016 in order to continue deliver water to the commingling pond. The City is considering various options with respect to what reuse practices it will adopt and what role the South Intake will play in the 2020-2025 interval.

Educating irrigators on effluent watering practices to most efficiently utilize the water is key to the above goal. Two issues associated with effluent reuse are the uneven seasonal supply/demand phenomenon and the high total dissolved solid (TDS) content of the effluent. Lake Havasu City, like most other municipal water providers in the desert southwest, experiences seasonal demand for irrigation water. Effluent is more or less evenly generated throughout the year, yet during the winter when irrigation demand is low, much of the effluent must be disposed by percolation below the accounting surface and is permanently lost. Summer demand consumes most available effluent generated at that time, but the 2014 Reclaimed Water Management report indicates that there is enough effluent year-round to justify adding the targeted first and second priority users. However, if all possible locations were converted, then summer generated-effluent would not be enough to meet the demand. To that end, Lake Havasu City initiated a subsurface recharge program in 2008 with the intent to develop a recovery component (see next section).

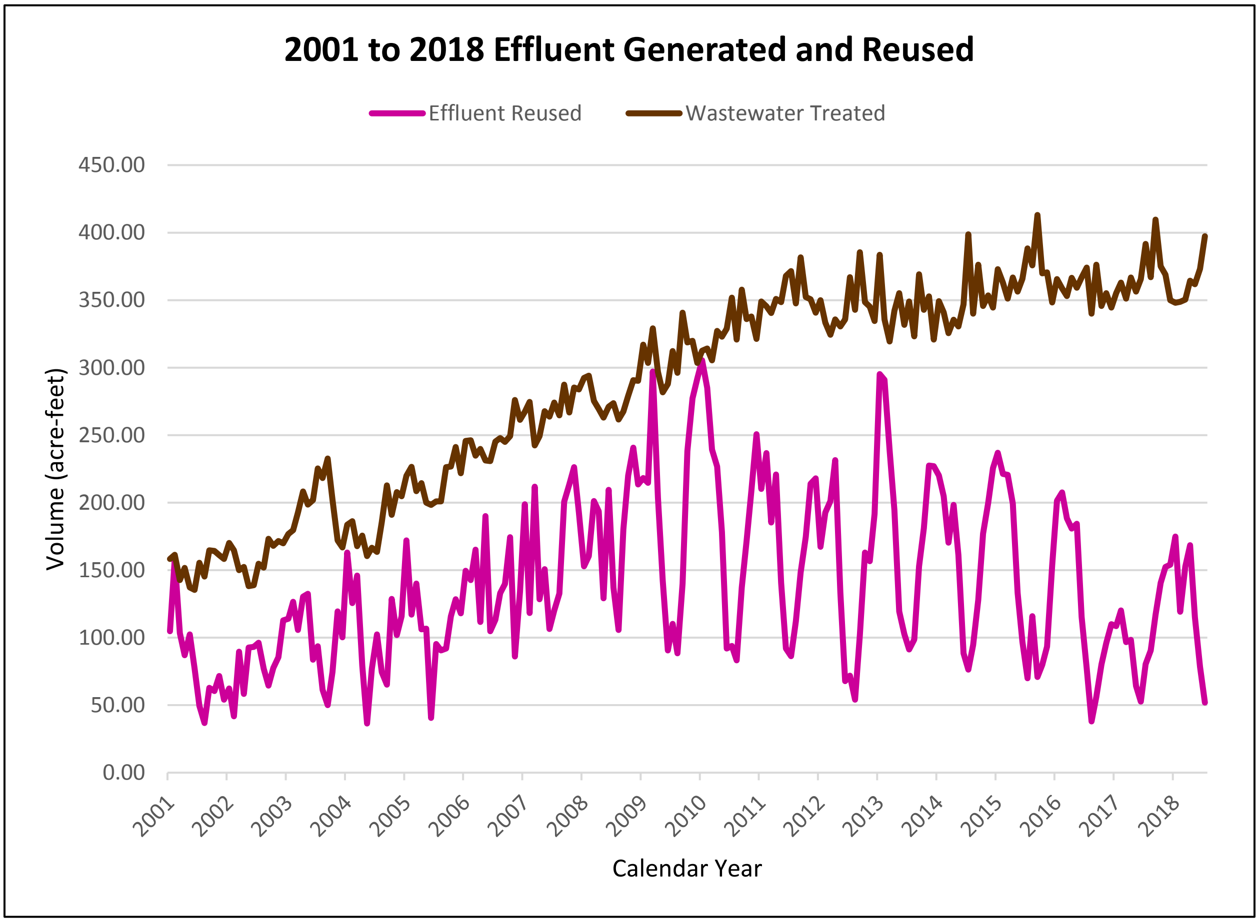

FIGURE 5-1: VOLUMES OF EFFLUENT GENERATED FROM LAKE HAVASU CITY'S THREE WASTEWATER TREATMENT PLANTS AND THE VOLUMES OF EFFLUENT THAT HAVE BEEN REUSED FOR IRRIGATION

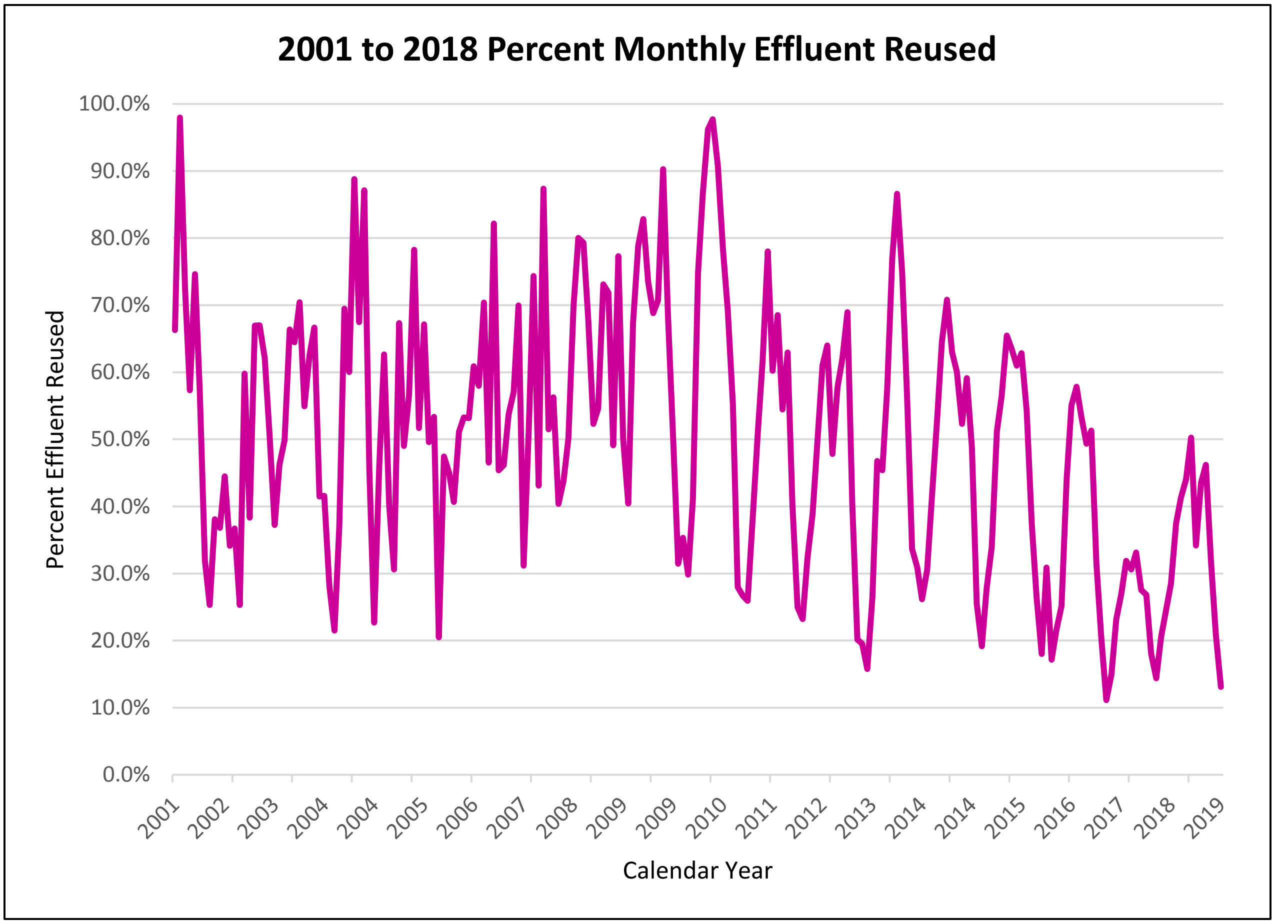

FIGURE 5-2: 2001 TO 2018 PERCENT MONTHLY EFFLUENT REUSED COMPARED TO THE TOTAL AMOUNT GENERATED

*Note that since about 2010, the summer percentage has gone down due to the increased effluent available as a result of the sewer expansion program that ended in 2011.

TABLE 5-1: ESTIMATED IRRIGATION DEMANDS OF THE TWO TOP PRIORITY AREAS PLUS NAUTILUS ELEMENTARY SCHOOL IN LAKE HAVASU CITY, IDENTIFIED IN THE 2014 RECLAIMED WATER MANAGEMENT STUDY

User	Average Demand (gpd)	Annual Demand (ac-ft)
Rotary Municipal Park	98,400	110
London Bridge Beach	14,650	16
Aquatic Center	1,100	1
Grand Island Park	18,300	21
Arizona State University	34,282	38
Cypress Municipal Park	14,400	16
Jack Hardy Municipal Park	4,400	5
SR-95 Landscape	13,000	15
Nautilus Elementary School	18,700	21

FIGURE 5-3: PRIORITY AREAS IDENTIFIED FOR CONVERTING POTABLE WATER IRRIGATION TO EFFLUENT

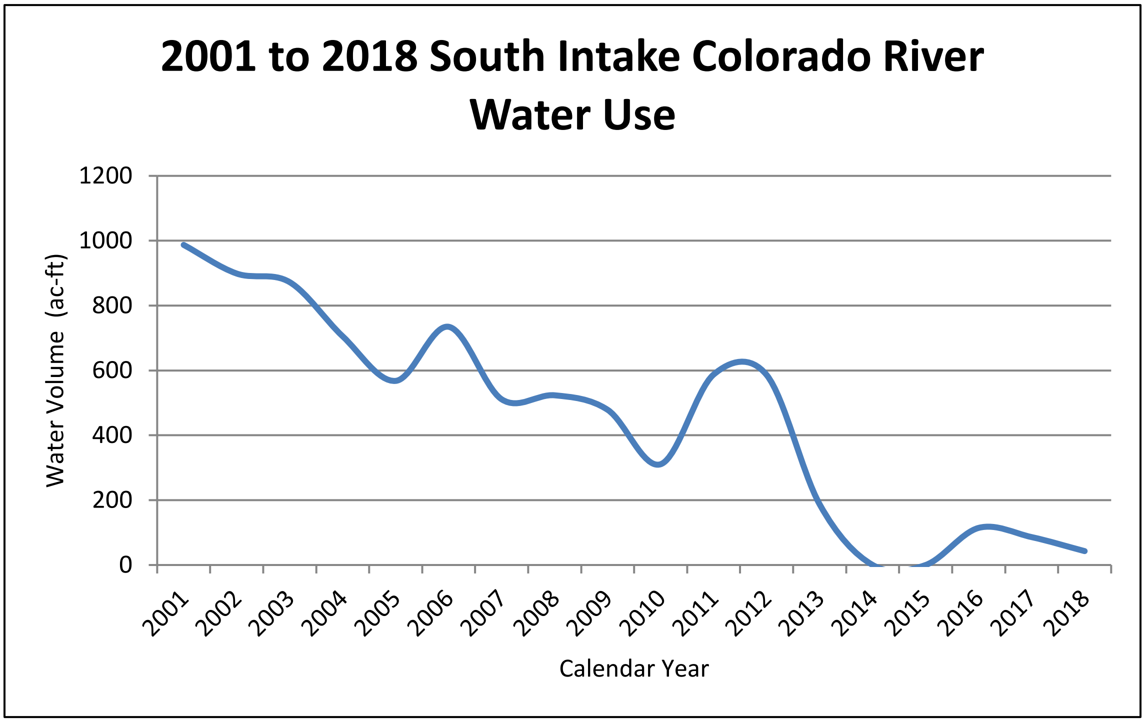

FIGURE 5-4: 18 YEAR TREND OF DECLINING COLORADO RIVER WATER USE FROM THE SOUTH INTAKE

*Note from 2014 to 2015, the South Intake was inactive with a water volume of zero acre-feet.

The second issue of effluent high TDS has been investigated through a feasibility study to reduce TDS and hardness of source water at the City's water treatment plant. The intent was to determine a viable economic treatment method to provide higher quality treated water to customers. In turn, the customers would not need to use salt consuming, ion exchange water softeners that are largely responsible for high TDS in the wastewater. High TDS in effluent degrades plant growth when consistently applied during irrigation. Though several treatment methods, including granulated active carbon and reverse osmosis, were studied, none proved to be economically practical through initial water treatment. The City will have to focus on customer on-site treatment to decrease wastewater TDS concentrations.

5.2 – EXCESS EFFLEUENT STORAGE – REUSE ISSUES

Storing excess effluent during the winter months and recovering or utilizing it during the summer is a crucial aspect of expanding the effluent reuse in the city. As in other places throughout the southwest, irrigation demand is much higher during the summer than during the cooler months.

At the same time, the amount of effluent generated throughout the year does not vary significantly, so in the winter there is an excess amount that needs disposal. Adding effluent irrigation customers will eventually result in effluent availability deficiencies during the summer. Winter storage and later accessibility is the key component to expand reuse in the city.

The City's main approach to this problem up to this point has been recharging effluent into the subsurface adjacent to its North Regional Wastewater Treatment Plant (NRWWTP). After receiving an aquifer protection permit from the Arizona Department of Environmental Quality to dispose effluent from the NRWTTP, Lake Havasu City completed and outfitted four, four-foot diameter vadose injection wells, each 180 feet deep adjacent to the treatment plant in the summer of 2008. A 250,000 gallon reuse tank at the treatment plant temporarily stores effluent, which is connected to a distribution pipeline that pumps effluent either away from the NRWWTP to customers and other wastewater treatment plant disposal sites or to a pipeline network leading to the vadose injection wells.

This site was chosen for this disposal method due to favorable hydrologic conditions. The Colorado River Aquifer surface lies approximately 400 feet below ground level in a sand and gravel alluvium and is a few feet above the regional accounting surface of 449.7 feet amsl established by Reclamation. Any water extracted at or below this surface would be charged against Lake Havasu City's annual Colorado River allocation, but any water diverted above this surface is considered groundwater not under the influence of the Colorado River. Placing water in the vadose zone overlying the aquifer will create a "mound of water" that could later be extracted independent of the City's federal allocation. Vadose well depths assure that mounding water would be above the accounting surface. The wells were placed in service as a pilot project beginning mid-December 2008, injecting between 0.5 and 1 million gallons of effluent per day. Since then, the City has recharged over 3700 ac-ft (as of early 2019) of effluent forming an asymmetrical water mound with a groundwater gradient to the southwest.

In 2012, the City drilled an exploratory recovery well to attempt to recover some of the stored effluent. The well however was unsuccessful as the local geology was not conducive for the well to yield more than 5 gpm without drying up. In 2016, the City drilled a second exploratory recovery well to extract the recharged water in a location deemed more favorable. This second well was successful with a production of 60-100 gpm. In 2018, the City was awarded a grant from the BOR (BOR-LC-18-F001) to develop a design plan for construction of a pipeline and other appurtenances (e.g. valves, pressurizing systems, etc.) from the effluent recovery well at the NRWWTP recharge field to a nearby effluent pipeline leading from the NRWWTP to various end users within the water service area. Water from the recovery well will offset on a per volume basis, Colorado River water currently applied. Upon receiving the design plan for constructing this line, the city plans to seek further funding to have it installed.

6.0 EXISTING LAKE HAVASU CITY WATER CONSERVATION ORDINANCES AND RESOLUTIONS

6.1 GENERAL

Lake Havasu City, since the 1980's, has implemented several water conservation and water budget regulatory elements and added resolutions promoting water conservation. Water conservation ordinances and water accounting ordinances pertaining to water consumption limits that have been adopted by the city are included in Titles 7, 11, 12 and 14 of Lake Havasu City Code (http://www.amlegal.com/nxt/gateway.dll/Arizona/lakehavasu_az/lakehavasucityarizonacodeofordinances?__f=templates$fn=default.htm$3.0$vid=amlegal:lakehavasu_az). These conservation ordinances and regulations and their success in improving water use efficiency are discussed in the following section.

6.2 WATER CONSERVATION ORDINANCES

Title 7 - Water Allocation and Management

The purpose of this title is to coordinate how water allocations will be assessed and accounted with growth of the City (Chapter 7.08), regulate private water well drilling within the City's water service area, establish through reference water conservation ordinances (Chapter 7.12) and develop water waste measures during water shortages. The City's entitlement is split and budgeted into two geographic areas based on whether the location is within or outside the original Lake Havasu Irrigation and Drainage District (the platted parcels in the city) and individual water service allocations are issued based on zoning type and amounts referenced by the Arizona Department of Water Resources (250 gallons per day (gpd) for single family residences, 200 gpd for multi-family zoning, and 1.59 ac-ft per acre for commercial/industrial use). Revisions to this title are being considered to budget water recently acquired by the City and to address how water is accounted.

Lake Havasu City has established water well regulations (§ 7.08.060) to prevent private interests in accessing water from the Colorado River Aquifer, which is hydrologically connected to Lake Havasu. This water is federally controlled and needs an entitlement contract with the Secretary of the Interior to access. In Lake Havasu City's case, unauthorized access to this water would be counted against the City's entitlement. Waste of water restrictions (Chapter 7.20) were adopted by the City Council in April 2010 to regulate excessive water waste only during direct water shortage conditions such as declared Colorado River Shortages or emergency situations. Such measures regulated include over-watering during outside irrigation, failure to fix leaks, hosing/washing buildings or impervious surfaces, use of outside water features and re-filling swimming pools. Other water conservation ordinances are discussed below.

Title 11 – Lake Havasu Irrigation and Drainage District

Chapter 11.04 Public Improvements, Article X – Irrigation and Drainage District Rules and Regulations refers to Ordinance 09-970, which adopts the document, Regulations Governing Domestic Water Service within the Lake Havasu Irrigation and Drainage District (IDD). Water conserving measures outlined in this document include unauthorized use of water such as causing water to waste because of plumbing leaks, washing sidewalks and driveways in a manner that prevents usual and customary use of public streets and sidewalks and over irrigation such that water runs onto public right of ways and promotes safety hazards. These rules only apply to the IDD, which is the current platted portion of the City where 95% of the growth has taken place. However, future growth is expected north of the IDD boundary. The waste of water ordinance developed in Title 7 was developed to cover all of the City's expanded water service area.

Title 12 – Buildings and Construction

Chapter 12.08.100 of the City Building Code specifies criteria for installing low-flow plumbing devices in new construction and additions in the City starting in October 1, 1990 as well as for replacement of certain water fixtures or devices. This code specifies that all faucets and showerheads will not allow a water flow rate in excess of 2.75 gallons per minute and that public restroom faucets must also be self-closing. Toilets and urinals must have a flow rate of 1.6 gallons/flush or less. Chapter 12.08.105 mandates that water cooled refrigeration systems must be equipped with a water tower, an evaporative condenser, or an acceptable recirculation system.

Title 14 - Water Conservation Landscape Requirements

Chapter 14.04.04 of the Lake Havasu City Code sets regulations for Landscape Standards. The code stipulates that low water use plants be used in landscaping on lots with a zoning district classification R3 or higher (see Section 1.6.1). Also instituted is a "no-turf" policy for commercial, multi-family, and industrial uses. The "no-turf" policy is not applicable to single-family residential. The Lake Havasu City Zoning Department enforces the code as part of the design review process. Although there are no codes governing the type or intensity of landscaping for single-family residential zoning classifications R1 and R2, a landscape plant list is advertised to citizens. There is a minimum landscape requirement of 10 percent for commercial and industrial, and 20 percent for multi-family residential. Provisions in the same chapter prohibit outdoor bodies of water such as fountains or lakes in any multi-family, commercial or industrial development. Also included in this code is the addition of non-vegetative landscaping to supplement previous vegetative landscaping requirements. Non-vegetative landscaping includes architectural features such as sculptures, benches, masonry and stone walls or decorative paving.

6.3 WATER CONSERVATION RESOLUTIONS

Recommended Landscape Plant List Resolution

Resolution 10-2450, "Revised Lake Havasu City Water Conserving Plant List for Landscaping," revising resolution 90-625, was developed in 2010 to recommend the use of low water consuming plant species, many of which are native to Arizona and the lower Colorado River region. This plant list has since been revised, and is now titled “Lake Havasu City’s Recommended Landscaping Plant List.” The list contains a variety of species of trees, shrubs, cacti, succulents, groundcovers and wildflowers, and is currently posted on the City’s water conservation website, and the City’s main website as a PDF. However, the list is now in the process of being converted to a plant database that will display the multitude of plants available to the community in a more user-friendly way. The online database is currently in the process of being built, and will be available on the City website in 2020. This plant list will also be used through Chapter 14.04.04 of the City Code for applicant landscape design review.

Water Shortage Response Strategy

Resolution 10-2415, “Water Supply Stages and Recommended Shortage Response Plan,” was adopted in 2010 to formalize mitigation options available to Lake Havasu City when its water supply is reduced below demand requirements. The contents of this resolution are discussed in section 8.0, Water Supply Stages And Water Shortage Response Plan.

Increasing Scale Water Rates

Lake Havasu City established through resolution a 4-tiered “increasing scale” water rate structure in 1990 that has since then had several rate changes. Rate and fee adjustments are made after completing a water rate study and approval from City Council through Title 3.2 of the Lake Havasu City Code. The intention of this rate structure was to reduce water consumption while still providing water at a fair price. Most of these rate increases have had the desired effect of helping to reduce water consumption (Figure 3-1). The most recent water rate study was initiated in 2008 and new rates instituted in August 2009. Rates increased in the top three volume tiers while slightly decreasing in the lowest volume category (0 – 1,300 cubic feet) so as not to penalize those customers who voluntarily conserve (Table 2-6). The affect on water consumption is yet undetermined, but any difference due to this particular rate change may be masked by the effects of how the City finances the sewer expansion program. Customer monthly sewer rates are locked in one year intervals based largely on an average of winter water consumption (November through March). Those customers who conserve water during this period will have lower monthly sewer charges.

Fix a Leak Week Proclamation

Lake Havasu City's previous Mayor, Mark Nexsen, issued a proclamation on April 17, 2009 that the fourth week of each month is fix-a-leak week. The proclamation addresses the awareness of possible water leaks in plumbing at home and of course repairing them as soon as possible. This proclamation lost momentum with changes in the City's Water Conservation Specialist position in 2016. However, Lake Havasu City's current Water Conservation Specialist plans to have a large banner displayed in one of the city's high traffic areas during this week to remind citizens to check their water systems, and revamp this proclamation.

6.3.1 MODIFICATIONS TO THE CITY CODE

Lake Havasu City will be reviewing and modifying the City's water allocation budget in Title 7 over the next two-three years. The current budget was established using per capita consumption levels higher than what the City has experienced in the last five years. A more detailed sense of what proportions of the water will be allocated to customers is needed. There is also some redundancy within the regulations that need to be streamlined. Water conservation measures are spread over four titles in the City Code and city staff will examine ways to consolidate these measures for easier referencing.

7.0 CURRENT WATER CONSERVATION ACTIVITIES INCLUDING IDENTIFIED CRITICAL WATER CONSERVATION MEASURES

Water conservation efforts currently utilized by Lake Havasu City will help to alleviate the water supply issues the City will face during the next few decades. Conservation measures already implemented have helped to reduce consumption to approximately 189 gpcd (2018). These activities include critical conservation measures (*), identified in the Bureau of Reclamation's Conservation Plan Guidelines. Activities beyond the City Code regulations are discussed in this section.

7.1 WATER CONSERVATION SPECIALIST*

The City designated an official Water Conservation Officer in 2004 to oversee daily conservation efforts. The job title was changed to Water Conservation Specialist in 2014. Duties are as follows:

1. Investigate high water usage for businesses and residents.
2. Perform residential and commercial water audits for high water usage residents and businesses as needed.
3. Hold water conservation and irrigation education workshops.
4. Teach water conservation to students in our public school system.
5. Conduct presentations to public and private groups on water conservation, water availability, and water resources.
6. Provide a water conservation presence at public events such as Winterfest, Homeshow, Master Gardeners Day, and Fall Fun Fair.
7. Create and coordinate water conservation activities such as the National Mayors Water Conservation Challenge, student film contests, and other community involved activities.
8. Run and oversee the Lake Havasu City Water Conservation Volunteer group.

The Water Conservation Specialist (WCS) role when conducting residential audits consists of an interview with the customer, searching for water leaks or excessive water use practices inside and outside the home, and giving recommendations on what to do to correct any problem. The WCS also has low flow water kits with flow reduction devices such as showerheads and faucet aerators, toilet leak detection tablets and irrigation stop valves that can be installed in the irrigation line prior to bubbler heads to hand out to individuals when needed.

The non-residential audit program focuses on excessive use and on appropriate water meter sizing. Larger water meters meant for multiple tenants or lessees may not measure very small flow rates, allowing leaks to go undetected and increasing the city's unmetered water loss. The audit program identifies these situations and recommends replacement meters to the City's Water Division staff. Other leaks and plumbing issues are also recognized for correction.

The WCS also works with the public to promote for water conservation practices and performs presentations to educate primary school students, special interest groups like the Lake Havasu Master Gardener's Club and the general public on water conservation measures they can take to save water and money. Specific programs and events that the WCS currently coordinates include:

1. Hosting the Water Conservation Recognition Program. This program has been effective since February of 2017, and provides an award to either a resident, business, or organization that has demonstrated extraordinary efforts towards water conservation and quality. Every quarter of the year, an awardee is announced in the local news outlets, and provided a certificate signed by the WCS and Lake Havasu City's Mayor.
2. School presentations for 2nd and 4th grade to 7th, 8th, high school, and college classes.
3. A 4th grade Water Festival. The Water Festival consists of a science education day dedicated to water science and conservation.
4. Creating and maintaining an online database, which contains over 400 plant species including trees, shrubs, cacti, and flowers recommended in Lake Havasu City based off the City's current recommended landscaping plant list. The database will contain things such as foliage, litter, growth, and most importantly, water needs. Through this database, residents are able to look up the water needs of their landscape on their own.
5. An Earth Day water conservation event. This event varies annually, but ideally involves the schools and the community.
6. A community campaign with the goal to win the National Mayor's Challenge for Water Conservation held in April of every year. This contest is sponsored by the Wyland Foundation. Cities of similar sizes compete against each other to see who can pledge to save the most water. It is calculated based upon residents pledging to conserve water in various ways. This year we launched a citywide campaign and came in 4th place. The WCS will be expanding our promotions for this contest every year in April. The promotion and excitement of the contest keeps water conservation in the news and on everyone's minds.
7. Service to have residential pressure regulators checked on request by the homeowner. Too many homes in high water pressure areas have failed pressure regulators, often resulting in damage to appliances or the home itself through leaking pipes

8. Facilitate the "Follow the Water" tour to Lake Havasu City's 6th grade youth. Every year from fall through spring, the WCS invites all 6th grade teachers to schedule their class to attend the tour to teach students about where their water comes from, how it is treated for potable use, and how it is treated to create effluent.

7.2 EFFLUENT IRRIGATION TO SUPPLANT POTABLE WATER IRRIGATION

Lake Havasu City has for many years provided effluent to golf courses and a few other turf and landscape irrigation sites, reducing current demand on the City's Colorado River allocation and preparing for variable future federal and state management policies dictating how water supply reductions will be applied on the Colorado River. Expanded reuse of treated wastewater is more fully discussed in Section 5.1.

7.3 DISTRIBUTION SYSTEM AUDIT, LEAK DETECTION, AND SYSTEM UPGRADES

Lake Havasu City periodically conducts distribution system leak detection surveys to identify and repair system problems. The last survey in 2013, covering the east side of the city, revealed 14 leaks with a cumulative estimated leak rate of 8 gpm or 4.2 million gallons per year. The City has also purchased an acoustical leak detection multi-sensor meter for pinpointing leaks at fire hydrants.

In 2019, the City applied for a grant with the BOR (BOR-DO-19-F005) to conduct another citywide leak detection survey. This leak detection survey, if funded, will be the first of its kind for Lake Havasu City. Unlike previous leak detection survey methods, this leak detection test will be conducted via satellite imagery. Imagery from two satellite passes at specific microwave bands capable of detecting chlorine in water surrounding distribution pipelines will be used by a sole source contractor to assess general areas of potential leaks. Identified potential leak areas will then be prioritized such that a field crew will focus on-site surveys to pinpoint leaks.

The City's Water Division took advantage of the City's wastewater expansion program by replacing old PVC water service lines to residential customers with wrapped copper lines as sewer laterals are installed. The PVC lines have proven to be undependable with many leaks and ruptures taking place. The copper lines have drastically reduced the number of repairs and improved the distribution system efficiency.

The City's Water Division was involved in a 2015-16 a citywide water audit to assess the city's water budget and compare the amount of water the City diverts from the Colorado River aquifer to how much water is metered for billing. The results indicated the City's water audit data validity score (a weighted scale for the components of consumption and water loss) is 80 out 100, and provided various recommendations to improve these results. One such recommendation was that the City implement a water audit annually as prescribed by some state laws.

The City will be looking into conducting another audit within the next 5 years as part of the recommendations from the audit.

7.4 Closely Monitor Unmetered Water Use

Not all water use in Lake Havasu City is metered. The City's Fire Department uses water for training and extinguishing fires that is taken from unmetered hydrants. Their use was reported to the Water Resources Coordinator as events occur prior to 2010, but their water use has since been estimated based on past use history. This issue will be revisited to more accurately determine the department's use. Unmetered use, water leaks and accidents also occur in the City every year. The lost water volume is estimated weekly and added to the monthly accounting report. The 2015 water audit the City had conducted also indicated unmetered fire lines and loops could lead to water theft. As such, it has been recommended that these systems be metered or put on private hydrants.

7.5 Government Role Model

Reducing community water consumption relies greatly on education and public outreach, yet leadership by example is also an effective way to show that the water provider is serious when promoting these reductions. Lake Havasu City began this role by upgrading turf irrigation efficiencies on its own facilities and with partnerships of other irrigators, replacing rupture prone water service lines with more reliable ones during the sewer expansion program, actively locating and repairing distribution system leaks, tracking unmetered water use, and actively seeking funding for water conservation efficiency upgrades, education and outreach. The City has replaced and will continue to replace selected, irrigated turf areas with xeriscaping. The City is also working to convert several public turf and landscape areas from potable water to effluent.

In recent years, the City's WCS has assisted the community with water conservation related projects to further promote the "lead by example" moto. Such projects have included assisting Mohave State Bank in their efforts to reduce their landscape irrigation, and assisting New Horizons (a non-profit for disabled persons in Lake Havasu City) in the building of a community garden. In both cases, the WCS helped each property choose appropriate xeriscape plants to install, and determined areas to maximize green infrastructure to capture stormwater runoff. Both of these successful projects were able to greatly reduce their irrigation, and solve issues regarding flooding. See Section 9 for examples of future work the City has planned for citywide water conservation.

7.6 Measurement And Accounting

The City has water meters on all its conventional wells, at all discharge points (except fire hydrants) and at the reuse facilities. All previously unmetered water accounts in the City's water system have been upgraded to metered service.

Also, a computerized accounting system capable of showing historical billing for an account to determine if any variance in usage has occurred has been implemented. The horizontal collector well, the City's primary water diversion point, is not directly metered due to construction restrictions at that site that limit proper metering practices. Instead the water from this well is metered at the entrance of the City's water treatment plant. This meter has been replaced and the current one is continuously calibrated against outflow meters from the treatment plant to make sure the diversion readings are true.

7.7 WATER PRICING STRUCTURE

The City implemented an increasing scale rate structure in 1990 for all customers which is a disincentive for excessive use. Since that time, several rate increases have gone into effect, the last occurring on August, 2009. The current pricing structure is given in section 2.2.5 (Table 2-6) and discussed further in section 6.3. Future rate increases are not currently being considered, although if Colorado River shortages are declared by the Bureau of Reclamation and these shortages directly impact Lake Havasu City's water entitlement, then implementation of rate increases will be one possible strategy to curb consumption.

8.0 WATER SUPPLY STAGES AND WATER SHORTAGE RESPONSE PLAN

8.1 INTRODUCTION

The principle's contained in this section are essentially unchanged from Lake Havasu City's 2010 Water Conservation Update to the Bureau of Reclamation. Since the City has no large volume alternative water source, devising drought stages and targeted reduction goals in the traditional sense is not very compatible with the expected outcomes of declared Colorado River Shortages. Lake Havasu City's water supply is constant under any typical non-emergency situation with the exception of federally declared Shortages on the river, which as of this writing have never happened. All Arizona 4th priority Colorado River mainstream contractors are in this situation. Unlike the Central Arizona Project, which will also share Shortage reductions, fourth priority mainstream users have no other local sources and are not severely impacted by local drought conditions, but by regional climate trends. Instead of steadily declining local groundwater or surface water levels, federal policy dictates when Shortages will take place. This will mean an instant, step-wise reduction in the City's Colorado River water entitlement as shortages deepen.

When Shortages are declared, these water providers will operate either under what could be called "paper" Shortage conditions, when the gap between the water provider's annual allocation demand and its entitlement is sufficiently separate to absorb the assigned reduction, or under "wet water" conditions, when Shortage reductions are larger than the aforementioned gap. Paper Shortages in a strict sense do not require the City to initiate any accelerated water conservation action, yet these conditions send a strong signal that future water supply availability is highly uncertain and prudent action may be warranted. Paper Shortages may disappear when either water reductions are subtracted from the City's prior year water consumption (possibly starting in 2026 – see Section 4.0) or when the City's water demand reaches the normal supply entitlement. Under wet water Shortages, a mandatory reduction of the City's annual allocation will be realized, which of course, will have to be addressed in some fashion. Strategies to ameliorate these reductions have been drafted forming an alternative Shortage response plan that was approved by the Lake Havasu City Council in March 2010 for inclusion in this water conservation plan.

8.1.1 STRATEGIES TO AMELIORATE WATER SHORTAGES

There are at least five basic strategies available to water providers that address reductions in water supply; ask citizens to voluntarily conserve water, establish mandatory water use restrictions, utilize alternative water sources, mandate water rationing allocations and modify tiered water rates to suit the situation. All of these strategies need to consider the amount or goal of the city-wide reduction, how effective the strategy will be in accomplishing that goal and the City's financial capability in implementing the strategy.

The City Manager, through staff recommendations, will advise City Council on the Shortage implications to the City and submit what strategies should be implemented, noting that adjustments could be made with changing conditions. Those conditions include, but are not limited to the success of meeting the city-wide water consumption reductions, financial burden affects, and the feasibility of accessing alternative water sources. The main points of each strategy are given below.

1) Voluntary Water Conservation (VWC)
   - includes education on water conservation measures.
   - education about the City's short and long term water situation.
   - rebates for water conserving devices.
   - set water rates so that higher users pay a lot more and/or reward conservation activities that lead to a determined % reduction.

Volunteer water conservation has been promoted continuously through the City's Slow the Flow campaign and will be emphasized during all water supply stages. Water providers in other areas have found that this strategy is successful when required water use reductions are less than 15%. Particularly, success depends on the cooperation of the community to collectively participate and the ability of the City to educate the public. Lake Havasu City's water conservation program would have to enhance its community outreach by providing information to all sectors on current and future water supply conditions as well as what measures need to be implemented to successfully reach the reduction goal. Public outreach will be accomplished with enhanced advertising in all types of media, holding public meetings, and offering water conservation programs such as rebates and workshops. A citizen volunteer water conservation program has been developed to help enhance this effort. The City may suggest irrigation schedules for residents and promote changes that City government will make to lead the way in modifying water use habits. Rebates on water bills for those customers who have exceeded the requested percent reduction will be considered. As the gap between demand and available allocation closes, the City will intensify efforts to educate citizens on water conservation practices, to inform the public of the City's water supply situation and to offer various incentives for increased conservation.

2) Mandatory Restrictions (MR)
   - focus on non-essential measures – e.g. irrigation, water waste, etc.
   - may be applied to both residential and non-residential water use.
   - quantify to fit desired reductions that satisfy the shortage situation.
   - mandate government water use conservation program.

Water districts in other areas whose goals to reduce water consumption that are greater than 10-15% during water supply shortages have not found voluntary measures sufficient. Higher reduction goals usually entail some mandatory aspect in water management. The most common restrictions imposed are enacting no water waste ordinances and restricting residential and some commercial irrigation use. Irrigation is addressed as this is almost universally the greatest use of municipal water and it is relatively easy to manipulate to fit the water shortage severity.

Most water providers begin by restricting use to three times per week based on address, one time per zone per day for some length of time and restrict irrigation times to the period between early evening and early morning. Both the duration and number of days are reduced as conditions worsen.

If Lake Havasu City adopts irrigation scheduling, there is quite a bit of flexibility regarding how the restrictions are imposed. The time of day and the number of watering days of the week for each home can be adjusted throughout the year or adjusted according to the severity of the Shortage, the restrictions could be imposed only a particular time of the year, and the water scheduling could be advanced to the public as a voluntary measure before the need for mandating. Graduated restrictions may also be applied to changing Shortage conditions. For example, light restrictions may be imposed during “Paper Shortages,” but additional magnitudes of restriction may be applied as Shortages creep closer to “Wet Water” Shortages.

Other restrictions may be addressed through Ordinance 10-1004, No Water Waste, whose provisions may be implemented through the City Council as the water supply conditions dictate (see Section 6.2).

3) Alternative Water Sources (AWS)

The two main potential water sources outside Lake Havasu City are firmed Colorado River water banked through the AWBA and water leased through land fallowing agreements. Both will dramatically demand more funding through the City’s budget. Requesting water from the AWBA account will include a recovery charge, which is estimated to be between $80 and $150 per acre-foot, depending when the water is withdrawn. The water will be sold to a customer within the Central Arizona Project system and credits will be assigned to the City’s account. The city can then pump an equal volume of water locally. The City is required to replace the water within a three-year period after a Shortage ends OR pay cash at water market value at that time. If the City is not using its entire entitlement after a period of Shortage ends and a normal supply condition resumes, the City cannot use any of its unused entitlement to “pay back” that water. The water market value cannot be precisely predicted because there is no precedent as there has never been a Shortage declared on the Colorado River. Values will probably be based on other lease fallowing agreements or private water sales during a Shortage period. The market value would be expected to be much higher than the $1400 per acre-foot that Lake Havasu City paid for the Cibola acquisition in 2008. Of course market value will fluctuate through time, probably increasing into the future. Regardless, compared to the $0.25 per acre-foot cost through the City’s Bureau of Reclamation Colorado River contract, there will be a much larger financial burden on the City. The firmed water account is good until 2096 or until all water has been withdrawn from the account. Because the account is not replenished, the City will have to be prudent in using this source to make it last 86 years.

The City is also in discussion with the Yuma Mesa Irrigation and Drainage District to possibly develop a land fallowing agreement that would allow farmers within the district to lease some of their water during times of “wet water” Shortage.

The concept of this agreement would be to "firm" land, by paying an annual retainer that would be under normal irrigation use until that water is needed by the City. The agreement would include compensating the farmer for lost crop revenue at market prices established at that time.

Reuse of the City's water via treated wastewater or effluent is a third alternative water source distinct from the other two mentioned. Increased use of effluent in place of potable water for irrigation on large landscape areas extends the City's water allocation. The main difference from the two other alternatives is that this water source is currently utilized, is planned to be maximized in the near future, and is a potential revenue stream.

A water resources fund dedicated to paying for the firmed water or for water resulting from fallowed land needs to be established prior to Shortages if the City elects to implement this strategy. Future Shortage conditions may be such that the City may have no other recourse. Water conservation, whether voluntary or mandatory, has its limits with respect to maintaining an achievable standard of comfort. Accessing the firmed water or paying for agricultural water may be the most plausible approaches in this situation. The water resources fund could be established in several ways including incorporating it into the water rate pricing structure noted below, redirecting water resource impact fees on new development, and/or dedicating some of the revenue of effluent sales to the fund. Notwithstanding, the process of acquiring the needed funding should begin long before Shortage conditions dictate the need to acquire these alternative water sources.

4) Water Rate Pricing (WRP)
   - Establish a special rate system effective for the Shortage term.
   - Need to be based on revenue/cost of delivery ratios and on the cost of acquiring alternative water sources (AWS).
   - Set excess surcharges to users that go over their allocation (WRA).

Restructuring water rates has historically encouraged water conservation. Water rate pricing may also be used to generate funds for the potential access of firmed water from the ABWA or water leased from a fallowing agreement. The City may explore seasonal water rates to correspond to demand changes, similar to the electric power industry. Revenue decoupling is another strategy electric utilities employ to generate targeted revenue while at the same time not to disincentive energy efficiency. Similarly, water conservation efforts would not need to be impacted if the desired revenue is not impacted by the amount of billable water delivered.

The water rate pricing strategy is present for two main reasons, to provide a financial incentive for high water use consumers to conserve and to establish or augment a rainy day fund to help pay for alternative water source acquisitions. Historically, water consumers decrease their use when rates are increased and if the City decides to access the firmed water from the AWBA, there will increased costs associated with recovering, managing and replacing that water. The rate strategy could be applied a couple of different ways.

The normal supply three-tiered rate structure permanently in effect could be modified during "wet water" shortages to reflect increased costs associated with possible water acquisition and/or to offset revenue reductions due to decreased water consumption. More tiers could be added to the rate schedule or different rates could be applied to different user categories. Excess rates may also be applied for the high volume consumer based on the citywide percent reduction goals. Careful rate consideration must be made in order not to penalize the user who is already conserving water.

5) Water Rationing Allocations (WRA)
   - Allocate water to each customer based on desired water % reduction to fit the shortage scenario.
   - Needs to be equitable among users.
   - Fit allocations to needed reduction – May be adjusted annually or sooner if goals are not met.

Drought status has been severe enough in some areas of the country (California, Texas and Georgia) that temporary water rationing went into effect, including making water available only during a specific time of day. A few California water providers have established the allocation rationing model by setting allocation limits to customers based on a percentage reduction of their prior use. The cities of Goleta, Redwood City and Santa Cruz along with the Redwood Valley County Water District have provisions for allocations in advanced drought stages of their water management plans. This strategy has met with mixed success in past drought situations. The California Department of Water Resources has published an urban drought guidebook detailing the allocation rationing concept. The document presents five allocation schemes; 1) percent reduction, based on prior use, 2) financial rationing based on the number of residents in a home, 3) per connection allotment that establishes a customer's water consumption goal on a unit basis calculated from an estimate of essential uses, 4) a per capita allotment per person, and 5) a hybrid of per capita and percent reduction. The type of rationing established depends on 1) the amount of water available for health, safety and sanitary purposes, C&I uses and landscape irrigation; 2) seasonal variation in water consumption; and 3) the degree of homogeneity among customer types. The hybrid model for residential accounts has been noted as providing an equitable way to balance reductions with those customers who already conserve.

8.1.2 ABOUT IMPLEMENTING WATER RATIONING ALLOCATIONS

Water rationing allocations are recommended only during "wet water" Shortages when the City's actual allocated supply is reduced by 20% or more. Reductions less than this may be addressed through a combination of the above mentioned strategies. Introducing allocation rationing during reductions greater than 20% will afford the City a good chance of obtaining its goal. The allocations could be assessed in combination with some of the other strategies mentioned to ameliorate the burden on the City's customers and could be flexibly managed in several different ways to fit the particular Shortage conditions.

Any apportionment rationing will require a set of criteria to base decisions on the amount of water a particular customer will receive in a year or month. The criteria include account historical usage, family size (per capita consumption), and health and safety needs. City financial and logistical considerations, community impacts, and supply availability also need to be considered when planning this strategy. Reclamation will make its determination in August of the year before the Shortage is implemented, giving local water providers about 4 months to make final preparations.

There are several approaches to meet percent reduction goals for residential accounts under the allocation rationing strategy. One approach is a month by month reduction based on the prior year's use or prior five-year average for each month. This percent reduction could be weighted among customers based on level of consumption (i.e. to what rate tier the average corresponds) so that customers who already conserve will not be penalized. Alternately, the reduction could also be based on the prior year or averaged five-year total consumption regardless of month. This second tactic will heavily rely on the customer to pay attention to their water use throughout the year. A basic health and safety allocation should be assigned per person (68 gpcd was used by Goleta Water District) and customers on higher tiers would have to proportionately cut back on consumption so that those customers who already conserve are not penalized. For example, if the reduction is based on a customer's averaged monthly consumption, then a customer account that is using less than 1000 cubic feet per month, may not have their water reduced. Those customers that use progressively more water could have imposed on their account a sliding scale percentage reduction with more use (Table 8-1).

TABLE 8-1: AN EXAMPLE OF RESIDENTIAL REDUCTIONS BASED ON CONSUMPTION HISTORY, KEEPING A BASE SUPPLY FOR HEALTH AND SAFETY CONSIDERATIONS

Average Consumption History (cu. ft.)	Percent Reduction from Average
Less than 1,000	No reduction
1,000 – 1,200	5%
1,200 – 1,400	10%
1,400 – 1,600	15%
1,600 – 1,800	20%
1,800 – 2,000	25%
2,000 – 4,000	30%
4,000 – 6,000	35%
6,000 – 8,000	40%
8,000 – 10,000	45%
Greater than 10,000	50%

*Some residents may have greater needs for health and safety than others, which can be accommodated. The reductions do not consider the size of the property or landscape irrigation requirements.

About 60% of Lake Havasu City's total annual water consumption occurs as residential landscape irrigation, most of which takes place during the warmer months. Since water demand is highly seasonal, a third possible approach to allocation reductions is to shoulder the burden of the required reduction to one part of the year. Each season has benefits and disadvantages on some level. Limiting water consumption during the winter months would help customers financially by keeping their monthly sewer charges lower and more water would be available in the summer months for most usual practices (i.e. fewer restrictions). A winter averaging program is already in place that sets monthly sewer charges for the rest of the year and forcing a reduction on top of that may not yield the desired results. The City would also experience reduced revenue to pay for the sewer program. Focusing on reductions during the summer would not impact incoming sewer revenue and would help in reducing peak flow periods. Saving water at this time of year will also keep citizens focused on water conservation for more of the year (since winter averaging will still be in effect). Limiting water use during the summer may worry citizens about damage to their landscapes, yet an aggressive public education program could ease those concerns.

Straight percent reductions have been favored for non-residential customers during water shortages in other regions of the country, yet some water providers have considered the number of employees that a company has to factor in health, safety and sanitary needs. The amount of reduction mandated will depend on the overall reduction to the City's allocation and the proportion of the non-residential consumption to the residential consumption.

Enforcement of rationing programs is typically in the form of excess surcharges assessed to customers who exceed their allocation limit. Excess surcharges are separate from drought surcharges in which the latter is a part of the water rate pricing strategy to compensate for lost revenue during water shortages. Excess surcharges are automatically included as a separate line item in the customer's water bill and the surcharge is usually much steeper than a change in water rates due to revenue losses, on the order of $3.00 to $25.00 per 1000 gallons used above the allocation limit.

8.1.3 WATER RATIONING ALLOCATION CAVEATS

Unlike mandatory restrictions, the ideology of water rationing allocations does not by itself, necessarily restrict how the water is used. In a perfect world for a given allocation period, customers are expected to stay within their allocations and the water provider is expected to keep the customer informed regarding their status. However, none of the water providers who have a rationing allocation component in their drought mitigation plan use this strategy alone. Most initially address shortage reductions with voluntary and mandatory restrictions that are kept in place while implementing allocations as conditions worsen and deeper water consumption reductions are required. A highly organized effort is required by the water provider to assess the allocations among its customers, particularly developing a mechanism to keep customers informed of their use. One way to approach this caveat is to have in place a residential meter recording program, such as a radio transmission/receiver system, that can yield real time water volumes available for both city staff and customer use.

Lake Havasu City's lag time, between when the water meters are read, which are done manually, and when the customer knows how much they have consumed (i.e. when they receive their water bill), is approximately 3-4 weeks.

A prime reason why many water providers do not use allocation rationing is the intense labor needed to develop and implement such a program. The required manpower to fully develop and implement this process is greater than the present workforce Lake Havasu City has dedicated to water conservation/supply. At least three more employees need to be dedicated to the program to administer the program's logistics, such as tracking customer usage and communicating that usage to the customer, database development and management, public outreach and field checking water issues (e.g. violations). The public needs to be kept fully informed about their water usage and the circumstances under which they are using the water. The program's projected costs and the City's budget climate will dictate whether this form of water management is implemented.

One seeming advantage of this strategy is the implied flexibility the customer has in using the water, yet when this approach has been implemented in California, mandatory irrigation and no water waste restrictions have also been in place. Quite a few water providers use the term rationing in their drought shortage plans, but the measures within the rationing scheme are really restrictions on irrigation and other water use to obtain the desired reductions. A mandatory restriction with penalties is by far the most common strategy for water providers across the country to reduce water consumption under stressed conditions.

8.2 SHORTAGE RESPONSE STRATEGIES IMPLEMENTATION EXAMPLES

These strategies can be thought of as a toolbox, from which the City could implement with changing water supply conditions. Each strategy could stand alone, depending on the water reduction goals and how the City would like to approach the problem, but most water providers across the country use some hybrid form to conserve their dwindling resources. This approach maximizes water consumption efficiency, gives the City flexibility to adapt to varying resource and financial circumstances and minimizes the burden on the community. Table 8-2 provides examples of hybrids matched against water supply stages for Lake Havasu City. These possible scenarios are ordered from least restrictive, where citizens have more of a choice in their water use, to a more mandatory guided effort. There are other possible combinations of strategies, yet the five selected give a sense of flexibility to implement strategies that fit the City's water supply and financial situation at the time of Shortage.

TABLE 8-2: WATER SUPPLY STAGES AND EXAMPLE DROUGHT STRATEGY COMBINATIONS TO MITIGATE LAKE HAVASU CITY SHORTAGE REDUCTIONS

Stage	Example Drought Strategy Combinations				
Normal Supply	VWC	VWC	VWC	VWC	VWC
Paper Shortage	VWC	VWC / WRP	VWC / WRP	MR / WRP	MR / WRP
Wet-Water Shortage	VWC / AWS / WRP	AWS / WRA / WRP	AWS / MR / WRP	WRA / MR / WRP	AWS / WRA MR / WRP

*Strategies include Voluntary Water Conservation (VWC), Water Rate Pricing (WRP), Mandatory Restrictions (MR), Alternative Water Sources (AWS), and Water Rationing Allocations (WRA).

8.2.1 PAPER SHORTAGE CONDITIONS

Although a Paper Shortage does not specifically limit the actual amount of water that the City would normally use in a particular year, the gap between the demand and the allocation ceiling will be variable, tending toward a convergence with time. The first Shortage declaration will be 400 KAF when Lake Mead's elevation drops to 1075 feet amsl. Each year after, while the elevation is still below 1075 feet, but above 1050 feet amsl, the Shortage volume may or may not stay the same, depending on the allocation needs of the higher priority users. Under normal economic conditions, the City's population will grow through this same period, pressing for greater water needs and thus narrowing the supply – demand gap. If the lake's elevation drops below the next two trigger elevations, successively larger Shortage volumes come into play (500 KAF and 600 KAF) along with the expected demand increases. Aspects of the proposed strategies presented in Table 8-2 can also be applied within the Paper Shortage stage (Table 8-3). As the supply – demand gap closes; the City will have the opportunity to proactively adjust to the increasingly deleterious conditions, if it wishes, by taking steps to prepare for Wet Water Shortages during Paper Shortages. Action measures in the table are only examples of what could be implemented given the type of strategy employed. Since the Paper Shortage category's length of applicability is uncertain, a long term management approach is recommended.

8.3 PROJECTED WATER SAVINGS

Calculated water savings using any of the above strategies depends on available historical consumption rates and a few assumptions where data is not obtainable, such as frequency and duration of irrigation at all residences. Also many water accounts belong to part time residents or second home vacationers that may not regulate water use (such as fixed irrigation schedules throughout the year) or be responsive to changing conditions such as developed leaks or appliance failures.

Converting non-residential, potable water irrigators to effluent use is directly quantifiable and at this point a voluntary measure for the user if an effluent pipeline is in close proximity and if enough effluent is available. The percent potable water saved would be account specific. The City saved over 2200 ac-ft of potable water due to effluent irrigation in 2014. Similarly, the amount of water saved by irrigation converting from potable water to well water not tied to the City's Colorado River allocation can be determined. Most likely, these two efforts would be done before Shortages as normal water conservation measures.

Other voluntary water conservation measures will rely heavily on public outreach by the City, particularly when focusing on outside water use. Historical billed water consumption indicates that residential irrigation composes approximately 60% of the total City's water consumption. A focused effort on landscape irrigation that is sanctioned by local landscape and nursery companies can help lower irrigation volumes. Depending on how the recommended restrictions are structured and the cooperation of the community, total allocation reductions between 5% and 15% can realistically be obtained as documented from other water providers who experienced recent droughts in California and Texas.

Estimating water savings from other water conservation measures is not easily quantifiable because these measures may not be able to be separated from the account as a whole. For example, rebate efforts (replacing high use toilets and installing pool covers) and establishment of a hotel water savings program or commercial water conservation plans would require the water use from targets practices to be isolated to get a really good idea of the percentage reduction. Other uses associated with domestic (especially if there is no irrigation meter) or restaurant consumption may overwhelm a perceived reduction, although intuitively there is a savings. Likewise, advertising and education campaigns most certainly help, but are hard to quantify in terms of real water savings.

TABLE 8-3: EXAMPLE OF PAPER SHORTAGE STAGE OF TABLE 8-2 EXPANDED TO INCLUDE POSSIBLE INCREASED WATER CONSERVATION MEASURES AS THE ALLOCATION DEMAND NEARS THE ENTITLEMENT CEILING

Paper Shortage 400K-600K ac-ft	VWC	VWC/WRP	MR/WRP
Percent water demand allocation below entitlement ceiling	Stress extent of voluntary measures.	WRP should be scaled for revenue loss and for AWS funding.	Tier mandatory restrictions.
> 20%	Continue public education similar to Normal supply conditions, but add messages about Shortages.	Implement a revised water rate structure to fund firmed water orders.	Impose irrigation restrictions & strictly enforce No Water Waste Ordinance.
20% - 10%	Step up public outreach & suggest irrigation schedules along with other water use limitations.	Review revenue generation for firmed water orders and adjust as needed.	Same as above.
< 10%	Full scale public outreach, rewards program(?), more stringent irrigation requests, & intensify water audit program.	Continue review of revenue generation for firmed water orders and adjust as needed.	Tighten irrigation restrictions by reducing # of days and duration.

*Strategies include Voluntary Water Conservation (VWC), Water Rate Pricing (WRP), Mandatory Restrictions (MR), Alternative Water Sources (AWS), and Water Rationing Allocations (WRA).

8.4 NON-SHORTAGE EMERGENCY SITUATIONS

Lake Havasu City has short term water supply emergency contingency plans in the City's Emergency Response Plan, yet the provisions in the plan do not cover long term catastrophic disruption in water supply. Many of the strategies for Shortage response in this document are applicable, depending on the severity and type of the disruption. Barring out-right disconnection of the distribution system so that water cannot be transferred to the customers, wet water reductions by allocation rationing, restrictions and water rate pricing could be utilized either alone or in combination. Complete incapacitation of the City's water treatment plant would mean by-passing it and pumping only from the existing north and central well fields as in the past, at least until a new connection and treatment process can be configured to the force main from the Horizontal Collector Well. Adjustments of this magnitude and the associated time involved may require a schedule of varying strategies to accommodate for health and safety water demands as well as responsibly easing stress on the citizens as soon as possible.

9.0 2020 – 2025 WATER CONSERVATION ACTIVITIES

The overall goal of the 2020-2025 water conservation plan cycle is to continue to decrease Lake Havasu City's per capita water consumption, and attempt to close the gap between the City's consumption gpcd and the City's diversion gpcd. With a current (2018) citywide consumptive gpcd of 189, the City should be able to continually reduce the overall gpcd with continued implementation of water conservation measures.

9.1 MEASURES THAT WILL BE IMPLEMENTED WITHIN THE 5 YEAR PERIOD

A number of activities ranging from an increased education/outreach component to converting more potable water irrigation customers to effluent are proposed over the next five years to help lower the City's water consumption.

9.1.1 WATER CONSERVATION SPECIALIST PROPOSED PROGRAMS

1. Create and implement the "Slow the Flow" program. This program will target key areas of water conservation (specifically hotel, restaurant, multi-family property, and landscape irrigation), and build lasting partnerships between the City and local businesses and HOAs. More information on this program is described in section 9.1.3.
2. Continue to develop Green Infrastructure and native plant settings throughout the city.
3. Continue Lake Havasu City's Water Conservation Recognition program. In this program, individuals, groups, or businesses are awarded a certificate of recognition signed by the Mayor and WCS quarterly and recognized in the local news outlets for water conservation related actions.
4. Develop and implement Lake Havasu City's Xeriscape Demonstration program. Similar to the Water Conservation Recognition program, this program would invite residents and businesses to be recognized and showcased for their water-appropriate xeriscape designs. Instead of recognizing these awardees in the paper, their landscapes will be showcased in a special section on the City's Plant Database.
5. Continue and implement more community water conservation contests. The WCS will be adding new contests over the next five years to encourage participation in Lake Havasu City's elementary and middle school youth.
6. Bring back the Water Conservation Calendar. The Water Conservation Calendar has been a great way to remind our citizens of water saving tips specific to each month.

Along with the tips, the water conservation calendar can showcase drought tolerant landscapes, rainwater harvesting, or green infrastructure.

6. Further develop the Lake Havasu City citizen volunteer water conservation group to help with public education and outreach. More specifically, the WCS will be revamping the existing program to host monthly meetings, and allow volunteers to help with maintaining Lake Havasu City's Water Conservation website (www.havasuwatersavers.org), and the City's new Recommended Landscaping Plant Database (www.lhcaz.gov/plants).
7. Continue to implement the City's awareness campaign and provide open workshops and guest presentations to local clubs, and schools to inform residents of Colorado River shortage year projections and how it will impact their life, neighborhood, and community. This will include educating citizens about the City's shortage response strategies. Secondarily, there will be an increased effort in the next 5 years to communicate with the City's realtor businesses so that they can better inform new residents of our water pressure zones, and our Winter Quarter Averaging to determine sewer charges.
8. Continue to sponsor the 4th Grade Water Festival. The City has been sponsoring the non-profit Arizona Project WET to host the first 4th Grade Water Festival in Lake Havasu City for 3 years now. Since the year 2000, Arizona Project WET has helped communities throughout the state present water education to fourth graders and their teachers through the Arizona Water Festivals. Students and teachers from the community will gather for fun and educational STEM-integrated activities focused on watershed management, the water cycle, water conservation, and groundwater.
9. Continue the Follow the Water Tour program to educate the public on the City's water production, distribution, and reuse facilities. The Follow the Water Tour targets Lake Havasu City's 6th grade youth, and invites all ~500 students to be taken on the tour at varying times throughout the cooler seasons of the year. The tour is also opened up to the public a few times throughout the winter, and available to many different clubs and interest groups upon request.

9.1.2 CONVERSION OF POTABLE WATER IRRIGATION TO EFFLUENT

This topic is extensively covered in Section 5.0, Effluent Reuse, including the addition of new customers that currently use potable water for irrigation who may be converted within the next five years. As noted in Section 5.2, effluent not used directly for reuse is either recharged to the subsurface via percolation pond or vadose injection well. Further potential customers are briefly discussed in Section 9.2 below.

The city has conducted a feasibility study for an effluent pipeline that would connect the North Regional Wastewater Treatment Plant to its southern most park, SARA Park. The proposed pipeline route would lie within a City owned easement in which the Western Area Power Administration (WAPA) operates. The advantage to this route is that many more irrigation customers such as all the schools and most city parks could be gravity fed from this pipeline. The costs of this pipeline installation are high; however, as more customers seek effluent as a potential water source, this may be revisited as a possible project for the City.

9.1.3 OTHER MEASURES SCHEDULED TO IMPLEMENT OVER THE NEXT 5 YEARS

Even small reductions in consumption spread out over such a large user base can potentially realize significant savings. To this end, there are several other conservation activities recommended for completion within the next five years.

1) Develop a program for customers to drain their pool water into the sewer system so that it can be recycled. This may include the development of a device(s) that could easily facilitate that process. In the past few years, this idea has not gained much traction. Therefore, the WCS plans to gather the local pool companies and any other relevant stakeholders together to have an open discussion about how we can encourage the City's citizens to drain their pools into the sanitary sewer. Upon gathering feedback, a program will be established to encourage this change.

2) Examine alternatives to conventional water softeners and reverse osmosis systems that generate very little to no water waste. Regeneration cycles in current softeners consume between 30 and 40 gallons of water that becomes the brine. The reverse osmosis process uses between 3-5 gallons for every 1 gallon of clean water produced. Water softeners using salt also increase effluent total dissolved solid content, which degrades effluent quality for irrigation. The copious amount of salt used in water softeners creates a burden on the wastewater treatment plant to filter out. The treatment process, even with an A+ rating from ADEQ, is unable to filter out most of the salt and dissolved solids resulting from residential water softeners. The practice of periodically flushing turf areas to dissolve salt build-up is also a waste of water.

3) The City will continue to issue water stop valves for residential bubbler irrigation systems, which prevent water waste in case a bubbler head or riser is broken. Boxes of these have been handed out at community fairs over the past few years. Due to their popularity, we will be promoting and handing out even more in the upcoming years.

4) Develop Commercial/Industrial Water Conservation Planning and Individual Custom Water Conservation Plans – In 2018, Lake Havasu City commercial users represented 9.3 percent of water consumption; construction/industrial users represented 1.7 percent (Figure 3-2).

Though these categories compose a relatively small percentage of the total water consumed in the city, there are opportunities to make efficiency improvements in irrigation, and business practices involving water usage. A general commercial/industrial Water Conservation Planning document could be developed to show what individual businesses can do to not only lower their water consumption, but also their overhead costs. The planning document would outline a strategy/methodology for developing voluntary custom water conservation plans for each entity. The plans would be tailored to alter current business practices to save more water and money.

5) Slow the Flow program - The Slow the Flow program is an umbrella program to target certain areas of water use and build partnerships. Below are the areas of focus and their descriptions:

Water Upon Request Partnership Program

Build relationships with local restaurants and encourage them to voluntarily participate in a “water upon request” program in which they only provide water to customers upon request. This program would save local restaurants water, time, and money by eliminating unconsumed glasses of water. Due to the fact that most restaurants use reverse osmosis water in Lake Havasu City, and assuming the typical RO system wastes 3 to 5 gallons of potable water for every RO gallon produced, this has the potential to save an estimated 64 to 96 oz. of water per 16 oz. unconsumed glass served, or approximately 4 to 6 gallons for every 8 glasses (1 gallon) served. In addition, more water would indirectly be saved by requiring restaurants to run less dishwasher loads. Lake Havasu City could further incentivize businesses by helping to provide promotional materials (i.e. an informative tabletop display) to inform their guests.

Linen and Towel Exchange Partnership Program

Build relationships with local motels/hotels/resorts and encourage them to voluntarily participate in a “linen exchange” program in which linens are changed only on the third day of a guest’s stay, unless otherwise requested. Secondarily, they can participate in a “towel exchange” in which customers can opt to reuse their towels and inform housekeeping by leaving them hung up on a rack, or if they wish to have their towels washed, they can inform housekeeping by simply leaving their towels on the floor. This would save the local hospitality businesses detergent, water, labor, energy and laundry expenses. It would also reduce wear and tear on the linens, towels, and laundry equipment. Due to the amount of linen and towel material in a typical hotel room, this could save an estimated 50 gallons of water per room per day. Lake Havasu City could further incentivize businesses by helping to provide promotional materials (i.e. an informative towel rack hanger and “daily sheet changing” card) to inform their guests.

Multifamily Property Water Use Analysis Program

Analyze all multifamily property complexes within Lake Havasu City to better understand what 'normal' water use constitutes on these properties, and key areas in which these properties are able to save water. Gathering historical water use data on these complexes along with completing onsite audits will provide baseline data needed to determine areas of improvement for water use. Upon completing research on these properties, Lake Havasu City could then build a relationship with these complexes to help inform them of areas in which they may be able to save water and money. It also provides an outreach opportunity to inform these complexes of the possible effects on water use during a wet water shortage, and how cutting back on water now may benefit them in the future.

Secondarily, multifamily properties and HOAs in Lake Havasu City are largely the only sector in the community (besides schools and parks) that have turf irrigation. Although multifamily properties only constitute 8.2% of Lake Havasu City's consumptive use (Figure 3-2), a few HOAs have consistently been in the top 3 largest water users in the entire city due to over-irrigating their turf. The WCS will be looking into setting up a Landscape Water Budget program to monitor the irrigation efficiency of these properties. With a water budget program tool (i.e. Waterfluence, which is currently being considered), the WCS will easily be able to keep track of HOAs actual water use versus a pre-determined budget benchmark based on site-specific characteristics and real-time weather. With a Landscape Water Budget program, the WCS will be able to give each HOA an individualized monthly report to help them better manage their turf, and see where they can improve their water use. This may also open the opportunity to seek funding for a "cash for grass" type program to help convert turf at these sites to xeriscape.

Golf Course Water Use Analysis Program

Build relationships with local, privately-owned golf course management and golfers for all golf courses to analyze which turf areas golfers rarely play in. Lake Havasu City would provide golfers with GPS logging devices to identify where they actually travel on the golf course. Using this detailed information, areas of non-functional turf can be identified. This information can be provided to the golf course's management, and aid in finding future areas for turf conversion to xeriscape.

Xeriscape Lecture Series

Build relationships with the local nurseries, and landscape companies in Lake Havasu City by offering a xeriscaping lecture series directed at landscape professionals, but also open to the general public. Lake Havasu City would utilize the talents of its' Arborist and maintenance team, Backflow Specialist, Water Conservation Specialist, and Stormwater Specialist to host the series. If Master Gardeners are available to help host as well, that would be optimal.

The series would consist of multiple lectures to cover the topics of irrigation equipment, irrigation installation, backflow uses and installation, proper plant choices for xeriscapes, proper watering guidelines for plants, proper plant maintenance techniques, landscape grading, low-impact development, stormwater retention techniques, and rainwater/gray water harvesting techniques, application, and installation. Completion of the series would give participants some sort of 'watersmart' certificate or work credit hours.

6) Lake Havasu City Recommended Landscaping Plant List – The WCS created the City's recommended landscaping plant list in 2017, and is now in the process of converting the document to a plant database. The plant database will consist of ~500 species of plants including trees, shrubs, groundcovers, ornamental grasses, vines, cacti, succulents, and perennials along with varying gardening characteristics such as water requirements, sun exposure, growth rates/sizes, foliage type, flower color and season, allergen information, etc. the plant database (www.lhcaz.gov/plants) will also host a section for the City's proposed Xeriscape Demonstration program.

7) Earth Day Water Conservation Event - The WCS strives to have an annual water conservation event coinciding with Earth Day. Right now there are talks in progress with Thunderbolt Middle School to sell Earth Day/water conservation themed T-shirts for school kids, school employees, and city staff to wear either daily or on casual Fridays. The proceeds from the T-shirts will go towards a water conservation activity for the middle school students. For example: planting native plants utilizing green infrastructure in the parks or on school grounds. Ideally this event will be open to the community to volunteer and participate.

8) Continue to periodically conduct leak detection surveys of the City's water distribution system, continue water meter replacements as the reach a certain age or become defective, and conduct larger-scale upgrades to the water system. This includes locating an appropriate site and installation of a second horizontal collector well to make sure the City has enough diversion capacity to replace the current horizontal collector well volume if it goes down for repair or when the city daily demand exceeds that well.

9.2 WATER CONSERVATION MEASURES UNDER CONSIDERATION

9.2.1 FUTURE WASTEWATER RECYCLING

Lake Havasu City's annual wastewater volume is only ¼ of the potable water delivered to customers. Most of the water delivered that is not returned via the sewer system is used for home, commercial, park or school irrigation with a smaller quantity used in construction and industry. Potable water used for irrigation percolates into the subsurface, evaporates or is consumed by plants. In all these cases, the water is irretrievable, so Lake Havasu City will be examining options to permanently increase the above ratio. Converting irrigators to effluent, as mentioned in Section 5 and above in Section 9.1.2 will help, yet the extent to which effluent is used for irrigation depends on its availability.

As the City grows, there will be opportunities for new developments to increase water efficiency, including incorporating graywater and/or effluent plumbing. Effluent plumbing for irrigation would probably be restricted to larger residential developments outside the City's IDD. The City is not configured for this irrigation method to residences within the IDD, yet a limited graywater irrigation plumbing system can be installed in existing homes and businesses. More extensive graywater plumbing could be installed during new construction. To the extent that either of these alternative water uses are realized will determine the amount of effluent generated at the City's three wastewater treatment plants as development moves ahead.

Increased effluent volumes could translate into more irrigation customers converting from potable water. The Lake Havasu Unified School District irrigates ten facilities, including one high school, one middle school, six elementary schools and a district office complex, all of which use potable water. Several City parks and other landscaping could also benefit, especially if the new effluent pipeline discussed in Section 9.1.2 is constructed. There are also two private business water wells within the City's water service area used for landscape irrigation. The water volumes are included in the City's annual Colorado River allocation. Both irrigation sites have an effluent pipeline adjacent to them. The sites have not been converted to effluent because the cost of the effluent is much greater than using the well water. The City will be investigating alternative pricing for these two sites to make the conversion to effluent more attractive.

An alternative to adding more customers for effluent use is the eventual shut down or hibernation of the City's South Intake of lake water that is blended with effluent at the Mulberry Wastewater Treatment Plant for the London Bridge Golf Course. Replacing this water with effluent would add significantly to the City's allocation for potable water treatment. Stopping South Intake deliveries, however, should be subordinate to converting potable water irrigators to effluent since the cost of delivering the raw lake water is much lower than delivering treated water to irrigation sites. If the effluent total dissolved solid concentration can be significantly lowered over the next five years, there will be no need to dilute the effluent with lake water.

9.2.2 WATER METER TECHNOLOGICAL UPGRADES

There are almost 30,000 conventional water meters in Lake Havasu City, all of which need to be manually read and submitted to the City's Finance Department. The current timing between the meter reading and the customer receiving the bill is between three and four weeks. Unless each customer tracks their own water meter readings, that time delay does not let the customer quickly correct their situation if they have an undetected leak or are overusing water. This is most important during winter water consumption averaging to determine monthly sewer fees (Section 7.1). All water meters replaced as part of the City's meter replacement program (which retires old inaccurate meters with new ones) have the capability of adding a radio transmitter. The City has explored the feasibility of adding transmitters to all water meters so that they send radio signals to a central receiver that collects and sorts by account customer the amount of water used at any given moment (Automated Metering Infrastructure – AMI).

The usage could also be uploaded to a customer account that can be tracked in real time by the customer, thus eliminating the time delay. The City would also have the capability of closely managing its supply by quickly responding to issues, particularly during Shortages. As of this time, adding radio transmitters to all water meters in the City, and building the infrastructure to receive real-time data is proportionally expensive for the City. However, older meters are still continuously being swapped out for newer ones capable of being retrofitted for radio transmitters as part of our Meter Replacement Program, and the option to seek grant funding to help acquire AMI in the future is still a possibility.

9.2.3 INCENTIVIZING GRAYWATER SYSTEMS IN NEW DEVELOPMENTS

With drought conditions remaining relatively unscathed in the last two decades, future water supply availability is more uncertain than ever. Installing gray water reuse systems in new construction is a cost effective way to prepare for this future. While retrofitting older homes for gray water use is very expensive, putting gray water systems in new homes is very cost effective. The few hundred dollars to install gray water plumbing in new homes could easily be recouped by properly value, or a few months' savings on water/sewer bills. These gray water systems could replace all potable water irrigation when installed appropriately for the irrigation demand. Subdivision-wide graywater systems could be an alternative to the installation of purple pipe in new developments. This would save the builder tremendous amounts of money in infrastructure installing purple pipe. This would also save the city money and resources, because the gray water would be directly used on residential irrigation instead of going through the sewer system, treated, stored, and moved again. Those solely on gray water systems would be exempt from outside watering restrictions during water shortages.

9.2.4 RAINWATER HARVESTING

Lake Havasu City would like to continue a program to install or give incentives to install rainwater harvesting systems on city, school, and commercial roofs and parking lots adjacent to irrigable landscaping. The City already installed two rainwater/gray water systems in 2017 after obtaining a grant from the BOR (BOR-LC-16-001) to install systems on two municipal buildings. The two systems not only capture rainwater from the building roofs, but also capture evaporative cooler condensate from the evaporative coolers used on both buildings. Between the rainwater capture, and evaporative cooler condensate, the surrounding landscapes of one of the buildings is now watered independent of potable water. The other relies on a reduced potable water volume, as there is not enough condensate from their two evaporative coolers to supply gray water year round.

Rainwater harvesting combined with green infrastructure (see next section) on drought tolerant xeriscaping would substantially lower potable water demand and would mitigate storm water damage as well.

This includes potential water quality improvements as normal runoff that can collect oil and other contaminants as it flow towards Lake Havasu, would be redirected to percolate into the subsurface and be filtered as it slowly migrates towards the lake.

9.2.5 Green Infrastructure and Native Plant Community Demonstration Park

The City wishes to expand its green infrastructure (GI) efforts to both conserve potable water as well as demonstrate alternative irrigation strategies to the public. Xeriscaping/GI projects that are being explored include:

a) Beautifying margins of the multipurpose path on, "The Island" that are now mostly barren with native and drought tolerant plants. GI is needed to eliminate pooling of rain water on an adjacent road and channeling the water to plantings.

b) Beautifying margins along the sides of Highway 95 which runs straight through town. An effluent pipeline lies adjacent to the highway from the city's north end to just south of the London Bridge, which can be easily tapped for the planned xeriscaping along this stretch. Storm water also can be redirected along the highway for irrigation. Once established, the native plants proposed for this work will require only the occasional storm water runoff delivered by GI.

c) Showcasing GI through a community Demonstration Park. In order to showcase both native Mohave County plants and GI, the WCS and volunteer group will search for an area of town to display both. The goal is to develop a GI system (i.e. storm water basins, channels, and porous concrete) capable of naturally providing 100% of the water demand required by all plantings. This system could also include rainwater harvesting from adjacent roof top or parking lot surfaces. The demonstration park will be well-signed, allowing the community to learn more about native plants and GI concepts they can then easily apply to their own homes. The park will create a dramatic depiction that shows the esthetics of desert plants and GI.

d) Other areas of the city will be explored for the practical application of GI to benefit landscaping and/or improving storm water runoff water quality.

10.0 PROJECTED RESULTS OF SELECTED MEASURES

10.1 PLAN SUMMARY AND MONITORING

The water conservation measures and activities discussed in the above sections form the basis for the Lake Havasu City Conservation Plan. Measures in sections five and seven have been successfully implemented in Lake Havasu City, have proven effective, and will not only be continued, but many will be enhanced over the next five years. Additional conservation measures discussed in Section nine, were reviewed for applicability to the Lake Havasu City conservation program, and are included in the plan as appropriate. Section eight, Water Supply Stages and Water Shortage Response Plan, is untested yet should provide city leaders many options to mitigate water allocation shortfalls. This section summarizes the Lake Havasu City 2015-2020 Water Conservation Plan, and includes ongoing programs, revisions to ongoing programs, and additional measures that were determined to be feasible and practical for meeting the goals of the program.

Elements of the plan, status, proposed revisions, monitoring techniques, and goals established for the 2020-2025 conservation period are as follows:

1. Water Measurement and Accounting System

Lake Havasu City has two ways to account for water use, diversion meters and billed consumption through user end meters. Ideally, the difference between the diversion volume and the billed consumed should equal the unaccounted water loss in the distribution system. Typical values for annual unaccounted losses range from ~7% to ~10%.

2. Water Pricing Structure

The structure of water pricing was modified by the ordinance passed in 1990 to institute an increasing rate structure. All customers are billed according to the increasing rate structure. This conservation measure was very successful in reducing the unit consumption rate. Additional rate structure changes were implemented for July 2000, July 2001, October 2002, July 2003, and July 2004. This increasing rate structure has been successful in reducing water usage, yet the frequency of rate increases has slowed with the most recent rate increase in August 2009. This last rate increase only affected tiers 2 through 4. Tier one rates actually decreased with an accompanying drop in the water volume from 1500 cu. ft. to 1300 cu. ft. to reward customers when they conserve. This last rate hike was established primarily to support 10-year community improvement projects for water distribution upgrades. The City is also now in the process of having another water rate study conducted near the end of 2019 or beginning of 2020. The City's Water Resources Coordinator and Water Conservation Specialist will be heavily involved with the study to ensure that new rate suggestions will continue to promote water conservation.

3. Public Education and Outreach Program

As stated, an information/education program is vital to the success of any water conservation program. Many of the informational techniques recommended are in place and continuation of these programs is an integral component of this Water Conservation Plan.

This program will be continued and expanded, the focus of efforts will be aligned to accomplish the overall goals of the Water Conservation Plan:

- Continue to recruit and utilize a volunteer water conservation citizen group to help with presentations and workshops, maintain the City's water conservation website (www.havasuwatersavers.org), plant database (www.lhcaz.gov/plants) and other related work.
- Post articles in the local print media, website and social media promoting various forms of water conservation.
- Expand presentations about water conservation to K-12 students in our entire public school system.
- Promote city-wide water conservation awareness through contests and other community involvement.
- Continue to expand the City's water conservation website by showcasing current events and giving tips for water saving measures, explain winter consumption averaging, etc.
- Continue and expand presence at local events such as the Home Show, Winterfest, etc.

The effectiveness of each component of the public education and outreach program will be qualitatively assessed, followed up with an annual assessment of water consumption by category compared to previous annual amounts. In addition, this program will be evaluated based on achieving specific program element goals, for example, successful dissemination of information.

4. Water Conservation Implementation

The City's Water Conservation Specialist and Water Resources Coordinator are responsible for planning, coordinating, and implementing various conservation plan elements and monitoring results.

5. Free Water Audit Program

Lake Havasu City currently conducts a customer audit program (residential and non-residential) to assist in determining normal water usage and identifying potential water waste issues.

Audits may originate in one of the following ways; the City's customer service may alert the WCS to an account's unusually high water consumption, the WCS may observe an irrigation leak and contact the customer, or most frequently, the customer receives a high water bill and contacts the WCS to schedule an audit. The WCS suggests what corrective action the customer needs to do in order to alleviate the high usage. Monitoring of this program consists of tracking audit requests and monitoring post audit water consumption.

6. Water Regulations

City ordinances to mandate low water use landscape materials for new developments in zoning classification R3 (multi-family) and above and to mandate low flow plumbing fixtures in new construction have been in effect for over 25 years. They have been very effective and no anticipated revisions are expected. The 2010 no waste of water ordinance will be helpful during water shortages, yet this regulation may be modified to suit the intended purpose. Effectiveness of this regulation will be monitored through tracking the monthly diversions and comparing those with previous year monthly totals.

7. Distribution System Audit Program

Distribution system audits are conducted on an on-going basis by the City's Water Division to find leaks and inefficiencies in the system. The overall goal is to maintain "Billing Date Difference and Unaccounted Losses" below 10 percent. The City's Fire Department also regularly inspects fire hydrants and standpipes to ensure proper operation and integrity.

8. Water Shortage Response Plan

An official water shortage response plan, defined in Section 8 and approved by the City Council in 2010, provides a flexible means to mitigate a variety of shortage scenarios. The plan promotes early voluntary water conservation through public education followed by more restrictive measures during harsh conditions. The goals of this program are to make sure the City uses the most effective strategy to get through shortage periods. Daily water diversion volumes will be monitored and evaluated for success.

9. Wastewater Reclamation and Recycling Program

This has been an element of the existing Lake Havasu City conservation program for some time. It is an important conservation measure that is a major component of the City's management plans, which identify both short-term and long-term goals.

The short-term (2020-2025) conservation goal is to increase usage of treated wastewater and reduce the volume of water disposed in the Island percolation ponds. This requires storing through subsurface injection, increasing effluent volumes during the winter and pumping that water out of the ground to supply more customers during the summer. Metering of effluent use (reuse, storage and percolation) is in place. Monitoring of the increased usage will be performed using existing monthly reports of effluent reuse, combined with metered percolation volumes.

Lake Havasu City is working to expand effluent reuse operations at specific parks where reclaimed water infrastructure has already been installed.

10.2 PROJECTED RESULTS

The billed per capita consumption average for 2018 was 189.3 gpcd, but the diversion per capita was 201.4 gpcd. These numbers span the 2010-2015 water conservation plan goal of reaching 200 GPCD, but they still show a discrepancy mentioned in that document. The main goal of the City's current water audit study is to find the causes of this difference so that the City can correct the situation and try to bridge the gap between consumption and diversion volumes.

The City's Water Conservation Specialist has many new ideas to not only promote water conservation for residential and commercial customers, but to reduce potable irrigation water beyond replacing that water with effluent. Gray water incentives, rainwater harvesting, green infrastructure and xeriscaping projects mentioned in this plan will result in direct water use reductions, though the estimated combined savings from these potential projects is not easily quantifiable. Most of the programs and projects will result in modest water savings (probably tenths of acre-feet/year), but there are a few such as successful turf removal of targets sites at the London Bridge Golf course that could measure savings up to hundreds of acre-feet in effluent used at that site and eliminate the need to use the South Intake lake diversion (see below). Effluent saved at this site would help its availability to other year-round irrigation sites that now use potable water. The scope and parameters of each project will have to be detailed out and include the estimated resulting water savings. Combined estimated savings, excluding the London Bridge Golf Course turf removal project, could reach ~2-5 GPCD for all other projects.

The City's effort in conducting an annual to semi-annual water audit should help in identifying and correcting unaccounted water losses. This and ongoing leak detection surveys and various water system upgrades will help maintain efficient water operation. Previous leak detection surveys have resulted in many tens of acre-feet water savings. Possible source water treatment improvements could result in the elimination of residential and commercial water softeners and reverse osmosis that waste quite a lot of water, especially in the home. Total elimination of these systems could result up to several hundred acre-feet per year savings (~4-5 GPCD). Unfortunately, after performing a feasibility study on source water improvement options that would soften the water and further remove dissolved solids, it was found that implementation, maintenance, and disposal of waste at the City's water treatment plant would be prohibitively expensive, and therefore, unfeasible at this point in time.

A city-wide effort to drain swimming pool water into the sewer for treatment and reuse could add 50 to 100 ac-ft of effluent to that water budget. Very little today is drained into the sewer and lost to evaporation down city streets.

Conversion of potable water for larger scale irrigation to effluent is actively being designed for a first phase of locations (Table 5-1). These landscape sites (parks and other landscaping) will be converted in the next 2-3 years resulting in an estimated direct diversion reduction of 243 ac-ft/year or 4 GPCD.

If the South Intake surface water diversion point is eliminated, then potentially up to 600 ac-ft/yr (10 GPCD) would be saved. If the effort to incentivize the two private water well irrigators to convert to effluent use, then another 440 ac-ft (7.5 GPCD) or so savings will be realized.

Residential irrigation is still the single largest category of water consumption, but it is also one of the most difficult to directly address. Outreach in various forms, including reinstating the Fix a Leak Week Proclamation and bringing the Lake Havasu City Recommended Landscaping Plant List online, will continue to help citizens be more efficient with their watering habits. The citizen water conservation volunteer group will help with public education on this topic particularly from the perspective of irrigation scheduling and its relation to winter consumption averaging and residential monthly sewer fees, to adjustments for weather conditions (short-term events and seasonal variations), and to landscape styles (e.g. xeriscaping, native plantings, etc.).

Total residential consumption has remained relatively steady at 66-68% of total consumption from 2015 to 2018 as the City recovers from the recession in terms of accelerating new house construction and as population increases.

The estimated savings presented herein could total up to more than 20 GPCD, representing a reduction of current (2018) consumption levels to ~170 GPCD (~189 GPCD diversion).

11.0 ENVIRONMENTAL REVIEW

As part of the application process to obtain the additional Colorado River water allotment of 4,349 ac-ft/yr, Lake Havasu City was required to submit an Environmental Assessment for its service area. The Environmental Assessment was prepared pursuant to the requirements of the National Environmental Policy Act (NEPA), and focused primarily on the 28 square mile area outside the boundaries of the Lake Havasu Irrigation and Drainage District (IDD) (i.e., the expanded service area). The area within the IDD was already committed to urban development as part of the original water allocation contract. The final Environmental Assessment, prepared by Willdan Associates, was completed in June 1992.

The water conservation plan outlined in this document focuses on the current expanded water service area, which was established in 1995 and covered by the 1992 Environmental Assessment report. Water savings generated by the elements of this plan are not intended to provide for further expansion of the service area, or to alter the proposed land uses identified in City planning documents by allowing more intense development. Rather, water savings projected from the elements of this plan will be used to reduce the amount of additional water allocations to be obtained by Lake Havasu City to meet projected demands within the service area. Consequently, because no new impacts relative to service area or land use have been generated by this water conservation plan, no environmental impacts beyond those identified in the 1992 Environmental Assessment are anticipated.

Should the City implement conservation practices, either during the 2020-2025 conservation period or in the future that require environmental compliance, possible environmental reviews may be required.

12.0 IMPLEMENTATION SCHEDULE AND BUDGET

The implementation schedule for the conservation program components discussed in this conservation plan is summarized in Table 12-1. All plan elements are scheduled for implementation during the 2020 - 2025 conservation period.

TABLE 12-1: IMPLEMENTATION SCHEDULE FOR CONSERVATION PLAN

GOAL	TIMEFRAME	BUDGET
Water audit on measurement and accounting system	2020 - 2025	$50,000 per audit
Water conservation awareness campaign.	2020 - 2025	$8,000/year
Water Resources Coordinator	Hired in 2005	Salaried
Water Conservation Specialist	Hired in 2001	Salaried
Distribution system leak detection program	2020 - 2025	$100,000 per survey (entire distribution system)
Effluent recharge and recovery program	2020 - 2025	$2,000,000 in 5-year CIP Plan
Continue and expand K-12 water conservation education program.	2020 - 2025	$6,000/year
Continue Arizona WET Festival	2020 - 2025	$7,000/year – In current FY15-16 Operations budget
Continued support for citizen volunteer water conservation group.	2020 -2025	No Direct Costs
Slow the Flow program targeting the hospitality industry, HOAs, and landscape irrigation	2020 - 2025	Up to $1,000,000 - To be added to future FY Operations budgets, beginning in FY 20-21.
Add effluent irrigation to Rotary Park and other entities.	2020 - 2025	$2,000,000 for all initial targeted locations
Green infrastructure, rain water harvesting and xeriscape demonstration site(s)	2020 - 2025	$500,000 – to be added to future FY Operations budgets
Installation of pipeline to recover stored effluent from recovery well in the NRWWTP field	2020 -2025	$100,000 – to be added in future FY Operations budget.
Develop swimming pool water discharge program	2020 - 2025	$20,000 – to be added in future FY Operations budgets
Develop Commercial/Industrial Water Conservation Planning Document and Individual Custom Water Conservation Plans	2020 - 2025	$10,000 – to be added to future FY Operations budgets
Continue to upgrade water service meters capable of radio transmitter adaption.	2020 - 2025	Built into the annual FY Operations budget
Consider gray water systems for developers	2020 - 2025	No direct cost, however, the City may look into providing incentives