APPENDIX J: OPTIONS CHARACTERIZATION SHEETS

Austin WATER | WATER FORWARD INTEGRATED WATER RESOURCE PLAN

Options Characterization Sheets Index

Acronym Glossary

Sectors

SFR	Single-family residential customer class
MFR	Multi-family residential customer class
COM	Commercial customer class
WS	Wholesale customer class
LV	Large-volume customer class
COA	City of Austin customer class

Residential End-Use Fields

SB	Showers/Baths
TL	Toilets
CW	Clothes washers
DW	Dishwashers
FB	Faucets/Basins
LK	Leaks
IRR	Irrigation/Landscaping

Commercial End-Use Fields

MEQ	Medical Equipment
POL	Pools
LND	Laundry
KCH	Kitchen/Dishwashing
HVC	Cooling and Heating
DOM	Domestic/Restroom
MISC	Miscellaneous/Other
IRR	Irrigation/Landscaping

Austin WATER | WATER FORWARD INTEGRATED WATER RESOURCE PLAN

Demand Management Option Name:

Advanced Metering Infrastructure

DRAFT RESULTS 8-1-2017

Short Description:

Customer-facing real time water information and metering through AMI

Details:

Implement customer facing programs that provide real-time water use information, including commercial customer benchmarking. Savings are achieved through identification of customer-side leaks, behavior modification, and other water-saving opportunities. Implemented through Advanced Metering Infrastructure (AMI). Assumes meter deployment by 2022 (dependent upon Council approval). Current pilot studies underway studying savings from residential customer engagement via mobile and web-based application. Texas Water Development Board State Water Implementation Fund for Texas (SWIFT) application for funding meters, meter boxes, and accompanying data transmission infrastructure has been submitted and contractors are being sought for AMI design and implementation. Note that information provided herein is for planning purposes only and will likely vary from actual AMI implementation, depending on the package selected and decisions made by the Utility. While the measure analysis focuses on reduction in water loss through identification of customer side leaks, implementation of AMI may lead to additional reductions in apparent losses. There are four pillars of apparent water loss control: (1) improving customer meter accuracy, (2) reducing unauthorized consumption, (3) reducing data transfer/archive errors, and (4) reducing data billing errors. This option represents savings from reductions in apparent losses and has potential synergies with strategies like Utility Side Water Loss Control which targets real losses. Real losses are almost entirely comprised of leaks in the distribution system whereas apparent losses are almost entirely comprised of meter inaccuracies.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

Sectors: SFR, MFR, COM
End Uses: All, leaks assumed to mirror City-wide usage patterns in indoor/outdoor split
Both new and existing developments

Timing of Implementation:

Fully metered by 2022, dependent upon Council approval.

Lifespan (years):

20 years

WATER SAVINGS ANALYSIS

Assumptions:

Implementation of an AMI program is assumed to entail high-resolution usage reporting for all participants as well as customer-side leak identification and notification. To this end, AMI is expected to produce savings primarily from reducing the occurrence of large customer-side leak events (100 - 550 Gallons per day, per 2015 REUWS2 study). Previous studies have shown a reduction of large customer-side leak volumes of approximately 50% from this type of implementation (Naphade, 2011). Therefore, we assume a total 15% reduction in total estimated leak volume for this analysis. Note that by 2020, it is assumed that AMI implementation will have reached 20% of all customers. Therefore, savings in 2020 represent 20% of the total estimated savings potential produced by this option.

Average Weather Water Savings Summary (in AF per year):

Savings estimates are subject to change dependent on implementation approach and portfolio context.

YEAR	SFR	MFR	COM	COA	NRW	TOTAL
2020	210	170	200	10	0	590
2040	1,280	1,120	1,370	110	0	3,880
2070	1,820	1,710	2,080	150	0	5,760
2115	2,670	3,170	3,310	230	0	9,380

Average Weather Cumulative Total Water Savings (in AF over 100 year planning period):

TOTAL	163,630	166,910	190,630	14,000	0	535,170

Average Weather Annual Average Water Savings (in AF per year):

TOTAL	720	620	760	60	0	2,160

AVOIDED COST ANALYSIS[1]

Assumptions:

The avoided cost analysis includes reduced marginal water treatment and wastewater treatment costs (for the indoor portion of the savings). With AMI, there are potential cost savings experienced by the Utility, such as from improvements in customer billing (increased revenues), reduction in meter reading, reduced phone call answering times, and reduced paper mailings. These reductions are somewhat unknown and dependent upon the actual AMI system and implementation level selected by the Utility. Some of the cost reductions, such as reduced staff hours, would likely be absorbed into other Utility activities. Therefore, cost savings beyond the avoided water and wastewater treatment costs are not estimated in the IWRP cost calculation.

Avoided Cost Summary (current dollars):

	TOTAL Costs Avoided	Water Treatment Cost Avoided	Wastewater Treatment Cost Avoided
2020	$102,400	$90,600	$11,800
2040	$664,900	$580,800	$84,100
2070	$995,800	$862,600	$133,200
2115	$1,629,200	$1,401,900	$227,300

Cumulative Total (in $ over 100 year planning period):

TOTAL	$92,514,600	$80,063,300	$12,451,300

Avoided Cost Input Assumptions (current dollars):

Water Treatment Cost ($/KGAL)*	$0.46
Wastewater Treatment Cost ($/KGAL)**	$0.26
Indoor Percent of Measure Savings	72%

*Per the AW Water Loss Report to TWDB, Line 44, CY 2016

**Assumed all chemical costs and 90% of electrical costs at treatment plants and all chemical and electrical costs at lift stations

[1]This information is provided for Utility planning purposes only. The avoided costs/comparison method for portfolio analysis is more comprehensive.

COST ANALYSIS

Assumptions:

The initial costs are assumed at $80.2 million for an engineering study, meters, infrastructure, and construction (per the current SWIFT application). Annual data hosting fees, application development, and communication costs are estimated at $326,000 per year, however these costs are high level planning estimates as the AMI selected design and implementation is to be determined. One additional full-time equivalent (FTE) employee is assumed for business intelligence management activities. After initial deployment, annual operations and maintenance (O&M) costs include meter replacements at a placeholder amount of $1 million per year over current replacement costs. The useful life of this investment is assumed at 20 years, as a capital reinvestment is likely at that point, with debt terms assumed for 20 years.

Capital Cost Summary (current dollars):

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost	$68,160,000	$11,914,700	$120,400	$0	$12,839,600	$93,034,700
Customer Cost						
Community Cost**	$68,160,000	$11,914,700	$120,400	$0	$12,839,600	$93,034,700

Annual Cost Summary (current dollars):

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost	$4,651,735	$ 1,400,800	$0	$0	$0	$0
Customer Cost						
Community Cost**	$4,651,735	$1,400,800	$0	$0	$0	$0

Unit Cost Summary (current dollars):

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	$ 6,052,500	$2,800
Customer Cost		
Community Cost**	$ 6,052,500	$2,800

*Annual Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

High	Comment: Majority of savings are indoor and not susceptible to climate change. Outdoor leak volumes are more susceptible to variations in temperature and precipitation.

Comments:

Literature Review/Case Studies:

2015 REUWS2 study found that leakage events makes up approximately 12.4% of total indoor water usage. Of this amount, approximately 30% are attributed to "large leaks" ranging from 100 - 550 gallons per day. Therefore, large leaks make up approximately 4% of total SFR indoor demand.
City of Dubuque (IA) estimated a 44% reduction in baseline for leaks alone from pilot study participants with access to AMI Portal and usage statistics, though no information was provided as to the volumetric composition of this reduction (i.e., large or small leak events) nor to the number of households contributing to this reduction. Therefore, reductions were assumed to apply to "large leak" events as these are typically most identifiable.

References:

City of Las Virgenes. 2012. "Cost-Benefit Analysis for the AMR/AMI Installation Project." http://www.lvmwd.com/home/showdocument?id=1712
City of Corona (CA). 2012. Advanced Metering Infrastructure Program. Water SMART: Water and Energy Efficiency Grants for Fiscal Year 2012. https://www.usbr.gov/watersmart/weeg/docs/2012apps/1038.pdf
Hawkins, Chelsea and Allen Berthold. 2015. "Considerations for Adopting AMI and AMR." http://www.allianceforwaterefficiency.org/WorkArea/DownloadAsset.aspx?id=9674
DeOreo, W. 2014. "Some Key Findings of the 2014 REUWS Update Study". Sustainable Water Management Conference. Denver, CO.
City of Dubuque, IA & IBM. 2011. "Smart Water Pilot Study Report". http://www.cityofdubuque.org/DocumentCenter/Home/View/3116
Water Research Foundation. 2011. "Advanced Metering Infrastructure: Best Practices For Water Utilities." http://www.waterrf.org/Pages/Projects.aspx?PID=4000

Demand Management Option Name:

Water Loss Control Utility Side

DRAFT RESULTS 8-1-2017

Short Description:

Enhance current utility-side water loss control programs

Details:

There are approximately 3,837 miles of water pipeline citywide. From FY2013 – 2015, Austin lost an average of 4.88 billion gallons of water a year from leaks in the city water distribution system. This equates to an ILI (Infrastructure Leakage Index) of 3.26. In 2011, Austin Water launched the "Renewing Austin Program (RAP)" focusing on replacing and upgrading aging water distribution infrastructure to ensure the reliability and quality of Austin's Water supply. Austin Water has replaced and relocated a total of about 62 miles of water mains under the RAP at the end of 2016. Austin Water's current plan is to continue the Renewing Austin Program to replace aged water mains at about 10 miles per year with spending at about $15 million annually. The target ILI for Austin is sustaining an ILI at or below 2.7. This measure represents an aggressive leak detection, correction, and prevention program to reduce the ILI to 2.7 by 2020 and further reduce and sustain a 2.0 ILI from 2040 to 2115. The measure analysis focuses on four pillars of real water loss control: (1) active leak detection, (2) response to leaks, (3) pressure management, and (4) pipeline and asset management selection, installation, maintenance, renewal, and replacement. This option represents savings from reductions in real losses and has potential synergies with strategies like Advanced Metering Infrastructure (AMI) which may also target apparent losses. Real losses are almost entirely comprised of leaks in the distribution system whereas apparent losses are almost entirely comprised of meter inaccuracies.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

Sectors: System-wide
End Uses: Water losses (NRW)
Both new and existing developments

Timing of Implementation:

While utility-side water loss reduction strategies have been in place for many years, implementation of this strategy is assumed to begin in 2015 and continue through 2115 for analysis purposes.

Lifespan (years):

30 years

WATER SAVINGS ANALYSIS

Assumptions:

ILI of 2.7 by 2020 reducing to 2.0 by 2040 and maintaining the 2.0 to 2115. No assumptions are made for reduction of losses between the diversions and treatment plant. Yield is calculated as a function of baseline demands.

Average Weather Water Savings Summary (in AF per year):

Savings estimates are subject to change dependent on implementation approach and portfolio context.

YEAR	SFR	MFR	COM	COA	NRW	TOTAL
2020	0	0	0	0	3,110	3,110
2040	0	0	0	0	9,330	9,330
2070	0	0	0	0	10,920	10,920
2115	0	0	0	0	13,060	13,060

Average Weather Water Savings - Cumulative Total (in AF over 100 year planning horizon):

TOTAL	0	0	0	0	975,680	975,680

Average Weather Annual Average Water Savings (in AF per year):

TOTAL	0	0	0	0	10,160	10,160

AVOIDED COST ANALYSIS[1]

Assumptions:

Avoided Cost Summary (current dollars):

	TOTAL Costs Avoided	Water Treatment Cost Avoided	Wastewater Treatment Cost Avoided
2020	$464,900	$464,900	$0
2040	$1,395,200	$1,395,200	$0
2070	$1,633,300	$1,633,300	$0
2115	$1,954,400	$1,954,400	$0

Cumulative Total (in $ over 100 year planning horizon):

TOTAL	$145,963,619	$145,963,619	$0

Avoided Cost Input Assumptions (current dollars):

Water Treatment Cost ($/KGAL)*	$0.46
Wastewater Treatment Cost ($/KGAL)**	$0.26
Indoor Percent of Measure Savings	0%

*Per the AW Water Loss Report to TWDB, Line 44, CY 2016

**Assumed all chemical costs and 90% of electrical costs at treatment plants and all chemical and electrical costs at lift stations

[1]This information is provided for Utility planning purposes only. The avoided costs/comparison method for portfolio analysis is more comprehensive.

COST ANALYSIS

Assumptions:

Assumes $93 million for assets management capital improvements per five year cycle over 30 year lifespan.
Assumes $1.75 million per year for active leak detection O&M over 30 year lifespan.
Costs for a pressure management study are included at $250,000.

Capital Cost Summary (current dollars):

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost	$446,400,000	$106,270,000	$ 5,580,000		$514,466,000	$1,072,716,000
Customer Cost						
Community Cost **	$ 446,400,000	$ 106,270,000	$ 5,580,000	$ -	$ 514,466,000	$ 1,072,716,000

Annual Cost Summary (current dollars):

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost	$ 35,748,900	$ 1,750,000	$ -	$ -	$ -	$ -
Customer Cost						
Community Cost **	$ 35,748,900	$ 1,750,000	$ -	$ -	$ -	$ -

Unit Cost Summary (current dollars):

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	$ 37,498,900	$ 3,690
Customer Cost		
Community Cost **	$ 37,498,900	$ 3,690

*Annual Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

High	Comment: Water loss control measures generally are not susceptible to climate change. However, climate extremes may exacerbate expansion and contraction of soils, leading to more frequent main breaks and requiring greater investment to achieve savings goals.

Comments:

Austin Water's Renewing Austin Program (RAP) is part of a sustained, long-term approach to ensuring the reliability of Austin's water distribution system. This program has multiple benefits of the Austin community. In addition to contributing to water loss control, the RAP upgrades aged system water lines as part of Austin Water's asset management efforts and efforts to ensure on-going system reliability.

Literature Review/Case Studies:

References:

Pressure Management: Industry Practices and Monitoring Procedures, Water Research Foundation 2014
http://cuwcc.org/Portals/0/Document%20Library/Resources/Publications/Potential%20BMP%20Reports/2010%20PBMP%20Report-%20Distribution%20System%20Pressure%20Management.pdf

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Demand Management Option Name:

CII Ordinances for Cooling Towers and Steam Boilers

DRAFT RESULTS 8-1-2017

Short Description:

Require older cooling towers and steam boilers to meet efficiency standards

Details:

Require older cooling towers to meet water efficiency benchmarks and use efficient equipment and require efficiency standards for steam boilers in new development. No assumptions made for boilers as it is thought to be a small incremental amount of savings. This would change city code to require: 1) all cooling towers to meet same efficiency equipment standards currently only required for new and replacement towers since 2008 (makeup and blowdown submeters, conductivity controller, drift eliminator and overflow alarm) and achieve 5 cycles of concentration (added to code December 2010); and 2) all steam boilers to have conductivity controllers, makeup meters, steam condensate return systems and blowdown heat exchangers for steam boilers. These code changes were approved by Council action in June 2017.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

Sectors: MFR, COM, and COA
End Uses: HVAC
Existing development

Timing of Implementation:

100% compliance by 2040

Lifespan (years):

Through 2115

WATER SAVINGS ANALYSIS

Assumptions:

Assumed 400 cooling towers that currently have 3 cycles of concentration will have 5 cycles of concentration when in compliance. The average tonnage is assumed at 375 which translates to 6750 gallons per day for blowdown under current conditions. Under future conditions, blowdown is estimated to reduce to 3375 gallons per day. Water savings are assumed for 9 months of operation. The following table shows the demand reductions associated with the cooling tower retrofits throughout the entire planning horizon.

Average Weather Water Savings Summary (in AF per year):

Savings estimates are subject to change dependent on implementation approach and portfolio context.

YEAR	SFR	MFR	COM	COA	NRW	TOTAL
2020	0	40	950	70	0	1,060
2040	0	40	950	70	0	1,060
2070	0	40	950	70	0	1,060
2115	0	40	950	70	0	1,060

Average Weather Cumulative Total Water Savings (in AF over 100 year planning period):

TOTAL	0	3,540	91,460	7,080	0	102,080

Average Weather Annual Average Water Savings (in AF per year):

TOTAL	0	40	950	70	0	1,060

AVOIDED COST ANALYSIS[1]

Assumptions:

Includes reduced marginal water treatment and wastewater treatment costs (for indoor portion of savings). The following table shows avoided costs associated with the 400 cooling tower retrofits throughout the entire planning horizon.

Avoided Cost Summary (current dollars):

	TOTAL Costs Avoided	Water Treatment Cost Avoided	Wastewater Treatment Cost Avoided
2020	$248,100	$159,100	$89,000
2040	$248,100	$159,100	$89,000
2070	$248,100	$159,100	$89,000
2115	$248,100	$159,100	$89,000

Cumulative Total (in $ over 100 year planning period):

TOTAL	$23,818,330	$15,270,349	$8,547,981

Avoided Cost Input Assumptions (current dollars):

Water Treatment Cost ($/KGAL)*	$0.46
Wastewater Treatment Cost ($/KGAL)**	$0.26
Indoor Percent of Measure Savings	100%

*Per the AW Water Loss Report to TWDB, Line 44, CY 2016

**Assumed all chemical costs and 90% of electrical costs at treatment plants and all chemical and electrical costs at lift stations

[1]This information is provided for Utility planning purposes only. The avoided costs/comparison method for portfolio analysis is more comprehensive.

COST ANALYSIS

Assumptions:

The cost of retrofit for the 400 customers assumes $600 for submetering (NC DENR, 1998), $4,400 for controller and sensors (parts and installation) (CUWCC, 2016). O&M is assumed for code enforcement. One full-time equivalent (FTE) employee is assigned for initial inspections and administration of this program. There are no capital investments required by the Utility.

Capital Cost Summary (current dollars):

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost						$ -
Customer Cost	$ 4,000,000					$ 4,000,000
Community Cost*	$ 4,000,000	$ -	$ -	$ -	$ -	$ 4,000,000

Annual Cost Summary (current dollars):

	Annual Capital/Upfront /Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost		$ 75,000				
Customer Cost	$ 40,000					
Community Cost**	$ 40,000	$ 75,000	$ -	$ -	$ -	$ -

Unit Cost Summary (current dollars):

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	$ 75,000	$ 71
Customer Cost		
Community Cost**	$ 75,000	$ 71

*Annual Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

Medium	Comment: Increased temperature might diminish efficiency of the cooling process and could cause increases in seasonal use of cooling system

Comments:

Literature Review/Case Studies:

Data/information from Austin Water: 400 RZP permitted cooling towers in WIERS data base. Based on AW potable water quality, 3-5 cycles considered easily achievable for cooling towers without requirements. Increasing from 3 to 5 cycles would result in approx. 17% water savings. Average capacity for cooling towers estimated to be approx. 350-400 tons. Average lifetime for galvanized steel cooling tower is 20 years. Without these additional requirements for older towers, savings from 2008 and 2010 code changes would be realized by 2030. 2007 WCTF indicates a peak day savings of 0.95 MGD by the 10th year of implementation if 2008 and 2010 code changes would have applied to both new and existing towers.
Cooling tower sophistication can vary greatly and the cost is specific to the cooling tower. From the CUWCC 2016 - A basic conductivity controller with a single pump can cost $700. Conductivity controllers with two pump relays with more sophisticated software algorithms cost roughly $1,400. A sensor and pump relay to more finely administer a biocide and oxidizer raises the cost of the controller to approximately $2,400. A pH sensor and additional pump relay for administering acid would increase the price to $3,400.
Percent of make up water saved can be estimated from an equation (CUWCC, 2016). The NC DENR estimates make-up water saved by going from an initial concentration to a new concentration (1998).
Cooling towers offer substantive water savings potential, but have proved vexing for voluntary conservation efforts. In Denver, after spending money to improve efficiency via rebate programs, many towers reverted back to inefficient operations within a few years. Water efficiency in cooling towers requires careful management and attention. Lower water costs may sometimes discourage O&M spending for water efficiency.

References:

Innovations in Efficiency Showcase Cooling Tower Management Oct 2015 www.allianceforwaterefficiency.org/WorkArea/DownloadAsset.aspx?id=9416
The Dollar Side of Water Conservation in the CII Sector, presentation by Bill Hoffman, Water Management
North Carolina Water Efficiency Manual for CII Facilities (1998), NC DENR. (http://water.monroenc.org/wp-content/uploads/Water-efficency-for-industrial-commercial-and-institutional-customers.pdf)
BMP Cost and Savings Study Update (June 2016), California Urban Water Conservation Council.
Bill Hoffman, P.E. "The Energy - Water Nexus of Cooling Towers"

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INTEGRATED WATER RESOURCE PLAN

Demand Management Option Name:

Development-focused Water Use Benchmarking and Budgeting

DRAFT RESULTS 8-1-2017

Short Description:

Requirement of water use estimate submittal paired with enhanced outreach and education with transition to water budgeting

Details:

By 2020, as part of an education and outreach program, this option would require submittal of water use estimates for new development. City staff will provide potential water use efficiency and alternative water recommendations and information on available incentive and rebate programs. This information will tie into the development of databases to be used to develop benchmarks for efficient water usage for various development types. Implementation of the measure will look for ways to tie into the Service Extension Request (SER) and Austin Energy Green Building (AEGB) programs. By 2040, this option is expanded to include requirement of water use estimate submittals for new development concurrent with preliminary plan submittal to be reviewed by City staff and a requirement that new development meet a benchmark water budget usage that is lower than comparable existing buildings (compliance mechanism to be determined).

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

Sectors: SFR, MFR, COM, and COA
End Uses: All
New development

Timing of Implementation:

2020 - water use estimate submittal required; 2040 - buildings assumed to be required to meet a benchmark usage 10% lower than comparable existing buildings

Lifespan (years):

Through 2115

WATER SAVINGS ANALYSIS

Assumptions:

No savings are assumed for the water estimate submittal action; however this is a critical step to getting to the water budgeting measure which has more substantial savings potential. At the 2040 planning horizon, savings are assumed at 10% for the residential (SFR/MFR), COM, and City of Austin (COA) sectors for new development. An assumption of 10% savings is maintained for the 2070 and 2115 planning horizons. The underlying assumption is that Advanced Metering Infrastructure (AMI) messaging is fully implemented and utilized for the water budgeting action.

Average Weather Water Savings Summary (in AF per year):

Savings estimates are subject to change dependent on implementation approach and portfolio context.

YEAR	SFR	MFR	COM	COA	NRW	TOTAL
2020	0	0	0	0	0	0
2040	2,400	2,260	2,050	70	0	6,780
2070	4,370	4,430	4,310	340	0	13,450
2115	8,880	10,030	9,290	1,480	0	29,680

Average Weather Cumulative Total Water Savings (in AF over 100 year planning period):

TOTAL	405,200	431,990	407,220	47,710	0	1,292,120

Average Weather Annual Average Water Savings (in AF per year):

TOTAL	5,330	5,680	5,360	630	0	17,000

AVOIDED COST ANALYSIS[1]

Assumptions:

Includes reduced marginal water treatment and wastewater treatment costs (for indoor portion of savings).

Avoided Cost Summary (current dollars):

	TOTAL Costs Avoided	Water Treatment Cost Avoided	Wastewater Treatment Cost Avoided
2020	$0	$0	$0
2040	$1,411,300	$1,014,700	$396,600
2070	$2,804,900	$2,012,000	$792,900
2115	$6,209,100	$4,440,200	$1,768,900

Cumulative Total (in $ over 100 year planning period):

TOTAL	$269,870,500	$193,303,600	$76,566,900

Avoided Cost Input Assumptions (current dollars):

Water Treatment Cost ($/KGAL)*	$0.46
Wastewater Treatment Cost ($/KGAL)**	$0.26
Indoor Percent of Measure Savings	71%

*Per the AW Water Loss Report to TWDB, Line 44, CY 2016

**Assumed all chemical costs and 90% of electrical costs at treatment plants and all chemical and electrical costs at lift stations

[1]This information is provided for Utility planning purposes only. The avoided costs/comparison method for portfolio analysis is more comprehensive.

COST ANALYSIS

Assumptions:

Two full-time equivalent (FTEs) employees are assumed for program administration in 2040. An annual budget of $200,000 is assumed for the education and outreach component of this option.

Capital Cost Summary (current dollars):

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost						$ -
Customer Cost						$ -
Community Cost*	$ -	$ -	$ -	$ -	$ -	$ -

Annual Cost Summary (current dollars):

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost		$ 350,000				
Customer Cost	$ -					
Community Cost**	$ -	$ 350,000	$ -	$ -	$ -	$ -

Unit Cost Summary (current dollars):

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	$ 350,000	$ 21
Customer Cost		
Community Cost**	$ 350,000	$ 21

*Annual Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

High	Comment: Not susceptible to future hydrologic variability

Comments:

Literature Review/Case Studies:

References:

WaterDM 2008 summary report can be downloaded from http://www.waterdm.com/sites/default/files/JAWWA%20(2010)%20Water%20Budgets%20and%20Rate%20Structures%20-%20Innovative%20Management%20Tools.pdf
Irvine Ranch Water District began program in 1991 http://irwd.com/images/pdf/doing-business/environmental-documents/UWMP/IRWD_UWMP_2015_rev_01-03-17_FINAL.pdf
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Bohlig, C. and R. Harris. 2014. EBMUD Informational Water Budget Program – Honey I Shrunk the Water Budget. Water Smart Innovations 2014. Las Vegas, Nevada. ttps://www.watersmartinnovations.com/documents/sessions/2014/2014-T-1402.pdf
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Austin WATER | WATER FORWARD
INTEGRATED WATER RESOURCE PLAN

Demand Management Option Name:

Landscape Transformation Ordinance

DRAFT RESULTS 8-1-2017

Short Description:

Require regionally appropriate landscapes

Details:

Implement ordinances to encourage water use efficiencies and reduce water needs for outdoor irrigation and other goals through regionally appropriate landscapes with an emphasis on landscape functionality (Implementation of this option could include implementing turf grass area, irrigated area, and/or irrigation area limitations).
Note that current Landscape Ordinance has existing requirements for landscaped areas, plant selection, and irrigation systems for Commercial and Multifamily properties. As there is no current plan review process for single family residential, the existing Landscape Ordinance does not currently apply to this sector.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

Sectors: SFR, MFR, COM
End Uses: Outdoor Irrigation
New development

Timing of Implementation:

2025

Lifespan (years):

Through 2115

WATER SAVINGS ANALYSIS

Assumptions:

Savings Forecast:
Ordinance would only apply to new construction parcels. Average Single Family (SF) transformed landscape area assumed as product of average SF parcel size (6300 sq. ft.), average SF pervious area (70% per COA Watershed Protection Department), maximum recommended turf grass area (50% per Austin Homebuilders' Association Sensible Landscape Guidance Document) and average proportion of yard scape that is turf grass (1500 sq. ft. of turf per 1900 sq. ft. of total yard area per AW Conservation staff). This results in an average converted area of ~1800 sq. ft. per SF parcel.

Significant outdoor water savings have been achieved to date through the combined effect of the existing landscape ordinance for COM/MF development, in effect since 1982 and most recently revised in 2010, recent market trends that have shifted toward native and adaptive plant palettes, and City water codes including the Water Conservation Code. A new Landscape Transformation Ordinance is assumed to entail further requirements to reduce irrigation water use by 10% as compared to similar existing development. This reduction could be achieved through a variety of mechanisms, including reduction of irrigated area, installation of drought tolerant plants, and reductions of turf area. The total number of parcels were estimated and projected into the future by assuming a constant ratio of 9 multi-family (MF) units per parcel and 56 commercial (COM) employees per parcel, from historical data.

Note: The above assumptions were developed for the high-level strategic integrated water resource plan (IWRP) development process. Should this option be incorporated into IWRP plan recommendations, actual new ordinance details would need to be developed through subsequent implementation processes with future additional stakeholder and public input opportunities.

Average Weather Water Savings Summary (in AF per year):

Savings estimates are subject to change dependent on implementation approach and portfolio context.

YEAR	SFR	MFR	COM	COA	NRW	TOTAL
2020	0	0	0	0	0	0
2040	2,490	280	460	0	0	3,230
2070	6,440	770	810	0	0	8,020
2115	13,510	1,320	1,750	0	0	16,580

Average Weather Water Savings - Cumulative Total (in AF over 100 year planning period):

TOTAL	614,280	66,350	82,120	0	0	762,750

Average Weather Annual Average Water Savings (in AF per year):

TOTAL	6,750	730	900	0	0	8,380

AVOIDED COST ANALYSIS[1]

Assumptions:

Includes reduced marginal water treatment costs.

Avoided Cost Summary (current dollars):

	TOTAL Costs Avoided	Water Treatment Cost Avoided	Wastewater Treatment Cost Avoided
2020	$0	$0	$0
2040	$483,400	$483,400	$0
2070	$1,200,000	$1,200,000	$0
2115	$2,479,300	$2,479,300	$0

Cumulative Total (in $ over 100 year planning period):

TOTAL	$114,109,100	$114,109,100	$0

Avoided Cost Input Assumptions (current dollars):

Water Treatment Cost ($/KGAL)*	$0.46
Wastewater Treatment Cost ($/KGAL)**	$0.26
Indoor Percent of Measure Savings	0%

*Per the AW Water Loss Report to TWDB, Line 44, CY 2016

**Assumed all chemical costs and 90% of electrical costs at treatment plants and all chemical and electrical costs at lift stations

[1]This information is provided for Utility planning purposes only. The avoided costs/comparison method for portfolio analysis is more comprehensive.

COST ANALYSIS

Assumptions:

Two full-time equivalent (FTEs) employees and two vehicles assumed for additional single family plan residential review process.

Capital Cost Summary (current dollars):

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost						
Customer Cost						
Community Cost*	$ -	$ -	$ -	$ -	$ -	$ -

Annual Cost Summary (current dollars):

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost		$ 190,000				
Customer Cost						
Community Cost**	$ -	$ 190,000	$ -	$ -	$ -	$ -

Unit Cost Summary (current dollars):

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	$ 190,000	$ 23
Customer Cost		
Community Cost**	$ 190,000	$ 23

*Annual Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

Medium	Comment: Outdoor water use may increase regardless of plant type or amount of turf in especially dry conditions.

Comments:

Literature Review/Case Studies:

USEPA. " WaterSense New Home Specification". 2014. https://19january2017snapshot.epa.gov/www3/watersense/docs/home_finalspec508.pdf
USEPA. "WaterSense Water Budget Tool". 2014. https://www.epa.gov/watersense/water-budget-tool

References:

Austin Homebuilders Association - Sensible Landscaping for Central Texas (https://www.hbaaustin.com/wp-content/uploads/2016/05/HBA_Sensible_Landscaping_Bro.pdf)
City of Austin WaterWise Landscape Rebate http://www.austintexas.gov/sites/default/files/files/Water/Conservation/Rebates_and_Programs/WaterWise_Landscape_Residential_Rebate_Application.pdf
City of Austin Land Development Code § 25-2 (Landscaping Ordinance)
City of Austin Code of Ordinances § 6-4 (Water Conservation Code)

Austin WATER | WATER FORWARD INTEGRATED WATER RESOURCE PLAN

Demand Management Option Name:

Landscape Transformation Incentives

DRAFT RESULTS 8-1-2017

Short Description:

Landscape incentives to encourage water use efficiency and reduce outdoor water use

Details:

Implement incentives to encourage water use efficiencies and reduce water needs for outdoor irrigation and other goals through regionally appropriate landscapes with an emphasis on landscape functionality (implementation of this option could include increasing WaterWise landscape rebates for SFR and MFR and implementing a new WaterWise landscape rebate for COM beyond City of Austin Land Development Code requirements). The current WaterWise landscape rebate offers $35 for every 100 sq ft ($0.35/sq ft) converted with a minimum of 500 sq ft but has a very low participation rate. The maximum rebate is $1,750 per property.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

Sectors: SFR, MFR, COM
End Uses: Outdoor Irrigation
Existing development

Timing of Implementation:

2020

Lifespan (years):

10 years

WATER SAVINGS ANALYSIS

Assumptions:

Savings Forecast:
Incentive would only apply to existing customers who have satisfied rebate requirements similar to those in effect now. Assuming average conversion of 900 sq. ft. per single family residential (SFR) participant and assuming 5 Gallons reduction of demand per sq. ft. converted, from previous AW Landscape Transformation Rebate data.

Currently existing MFR/COM participants are assumed to convert 30% of their improved landscape on average (improved landscape assumed to be 50% of total pervious cover on parcel) from turf to water-saving vegetation. Future COM/MF parcels are assumed to develop in accordance with the existing Landscape Ordinance, which requires plant selection from the City of Austin Preferred Plant List for landscaped areas. This requirement does not apply to SFR parcels.

The same savings per square foot of converted area are assumed as for the SFR sector.

Program Participation:
Participation rates for all three sectors assumed to reach 10% by 2040, 20% by 2070 and 30% by 2115.

Average Weather Water Savings Summary (in AF per year):

Savings estimates are subject to change dependent on implementation approach and portfolio context.

YEAR	SFR	MFR	COM	COA	NRW	TOTAL
2020	0	0	0	0	0	0
2040	290	10	11	0	0	311
2070	840	21	22	0	0	883
2115	1,880	31	33	0	0	1,944

Average Weather Cumulative Total Water Savings (in AF over 100 year planning period):

TOTAL	82,010	1,750	1,840	0	0	85,600

Average Weather Annual Average Water Savings (in AF per year):

TOTAL	850	20	20	0	0	890

AVOIDED COST ANALYSIS[1]

Assumptions:

Includes reduced marginal water treatment costs.

Avoided Cost Summary (current dollars):

	TOTAL Costs Avoided	Water Treatment Cost Avoided	Wastewater Treatment Cost Avoided
2020	$0	$0	$0
2040	$46,900	$46,900	$0
2070	$132,300	$132,300	$0
2115	$290,100	$290,100	$0

Cumulative Total (in $ over 100 year planning period):

TOTAL	$12,806,100	$12,806,100	$0

Avoided Cost Input Assumptions (current dollars):

Water Treatment Cost ($/KGAL)*	$0.46
Wastewater Treatment Cost ($/KGAL)**	$0.26
Indoor Percent of Measure Savings	0%

*Per the AW Water Loss Report to TWDB, Line 44, CY 2016

**Assumed all chemical costs and 90% of electrical costs at treatment plants and all chemical and electrical costs at lift stations

[1]This information is provided for Utility planning purposes only. The Avoided Costs calculation method for portfolio analysis is more comprehensive.

COST ANALYSIS

Assumptions:

One full time equivalent (FTE) employee and half a vehicle (due to potential vehicle sharing across programs) assumed for administration of this program.

Note that rebate amount is not included in this cost analysis. A preliminary placeholder rebate amount will be developed during the portfolio development and evaluation process. Specific program detail including rebate amounts would be developed during later implementation stages.

Capital Cost Summary (current dollars):

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost						
Customer Cost						
Community Cost*	$ -	$ -	$ -	$ -	$ -	$ -

Annual Cost Summary (current dollars):

	Annual Capital/Upfront/ Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost		$ 85,000				
Customer Cost						
Community Cost**	$ -	$ 85,000	$ -	$ -	$ -	$ -

Unit Cost Summary (current dollars):

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)	
Utility Cost	$ 85,000	$ 96	Not including rebate costs (see note above)
Customer Cost			
Community Cost**	$ 85,000	$ 96	Not including rebate costs (see note above)

*Annual Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

Medium	Comment: Outdoor water use may increase regardless of plant type or amount of turf in especially dry conditions.

Comments:

Literature Review/Case Studies:

References:

City of Austin WaterWise Landscape Rebate http://www.austintexas.gov/sites/default/files/files/Water/Conservation/Rebates_and_Programs/WaterWise_Landscape_Residential_Rebate_Application.pdf
City of Austin Land Development Code § 25-2 (Landscaping Ordinance)
City of Austin Code of Ordinances § 6-4 (Water Conservation Code)

Demand Management Option Name:

Irrigation Efficiency Incentives

DRAFT RESULTS 8-1-2017

Short Description:

Expand current program to include smart irrigation system controllers

Details:

Expand current irrigation rebate programs to include irrigation system controllers system controllers that make flow data accessible and are capable of responding to leaks and high flow situations. There are ~89,300 existing single family residential irrigation systems and ~3,500 commercial/multi-family irrigation systems on parcels greater than 1 acre. COM/MF systems less than one acre (and therefore not under annual inspection requirements) account for approximately 30% of COM/MF irrigation system permits on average. Therefore, there are an estimated 5030 total COM/MF irrigations systems as of 2015.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

Sectors: SFR, MFR, COM
End Uses: Outdoor Irrigation
New and existing development

Timing of Implementation:

2020

Lifespan (years):

10 years

WATER SAVINGS ANALYSIS

Assumptions:

The program incentivizes adoption of smart irrigation controllers to improve irrigation system efficiency by identifying leaks and zones with high flows and reducing excessive watering related to improper irrigation scheduling , with 8% savings associated with improved irrigation system performance based on previous literature review and adjustment for one-day-a-week watering restrictions. Base case irrigation system usage (per year) was assumed as the median of MF/COM billing data for 2015 and average of Base Year Irrigation Demand per SF Household from Disaggregated Demand Model.

Number of eligible irrigation systems were projected for each planning horizon using ratio of parcels with registered irrigation systems to total parcels for each sector (assumed constant during planning period) and growing with total number of existing parcels in each planning horizon. Some percentage of these systems are likely to abandoned (i.e., not in-use) which reflects a caveat of this estimation process. Therefore, reported savings represent the maximum savings potential.

Participation rates for all three sectors are projected to reach 20% by 2040 and 30% by 2070. Participation is assumed to remain constant beyond 2070 due to assumed saturation of smart irrigation system controllers in the marketplace by the 2070 planning horizon.

Average Weather Water Savings Summary (in AF per year):

Savings estimates are subject to change dependent on implementation approach and portfolio context.

YEAR	SFR	MFR	COM	COA	NRW	TOTAL
2020	20	10	10	0	0	40
2040	140	40	70	0	0	250
2070	310	90	170	0	0	570
2115	310	90	170	0	0	570

Average Weather Cumulative Total Water Savings (in AF over 100 year planning period):

TOTAL	22,190	6,230	12,220	0	0	40,640

Average Weather Annual Average Water Savings (in AF per year):

TOTAL	230	60	130	0	0	420

AVOIDED COST ANALYSIS[1]

Assumptions:

Includes reduced marginal water treatment costs.

Avoided Cost Summary (current dollars):

	TOTAL Costs Avoided	Water Treatment Cost Avoided	Wastewater Treatment Cost Avoided
2020	$6,300	$6,300	$0
2040	$36,700	$36,700	$0
2070	$84,200	$84,200	$0
2115	$84,200	$84,200	$0

Cumulative Total (in $ over 100 year planning period):

TOTAL	$6,079,500	$6,079,500	$0

Avoided Cost Input Assumptions (current dollars):

Water Treatment Cost ($/KGAL)*	$0.46
Wastewater Treatment Cost ($/KGAL)**	$0.26
Indoor Percent of Measure Savings	0%

*Per the AW Water Loss Report to TWDB, Line 44, CY 2016

**Assumed all chemical costs and 90% of electrical costs at treatment plants and all chemical and electrical costs at lift stations

[1]This information is provided for Utility planning purposes only. The avoided costs/comparison method for portfolio analysis is more comprehensive.

COST ANALYSIS

Assumptions:

One full time equivalent (FTE) employee and half a vehicle (due to potential vehicle sharing across programs) assumed for program administration and inspections.

Note that rebate amount is not included in this cost analysis. A preliminary placeholder rebate amount will be developed during the portfolio development and evaluation process. Specific program detail including rebate amounts will be developed during later implementation stages.

Capital Cost Summary (current dollars):

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost						
Customer Cost						
Community Cost*	$ -	$ -	$ -	$ -	$ -	$ -

Annual Cost Summary (current dollars):

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost		$ 85,000				
Customer Cost						
Community Cost**	$ -	$ 85,000	$ -	$ -	$ -	$ -

Unit Cost Summary (current dollars):

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)	
Utility Cost	$ 85,000	$ 202	Not including rebate costs (see note above)
Customer Cost			
Community Cost**	$ 85,000	$ 202	Not including rebate costs (see note above)

*Annual Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

Medium	Comment: Increases in temperature or prolonged drought periods may result in changes to customer system management resulting in higher water use.

Comments:

Literature Review/Case Studies:

A literature review conducted by the Lawrence Berkeley National Laboratory surveyed experimental and real-word savings produced by various classes of irrigation controllers including, producing an average savings of 24%.
Another literature conducted by the Alliance for Water Efficiency cited several studies that showed increases in water use when weather-based irrigation controllers were installed and improved water use adequacy at the sake of water use efficiency, in an experimental setting. They highlight the need for further data related to more efficient system operation and management.
The RainBird Corporation in collaboration with the University of Arizona, found an estimated savings ranging from 15 - 22% from retrofits of irrigation spray heads with pressure regulating heads designed to reduce high-pressure flows and improve distribution uniformity. However, the State of Texas requires irrigation systems to operate at the manufacturer's specified operating pressure. This provision reduces the opportunity for water savings from flow pressure reduction to only systems that are improperly installed and operating in violation of state requirements.

References:

Lawrence Berkeley National laboratory. (2014) "Estimates of Savings Achievable from Irrigation Controller". https://eta.lbl.gov/sites/all/files/publications/lbnl-6604e.pdf
Mayer, et al. 2015. "A review, analysis, and synthesis of published and pending research on outdoor water use and water savings.". Alliance for Water Efficiency. www.allianceforwaterefficiency.org/WorkArea/DownloadAsset.aspx?id=9155
Brown and Gilbert, 2015. "Application Efficiency and Distribution Uniformity of Pressure-Regulated and Non-Pressure-Regulated Rotor Irrigation Heads Analysis". Submitted to RainBird Corporation. http://prs.rainbird.com/sites/default/files/_media/resource/prs-research-results_0.pdf

WATER FORWARD
INTEGRATED WATER RESOURCE PLAN

Demand Management Option Name:

Alternative Water Ordinances

DRAFT RESULTS 8-1-2017

Short Description:

Require on-site (building-scale) alternative water use of rainwater, stormwater, blackwater, and/or AC condensate

Details:

This option would require on-site (building-scale) alternative water use of rainwater, stormwater, blackwater, and/or AC condensate. Should this option be incorporated into IWRP plan recommendations, actual new ordinance details would need to be developed through subsequent implementation processes with future additional stakeholder and public input opportunities.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

Sectors: MFR, COM, COA
End Uses: Non-potable indoor and outdoor
New development

Timing of Implementation: TBD

Lifespan (years): TBD

WATER SAVINGS ANALYSIS

Assumptions:

See attached alternative source water sheets for estimates of potential demand volumes that could be met by this option.

COST ANALYSIS

Assumptions:

See attached alternative source water sheets for estimates of potential costs that may be associated with this option.

Austin WATER | WATER FORWARD INTEGRATED WATER RESOURCE PLAN

Demand Management Option Name:

Alternative Water Incentives - Rainwater, Stormwater, AC Condensate

DRAFT RESULTS 8-1-2017

Short Description:

Incentivize on-site (building-scale) alternative water use of rainwater, stormwater, and ac condensate

Details:

This option would offere an incentive to encourage the installation and use of rainwater and stormwater harvesting and AC condensate reuse systems. Should this option be incorporated into IWRP plan recommendations, incentive program details would be developed through subsequent implementation processes including interdepartmental coordination.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

Sectors: SFR, MFR, COM, COA
End Uses: Non-potable indoor and outdoor
Existing and new development

Timing of Implementation:

TBD

Lifespan (years):

TBD

WATER SAVINGS ANALYSIS

Assumptions:

See attached alternative source water sheets for estimates of potential demand volumes that could be met by this option.

COST ANALYSIS

Assumptions:

See attached alternative source water sheets for estimates of potential costs that may be associated with this option.

Demand Management Option Name:

Alternative Water Incentives - Graywater and Blackwater

DRAFT RESULTS 8-1-2017

Short Description:

Offer an incentive to encourage the installation and use of graywater and onsite blackwater reuse systems

Details:

This option would offere an incentive to encourage the installation and use of graywater harvesting and onsite blackwater reuse systems. Should this option be incorporated into IWRP plan recommendations, incentive program details would be developed through subsequent implementation processes including interdepartmental coordination.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

Sectors: SFR, MFR, COM, COA
End Uses: Non-potable indoor and outdoor
Existing and new development

Timing of Implementation:

TBD

Lifespan (years):

TBD

WATER SAVINGS ANALYSIS

Assumptions:

See attached alternative source water sheets for estimates of potential demand volumes that could be met by this option.

COST ANALYSIS

Assumptions:

See attached alternative source water sheets for estimates of potential costs that may be associated with this option.

Alternative Source Water Name:

AC Condensate Reuse

DRAFT RESULTS 8-1-2017

Short Description:

Collection and reuse of condensate water from Air Handling Units (AHUs) for cooling systems from new development with cooling capacity over 200 tons

Details:

to collect and make beneficial use of AC Condensate from cooling systems. This condensate can be used for any non-potable applicable including (but not limited to): cooling tower makeup water, irrigation, indoor toilet flushing, etc.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

Sectors: MFR, COM, COA
End Uses:
New and existing development

Characterization Year:

2115

DEMAND MET BY OPTION ANALYSIS

Assumptions:

Assumed total square footage per sector will scale with MF Units and or COM/COA Employment projections, with per unit/per employee square footage rate estimated from ECAD Ordinance Audit data available form Austin Energy. AC Condensate production estimated using the rule of thumb of 0.5-0.6 gallons/hour produced per 1000 sq. ft. of conditioned area (per SAWS AC Condensate Collection Manual). Finally, total square footage was scaled to 2015 percentage of MF/COM/COA buildings greater than 50,000 sq. ft. (equivalent to an average cooling load of 200 tons) from aforementioned ECAD Audit data and held constant into future. Assumed 80% average cooling capacity factor and operation during 9 months of year, per SAWS AC Condensate Collection Manual guidance.

Average Weather Demand Met By Option in 2115 Summary (Acre Feet):

Note: Drought yields to be determined. Yields are subject to change dependent on implementation approach and portfolio context. Annual cumulative volume represents the total volume produced from all systems.

	SFR	MFR	Non-Residential
Annual Cumulative Volume (AF/Year)	-	1,770	3,380
Annual Average System Volume (Gal/Year)	-	109,774	125,463

COST ANALYSIS

Assumptions:

Capital Cost – Facilities
o AC condensate recovery system estimated as 3% of total cooling mechnical engineering costs for a new building
o Total cost of cooling for a new buiding estimated using rule of thumb dollar per square foot amounts and estimated square footage for new development through 2115
Engineering, Legal Costs and Contingencies
o 35% cost of facilities
Mitigation and Permitting
o 5% cost of facilities
Annual O&M – Labor & Material
o Not included in analysis
Annual O&M – Energy
o Not included in analysis
Annual O&M - Advanced/Decentralized Treatment
o Not included in analysis
Annual Purchase/Import Cost
o Not applicable

Capital Cost Summary (current dollars):

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost						
Customer Cost	$ 309,194,430	$ 108,218,051	$ 15,459,722	$ -	$ -	$ 417,412,481
Community Cost*	$ 309,194,430	$ 108,218,051	$ 15,459,722	$ -	$ -	$ 432,872,202

Annual Cost Summary (current dollars):

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost						
Customer Cost	$ 13,913,749	$ -	$ -	$ -	$ -	$ -
Community Cost**	$ 13,913,749	$ -	$ -	$ -	$ -	$ -

Unit Cost Summary (current dollars):

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	$ -	$ -
Customer Cost	$ 13,913,749	$ 2,702
Community Cost**	$ 13,913,749	$ 2,702

*Annual Unit Cost = Total Annual Cost ÷ Annual Average Yield
**Community Cost = Utility Cost + Customer Cost

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

Medium	Comment: Increased temperature might diminish efficiency of the cooling process and could cause increases in seasonal use of cooling system

Comments:

Literature Review/Case Studies:

A/C Condensate collection systems can vary in cost depending on the intended end-use of condensate water. Most cooling towers can accommodate gravity-fed collection of condensate from AHUs to supplement makeup water in the cooling tower system. However, systems in which the cooling tower sits above AHUs will require storage and pumping to deliver condensate for makeup water.
Alternatively, condensate can be reused for irrigation or treated and return inside a COM/MFR (per plumbing and state codes) for use in non-potable end-uses (toilet flushing, clothes washing, etc.). These systems would increase system cost due to requirement for additional storage, treatment, and reticulation. If these additional provisions are not required, additional system cost can be considered negligible for a gravity-fed makeup water supplement.

References:

North Carolina Water Efficiency Manual for CII Facilities (1998), NC DENR. (http://water.monroenc.org/wp-content/uploads/Water-efficency-for-industrial-commercial-and-institutional-customers.pdf)
Bill Hoffman, P.E. "The Energy - Water Nexus of Cooling Towers"
Glawe, D. 2013. "San Antonio Condensate Collection and Use Manual for Commercial Buildings". San Antonio Water System. http://www.saws.org/conservation/commercial/Condensate/docs/SACCUManual_20131021.pdf
City of Austin, ECAD Ordinance
Guz, K. 2005. "Condensate Water Recovery". ASHRAE Journal. Vol. 47, No. 6, June 2005

Austin WATER | WATER FORWARD INTEGRATED WATER RESOURCE PLAN

DRAFT RESULTS 8/1/17

Alternative Source Water Name:

Rainwater Harvesting

Short Description:

Lot or building scale rainwater (roofwater) harvesting

Details:

Rainwater Harvesting involves the capture and storage of roof water to supply a range of onsite demands at the lot/building scale. Implementing rainwater harvesting in new developments provides an opportunity to plumb the residence or building with internal connections for toilet flushing or clothes washing. Where used indoor treatment is required.

Three scenarios are considered for simplicity. These are:
1. A proportion of newly constructed SFR, MFR and COM buildings have a rainwater tank supplying outdoor end uses.
2. A proportion of newly constructed SFR, MFR and COM buildings have a rainwater tank supplying outdoor end uses and indoor (non-potable) end uses via dual reticulation.
3. A proportion of newly constructed SFR buildings have a rainwater tank supplying all end uses (i.e. potable supply).
All scenarios assume back-up supply from the centralized water distribution system.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

1. Outdoor: SFR - IRR; MFR - IRR; COM - IRR.
2. Outdoor + Indoor Non Potable: SFR - IRR, TL, CW; MFR - IRR, TL; COM - IRR, TL, HVC.
3. Potable: SFR - ALL USES

Characterization Year: 2115

Intended use of supply: Variable

Supply Type: Decentralized

Timing of Implementation: NA

Lifespan (years): 40

DEMAND MET BY OPTION ANALYSIS

Assumptions:

Demand

o Variable per DTI (estimated from demand model)

o Monthly outdoor demand profile generated using historical gross lake evaporation data (quadrangle 811) and precipitation data in a standard irrigation model to account for monthly and year to year variation in outdoor demand based on climate.

Yield

o Daily water balance calculation for historical time series

o Daily rainfall analyzed for the historical period (1938 – 2016) using Station: AUSTIN CAMP MABRY TX US

o Note: Climate change adjusted dataset can be used instead of historical dataset in the portfolio evaluation process

o Typical or Average Roof Areas, per DTI, are based on current Land Uses building footprint data and demographic projections:

- [SFR] Average roof varies per DTI, between approx. 1500-3700 ft2 per house.
- [MFR] Nominal building = 5,000 sq ft (noting that the density, in terms of units/building, varies by DTI)
- [COM] Nominal building = 10,000 sq ft (noting that the density, in terms of employees/building, varies by DTI)
- Current roof areas and building numbers estimated based on Current Land uses building footprint data
- Future roof areas estimated taking into account demographic changes (increase in units/employees) and growth/change in land use (including densification) from the future land use map generated for this project.

o Connected Roof Area = 67% (of total roof area). Previous project estimates have estimated between 50% - 80%.

o Roof Runoff coefficient = 0.9

o Tank volumes optimised from yield/storage curve in order to maximise yield and minimise cost & tank footprint/space:

- [SFR] 2000 Gallons per house
- [MFR] 5000 Gallons per building
- [COM] 10,000 Gallons per building

Year

2115

Average Weather Demand Met By Option in 2115 Summary (Acre Feet):

Note: Drought yields to be determined. Results reported from the 75th percentile of project opportunities/systems identified in the analysis. Yields are subject to change dependent on implementation approach and portfolio context. Annual cumulative volume represents the total volume produced from all systems identified within the 75th percentile. Annual average system volume represents the average yield from each project opportunity/system.

SCENARIO 1 - Outdoor: SFR - IRR; MFR - IRR; COM - IRR

	SFR	MFR	Non-Residential
Annual Cumulative Volume (AF/Year)	11,955	2,786	3,966
Annual Average System Volume (Gal/Year)	8,790	29,230	59,109

SCENARIO 2 - Outdoor + Indoor Non Potable: SFR - IRR, TL, CW; MFR - IRR, TL; COM - IRR, TL, HVC

	SFR	MFR	Non-Residential
Annual Cumulative Volume (AF/Year)	23,378	4,627	6,489
Annual Average System Volume (Gal/Year)	16,305	50,694	100,104

SCENARIO 3 - Potable: SFR - ALL USES

	SFR	MFR	Non-Residential
Annual Cumulative Volume (AF/Year)	27,662	N/A	N/A
Annual Average System Volume (Gal/Year)	20,888	N/A	N/A

COST ANALYSIS

Assumptions:

NB: Capital and Annual O&M costs will likely be borne by the customer/developer. The below costs are total community costs.

Capital Cost – Facilities

o Cost elements calculated for the typical building per DTI using unit costs and cost curves from GHD's cost databases, and using water balance outputs (demand and supply volumes) and GIS outputs (e.g. number of houses, buildings, roof areas)

o Cost elements include:
- Treatment (e.g. Filter + UV Disinfection) if used indoor non-potable or potable supply
- Storage
- Pump (assume 50% are gravity fed if supplying IRR only)
- Reticulation (within building) if used for indoor non-potable supply

Engineering, Legal Costs and Contingencies

o 20% of capital cost

Mitigation and Permitting

o 0% of capital cost if used only for irrigation; 5% of capital cost otherwise

Annual O&M – Labor & Material

o Estimated as proportion of capital cost (Civil 0.5%, Pumps 5%, Treatment 5%)

Annual O&M – Energy

o Pumping Energy = 750 kWh/ML (2839 kWh/MG) (outdoor) and 1500 kWh/ML (5678 kWh/MG) (indoor & outdoor) (per previous projects & water-energy nexus studies)

o Electricity cost 0.09 $USD/kWh

Annual O&M - Advanced/Decentralized Treatment

o Represents the treatment energy cost (treatment capital cost and O&M in other categories)

o UV Disinfection: 82 kWh/ML (310 kWh/MG)

Annual O&M - Conventional W/WW Treatment

o Not applicable

Annual Purchase/Import Cost

o Not applicable

SCENARIO 1 - Outdoor: SFR - IRR; MFR - IRR; COM - IRR

Capital Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost	$ -	$ -	$ -	$ -	$ -	$ -
Customer Cost	$ 1,211,204,086	$ 242,240,817	$ -	$ -	$ -	$ 1,453,444,903
Community Cost	$ 1,211,204,086	$ 242,240,817	$ -	$ -	$ -	$ 1,453,444,903

Annual Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost	$ -	$ -	$ -	$ -	$ -	$ -
Customer Cost	$ 36,336,123	$ 11,873,202	$ 778,727	$ -	$ -	$ -
Community Cost**	$ 36,336,123	$ 11,873,202	$ 778,727	$ -	$ -	$ -

Unit Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	$ -	$ -
Customer Cost	$ 48,988,051	$ 2,619
Community Cost**	$ 48,988,051	$ 2,619

*Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

Per System Cost Summary (current dollars):

Note: Represents average per project opportunity/system cost

	SFR	MFR	Non-Residential
Capital Cost	$ 2,023	$ 4,300	$ 8,283
Annual O&M	$ 22	$ 42	$ 79

SCENARIO 2 - Outdoor + Indoor Non Potable: SFR - IRR, TL, CW; MFR - IRR, TL; COM - IRR, TL, HVC

Capital Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost	$ -	$ -	$ -	$ -	$ -	$ -
Customer Cost	$ 2,615,044,340	$ 523,008,868	$ 130,752,217	$ -	$ -	$ 3,268,805,425
Community Cost	$ 2,615,044,340	$ 523,008,868	$ 130,752,217	$ -	$ -	$ 3,268,805,425

Annual Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost	$ -	$ -	$ -	$ -	$ -	$ -
Customer Cost	$ 81,720,136	$ 49,015,389	$ 5,743,820	$ 313,995	$ -	$ -
Community Cost**	$ 81,720,136	$ 49,015,389	$ 5,743,820	$ 313,995	$ -	$ -

Unit Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	$ -	$ -
Customer Cost	$ 136,793,340	$ 3,966
Community Cost**	$ 136,793,340	$ 3,966

*Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

Per System Cost Summary (current dollars):

Note: Represents average per project opportunity/system cost

	SFR	MFR	Non-Residential
Capital Cost	$ 4,266	$ 8,726	$ 17,161
Annual O&M	$ 89	$ 194	$ 371

SCENARIO 3 - Potable: SFR - ALL USES

Capital Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost	$ -	$ -	$ -	$ -	$ -	$ -
Customer Cost	$ 1,375,900,982	$ 275,180,196	$ 68,795,049	$ -	$ -	$ 1,719,876,227
Community Cost	$ 1,375,900,982	$ 275,180,196	$ 68,795,049	$ -	$ -	$ 1,719,876,227

Annual Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost	$ -	$ -	$ -	$ -	$ -	$ -
Customer Cost	$ 42,996,906	$ 34,028,610	$ 4,606,236	$ 251,808	$ -	$ -
Community Cost**	$ 42,996,906	$ 34,028,610	$ 4,606,236	$ 251,808	$ -	$ -

Unit Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	$ -	$ -
Customer Cost	$ 81,883,559	$ 2,960
Community Cost**	$ 81,883,559	$ 2,960

*Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

Per System Cost Summary (current dollars):

Note: Represents average per project opportunity/system cost

	SFR	MFR	Non-Residential
Capital Cost	$ 3,188	N/A	N/A
Annual O&M	$ 90	N/A	N/A

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

Medium	Annual yields may vary from year to year.

Comments:

Literature Review/Case Studies:

References:

1. https://www.basix.nsw.gov.au/basixcms/images/BASIX_Rainwater_Harvesting_System_Guidelines.pdf
2. http://www.edwardsaquifer.net/pdf/RainwaterCommitteeFinalReport.pdf
3. http://www.twdb.texas.gov/publications/brochures/conservation/doc/RainwaterHarvestingManual_3rdedition.pdf
4. https://austintexas.gov/faq/rainwater-harvesting
5. http://www.austintexas.gov/sites/default/files/files/Water/Conservation/Rebates_and_Programs/Rainwater_Harvesting_Rebate_FAQ.pdf

Austin WATER | WATER FORWARD INTEGRATED WATER RESOURCE PLAN

Alternative Source Water Name:

Stormwater Harvesting

DRAFT RESULTS 8/1/17

Short Description:

Lot scale stormwater harvesting and reuse

Details:

Lot scale stormwater harvesting involves the capture and storage of stormwater runoff generated from impervious surfaces (including roof water) within the lot boundary of multi-family residential or commercial development to supply a range of onsite demands at the lot/building scale. Implementing stormwater harvesting in new developments provides an opportunity to plumb the building with internal connections for toilet flushing, clothes washing or to cooling towers. Retrofitting existing buildings with internal connections to a dual supply source can be cost prohibitive and/or practically difficult, and so it is assumed for the purposes of this study that stormwater harvesting at the lot scale for existing development would be used solely for irrigation/landscaping. Where used for irrigation/landscaping only, it is assumed that there will be filtration. Where used to supply indoor non-potable end-uses, UV Disinfection is assumed. Storage is assumed to be an underground tank/cistern. All scenarios assume back-up supply from the centralized water distribution system.

Two scenarios are considered for simplicity. These are:
1. A proportion of newly constructed MFR and COM buildings have an underground stormwater harvesting tank supplying outdoor end uses.
2. A proportion of newly constructed MFR and COM buildings have an underground stormwater harvesting tank supplying outdoor end uses and indoor (non-potable) end uses via dual reticulation.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

1. Outdoor: MFR - IRR; COM - IRR.
2. Outdoor + Indoor Non Potable: MFR - IRR, TL, CW; COM - IRR, TL, CW, HVC.

Characterization Year: 2115

Intended use of supply: Variable

Supply Type: Decentralized

Timing of Implementation: NA

Lifespan (years): 40

DEMAND MET BY OPTION ANALYSIS

Assumptions:

Demand

o Variable per DTI (estimated from demand model)

o Monthly outdoor demand profile generated using historical gross lake evaporation data (quadrangle 811) and precipitation data in a standard irrigation model to account for monthly and year to year variation in outdoor demand based on climate.

Yield

o Daily water balance calculation for historical time series

o Daily rainfall analyzed for the historical period (1938 – 2016) using Station: AUSTIN CAMP MABRY TX US

o Note: Climate change adjusted dataset can be used instead of historical dataset in the portfolio evaluation process

o Nominal Building Roof Areas (i.e. Building Footprints) were selected for MFR and COM for the purpose of the rainwater harvesting analysis: 5,000 sq ft for MFR and 10,000 sq ft for COM. The total number of nominal buildings per DTI was informed the assumed increase in MFR or COM land use area between now and 2115. This results in the density of MFR buildings (units/building) and COM buildings (employees/building) being variable per DTI, in order to reflect higher and lower density areas. The total current roof area and building numbers were estimated based on the Current Land uses building footprint data. The total future roof area was estimated taking into account demographic changes (increase in units/employees) and growth/change in land use (including densification) from the future land use map generated for this project.

o For these nominal buildings, the amount of impervious area on the lot (additional to the roof area) per nominal building was informed by analysis of the current land use and building footprint data. This identified that the ratio of roof area to other impervious area for MFR was in the order of 1:1 and for COM in the order of 1:2.

o Connected Catchment Area = 67% (of total impervious catchment area). This is an allowance for not all runoff generated onsite necessary being directed to the one location.

o Runoff coefficient = 0.9

o Tank volumes optimised from yield/storage curves in order to maximise yield, whilst minimise cost & tank footprint/space (& cost):

- [MFR] 10,000 Gallons per nominal building/lot (noting stormwater runoff from catchment approx 111,000 gallons)
- [COM] 30,000 Gallons per nominal building/lot (noting stormwater runoff from catchment approx 335,000 gallons)

Year

2115

Average Weather Demand Met By Option in 2115 Summary (Acre Feet):

Note: Drought yields to be determined. Results reported from the 75th percentile of project opportunities/systems identified in the analysis. Yields are subject to change dependent on implementation approach and portfolio context. Annual cumulative volume represents the total volume produced from all systems identified within the 75th percentile. Annual average system volume represents the average yield from each project opportunity/system.

SCENARIO 1 - Outdoor: MFR - IRR; COM - IRR

	SFR	MFR	Non-Residential
Annual Cumulative Volume (AF/Year)	N/A	4,973	9,464
Annual Average System Volume (Gal/Year)	N/A	52,180	146,228

SCENARIO 2 - Outdoor + Indoor Non Potable: MFR - IRR, TL, CW; COM - IRR, TL, CW, HVC

	SFR	MFR	Non-Residential
Annual Cumulative Volume (AF/Year)	N/A	8,961	15,511
Annual Average System Volume (Gal/Year)	N/A	99,161	247,652

COST ANALYSIS

Assumptions:

NB: Capital and Annual O&M costs will likely be borne by the customer/developer. The below costs are total community costs.

Capital Cost – Facilities

o Cost elements calculated for the typical building per DTI using unit costs and cost curves from GHD's cost databases, and using water balance outputs (demand and supply volumes) and GIS outputs (e.g. number of houses, buildings, roof areas)

o Cost elements include:

- Treatment (Filtration only if used for irrigation landscaping only; Filtration + UV Disinfection if used for indoor non-potable)
- Storage (underground tank/cistern)
- Pump
- Reticulation (within building) if used for indoor non-potable supply

Engineering, Legal Costs and Contingencies

o 20% cost of facilities

Mitigation and Permitting

o 0% cost of facilities if used only for irrigation; 5% cost of facilities otherwise

Annual O&M – Labor & Material

o Estimated as proportion of capital costs (Civil 0.5%, Pumps 5%, Treatment 5%)

Annual O&M – Energy

o Pumping Energy = 750 kWh/ML (2839 kWh/MG) (outdoor) and 1500 kWh/ML (5678 kWh/MG) (indoor & outdoor) (per previous projects & water-energy nexus studies)

o Electricity cost 0.09 $USD/kWh

Annual O&M - Advanced/Decentralized Treatment

o Represents the treatment energy cost (treatment capital costs and O&M in other categories)

o For outdoor use: 0 kWh/ML (0 kWh/MG)

o For indoor use: 82 kWh/ML (310 kWh/MG)

Annual O&M - Conventional W/WW Treatment

o Not applicable

Annual Purchase/Import Cost

o Not applicable

SCENARIO 1 - Outdoor: MFR - IRR; COM - IRR

Capital Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost	$ -	$ -	$ -	$ -	$ -	$ -
Customer Cost	$ 2,025,635,817	$ 405,127,163	$ -	$ -	$ -	$ 2,430,762,980
Community Cost	$ 2,025,635,817	$ 405,127,163	$ -	$ -	$ -	$ 2,430,762,980

Annual Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost	$ -	$ -	$ -	$ -	$ -	$ -
Customer Cost	$ 60,769,074	$ 17,580,054	$ 1,202,068	$ -	$ -	$ -
Community Cost**	$ 60,769,074	$ 17,580,054	$ 1,202,068	$ -	$ -	$ -

Unit Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	$ -	$ -
Customer Cost	$ 79,551,197	$ 5,510
Community Cost**	$ 79,551,197	$ 5,510

*Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

Per System Cost Summary (current dollars):

Note: Represents average per project opportunity/system cost

	SFR	MFR	Non-Residential
Capital Cost	N/A	$ 22,394	$ 63,071
Annual O&M	N/A	$ 214	$ 576

SCENARIO 2 - Outdoor + Indoor Non Potable: MFR - IRR, TL, CW; COM - IRR, TL, CW, HVC

Capital Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost	$ -	$ -	$ -	$ -	$ -	$ -
Customer Cost	$ 2,434,020,724	$ 486,804,145	$ 121,701,036	$ -	$ -	$ 3,042,525,905
Community Cost	$ 2,434,020,724	$ 486,804,145	$ 121,701,036	$ -	$ -	$ 3,042,525,905

Annual Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost	$ -	$ -	$ -	$ -	$ -	$ -
Customer Cost	$ 76,063,148	$ 43,513,828	$ 4,074,948	$ 222,764	$ -	$ -
Community Cost**	$ 76,063,148	$ 43,513,828	$ 4,074,948	$ 222,764	$ -	$ -

Unit Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	$ -	$ -
Customer Cost	$ 123,874,688	$ 5,062
Community Cost**	$ 123,874,688	$ 5,062

*Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

Per System Cost Summary (current dollars):

Note: Represents average per project opportunity/system cost

	SFR	MFR	Non-Residential
Capital Cost	N/A	$ 28,910	$ 77,554
Annual O&M	N/A	$ 596	$ 1,483

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

Medium	Annual yields may vary from year to year.

Comments:

Literature Review/Case Studies:

References:

1. http://www.twdb.texas.gov/publications/brochures/conservation/doc/RainwaterHarvestingManual_3rdedition.pdf
2. https://austintexas.gov/faq/rainwater-harvesting

Austin WATER | WATER FORWARD INTEGRATED WATER RESOURCE PLAN

Alternative Source Water Name:

Graywater Harvesting

DRAFT RESULTS 8/1/17

Short Description:

Lot or building scale graywater diversion or treatment systems

Details:

Graywater harvesting is defined, for the purpose of this project, as the reuse of water from the laundry, shower and bath at the lot/building scale to meet non-potable demands. There are two main types, graywater diversion devices and graywater treatment systems. Graywater diversion is untreated, and therefore cannot be stored and can only be used to supply sub-surface irrigation. They typically include a surge-tank and may include a filter. The system may be gravity fed or require a pump, depending on the site. Graywater treatment systems include treatment, storage and a pump. The treated graywater can be reused to supply outdoor end use demands as well as non-potable indoor end use demands (toilet flushing and clothes washing). Graywater is not considered for outdoor end uses in Critical Water Quality Zones, floodplains, or the Edwards Aquifer Recharge Zone.

Two scenarios are considered for simplicity. These are:
1. A proportion of newly constructed SFR, MFR and COM buildings have a graywater diversion system supplying outdoor end uses.
2. A proportion of newly constructed SFR, MFR and COM buildings have a graywater treatment system supplying outdoor and indoor end uses.
All scenarios assume back-up supply from the centralized water distribution system.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

1. Outdoor: SFR - IRR, MFR - IRR, COM - IRR
2. Outdoor + Indoor Non Potable: SFR - IRR, TL, CW; MFR - IRR, TL, CW; COM - IRR, TL

Characterization Year: 2115

Intended use of supply: Variable

Supply Type: Decentralized

Timing of Implementation: NA

Lifespan (years): 30

DEMAND MET BY OPTION ANALYSIS

Assumptions:

Demand
o Variable per DTI (estimated from demand model)
o For graywater diversion, it is assumed that only 75% of the IRR demand can be accessed. (For SFR, for the 50% of systems that are assumed to be gravity fed, it is assumed than only 50% of the IRR demand, whereas if pressurised it is assumed that 100% of the demand can be accessed. This averages at 75%. For MFR & COM, there will be landscaped areas there may be areas that are not suitable for supply by a sub-surface system, so although pressurised 75% has also been assumed.)
Source generation
o Average daily graywater generation volumes are calculated from the demand model end use volumes, based on the following assumptions:
o Graywater [SFR & MFR] = 100% * Shower/Baths + 100% * Clotheswashing + 50% * Faucets/Basins (assumes the other 50% is assumed to be used in the kitchen)
o Graywater [COM] = 100% * Laundry + 50% * Domestic (assumes the other 50% is for toilets)
o This is the same for graywater diversion and graywater treatment
Storage
o Graywater diversion: Surge tanks for capturing instantaneous/peak flows (can't store untreated graywater)
o Graywater treatment: Storage size is variable by customer class and DTI, and is automatically sized at 3 times the average daily graywater generation volume.
Yield
o Graywater yield (the volume of demand that is supplied by graywater) is calculated from a water balance calculation of graywater supply and graywater demand.
Other
o For a given building, the gray water available to reuse for the supply of end use demands within that building is limited to the volume of graywater generated from that building.
o Note that for higher saturation scenarios, 50% and higher, there would need to be consideration given to the minimum dry weather flows that must be retained in the centralized wastewater system to maintain the necessary scouring velocities.
Year
2115

Average Weather Demand Met By Option in 2115 Summary (Acre Feet):

Note: Drought yields to be determined. Results reported from the 75th percentile of project opportunities/systems identified in the analysis. Yields are subject to change dependent on implementation approach and portfolio context. Annual cumulative volume represents the total volume produced from all systems identified within the 75th percentile. Annual average system volume represents the average yield from each project opportunity/system.

SCENARIO 1 - Outdoor: SFR - IRR, MFR - IRR, COM - IRR

	SFR	MFR	Non-Residential
Annual Cumulative Volume (AF/Year)	9,778	8,275	5,706
Annual Average System Volume (Gal/Year)	8,663	109,774	125,463

SCENARIO 2 - Outdoor + Indoor Non Potable: SFR - IRR, TL, CW; MFR - IRR, TL, CW; COM - IRR, TL

	SFR	MFR	Non-Residential
Annual Cumulative Volume (AF/Year)	28,844	30,926	11,892
Annual Average System Volume (Gal/Year)	20,379	340,036	186,192

COST ANALYSIS

Assumptions:

NB: Capital and Annual O&M costs will likely be borne by the customer/developer. The below costs are total community costs.

Capital Cost – Facilities

o Cost elements calculated for the typical building per DTI using unit costs and cost curves from GHD's cost databases, and using water balance outputs (demand and supply volumes) and GIS outputs (e.g. number and characteristics of houses, buildings)

o Cost elements for graywater diversion include:
- Collection (dual plumbing)
- Diversion system (typically includes filtration and surge tank)
- Pump (assume 50% of installations are gravity fed and 50% require a pump)

o Cost elements for graywater treatment systems include:
- Collection (dual plumbing)
- Treatment system
- Balancing Storage
- Pump
- Reticulation (within building)

o Note: Treatment systems will vary. For example, the New South Wales government (Australia) accredited graywater systems include: (i) MBR (combination of biological treatment and advanced membrane filtration) and UV disinfection; (ii) aeration, membrane filtration and UV disinfection; (ii) aeration and chlorination; (iii) vertical flow reed bed filter and UV disinfection. See http://www.health.nsw.gov.au/environment/domesticwastewater/Pages/gts.aspx

Engineering, Legal Costs and Contingencies

o 35% of capital cost

Mitigation and Permitting

o 0% for SFR Gray Water Diversion, 5% of capital cost for all other contexts

Annual O&M – Labor & Material

o Estimated as proportion of capital cost (Civil 0.5%, Pumps 5%, Treatment 5%)

Annual O&M – Energy

o Pumping Energy = 750 kWh/ML (2839 kWh/MG) (outdoor) and 1500 kWh/ML (5678 kWh/MG) (indoor & outdoor) (per previous projects & water-energy nexus studies)

o Electricity cost 0.09 $USD/kWh

Annual O&M - Advanced/Decentralized Treatment

o Represents the treatment energy cost (treatment capital cost and O&M in other categories)

o For graywater diversion: no treatment

o For graywater treatment systems: 1000 kWh/ML (3785 kWh/MG)

Annual O&M - Conventional W/WW Treatment

o Not applicable

Annual Purchase/Import Cost

o Not applicable

SCENARIO 1 - Outdoor: SFR - IRR, MFR - IRR, COM - IRR

Capital Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost	$ -	$ -	$ -	$ -	$ -	$ -
Customer Cost	$ 939,932,459	$ 328,976,361	$ 5,810,642	$ -	$ -	$ 1,274,719,462
Community Cost	$ 939,932,459	$ 328,976,361	$ 5,810,642	$ -	$ -	$ 1,274,719,462

Annual Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost	$ -	$ -	$ -	$ -	$ -	$ -
Customer Cost	$ 42,490,649	$ 18,821,920	$ 661,836	$ -	$ -	$ -
Community Cost**	$ 42,490,649	$ 18,821,920	$ 661,836	$ -	$ -	$ -

Unit Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	$ -	$ -
Customer Cost	$ 61,974,405	$ 3,898
Community Cost**	$ 61,974,405	$ 3,898

*Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

Per System Cost Summary (current dollars):

Note: Represents average per project opportunity/system cost

	SFR	MFR	Non-Residential
Capital Cost	$ 2,239	$ 6,687	$ 7,288
Annual O&M	$ 47	$ 131	$ 138

SCENARIO 2 - Outdoor + Indoor Non Potable: SFR - IRR, TL, CW; MFR - IRR, TL, CW; COM - IRR, TL

Capital Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost	$ -	$ -	$ -	$ -	$ -	$ -
Customer Cost	$ 8,682,069,072	$ 3,038,724,175	$ 434,103,454	$ -	$ -	$ 12,154,896,700
Community Cost	$ 8,682,069,072	$ 3,038,724,175	$ 434,103,454	$ -	$ -	$ 12,154,896,700

Annual Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost	$ -	$ -	$ -	$ -	$ -	$ -
Customer Cost	$ 405,163,223	$ 339,267,657	$ 11,933,248	$ 7,955,498	$ -	$ -
Community Cost**	$ 405,163,223	$ 339,267,657	$ 11,933,248	$ 7,955,498	$ -	$ -

Unit Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	$ -	$ -
Customer Cost	$ 764,319,627	$ 10,666
Community Cost**	$ 764,319,627	$ 10,666

*Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

Per System Cost Summary (current dollars):

Note: Represents average per project opportunity/system cost

	SFR	MFR	Non-Residential
Capital Cost	$ 9,309	$ 108,397	$ 56,520
Annual O&M	$ 329	$ 5,102	$ 2,701

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

High	This option is not significantly impacted by hydrologic or climatic variability.

Comments:

Literature Review/Case Studies:

References:

1. http://www.health.nsw.gov.au/environment/domesticwastewater/Pages/gts.aspx
2. https://www.austintexas.gov/sites/default/files/files/Water/Conservation/GrayWater-FAQ.pdf
3. https://www.austintexas.gov/sites/default/files/files/Watershed/growgreen/2015LPT/Gray-Water-Navigating-Through-City-Code-Stefani.pdf

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INTEGRATED WATER RESOURCE PLAN

Alternative Source Water Name:

Building Scale Wastewater Reuse

DRAFT RESULTS 8/1/17

Short Description:

Lot or building scale blackwater treatment plants

Details:

This involves the onsite capture and treatment of the wastewater stream generated from a building for onsite reuse via a dual (purple) pipe system to supply outdoor demands (irrigation/landscaping) and non-potable indoor demands (toilets and potentially also laundry and cooling towers). Blackwater treatment plants are most commonly installed in commercial buildings and high density, multi-story multi-family residential buildings. Treatment of blackwater to Type 1 quality is required. Treatment may be one of a combination of Membrane Bioreactor (MBR), Moving Bed Biofilm Reactor (MBBR), passive (e.g. engineered wetlands) or other systems, with microfiltration or ultrafiltration, and UV disinfection and/or chlorination. Wastes (sludge) from the treatment process are discharged back to the wastewater network. Blackwater reuse is not considered for outdoor end uses in Critical Water Quality Zones, floodplains, or the Edwards Aquifer Recharge Zone. This option assumes back-up supply from the centralized water distribution system.

One scenario is considered for simplicity. This is:
1. A proportion of newly constructed MFR and COM buildings have a blackwater treatment system supplying outdoor and non-potable indoor end uses.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

1. MFR - IRR, TL, CW; COM - IRR, TL, CW, HVC

Characterization Year: 2115

Intended use of supply: Variable

Supply Type: Decentralized

Timing of Implementation: NA

Lifespan (years): 30

DEMAND MET BY OPTION ANALYSIS

Assumptions:

Demand
o Variable per DTI (estimated from demand model)
o For MFR customer sector, the Irrigation/Landscaping end use demand may incorporate some water use by pools which may slightly overestimate the demand. Many pools may be sourced with water that would be metered as irrigation and therefore be represented in a different demand sector in the model, so although a limitation of the demand model it is not considered significant.

Source generation
o Blackwater [MFR] = Total Demand - Irrigation/Landscaping - Leaks
o Blackwater [COM] = Total Demand - Irrigation/Landscaping - Pool - 50% * Misc (assumes 50% of Misc is consumed or losses)

Storage
o Storage size is variable per customer class and DTI, and is automatically sized at 3 times the average daily blackwater generation volume.

Yield
o Blackwater yield (the volume of demand that is supplied by blackwater) is calculated from a water balance calculation of blackwater supply and demand.
o For a given building, the wastewater available to reuse for the supply of end use demands is limited to the volume of wastewater generated from the building.

Other
Note that for higher saturation scenarios, 50% and higher, there would need to be consideration given to the minimum dry weather flows that must be retained in the centralized wastewater system to maintain the necessary scouring velocities.

Year
2115

Average Weather Demand Met By Option in 2115 Summary (Acre Feet):

Note: Drought yields to be determined. Results reported from the 75th percentile of project opportunities/systems identified in the analysis. Yields are subject to change dependent on implementation approach and portfolio context. Annual cumulative volume represents the total volume produced from all systems identified within the 75th percentile. Annual average system volume represents the average yield from each project opportunity/system.

SCENARIO 1 - MFR - IRR, TL, CW; COM - IRR, TL, CW, HVC

	SFR	MFR	Non-Residential
Annual Cumulative Volume (AF/Year)	N/A	38,905	39,731
Annual Average System Volume (Gal/Year)	N/A	402,896	629,853

COST ANALYSIS

Assumptions:

NB: Capital and Annual O&M costs will likely be borne by the customer/developer. The below costs are total community costs.

Capital Cost – Facilities

o Cost elements calculated for the typical building per DTI using unit costs and cost curves from GHD's cost databases, and using water balance outputs (demand and supply volumes) and GIS outputs (e.g. number and characteristics of houses, buildings)

o Cost elements include:
- Treatment system
- Balancing Storage
- Pump
- Reticulation (within building)

o Note: Treatment systems will vary. These may include Membrane Bioreactor (MBR), Moving Bed Biofilm Reactor (MBBR), passive (e.g. engineered wetlands such as SFPUC's living machine - see ref #1) or other systems, with microfiltration or ultrafiltration, and UV disinfection and/or chlorination.

Engineering, Legal Costs and Contingencies

o 35% of capital cost

Mitigation and Permitting

o 5% of capital cost

Annual O&M – Labor & Material

o Estimated as proportion of capital cost (Civil 0.5%, Pumps 5%, Treatment 5%)

Annual O&M – Energy

o Pumping Energy = 1500 kWh/ML (5678 kWh/MG) (per previous projects)

o Electricity cost 0.09 $USD/kWh

Annual O&M - Advanced/Decentralized Treatment

o Represents the treatment energy cost (treatment capital cost and O&M in other categories)

o GHD Energy Curve for MBR Treatment Plants (kWh per ML/d capacity). For larger through to smaller MFR & COM treatment plant capacities this ranges between 1400-2100 kWh/ML (5300-7950 kWh/MG)

Annual O&M - Conventional W/WW Treatment

o Not applicable

Annual Purchase/Import Cost

o Not applicable

SCENARIO 1 - MFR - IRR, TL, CW; COM - IRR, TL, CW, HVC

Capital Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost	$ -	$ -	$ -	$ -	$ -	$ -
Customer Cost	$ 10,298,450,129	$ 3,604,457,545	$ 514,922,506	$ -	$ -	$ 14,417,830,181
Community Cost	$ 10,298,450,129	$ 3,604,457,545	$ 514,922,506	$ -	$ -	$ 14,417,830,181

Annual Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost	$ -	$ -	$ -	$ -	$ -	$ -
Customer Cost	$ 480,594,339	$ 488,653,797	$ 13,094,353	$ 15,685,328	$ -	$ -
Community Cost**	$ 480,594,339	$ 488,653,797	$ 13,094,353	$ 15,685,328	$ -	$ -

Unit Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	$ -	$ -
Customer Cost	$ 998,027,817	$ 12,692
Community Cost**	$ 998,027,817	$ 12,692

*Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

Per System Cost Summary (current dollars):

Note: Represents average per project opportunity/system cost

	SFR	MFR	Non-Residential
Capital Cost	N/A	$ 175,286	$ 232,702
Annual O&M	N/A	$ 8,797	$ 11,707

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

High	This option is not significantly impacted by hydrologic or climatic variability.

Comments:

Literature Review/Case Studies:

References:

1. https://sfwater.org/index.aspx?page=1156

Austin WATER | WATER FORWARD INTEGRATED WATER RESOURCE PLAN

Supply Option Name:

Aquifer Storage and Recovery (ASR)

DRAFT RESULTS 7/28/17

Short Description:

Carrizo-Wilcox ASR (Conventional) used as the representative option for analysis

Other ASR options considered in screening and combined for this option:
o Trinity ASR
o Edwards ASR
o Carrizo-Wilcox ASR (Infiltration)

Details:

Aquifer storage and recovery is a strategy in which water (ex: potable drinking water) can be stored in an aquifer during wetter periods and recovered for use during drier periods. Storing water underground can improve drought preparedness and reduces the amount of water that evaporates compared to water storage in open above-ground reservoirs. This type of strategy is currently being used by cities in Texas including San Antonio, Kerrville and El Paso. Exploring aquifer storage and recovery as a potential option was a recommendation of the 2014 Task Force and has been analyzed by Austin Water as part of Feasibility and Engineering Analysis #5 (Northern Edwards and Trinity Aquifers).

Carrizo-Wilcox ASR (Conventional) option includes facilities to pipe treated drinking water from the City of Austin's distribution system to an ASR wellfield for injection and storage in the Carrizo-Wilcox aquifer. Facilities also include a pump station and storage tank to convey recovered water from the ASR wellfield to the City of Austin distribution system.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

All End Uses and Development Types

Characterization Year: 2115

Intended use of supply: Drought

Supply Type: Storage

Timing of Implementation: NA

Lifespan (years): 30

YIELD ANALYSIS

Assumptions:

o 5 cycles: 4 years in at 15,000 AF/y, 2 years out at 30,000 AF/y

Average Weather Yield Summary (Acre Feet):

*Drought yields to be determined

Annual Yield (AF/Year)
10,000

COST ANALYSIS

Assumptions:

Capital Cost – Facilities
o Reversible pipeline 28 miles long, sized for 30,000 AF/yr
o Wells at 1,800 gpm each
o Pump station in at 15,000 AF/y, out at 30,000 AF/yr
Engineering, Legal Costs and Contingencies
o 35% cost of facilities
Mitigation and Permitting
o 5% cost of facilities
Land Acquisition
o Calculated at 4% cost of facilities
Annual O&M – Labor & Material
o Consultant estimate
Annual O&M – Energy
o Pipeline in at 15,000 AF/y, out at 30,000 AF/yr
o Wells' energy use based on estimated pumping level at 30,000 AF/yr
o Electricity cost 0.09 $USD/kWh
Annual O&M - Advanced/Decentralized Treatment
o None
Annual O&M - Conventional W/WW Treatment
o Calculated based on proportion of water and wastewater treatment for each option
Annual Purchase/Import Cost
o None

Capital Cost Summary (current dollars):

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest (5% over 30 yrs)	Total Capital/Upfront/ Interest/Land Cost
Community Cost**	$69,120,780	$24,192,273	$6,912,078	$2,764,831	$97,999,384	$200,989,347

Annual Cost Summary (current dollars):

	Annual Capital/Upfront /Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Community Cost**	$6,699,645	$650,000	$1,100,000	$0	$2,081,862	$0

Unit Cost Summary (current dollars):

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Community Cost**	$ 10,531,507	$1,053

*Annual Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

High	Little sensitivity to variation in hydrology or climate. Recovery rate may be influenced by fluctuations in supply available for storage.

Comments:

Underground storage option; water not subject to evaporation

Literature Review/Case Studies:

http://www.saws.org/Your_Water/WaterResources/projects/asr.cfm

References:

Water Forward IWRP Consultant team developed cost and yield information for this option

Austin WATER | WATER FORWARD INTEGRATED WATER RESOURCE PLAN

Supply Option Name:

Brackish Groundwater Desalination

DRAFT RESULTS 7/28/17

Short Description:

Desalination of brackish groundwater; source aquifer for option concept is the Trinity Aquifer

Details:

Desalination is the process of removing dissolved solids from seawater or brackish groundwater, often by forcing the source water through membranes under high pressure. The specific process used to desalinate water varies depending upon the total dissolved solids, the temperature, and other physical characteristics of the source water but always requires disposal of concentrate that has a higher total dissolved content than the source water. Disposal may take the form of an injection well, evaporation beds, or an ocean outfall diffuser. Exploring desalination of brackish groundwater as a potential option was a recommendation of the 2014 Task Force.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

All End Uses and Development Types

Characterization Year: 2115

Intended use of supply: Constant

Supply Type: Desalination

Timing of Implementation: NA

Lifespan (years): 30

YIELD ANALYSIS

Assumptions:

o Estimated based on typical Trinity well capacity

Average Weather Yield Summary (Acre Feet):

*Drought yields to be determined

Annual Yield (AF/Year)
10,000

COST ANALYSIS

Assumptions:

Capital Cost – Facilities
o All-in costs from SAWS on a similar project
o Pipeline distance of approximately 22 miles, 75% rural, 25% urban
Engineering, Legal Costs and Contingencies
o 35% cost of facilities
Mitigation and Permitting
o 5% cost of facilities
Land Aquisition
o 4% cost of facilities
Annual O&M – Labor & Material
o Based on SAWS project O&M costs
Annual O&M – Energy
o Estimated based on pipeline length and pumping level
o Electricity cost 0.09 $USD/kWh
Annual O&M - Advanced/Decentralized Treatment
o Water treatment (2.5% cost of facilities)
Annual O&M - Conventional W/WW Treatment
o Calculated based on proportion of water and wastewater treatment for each option
Annual Purchase/Import Cost
o Not applicable

Capital Cost Summary (current dollars):

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest (5% over 30 yrs)	Total Capital/Upfront/ Interest/Land Cost
Community Cost**	$200,885,586	$70,309,955	$10,044,279	$8,035,423	$275,257,849	$564,533,093

Annual Cost Summary (current dollars):

	Annual Capital/Upfront /Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Community Cost**	$18,817,770	$1,370,000	$1,100,000	$5,022,140	$586,206	$0

Unit Cost Summary (current dollars):

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Community Cost**	$ 26,896,115	$2,690

*Annual Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

Medium	Sensitivity to variations in climate and hydrology would vary depending on source aquifer and utilization rates.

Comments:

Literature Review/Case Studies:

SAWS Groundwater Desalination Project (http://www.saws.org/Your_Water/WaterResources/Projects/desal.cfm) - Wilcox Aquifer

References:

Water Forward IWRP Consultant team developed cost and yield information for this option

Austin WATER | WATER FORWARD
INTEGRATED WATER RESOURCE PLAN

Supply Option Name:

Direct Non-potable Reuse (Reclaimed Water System)

DRAFT RESULTS 7/28/17

Short Description:

Reclaimed water purple pipe system expansion (based on current Master Plan and Region K Plan); Expanded option beyond Master Plan/Region K Plan currently under development

Details:

Through its Water Reclamation Initiative (WRI) program, AW provides highly treated wastewater effluent for non-potable uses such as irrigation, cooling, manufacturing, and toilet flushing. Austin's direct reuse (purple pipe) system currently supplies approximately 4,600 AF per year. To meet projected demands, an additional 28,000 AFY are needed for direct municipal purposes by year 2070. An additional 10,500 AFY were projected for steam electric needs in Travis County.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

Non-potable End Uses, Both Development Types

Characterization Year: 2115

Intended use of supply: Constant

Supply Type: Reuse

Timing of Implementation: NA

Lifespan (years): 30

YIELD ANALYSIS

Assumptions:

o 4,600 AFY existing direct reuse supply
o Additional 28,000 AFY for direct municipal and manufacturing non-potable purposes
o Additional 10,500 AFY of COA direct non-potable use for steam electric needs in Travis County
o Expanded option beyond Master Plan/Region K Plan currently under development

Average Weather Yield Summary (Acre Feet):

*Drought yields to be determined

Annual Yield (AF/Year)
43,100

COST ANALYSIS

Assumptions:

Capital Cost – Facilities
o Intake pump station
o Transmission pipeline
o Storage tanks
o Wastewater treatment plant filter and process improvements
Engineering, Legal Costs and Contingencies
o 35% cost of facilities
Mitigation and Permitting
o 5% cost of facilities
Land Acquisition
o Calculated at 4% cost of facilities
Annual O&M – Labor & Material
o Intake, pipeline, pump station (1% cost of facilities)
Annual O&M – Energy
o Approx. 8,910,000 kW-hr per year
o Electricity cost 0.09 $USD/kWh
Annual O&M - Advanced/Decentralized Treatment
o Water treatment (2.5% cost of facilities)
Annual O&M - Conventional W/WW Treatment
o Calculated based on proportion of water and wastewater treatment for each option
Annual Purchase/Import Cost
o Not applicable
Note: additional cost estimates including customer costs and costs for expanded option beyond Master Plan/Region K Plan, are currently under development.

Capital Cost Summary (current dollars):

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest (5% over 30 yrs)	Total Capital/Upfront/ Interest/Land Cost
Community Cost**	$403,697,211	$141,294,024	$20,184,861	$16,624,000	$553,607,839	$1,135,407,934

Annual Cost Summary (current dollars):

	Annual Capital/Upfront /Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Community Cost**	$37,846,931	$4,036,972	$801,900	$10,092,430	$180,468	$0

Unit Cost Summary (current dollars):

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Community Cost**	$ 52,958,701	$1,229

*Annual Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

High	Actual water demands may increase faster/slower than projected.

Comments:

Literature Review/Case Studies:

https://www.austintexas.gov/department/water-reclamation

References:

Austin Water - Direct Reuse Strategy in Region K Plan used as references for cost and yield information; Region K Water Plan, Vol2, pages 5-55 through 5-57, Chapter 5 Appendix pdf page 53
http://www.regionk.org/wp-content/uploads/2016_Region_K_Plan_Chpt_5.pdf
http://www.regionk.org/wp-content/uploads/2016_Region_K_Plan_Chpt_5_Appendices.pdf

Austin WATER | WATER FORWARD INTEGRATED WATER RESOURCE PLAN

Supply Option Name:

Direct Potable Reuse (DPR)

DRAFT RESULTS 7/28/17

Short Description:

Direct Potable Reuse

Details:

This option would convey highly treated reclaimed water from one treatment train at South Austin Regional (SAR) WWTP to the Ullrich WTP to meet city demands. This approach would include advanced water treatment, potentially including microfiltration and reverse osmosis. The treated water would then be blended with raw water prior to being pumped back to the headworks of Ullrich WTP for conventional treatment.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

All End Uses and Development Types

Characterization Year: 2115

Intended use of supply: Variable

Supply Type: Reuse

Timing of Implementation: NA

Lifespan (years): 30

YIELD ANALYSIS

Assumptions:

o Estimated based on approximate yield available from one treatment train at South Austin Regional WWTP.

Average Weather Yield Summary (Acre Feet):

*Drought yields to be determined

Annual Yield (AF/Year)
20,000

COST ANALYSIS

Assumptions:

Capital Cost – Facilities
o Pump station at WWTP
o Transmission pipeline from WWTP to WTP (approx. 15 miles)
o Membrane plant and UV facility to treat reclaimed water and blend with raw water before introducing to WTP
Engineering, Legal Costs and Contingencies
o 35% cost of facilities
Mitigation and Permitting
o 15% cost of facilities
Land Acquisition
o 4% cost of facilities
Annual O&M – Labor & Material
o Intake, pipeline, pump station (1% cost of facilities)
Annual O&M – Energy
o Approx. 5,000,000 kW-hr per year
o Electricity cost 0.09 $USD/kWh
Annual O&M - Advanced/Decentralized Treatment
o Water treatment (2.5% cost of facilities)
Annual O&M - Conventional W/WW Treatment
o Calculated based on proportion of water and wastewater treatment for each option
Annual Purchase/Import Cost
o Not applicable

Capital Cost Summary (current dollars):

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest (5% over 30 yrs)	Total Capital/Upfront/ Interest/Land Cost
Community Cost**	$291,984,864	$102,194,702	$43,797,730	$11,679,395	$427,867,700	$877,524,390

Annual Cost Summary (current dollars):

	Annual Capital/Upfront /Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Community Cost**	$29,250,813	$2,919,849	$450,000	$7,299,622	$4,163,724	$0

Unit Cost Summary (current dollars):

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Community Cost**	$ 44,084,007	$ 2,204

*Annual Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

High	Supplies all end uses and moves toward closed loop supply.

Comments:

Literature Review/Case Studies:

Texas Water Development Board - Direct Potable Reuse Resource Document (April 2015)
http://www.twdb.texas.gov/publications/reports/contracted_reports/doc/1248321508_Vol1.pdf?d=1501294805363

References:

Conceptually, treatment facilities and other necessary infrastructure associated with this option would be constructed at South Austin Regional WWTP using same approach as Big Spring and Wichita Falls

Austin WATER | WATER FORWARD
INTEGRATED WATER RESOURCE PLAN

Supply Option Name:

Indirect Potable Reuse (IPR) with Capture Lady Bird Lake Inflows

DRAFT RESULTS 7/28/17

Short Description:

A combined option of IPR Through Lady Bird Lake and Capture Lady Bird Lake Inflows used as the representative option for analysis.

Other options considered in screening and combined for this option:
o IPR - Alluvial Aquifer
o IPR - Bed and Banks

Details:

This option would convey highly treated reclaimed water from one treatment train at South Austin Regional (SAR) WWTP to Lady Bird Lake and subsequently divert water by a potential new intake pump and piping system downstream of Tom Miller Dam to the Ullrich WTP to meet city demands. This approach would supplement water releases from Lakes Buchanan and Travis to extend water supplies during severe drought. This option is a drought strategy that would be recommended for implementation in the event of 400,000 AF of combined storage or less in Lakes Buchanan and Travis. In addition, this option would capture available spring flows into Lady Bird Lake and convey the water to Ullrich WTP through a potential new intake pump and piping system.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

All End Uses and Development Types

Characterization Year: 2115

Intended use of supply: Drought

Supply Type: Reuse

Timing of Implementation: NA

Lifespan (years): 30

YIELD ANALYSIS

Assumptions:

o Estimated based on approximate yield available from one treatment train at South Austin Regional WWTP: 20,000 AFY (drought option)
o Yield from capturing spring inflows estimated based on analysis conducted as part of Austin Water's Feasibility and Engineering Analysis (FEA) #4: long term average: 3,000 AFY

Average Weather Yield Summary (Acre Feet):

Annual Yield (AF/Year)
3,000

Target Drought Yield Summary (Acre Feet):

Annual Yield (AF/Year)
20,000

COST ANALYSIS

Assumptions:

Capital Cost – Facilities
o Pump stations (25MGD capacity) to convey treated effluent from SAR WWTP to Lady Bird Lake, just upstream of Longhorn Dam
o Transmission line from SAR WWTP to Lady Bird Lake, just upstream of Longhorn Dam (48-inch pipeline, 10 miles)
o Intake & Pump station (20 MGD capacity) & Transmission line from pump station to Ullrich intake
Engineering, Legal Costs and Contingencies
o 35% cost of facilities
Mitigation and Permitting
o 5% cost of facilities
Land Acquisition
o 4% cost of facilities
Annual O&M – Labor & Material
o Intake, pipeline, pump station (1% cost of facilities)
Annual O&M – Energy
o Approx. 900,000 kW-hr per year
o Electricity cost 0.09 $USD/kWh
Annual O&M - Advanced/Decentralized Treatment
o Water treatment (2.5% cost of facilities)
Annual O&M - Conventional W/WW Treatment
o Calculated based on proportion of water and wastewater treatment for each option
Annual Purchase/Import Cost
o Not applicable

Capital Cost Summary (current dollars):

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest (5% over 30 yrs)	Total Capital/Upfront/ Interest/Land Cost
Community Cost**	$61,100,793	$21,385,278	$3,055,040	$2,444,032	$83,721,651	$171,706,794

Annual Cost Summary (current dollars):

	Annual Capital/Upfront /Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Community Cost**	$5,723,560	$611,008	$81,000	$1,527,520	$4,163,724	$0

Unit Cost Summary (current dollars):

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Community Cost**	$ 12,106,812	$ 605

*Annual Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

High	Supplies all end uses and moves toward closed loop supply.

Comments:

Indirect Potable Reuse (IPR) Through Lady Bird Lake (LBL) is a drought option that would be recommended for implementation in the event of 400,000 AF of combined storage or less in Lakes Buchanan and Travis. Approximate drought yield target volume of 20,000 AFY used for unit cost calculation. Average weather yield of approximately 3,000 AFY is based on long term average yield estimate for the Capture Local Inflow to Lady Bird Lake option.

The capital cost estimates for the IPR Through LBL option include the infrastructure costs for the Capture Local Inflows to LBL option. For the operations and maintenance (O&M) costs, the IPR through LBL option was assumed to be in drought operation mode (approximate 20,000 AFY). Under average weather conditions the O&M costs would be significantly lower due to the lower amount of long-term average yield for the Capture Local Inflow to LBL option (approximately 3,000 AFY).

Literature Review/Case Studies:

References:

Austin Water - Capture Local Inflows to Lady Bird Lake and Indirect Potable Reuse Strategy in Region K Plan used as references for developing cost and yield information; Region K Water Plan, Vol2, pages 5-65 through 5-68, Chapter 5 Appendix pdf pages 59 and 60
http://www.regionk.org/wp-content/uploads/2016_Region_K_Plan_Chpt_5.pdf
http://www.regionk.org/wp-content/uploads/2016_Region_K_Plan_Chpt_5_Appendices.pdf
Feasibility and Engineering Analysis (FEA2 and FEA4) draft reports

Austin WATER | WATER FORWARD INTEGRATED WATER RESOURCE PLAN

Supply Option Name:

Additional Supply from Lower Colorado River Authority (LCRA)

DRAFT RESULTS 7/28/17

Short Description:

Additional Supply from LCRA

Details:

This would involve securing additional supply from the Lower Colorado River Authority (LCRA). Currently LCRA has approximately 54,600 acre-feet of water available for contracting (50,000 acre-feet of which is the LCRA Board's reserve amount and is subject to contracting approval by the LCRA Board). There could be additional supply volumes available for contracting over time as LCRA plans to continue to develop additional supplies in the future.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

All End Uses and Development Types

Characterization Year: 2115

Intended use of supply: Constant

Supply Type: Surface Water

Timing of Implementation: NA

Lifespan (years): TBD

YIELD ANALYSIS

Assumptions:

o Based on availability per discussion with LCRA.

Average Weather Yield Summary (Acre Feet):

*Drought yields to be determined

Annual Yield (AF/Year)
54,600

COST ANALYSIS

Assumptions:

Capital Cost – Facilities
o Not Applicable
Engineering, Legal Costs and Contingencies
o Not Applicable
Mitigation and Permitting
o Not Applicable
Land Aquisition
o Not Applicable
Annual O&M – Labor & Material
o Not Applicable
Annual O&M – Energy
o Not Applicable
Annual O&M - Advanced/Decentralized Treatment
o Not Applicable
Annual O&M - Conventional W/WW Treatment
o Calculated based on proportion of water and wastewater treatment for each option
Annual Purchase/Import Cost
o Water cost assumed to be $145/AF (current LCRA firm water use rate).
o In the portfolio process, will need to acccount for potential variations in amounts to be secured and timing of reservation fees to secure this water.

Capital Cost Summary (current dollars):

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest (5% over 30 yrs)	Total Capital/Upfront/ Interest/Land Cost
Community Cost**	$0	$0	$0	$0	$0	$0

Annual Cost Summary (current dollars):

	Annual Capital/Upfront /Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Community Cost**	$0	$0	$0	$0	$11,366,967	$7,830,000

Unit Cost Summary (current dollars):

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Community Cost**	$ 19,196,967	$ 352

*Annual Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

Medium	Dependent on variations in climate and hydrology but this risk is buffered some by system storage. Hydrology data from the latest drought (2007-2016) is being prepared for use in updating the firm yield analysis and the LCRA Water Management Plan update scheduled to begin in 2018.

Comments:

Literature Review/Case Studies:

References:

https://www.lcra.org/water/water-supply/water-supply-contracts/Pages/default.aspx

Austin WATER | WATER FORWARD INTEGRATED WATER RESOURCE PLAN

Supply Option Name:

Off-Channel Reservoir (OCR) with Lake Evaporation Suppression

DRAFT RESULTS 7/28/17

Short Description:

This option is a combination of the Off-Channel Reservoir option with the Lake Evaporation Suppression option

Details:

This strategy would involve the construction of a new off-channel reservoir in the Austin region. The approximate size of this reservoir would be about 25,000 AF. An evaporation suppressant would be applied during summer months to reduce water lost through evaporation.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

All End Uses and Development Types

Characterization Year: 2115

Intended use of supply: Constant

Supply Type: Storage

Timing of Implementation: NA

Lifespan (years): 50

YIELD ANALYSIS

Assumptions:

o Off channel reservoir is an estimated yield based on anticipated potential size
o Lake Evaporation Suppression: surface area of 1300 acres; 52.14”/year (median evaporation)

Average Weather Yield Summary (Acre Feet):

*Drought yields to be determined

Annual Yield (AF/Year)
25,827

COST ANALYSIS

Assumptions:

Capital Cost – Facilities
o 25,000 AF off-channel reservoir in the Austin region
o New river intake, pump station, and pipeline (to pump from river to reservoir)
o New pump station and pipeline from the reservoir to the point of use
o Boat for application of lake evaporation suppressant

Engineering, Legal Costs and Contingencies
o 35% cost of facilities

Mitigation and Permitting
o 5% cost of facilities

Land Acquisition
o 4% cost of facilities

Annual O&M – Labor & Material
o Intake, pipeline, pump station (1.5% cost of facilities)

Annual O&M – Energy
o Approx. 3,750,000 kW-hr per year
o Electricity cost 0.09 $USD/kWh

Annual O&M - Advanced/Decentralized Treatment
o Not applicable

Annual O&M - Conventional W/WW Treatment
o Calculated based on proportion of water and wastewater treatment for each option

Annual Purchase/Import Cost
o Not applicable

Capital Cost Summary (current dollars):

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest (5% over 30 yrs)	Total Capital/Upfront/ Interest/Land Cost
Community Cost**	$226,171,476	$79,160,016	$11,307,777	$9,046,222	$309,883,308	$635,568,799

Annual Cost Summary (current dollars):

	Annual Capital/Upfront /Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Community Cost**	$12,713,096	$3,426,229	$337,210	$0	$5,376,825	$0

Unit Cost Summary (current dollars):

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Community Cost**	$ 21,853,361	$ 846

*Annual Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

Medium	Surface water is vulnerable to evaporation. If Colorado River system used as a source of supply, yield would be dependent on rainfall and inflows. If stormwater used as a source of supply, yield would be dependent on rainfall within local watersheds.

Comments:

Literature Review/Case Studies:

References:

Austin WATER | WATER FORWARD INTEGRATED WATER RESOURCE PLAN

CDM Smith

Austin WATER | WATER FORWARD INTEGRATED WATER RESOURCE PLAN

Supply Option Name:

Imported Option Category - Seawater Desalination

DRAFT RESULTS 7/28/17

Short Description:

Seawater Desalination used as the representative option for analysis

Other options considered in screening and combined for this option:
o Conventional Groundwater
o Interbasin Transfer

Details:

This option would involve sourcing water from the Gulf of Mexico and treating it via a desalination plant where dissolved solids are removed by forcing the source water through membranes at high pressure. The specific process used to desalinate water varies depending on the total dissolved solids, the temperature, and other physical characteristics of the source water, but always requires the disposal of concentrate that has a higher total dissolved content than the source water. Disposal may take the form of an injection well, evaporation beds, or an ocean outfall diffuser. This option could be implemented through a regional partnership approach.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

All End Uses and Development Types

Characterization Year: 2115

Intended use of supply: Constant

Supply Type: Desalination

Timing of Implementation: NA

Lifespan (years): 30

YIELD ANALYSIS

Assumptions:

o This is a large scale imported water option. Yield has been scaled to reflect the large-scale nature of the infrastructure required.

*Drought yields to be determined

Average Weather Yield Summary (Acre Feet):

Annual Yield (AF/Year)
84,000

COST ANALYSIS

Assumptions:

Capital Cost – Facilities
o 75MGD desalination facility
o Intake Pump Station
o Transmission Pipeline (approximately 250 miles)
o Concentrate Disposal Pipeline
o Transmission Pump Stations
o Treatment Plant
o Distribution Improvements- Terminal Storage

Engineering, Legal Costs and Contingencies
o 35% cost of facilities

Mitigation and Permitting
o 5% cost of facilities

Land Acquisition
o Land acquisition is scaled from San Antonio Bay Desal Project, based on mileage

Annual O&M – Labor & Material
o Intake, pipeline, pump station (1% cost of facilities)

Annual O&M – Energy
o Approx. 250,000,000 kW-hr per year
o Electricity cost 0.09 $USD/kWh

Annual O&M - Advanced/Decentralized Treatment
o Water treatment based on SAWS project

Annual O&M - Conventional W/WW Treatment
o Calculated based on proportion of water and wastewater treatment for each option

Annual Purchase/Import Cost
o Not applicable

Capital Cost Summary (current dollars):

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest (5% over 30 yrs)	Total Capital/Upfront/ Interest/Land Cost
Community Cost**	$1,393,976,750	$487,891,862	$69,698,837	$55,759,070	$1,910,057,604	$3,917,384,123

Annual Cost Summary (current dollars):

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Community Cost**	$130,579,471	$7,925,246	$22,500,000	$76,213,000	$17,487,641	$0

Unit Cost Summary (current dollars):

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Community Cost**	$ 254,705,358	$ 3,032

*Annual Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

High	Minimal dependence on hydrologic and climate variability.

Comments:

Literature Review/Case Studies:

http://www.twdb.texas.gov/innovativewater/desal/seaprojects.asp

References:

2016 Region L Water Plan (used for reference scaling)
2016 Region L Water Plan, Vol2, pdf pg 275-293 (San Antonio Bay Desal Project)

Supply Option Name:

Community Rainwater Harvesting

DRAFT RESULTS 8/1/17

Short Description:

Community Scale Rainwater Harvesting and Reuse

Details:

Community scale rainwater harvesting is defined for the purpose of this project as the collection of roofwater from new development areas from a dedicated (dual) roofwater drainage network for storage at a central downstream location, for treatment and reuse via dual pipe systems at new developments at the community scale. This is assumed to require UV Disinfection. Storage is assumed to be an underground tank/cistern. This option assumes back-up supply from the centralized water distribution system.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

1. Outdoor + Indoor Non Potable: SFR, MFR, COM - IRR, TL , CW, HVC and COA - IRR

Characterization Year: 2115

Intended use of supply: Variable

Supply Type: Decentralized

Timing of Implementation: NA

Lifespan (years): 50

DEMAND MET BY OPTION ANALYSIS

Assumptions:

Demand

o Variable per DTI (estimated from demand model)

o Monthly outdoor demand profile generated using historical gross lake evaporation data (quadrangle 811) and precipitation data in a standard irrigation model to account for monthly and year to year variation in outdoor demand based on climate.

Yield

o Daily rainfall analyzed for the historical period (1938 – 2016) using Station: AUSTIN CAMP MABRY TX US

o Note: Climate change adjusted dataset can be used instead of historical dataset in the portfolio evaluation process

o Connected Catchment Area = 67% (of total roof catchment area). This is an allowance for not all roof areas being able to be connected.

o Runoff coefficient = 0.9

Year

Analysis completed at ultimate timeslice of 2115.

Average Weather Demand Met By Option in 2115 Summary (Acre Feet):

Note: Drought yields to be determined. Results reported from the 75th percentile of project opportunities/systems identified in the analysis. Yields are subject to change dependent on implementation approach and portfolio context. Annual cumulative volume represents the total volume produced from all systems identified within the 75th percentile. Annual average system volume represents the average yield from each project opportunity/system.

SCENARIO 1 - Outdoor + Indoor Non Potable: SFR, MFR, COM - IRR, TL , CW, HVC and COA - IRR

Annual Cumulative Volume (AF/Year)	1,540
Annual Average System Volume (Gal/Year)	33,464,807

COST ANALYSIS

Assumptions:

NB: Capital and Annual O&M costs may be borne by the customer/developer or the Utility. The below costs are total community costs.

Capital Cost – Facilities

o Cost elements calculated for each project opportunity using unit costs and cost curves from GHD's cost databases, and using water balance outputs (demand and supply volumes) and GIS outputs (e.g. number of houses, buildings, area serviced, transfer distance, etc.)

o Cost elements include:
- Roofwater Collection System (dual roofwater drainage system)
- Storage
- Treatment
- Balancing storage
- Transfer pump station and pipeline
- Distribution pipelines (e.g. throughout streets)
- Reticulation (e.g. on-lot & within building)

Engineering, Legal Costs and Contingencies

o 35% cost of facilities

Mitigation and Permitting

o 5% cost of facilities

Annual O&M – Labor & Material

o Estimated as proportion of capital costs (Civil 1%, Pumps 5%, Treatment 5%)

Annual O&M – Energy

o Pumping energy calculated based on estimated design flow, hours operation, and pump duty power, for a project opportunity

o Electricity cost 0.09 $USD/kWh

Annual O&M - Advanced/Decentralized Treatment

o Represents the treatment energy cost (treatment capital costs and O&M in other categories)

o UV Disinfection: 82 kWh/ML (310 kWh/MG)

Annual O&M - Conventional W/WW Treatment

o Not applicable

Annual Purchase/Import Cost

o Not applicable

SCENARIO 1 - Outdoor + Indoor Non Potable: SFR, MFR, COM - IRR, TL , CW, HVC and COA - IRR

Capital Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost	$ 184,090,753	$ 64,431,764	$ 9,204,538		$ 245,238,388	$ 502,965,442
Customer Cost	$ 39,002,927	$ 13,651,024	$ -	$ -	$ -	$ 52,653,951
Community Cost	$ 223,093,680	$ 78,082,788	$ 9,204,538	$ -	$ 245,238,388	$ 555,619,393

Annual Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost	$ 10,059,309	$ 3,661,376	$ 14,907	$ 18,698	$ -	$ -
Customer Cost	$ 1,053,079	$ -	$ -	$ -	$ -	$ -
Community Cost**	$ 11,112,388	$ 3,661,376	$ 14,907	$ 18,698	$ -	$ -

Unit Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	$ 13,754,290	$ 8,928
Customer Cost	$ 1,053,079	$ 684
Community Cost**	$ 14,807,369	$ 9,612

*Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

Per System Cost Summary (current dollars):

Note: Represents average per project opportunity/system cost

Capital Cost	$ 12,272,717
Annual O&M	$ 246,332

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

Medium	Annual yields may vary from year to year.

Comments:

Literature Review/Case Studies:

References:

http://www.wannonwater.com.au/2015/june/roof-water-harvesting-project-expanded-in-warrnambool.aspx

Supply Option Name:

Community Stormwater Harvesting

DRAFT RESULTS 8/1/17

Short Description:

Community Scale Stormwater Harvesting and Reuse

Details:

Stormwater harvesting is defined for the purpose of this project as the collection of stormwater runoff from urban areas (e.g. impervious surfaces including roads, pavements and roofs), for treatment and reuse for irrigation/landscaping or reuse for dual pipe systems at the community scale.

Implementing stormwater harvesting in new developments provides an opportunity to plumb buildings with internal connections for toilet flushing, clothes washing or to cooling towers. Retrofitting existing buildings with internal connections to a dual supply source can be cost prohibitive and/or practically difficult, and so it is assumed for the purposes of this study that stormwater harvesting for existing developed areas would be used solely for irrigation/landscaping of public open space. Where used for irrigation/landscaping only, it is assumed that there will be filtration. Where used to supply indoor non-potable end-uses, it is assumed UV Disinfection is also required. Storage is assumed to be an underground tank/cistern or more typically an open storage. All scenarios assume back-up supply from the centralized water distribution system.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

1. Outdoor: SFR, MFR, COM - IRR
2. Outdoor + Indoor Non Potable: SFR, MFR, COM - IRR, TL , CW, HVC and COA - IRR

Characterization Year: 2115

Intended use of supply: Variable

Supply Type: Decentralized

Timing of Implementation: NA

Lifespan (years): 50

DEMAND MET BY OPTION ANALYSIS

Assumptions:

Demand
o Variable per DTI (estimated from demand model)
o Monthly outdoor demand profile generated using historical gross lake evaporation data (quadrangle 811) and precipitation data in a standard irrigation model to account for monthly and year to year variation in outdoor demand based on climate.
Yield
o Daily rainfall analyzed for the historical period (1938 – 2016) using Station: AUSTIN CAMP MABRY TX US
o Note: Climate change adjusted dataset can be used instead of historical dataset in the portfolio evaluation process
o Connected Catchment Area = 67% (of total impervious catchment area). This is an allowance for not all runoff generated onsite necessarily being directed to one location.
o Runoff coefficient = 0.9
o Perviousness per Land Use type (assumptions drawn from Remaining Pervious 2013 dataset obtained from the Austin Open Data Portal) applied to future (2070) land use map to calculate future stormwater runoff volumes.
o Catchment Areas of proposed storages calculated from Travis County Contours 2012 (dataset obtained from the Austin Open Data Portal). Alternatively, for new development areas, the development itself is taken as the stormwater catchment.
o Stormwater may be harvested from storm drains or flood detention structures
Year
Analysis completed at ultimate timeslice of 2115.

Average Weather Demand Met By Option in 2115 Summary (Acre Feet):

Note: Drought yields to be determined. Results reported from the 75th percentile of project opportunities/systems identified in the analysis. Yields are subject to change dependent on implementation approach and portfolio context. Annual cumulative volume represents the total volume produced from all systems identified within the 75th percentile. Annual average system volume represents the average yield from each project opportunity/system.

SCENARIO 1 - Outdoor: SFR, MFR, COM - IRR

Annual Cumulative Volume (AF/Year)	10,700
Annual Average System Volume (Gal/Year)	25,449,796

SCENARIO 2 - Outdoor + Indoor Non Potable: SFR, MFR, COM - IRR, TL , CW, HVC and COA - IRR

Annual Cumulative Volume (AF/Year)	22,387
Annual Average System Volume (Gal/Year)	46,169,282

COST ANALYSIS

Assumptions:

NB: Capital and Annual O&M costs may be borne by the customer/developer or the Utility. The below costs are total community costs.

Capital Cost – Facilities

o Cost elements calculated for each project opportunity using unit costs and cost curves from GHD's cost databases, and using water balance outputs (demand and supply volumes) and GIS outputs (e.g. number of houses, buildings, area serviced, transfer distance, etc.)

o Cost elements include:

- Diversion structures (e.g. pit and pipeline)
- Storage
- Treatment
- Balancing storage
- Transfer pump station and pipeline
- Distribution pipelines (e.g. throughout streets)
- Reticulation (e.g. on-lot & within building)

Engineering, Legal Costs and Contingencies

o 35% cost of facilities

Mitigation and Permitting

o 5% cost of facilities

Annual O&M – Labor & Material

o Estimated as proportion of capital costs (Civil 1%, Pumps 5%, Treatment 5%)

Annual O&M – Energy

o Pumping energy calculated based on estimated design flow, hours operation, and pump duty power, for a project opportunity

o Electricity cost 0.09 $USD/kWh

Annual O&M - Advanced/Decentralized Treatment

o Represents the treatment energy cost (treatment capital costs and O&M in other categories)

o For outdoor use: 82 kWh/ML (310 kWh/MG)

o For indoor use: 822 kWh/ML (3100 kWh/MG)

Annual O&M - Conventional W/WW Treatment

o Not applicable

Annual Purchase/Import Cost

o Not applicable

SCENARIO 1 - Outdoor: SFR, MFR, COM - IRR

Capital Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost	$ 221,163,653	$ 77,407,279	$ 11,058,183	$ -	$ 294,625,433	$ 604,254,548
Customer Cost	$ -	$ -	$ -	$ -	$ -	$ -
Community Cost	$ 221,163,653	$ 77,407,279	$ 11,058,183	$ -	$ 294,625,433	$ 604,254,548

Annual Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost	$ 12,085,091	$ 3,939,736	$ 133,652	$ 129,871	$ -	$ -
Customer Cost	$ -	$ -	$ -	$ -	$ -	$ -
Community Cost**	$ 12,085,091	$ 3,939,736	$ 133,652	$ 129,871	$ -	$ -

Unit Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	$ 16,288,350	$ 1,522
Customer Cost	$ -	$ -
Community Cost**	$ 16,288,350	$ 1,522

Per System Cost Summary (current dollars):

Note: Represents average per project opportunity/system cost

Capital Cost	$ 1,614,333
Annual O&M	$ 30,681

SCENARIO 2 - Outdoor + Indoor Non Potable: SFR, MFR, COM - IRR, TL , CW, HVC and COA - IRR

Capital Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost	$ 674,445,435	$ 236,055,902	$ 33,722,272	$ -	$ 898,469,416	$ 1,842,693,025
Customer Cost	$ 306,617,371	$ 107,316,080	$ -	$ -	$ -	$ 413,933,451
Community Cost	$ 981,062,806	$ 343,371,982	$ 33,722,272	$ -	$ 898,469,416	$ 2,256,626,476

Annual Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost	$ 36,853,861	$ 25,058,469	$ 207,908	$ 1,988,181	$ -	$ -
Customer Cost	$ 8,278,669	$ -	$ -	$ -	$ -	$ -
Community Cost**	$ 45,132,530	$ 25,058,469	$ 207,908	$ 1,988,181	$ -	$ -

Unit Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	$ 64,108,419	$ 2,864
Customer Cost	$ 8,278,669	$ 370
Community Cost**	$ 72,387,088	$ 3,233

*Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

Per System Cost Summary (current dollars):

Note: Represents average per project opportunity/system cost

Capital Cost	$ 4,268,642
Annual O&M	$ 172,497

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

Medium	Annual yields may vary from year to year.

Comments:

Literature Review/Case Studies:

References:

1. Waller Creek Case Study
2. Brentwood Case Study
3. http://www.twdb.texas.gov/publications/brochures/conservation/doc/RainwaterHarvestingManual_3rdedition.pdf
4. https://austintexas.gov/faq/rainwater-harvesting
5. Using Graywater and Stormwater to Enhance Supplies: An Assessment of Risks, Costs and Benefits (National Academy of Sciences)

Austin WATER | WATER FORWARD INTEGRATED WATER RESOURCE PLAN

Supply Option Name:

Distributed Waste Water Reuse

DRAFT RESULTS 8/1/17

Short Description:

Community scale distributed waste water reuse

Details:

Distributed Wastewater Reuse is defined for the purpose of this project as the collection of wastewater from the sewerage system in new development areas, treatment to Type 1 quality, and reuse at the local/community scale. These facilities would be completely separate from the centralized wastewater collection system. Facilities may be located at the site of existing local WWTP, or at new potential sites.

Reuse via a dual (purple) pipe system will supply irrigation, landscaping, toilet, laundry (clothes washing), and cooling demands. Treatment plants are sized to meet demand and peak wet weather flow.

Reuse from this option is not considered for outdoor end uses in Critical Water Quality Zones, floodplains, or the Edwards Aquifer Recharge Zone.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

1. Outdoor + Indoor Non Potable: SFR, MFR, COM - IRR, TL , CW, HVC and COA - IRR

Characterization Year: 2115

Intended use of supply: Variable

Supply Type: Decentralized

Timing of Implementation: NA

Lifespan (years): 50

DEMAND MET BY OPTION ANALYSIS

Assumptions:

Demand

o Variable per DTI (estimated from demand model)

o Monthly outdoor demand profile generated using historical gross lake evaporation data (quadrangle 811) and precipitation data in a standard irrigation model to account for monthly and year to year variation in outdoor demand based on climate.

Yield

o Yield calculated from a water balance calculation (with both wastewater generation and end use demands calculated from disaggregating total future DTI demand by customer class to the land use area within the project area).

Year

Analysis completed at ultimate timeslice of 2115.

Average Weather Demand Met By Option in 2115 Summary (Acre Feet):

Note: Drought yields to be determined. Results reported from the 75th percentile of project opportunities/systems identified in the analysis. Yields are subject to change dependent on implementation approach and portfolio context. Annual cumulative volume represents the total volume produced from all systems identified within the 75th percentile. Annual average system volume represents the average yield from each project opportunity/system.

SCENARIO 1 - Outdoor + Indoor Non Potable: SFR, MFR, COM - IRR, TL , CW, HVC and COA - IRR

Annual Cumulative Volume (AF/Year)	31,391
Annual Average System Volume (Gal/Year)	1,461,260,173

COST ANALYSIS

Assumptions:

NB: Capital and Annual O&M costs may be borne by the customer/developer or the Utility. The below costs are total community costs.

Capital Cost – Facilities

o Cost elements calculated for each project opportunity using unit costs and cost curves from GHD's cost databases, and using water balance outputs (demand and supply volumes) and GIS outputs (e.g. number of houses, buildings, area serviced, transfer distance, etc.)

o Cost elements include:

- Treatment (sized for wet weather flows)
- Balancing storage
- Transfer pump station and pipeline
- Distribution pipelines (e.g. throughout streets)
- Reticulation (e.g. on-lot & within building)

Engineering, Legal Costs and Contingencies

o 35% cost of facilities

Mitigation and Permitting

o 5% cost of facilities

Annual O&M – Labor & Material

o Estimated as proportion of capital costs (Civil 1%, Pumps 5%, Treatment 5%)

Annual O&M – Energy

o Pumping energy calculated based on estimated design flow, hours operation, and pump duty power, for a project opportunity

o Electricity cost 0.09 $USD/kWh

Annual O&M - Advanced/Decentralized Treatment

o Represents the treatment energy cost (treatment capital costs and O&M in other categories)

o GHD Energy Curve for MBR Treatment Plants (kWh per ML/d capacity)

Annual O&M - Conventional W/WW Treatment

o Not applicable

Annual Purchase/Import Cost

o Not applicable

SCENARIO 1 - Outdoor + Indoor Non Potable: SFR, MFR, COM - IRR, TL , CW, HVC and COA - IRR

Capital Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost	$ 353,739,609	$ 123,808,863	$ 17,686,980	$ -	$ 471,237,855	$ 966,473,308
Customer Cost	$ 335,795,957	$ 117,528,585	$ -	$ -	$ -	$ 453,324,542
Community Cost**	$ 689,535,567	$ 241,337,448	$ 17,686,980	$ -	$ 471,237,855	$ 1,419,797,850

Annual Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost	$ 19,329,466	$ 16,867,063	$ 309,147	$ 3,292,390	$ -	$ -
Customer Cost	$ 9,066,491	$ -	$ -	$ -	$ -	$ -
Community Cost**	$ 28,395,957	$ 16,867,063	$ 309,147	$ 3,292,390	$ -	$ -

Unit Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	$ 39,798,067	$ 1,268
Customer Cost	$ 9,066,491	$ 289
Community Cost**	$ 48,864,558	$ 1,557

*Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

Per System Cost Summary (current dollars):

Note: Represents average per project opportunity/system cost

Capital Cost	$ 50,534,230
Annual O&M	$ 2,924,086

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

High	This option is not significantly impacted by hydrologic or climatic variability.

Comments:

Literature Review/Case Studies:

References:

When does building an MBR make sense? How variations of local construction and operating cost parameters impact overall project economics (Thor Young*, Sebastian Smoot*, Jeff Peeters**, Pierre Côté)
Emory Water Hub Case Study
Highland Mall Case Study

Austin WATER | WATER FORWARD INTEGRATED WATER RESOURCE PLAN

Supply Option Name:

Waste Water Scalping (Sewer Mining)

DRAFT RESULTS 8/1/17

Short Description:

Community Scale Waste Water Scalping and Reuse

Details:

Local Wastewater Scalping (or 'Sewer Mining') is defined for the purpose of this project as involving the extraction of wastewater from the existing centralized wastewater collection system, treatment to Type 1 quality, and reuse at the local/community scale. The treatment plant is situated close to both the demand and to the sewer extraction point, to reduce reticulation and pumping costs. This can be located either within existing open space or within a new development.

Reuse via a dual (purple) pipe system will supply irrigation, landscaping, toilet and potentially also laundry (clothes washing) and cooling demands. Treatment plant wastes (sludge) from the treatment process are discharged to the centralized wastewater collection system for subsequent treatment at the downstream WWTPs.

Reuse from this option is not considered for outdoor end uses in Critical Water Quality Zones, floodplains, or the Edwards Aquifer Recharge Zone. All scenarios assume back-up supply from the centralized water distribution system.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

1. Outdoor: COA - IRR
2. Outdoor + Indoor Non Potable: SFR, MFR, COM - IRR, TL , CW, HVC and COA - IRR

Characterization Year:	Intended use of supply:	Supply Type:
2115	Variable	Decentralized

Timing of Implementation:	Lifespan (years):
NA	50

DEMAND MET BY OPTION ANALYSIS

Assumptions:

Demand

o Variable per DTI (estimated from demand model)

o Monthly outdoor demand profile generated using historical gross lake evaporation data (quadrangle 811) and precipitation data in a standard irrigation model to account for monthly and year to year variation in outdoor demand based on climate.

Yield

o Upstream contributing areas of proposed sewer mining opportunities calculated from spatial analysis that identifies the existing sewer network from any given point.

o Possible extraction locations identified as manholes on sewers with minimum diameter of 16 inches and maximum depth of 50 feet.

o Maximum wastewater availability was set at 50% of average dry weather flow, allowing a minimum base flow to be retained in the sewer, so as not to block or negatively impact infrastructure.

o Yield calculated from a water balance calculation (with demand calculated from disaggregating total future DTI demand by customer class to the land use area within the project area).

Year

Analysis completed at ultimate timeslice of 2115.

Average Weather Demand Met By Option in 2115 Summary (Acre Feet):

Note: Drought yields to be determined. Results reported from the 75th percentile of project opportunities/systems identified in the analysis. Yields are subject to change dependent on implementation approach and portfolio context. Annual cumulative volume represents the total volume produced from all systems identified within the 75th percentile. Annual average system volume represents the average yield from each project opportunity/system.

SCENARIO 1 - Outdoor: COA - IRR

Annual Cumulative Volume (AF/Year)	801
Annual Average System Volume (Gal/Year)	16,318,864

SCENARIO 2 - Outdoor + Indoor Non Potable: SFR, MFR, COM - IRR, TL , CW, HVC and COA - IRR

Annual Cumulative Volume (AF/Year)	16,440
Annual Average System Volume (Gal/Year)	66,960,556

COST ANALYSIS

Assumptions:

NB: Capital and Annual O&M costs may be borne by the customer/developer or the Utility. The below costs are total community costs.

Capital Cost – Facilities

o Cost elements calculated for each project opportunity using unit costs and cost curves from GHD's cost databases, and using water balance outputs (demand and supply volumes) and GIS outputs (e.g. number of houses, buildings, area serviced, transfer distance between sewer and demand center, etc.)

o Cost elements include:

- o Extraction (maintenance shaft, connection to sewer, pump, rising main)
- o Treatment (note not required to handle wet weather flows)
- o Balancing storage
- o Transfer pump station and pipeline
- o Distribution pipelines (e.g. throughout streets)
- o Reticulation (e.g. on-lot & within building)

Engineering, Legal Costs and Contingencies

o o 35% cost of facilities

Mitigation and Permitting

o 5% cost of facilities

Annual O&M – Labor & Material

o Estimated as proportion of capital costs (Civil 1%, Pumps 5%, Treatment 5%)

Annual O&M – Energy

o Pumping energy calculated based on estimated design flow, hours operation, and pump duty power, for a project opportunity

o Electricity cost 0.09 $USD/kWh

Annual O&M - Advanced/Decentralized Treatment

o Represents the treatment energy cost (treatment capital cost and O&M in other categories)

o GHD Energy Curve for MBR Treatment Plants (kWh per ML/d capacity)

Annual O&M - Conventional W/WW Treatment

o Not applicable

Annual Purchase/Import Cost

o Not applicable

SCENARIO 1 - Outdoor: COA - IRR

Capital Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost	$ 51,729,827	$ 18,105,439	$ 2,586,491	$ -	$ 68,912,420	$ 141,334,177
Customer Cost	$ -	$ -	$ -	$ -	$ -	$ -
Community Cost	$ 51,729,827	$ 18,105,439	$ 2,586,491	$ -	$ 68,912,420	$ 141,334,177

Annual Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost	$ 2,826,684	$ 2,214,940	$ 6,226	$ 116,024	$ -	$ -
Customer Cost	$ -	$ -	$ -	$ -	$ -	$ -
Community Cost**	$ 2,826,684	$ 2,214,940	$ 6,226	$ 116,024	$ -	$ -

Unit Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	$ 5,163,874	$ 6,444
Customer Cost	$ -	$ -
Community Cost**	$ 5,163,874	$ 6,444

*Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

Per System Cost Summary (current dollars):

Note: Represents average per project opportunity/system cost

Capital Cost	$ 3,233,114
Annual O&M	$ 146,074

SCENARIO 2 - Outdoor + Indoor Non Potable: SFR, MFR, COM - IRR, TL , CW, HVC and COA - IRR

Capital Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront/ Interest/Land Cost
Utility Cost	$ 437,849,002	$ 153,247,151	$ 21,892,450	$ -	$ 583,285,046	$ 1,196,273,649
Customer Cost	$ 138,702,039	$ 48,545,714	$ -	$ -	$ -	$ 187,247,753
Community Cost	$ 576,551,042	$ 201,792,865	$ 21,892,450	$ -	$ 583,285,046	$ 1,383,521,403

Annual Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Annual Capital/Upfront/Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost	$ 23,925,473	$ 19,832,782	$ 101,113	$ 2,210,978	$ -	$ -
Customer Cost	$ 3,744,955	$ -	$ -	$ -	$ -	$ -
Community Cost**	$ 27,670,428	$ 19,832,782	$ 101,113	$ 2,210,978	$ -	$ -

Unit Cost Summary (current dollars):

Note: Represents cumulative costs for all project opportunities/systems identified within the 75th percentile

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	$ 46,070,347	$ 2,802
Customer Cost	$ 3,744,955	$ 228
Community Cost**	$ 49,815,302	$ 3,030

*Unit Cost = Total Annual Cost ÷ Annual Average Yield

**Community Cost = Utility Cost + Customer Cost

Per System Cost Summary (current dollars):

Note: Represents average per project opportunity/system cost

Capital Cost	$ 5,473,113
Annual O&M	$ 276,811

ADDITIONAL INFORMATION

Climate Resiliency Indicator:

High	This option is not significantly impacted by hydrologic or climatic variability.

Comments:

Literature Review/Case Studies:

References:

1. Emory Water Hub Case Study
2. Highland Mall Case Study

Austin WATER | WATER FORWARD INTEGRATED WATER RESOURCE PLAN

Supply Option Name:

Imported Option Category - Conventional Groundwater

DRAFT RESULTS 11/19/2017

Short Description:

Conventional Groundwater

Details:

Conventional groundwater sourced from the Carrizo-Wilcox east of Austin. Austin Water acquires water rights, and develops all source water, treatment, and disposal infrastructure.

Applicable Customer Sectors, End Uses, and Development Types (new, existing, or both):

All End Uses and Development Types

Characterization Year: 2115

Intended use of supply: Constant

Supply Type: Groundwater

Timing of Implementation: NA

Lifespan (years): 30

YIELD ANALYSIS

Assumptions:

o Estimated based on typical Carrizo-Wilcox well development program

Average Weather Yield Summary (Acre Feet):

Annual Yield (AF/Year)
20,000

COST ANALYSIS

Assumptions:

Capital Cost – Facilities
o Wells are 1,500 gpm
o Pipeline length of 66 miles, 75% rural, 25% urban
o Pipeline sized for constant average delivery
Engineering, Legal Costs and Contingencies
o 35% cost of facilities
Mitigation and Permitting
o 5% cost of facilities
Land Aquisition
o Land aquifision for water rights purchase based on 2 AF/acre and $10k/acre
Annual O&M – Labor & Material
o 1% cost of facilities
Annual O&M – Energy
o Estimated based on pipeline length and pumping level
o Electricity cost 0.09 $USD/kWh
Water Treatment
o Estimated based on treatment level (disinfection) from Unified Costing Model
o Electricity cost 0.09 $USD/kWh
Annual Purchase/Import Cost
o Not applicable

Capital Cost Summary (current dollars):

	Capital Cost - Facilities	Engineering, Legal Costs & Contingencies	Mitigation & Permitting	Land Acquisition	Interest	Total Capital/Upfront / Interest/Land Cost
Utility Cost	$107,346,120	$37,571,142	$15,000,000	$100,000,000	$247,322,464	$507,239,726
Customer Cost	$ -	$ -	$ -	$ -	$ -	$ -
Community Cost	$ -	$ -	$ -	$ -	$ -	$ -

Annual Cost Summary (current dollars):

	Annual Capital/Upfront /Interest/Land Cost ($/yr)	Annual O&M - Labor & Material ($/yr)	Annual O&M - Energy ($/yr)	Annual Advanced/ Decentralized Treatment O&M ($/yr)	Annual Conventional W/WW Treatment O&M ($/yr)	Annual Purchase/Import ($/yr)
Utility Cost	$16,907,991	$1,000,000	$3,300,000	$0	$1,172,412	$0
Customer Cost	$ -	$ -	$ -	$ -	$ -	$ -
Community Cost	$ -	$ -	$ -	$ -	$ -	$ -

Unit Cost Summary (current dollars):

	Total Annual Cost ($/yr)	Annual Unit Cost* ($/AF/yr)
Utility Cost	22,380,403	$1,119
Customer Cost	$ -	$ -
Community Cost	$ -	$ -

*Unit Cost = Total Annual Cost ÷ Annual Average Yield

ADDITIONAL INFORMATION

Climate Resiliency Score:

Medium	Sensitivity to variations in climate and hydrology would vary depending on source aquifer and utilization rates

Comments:

Literature Review/Case Studies:

San Antonio Water System

References:

San Antonio Water System

APPENDIX K: WATER FORWARD DECENTRALIZED OPTIONS MODELING

The purpose of this appendix is to provide information on Water Forward Decentralized Options modeling.

K.1 Introduction

Subconsultant GHD performed a geospatial analysis to characterize decentralized supply and demand management options for input to the IWRP portfolios. Options considered included lot/building scale wastewater reuse, lot scale graywater reuse, lot scale stormwater harvesting, lot scale rainwater harvesting, community scale distributed wastewater reuse, community scale sewer mining, community scale stormwater harvesting, and community scale rainwater harvesting. The analysis considered potential opportunities across the entire city to use these alternative source waters to meet non-potable outdoor and indoor demands for a range of sectors.

Due to the decentralized nature of the options, a geo-spatial approach was used to explore at a strategic level where in Austin Water's projected future service it would be more or less suitable to implement each of the decentralized options. This resulted in the development of spatially variable yields and costs for each of the decentralized options (using Delphi Trend and Imagine Austin (DTI) polygons as the reporting scale) across the study area. While this work provides a more disaggregated spatial resolution understanding of the opportunity for decentralized options, it is important to understand that this work is based on a high-level assessment and further detailed analysis for specific suitability in any given location is recommended.

K.2 Methodology

K.2.1 Analysis Approach

The geospatial analysis explored the potential opportunities for decentralized options to meet non-potable demands for Austin in the future. It is important to note that by their very nature decentralized opportunities are spatially variable, with local conditions impacting the viability of options and the scale of potential options. For this reason spatial analysis was the primary approach used to identify opportunities.

The approach can be summarized in **Figure K-1** Geospatial Analysis Method Summary, where future demand is matched with potential future supply from decentralized alternative water sources, with their particular characteristics and constraints to identify an Opportunity. Each Opportunity is then analyzed to develop a series of performance measures, such as yield and cost. Many potential opportunities were identified across the City and a subset of opportunities for each option was selected to achieve the desired volumetric total to meet demands and then summarized at the DTI level for inclusion in the portfolios.

Figure K-1 Geospatial Analysis Method Summary

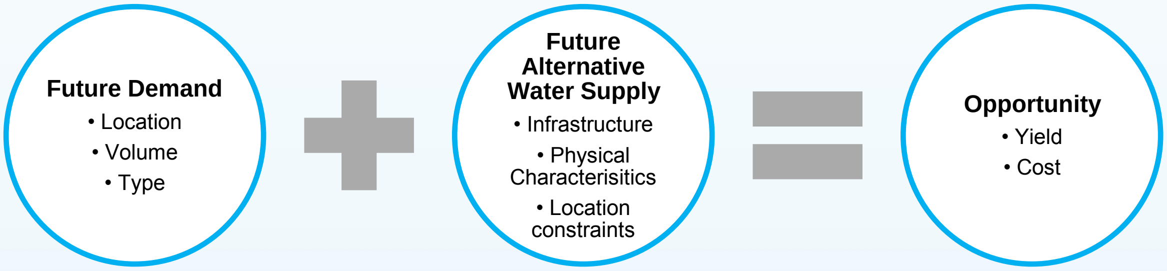

Table K-1 below outlines the options that were considered in the analysis, including the sub-options or scenarios evaluated. More details regarding assumptions used to develop cost and yield estimates for each option and sub-option evaluated is available in **Appendix J**.

Table K-1 Options Considered in Water Forward Geospatial Decentralized Analysis

#	Option	Sub-option /Scenario	SFR	MFR	COM	COA	End Uses
D8	Lot Scale Stormwater Harvesting	Outdoor		Y			IRR
		Outdoor			Y		IRR
		Dual pipe		Y			IRR TL CW
		Dual pipe			Y		IRR TL CW HVC
D9	Lot Scale Rainwater Harvesting	Outdoor	Y				IRR
		Outdoor		Y			IRR
		Outdoor			Y		IRR
		Dual pipe	Y				IRR TL CW
		Dual pipe		Y			IRR TL
		Dual pipe			Y		IRR TL HVC
		Potable	Y				ALL
D10	Gray Water Harvesting	Outdoor	Y				IRR
		Outdoor		Y			IRR
		Outdoor			Y		IRR
		Dual pipe	Y				IRR TL CW
		Dual pipe		Y			IRR TL CW
		Dual pipe			Y		IRR TL
D11	Building Scale Wastewater Reuse	Dual pipe		Y			IRR TL CW
		Dual pipe			Y		IRR TL CW HVC
S9	Distributed WW Reuse	Dual pipe	Y	Y	Y	Y	IRR TL CW HVC
S10	Sewer Mining	Outdoor				Y	IRR
		Dual pipe	Y	Y	Y	Y	IRR TL CW HVC
S11	Community Stormwater	Outdoor				Y	IRR
		Outdoor	Y	Y	Y	Y	IRR
		Dual pipe	Y	Y	Y	Y	IRR TL CW HVC
S12	Community Rainwater	Dual pipe	Y	Y	Y	Y	IRR TL CW HVC

K.2.2 Key Information

This section describes some of the key information and assumptions used in this analysis. With the key concepts described in the previous section, these are the foundation of the analysis.

K.2.2.1 Delphi Trend and Imagine Austin (DTI) polygons

The Delphi Trend and Imagine Austin (DTI) polygons are the geographic unit of analysis and reporting for this work as well as the Disaggregated Demand Model (described below). The data include long-range, small-polygon-based population and employment forecasts produced by the City Demographer in conjunction with Austin Water. Contains estimates of water service population, single family and multifamily units, and employment for 2010, as well as projections for 2020, 2040, 2070, and 2115

K.2.2.2 Future Demand Estimates

Future demand estimates were derived from the Disaggregated Demand Model (DDM) developed by Austin Water. The DDM makes use of historical billing, historical land use, and historical and projected demographic data to project potential water use broken down by sector and end use for each IWRP planning horizon (2020, 2040, 2070, 2115) (see **Appendix C** for more information about the DDM). Future water demands at the DTI polygon level were allocated spatially at a more refined level using some high level assumptions about growth/change in development patterns over time.

K.2.2.3 Residential and Commercial Building Characteristics

Assumptions regarding building characteristics were required to generate option yield estimates. This includes roof areas and/or density (units or employees per building). Current roof areas and building numbers were estimated based on current building footprint GIS data. Future roof areas were estimated by taking into account demographic changes (increase in units/employees) and growth/change in development patterns over time. Key assumptions are listed below:

- Single family residential - Average roof varies per DTI, between approx. 1500-3700 ft2 per house
- Multi-family residential - Nominal building = 5,000 ft (noting that the density, in terms of units/building, varies by DTI)
- Commercial - Nominal building = 10,000 ft (noting that the density, in terms of employees/building, varies by DTI)

K.2.2.4 Historical Weather Data

The following historical climate data was used in the analysis to generate yield estimates for the rainwater and stormwater options.

- Precipitation - Daily rainfall (1938 – 2016) (Station: AUSTIN CAMP MABRY TX US)
- Evaporation - Monthly gross lake evaporation data (Quadrangle 811).

K.2.2.5 Environmental Constraints

The unique environment of Austin means that there are areas where it is prohibited to apply recycled water and grey water for outdoor uses and this was reflected in the analysis. These areas include the Edwards Aquifer Recharge Zone and the Contributing Zone (catchment) of Barton Creek, and are north-west, west and south west of the CBD of Austin.

K.3 Results and Use in Portfolio Building

The decentralized options analysis outputs are yield and cost results for each option and sub-option at the DTI scale. This means, there can be a high degree of complexity in how portfolios (combinations of options) can be selected/defined. To enable additional functionality in selecting portfolios, GHD developed a decentralized portfolio tool that allowed the user to quickly set a level of implementation for each decentralized alternative water source water scenario. Each strategy at it's specified level of implementation was added together, summing up to a total volume of alternative water available to meet non-potable demands across the City. Alternative water supplies were constrained to the volume of non-potable demand available to be met.