DRAFT Refined Analysis Assumptions used to Model Retail Demands for Scenarios A, B, C, & D

Data Link: ***Refined Data June 2021***

THEMES (Input from Expert Panel, MAs and MWD Staff)	**Scenario A** (Low Demands, Stable Imports)	**Scenario B** (High Demands, Stable Imports)	**Scenario C** (Low Demands, Reduced Imports)	**Scenario D** (High Demands, Reduced Imports)
↓	*This scenario is characterized by lower retail water demands and stable regional and local supplies. Demands are impacted by lower economic and demographic growth and a continuing water use ethic across the region. Both regional and local supplies show more stable production due to less severe climate change and less restrictive regulatory constraints on existing water supply projects, and a relatively robust implementation of new water supply projects at the local level.*	*This scenario is characterized by higher retail demands, stable regional and local supplies. Demand are impacted by higher economic and demographic growth and a rebound of water use ethic. Both regional and local supplies show more stable production due to less severe climate change and less restrictive regulatory constraints on existing water supply projects, and a relatively robust implementation of new water supply projects at the local level.*	*This scenario is characterized by lower retail water demands and less stable imported supplies. Demands are impacted by lower economic growth, demographic growth and with successful efforts among member agencies to manage water use behavior and drought-proof their local supplies. It couples a struggling economy with the rapid onset of climate change impacts that have affected imported supplies more drastically than less-vulnerable local supplies.*	*This scenario is characterized by higher retail demands, unstable imported and diminishing local supplies. Demand are impacted by higher economic and demographic growth and a rebound of water use ethic. In this scenario severe climate change impacts both imported and local supplies. Demands on Metropolitan are increasing due to rapidly increasing demands and diminishing yield from local supplies. Efforts to develop new local supplies to mitigate losses of underperforming projects. Losses of regional imported supplies are equally dramatic.*

<u>Retail Demand - Demographics</u>
The level of demographic (population, households, housing types, employment) growth is an important driver to water demand
	• Lower demographic growth
	  ▪ Utilized Center for Continuing Study of the California Economy's (CCSCE's) low growth forecast developed for the 2020 IRP
		• Higher demographic growth
		  ▪ Utilized CCSCE's high growth forecast developed for the 2020 IRP
			• Same as Scenario A	• Same as Scenario B

<u>Retail Demand - Immigration</u> Immigration is the most important factor for national population growth, California share of national growth stays consistent across scenarios, not impacted by climate change issues.	• CCSCE's forecast considers climate change impacts on international immigration and migration to California ▪ No basis to change population forecast or regional share growth due to climate impacts at this time	• Same across all scenarios	• Same across all scenarios	• Same across all scenarios
<u>Retail Demand - Households</u> New households are modeled separately from existing households to reflect increasing	• This scenario projects a total of **903,000** additional new households. • Assumes a median lot size of 5,000 sq. ft. for new housing units (approximately 30%	• This scenario projects a total of **2.6 million** additional new households. • Same median lot size assumption as Scenario A	• This scenario projects a total of **907,000** new households • Same median lot size assumption as Scenario A	• This scenario projects a total of **2.8 million** new households. • Same median lot size assumption as Scenario A

THEMES (Input from Expert Panel, MAs and MWD Staff)	**Scenario A** (Low Demands, Stable Imports)	**Scenario B** (High Demands, Stable Imports)	**Scenario C** (Low Demands, Reduced Imports)	**Scenario D** (High Demands, Reduced Imports)
efficiency and smaller sizes of new homes and lots. These new households include single family, multi family, and Accessory Dwelling Units (ADUs).	reduction compared to the existing median lot size) to reflect smaller lot sizes and more efficient outdoor use. Reduced lot size equates to less irrigable area.			
<u>Retail Demand - Overcrowding</u> In addition to normal housing growth to accommodate population growth, one-time additional housing units a "catch-up" factor is projected to reduce overcrowding, minimize cost burdened households, and bring vacancy rate back to normal level.	• This scenario assumes the lowest success rate, **340,000** additional households, as the "catch-up" factor. • CCSCE's total housing growth "catch-up" factor reflects a struggling economy and low population growth	• This scenario assumes a moderate success rate, **516,000** additional households, as the "catch-up" factor. • CCSCE's total housing growth "catch-up" factor reflects a strong economy and population growth	• This scenario assumes a low success rate, **344,000** additional households, as the "catch-up" factor. • CCSCE's total housing growth "catch-up" factor reflects a weak economy and slow population growth	• This scenario assumes the highest success rate, **696,000** additional households, as the "catch-up" factor. • CCSCE's total housing growth "catch-up" factor reflects a strong economy and population growth
<u>Retail Demand – Behavioral Retention</u> The lower retail demands observed since the last drought are driven by a structural and behavioral water use component, of which behavior is more reversible or at risk to rebound. Retail demands reflect both use per person and the number of people. Total demand can increase even without a degradation in efficient water use behavior.	• Efficient water use behavior is retained at a high level • Behavioral component: **90% retention** of the behavioral component of the observed reduced demand is retained reflecting continued strong water use ethic. • Structural Component: This permanent reduction in demand is accounted for based on demographic assumptions including a shift from single family homes toward multifamily construction with smaller lot sizes, ADUs, less irrigable area, and increased adoption of device-based conservation	• Efficient water use behavior is retained at a moderate level • Behavioral component: **50% retention** of the behavioral component of the observed reduced demand is retained reflecting a plausible rebound in water use ethic. • Structural Component: This permanent reduction in demand is accounted for based on demographic assumptions including a shift from single family homes toward multifamily construction with smaller lot sizes, ADUs, less irrigable area, and increased adoption of device-based conservation	• Same as Scenario A	• Same as Scenario B

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Retail Demand - Agricultural Demand A hotter and drier climate will impact irrigation needs	• Consistent with member agencies' 2020 UWMP and reflects discussions with member agencies ▪ No additional adjustments assumed	• Same as Scenario A	• Hotter and drier conditions coupled with increased regulatory constraints result in higher operation costs and ag land coming out of production. ▪ 20% decrease in demand by 2045 due to fewer farming operations ▪ 10% increase in irrigation requirements for remaining farms by 2045 due to hotter and drier conditions	• Same as Scenario C
Retail Demand - Seawater Barrier Demand Mitigating overdraft challenges will lead to higher demands on Metropolitan	• No modifications based on member agency discussions	• Same as Scenario A	• Climate change stresses will increase demand • Increased by 10% by 2045. The increase in demand is tempered by lower overall demands in this scenario and less overdraft challenges	• Climate change stresses will increase demand • Increased by 20% by 2045. The increase in demand reflects higher overall demands in this scenario and significant overdraft challenges
Imported Replenishment Demand Changes in natural recharge volume and patterns along with recycled water availability will impact demands on Metropolitan	• Replenishment water purchases from MWD is based on past discussions with member agencies and groundwater basin managers to meet their imported replenishment needs to supplement their natural recharge • Reflects scenario-based climate change impacts on natural recharge • Also reflects recycled water availability for replenishment demands (see recycled water assumption) • Though assumptions are the same across all scenarios, values used vary per scenario			

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Local Supply - Precipitation Precipitation is a major driver on future water supply. Metropolitan's modeling methodology requires use of annual weather variations over time (1922-2017). Adjustments were made to the historic record to reflect climate expert feedback on potential future impacts.	• Historical variation in precipitation from 1922-2017 will continue through 2045	• Same as Scenario A	• Modified 1922 – 2017 precipitation to reflect more extreme conditions. This will impact surface water reservoir and groundwater supply ▪ Increased the frequency and intensity of dry years ▪ Decreased the frequency and increased the intensity of wet years ▪ Kept 1922-2017 average similar	• Same as Scenario C
Desalination – Existing Local Projects	• Claude "Bud" Lewis (Carlsbad Desalination Plant) ▪ Assumed facility to operate at ~85% of capacity in normal and wet years, and full capacity during dry years. ▪ Normal, wet, and dry years vary by scenario	• Same across all scenarios	• Same across all scenarios	• Same across all scenarios
Desalination – Future Local Projects	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate for each scenario • No planned projects incorporated in this scenario	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate for each scenario • Includes Doheny Ocean Desalination Project, Huntington Beach Seawater Desalination Project, and West Basin Seawater Desalination Project • Operation assumed to be **85% of yield** in normal and wet years, full ultimate yield in dry years • Wet, normal, and dry years vary by scenario	• Same as Scenario A	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate foreach scenario • Includes Doheny Ocean Desalination Project, Huntington Beach Seawater Desalination Project, and West Basin Seawater Desalination Project • **Reduced yield by 20%** to approximate impacts from severe climate change and regulatory constraints • Operation assumed to be **85% of yield (after 20% reduction)** in normal and wet years, full ultimate yield in dry years • Wet, normal, and dry years vary by scenario

THEMES (Input from Expert Panel, MAs and MWD Staff)	**Scenario A** (Low Demands, Stable Imports)	**Scenario B** (High Demands, Stable Imports)	**Scenario C** (Low Demands, Reduced Imports)	**Scenario D** (High Demands, Reduced Imports)
Groundwater Recovery - Existing Local Projects	• Engaged with member agencies to confirm yield of projects currently in operation • No modifications to yield in this scenario	• Same as Scenario A	• Engaged with member agencies to confirm yield of projects currently in operation • **Decreased yield by 20%** to approximate increased regulatory requirements and severe climate change impacts to groundwater basins	• Same as Scenario C
Groundwater Recovery – Future Local Projects	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate for each scenario • **Reduced yield by 30%** in this scenario to reflect lower need to develop additional projects due to low demands.	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate for each scenario • **Reduced yield by 10%** in this scenario in recognition of strong project implementation	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate for each scenario • **Reduced yield by 20%** in this scenario to approximate the impact of regulatory requirements, but an increase in local project need due to reduced imports	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate for each scenario • **Reduced yield by 20%** in this scenario to approximate the impact of regulatory requirements, but an increase in local project need due to reduced imports • Though assumptions are the same for Scenario C and D, values used vary per scenario based on member agency feedback
Recycled Water - Existing Local Projects	• Engaged with member agencies to confirm yield of projects currently in operation • **Reduced yield by 20%** to approximate impact of decreased wastewater availability from low demands	• Engaged with member agencies to confirm yield of projects currently in operation • **No change to yield**	• Same as Scenario A	• Same as Scenario B

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Recycled Water - Future Local Projects	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate for each scenario • **Reduced yield by 30%** to approximate the impact of decreased wastewater availability from low demands and less need to develop projects due to stable imports ▪ 30% is based on observed local project development within the service area	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate for each scenario • **Reduced yield by 10%** in this scenario in recognition of strong project implementation	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate for each scenario • **Reduced yield by 30%** to approximate the impact of decreased wastewater availability from low demands and less need to develop projects due to stable imports ▪ 30% is based on observed local project development within the service area • Though assumptions are the same for Scenario A and C, values used vary per scenario based on member agency feedback	• Engaged with member agencies to identify the potential timing and implementation of planned projects appropriate foreach scenario • **Reduced yield by 20%** in this scenario to approximate the impact of regulatory requirements, but an increase in local project need due to reduced imports
LA Aqueduct Supply	• Estimates based on single trace LAA Forecast provided by LADWP in 2020 ▪ Reduced modeled output for each hydrology by 13,000 acre-feet to adjust for approximated bias from what was provided in 2020 and what LADWP used in their UWMP ▪ Note: MWD uses a 96-year hydrology as opposed to LA's 30-year hydrology for modeling methodology purposes	• Same as Scenario A	• Estimates based on single trace LAA Forecast provided by LADWP in 2020 ▪ Reduced modeled output for each hydrology by 13,000 acre-feet to adjust for approximated bias from what was provided in 2020 and what LADWP used in their UWMP ▪ Note: MWD uses a 96-year hydrology as opposed to LA's 30-year hydrology for modeling methodology purposes • Applied annual climate change factor of 0.1652% to reduce LAA supplies per LADWP UWMP	• Same as Scenario D
Surface Water Supply	• Used San Diego Surface Model to approximate annual variance around their UWMP long-term average (43,928 AFY) ▪ Based on 1922-2017 precipitation (see precipitation for local supply assumption) • For all other member agencies used provided scenario specific projections • Though assumptions are the same across all scenarios, values used vary per scenario			

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Groundwater Supply	• For Main San Gabriel Basin developed preliminary model: ▪ Calculates production based on consumptive demand ▪ Estimated passive and active recharge using local precipitation ▪ Tracks estimated key well level ▪ Cuts production by 30% if key well level falls below 160 ft MSL • OC Basin ▪ Assumed long-term Basin Production Percentage (BPP) goal of 85% ▪ PFAS impacts 2020-2024 • All other basins ▪ Used 2010-2019 Production Average or UWMP production data when available	• For Main San Gabriel Basin developed preliminary model: ▪ Calculates production based on consumptive demand ▪ Estimated passive and active recharge using local precipitation ▪ Tracks estimated key well level ▪ Cuts production by 30% if key well level falls below 160 ft MSL • OC Basin ▪ Assumed Basin Production Percentage (BPP) of 85% to 2030; reduced by 5% every 5 years afterwards to adjust for growing demands ▪ PFAS impacts 2020-2024 • All other basins ▪ Used 2010-2019 Production Average or UWMP production data when available	• For Main San Gabriel Basin developed preliminary model: ▪ Calculates production based on consumptive demand ▪ Estimated passive and active recharge using local precipitation ▪ Tracks estimated key well level ▪ Cuts production by 30% if key well level falls below 160 ft MSL • OC Basin ▪ Assumed long-term Basin Production Percentage (BPP) goal of 85% ▪ PFAS impacts 2020-2024 • All other basins ▪ Used 2015-2019 Production Average or UWMP production data when available	• For Main San Gabriel Basin developed preliminary model: ▪ Calculates production based on consumptive demand ▪ Estimated passive and active recharge using local precipitation ▪ Tracks estimated key well level ▪ Cuts production by 30% if key well level falls below 160 ft MSL • OC Basin ▪ Assumed Basin Production Percentage (BPP) of 85% to 2030; reduced by 5% every 5 years afterwards to adjust for growing demands ▪ PFAS impacts 2020-2024 • All other basins ▪ Used 2015-2019 Production Average or UWMP production data when available
State Water Project Supply Used DWR's Delivery Capability Report (DCR) projected SWP deliveries as basis for the scenario analysis. The DCR Existing Condition modeling result reflects SWP deliveries without climate impacts. The DCR Future Condition modeling result reflects SWP deliveries with climate impacts by using the Representative Concentration Pathway (RCP) 8.5 with 1.5 ft of sea level rise.	• Used a hybrid of the DCR Existing Condition (no climate impacts) and Future Condition (climate impacts) modeling results to project "moderate" climate change impacts to SWP deliveries ▪ Used 50% of the difference between Existing Condition and Future Condition deliveries	• Same as Scenario A	• Used a hybrid of the DCR Existing Condition (no climate impacts) and Future Condition (climate impacts) modeling results to project "severe" climate change impacts to SWP deliveries ▪ Move from Existing Condition deliveries to Future Condition deliveries linearly to 2035 • Additional degradation factor by 25% by 2035 to represent future regulations/unknowns/low cooperation	• Same as Scenario C

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<u>Colorado River Supply</u> Utilized expert input to identify evaporative losses, a range of temperature increases (Lukas and Payton, 2020) and a range of runoff decreases to reflect moderate to severe climate impacts (Milley and Dune, 2020)	• Moderate climate change impacts using Representative Concentration Pathway (RCP)4.5 ▪ Linear increase in temp to 2.1 °C by 2045 ▪ 15.6% decrease in runoff by 2045 (Powell and Mead inflows) ▪ 4.5% increase in Lake Mead and Lake Powell evaporation by 2045 • High cooperation-Drought Contingency Plan (DCP) continues after 2026, interim guidelines extended	• Same as Scenario A	• Severe climate change impacts using Representative Concentration Pathway (RCP) 8.5 ▪ Linear increase in temp to 2.75 °C by 2045 ▪ 25.6% decrease in runoff (Powell and Mead inflows) ▪ 4.5% increase in Lake Mead and Lake Powell evaporation by 2045 • Low cooperation- Drought Contingency Plan (DCP) ends after 2026, interim guidelines extended	• Same as Scenario C