Nevada Irrigation District Plan for Water - Demand Model Data Sources and Assumptions

Dec 2022

Category	Parameter	Historical Data Sources, Assumptions	Future Projections Sources, Assumptions	Additional Details	References
Model Setup	Demand model platform	IWFM Demand Calculator (IDC) demand model, with results linked by parcels to canals	Same platform as historical simulation	An IDC demand model will be used to quantify treated and raw water demand in NID. Results will be linked by parcels to canals to quantify upstream demand at NID's water supply sources (factoring in conveyance system losses, environmental flow requirements, and municipal purchases).	[1]
Model Setup	Simulation time step	Monthly	Monthly	IDC will simulate demand on a monthly time step using aggregated data and estimates. A monthly time step captures intra-annual conditions and interdependencies among different facors that influence demand.	[2] (Section 2.7)
Model Setup	Demand model grid	Unitized grid, results linked to parcels	Same approach as historical simulation	Demand will be simulated in IDC for different combinations of parcel characteristics found in NID that impact demand (land use type, soil type, elevation zone). The IDC results will be calculated first on a "unit" depth basis (e.g., inches/month) and then linked to parcels that most closely match those combinations of characteristics to quantify the demand "volume" (e.g., gallons/month or acre-feet/month).	[3]
Land Use	Land Use Area	Summarized from NID crop surveys, spatial land use mapping data (Land IQ, DWR, USDA, USGS), and survey data (DWR, counties)	Estimated from county general plan and zoning information, NID "soft service areas" (i.e., areas of potential growth), and recent historical trends. Will be verified with city and NID staff, and compared with land use projections (USGS).	Historical land use will be summarized from available spatial data sources and linked to specific parcels in NID. Future projected land use areas will be developed based on historical trends in land use, with spatial land use changes informed by zoning and general plan GIS data. The effects of alternate future land use scenarios on demand will be evaluated through sensitivity analyses to identify "bookend" results. Land use areas, trends, and sensitivity analysis results will be checked against other available tabular land use information and will be verified with NID and city/county staff.	[4]-[17]
Precipitation Simulation	Precipitation	PRISM gridded historical precipitation data, consistent with HEC-HMS model	Climate change-adjusted precipitation projections, consistent with HEC-HMS model	Precipitation will be simulated for elevation zones in NID that share similar historical precipitation rates. Demand model inputs will be checked for consistency with the HEC-HMS model inputs. PRISM data is recommended and used in various modeling applications by DWR and many commercial, research, and governmental organizations in the US. PRISM data closely compares with the U.S. Climate Reference Network precipitation data.	[2] (Section 9) [18]-[19]
Precipitation Simulation	Precipitation runoff	Calculated using the modified Soil Conservation Service (SCS) curve number method, routing runoff to the nearest waterway	Same approach as historical simulation, but calculated with future projected precipitation	IDC simulates precipitation runoff using a modification of the United States Department of Agriculture (USDA) SCS curve number method. Curve numbers will be derived from technical literature (SCS TR-55), depending on land use types, soil types, and typical hydrologic conditions.	[20]
Evapotranspiration	Evapotranspiration (ET)	Calculated from reference ET (ETo) and crop coefficients (Kc) following the FAO 56 guidelines. Historical ETo determined from CIMIS data. Historical Kc for different land uses calculated from local ET and ETo at times when spatial ET and land use information is available.	Calculated from ETo and Kc following the FAO 56 guidelines. Projected ETo estimated through climate change adjustments to historical ETo. Projected Kc for different land uses adjusted for estimated changes in crop production.	ET will be simulated across elevation zones in NID that share similar historical ETo rates. The industry-standard 'Kc-ETo' approach, documented in FAO 56, will be used to calculate ET due to crop characteristics (captured in Kc) and climate effects (captured in ETo). The IDC model will calculate ET of applied water (ETAW) and ET of precipitation (ETPR) using standard methodologies and best practices. Local Kc values will be developed using available information about local ET and crop water use (e.g., satellite-based ET information from OpenET) to provide locally-accurate representations of ET that account for deficit irrigation or other local factors that impact local ET.	[21]-[24], [38]-[39]
Soil Moisture Simulation	Soil types and soil parameters (wilting point, field capacity, total porosity, pore size distribution, saturated hydraulic conductivity)	Summarized from SSURGO and STATSGO soil data and technical literature. Parameters evaluated and calibrated using industry-standard approaches (e.g., pedotransfer functions) to ensure physically realistic soil water characteristics	Same approach as historical simulation	Simulated soil types in NID will be classified from USDA National Cooperative Soil Survey (NCSS) SSURGO/STATSGO data. Initial soil parameters will be assigned from SSURGO/STATSGO data, and will then be refined through calibration and comparison with technical literature. Soil parameter calibration will be done through application of pedotransfer functions (standard, predictive methods for translating raw soil data into soil water characteristics that are physically realistic).	[25]-[27]
Soil Moisture Simulation	Initial soil moisture (i.e., soil moisture at the first model time step)	Estimated to be equal to the soil field capacity	Same approach as historical simulation	The initial soil moisture depends on irrigation and hydrologic conditions preceding the model simulation period. The first model time step will begin at least two years prior to the analysis period. This will allow sufficient time for the model to simulate soil moisture with respect to irrigation and hydrologic conditions preceding the analysis period.	[25]-[26]
Soil Moisture Simulation	Minimum soil moisture (i.e., soil moisture at which irrigation is triggered)	Estimated to equal to 50% of the available soil moisture	Same approach as historical simulation	IDC simulates irrigation once the minimum soil moisture is reached. Setting the minimum soil moisture at 50% of the available soil moisture is typical in Califronia, and avoids simulation of additional water stress within the IDC (local Kc values will already account for typical water stress, as applicable; see parameter "ET"). Model assumptions will be confirmed with NID operators.	[25]-[26]
Agricultural Demand	Root depth	Defined for each simulated land use type based on representative values in technical literature	Same approach as historical simulation	Different crop types have different characteristic root depths, determining where in the soil the crop can extract moisture. Typical root depths for different crop types are documented in technical literature.	[28]
Agricultural Demand	Irrigation period (i.e., months when irrigation occurs)	Defined based on NID's historical irrigation delivery records.	Estimated to be similar to recent historical information. Will be verified with NID staff.	Typical irrigation periods will be evaluated from NID delivery records, reviewing different delivery areas, customers, and fields with different crop types. Future irrigation periods are estimated to be similar to recent historical operations, to be confirmed through discussion with NID operators.	[29]
Agricultural Demand	Irrigation reuse fraction (i.e., reuse of irrigation applied water)	Historical reuse for each irrigated land use simulated as a fraction of irrigation applied water. Will be confirmed with NID staff.	Estimated to be similar to historical information.	Reuse is simulated as a fraction of the total irrigation applied water. Reuse depends mainly on customer irrigation practices. Model assumptions will be confirmed with NID operators.	
Agricultural Demand	Irrigation tailwater fraction (i.e., runoff of irrigation applied water)	Historical tailwater from each irrigated land use simulated as a fraction of irrigation applied water. Will be confirmed with NID staff.	Projected changes estimated based on anticipated trends in irrigation methods. Will be confirmed with NID staff.	Tailwater is simulated as a fraction of the total irrigation applied water. Tailwater depends mainly on customer irrigation practices and irrigation methods for different crops and field conditions. Tailwater fractions will be estimated based on crop types, irrigation methods, and typical field slope. Model assumptions will be confirmed with NID operators.	
Urban Demand	Population	Estimated from California Department of Finance (DOF) population estimates for cities, counties	Estimated from California DOF population projections for counties, and NID's projected connections for treated water customers (from NID's 2020 Urban Water Management Plan).	California DOF population estimates and projections are consistent with methods used to evaluate projected water demands through 2040 in NID's 2020 Urban Water Management Plan (2020). The effects of alternate future population change scenarios on demand will be evaluated through sensitivity analyses to identify "bookend" cases. Population estimates, trends, and sensitivity analysis results will be verified with NID and city/county staff.	[30]-[31]
Urban Demand	Per Capita Water Use	Estimated based on population estimates and potable water production data from NID, cities, and the State Water Resources Control Board (SWRCB)	Estimated based on per capita water use targets and standards (indoor use, outdoor use, gross use)	Per capita water use (together with population) drives the IDC simulation of urban demand. Estimates, trends, and future projections will be verified with NID and city staff.	[32]-[34]
Urban Demand	Urban indoor water use fraction	Estimated based on urban water production and deliveries during winter months (Jan-Feb). Will be confirmed with city staff.	Estimated to be similar to historical information.	Fraction of urban applied water that is assumed to be used indoors (i.e., for drinking water, sanitation, etc.). IDC simulates indoor urban water use separately from oudoor urban water use (i.e., for landscape irrigation).	[32]-[33]

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Urban Demand	Urban reuse fraction	Outdoor reuse will be confirmed with city staff.	Estimated to be similar to historical information.	Reuse is simulated as a fraction of the total urban applied water. Model assumptions will be confirmed with city staff.	
Urban Demand	Urban return flow fraction (i.e., urban wastewater and runoff of applied water)	Indoor use assumed to be approximately 100% return flow (i.e., 100% wastewater inflow). Outdoor use assumed to have approximately 5-10% return flow, typical of landscape irrigation. Will be confirmed with city staff.	Estimated to be similar to historical information.	Return flow is simulated as a fraction of the total urban applied water. Model assumptions will be confirmed with city staff.	[1], [35]
Raw Water Demand	Raw water demand	Calculated as the amount of water needed to meet irrigation demand (in irrigation season) and winter service demand (in winter), after accounting for soil moisture, precipitation, reuse, return flow, ET, etc.	Same approach as historical simulation, but calculated with future projection information.	Irrigation applied water will be adaptively calculated using the IDC model. Historical results will be verified through comparison with NID delivery records in areas where NID supplies irrigation water. Model inputs will be calibrated for consistency with historical delivery records.	[36]
Treated Water Demand	Treated water demand	Calculated as the amount of water needed to meet urban demand, after accounting for population, per capita water use, reuse, return flow, etc.	Same approach as historical simulation, but calculated with future projection information.	Urban water demand will be adaptively calculated using the IDC model. Historical results will be verified through comparison with treated water delivery records in areas where NID supplies treated water. Model inputs will be calibrated for consistency with historical records.	[36]
Municipal Purchases	Municipal Purchases	Summarized from historical municipal purchase records.	Will be confirmed with staff.	Future projections of municipal water purchases from NID will be confirmed with staff.	[36]
Environmental Flows	Environmental Flows	Minimum in-stream flow requirements, as specified in the FERC Final Environmental Impact Statement for Hydropower License	Same approach as historical simulation.	NID's in-stream flow requirements are non-recoverable flows required downstream of NID facilities, and are not available for other uses in NID. Minimum flow requirements are classified depending upon the year type, ranging from 16,400 acre-feet/year in extremely critical years to 59,800 acre-feet/year in wet years.	[36]
Conveyance System Losses	Seepage	Estimated based on infrastructure characteristics (i.e., canal vs pipeline, dimensions, lining characteristics) and soil characteristics (as applicable).	Same approach as historical simulation.	Seepage losses from NID conveyance infrastructure will be estimated consistent with the previous NID demand model, based on conveyance type (canal, pipeline, siphon), segment configuration, lining characteristics (lined and unlined), and soil types for canal segments.	[36]-[37], [25]-[26]
Conveyance System Losses	Evaporation	Estimated based on infrastructure characteristics (i.e., canal vs pipeline, dimensions), and evaporative demand.	Same approach as historical simulation.	Evaporation losses from NID conveyance infrastructure will be estimated consistent with the previous NID demand model, based on conveyance type (canal, pipeline, siphon), segment configuration, dimensions, and evaporative demand (ETo and free surface evaporation coefficient).	[36], [38]-[39]

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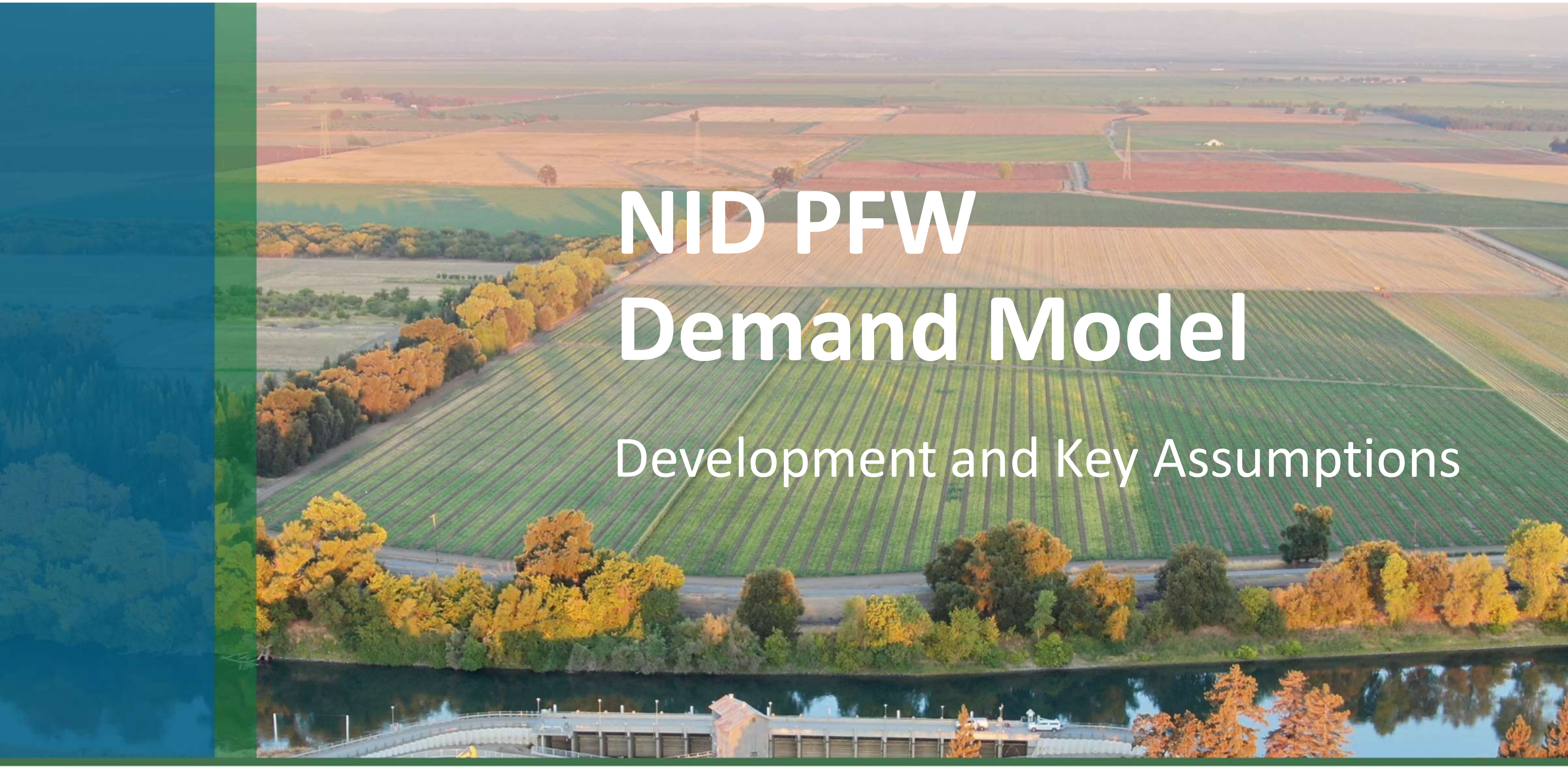


NID PFW Demand Model

Development and Key Assumptions

DAVIDS ENGINEERING, INC

Serving Stewards of Western Water Since 1993

Agenda

- Introduction to Demand Modeling
  - IDC (**I**WFM **D**emand **C**alculator)
- Demand Model
  - Approach
  - Key Inputs
- Next Steps
- Discussion and Questions

Introduction to Demand Modeling

What is Demand?

- "Demand" is the volume of water needed to satisfy water users' needs
  - Agricultural demand depends on crops, irrigation methods, climate, soils, etc.
  - Urban demand depends on population, per capita water use, climate, etc.

Source(s): NID (2020).

Demand

- Water needed for customers and environmental requirements
  - Raw water
  - Treated water
  - Municipal
  - Environmental
  - System losses
- Historical and projected demand

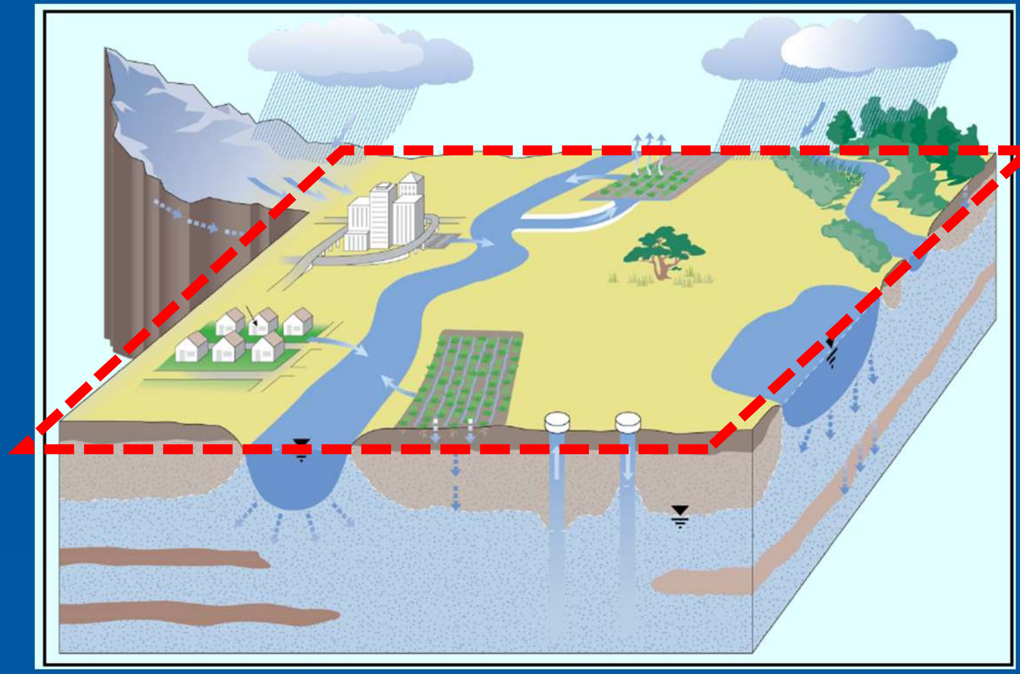
Quantifying Demand

- Land surface (root zone) water balance
  - Estimated based on demand sources (land use, pop., etc.)
  - Physically modeled on land surface
- Conveyance system water balance
  - System losses
  - Link to reservoirs

Source(s): https://www.nidwater.com/getting-irrigation-water

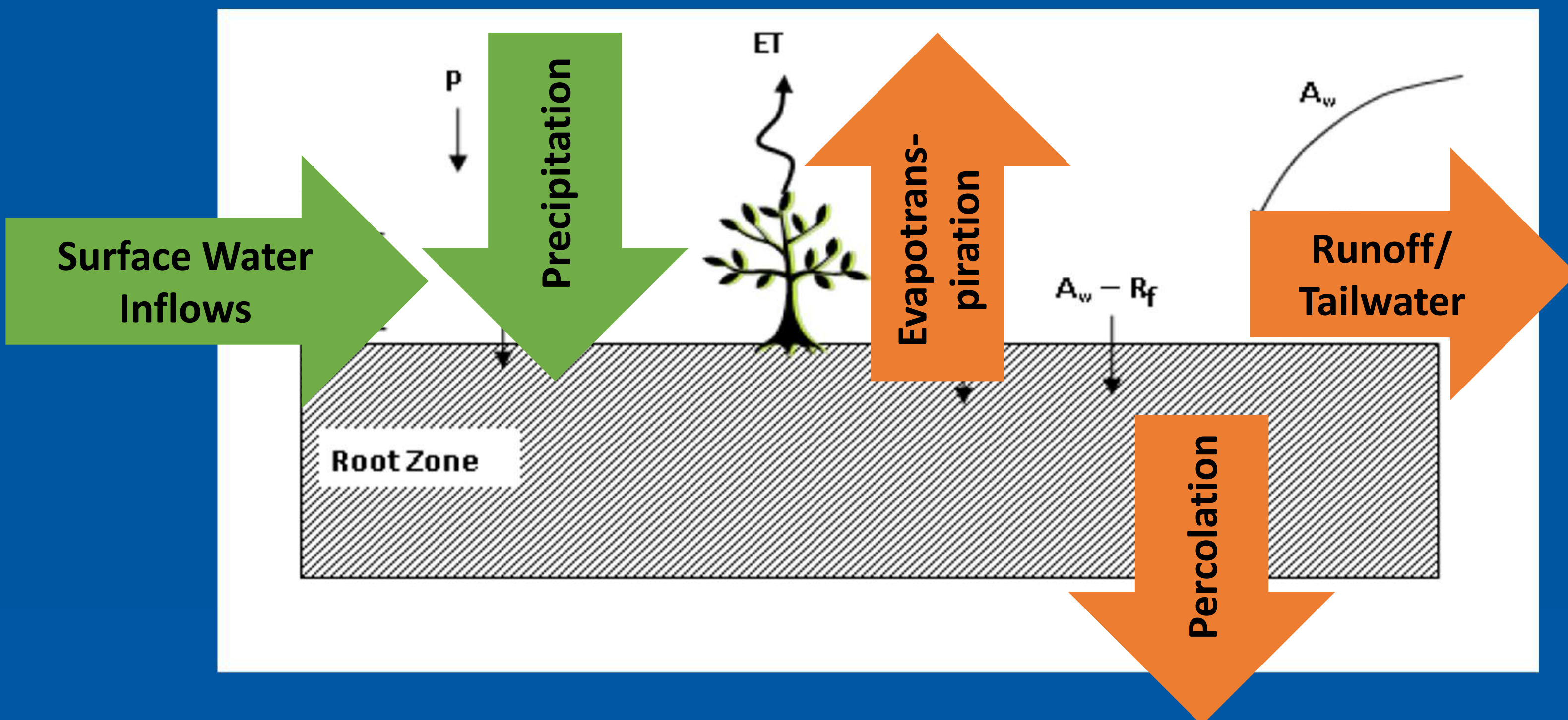
IDC: IWFM Demand Calculator

- Part of DWR's Integrated Water Flow Model (IWFM)
- Simulates physical processes on the land surface
- Widely used across California
  - Agricultural water planning studies
  - Groundwater sustainability planning



Source(s): DWR, 2022a; DWR, 2022b; DWR, 2020; Northern Sacramento Valley Inter-Basin Coordination Workgroup, 2020.

IDC: IWFM Demand Calculator

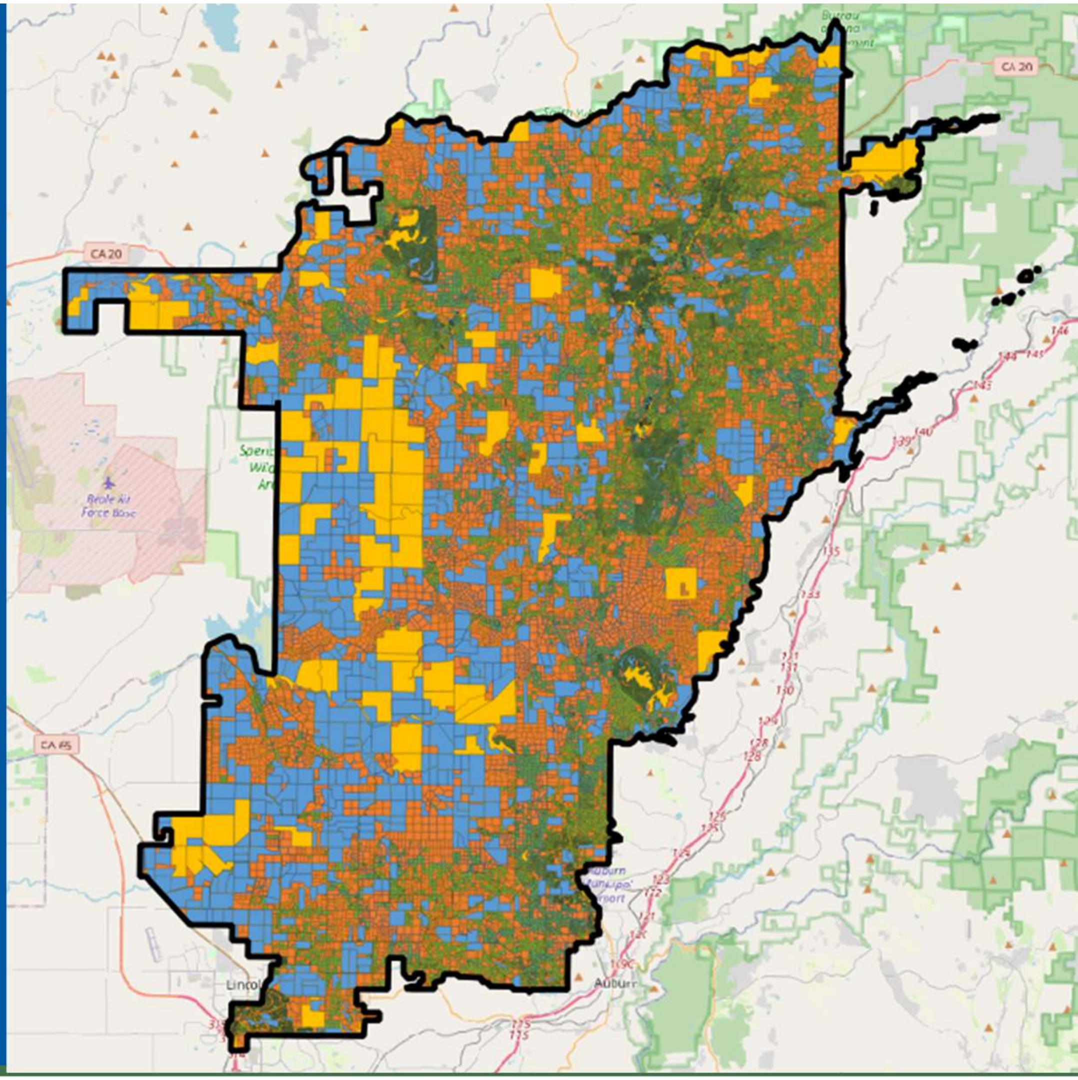


Source(s): DWR, 2022a; DWR, 2022b; DWR, 2020; Northern Sacramento Valley Inter-Basin Coordination Workgroup, 2020.

Demand Model

Model Structure

- IDC operates on a grid
- Goals:
  - Preserve demand detail
  - Streamline simulation of scenarios
  - Easier future updates
- IDC grid represents:
  - Elevation zones
  - Soil
  - Land use



Key Inputs

- Land use
  - Developed
  - Agricultural
  - Native and riparian vegetation
- Urban water use
  - Population
  - Per capita use
- Agricultural water use
  - Crop demand
  - Irrigation practices

 Source(s): https://www.nidwater.com/water-conservation-in-agriculture

Land Use

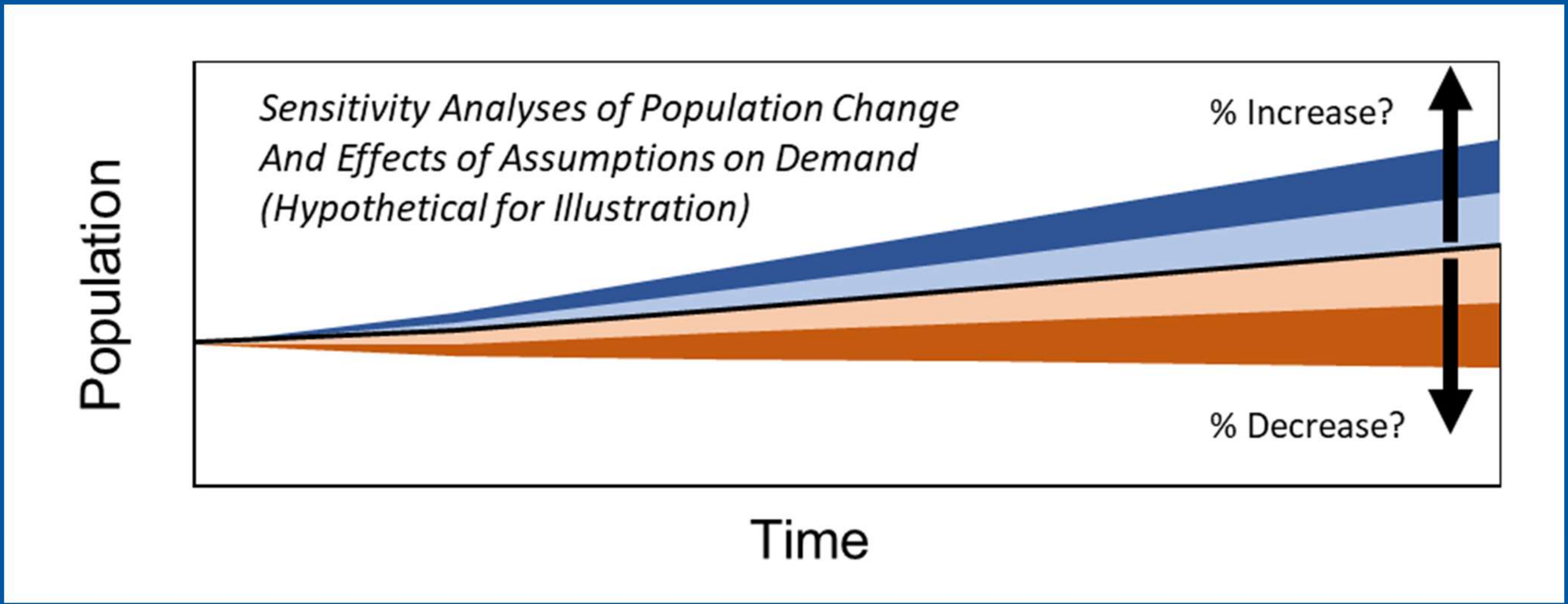
Period	Data/Information	Sources
Historical	Land Use Mapping, Surveys	DWR, Land IQ, USGS, USDA, Counties
	NID crop surveys	NID
Future	General Plan/Zoning	Counties/Cities, NID
	NID soft service areas	NID
	Projections informed by local planning, recent trends	USGS projections, local estimates

Population

Period	Data/Information	Sources
Historical	Population Estimates for Cities, Counties (Annual)	CA Dept. of Finance
Future	Population Projections for Counties (Annual)	CA Dept. of Finance*, Nevada County Transportation Commission
	Projected Connections, Treated Water Customers (5-year)	NID (Urban Water Mgmt Plan)

**Consistent with methods used to evaluate projected water demands through 2040 in NID's Urban Water Management Plan (2020).*

Sensitivity Analysis



Urban Water Use

Period	Data/Information	Sources
Historical	Potable water production (Monthly, per capita)	NID, Cities, State Water Resources Control Board
Future	Per Capita Targets	California Water Code, 2018 Water Conservation Legislation, Water Conservation Act of 2009

Ongoing Coordination

- NID operations
- NID management
- Stakeholders
- IDC update meeting in July

 Source(s): https://www.nidwater.com/

Discussion and Questions

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