Decision making under uncertainty: A water supply infrastructure planning tool

Tirusew Asefa, Ph.D. P.E., D.WRE, F.ASCE

January 18, 2022,





Planning for Multiple Futures: A Level of Service Approach[‡]

Deterministic Stochastic one random variable Stochastic two random variables Demand Capacity Demand Capacity Analyze shortages to determine future supply

Demand Capacity



[‡]Asefa, T., A. Adams, and N. Wanakule, 2015, A level of service concept for planning future water supply projects under probabilistic demand and supply framework, Journal of American Water Resources Association, 51(5) pp: 1272-285, DOI: 10.1111/1752-1688.12309 ³

TAMPA BAY Demand-Supply Variability



>//



Regional Performance Evaluation Model







Three New Water Supply Projects

Surface Water Treatment Plant Expansion with existing source water

Desalination Facility Expansion with existing source water New Groundwater Treatment Plant via Net Benefit from SHARP Program



Model ID	SWTP Location	Withdrawal Location	Treatment Capacity	Pipeline Assumptions
125 (baseline)	Existing site – no expansion	Existing locations – no expansion	No expansion	
126	Existing site	Existing locations	+20 mgd treatment capacity at existing site	Regional pipeline from AAF to SCH_3 demand node
128			+30 mgd treatment capacity at existing site	- 10 mgd minimum flow in the direction of SCH_3 only
129	Near regional reservoir (new site)	Directly from reservoir	New SWTP with 20 mgd treatment capacity	
130			New SWTP with 30 mgd treatment capacity	Pipeline flow is comprised only of regional water via AAF
131		From the reservoir influent / effluent pipe	New SWTP with 20 mgd treatment capacity	
132			New SWTP with 30 mgd treatment capacity	
133		Directly from reservoir	New SWTP with 20 mgd treatment capacity	Regional pipeline between AAF and SCH_3 demand node
134			New SWTP with 30 mgd treatment capacity	No minimum flow requirement
135		From the reservoir influent / effluent pipe	New SWTP with 20 mgd treatment capacity	Bidirectional flow is allowed (i.e., flow can go toward SCH_3 or toward AAF)
136			New SWTP with 30 mgd treatment capacity	Pipeline flow may be comprised of regional water via AAF or production from the new SWTP near the reservoir 7

The Benefits of New Infrastructure





Baseline infrastructure = Existing infrastructure , TECO Big Bend Connector Tunnel & Southern Hillsborough County Pipeline

The Benefit of New Infrastructure





Baseline infrastructure = Existing infrastructure , TECO Big Bend Connector Tunnel & Southern Hillsborough County Pipeline

Coupled Water Supply and Financial Model





Coupled Water Supply and Financial Model

Tampa Bay Water must meet *covenant thresholds* to maintain a good credit rating (*and low interest rate on debt for infrastructure*)

Rate Covenant:

 $\frac{\textit{Net Revenue} + \textit{Reserve Fund}}{\textit{Debt Service}} \ge 1.25$

 $\frac{\textit{Debt Covenant:}}{\textit{Net Revenue}} \ge 1.0$



Financial Model Structure





Financial Model Structure





What can Management Explore?

Repayment schedule of future and existing debt Uniform rate setting and reserve fund transfer policy

Timing & sequencing of potential future infrastructure projects

Inflation rate of operating costs	Rate of water demand growth	Interest and miscellaneous income
Targets for debt and rate covenants	Water availability and withdrawal permit capacity	Differences between budgeted and actual finances



Financial Feedbacks – Baseline Scenario



No management involvement – model balances uniform rate "Hands-off" policy approach



Financial Feedbacks – Baseline Scenario



Management wants no rate increase on the uniform rate "Fixed" policy approach



Financial Feedbacks – Baseline Scenario



Management wants minor increase on the uniform rate "Controlled Growth" policy approach



Investment vs. Demand Growth

High demand + dry futures may lead to severe water delivery shortfalls But, *low demand futures* can mean a high Uniform Rate to meet financial objectives

High demands and drought conditions = risk to water supply

Low demands and/or high investment = risk to financial stability





- Understanding both demand and supply uncertainty allows for risk assessment
- Uncertainty doe NOT mean no decision
- Coupling financial model allow implication to rate payers
- Next: Pilot model complete; currently on implementation

Participants

Tampa Bay Water





Tirusew Asefa

Nisai Wanakule



Hui Wang

44



Sandro Svrdlin

UNC Chapel Hill







David Gorelick

Christina Petagna

Greg Characklis



David Gold



Cornell



Lillian Lau

Patrick Reed

