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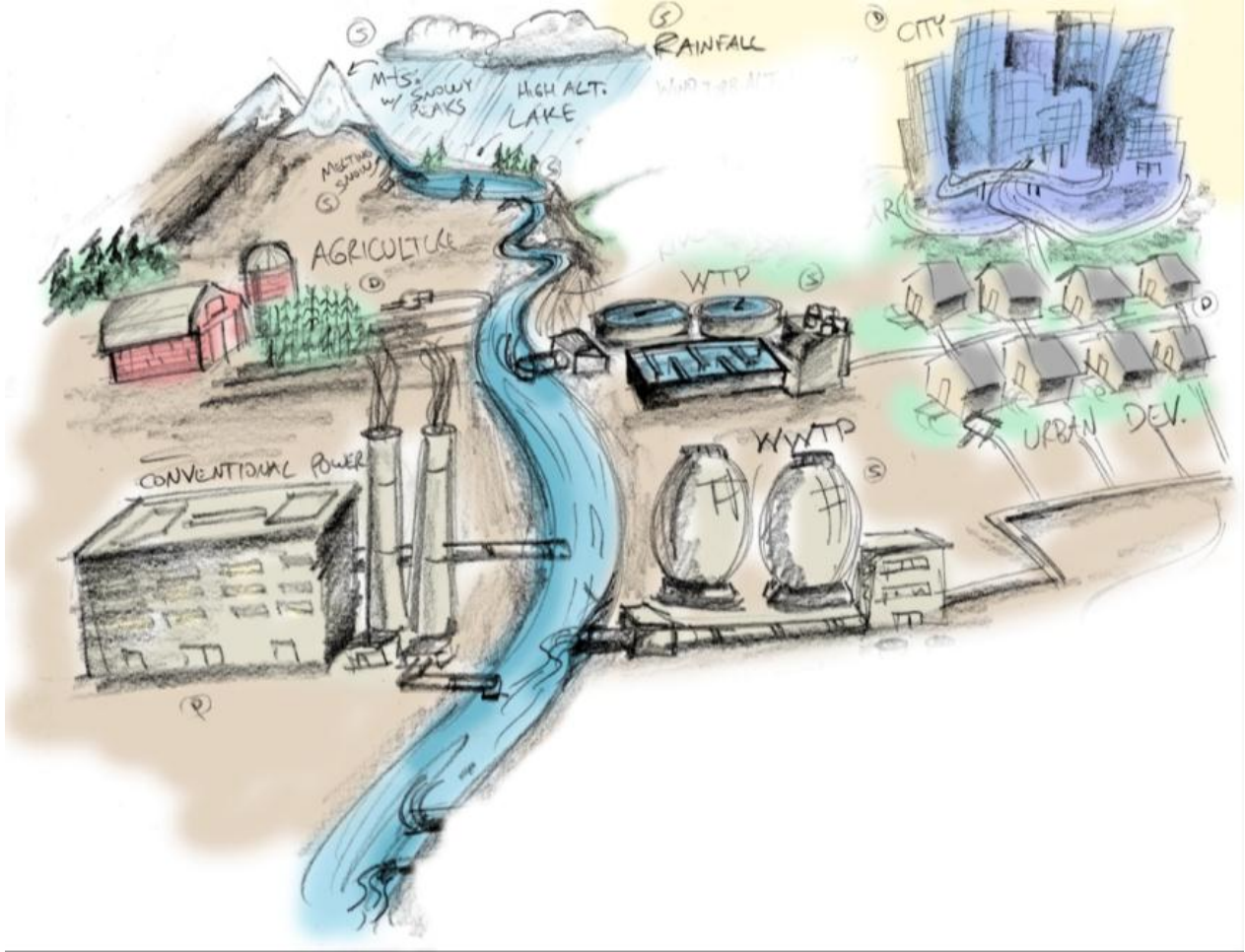
Practical Systems Modelling Approach for Effective IWRM Planning and Implementation

CH2MHILL VOYAGE

INTEGRATED RESOURCE MANAGEMENT

Tuck Wai Lee – CH2M HILL



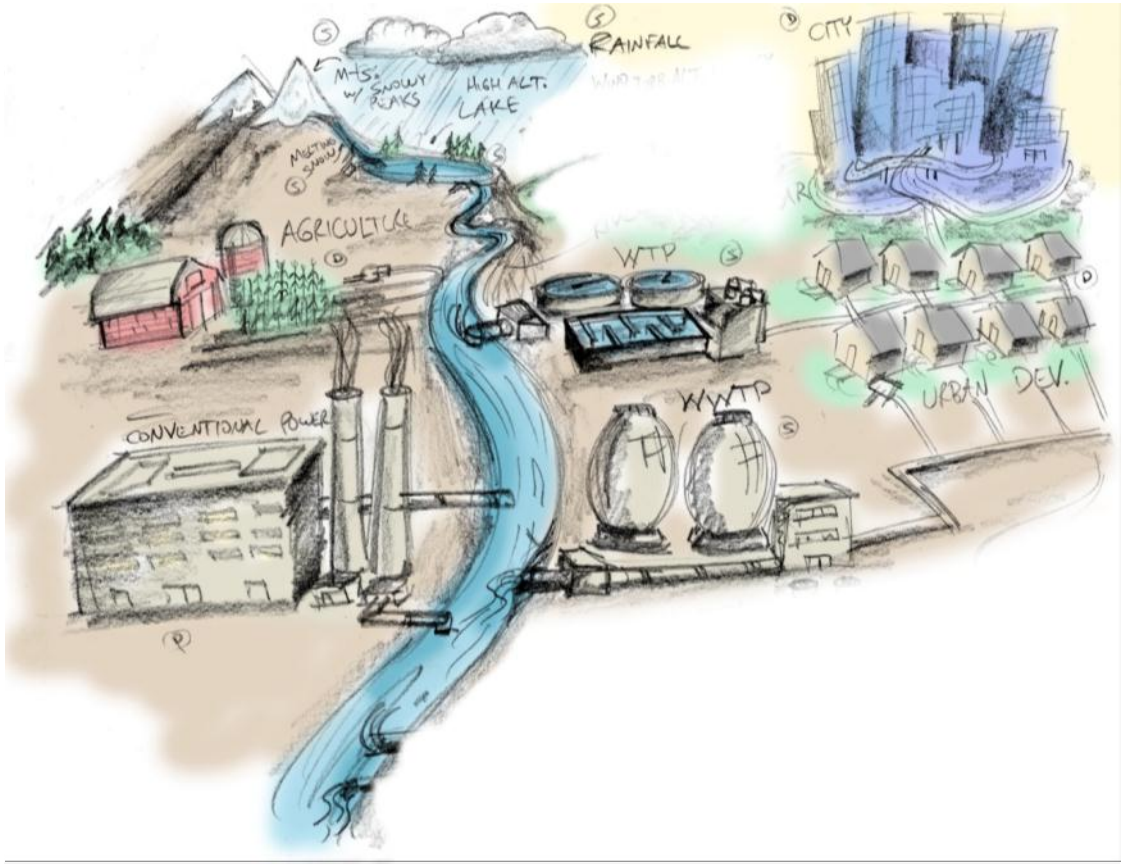
Day 1 – Key Takeaways

- Trust in data quality
- Visualization & stakeholders
- A lot of advances in national level efforts - very large scale, global / regional impacts

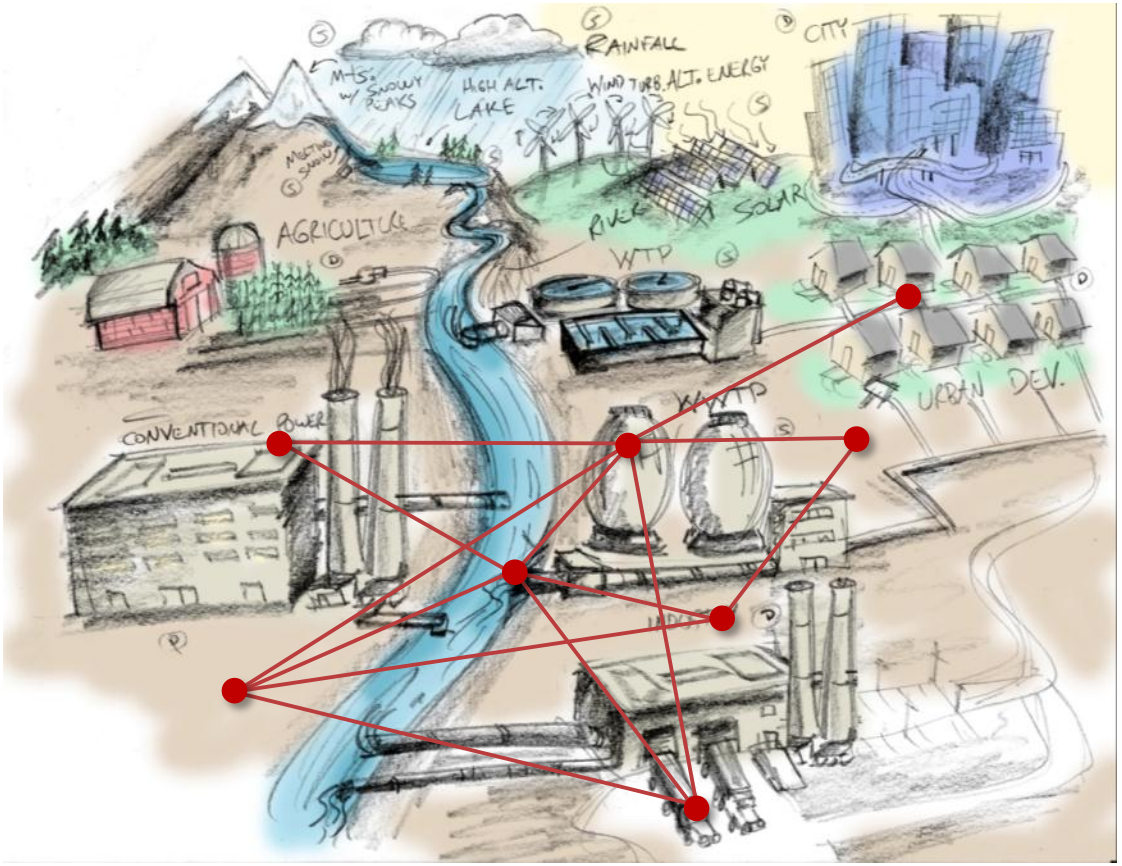
All above are critical for IWRM of large scale planning efforts & operations…

Immediate needs at city level planning & implementation.

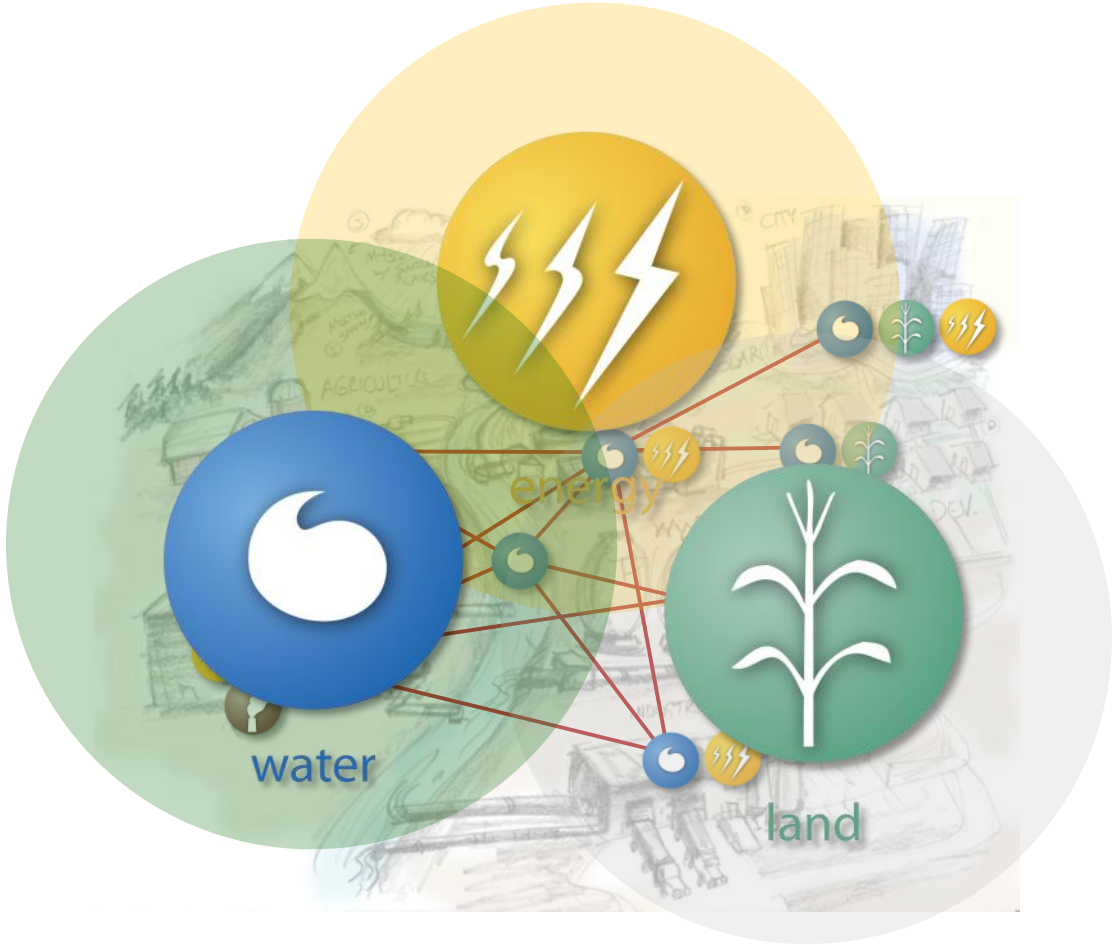
As we've built our communities, we've managed resources to meet individual needs as they've evolved over time.



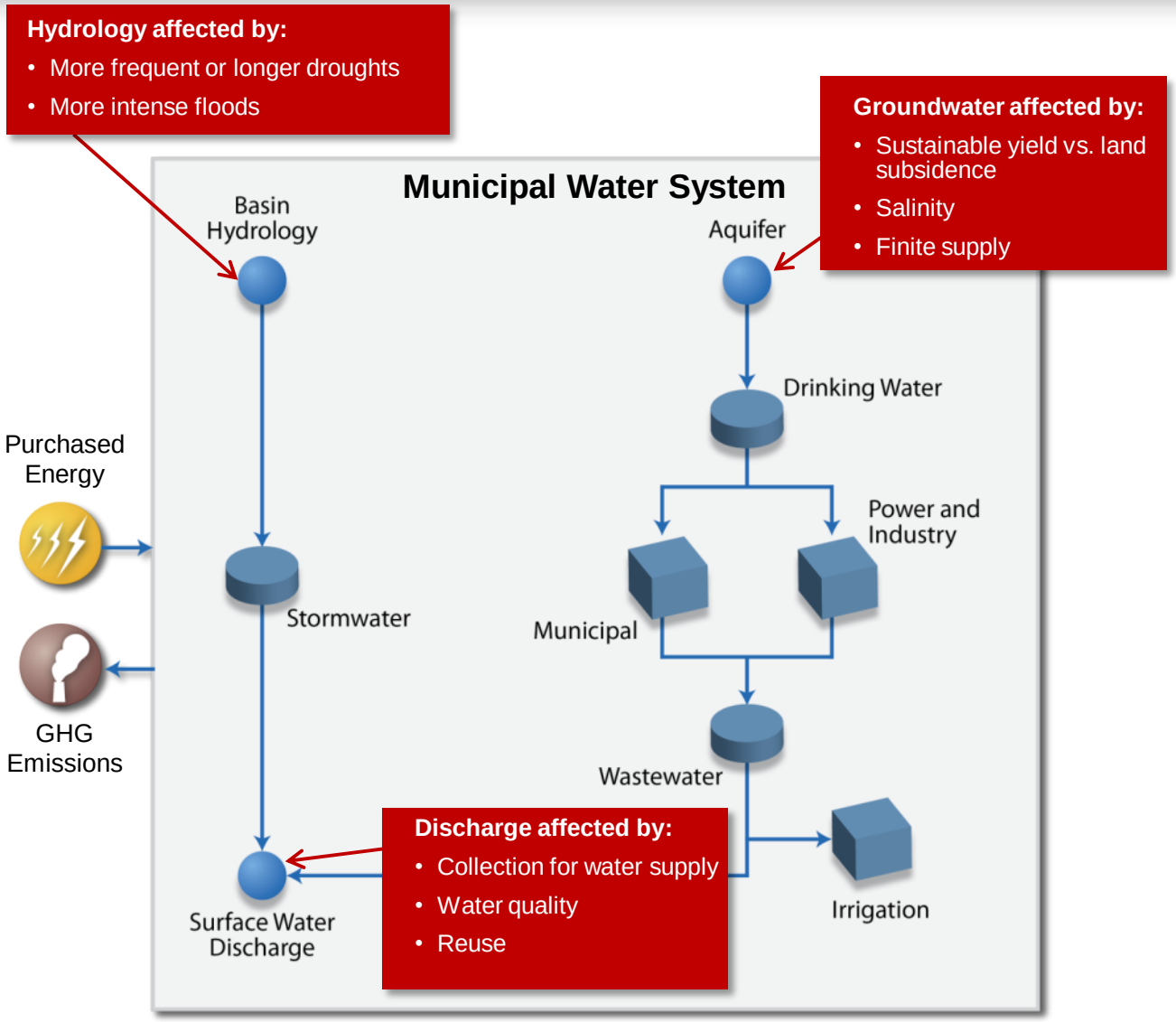
Today, these individual parts now interact within a complex, interdependent system



With systems thinking, we can understand how to balance supplies with demands and optimize how we manage resources



How do we get started with systems thinking?



- What are your goals and risks?
- What resources address these challenges?
- How is the system currently managed?
- What are the constraints?
- What alternatives exist?

Systems thinking improves performance of resource managers

- **Systems thinking** seeks to understand interdependencies of the systems we manage
- Transparent, defensible, and consider many solutions.
- Optimize decisions…to improve business performance.
- Plan for the future to mitigate risks of a changing world.
- Improve performance, work more efficiently, and value assets fairly to reduce costs.
- Steward resources responsibly
- Integrate systems using economics, market forces, decision science, and state-of-the-art engineering and science

Managing resource systems occurs at all stages of the infrastructure cycle

- System Definition
- **Data gathering**
- Scientific research
- Policy development

- Revenue strategy
- Political strategy
- Public relations
- Credible experts
- Partnership negotiations

- **System modeling**
- Risk assessment
- Scenario planning
- Resource economics
- **Decision science**

- **Environmental permitting**
- **Engineering & Design**
- **Construction delivery**
- **Commissioning**

- Optimization
- **Monitoring**
- **Adaptive management**

Modeling Approach / Needs are similar

- Review input data prior to inclusion in models (GIS, surveys, time series)
- Build models to represent performance of the system considered
- Run simulations that link together multiple models or run multiple scenarios to analyse different events or development options
- Review model results on maps and charts (time series and long/cross sections)
- Post process model outputs to produce useful data for dissemination to stakeholders

Key Elements for Practical Systems Modelling for IWRM Planning and Implementation

Understanding of System

Data Availability & Quality

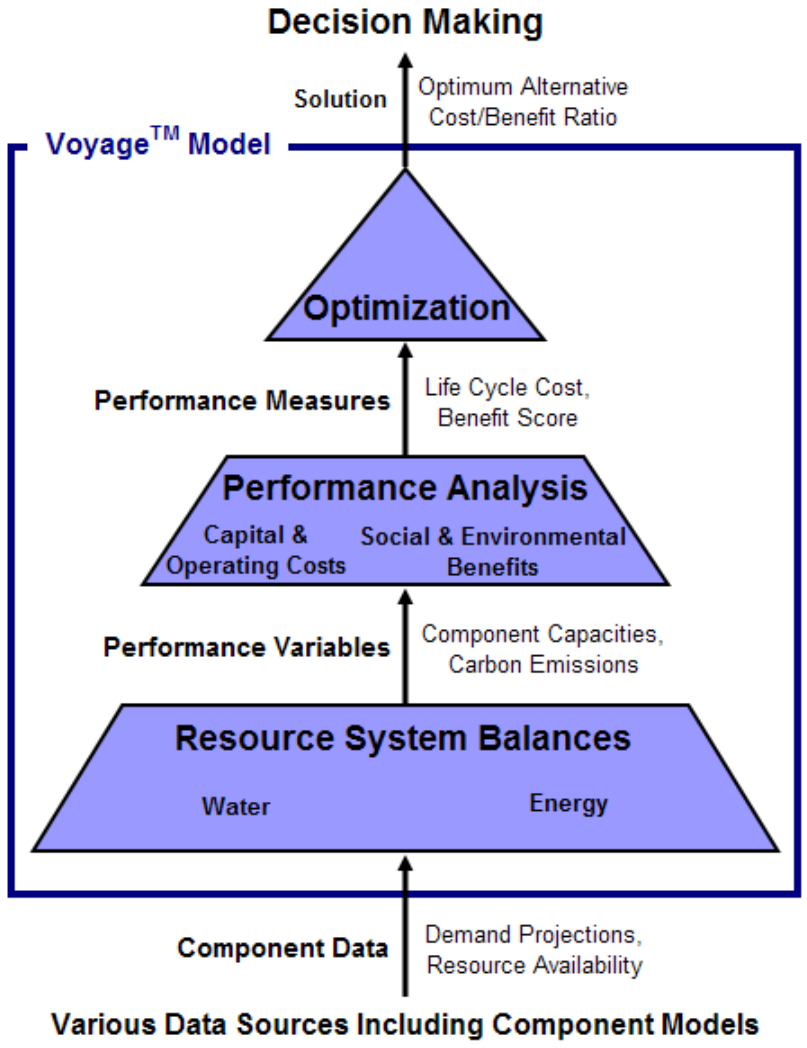
Multi-Criteria Decision Framework

Screening Level Assessment

Integrated & Dynamic Systems Modeling Tool

1. Data Availability & Quality

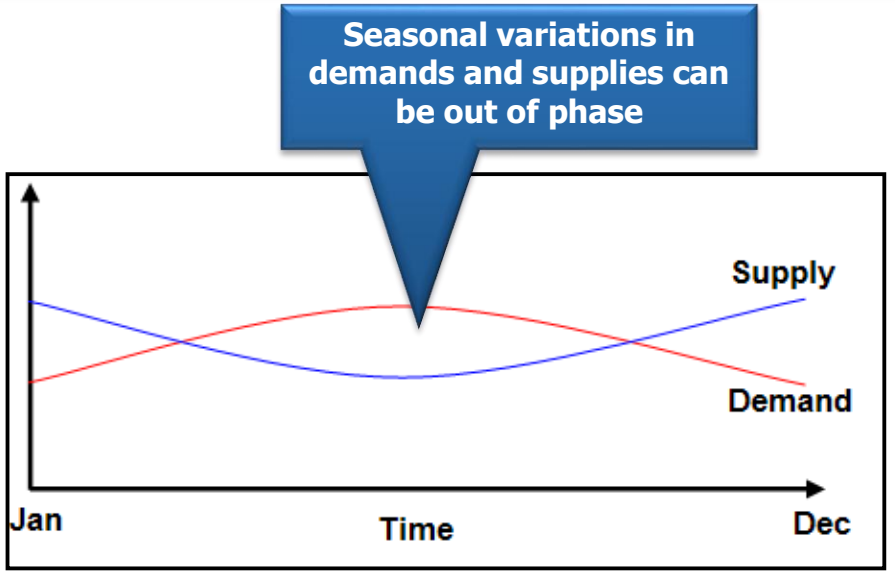
- Existing Information
  - Master Plans
  - Existing infrastructure & conditions
- Operating data
  - Projections
  - Population
  - Demands
- Component Model Outputs
  - External model packages
  - Spreadsheets

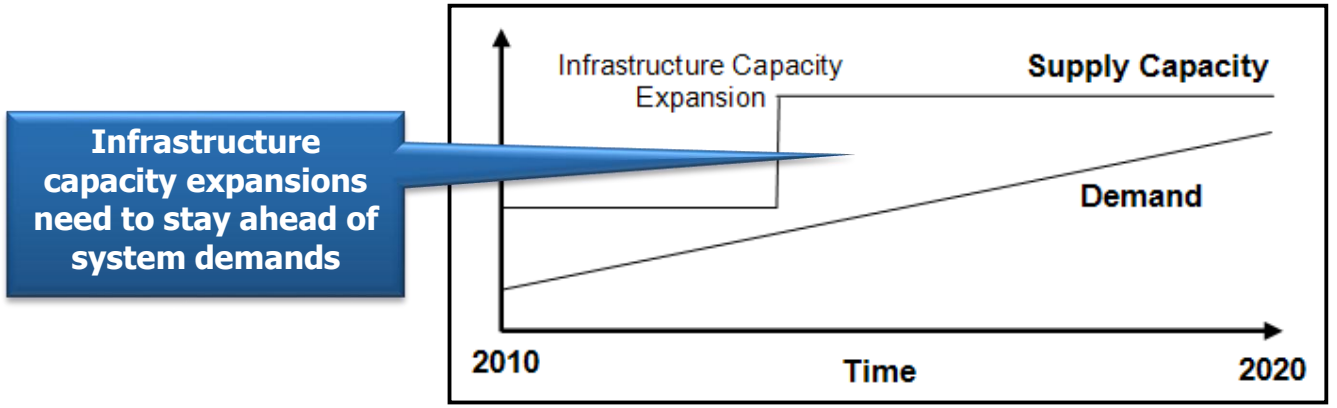


1. Data Availability & Quality

Dynamic System Simulation

- Time dependent variables
  - Rainfall data
  - Availability of supply capacity
  - Demands in seasonal variations
  - Long term population growth
  - Conservation measures

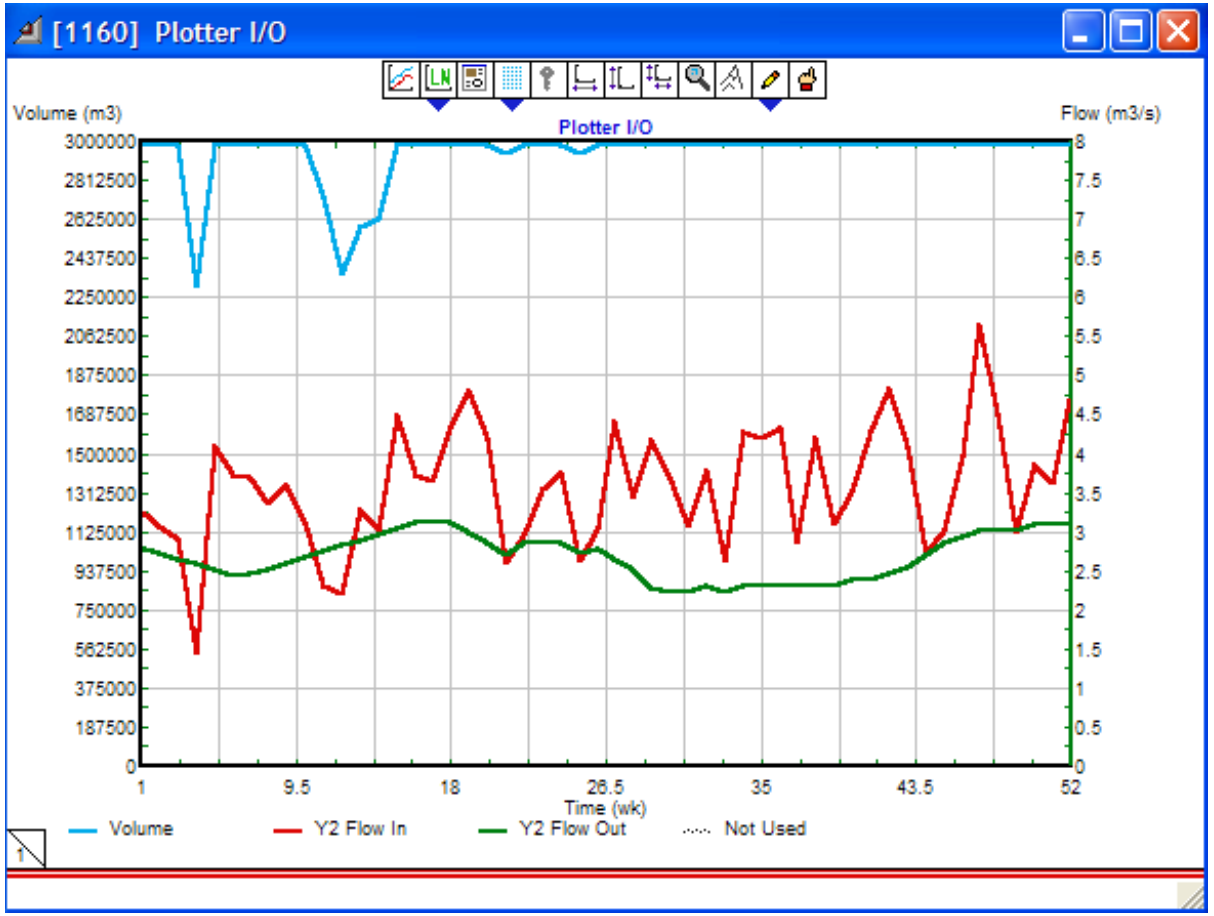




1. Data Availability & Quality

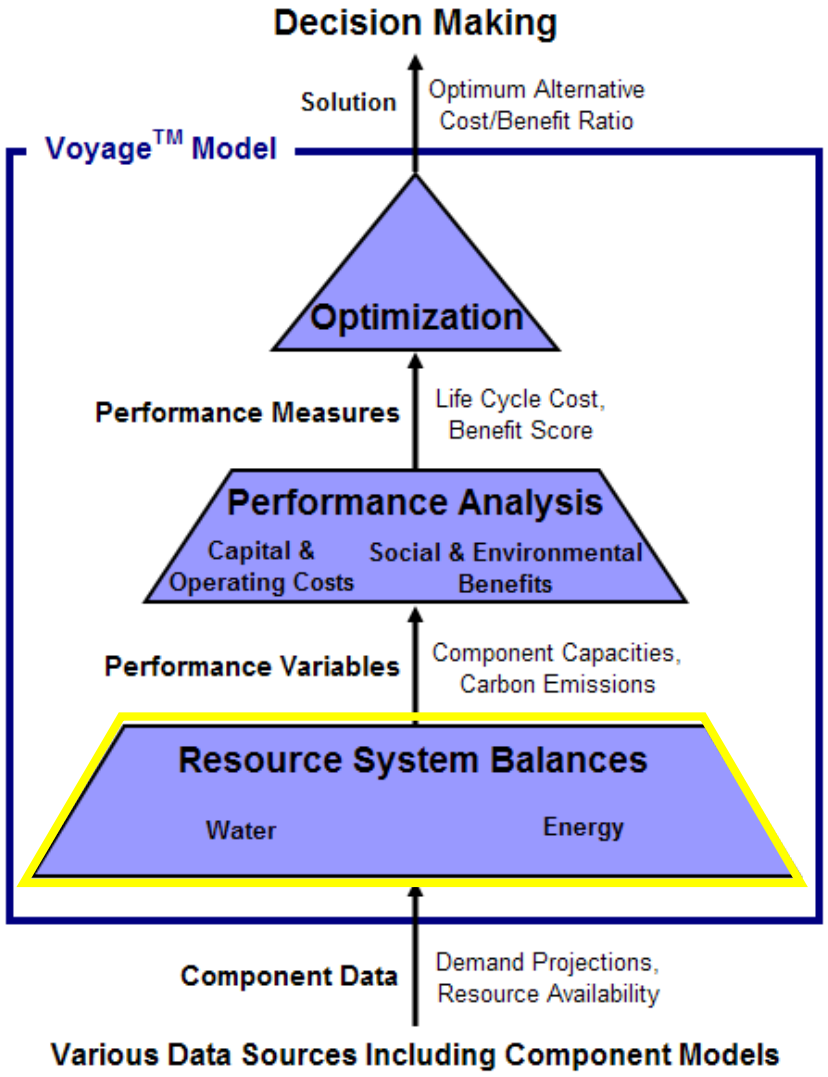
Analysis of “what if” Scenarios

- Varying demands
  - Changes in population
  - Changes in usage behavior
  - Changes in land use
- Varying supplies
  - Water quality
  - Weather patterns
  - Changes in water supply sources
- Varying costs & revenues
  - Alternative technologies
  - Infrastructure requirements
  - Rate changes



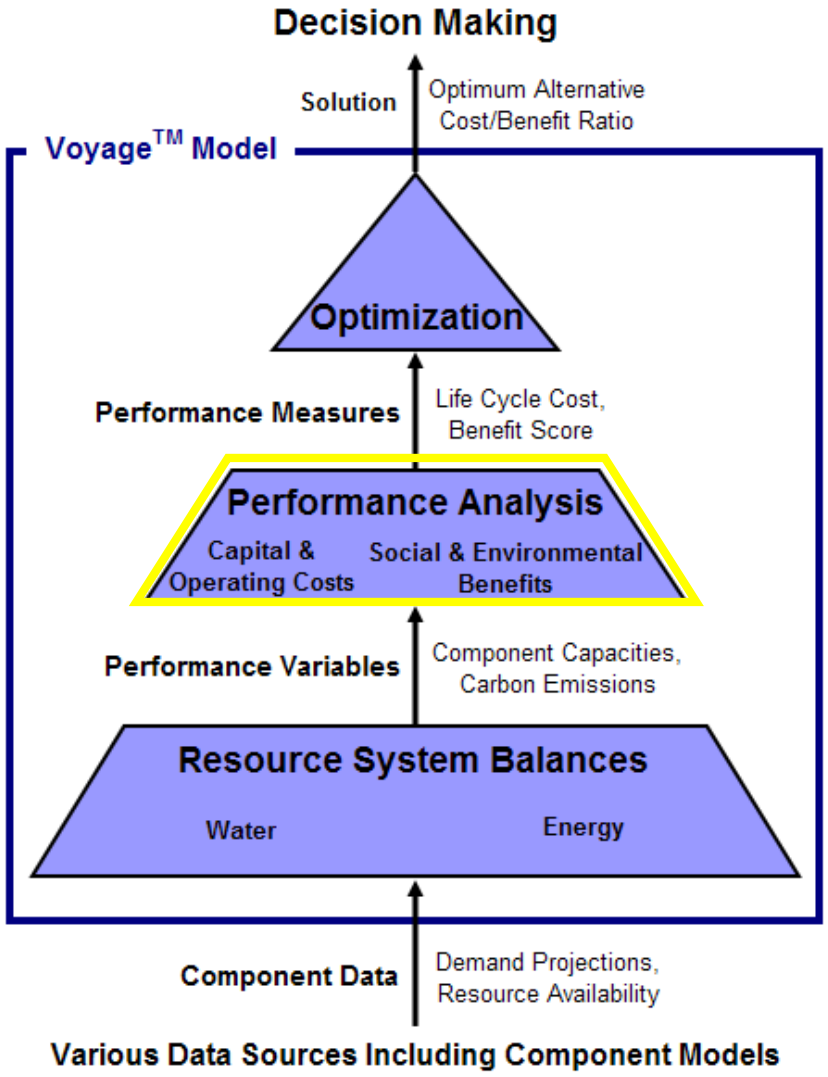
2. Understanding of System

- Integrated System Components & Interactions
  - System Components
  - Demands
  - Supplies
  - Treatment
  - Reuse
  - Storage
  - Transmission
- Accounts for potential positive and negative synergies
- Identify alternatives that make sense to be implemented first



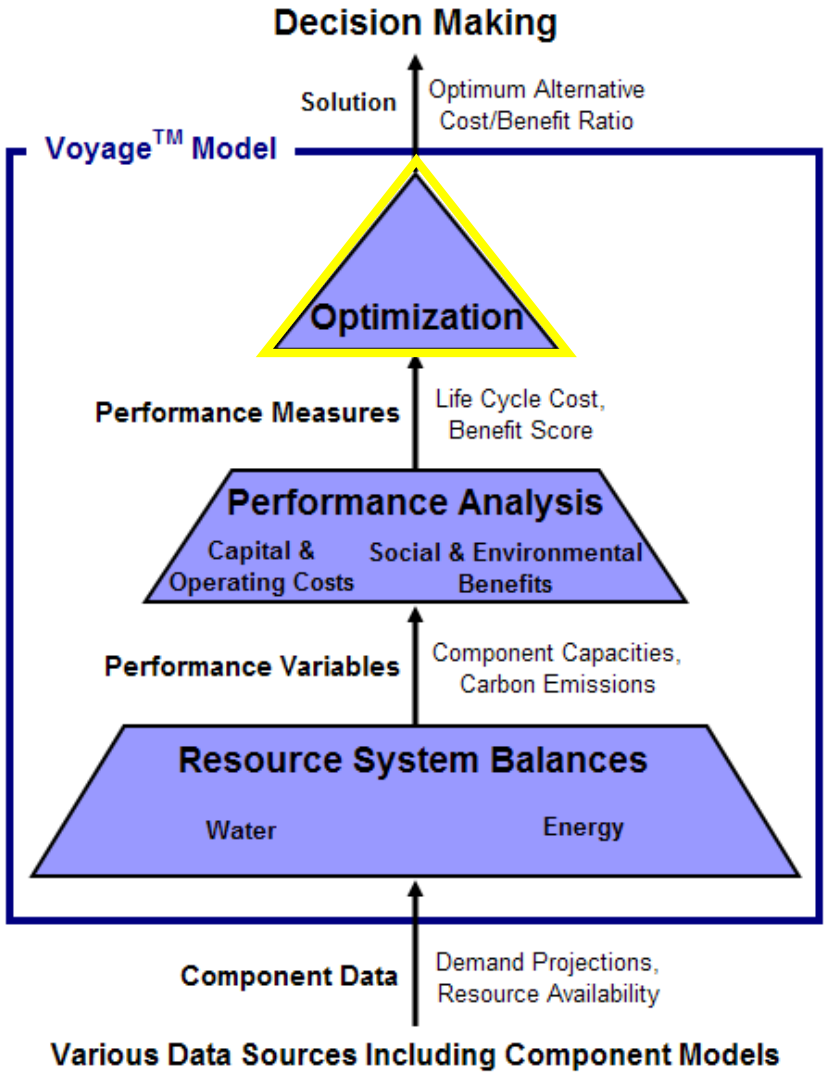
3. Multi-Criteria Decision Framework

- System economics
  - CAPEX, OPEX
  - Life Cycle Cost
- Environmental criteria
  - Liquid, gas, and solids releases
  - Ecological impacts
- Social criteria
  - Public health protection
  - Political imperatives
- Technical criteria can be included to consider implementation aspects
- Define goals and planning principles early; helps to direct data collection effort



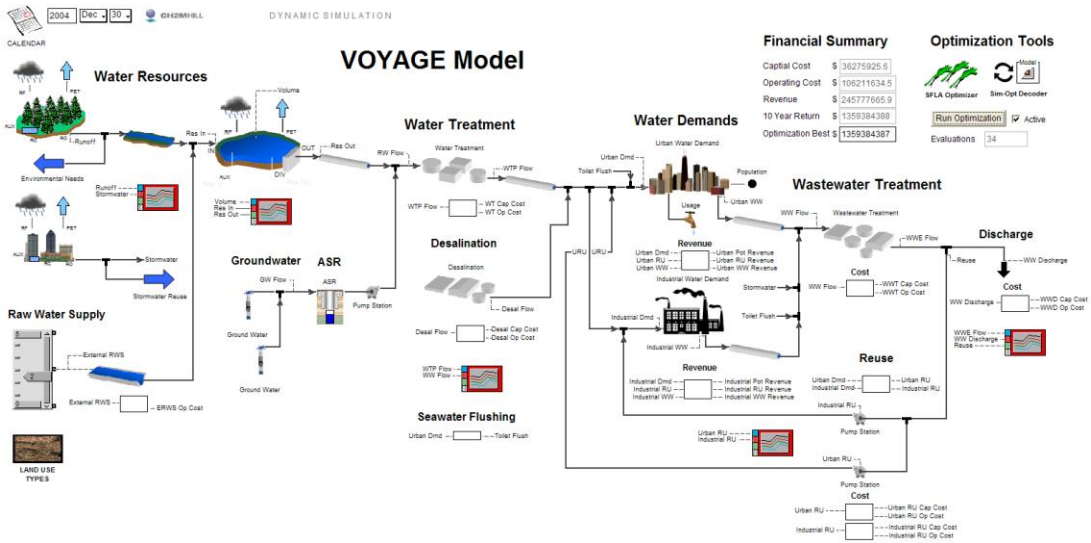
4. Screening Level Assessment

- Identify solutions with "fatal flaws" early in the process
  - More focused data collection efforts.
- Characterization of alternatives in terms of the parameters that are important to stakeholders' planning principles
  - Facilitates process of developing solution portfolios
- Evaluate large number of alternatives
  - Optimize multiple parameters simultaneously
  - Find the best combination of decisions
  - Advanced optimization algorithms possible

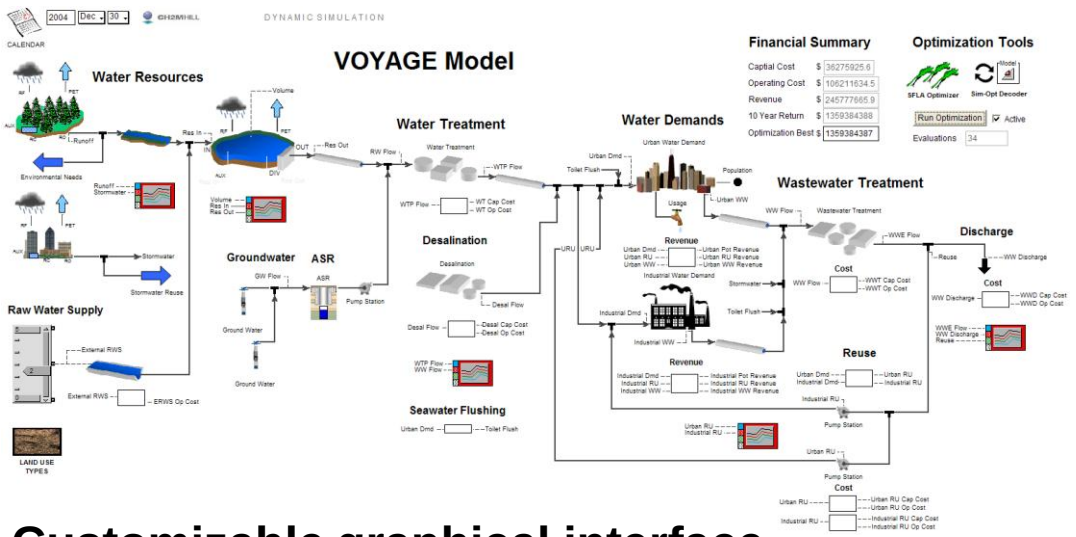


5. Integrated & Dynamic Systems Modeling Tool

- Integrated: Systems interactions for collaborative planning
  - All water cycle components: demands, supplies, storage, recycles
  - Accounts for project complexities, e.g. positive or negative synergies, implementation priorities
  - Cost and energy considered together with water balance
- Dynamic: Large Scale Planning Tool
  - Time steps: Monthly, Weekly, depends on modeling objectives
  - Allows for seasonality impacts on demand & supply
  - Multiple year simulation runs
  - Capital works planning over different phases of development

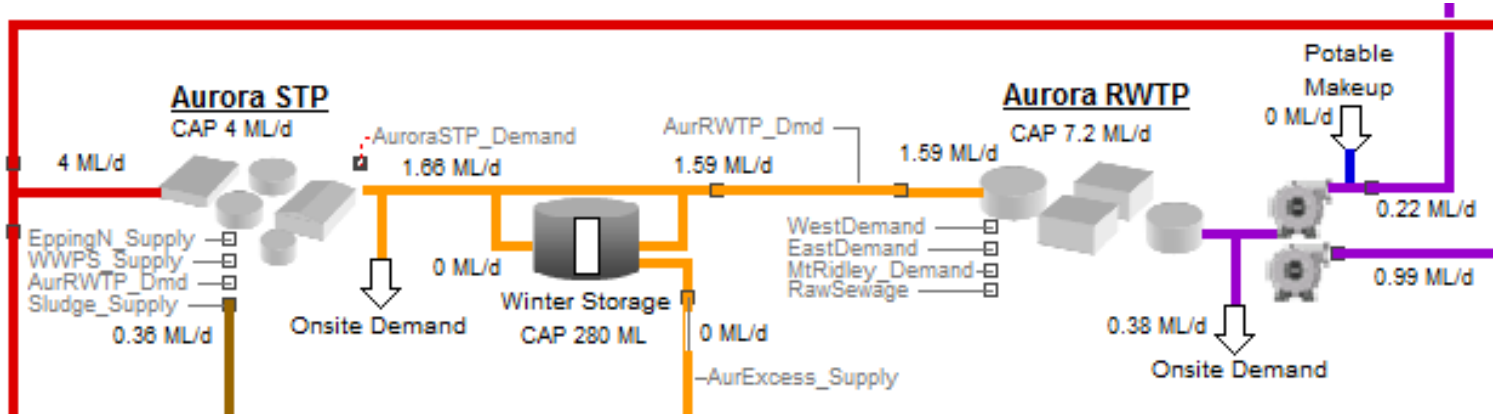


High level communication tool with a graphic interface that provides quicker understanding and processing of key information by stakeholders, leading to decision making.



Customizable graphical interface

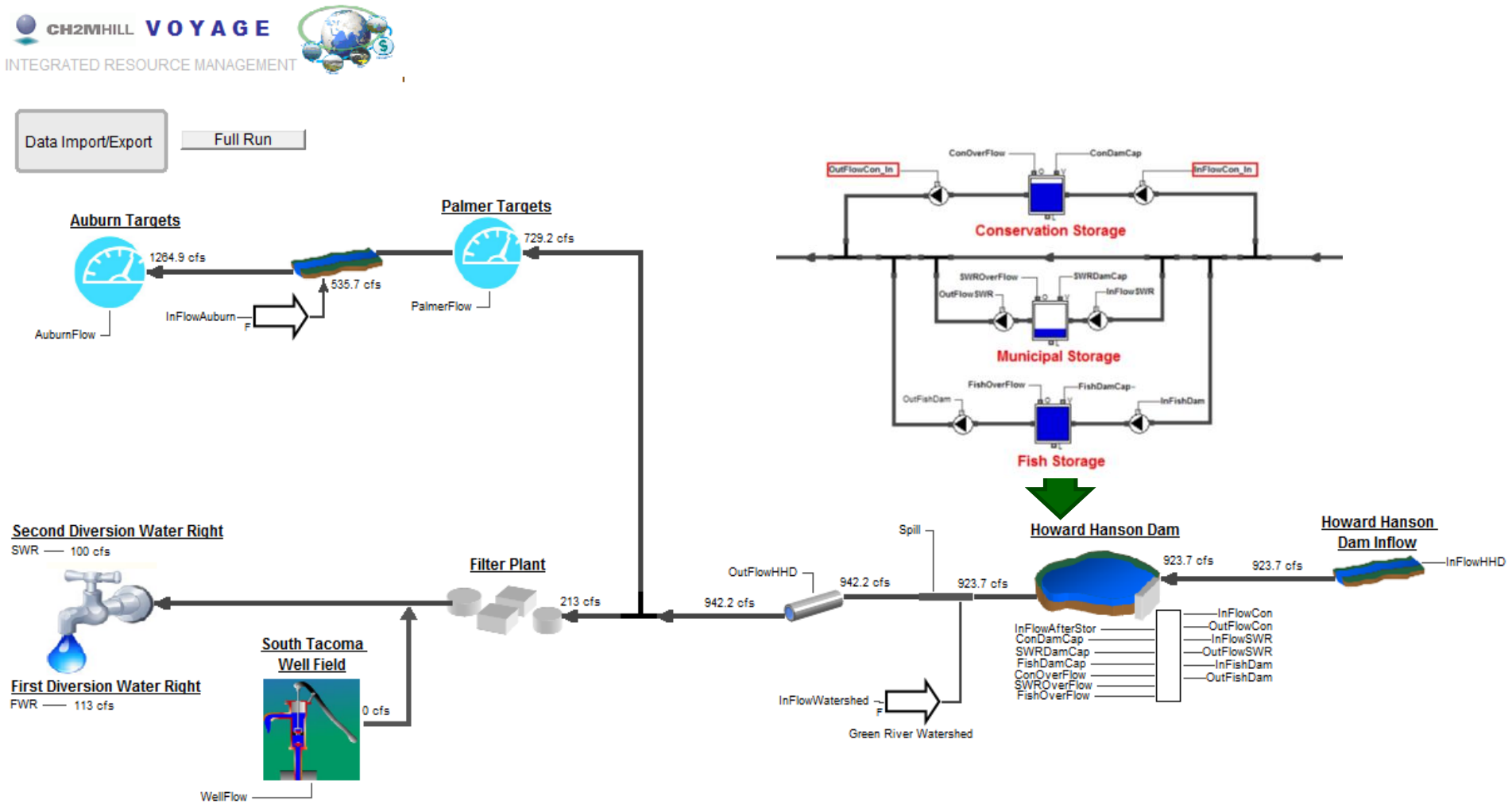
Geographic visualization in Google Earth™



Animation Capabilities

System Operations – US example

- Municipal storage
- Conservation storage
- Fish storage
- External reservoirs

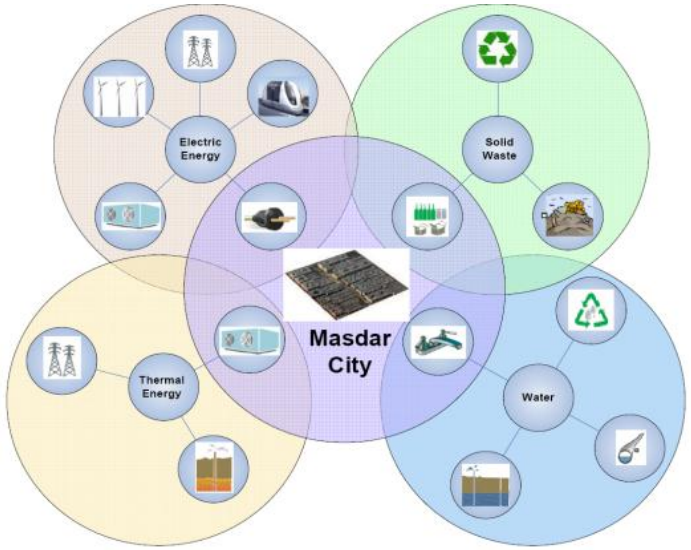


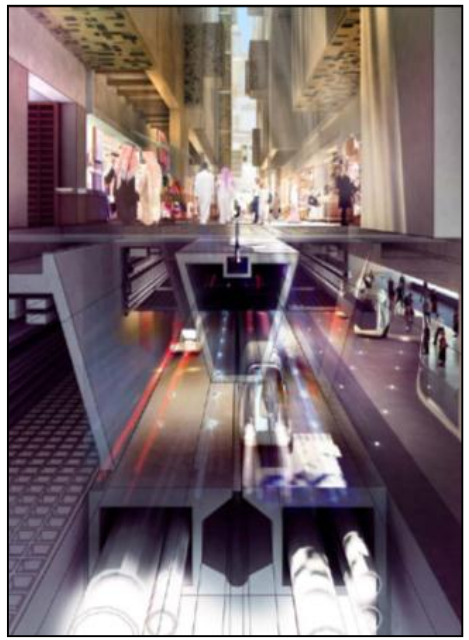
Project Results – US example

- Increased the risk-adjusted calculated average summertime yield by 20 percent
- Capacity to adaptively manage complex operating rules and optimize yield at varied time frames year-to-year
- City water can create strategies that minimize impacts in the future from climate variability and trend changes

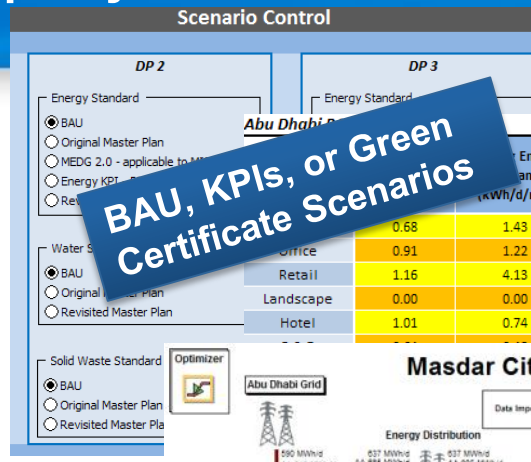
City planners adopt high-level systems integration model – Middle East

- Integrate resource balances (water, energy, waste) for the City for infrastructure and buildings
- Account for the interdependencies of resources – energy systems that use water, building standards that affect energy use, infrastructure performance and carbon footprint, etc.
- Aid in decision-support, both in development planning and monitoring results



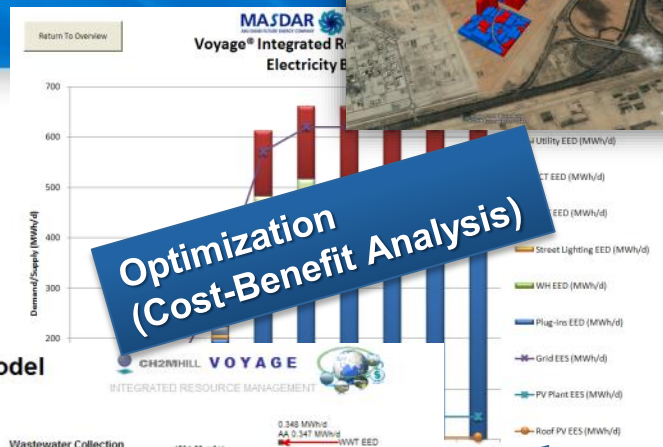


Custom Model Architecture matches project needs – Middle East

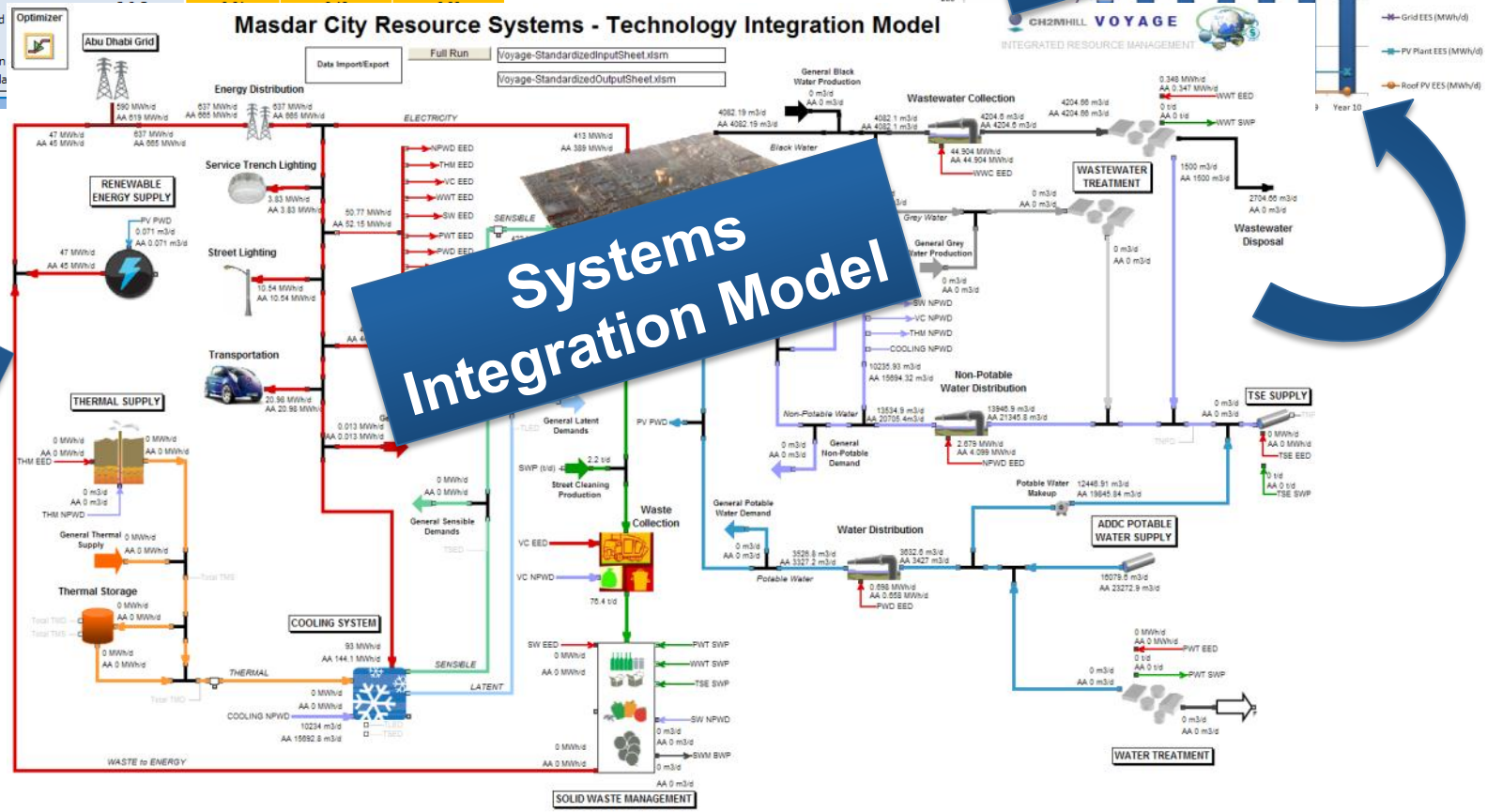


BAU, KPIs, or Green Certificate Scenarios

	Energy and (kWh/d/m2)	Latent Energy Demand (kWh/d/m2)
	0.68	1.43	0.00
Office	0.91	1.22	0.00
Retail	1.16	4.13	0.00
Landscape	0.00	0.00	0.00
Hotel	1.01	0.74	0.00



Optimization (Cost-Benefit Analysis)



Systems Integration Model

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Summary

- Practical approach to IWRM is needed for detailed planning and implementation work
- Systems thinking & results
- Tool to engage partners for collaboration & decision making

- Ultimate goal is to deliver implementable results on the ground…
- Access to / Integration of infrastructure, environment, risk management, and programme delivery specialists

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Thank You