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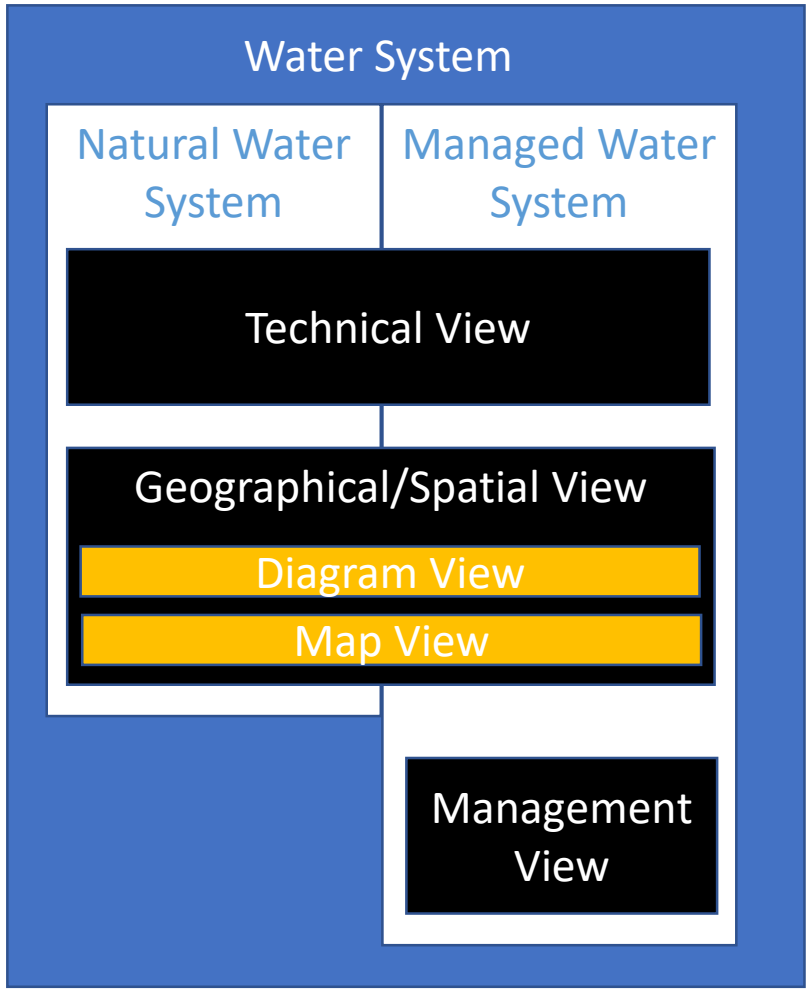
T. Butine

The “Water System”

Context, Scope and Terminology, and Implications to Water Conservation Goals

The “Water System”: Context and Scope

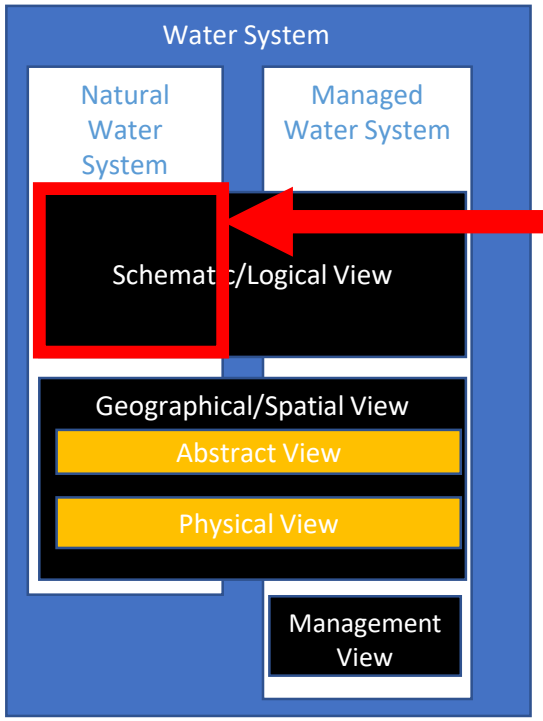


The purpose of this paper is to define the terms and relationships of “water” in order to properly define the context and scope of various elements and actions involved in the life of “water”. It may sound silly and superficial at first, and then overly complex later, or it may sound so abstract that it is useless. Be patient and see if there is value in describing the management of water.

The Water System is composed of the Natural Water System, which is composed of the elements and actions that occur in nature, and the Managed Water System, which is composed of human-made elements and actions for the purpose of sustaining human life.

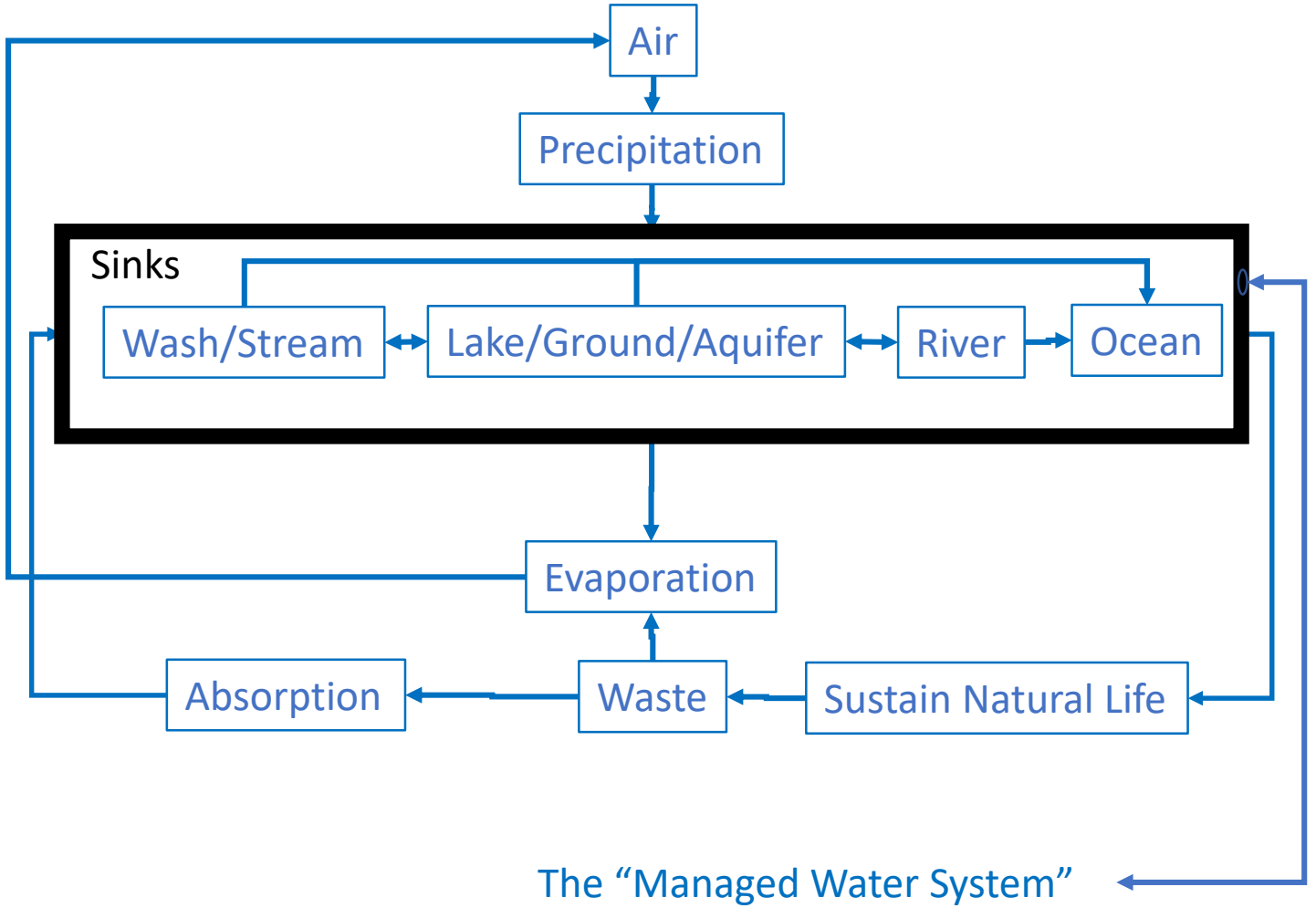
These systems can be defined and viewed in several perspectives:

- A technical view that names the elements, actions and relationships between them.
- A geographical or spatial view that describes the system relative to geographical or spatial boundaries. These can be described both in an abstract diagram and in a map.
- A management view, which of course is only pertinent in a managed system, that defines the structures, responsibilities, principles, policies and processes for managing the system.



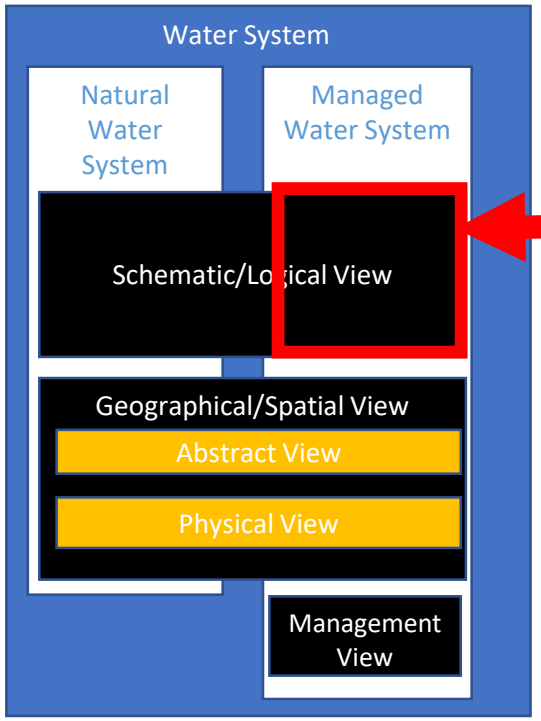
Schematic View of the Natural Water System

Context

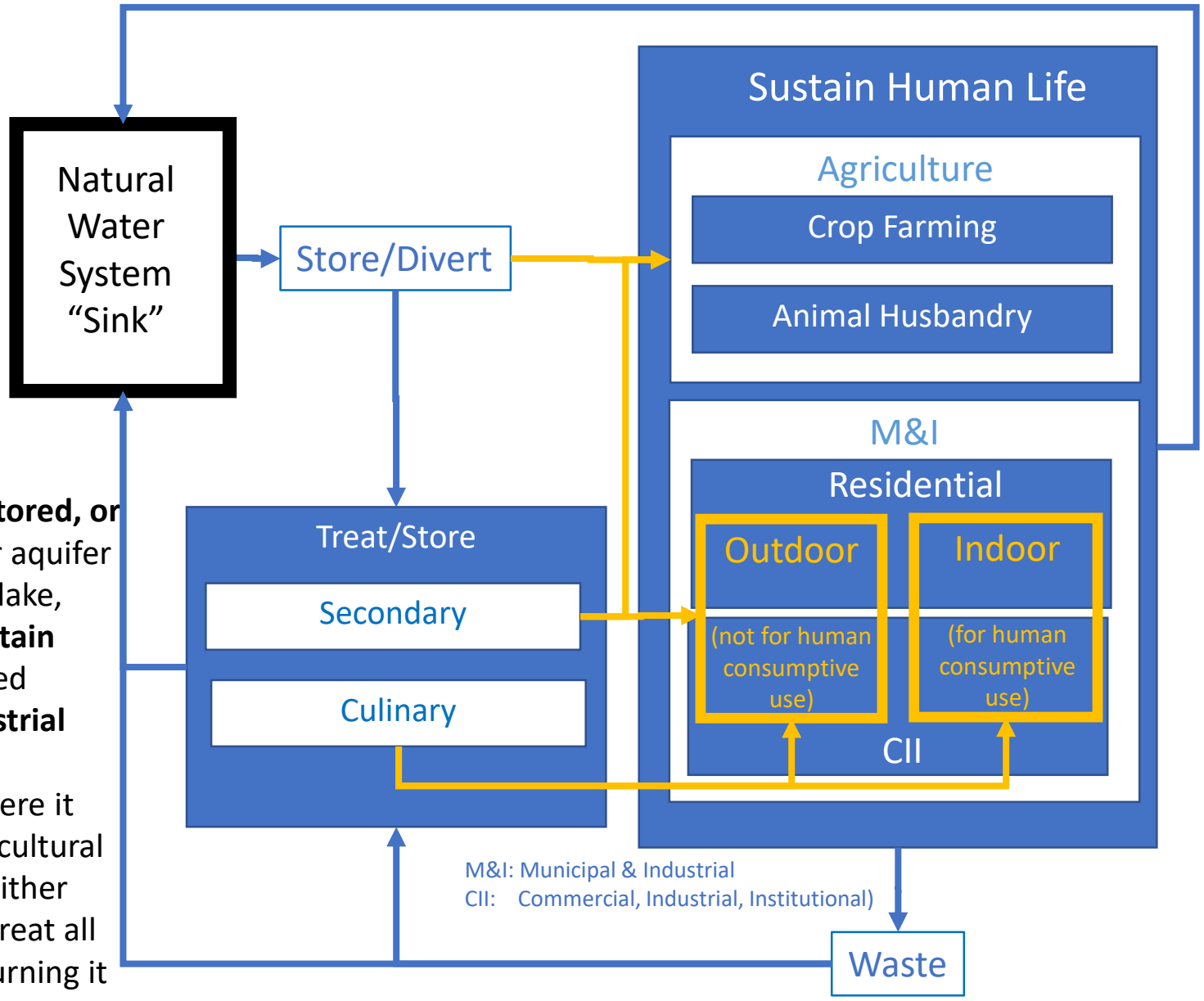


Bolded text denotes elements in the schematic: Water in the **air** (the "source") falls as **precipitation** into "**sinks**": **washes, streams, lakes, the ground, rivers and the ocean**. Most of it stays there, but a significant amount **evaporates** back into the **air**, and some of it is used to **sustain natural life** both plants and animals. Life sustenance produces "**waste** water" either through growth and maintenance processes or after life ceases, which is either absorbed back into the "sinks" or is evaporated back to the "source". All arrows are natural flows.

Schematic View of the Managed Water System



Context



Bolded text denotes elements in the schematic: Water **is stored, or directly diverted and then perhaps stored** in a reservoir or aquifer from a "**sink" in the Natural Water System** (wash, stream, lake, ground, river, ocean) to satisfy the demand required to **sustain human life**. For many water conditions, it can be safely used directly for **agricultural** purposes. For **Municipal and Industrial (M&I)** and certain agricultural purposes depending on the condition of the water, it is sent to a **treatment** facility, where it may be treated to an acceptable "**secondary**" level for agricultural and **outdoor M&I** uses or to a **culinary** level for M&I use, either only for **indoor** use or also for **outdoor** use. It is a goal to treat all **waste** water prior to reusing it to sustain human life or returning it to the **Natural Water System**, but some currently is not.

All arrow are "managed flows" using ditches, pipes, and pumps.

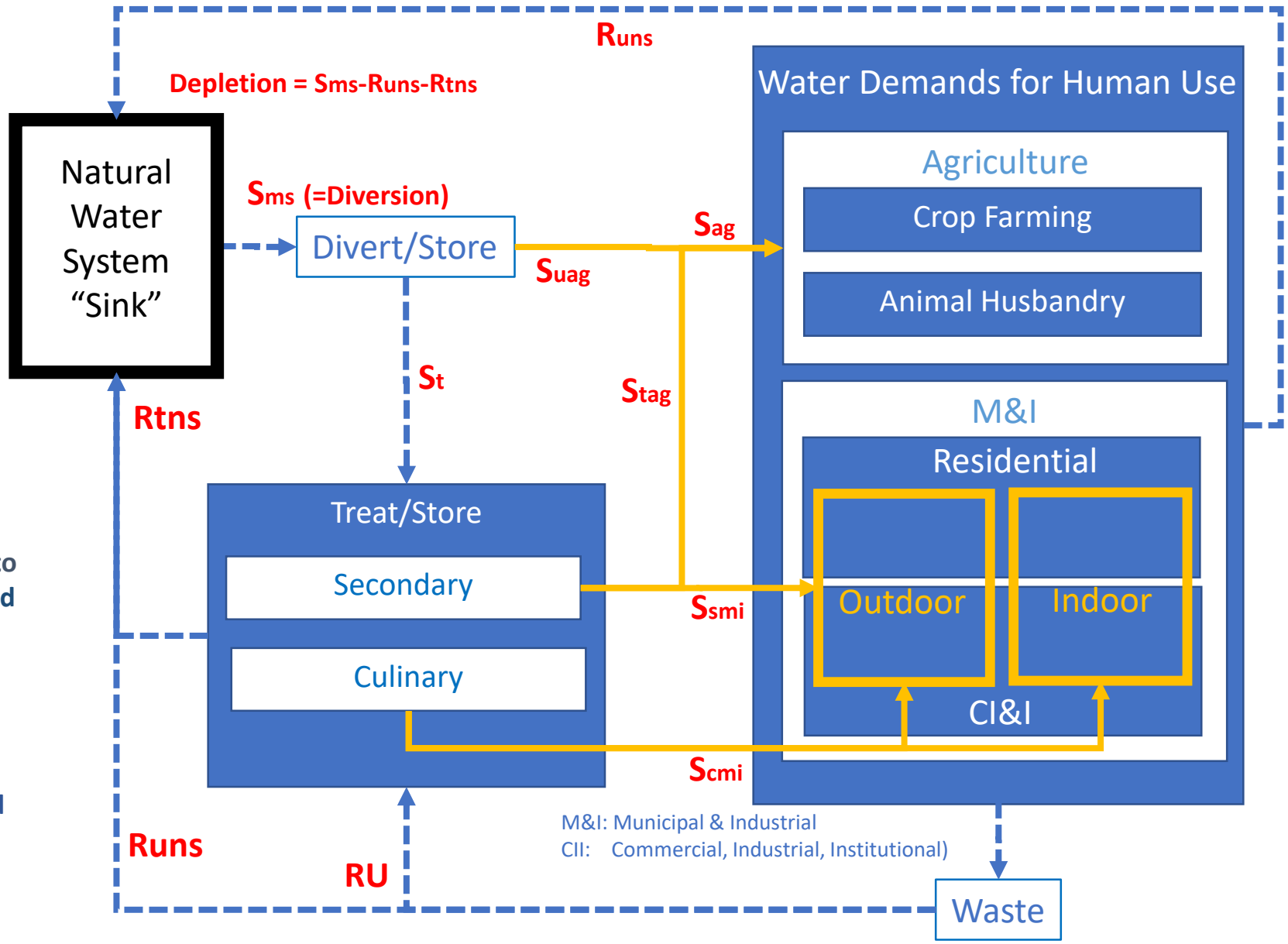
Managed Water System - Supply, Demand, Diversion, Depletion, Allocation and Conservation

Blue text below represents objects that are in the diagram.

Water is **diverted** from the Natural Water System to satisfy the **Water Demand for Human Use,** and is **stored** in various locations to enable immediate delivery when demand calls. The **solid gold arrows** in the diagram represent supply flows that satisfy immediate demand:

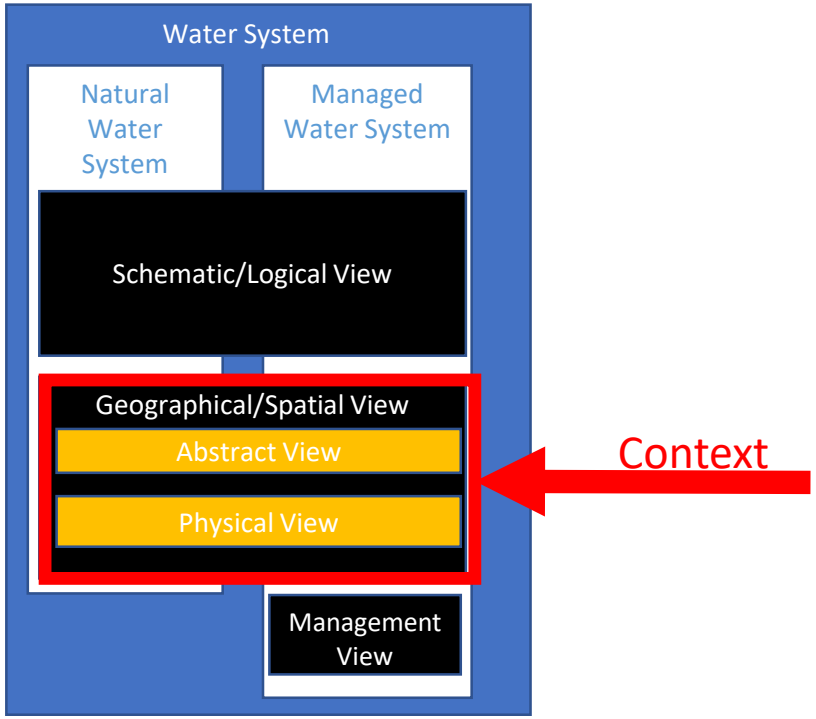
- **Agriculture Supply (S_{ag}),** whether **untreated (S_{uag}) or treated to some secondary level (S_{tag})**
- **Municipal & Industrial (M&I) Supply, whether treated to a culinary level (S_{cmi}) or secondary level (S_{smi})**

Water Demand for Human Use in Utah is constrained by the amount of water that may be "depleted" from (i.e., not returned to) the **Natural Water System**. **Depletion = [S_{ms} (= diversion) - water that is returned to the natural system], either untreated (R_{uns}) or treated (R_{tns}).** The amount "return flow" may also be influenced by requirements to support the **Natural Water System** (endangered species) and may be location-specific. In Utah's constrained system, it is a goal to reduce depletion, certainly below its available supply*, which is be done by reducing **Water Demand for Human Use** (="conservation), increasing Re-Use **(RU),** and/or increasing the returns **(Rtns, Runs).** **Diversion- and Depletion-**related flows are shown in **dashed blue arrows.**



*Available supply = 23% of Colorado River Upper Basin allocation + precipitation outside the Colorado Watershed – requirements of the Natural Water System

Description of the Geographical View of the Water System



This view is pretty simple so the time won't be taken to draw the diagrams and maps. Some simple statements:

For the Natural Water System, the scope is all of Earth, its surface, core and air/atmosphere. There is a finite amount of water in this system, with the exception of that which is added when a mass such as an asteroid impacts the Earth. Water in this system is in the form of gas, liquid or vapor, and a form with a slightly different molecular bonding structure that exists in the Earth's core which is transformed into gas and expelled to the air/atmosphere during volcanic events. The Natural Water System can be viewed as various interacting subsystems such as watersheds and weather systems.

Managed Water Systems are more definitively bounded since humans can define them. They are generally defined by ownership or political boundaries:

- There is a perhaps loosely or incompletely defined North American Natural Water System that is defined in terms of agreements concerning water movements across national borders.
- Utah has an incompletely defined Managed Water System that is defined in terms of water movements between bordering states, and water rights, sources, and interactions with the Natural Water System within the state.

Utah's Managed Water System – Description of the Management View

It has been proven through multiple case studies over the past 50 years that large systems with long lifetimes and many shareholder engaged in developing, maintaining and using the system cannot be effectively or efficiently managed without using program management principles and processes. They are used by virtually all corporations and many government agencies. The management view of Utah's Managed Water System would be presented in the Utah Water Management Program Plan, with would be a state-level program plan and a set of integrated sub-plans for each region. The contents would be:

- Definition of the program in terms of context and scope, vision and mission, requirements, goals and objectives, constraints, organization and responsibilities, and management practices
- Definition of the strategies to be used by the program to determine what work is to be done in terms of concepts to be used to achieve the goals and objectives, possible solutions and alternatives, evaluation methods and criteria, the analysis of the potential solutions and alternatives using the evaluation methods and criteria, the selection of solutions, and the phasing of their implementation
- Definition of projects to implement the phased solutions and their phasing and of the project accountability process

At the appropriate time per the project phasing, project planning would be initiated to do work: The project plans would include

- Project objectives, constraints
- The management of the project through its completion and the accountability of its results to it objectives

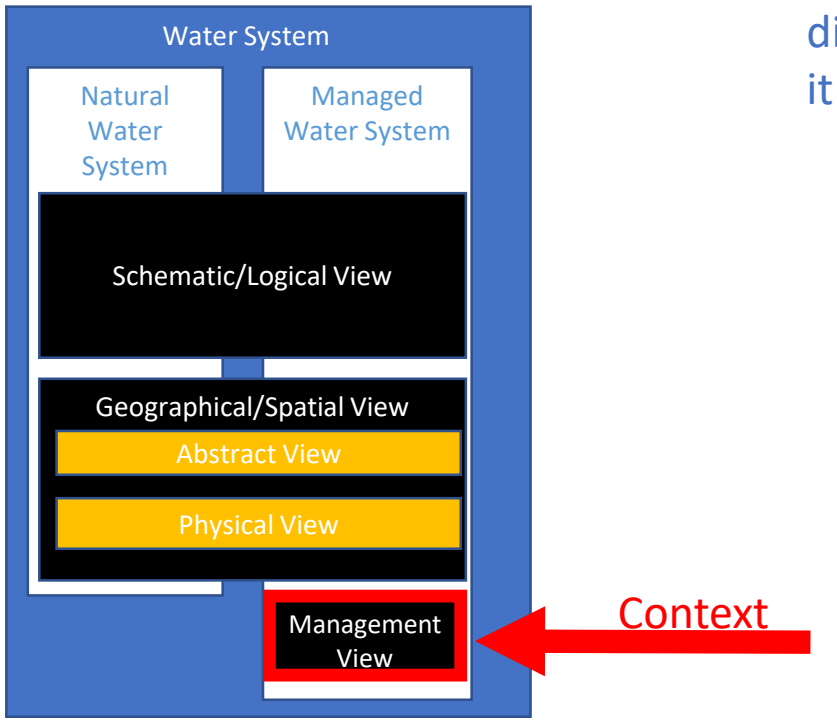
This information is captured in a program plan. The plan is a "living" document that is updated as projects complete or as the conditions change and new information becomes available.

Program can have sub-programs.

Program defines and initiates projects to perform work consistent with the program plan. These projects are of two types:

- "Sustaining" projects that operate on a budget cycle and perform maintenance and operations functions for the system
- "Development" projects that implement new functions are develop facts, data and positions that can be used in program planning.

Utah's Water Management Program



The program to manage Utah's Water Managed System has not yet been discretely defined or chartered. Here is a proposal for the characteristics it would have:

- Relationships defined with other managed water systems' management structures (e.g., the BoR, other states, Compact partners)
- The elements of a program plan as described in the previous page starting with a charter to an existing or new organization for the program, and following up with the development of the program definition section of the plan
- A re-organization as required to align existing state organizations
- A set of related regional (and/or county or municipal) programs with clearly defined relationships to the state program
- The state program would define and manage projects that would provide common data and infrastructure required by the regional programs.
- Regional programs would define and manage projects that would develop and sustain the information and necessary system components to manage the water supply and demand within the region.

Utah's "Managed Water System" Scope and Context: Observations and Conclusions

1. **Management and Planning**

   Utah should define, plan and manage programs at the state and regional/local levels for the purpose of managing its water system, using normal program management processes. The entire context of improving Utah's water management to improve both supply and demand is currently not defined. This should be the first step.

2. **Key Technical Elements of a Managed Water System**

   Supply must be defined, and must be defined in terms of probabilities, with only highly probable estimates used for management purposes.

   Demand for the various types and uses of water must be managed and balanced, and held safety under the supply estimates. Net demand is the key element to be managed, which in turn drives management of diversion, depletion, return, re-use and gross demand for the various types and uses of water, and the balancing of them.

3. **Water Requirements, Goals and Objectives**

   Utah must define requirements, goals and objectives in order to set the parameters for managing its water system. **They have not yet be defined**:

   Requirements define the condition that must be met.

   Goals define a target condition that is to be met at some future point, often not precisely defined; "and end at which effort is directed". In "planning" processes, goals are defined in a program plan and are not precise in specifying a specific value or time.

   Objectives define a condition that is to be met at a specific time. In planning processes, overall objectives may be defined in a program plan; however, specific objectives must be defined in each project plan, specifying what the project must achieve.

   For Utah's Managed Water System,

   - The requirement: net demand must be less than the supply.
   - Goal-setting requires some real thinking. They should be set in two directions, covering goals constrained by what could actually be supplied and, more difficult, by how demand should be shaped. For example:
   - Supply-constrained: the 90% high probability net demand must be 10% lower than the 90% high probability supply.
   - Demand-constrained: maximize state GDP and the happiness of its residents. This would then have to be detailed and the ramifications for water defined.
   - The program objective would define specific net demand (in acre-feet yearly) at specific years.
   - Project objectives would be more granular.

Utah's "Managed Water System" Scope and Context: Observations and Conclusions

4. Demand Balancing to Reduce Net Demand

Net demand can potentially be reduced by changing and appropriately balancing the internal demands for agriculture and M&I water, and internal to M&I, residential, CII, culinary, secondary, reuse and return water. This balancing is driven by requirements, and the goals and objectives for those categories of water use. It could be determined that it is not appropriate to deplete 70% of the state's (or a region's) allocated water supply on agriculture, or that it is not appropriate to use 60% of the culinary water on outdoor uses. Adjusting these internal demands could reduce net demand.

5. Implications to Utah's M&I Water Conservation Goals

1. The management structure for Utah's Water Management Program should be established before setting any goals and objectives. This is necessary in order to ensure that regional boundaries are correct, that the implementation structure is in place, and that the appropriate stakeholders are involved. The context and scope of the state and regional programs should be established. It is inappropriate that the state recommend regional water conservation goals, but rather that should provide the necessary processes, data, training and consultation for the regions to set their water demand objective, and then to plan the achievement of those objectives.
2. The definition of "water conservation" is not clear. Is it addressing net or gross demand? From the perspective of normal language definitions and from the report's contents, it appears to address gross demand. This seems to be an incorrect scope since it is net demand that matters. This would imply that water re-use should be in the scope of the report. The target of the report should be to set "net water demand" goals, not "water conservation goals".
3. The goals defined are specific for regions at a specific time. This may be appropriate, but it is at best incomplete and perhaps inappropriate. The goals are stated in terms of "objectives", which may be ok if the over-arching goals were also defined, but there is no evidence of that. Defining the higher level goals requires the context of the state's goals that drive the use of water. Without that context, it's impossible to judge the appropriateness of the water demand goal. The surveys and open houses provided some materials from which these higher-order goals could be derived. This step must be explicitly done.
4. The goals must be defined with respect to requirements and supply and demand constraints. This was not done.
5. M&I is of course only a part of Utah's water use, with agriculture using most of it. Since demand should be properly balanced between M&I and agriculture, setting goals for one without respect to the other gives an unbalanced goal. This must be addressed.