Rev 5, 5-27-19

Washington County Integrated Water Management Plan

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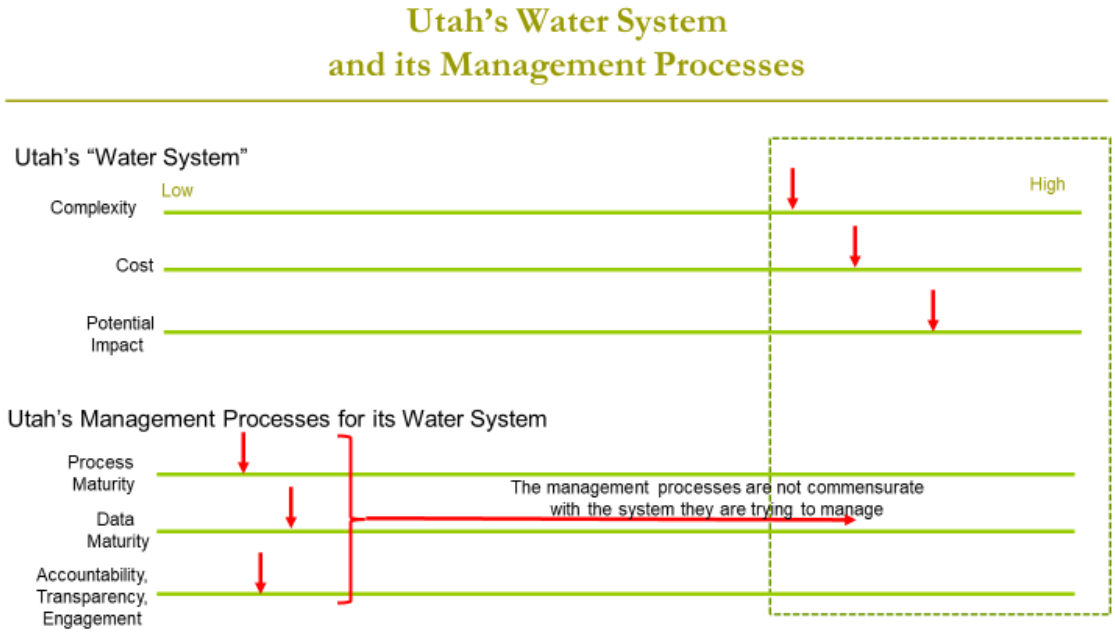
Author's Note: context for this paper

The genesis of this paper was a series of discussions between members of the Washington County Water Conservancy District's Board of Governors- - assistant general manager Zach Renstrom, St George Mayor Jon Pike and city manager Adam Lenhard, and Ivins Mayor Chris Hart. I am a citizen interested in water management with career in a complementary field as a senior systems engineer, manager and consultant in large-scale complex systems and their technical management; and the Board President of Conserve Southwest Utah (CSU), a local citizens group interested in conservation. CSU thinks our state and county can significantly improve its water situation with improved management processes.

Our state law on water conservation planning *requires planning but is weak in defining what it should contain or how it should be produced. Utah's Division of Water Resources issues guidance on those points, and water conservation planning throughout the state appropriately follows that guidance. That planning falls short of methods the private sector uses to manage a program the size and importance of our water (see Standard Program Planning Elements and Comparison to Utah Water Conservation Plans). State guidance for this planning, and its implementation is Washington County, provides a description of the water system, its supply and demand, and a list of what practices are being used and what could be used. They are not really "plans" in that they don't define actions to achieve an objective: there are no specific projects defined, with tasks, schedules, responsibilities, budgets, etc., like any normal project plan would have. There are no references to analyses indicating which actions/projects are warranted, and there is no traceability to vision, mission, goals, objectives and strategies. Basically, they are descriptions rather than plans that would define actions to achieve goals.*

The complexity, cost and potential impact of our water system warrants a robust management process.



Any proposal for an improvement naturally has to answer the question "what's wrong with it now?", and this question is hard to answer without offering criticism. This is generally met with surprise and I was asked to provide an example by creating a water conservation plan for the city of Ivins, an exemplary city for water use in the county. This was a fair challenge and I took seriously. My response was to create an example plan, but instead of focusing on Ivins, I decided to focus on a broader vision and produce an example of a county or regional Water Management Plan, using program and project management practices, with an assumption that there would be a similar plan at the state level and at the city level if appropriate.

CSU has a long history of issues with basis for the Lake Powell Pipeline and with Water Conservation planning and implementation. These issues have arisen in large part from the management practices used to provide direction and planning.

This paper is presented to serve as (1) an example of what a plan should contain, (2) a proposal for how "water" should be managed, and (3) specifically a proposal for how Washington County's water should be managed. Since it is being drafted in isolation without the participation of the required stakeholders, without access to all the required data, and without the performance of critical analyses, much of the technical content is lacking in detail and correctness. While I have been studying water for a few years, it is a big subject and my knowledge is limited. It is hoped that this draft can serve as a starting point for discussing the management process and for initiating the actual program planning necessary to address the management of water in the challenging environment of increasing demand and decreasing supply.

Water management occurs at the state, region/county and municipal utility level. Planning must be occurring at each of those levels, but it is either informal or it is done in a somewhat closed environment that does not have appropriate stakeholder participation. There is a lot of good work being done, but without a visible strategic program plan, the reasons and uses of the work is unknown to outsiders, and without transparency and engagement, there is a good chance of errors in priority, sequence and in the actual results. Program management principles are based in a logical derivation of actions in a transparent environment, with full engagement of stakeholders.

Although using the same program management principles across these levels would be more efficient, it is not required. This example plan assumes an optimum distribution of responsibility and integration/cooperation across the levels to reduce redundancy of effort and focus of expertise, and would change if the assumptions are untrue.

Further notes are included in italics in the body of the example plan.

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1 Executive Summary

The Concept of a Water Management Program

First, some definitions:

Program: A mechanism and organization to manage the work of an enterprise to achieve a goal over an indefinite long term.

Program plan: the vehicle a program uses to manage work

- driven by a vision, mission, goals and objectives held by stakeholders,
- following a set of strategies and using documented facts, data and reasoning to identify, evaluate and select solutions that will achieve the objectives,
- defining, planning, sequencing and executing projects for those actions,
- with accountability that objectives are achieved,
- in a transparent environment engaging all shareholders.

Vision: A desired state or condition

Mission: An organization's role in achieving a vision

Goal: The purpose toward which an endeavor is directed in order to achieve a vision, generally not strictly measurable or tangible.

Objective: A measurable and tangible product that is to be achieved, attained or accomplished.

Strategy: The top-level concepts describing how goals and objectives are to be achieved.

Project: A mechanism and organization to achieve a specific objective within a specific time frame. If the project is derived as part of a strategic program plan, it would be defined in a program plan.

Project Plan: The tasks, schedules, responsibilities and budget defining how the project is to achieve its objectives. If the project is derived as part of a strategic program plan, the project planning and the execution of the plan would be initiated by the program, and the project would be held accountable for accomplishing its objectives by the program

It is often the case that a program may not be "strategic", and a program plan is not necessary: where there are only a few stakeholders that have well-established working relationships, where the program involves minimal financial investment, where impact of the program is small. That does not match the definition of Utah's water system: it is far too complex, costly and impactful to our economy and quality of life to not manage as a strategic program. While valuable projects are currently being executed at all levels of water management throughout the state, they are not being managed strategically; that is, they are not driven by a common vision, a set of integrated mission statements, shared goals and objectives, and shared strategies, in a transparent environment using documented facts, data and reasoning, engaging all shareholders. This leaves much of the work product compromised, not optimally used, and controversial. And it leaves some strategic work not

performed. The value of effort would be increased significantly if it were planned strategically.

> *Examples of projects: determining if the LPP should be built (more likely this would be multiple linked projects), building the LPP (one big project), implementing a landscape ordinance, implementing tiered water rates, the yearly O&M for a water utility.*

It is the proposal of this paper that Utah and its regions, counties and municipalities manage water as a program, with a structured set of integrated program plans. By "integrated" it is meant that:

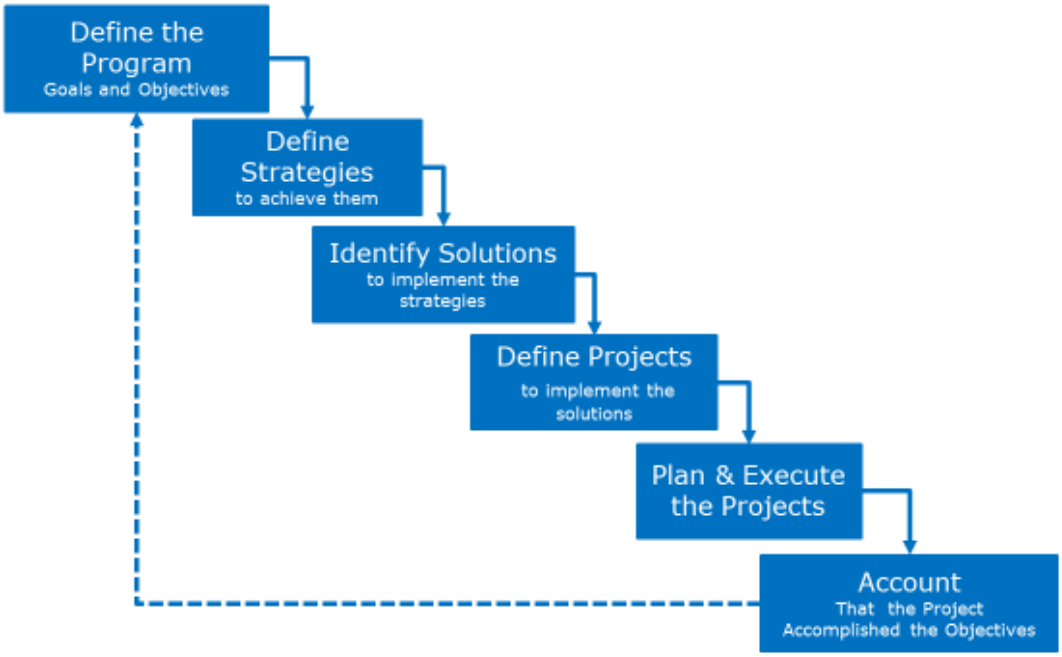
1. The shareholders at each planning level are identified; that they agree to a shared vision and goals, and to complementary missions and shared or complementary strategies; that they understand (and preferably agree with or accept) their roles in program planning and in specific project planning and execution activities.
2. The projects at each level are linked, such that project deliverables required by one level of another is recorded in both program plans, and the timing/sequence of project precedence is defined.

It may prove economical to have one program plan for a county/region and its municipalities. It may be a challenge to manage unequal supply, demand and goals across regions and municipalities.

However, this integration, both in process and product, is too much to implement across the state in one step. So, the proposal is that:

- Washington County implement a prototype, with cooperation and involvement from the state and the cities in the county.
- In it, projects are identified at the state, county and city level in support of the county's strategic plan and to account for local projects already underway.
- A small overhead budget is established for the program planning, using existing budgets for the projects (since these projects should be or are being done anyway)
- Start with an agreement in principle, first with the WCWCD Board, and then with the DWRe Board and the Executive Water Finance Board
- Learn lessons from the prototype, adapt it for the state level (or do the planning concurrently), and then phase it into the other regions

The process at a high level:


Define the Program
Goals and Objectives
Define Strategies
to achieve them
Identify Solutions
to implement the strategies
Define Projects
to implement the solutions
Plan & Execute the Projects
Account
That the Project Accomplished the Objectives

The Challenge

Utah, Washington County and its cities are growing rapidly, increasing the demand for water in a time where supplies are decreasing. We don't know how much our demand can reasonably be reduced or how much our supply will be reduced, or by when. Setting appropriate goals and objectives, and identifying the best actions to achieve them, and then planning and executing the projects to implement those actions, is of great importance to our economy and quality of life to ensure our water demand does not exceed the supply. Strategic planning, that is a plan that derives actions from clear objectives and strategies, is warranted for such an important element of our lives. The purpose of this document is to provide that strategic planning. Elements of that planning are done at the state, region/county and municipal level. To avoid redundancy of effort and the associated costs and incompatible solutions, and to best use scarce and focused skills and knowledge, planning at these various levels should be integrated. This means that needs for and uses of facts, data and analysis should be shared across the levels and that action plans should be coordinated.

The Political Context

Corporations face challenges like this frequently, and have developed program management processes to plan and execute actions to address them. Governments are typically more resource-constrained than corporations, and have a much more independent and diverse set of stakeholders. This is especially true in Utah, where independence and self-determination are highly valued. It makes setting a common direction more difficult. Water Management is undertaken at different levels of granularity, at the federal, state, region, county, city and individual levels. A higher level telling lower level what to do is resisted. However, lower levels of granularity lack the resources to discover facts and data and to figure out what actions to take in reaction to them, and many of the facts and data and actions are common at various levels of granularity, making their discovery redundant.

The Solution

This paper illustrates how and why Program Management principles used in major corporations to achieve strategic goals can and should be used to manage Utah's water supply and demand.

The Purpose and Scope of this document

This document is an example of a program plan for managing Washington County's water demand and supply. The information in it doesn't pretend to be technically correct, but an attempt was made at realism in order to properly illustrate the concept.

Since a companion plan does not apparently exist at the state level, there are strategies, solutions and actions described in this plan that would be in a state plan, and are annotated as such. There are options of how the county and local municipalities' plans would be integrated: all in one physical plan, with sections and ownership for each municipality or separate plans that require more manual integration. These boundaries aren't technically pertinent. It's all a matter of how

local authorities think the management would be most cost effective. It is a political/organizational challenge to get these levels in agreement with the concept, form and methods of integration.

In order for this plan to be effective, cooperation with the stakeholders in the county, including most importantly the citizens, businesses and institutions within the county and the water agencies that serve them, must be achieved.

This plan defines the scope of the program, its goals and objectives, the strategies and solution concepts for achieving the goals and objectives, the identification and evaluation of actions to implement the strategies and solution concepts, the planning of projects to implement those actions, and the execution and accountability of those projects.

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2 Introduction

A program is a mechanism and organization to manage the work of an enterprise to achieve a goal over a long term. For practical purposes, they can be considered permanent. Programs define and launch projects to perform well-conceived actions to achieve specific objectives within a specific schedule. Managing an enterprise involving a large number of stakeholders of different perspectives, spanning many decades, involving large funding, with the potential for significant economic, environmental and/or quality of life impacts cannot be addressed effectively without the discipline of a program management process.

The process of developing a program plan is straightforward and corresponds to the structure of this plan:

1. **Define the program**: its context and scope, stakeholders, vision, mission, requirements, goals and objectives.
2. **Define the strategies** to accomplish the goals and objectives
3. **Identify solutions,** starting with potential solutions, criteria for evaluating them, applying the criteria to select those to be implemented, and then phasing the steps of that implementation. Often there are insufficient facts and data to make decisions on solutions, which then requires action to determine them. Often the actions are inter-related and require several steps, which then requires sequencing to be defined.
4. **Define projects** and their sequencing to implement the actions.
5. **Plan and execute the projects**, at the appropriate time according the sequence.
6. **Account** that the projects achieve their objectives.

The management of Utah's water system certainly fits the definition of a program, or rather, due to the size and complexity of the system, a set of related programs: one at the state level and others at the regional or perhaps county or municipal level. The processes are common and should be defined for the entire state. Much of the fact and data requirements are common across the state and should only be derived once. The definition of actions required to implement the state's goals and objectives will likely vary by region or county or municipality, which requires programs to be defined at those levels too. However, since this planning is not simple, requiring significant investment of time and expertise, optimizing the integration of planning across state, region, county, and municipal programs would improve the cost efficiency of the planning and management.

Program boundaries should be drawn to encompass an area that shares the same water source, climate and economy. Goals, objectives and the means for achieving them should be shared. It will be challenging to keep the various local government entities within an area unified. Washington County fits the definition of such a bounded program for water management.

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3 Definition of the Program

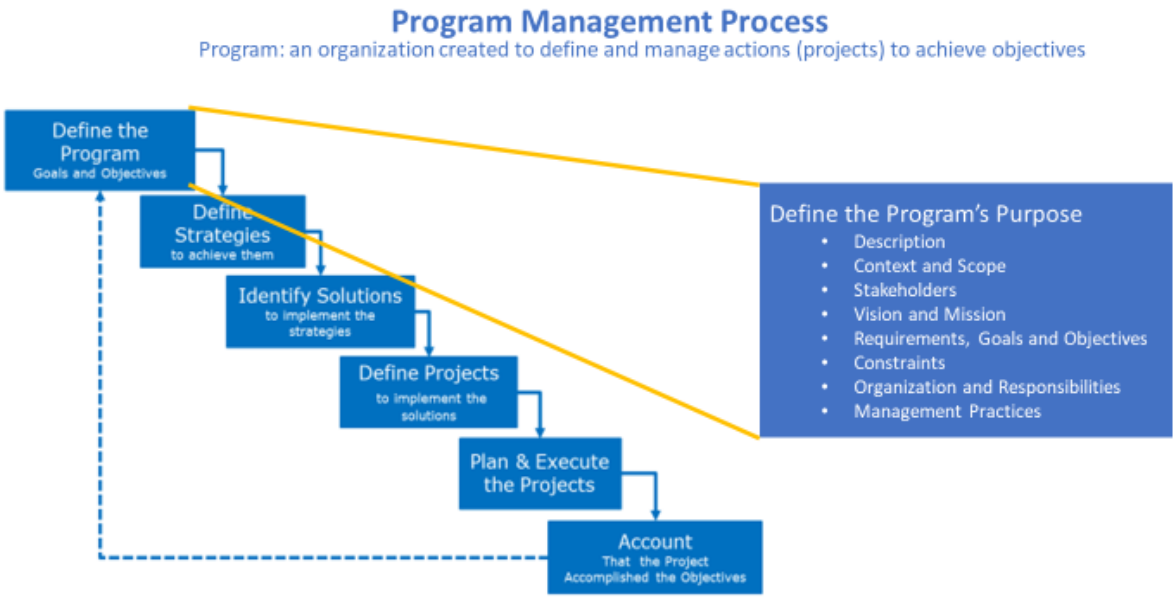

Figure 2: Define the Program

3.1 Program Description

The purpose of this program plan is to define the Water Management Program for Washington County. The Washington County Water Management Program will derive, initiate and control the actions necessary to manage the water supplied to, used in and passed through Washington County. This document is intended to capture the information necessary to perform that task: defining the management structure and processes, the logic behind the derived actions, and the definition and budgeting of those actions. The document must be "living," meaning that it is updated as actions are executed and as new information or conditions emerge. The processes are intended to be open and transparent, engaging all stakeholders - the citizens of the county and their elected representatives, businesses and institutions, the appointed management and staff of water agencies, and experts including individuals, government and non-government organizations.

Any multi-billion-dollar financial investment, impacting the livelihoods of hundreds of thousands of citizens over the lifetime of the county warrants rigorous, accountable management with the open engagement of stakeholders. It is the purpose of this program as defined in this plan to apply that rigor and accountability.

Due to the effort and expertise required to perform this planning and the close relationships between the water supplies and demands across the county and its municipalities, this program will address the county as a whole, with appropriate allocation of responsibilities to local government agencies addressed appropriately for program funding, project budgeting and execution.

3.2 Context and Scope

The context would be defined at the state level and incorporated here to use as the basis for defining the region's scope. Most/all of the definition of terms would come from the state context.

The scope of this program covers all water in Washington County, both in the Natural System, in terms of understanding its sources and uses of water, and in the "Managed System," focusing on the supply, demand/use/reuse, and relationships to the Natural System, for culinary and secondary water, including both agricultural and Municipal and Industrial water. This is a big scope, and cannot be evenly addressed in one step. This plan will define, as it matures over time, how the scope is managed in a step-wise fashion. It is recognized that the challenge of shrinking water supplies and growing population cannot adequately be addressed without a holistic and integrated approach. This will require cooperative participation of all stakeholders.

The following diagram and related text describe the context and scope of the system for which this plan defines all management, maintenance and development actions. Refer to the appendix Program Scope Derivation for details and to Terms for the definition of terms used in the diagram.

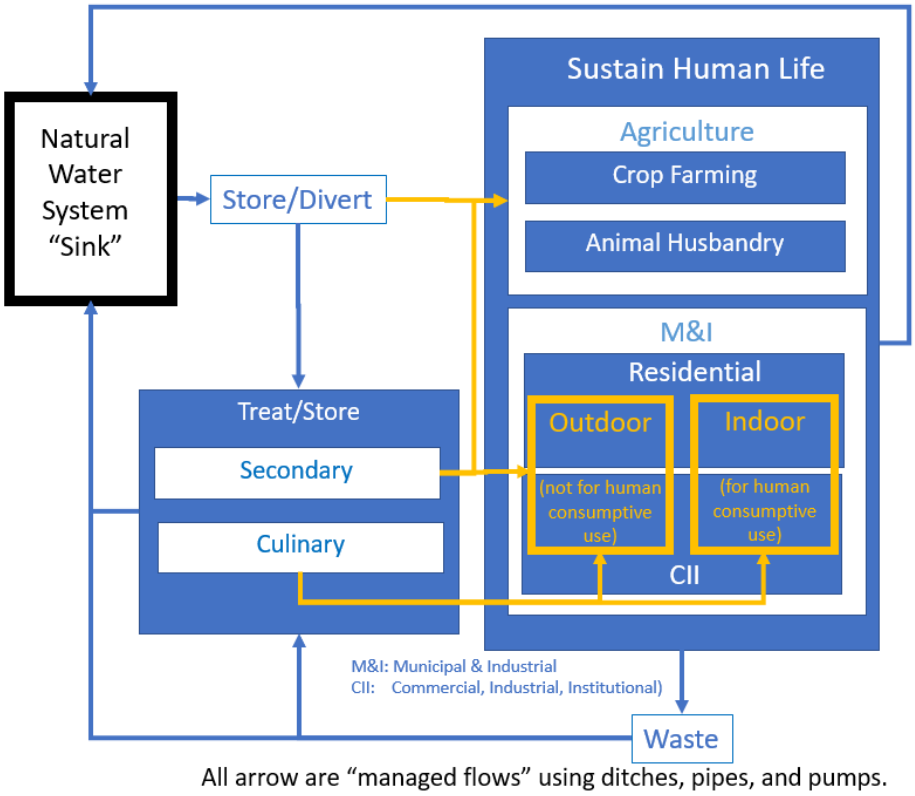

Figure 3: The Generalized Schematic of the Managed Water System

The upper element of this figure is a miniature of Figure 1, showing the portion of that diagram that is expanded in the main portion of Figure 4. The **bolded text** in this paragraph identifies elements depicted 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 arrows are "managed flows" using ditches, pipes, and pumps.

3.3 Stakeholders

A stakeholder in organization or program is a person or another organization that has a concern or interest due to an affect by or ability to affect the subject organization's actions, objectives and policies. It is critically important that the program identify its stakeholders, their mission for the program, and the level and points of their participation in program actions, with their knowledge and preferably their concurrence. Any project initiated by a program should engage appropriate stakeholders, again with their knowledge and concurrence. This is critical to the success of the project and the program not only from the perspective of acceptance but because the validity of the outcome is jeopardized when perspectives and knowledge is excluded.

For the Washington County Water Management Program, the stakeholders are:

1. Local citizens and citizen groups
2. Local business owners (commercial, industrial and agricultural) and institution representatives and their organizations
3. Local and state government elected officials
4. Management and staff of local and state water agencies and other pertinent agencies

The citizens and businesses are the users of the water and the sources of funding. Representatives are elected by citizens, and they hire water agency management, and are responsible to the citizens management's actions. Management hires the staff. It's a complicated arrangement. Neither the citizens nor their representatives are generally experts in water, but their engagement in water management is critical.

3.4 Vision and Mission

The vision (the desired state) for water in Washington County is that there is enough water to support both human uses (agricultural, municipal and industrial) and the natural environment, at an affordable cost and a quality appropriate for the use, allowing for economic prosperity, enabling a high quality of life and attractive water-wise landscape.

The mission of this program (its role in achieving the vision) is to

- Achieve the vision
- Integrate the various local government agencies involved in the management of the county's water system and the Utah Water Management Program for processes, data and funding necessary to perform the mission
- Provide an environment of transparency and openness, inviting citizen engagement
- Provide clear accountability of the reasons for proposed plans, their costs and benefits, estimated and actual.

The missions of the program's stakeholders (their roles in achieving the vision) are:

Local citizens, businesses and their non-government organizations:

1. Partner with governments and agencies to provide productive perspectives
2. Advocate and help define and implement standard program and project management policies, processes and plans
3. Participate in analyses and planning activities
4. Engage membership and encourage the public to help implementation

Local and state government elected officials

1. Appoint agency boards
2. Encourage and support local engagement
3. Form and act on positions requiring legislation in support of water management plans

Government agencies

Municipal Utilities

1. Determine with county/regional water agencies how to manage municipal water demand and supply (i.e., separate integrated plans or one integrated plan)
2. Manage the Municipal Water Management Program Plans (or the municipal portion of the county/regional program plan) and the integration with the county/regional plan) in order to manage the water demand, supply and quality for the municipality and the natural environment within its boundaries
3. Plan, execute, monitor and account projects for the municipality
4.

Local Water District/Regional Water Program

1. Manage the water demand, supply and quality for the direct customers of the district/region
2. Support municipal utilities in managing their demand, supply and quality
3. Lead the county/regional program planning for water demand and supply maintenance, operations and improvements
4. Participate in the integration of the county/regional program plan with municipal and state program plans
5. Participate in state program planning of water demand and supply maintenance, operations and improvements

6. Plan, execute, monitor and account projects for the county/region

State Water Agencies

1. Manage the state Water Management Program Plan
2. Support county/regional and municipal water management programs with processes, data, analysis, etc., as defined and integrated in the various levels of program plans

3.5 Requirements, Goals and Objectives

Many or most requirements, goals and objectives would be consistent across regions and would be defined with their cooperation at the state level.

The program must define requirements, goals and objectives in order to set the parameters for managing its water system. 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; the "end at which effort is directed." Objectives define a condition that is to be met at a specific time. Specific objectives must be defined in each project plan, specifying what the project must achieve.

Requirements that the goals and objectives must meet:

1. The demand (use of water) must be safely less than the supply (*must be quantified)*. If a safe margin cannot be maintained by the actions defined in this plan, other extra-program adjustments must be made.
2. The demand must favorably comparable with other communities that live under similar conditions.
3. Water must be safe for its intended use, and use must be safely constrained to its intended use.
4. Water must be "affordable", at the lowest cost possible and yet incentivizing demand reduction (*must be quantified)*.
5. All work must be budget-constrained.
6. The Natural Water System must be sustained.
7. Legal conditions must be met.

Prerequisite Facts, Data and Assumptions upon which the Goals and Objectives Depend

Sources of Facts and Data:

1. 2016 Washington County M&I Water Use/Demand – pending response to comments
   - Current M&I use in the county
2. Utah Water Flow Analysis: definition of current Utah water supply and demand uses, with extrapolated Washington County water supply and demand; pending return comments from the DWRe
   - Current Utah supply and depletions, unknown accuracy, extrapolated for Washington County
3. Utah's Regional M&I Water Conservation Goals – pending response to comments

- Conservation practices/methods and new supply development costs and yields
- Analysis of conservation potential
- Recommended demand goals
- Issues to be resolved

4. Washington County Yearly Population Projections, from page 165 of the Gardiner Study .
5. Agriculture statistics:
    - Employs less than 5% of the state's labor, contributes less than 1% of the state GDP (2018 Economic Report to the Governor)
    - 75% from livestock, mostly beef and milk
    - Main crop is hay to feed livestock
    - Uses 80% of the water in the state
6. Utah 2010 M&I Water Sources and Users
7. The State of Water Planning in the West, page 58 for Utah
8. Zoning and Water in Colorado

Facts and Data required by this plan:

1. Utah's and Washington County's overall current and probabilistically projected future supply and depletion allowance, including the Colorado River allocation
2. Utah's and Washington County's agricultural water current and probabilistically projected future supply, depletion allowance and demand.
3. Accounting of Virgin River use in the Colorado River allocation and of Washington County's use of Upper Basin allocation.
4. Water supply improvement options and probabilistic yields and costs, including all costs – development/construction, operations, maintenance, finance; including comparisons to similar improvements implemented elsewhere
5. Water demand (gross and net) improvement options and probabilistic yields and costs (including all costs – development/construction, operations, maintenance, finance; including comparisons to what has been accomplished elsewhere)
6. The normalized water demand currently realized in other comparable southwest communities by the end of 2020.
7. Cost and yields of gross and net water demand reduction implementation in other states/communities.
8. Cost of comparable new water development projects in other states and derivation of LPP costs from it.
9. Probabilistic demand constraint: point in demand reduction at which it is too expensive (economically damaging) or too austere (damaging to the quality of life) to consider going lower.
10. Water treatment options: how much and where is water that can be treated to secondary or culinary levels using conventional methods and

what water requires other more expensive methods like Reverse Osmosis.

11. M&I water savings due to zoning for smaller lot sizes and multi-story housing.
12. The impact to water demand of placing most of the cost of water into the use fee; in a separate analysis, include the LPP costs.
13. The issues and opportunities for moving water from agricultural to M&I uses.

Assumptions, including those made due to currently inadequate facts and data (to be supplied/corrected by projects defined in this plan):

1. The state population will grow at the rate defined by the Gardiner Institute Projected Population Growth (refined every 5 years)
2. The current rate of demand will cause state water supplies to be exhausted within 50 years (needs refinement as data becomes available)
3. All properties (Ag and M&I), culinary and secondary, are metered.
4. The LPP will be granted a federal license. The lack of key analyses should and will delay the go-ahead. Projects correcting this lack are defined in this program. Until better data and analysis is available, additional water supply from the LPP is not be assumed.
5. Washington County high-probability local water supply will be approximately 100,000 AFY in 2065 (32,590,000,000 gal). Here are calculations of the population that will support at various usage rates:

GPCD	Supported Population	Projected Year of that Population
300	298,000	2036
270	330,000	2041
220	406,000	2052
175	510,000	2065

Table 1 Water Demand, Population Supported, and Projected Year

Until better data and analysis is available, it would be safe to set an objective of these water use rates for the corresponding years.

Goals of the program:

1. Accomplish the vision and mission of the program.
2. Manage the program using standard program and project management processes.
3. Provide enough water supply to meet the demand within the constraints defined below

Objectives of the program:

1. Implement the initial operational Water Management System program, as defined by this plan as it matures, by the end of 2020.

2. Determine the county's total local and potential imported probabilistic supply by the end of 2020.
3. Set challenging and realistic *Error! Reference source not found.* objectives at 5 -year increments to 2065 by the end of 2020 based on the constraint that
    - the 90% high probability net demand is 10% lower than the 90% high probability supply (*must be quantified)*
    - the gross county product and the happiness of the residents is optimized and balanced (*must be quantified)*
    - compare favorably to other southwest communities (*must be quantified)*
4. Plan demand reductions and supply increases to meet the demand objectives

3.6 Constraints

1. Demand Constraints

   The lower limit constraint on a water demand objective that is derived from the amount of water necessary to sustain an adequate economy and quality of life (see Demand constraint, water).

   Per assumptions above, pending data otherwise: 175 GPCD in 2065

2. Supply Constraints

   The upper-end constraint on a water demand objective that is derived by the probabilistically safe available supply *(see Supply constraint, water).*

   Per assumptions above, pending data otherwise: 175 GPCD in 2065

3. Budget Constraints

   See appendix Budget Constraints.

3.7 Organization and Responsibilities

Program planning and management concepts could be implemented at the state and/or region/county and/or city level. I suspect that the level of planning/management required for "water management" could be done cheaper and much better if organizations were better integrated across the 3 levels, adjusting how they currently operate. These integrated program management organization would be responsible for

- *The planning of the program, which would identify and define the projects, their required budgets and funding sources, timing and phasing that will describe and manage all work within the scope of the program.*
- *The planning, or assignment of the planning, for all defined projects*
- *The accountability of the program and the projects to their plans.*
- *Reporting to the government entities that must approve the program and project plans and that provide the budget for their execution.*

The program management organization would draw from the involved government, non-government, institutional and business organizations, as well as citizens, and would be responsible to the local government entities providing funding.

Here is an example structure:

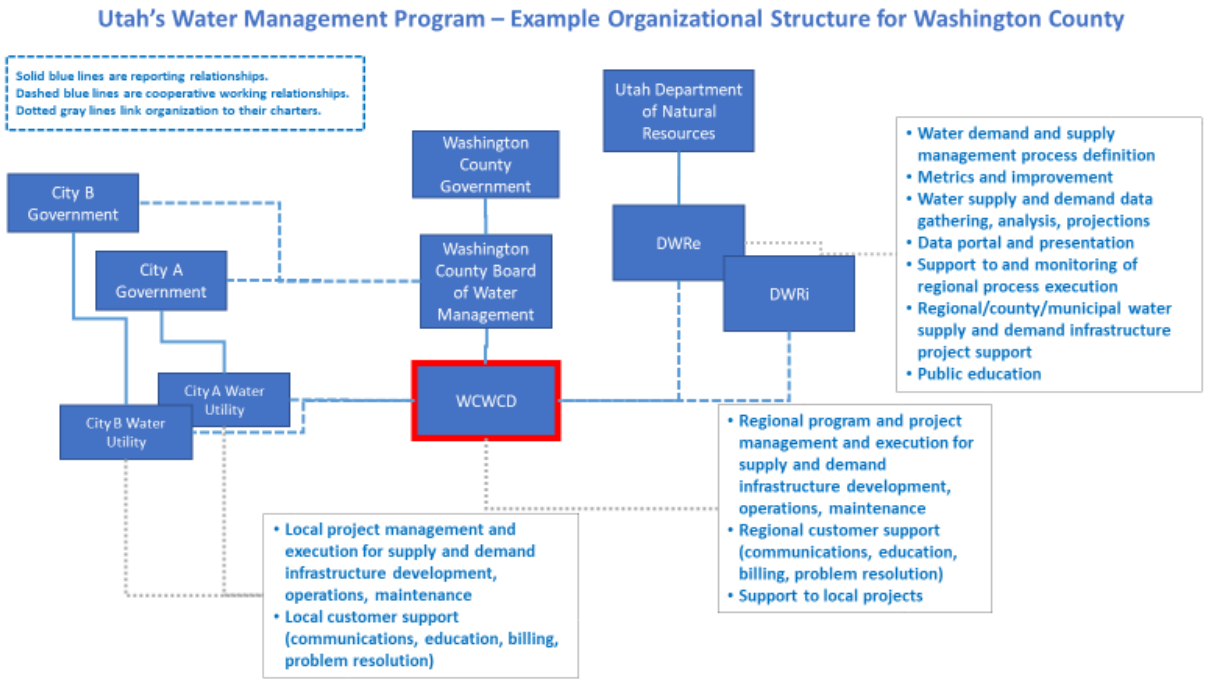

Figure 4 Example Water Management Program Organization

3.8 Management Practices

Follow practices and processes defined by the state including

- Program management practices, including step-wise strategy development and project planning
- Shareholder identification and engagement throughout the program
- Reliance on documented facts, data and reasoning with verified basis
- Transparency
- Accountability to objectives at the program and project level

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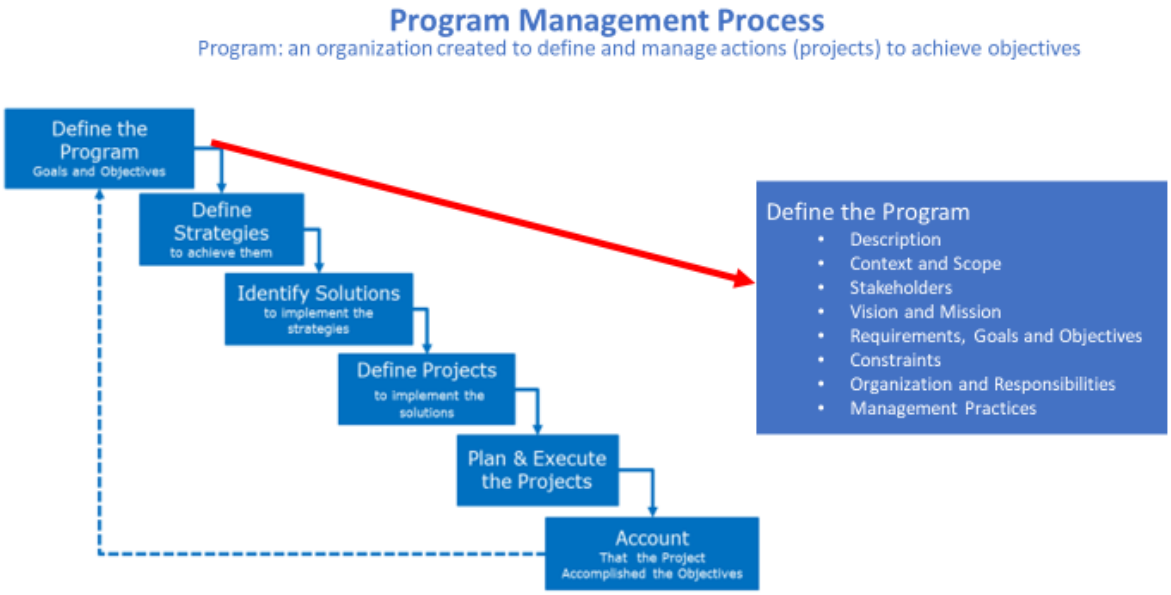
4 Strategies



4.1 The Current Situation and Related Potential Strategic Challenges

Strategies cannot be developed in a vacuum: they must be defined relative to the existing conditions. Those conditions are described below:

Program Management

The management processes in place are not commensurate with the system being managed. Utah's water system is fairly complex. It is a major expense for the state and that expense is growing as our water supply decreases and our water demand increases. The potential impact of water management decisions is high, directly effecting our state's economy and the quality of life for its citizens. In contrast, the maturity of our management processes is low, with little documentation or transparency of how decisions are reached and what information and reasoning is used, and little engagement of stakeholders. The maturity and mere existence of the data and facts necessary to set appropriate goals and objectives and to steer projects is low, as indicated by the Legislative Audit 2015-01 and the 2017 Recommended State Water Strategy. Recent efforts (see the Requirements, Goals and Objectives section of this document) have been steps in the right direction, but basic management process issues in their development has led to significant errors.

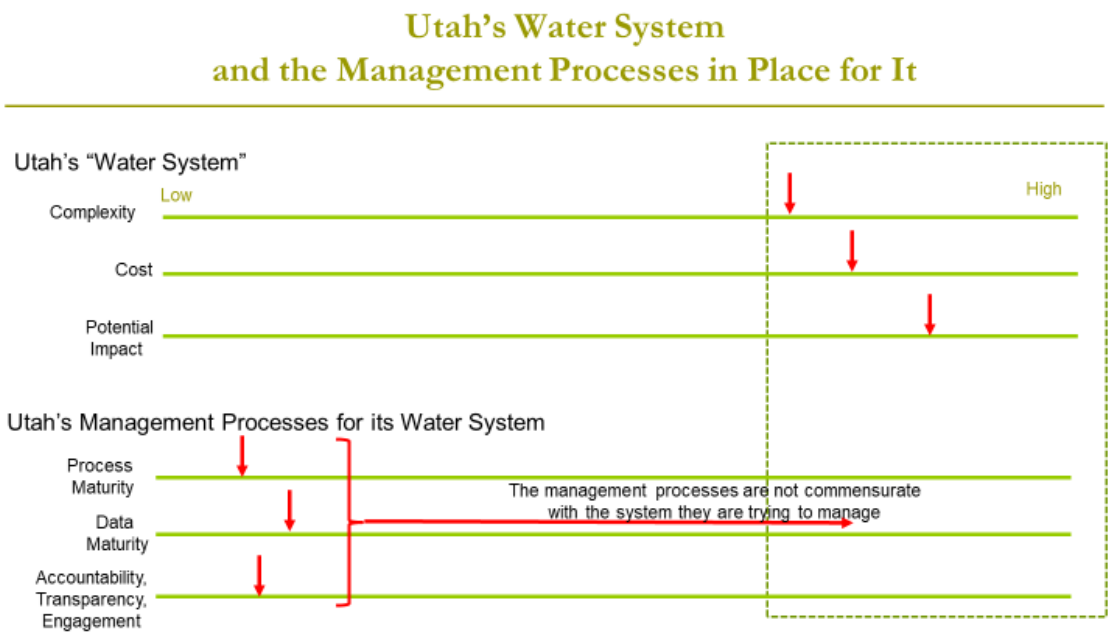


Figure 5 Utah's Water System compared to its Management Processes

Facts and Data

As outlined in Requirements, Goals and Objectives section, there are currently too many missing key facts and data to make informed decisions. Assumptions have been documented in this plan to take their place until they are properly derived. Goals and objectives cannot be reasonable established without those facts and data. There have been good efforts to discover facts and data, as in the M&I Water Use Report and the Utah's Regional M&I Water Conservation Goals report, but comments and issues with these reports remain unanswered. They expose issues with process maturity and accountability, transparency and engagement, indicating a more robust management system is warranted.

Current Focus

The focus of current water management is not on the sectors of high water use.

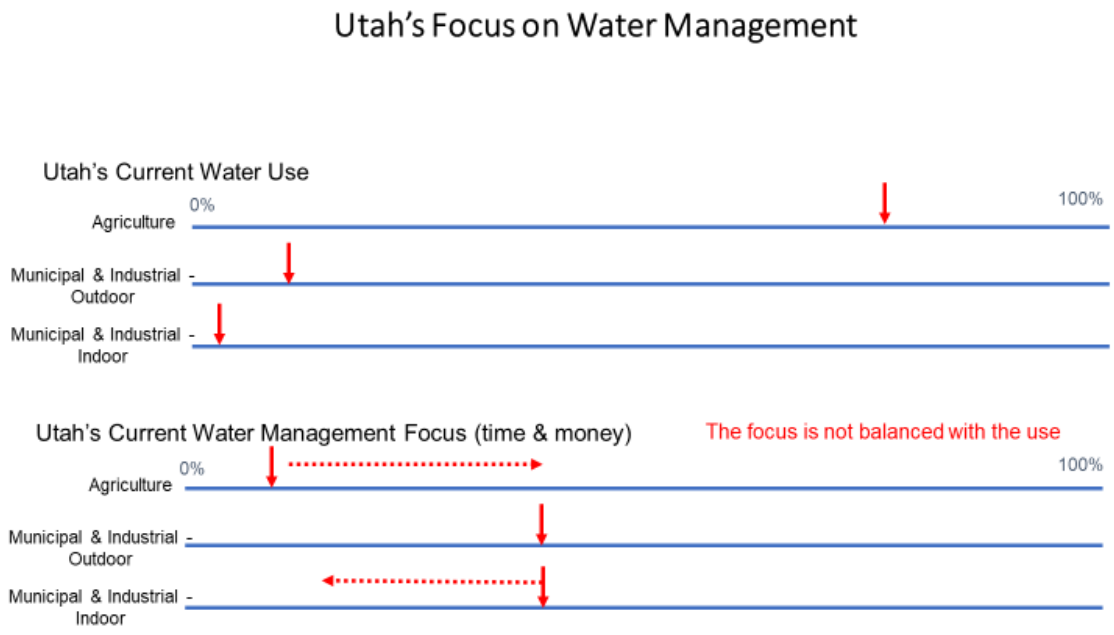


Figure 6 Utah's Water Management Focus

An Analysis of Washington County Project Expenditures 2000-2018 indicates $57M, not counting $33M in the LPP licensing process, was spent the following areas:

Demand Improvement (conservation)		9%
Agricultural		0%
M&I		
Passive	9%	
Active	0%	
Supply Infrastructure Improvement:		91%

Considering the LPP study/license expenses, the concentration is even more skewed to supply management, not very balanced with demand management. The reduction in M&I demand over that past 15 years is more likely the natural result of growth, driving smaller landscaped areas, than conservation efforts.

Accountability

Program and project plans, and the logical/factual basis for project derivation are not visible to most stakeholders and the decision-making process is obscure. Stakeholder participation is low. Project objectives are not clearly defined, and there is no apparent accountability of project outcomes to those objectives. Fundamentally, the basis for work and expenditures is unclear and undocumented.

Public Communications

Official words say conservation is important, but official actions say we have (or can get) plenty of water and can use as much as we wish. They paint the picture that we

are doing very well in our conservation, and that we can't do much better without reducing our county to a barren wasteland, killing all economic growth; and that we can easily, reliably and affordably import a lot of water from the Colorado River. These statements are made without reference to a basis in documented, auditable facts, data and reason. For decisions of the scale, expense and importance as our water, communications must be factual.

Attitudes

There is a growing awareness of a future water challenge. Citizens of the county seem generally willing to reduce demand, but they are unsure of how, don't have incentive to take unilateral action, and need help. Leadership is becoming more focused on reducing water demand, but there is a wariness of overt action. Increasing the water supply is seen as politically and practically easier and more desirable (and certainly, having more water from a somewhat independent source is beneficial). However, a clear-eyed view of the facts and data is being avoided, having significant impact on planning.

4.2 Concepts for Achieving Goals and Objectives

This should largely be inherited from the state's Water Management Plan.

These concepts are organized as follows:

- Management Concepts
- Technical Concepts
  - Operations and Maintenance (for water demand, re-use and supply)
  - Development
    - Demand Improvement
      - Active Conservation
      - Passive Conservation
    - Waste Water Re-use Improvement
    - Supply Improvement

Management Concepts

Implement program and project management practices for managing water:

- Establish program context, scope, organization, relationships and stakeholders
- Engage stakeholder actively in a transparent and accountable environment
- Establish goals, objectives, strategies and solutions based on documented facts, data and reasoning
- Use project management processes to implement solutions
- Make project results accountable to objectives

Technical Concepts

Operations and Maintenance

In an environment of constrained budgets, Operations and Maintenance must be given priority over new development actions to reduce demand or increase supply, although clearly over the long-term development actions must be authorized to keep demand safely below supply.

Development

There are several methods that could be applied to decreasing the demand and increasing the supply in order to meet the objectives stated in this plan, which can be classified as follows:

To reduce net demand: reducing the amount of water used per capita

1. Active conservation: mandatory and direct measures to reduce demand
2. Passive conservation: voluntary and indirect methods to reduce demand

To reduce gross demand: reducing the amount of water taken from the Natural Water System

1. Waste water re-use: treatment and recycling of waste water from the Managed Water System

To shift available supply

1. Agricultural water conversion to M&I use
2. Storm water capture and use

To increase water supply

1. Import water from outside the region
   a. From Lake Powell
   b. From Kanab Creek watershed
2. Increase precipitation and snow pack
   a. Climate change reversal

The order of priority for demand reduction:

1. Agriculture
   Since agricultural water use is about 80% of the state's total water use (and perhaps 70% of Washington County's use), reducing demand in this category, and/or determining the impact of reduction, should be the top priority.
   It is recognized that this is a very challenging area to address, and for those reasons perhaps it can't be addressed very directly initially.
2. Outdoor M&I
   Since outdoor M&I water use is 80% of the state's total M&I water use (which is 20% of the state's total water use, and 30% of Washington County's), reducing demand in this category should be considered the second priority.
3. Indoor M&I

Within each of these categories of water use, active conservation methods will achieve more dramatic effects more quickly and at a better cost/yield than passive methods. Conservation is generally less costly than importing water from outside the region. If there is no time-driver for importing water (e.g., the water right will disappear), conservation should be prioritized over it.

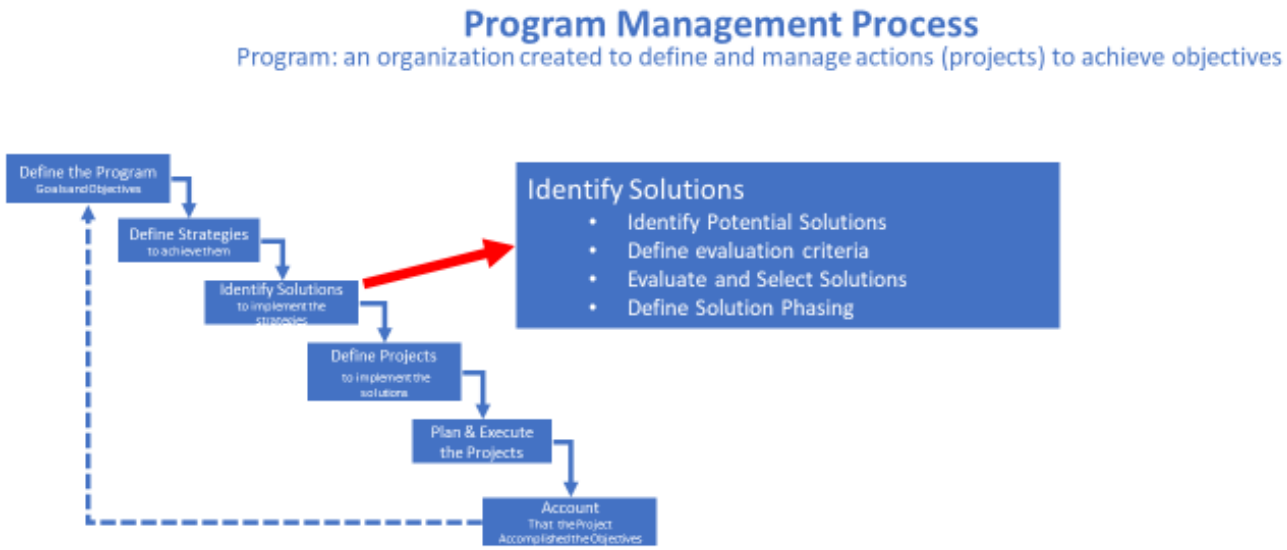
The long-term impact of climate change on Utah's and Washington County's water is large and potentially catastrophic. The state should support practices reducing these impacts as soon as possible.

Selection prioritization of methods/practices for reducing demand, shifting supply use, and increasing supply should be based on:

- Higher yields, nearer term, lower cost
- Higher probabilities
- Keeping within supply constraints at the lowest cost

A more detailed set of concepts are defined in Recommended State Water Strategy. In the context of this plan, those items labeled as "strategies" in the referenced document correspond to "concepts" here. Strategies, tactics, concepts, actions and projects are just varying levels of detail to describe how a goal or objective is to be or could be achieved.

5 Solutions



5.1 Potential Solutions

Management Solutions

If the stakeholders in Utah's (and Washington County's) Water System accept The Current Situation and Related Potential Strategic Changes as described above, an obvious solution is to improve the management processes. Incremental improvement is difficult without a roadmap. Program and project management principles are the only known proven and practical approaches to the scale of management necessary for Utah's Water System. Implementing it is technically easy if the stakeholders are properly identified and in agreement. Ideas:

1. Create an example (this document)
2. Engage stakeholders, modify the proposal as necessary, get agreement in concept
    - Engage state and local government officials in the executive branch (e.g., the Executive Water Finance Board) and/or legislative branch (e.g., the Subcommittee on Natural Resources, Agriculture, and Environmental Quality Appropriations)
    - Engage state and local water agencies (Washington County Water Conservancy District Board of Trustees, Utah's Division of Water Resources)
    - Communicate openly on the impacts coming to water users
3. Charter the program
    - Identify stakeholders
    - Form the initial program planning team
    - Introduce program management concepts
    - Communicate to stakeholders
    - Define context and scope
    - Define program structure/relationships (state, region, municipalities, etc.)
    - Define funding concepts

4. Develop and implement the program plan (this plan is an example)
5. Plan and budget yearly updates to the program plan and for the projects defined in it slated for execution within the year

Technical Solutions

Operations and Maintenance

A well-developed definition of solutions and on-going activities must already exist for this category.

Demand

Customer support

Re-use

Supply

Supply leak detection and repair

AWWA M36 Audit to gather data on leaks and non-revenue losses

Development

Demand Management

Active Conservation

Municipal and Industrial (M&I)

1. Conservation Zoning
   Implement Vision Dixie smart growth principles into zoning, calling for smaller lot sizes and higher-density housing and multi-use/multi-story buildings, live-where-you-work and live-where-you-shop concepts, with accountability of zoning to the principles.
   Currently there is little accountability, although the trend has been toward smaller lot sizes (and larger homes) resulting in less landscape area and therefore less outdoor water use. This has probably resulted in the bulk of water demand reduction. It is a no-cost option.
2. Building codes to reduce turf grass in new construction
   - Limited to the lesser of 500 sf or 5% of the landscape area for a declared practical use (rather than aesthetic purpose), with warnings that it may have to be eliminated in the future at the owner's cost if water demand goals cannot be met.
   - Cannot be planted on slopes or near hard surfaces
   - Emphasis on nature/water-wise shrubs and trees; special emphasis on shade trees
   - Design the turf area to fit the irrigation rather than the other way around
   - Special codes for parks and playgrounds limiting grass to purposeful areas
   - No over-spray in calm or windy conditions on hard surfaces
3. Water budgeting

- Assignment of a water budget (budgeted gallons per month) to each existing property based on indoor use, outdoor landscaping and micro-climate information
- Set water rates for budget use to "affordable," with slight credit for better-than-budget performance and significant penalty for worse-than-budget performance
- 1-2-year introduction to allow for education and tuning of usage and budgets
- Continuous support for out-of-budget conditions for customer who have a hard time keeping within their budget
- Long-term efforts for reduction of high budgets

4. Significantly increase tier pricing
   An intermediate method to be discontinued after water budgeting is implemented.
   - Set base rate at $30/mo for 10,000 gal
   - Increase the rate linearly for use over the base: 50% increase in water use of the base results in a 50% in the billed rate
5. Re-balance water cost distribution
   - Adjust the water use rate to the customer to cover 100% of the planned projected cost of water
   - Adjust the impact fee for new construction to cover only the capital costs of bring culinary and secondary water to the property and waste water from it.
   - Reserve the property tax line item only for emergencies when the planned costs change to a degree that the planned use rate cannot be increased effectively to cover the cost
6. Require turf grass reductions in existing properties
   - Over the long-term and with assistance, adjust existing properties to meet new construction code
7. Require landscape design and maintenance staff training
   - Require training and certification
   - Include in new construction inspection
   - Penalties for non-compliance
8. Increase use of secondary water for outdoor irrigation
   - Require new major developments to install secondary piping and develop connections to it
   - Carefully consider the economics of retro-fit existing neighborhoods
9. Treat brackish/high-solids water to secondary and/or culinary levels
   - Filtering/Reserve Osmosis

        - Possible harvesting of minerals
    10. Mandatory day/time irrigation restrictions
    11. Just-in-Time focused education
        - On the overall plan to manage our water and the impacts expected
        - Focus education on the specific conservation methods being implemented with both pre- and post-implementation support

Agricultural

1. Informative billing
    - Comparative water use
    - Projected future water bill
2. Water budgeting
    - Similar to M&I budgeting, where crops are assigned a budget and billed accordingly
3. Crop water use requirements
    - Set requirements and penalties for water use/area
4. Aquifer management requirements
    - Set requirements and penalties for sustaining aquifer recharging

Passive Conservation

Municipal and Industrial

1. Informative billing - comparative water use, projected future water bill
2. Incentives to upgrade indoor plumbing fixtures
3. Incentives to upgrade outdoor irrigation fixtures
4. General education on landscaping practices
5. General education on indoor water use
6. Voluntary day/time irrigation restrictions

Agricultural

1. Informative billing - comparative water use, projected future water bill
2. General education on crop selection
3. General education on irrigation
4. General education on aquifer management

Waste Water Treatment and Distribution

1. Secondary treatment and distribution
    - Pace treatment facility expansion to meet projected waste water volumes
    - Increase distribution to new neighborhoods
2. Culinary treatment and distribution
    - Add capacity and ability to route secondary-treated water to culinary treatment

Water Banking

A voluntary, market-based tool that could facilitate water transactions between willing sellers and buyers whereby water right owners willing to not use some of their water sell it temporarily to those others.

Supply Increase

1. Storm water capture and use - retention and settling ponds, pumping/piping to secondary usages or to culinary treatment facilities
2. Importing water from Lake Powell
3. Importing water from Kanab Creek watershed
4. Climate change reversal - changing state policies on fossil fuel extraction, increasing conversion to low/no emission energy, supporting broader efforts

Potential Integration with the "Electrical Power System"

There are two potential integration opportunities between the water system and the electrical power system that could generate additional revenue for water management:

1. Pumped Storage Electrical Generation
   Pumping water to a high reservoir during daily or weekly periods of relatively low electrical power rates and releasing through generators during periods of relatively high electrical power rates.
2. Bio-waste Electrical Generation
   Converting waste recovered from the waste water treatment facility into electricity.

5.2 Evaluation and Selection of Solutions

This should largely be defined in the state's Water Management Plan. There has been a good start on this, but there are many apparent analysis errors, probabilities are not addressed, key solutions are not yet analyzed, and source data from implementations in other states are missing.

Management Solutions

Addressing this class of actions to implement program management is a matter of political will. If the stakeholders think the current management processes are sufficiently clear and adequate to manage scope of Utah's Water System, then this set of actions may be null. If improvement is deemed necessary, the options identified above in Options for Achieving Program Goals and Objectives are applicable. The Legislative Audit 2015-01 and the 2017 Recommended State Water Strategy seem to provide enough evaluation, although the recommendations for Program Management are indirect.

Program Technical Solutions

Improving both water demand and supply must take into account actions currently on-going and those that are not yet identified.

The evaluation of options to decrease demand and increase supply is based on these factors:

- The cost to implement the option, including capital costs (development/implementation costs), the cost of capital (financing costs), maintenance costs and operations costs
- The yield of the option, reduced to GPCD increased supply or decreased demand
- Considering 90% probabilities for both cost and yield
- In terms of $/AFY by year; that is, the money it takes to save or to supply an AFY of water each year from implementation into the future, considering the county population projected for each year, based on the year 2015 considering the GPCD, dollar value and practices in place.
- The degree to which the option relies on changing people's behavior and the psychological tools and capacity available to make that change.
- The probabilistic difference between supply and demand

The evaluation relationships between these factors is not simple. For example, some solutions may appear to be the most effective from a cost-benefit analysis, but if the psychological adjustment is great and there is a safe difference between supply and demand, the selection could be biased to address the more difficult adjustments later.

Analysis and Selection of Potential Solutions

Analyses need to be performed and verified in an open environment for each entry in the table below (link to master analysis spreadsheets).

Description of the table:

- Concepts are from the list in section 2.2.
- Cost = the 90% high-probability yearly average cost, from implementation to 2065 using 2015 as the baseline
- Yield = the 90% high-probability yield from implementation to 2065 using 2015 as the baseline, in AFY.
- $/AFY = cost/yield
- Cost and yield estimates are from the draft Utah's Regional M&I Water Conservation Goals (V4, February 6, 2019), and from CSU's estimates; to be refined as analyses are completed and verified.
- Psych = psychological adjustment for water users, where H = high, L = low, M = medium
- All options identified are viable candidates for selection until flagged otherwise by "0" in the Implementation Priority column.
- A number in the Analysis Priority column indicates the priority given to a project to perform the analysis of the concept, with 1 being the highest.
- A number in the Implementation Priority column indicates the priority given to a project to develop and implement the concept.
- Both Analysis and Implementation actions may be phased with multiple projects.

Those solutions with an Implementation Priority are to be planned for implementation without any additional analyses required, in the order of priority. NA means the solution is already implemented but some further analysis is appropriate.

Potential Solutions	Cost	Yield	$/AFY	Psych	Notes	Analysis Priority	Impl. Priority
Management Solutions			NA	**NA**			NA
Initial program implementation							1
Basic analysis and fact-finding to support defining program requirements, goals, objectives and strategies						1	
Technical Solutions							
Operations and Maintenance			NA	NA			NA
Identify existing activities and budgets					8	2	
Perform AWWA M36 audit						2	
Demand Management Development							
Active conservation							
Municipal and Industrial (M&I)							
Conservation Zoning	small	13,000		L	1	2	
Building codes to reduce turf grass in new construction	small	13,000		L	1		1
Water budgeting	$3M	4400	800	M		2	
Significantly increase tier pricing	small	13,000	small	M	1,2		
Re-balance water cost distribution	small	13,000	small	L		2	
Require turf grass reductions in existing properties	large	13,000	large	H	1		
Require landscape design and maintenance staff training				M		3	
Increase use of secondary water for outdoor irrigation – new development				L		3	
Increase use of secondary water for outdoor irrigation – existing development				M		3	
Treat brackish/high-solids water to secondary and/or culinary levels				L		4	
Mandatory time/day irrigation restrictions				M	8		
Just-in-Time focused education				L	3		
Agricultural							
Water budgeting				M		3	

Crop water use requirements				M		2	
Aquifer management requirements				M		2	
Passive conservation							
Municipal and Industrial							
Informative billing				L	7	2	
Incentives to upgrade indoor plumbing fixtures – faucets, toilets				L	6	3	
Incentives to upgrade indoor plumbing fixtures – laundry				L	6	3	
Incentives to upgrade outdoor irrigation fixtures				L	6	3	
General education on landscaping practices				L	6	3	
General education on indoor water use				L	6	3	
Voluntary time/day irrigation restrictions				L			
Agricultural							
Informative billing				L		2	
General education on crop selection				L		2	
General education on irrigation				L		2	
General education on aquifer management				L		2	
Waste water re-use							
Secondary treatment and distribution				L		3	
Culinary treatment and distribution				M		3	
Water Banking							
Supply Management Development							
Storm water capture and use				L			
Import from Lake Powell (LPP)	$3.24 - 5B	2.6 - .75M	1252 – 6700		4	1	
Import from Kanab Creek watershed						2	
Climate change reversal					5		

Footnotes:

[1] Yield assumes 10% reduction in use

[2] This option is not considered viable if Water Budgeting is selected.

[3] Will be included in the selected option, not treated as a separate concept.

[4] Includes all financing costs including longer financing period for the county to re-pay the state for the bond; includes reduction in water supply considering the probability that all Compact states will be forced to reduce their allocation; will be adjusted as 90% high-probability numbers are derived

[5] Utah' water supply and demand is projected to be impacted more by climate change than most locations. In order for Washington County to remain a long-term-viable place to live due to both water supply and ambient temperatures, significant action is required to reduce fossil fuel extraction and burning world-wide. Utah should be leading on this effort due to the higher than average impact on the state. It is currently leading in the wrong direction.
[6] These concepts are currently implemented; analyses are required to see if they should receive the existing level of support, or more or less. For example, smart irrigation controllers are more effective on large turf areas than on water-use landscaping. Reducing turf areas reduces the effectiveness of the controller. Smart controllers require a reliable internet connection and current (day and time) micro-climate information that is often not available.
[7] If Water Budgeting is selected, this may not be a necessary concept.
[8] Need a clear understanding of actions and budgets, which probably exists; some analysis may be appropriate.
[9] Difficult to enforce

5.3 Phasing of Solution Actions

Often the set of solutions have precedence relationships between them that require a certain sequence. This section would define that logical sequence. In the case of this early draft/example plan, all of the high priority solutions are fairly low in number and fairly independent. Each solution listed in the above table with a priority 1 for implementation or analysis should be undertaken as soon as possible. They can proceed in parallel, budget constraints allowing. The analysis and fact-finding for the LPP has some dependency on the basic program-level analysis and fact-finding, which are described in the project definitions.

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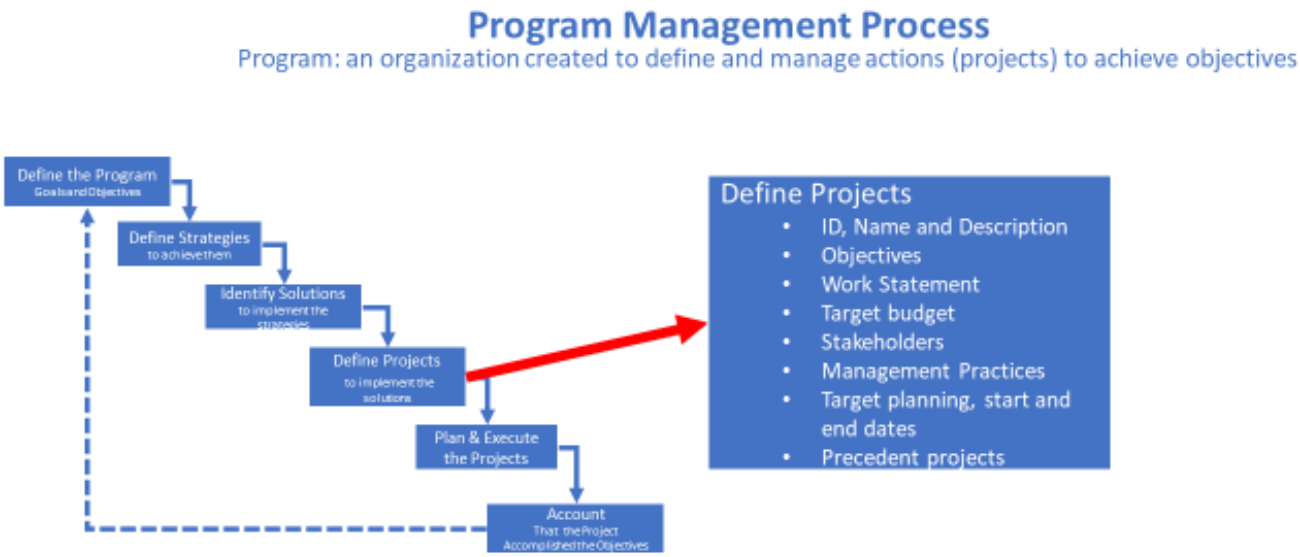
6 Project Definitions



There are 3 types of projects: Management, Sustaining and Development.

Management projects are defined to develop and manage the plans of the program. Some of these projects may act like the Sustaining projects defined below in that they may be defined on a yearly cycle.

Sustaining projects generally are defined/renewed on a yearly of budget cycle and include the operations and maintenance and overhead tasks for the program. Lessons learned and actual expenses are inputs to the planning process to create the next period's task structure and budget.

Development projects are defined to develop new system components, processes or management mechanisms in support of increasing supply or re-use or decreasing demand.

Since the state's Water Management Plan does not (yet?) exist, projects required by the county of the state are listed here too. They are denoted with "(state)" at the end of the project name.

6.1 Project Identification and Scope

Management Projects

M1: Washington County Water Management Program Initiation

1. Create an example (this document)
2. Modify/agree with the concept
    - Engage state and local government officials in the executive branch (e.g., the Executive Water Finance Board) and/or legislative branch (e.g., the Subcommittee on Natural Resources, Agriculture, and Environmental Quality Appropriations) and state

and local water agencies (Washington County Water Conservancy District Board of Trustees, Utah's Division of Water Resources)
    - Discuss options and agree in concept
3. Charter the program
    - Form the initial program planning team
    - Introduce program management concepts
    - Identify stakeholders and roles
    - Define context and scope
    - Define program structure/relationships (state, region, municipalities, etc.)
    - Define funding concepts
4. Develop and implement the program plan (this plan is an example)

M2: Define interim project chartering mechanism (until program is established; needs coordinate with state)
- Team selection and engagement
- Planning
- Incremental reviews and verification

M3: 2021 Update Rev 1 to Program Plan:
- Updating the program plan as new information becomes available from projects or as new direction/insight is gained
- Monitoring project status, adjusting project plans as needed, verifying project accountability

There would be a series of projects for each program (state and region) for each year.

Sustaining Projects

S2020-1: 2020 WCWCD Sustaining operations: O&M, Conservation Support, LPP support
S2020-2: 2020 St George Sustaining operations: O&M, Conservation Support
S2020-3: 2020 Ivins Sustaining operations: O&M, Conservation Support
S2020-N: etc. for each municipal water utility

S2021-N: the 2021 set of projects
There would be one of these for each water agency of each region and for the state program.

Development Projects

D1: Determine and Verify Facts/Data for LPP Decisions (state)
1. Current Colorado River watershed diversions and depletions.
2. Projected probabilistic future Colorado River depletion allowance.
3. Planned allocation within the state of the projected probabilistic future Colorado River depletion allowance
4. Probabilistic cost of the LPP
5. Virgin River watershed accounting in the Colorado River Compact

6. Financing plan, including payback and affordability assessment

D2: Pursue Federal License for the LPP (state)

Even though many facts and data required to verify the LPP as a viable solution have not be gathered and verified, there was been a large investment made in the federal licensing process. It makes sense to continue that process to its conclusion.

D3: Decision on the LPP (state and county)

Decision of go/no-go/postpone for the LPP based on analyses (risk and cost), state legislative and executive branch approval, local/county government/citizen approval.

D4: Determine and Verify Facts/Data – may be broken into several projects (state)

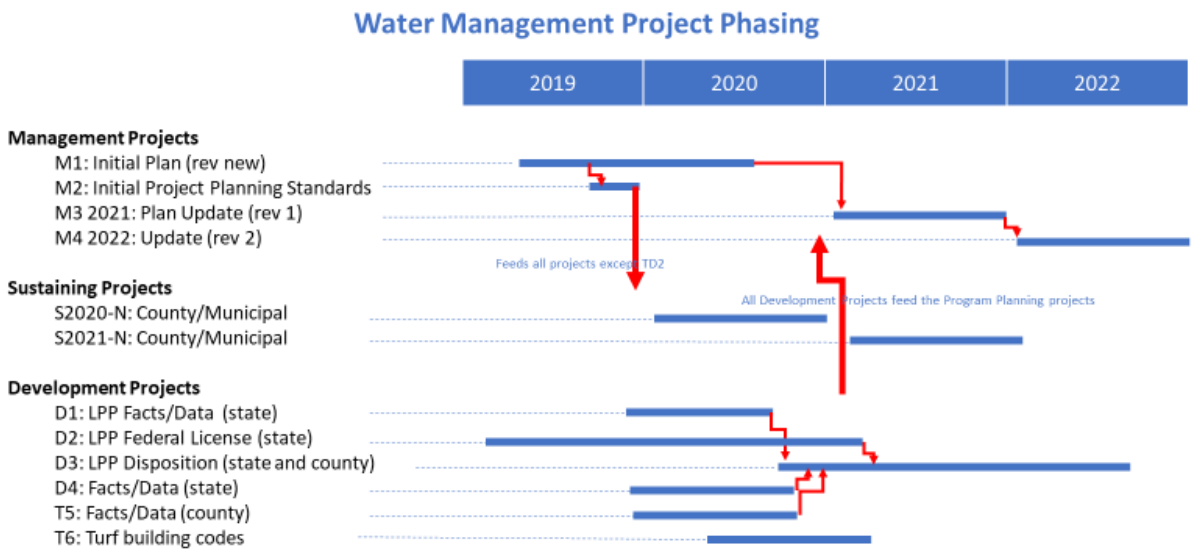
1. Projected future supply and demand constraints
2. Updated water supply improvement options, probabilistic yields and costs, including all cost categories (development/construction, operations, maintenance, finance), in-state calculations and comparison to other states
3. Updated water demand improvement options, probabilistic yields and costs, including all cost categories (development/construction, operations, maintenance, finance), in-state calculations and comparison to other states
4. Current water demand in communities in other states, normalized for comparison to Utah communities
5. Updated region definitions
6. Updated regional water demand objectives

D5: Determine and Verify Washington County Facts/Data - maybe broken into several projects

1. Current county water supply sources, amount diverted from those sources, uses of the diversions, depletions from those uses
2. Projected probabilistic future supply sources, diversions, uses, depletions
3. Future water supply constraint, water demand constraint, demand objectives
4. Verify LPP facts/data

D6: Implement building codes throughout Washington County to reduce turf grass in new construction

6.2 Project Phasing/Sequencing



6.3 Project Definitions

The project definition contain for each project contains:

- ID
- Name
- Objectives
- Work Statement
- Target Budget
- Stakeholders
- Reference to management practices (status reporting, plan maintenance, etc.)
- Target start and end dates, target planning start date
- Precedent and subsequent project dependences (internal and external to the program)
- Other constraints

This section would contain a sub-section or appendix entry for each project containing its definition. See examples in the appendix.

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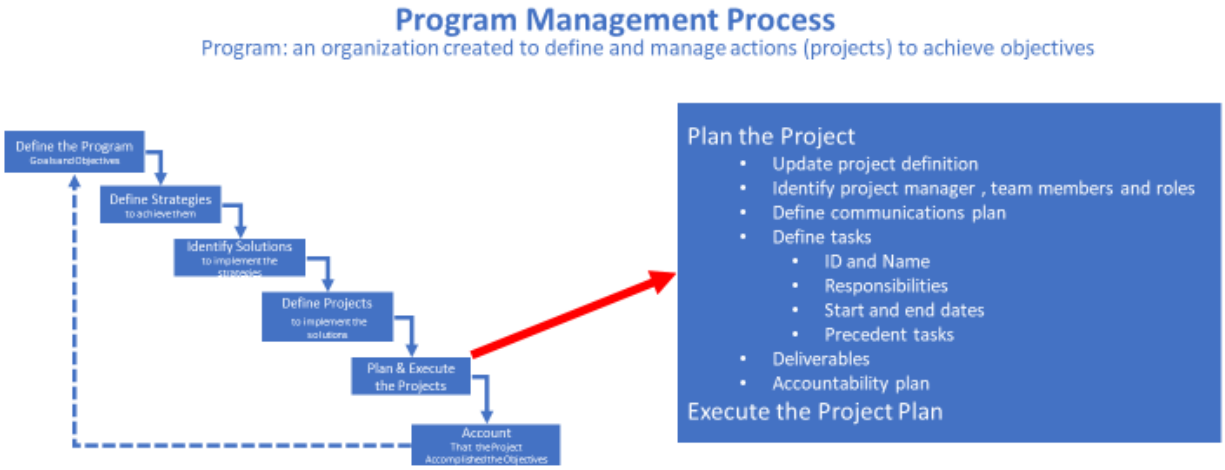
7 Project Planning



This section would reference the configuration-controlled and maintained plans for each project that has started planning, though all that have completed execution and are archived. See examples in the appendix.

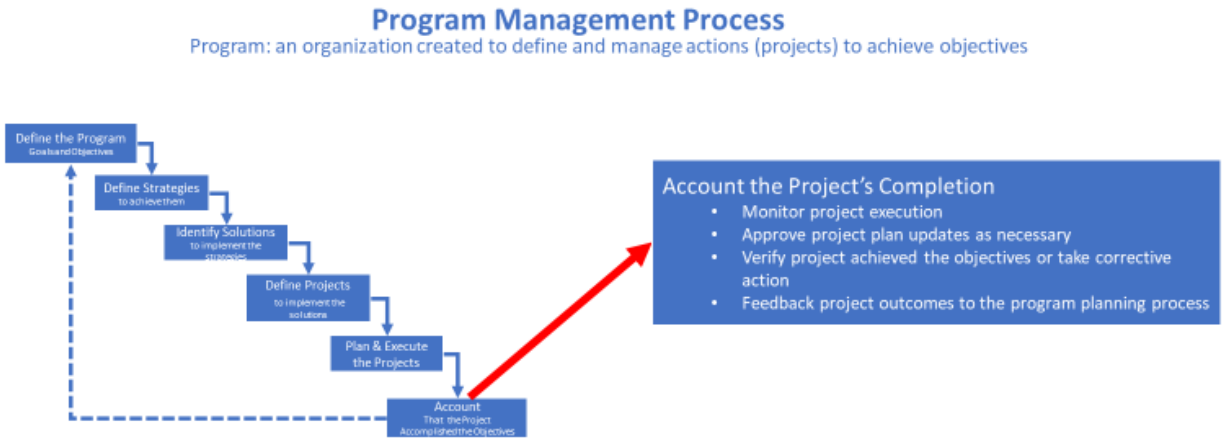
Project planning activity is initiated by the program per the project phasing plan, so that the plan can be completed and approved at the time slated for the project to be started as defined in the phasing plan.

Project Plan contents:

- The Project Definition from the program plan, updated as required
- Project manager name
- Team members and roles, including stakeholder representatives
- Communication plan: status and technical reviews
- Tasks, task precedence relationships, schedule, responsibilities
- Deliverables descriptions
- Accountability plan: what measures are to be taken, how and when, to verify objectives are met (this will be used in the Program Sustaining activity for accountability

8 Accountability

This section would document the technical review of the project outcomes relative to the project objectives. This may take some time after the project completion in order to gather the essential data.



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Appendices

1. Program Scope Derivation

The following diagrams and related text describe the context and scope of the system for which this plan defines all management, maintenance and development actions. The terms introduced and used are further defined in the *Error! Reference source not found.* section that follows.

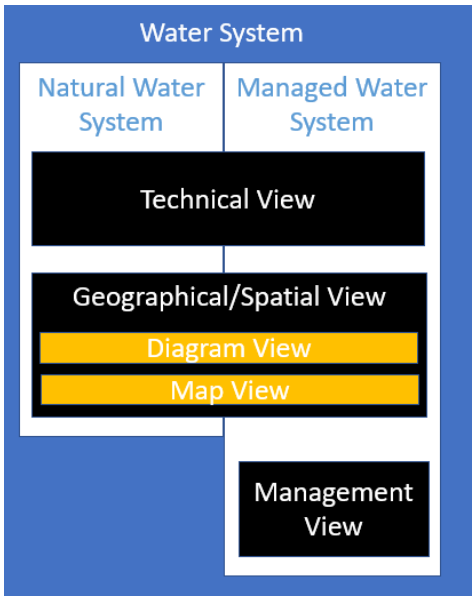

Figure 1

This simple diagram serves to define the top-level context of the system this plan addresses. 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 human-caused actions for the purpose of sustaining human life.

These systems can be defined and viewed in several perspectives:

- A schematic or logical view that names the elements, actions and relationships between them.
- A geographical/spatial view that describes the system relative to political and geographical 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.

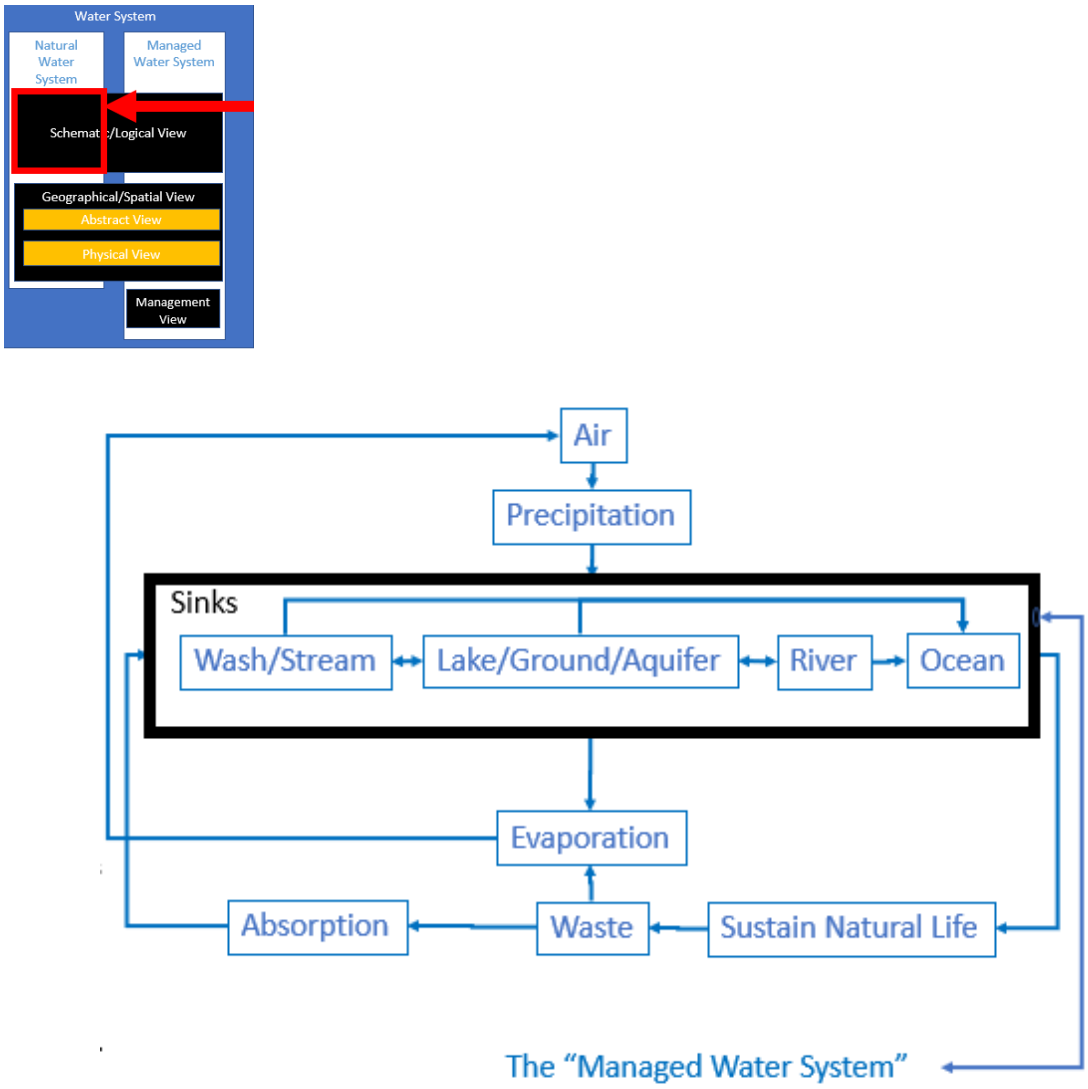

Figure 2: Generalized Schematic of the Natural Water System and Its Interaction with the Managed Water System

The upper element of this figure is a miniature of Figure 1, showing the portion of that diagram that is expanded in the main portion of Figure 2. The **bolded text** in this paragraph identifies elements depicted in the schematic: Water in the **air** (the "source") falls as **precipitation** into "**sinks**": **washes, streams, lakes, the ground, rivers and the ocean**. These sinks flow between each other as depicted by the **arrows**. 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" (**air**). All arrows are natural flows, except the one to and from the **Managed Water System**, which draws water from **sinks** and returns water to them.

Figure 3: Specific Schematic of the Natural Water System and Its Interaction with Washington County's Managed Water System

This diagram would be simple, just naming the rivers, lakes and aquifers that supply the managed water system and the flows that return water to the Natural Water System.

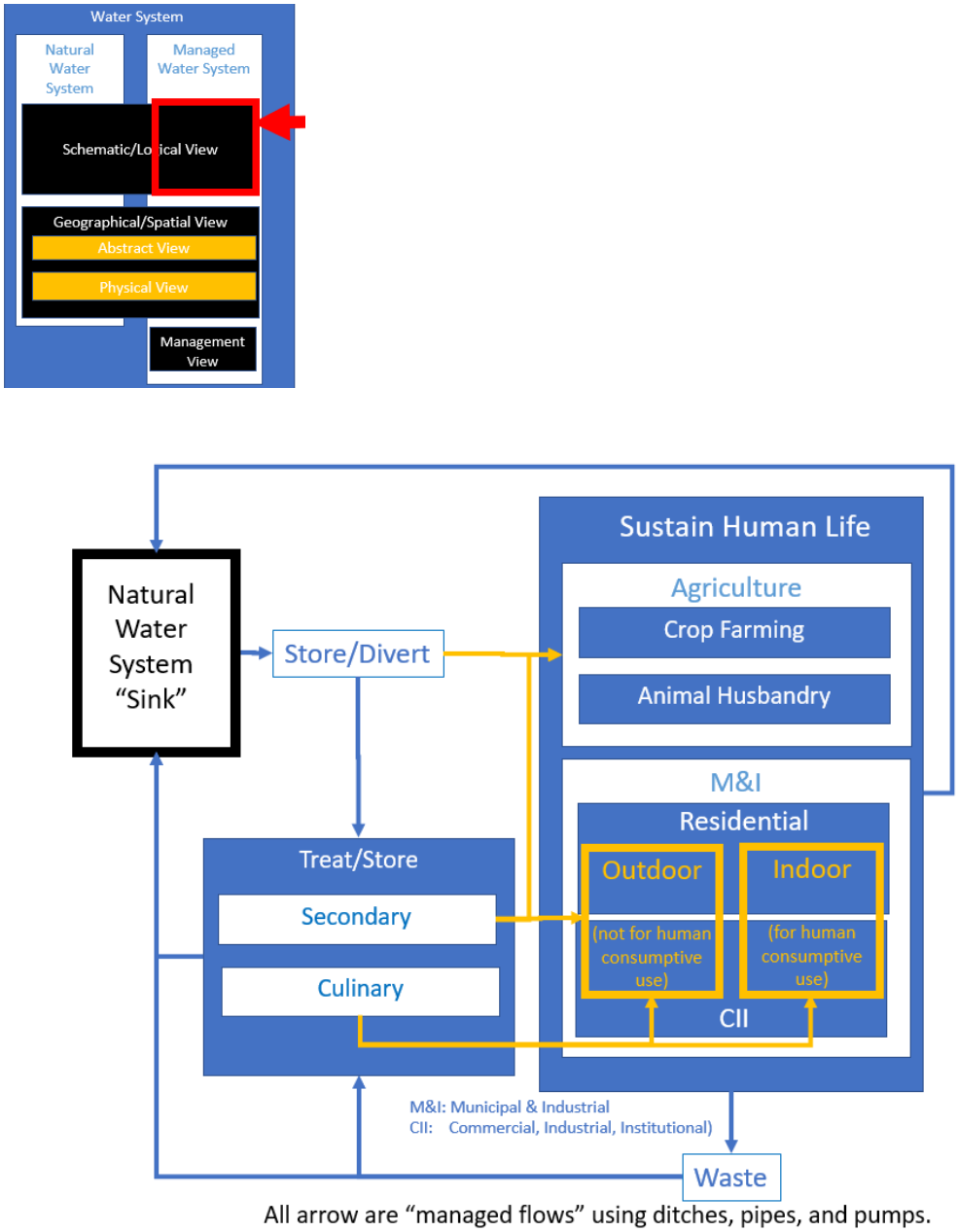

Figure 4: The Generalized Schematic of the Managed Water System

The upper element of this figure is a miniature of Figure 1, showing the portion of that diagram that is expanded in the main portion of Figure 4. The **bolded text** in this paragraph identifies elements depicted 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 arrows are "managed flows" using ditches, pipes, and pumps.

Figure 5: Specific Schematic of Washington County's Managed Water System

This diagram would name the specific elements for the county and quantify the flows. More detailed schematics could detail the specific elements, down to pumps and pipes if it is of value. Generally, we may want to get to the level of detail that project definitions would need to reference in order to properly scope the work to be done.

Figure 6: Map of Washington County's Managed Water System

This diagram would depict on a map the major elements for the county and quantify the flows. More detailed maps could be developed if of value. Generally, we may want to get to the level of detail that project definitions would need to reference in order to properly scope the work to be done.

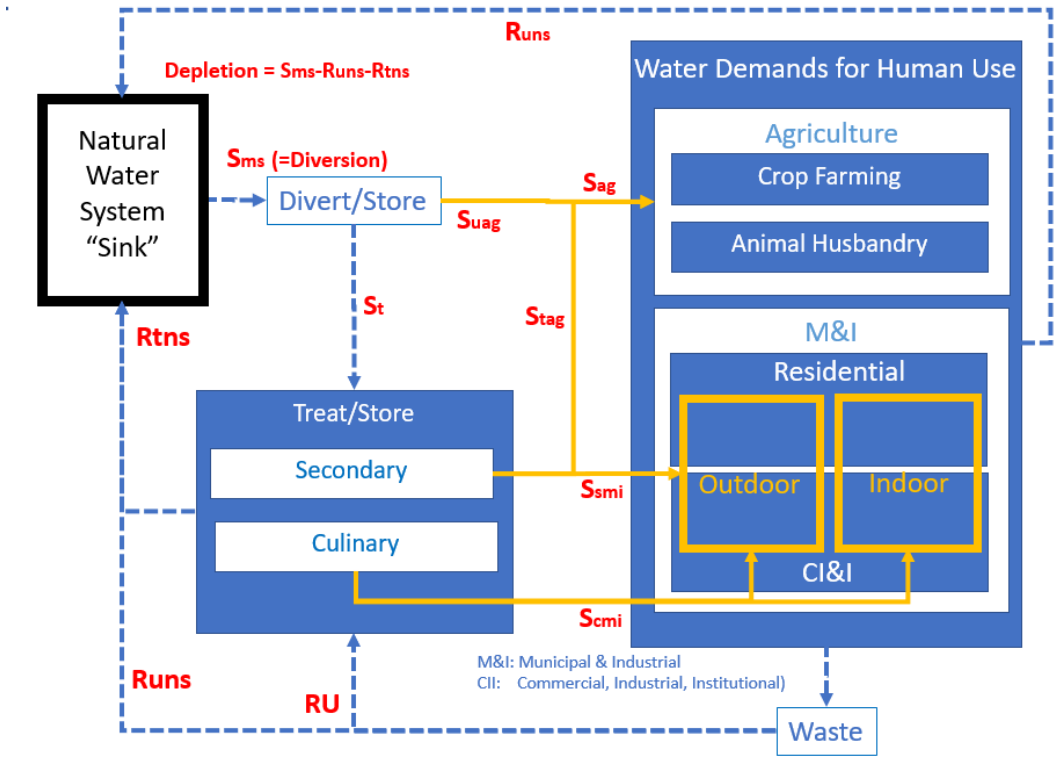

Figure 7: General Schematic of the Managed Water System - Supply, Demand, Diversion, Depletion, Allocation and Conservation

Bold text identifies elements in the schematic. 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 (Sag),** whether **untreated (Suag) or treated to some secondary level (Stag)**
- **Municipal & Industrial (M&I) Supply, whether treated to a culinary level (Scmi) or secondary level (Ssmi)**

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** = [**Sms** (= diversion) - water that is returned to the natural system], either untreated (**Runs**) or treated (**Rtn**s). 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

Figure 8: Specific Schematic of Washington County's Managed Water System

This diagram would name the specific elements of the water system and at flow rates. Perhaps other diagrams or maps would be required to describe project scopes. This could be added as needed.

2. Water System Descriptions

3. Terms

These terms and definitions start with general basic language as a foundation for more specific definitions more directly pertinent to the subject of water management. Many terms are derived from the context and scope statements.

Terms defined here are highlighted in bold italics and linked to the definition wherever they occur in the document so that terms with specific meaning are identified. (Not completely implemented yet.)

CII Water	See *Water, CII.*
Commercial Water	See *Water, Commercial.*
Conservation	The protection, preservation, management, or restoration of natural environments and the ecological communities that inhabit them. Conservation is generally held to include the management of human use of natural resources for current public benefit and sustainable social and economic utilization.
Conservation, Water	The reduction in the demand for water by humans; reduced water usage by humans
Culinary Water	Water from a managed water system that has been treated to a level safe for human consumption, used indoors or perhaps inappropriately for non-culinary outdoor uses like landscape irrigation.
Demand	A claim or requirement for use of an element
Demand constraint, water	The lower limit constraint on a water demand objective that is derived from the amount of water necessary to sustain an adequate economy and quality of life.
Demand, Water	A claim or requirement for use of water from a Managed Water System for human purposes (e.g., consumption, production, recreation, enjoyment)
Depletion (form the Natural Water System)	The portion of the natural water system diversion that is not returned from a managed water system to the natural water system. Colorado River allocations are defined in terms of depletion.
Diversion (from the Natural Water System)	A flow from the natural water system to a managed water system.
Flow	The movement of an element from a source to a sink or within a source. Depending on the flow, sources and sinks can change roles.
Flow, Water, Managed	Movement of water in the managed water system facilitated by infrastructure elements created by humans (e.g., pumps, pipes), possibly assisted by natural forces.
Flow, Water, Natural	Movement of water in nature facilitated by natural forces (e.g., gravity)
Goal	The purpose toward which an endeavor is directed in order to achieve a vision, generally not strictly measurable or tangible.
Industrial Water	See *Water, Industrial*.
Infrastructure	The basic facilities, services, and installations needed for the functioning of an organization, community or society.
Infrastructure, Water	The elements of a managed water system that facilitate the movement of water from a natural water source to a human use and back to a natural water sink (e.g., reservoirs, tanks, pipes, pumps, etc.), including any processing of that water required for safety or environmental purposes (e.g., treatment facilities).
Institutional Water	See *Water, Institutional.*

Loss, Managed System	Resources that escape the system before they can be productively used
Loss, Managed Water System	Water that escapes from the managed water system before they can be productively used; e.g., leaks from pipes, pumps, tanks, reservoirs; evaporation from reservoirs.
M&I Water	See *Water, M&I.*
Managed System	See *System, Managed.*
Managed System Loss	See *Loss, Managed System.*
Managed Water Flow	See *Flow, Water, Managed.*
Managed Water Sink	See *Sink, Water, Managed.*
Managed Water Source	See *Source, Water, Managed.*
Managed Water System	See *System, Water, Managed.*
Managed Water System Loss	See *Loss, Managed Water System.*
Mission	An organization's role in achieving a vision.
Municipal Water	See *Water, Municipal.*
Natural Resource	An element (any periodic element or molecule or composition of molecules) occurring in nature (e.g., water, mineral, air, plant, animal) that is used to support nature (water, mineral, air, living beings).
Natural System	See *System, Natural.*
Natural Water Flow	See *Flow, Water, Natural.*
Natural Water Sink	See *Sink, Water, Natural.*
Natural Water Source	See *Source, Water, Natural.*
Net Water Demand	See Water, Demand, Net **Error! Reference source not f ound.Error! Reference source not found.**
Objective	A measurable and tangible product that is to be achieved, attained or accomplished.
Plan	A plan list of steps with details of timing and resources, used to achieve an objective.
Program	A program is a mechanism and organization to manage the work of an enterprise to achieve a goal over an indefinite long term guided by a plan.
Program plan	A plan that includes the derivation of the program's goals and objectives and the strategies to be used to accomplish them, the potential solutions aligned with those strategies, the evaluation and selection of the solutions, the step-by-step phasing of elements of the solutions, the definition and phasing of the projects to be used to implement the steps, the chartering of project plans, the initiation of the projects, and the monitoring of the project execution and accountability of the project results to its objectives.

Project	A mechanism and organization to achieve a specific objective within a specific time frame. If the project is derived as part of a strategic program plan, it would be defined in a program plan.
Project plan	The tasks, schedules, responsibilities and budget defining how the project is to achieve its objectives. If the project is derived as part of a strategic program plan, the project planning and the execution of the plan would be initiated by the program, and the project would be held accountable for accomplishing its objectives by the program (see Program plan).
Probability	The mathematical chance of something being true
Probabilistic	Of, relating to, or based on *probability*
Return (to the Natural Water System)	The portion of the natural water system diversion that is returned from a managed water system to the natural water system.
Secondary Water	See *Water, Secondary.*
Sink	A place where an element can be stored in order to act as the destination of a flow.
Sink, Water	The destination of a flow of water.
Sink, Water, Managed	A place created by humans acting as the destination of a flow of water to store water temporarily (e.g., reservoir, tank)
Sink, Water, Natural	A place occurring in nature acting as the destination of a flow of water, storing the water temporarily (from seconds to millennia) e.g., air/atmosphere, ground, aquifers, washes, streams, rivers, lakes, oceans.
Source	A place where an element can be stored in order to act as the original of a flow.
Source, Water	The origin of a flow of water.
Source, Water, Managed	A place created by humans acting as the origin of a flow of water to store water temporarily (e.g., reservoir, tank)
Source, Water, Natural	A place occurring in nature acting as the origin of a flow of water, e.g., air/atmosphere, ground, aquifers, washes, streams, rivers, lakes, oceans.
Strategy	The top-level concepts describing how goals and objectives are to be achieved.
Supply constraint, water	The upper-end constraint on a water demand objective that is derived by the probabilistically safe available supply
System	A set of elements interacting under a set of rules or operations that may or may not be understood or defined.
System, Managed	A set of elements operating under a set of rules or operations that are controlled by humans to the degree they are understood and defined.
System, Natural	A set of elements that exist in nature under a set of natural rules or operations that may or may not be understood or defined to some degree.
System, Water	A system composed of elements that store, move and use water

System, Water, Managed	A water system where the water is stored in and moved by human-made elements and the uses are for human purposes (sustenance, food production, manufacturing production, recreation and enjoyment, etc.
System, Water, Natural	A water system where water is stored in and moved by natural elements and the uses support nature (plants and animals).
Vision	A desired state or condition
Water	A single or set of bonded H2O molecules existing in a liquid, solid, or vapor/gas state; in space or in the air/atmosphere, surface, subsurface or mantle/core of terrestrial bodies; stored in or moving between sources and sinks.
Water, CII	Water used for commercial, Industrial and Institutional purposes
Water Conservation	See *Conservation, Water.*
Water, Commercial	Water from a Managed Water System that is used for commercial business purposes, treated to the level of culinary water.
Water Demand Constraint	See Demand constraint, water
Water, Demand, Net	Equals demand for water from the Managed Water System minus the waste water than has been treated and returned to the system to be reused.
Water, Industrial	Water from a Managed Water System that is used for industrial purposes, treated to the level of culinary water.
Water, Institutional	Water from a Managed Water System that is used for institutional purposes (parks, schools, churches; entities not taxed), treated to the level of culinary water.
Water, M&I	Water from a Managed Water System that is used for municipal and industrial purposes, treated to the level of culinary water.
Water, Managed	Water in a Managed Water System.
Water, Municipal	Water from a Managed Water System that is used for residential, commercial and institutional purposes, treated to the level of culinary water.
Water, Secondary	Water from a Managed Water System that is used for agriculture and irrigation purposes on farms or landscape or dust control or other non-culinary purposes. It may be treated to some degree but not to the level of culinary water.
Water Source	See *Source, Water.*
Water Sink	See *Sink, Water.*
Water System	See System, Water
Water Supply Constraint	See Supply constraint, water

4. Budget Constraints

To be filled in for the water district and city utilities.

	WCWCD	Enterprise	Hurricane	Ivins	Laverkin	Leeds	Santa Clara	Springdale	St George	Toquerville	Washington
2020											
2021											
2022											
2023											
2024											
2025											
2026											
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2039											
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2042											
2043											
2044											
2045											

5. Technical Analysis References

6. Example Project Plans

Example project plans:

Example 1: The initial development of a real program plan

Project Definition	
Project ID	*M 1*
Project Name	*Washington County Water Management Program Initiation*
Objectives	*Approved program plan for the management of water supply and demand for Washington County, including setting goals and objectives, the derivation/acquisition of all facts and data necessary to develop strategies, identify and select solutions, and plan their incremental implementation*
Work Statement	*With appropriate stakeholder participation, develop the first version of the plan, including all sections.*
Budget	*$500,000*
Reference to management practices	*Standard program and project management processes and structures, full engagement of stakeholders, transparency and accountability.*
Start date End date	*11/4/2019* *7/31/2020*
Project Relationships	*Precedent projects: facts and data available from TD 1,2,3,4* *Dependent projects: guidance to M2, baseline plan to M3*
Other constraints	
Project Manager	*Zach Renstrom*
Team Members and Roles	*Experienced program management facilitator, staff from WCWCD, DWRe, local governments and water utilities, stakeholders from businesses, NGOs and citizens*
Communications Plan	• *Initial public announcement and call for participation*

	• *Announcement of draft plan and request for comments* • *Announcement of each section draft review* • *Full accountability of comments*
Deliverables	*First version of the program plan*
Accountability Plan	*Stakeholder agreement*

Project M1 Tasks:

ID	Name	Description	Lead, Team	Start Date	End Date	Precedent Task
1	Form Team	Project team and shareholder review team	Project mgr Steering team	11/3/19	12/1/19	
2	Orient team	General education of program planning, agree to structure and team operating rules	Facilitator Project team	12/1/19	12/20/19	
3	Define the program	See program plan outline	Full team	1/6/20	2/7/20	2
4	Shareholder review	Gather comments, make adjustments	Shareholders Project team	2/10//20	3/6/20	3
5	Define strategies and solutions	See program plan outline	Project team	2/27/20	5/1/20	3,4
6	Shareholder review	Gather comments, make adjustments	Shareholders Project team	5/4/20	5/22/20	5
7	Define projects	See program plan outline	Full team	4/18/20	6/26/20	5,6
8	Final review	Gather comments, make adjustments	Shareholders Project team	7/7/20	7/17/20	7
9	Final Communications	Public announcement, next steps, ramifications		7/10/20	7/17/20	8
10	Approval		Steering Team	7/21/20	7/25/20	8,9

Example2: *Washington County New Construction Turf Grass Limitation*

Project Definition	
Project ID	*D6*
Project Name	*Washington County New Construction Turf Grass Limitation*
Objectives	*Reduce water demand in new construction beginning in 2021 by 30%*
Work Statement	*Implement turf limitations via code changes and inspection requirements throughout the county*
Budget	*$200,000*
Reference to management practices	*Normal project management practices*
Start date *End date*	*4/1/2020* *12/18/2020*
Precedent and subsequent project dependences	*M2*
Other constraints	
Project Manager	
Team Members and Roles	
Communications Plan	*Announcement of intent, reviews to hear and respond to issues*
Deliverables	*Building code and inspection process updates*
Accountability Plan	*Measure actual consumption in the new construction over a 1-year period and compare to average*

Project D6 Tasks

ID	Name	Description	Lead, Team	Start Date	End Date	Precedent Task
1	Form Team	Project team and shareholder review team	Project mgr Steering team	4/1/20	12/1/19	
2	Orient team	General education of program planning, agree to structure and team operating rules	Facilitator Project team	12/1/19	12/20/19	
3						
4						
5						
6						
7						
8						
9						
10						

Revision Record

Rev 5

1. Added yearly planning update for the program plan and appropriate project plans to the list of management solutions.