Utah Division of Water Quality
Antidegradation Review Form

Part A: Applicant Information

Facility Name: St. George Regional Water Reclamation Facility

Facility Owner: City of St. George

Facility Location: 3780 South 1550 West, St. George, UT

Form Prepared By: Bowen, Collins & Associates

Outfall Number: 01

Receiving Water: Virgin River

What Are the Designated Uses of the Receiving Water (R317-2-6)?

Domestic Water Supply: 1C
Recreation: 2B - Secondary Contact
Aquatic Life: 3B - Warm Water Aquatic Life
Agricultural Water Supply: 4
Great Salt Lake: None

Category of Receiving Water (R317-2-3.2, -3.3, and -3.4): Category 3

UPDES Permit Number (if applicable): UT0024686

Effluent Flow Reviewed: 25.2 MGD peak month daily flow
Typically, this should be the maximum daily discharge at the design capacity of the facility. Exceptions should be noted.

<u>What is the application for? (check all that apply)</u>

☐ A UPDES permit for a new facility, project, or outfall.

☒ A UPDES permit renewal with an expansion or modification of an existing wastewater treatment works.

☐ A UPDES permit renewal requiring limits for a pollutant not covered by the previous permit and/or an increase to existing permit limits.

☐ A UPDES permit renewal with no changes in facility operations.

Part B. Is a Level II ADR required?

This section of the form is intended to help applicants determine if a Level II ADR is required for specific permitted activities. In addition, the Executive Secretary may require a Level II ADR for an activity with the potential for major impact on the quality of waters of the state (R317-2-3.5a.1).

B1. The UPDES permit is new or is being renewed and the proposed effluent concentration and loading limits are higher than the concentration and loading limits in the previous permit and any previous antidegradation review(s).

☒ **Yes** (Proceed to Part B2 of the Form)

☐ **No** No Level II ADR is required and there is no need to proceed further with review questions.

B2. Will any pollutants use assimilative capacity of the receiving water, i.e. do the pollutant concentrations in the effluent exceed those in the receiving waters at critical conditions? For most pollutants, effluent concentrations that are higher than the ambient concentrations require an antidegradation review. For a few pollutants, such as dissolved oxygen, an antidegradation review is required if the effluent concentrations are less than the ambient concentrations in the receiving water. (Refer to Section 3.3 of Implementation Guidance)

☒ **Yes** (Proceed to Part B3 of the Form)

☐ **No** No Level II ADR is required and there is no need to proceed further with review questions.

B3. Are water quality impacts of the proposed project temporary and limited (Section 3.3.3 of Implementation Guidance)? Proposed projects that will have temporary and limited effects on water quality can be exempted from a Level II ADR.

☐ **Yes** Identify the reasons used to justify this determination in Part B3.1 and proceed to Part G. No Level II ADR is required.

☒ **No** A Level II ADR is required (Proceed to Part C)

B3.1 Complete this question only if the applicant is requesting a Level II review exclusion for temporary and limited projects (see R317-2-3.5(b)(3) and R317-2-3.5(b)(4)). For projects requesting a temporary and limited exclusion please indicate the factor(s) used to justify this determination (check all that apply and provide details as appropriate) (Section 3.3.3 of Implementation Guidance):

☐ Water quality impacts will be temporary and related exclusively to sediment or turbidity and fish spawning will not be impaired.

Factors to be considered in determining whether water quality impacts will be temporary and limited:

a) The length of time during which water quality will be lowered: ☐
b) The percent change in ambient concentrations of pollutants: ☐
c) Pollutants affected: ☐
d) Likelihood for long-term water quality benefits: ☐
e) Potential for any residual long-term influences on existing uses: ☐
f) Impairment of fish spawning, survival and development of aquatic fauna excluding fish removal efforts: ☐

Additional justification, as needed: ☐

Level II ADR

Part C, D, E, and F of the form constitute the Level II ADR Review. The applicant must provide as much detail as necessary for DWQ to perform the antidegradation review. Questions are provided for the convenience of applicants; however, for more complex permits it may be more effective to provide the required information in a separate report. Applicants that prefer a separate report should record the report name here and proceed to Part G of the form.

Optional Report Name: [ ]

Part C. Is the degradation from the project socially and economically necessary to accommodate important social or economic development in the area in which the waters are located?

The applicant must provide as much detail as necessary for DWQ to concur that the project is socially and economically necessary when answering the questions in this section. More information is available in Section 6.2 of the Implementation Guidance.

C1. Describe the social and economic benefits that would be realized through the proposed project, including the number and nature of jobs created and anticipated tax revenues.

See Attached Supporting Information

C2. Describe any environmental benefits to be realized through implementation of the proposed project.

See Attached Supporting Information

C3. Describe any social and economic losses that may result from the project, including impacts to recreation or commercial development.

See Attached Supporting Information

C4. Summarize any supporting information from the affected communities on preserving assimilative capacity to support future growth and development.

See Attached Supporting Information

C5. Please describe any structures or equipment associated with the project that will be placed within or adjacent to the receiving water.

See Attached Supporting Information

Part D. Identify and rank (from increasing to decreasing potential threat to designated uses) the parameters of concern. *Parameters of concern are parameters in the effluent at concentrations greater than ambient concentrations in the receiving water. The applicant is responsible for identifying parameter concentrations in the effluent and DWQ will provide parameter concentrations for the receiving water. More information is available in Section 3.3.3 of the Implementation Guidance.*

Parameters of Concern:

Rank	**Pollutant**	**Ambient**		**Effluent**	
		Concentration / Units	**Basis**	**Concentration / Units**	**Basis**
1	See Supporting Information				
2					
3					
4					
5					
6					
7					
8					
9					
10					

Pollutants Evaluated that are not Considered Parameters of Concern:

Pollutant	**Ambient Concentration**	**Effluent Concentration**	**Justification**

Part E. Alternative Analysis Requirements of a Level II Antidegradation Review.

Level II ADRs require the applicant to determine whether there are feasible less-degrading alternatives to the proposed project. For new and expanded discharges, the Alternatives Analysis must be prepared under the supervision of and stamped by a Professional Engineer registered with the State of Utah. DWQ may grant an exception from this requirement under certain circumstances, such as the alternatives considered potentially feasible do not include engineered treatment alternatives.More information regarding the requirements for the Alternatives Analysis is available in Section 5 of the Implementation Guidance.

E1. The UPDES permit is being renewed without any changes to flow or concentrations. Alternative treatment and discharge options including changes to operations and maintenance were considered and compared to the current processes. No economically feasible treatment or discharge alternatives were identified that were not previously considered for any previous antidegradation review(s).

☐ **Yes** (Proceed to Part F)

☒ **No or Does Not Apply** (Proceed to E2)

E2. Attach as an appendix to this form a report that describes the following factors for all alternative treatment options 1) a technical description of the treatment process, including construction costs and continued operation and maintenance expenses, 2) the mass and concentration of discharge constituents, and 3) a description of the reliability of the system, including the frequency where recurring operation and maintenance may lead to temporary increases in discharged pollutants. Most of this information is typically available from a Facility Plan, if available.

Report Name: *See Attached Supporting Information*

E3. Describe the proposed method and cost of the baseline treatment alternative. The baseline treatment alternative is the minimum treatment required to meet water quality based effluent limits (WQBEL) as determined by the preliminary or final wasteload analysis (WLA) and any secondary or categorical effluent limits.

E4. Were any of the following alternatives feasible and affordable?

Alternative	Feasible	Reason Not Feasible/Affordable
Pollutant Trading	No	Plant is too big.
Water Recycling/Reuse	Yes	The City reuses a portion of the effluent for irrigation during the summer months.
Land Application	No	Plant is too big.
Connection to Other Facilities	No	No large faciliites near by.
Upgrade to Existing Facility	Yes	This is what is being proposed.
Total Containment	No	Plant is too big.
Improved O&M of Existing Systems	No	Existing facilities cant treat for nutrients and will not have capacity.
Seasonal or Controlled Discharge	No	Plant is too big.
New Construction	No	Not Affordable
No Discharge	No	Plant is too big.

E5. From the applicant's perspective, what is the preferred treatment option?

Convert Oxidation Ditches to Stage Aeration A2O Process with chemical addition.

E6. Is the preferred option also the least polluting feasible alternative?

☒ **Yes**

☐ **No**

If no, what were less degrading feasible alternative(s)? ☐

If no, provide a summary of the justification for not selecting the least polluting feasible alternative and if appropriate, provide a more detailed justification as an attachment.

☐

Part F. Optional Information

F1. Does the applicant want to conduct optional public review(s) in addition to the mandatory public review? Level II ADRs are public noticed for a thirty day comment period. More information is available in Section 3.7.1 of the Implementation Guidance.

☒ **No**

☐ **Yes**

F2. Does the project include an optional mitigation plan to compensate for the proposed water quality degradation?

☒ **No**

☐ **Yes**

Report Name: ☐

Part G. Certification of Antidegradation Review

G1. Applicant Certification

The form should be signed by the same responsible person who signed the accompanying permit application or certification.

Based on my inquiry of the person(s) who manage the system or those persons directly responsible for gathering the information, the information in this form and associated documents is, to the best of my knowledge and belief, true, accurate, and complete.

Print Name:____

Signature:____

Date:____

G2. DWQ Approval

To the best of my knowledge, the ADR was conducted in accordance with the rules and regulations outlined in UAC R-317-2-3.

Print Name:____

Signature:____

Date:____

Part G. Certification of Antidegradation Review

G1. Applicant Certification

The form should be signed by the same responsible person who signed the accompanying permit application or certification.

Based on my inquiry of the person(s) who manage the system or those persons directly responsible for gathering the information, the information in this form and associated documents is, to the best of my knowledge and belief, true, accurate, and complete.

Print Name: Jeff Beckman

Signature: [signature]

Date: 6/5/2020

REGISTERED PROFESSIONAL ENGINEER
No. 353485
JEFFERY T. BECKMAN
6/5/2020
STATE OF UTAH

G2. DWQ Approval

To the best of my knowledge, the ADR was conducted in accordance with the rules and regulations outlined in UAC R-317-2-3.

Print Name: Erica Gaddis

Signature: [signature]

Date: 06/22/2020

SUPPORTING INFORMATION

INTRODUCTION

The City of St. George (City) is planning to construct upgrades and improvements to the St. George Regional Water Reclamation Facility (SGRWF), termed the 2020 Expansion Project (Project). These improvements will increase treatment capacity and enable the SGRWRF to more reliably meet current and future wastewater treatment needs for the City and surrounding areas. The Project will also help ensure that the SGRWRF meets the recently implemented and future effluent discharge limits.

Bowen, Collins & Associates (BC&A) alogn with with Hazen & Sawyer Engineers (Hazen) to provided biological process modeling and assisted in development of the recommended biological treatment process.

BACKGROUND

The current SGRWRF is a 17-mgd design annual average flow oxidation ditch facility. Anticipated future growth indicates expansion well beyond the existing 17.0 mgd is needed. Previous modeling, performed by Hazen, utilizing data from 2012 through 2016 indicated that conversion of the current oxidation ditch configuration to an anaerobic-anoxic-oxic (A2O) configuration would provide adequate treatment capacity for the 25.2-mgd flow (peak month) while maintaining effluent quality to meet future nutrient limits.

Several reports regarding the SGRWRF Expansion Projected have been previously submitted to the Division of Water Quality. These reports include:

- St. George Regional Water Reclamation Facility Expansion Master Plan, Bowen Collins & Associates, Inc., August 2008.
- St. George Regional Water Reclamation Facility Pre-Design Report, Bowen Collins & Associates, Inc., June 2015.
- St. George Regional Water Reclamation Facility Optimization Study (Technical Memorandum No. 1 and No. 2), Bowen Collins & Associates, Inc., November 2015.
- St. George Regional Water Reclamation Facility 2020 Expansion Project Design Report, Bowen Collins & Associates, Inc. September 2019.

Many of the responses to the Level II Antidegradation Review are sections or data taken from these reports. The name of the report will be indicated, where data is used from previous report.

PART C – STATEMENT OF SOCIAL, ENVIRONMENTAL AND ECONOMIC IMPORTANCE

C1. Describe the social and economic benefits that would be realized through the proposed project, including the number and nature of jobs created and anticipated tax revenues.

The SGRWRF provides sewer service to St. George City, Washington City, Ivans City, and the City of Santa Clara. This area is one of the fastest growing areas in the United States. It is projected that these communities will continue to see high growth rates, including influx of industrial and commercial growth. Wastewater treatment capacity is an essential service that must be provided to allow this growth to take place.

See attached Supporting Document – C1 for future wastewater flow evaluations and growth projections.

C2. Describe any environmental benefits to be realized through implementation of the proposed project.

The proposed SGRWRF 2020 Expansion Project will ensure that the increased flows will be properly treated before being discharged to the Virgin River. See response to C1 for future flow projections.

C3. Describe and social or economic losses that may result from the project, including impacts to recreation and commercial development.

No social or economic losses due to the project have been identified, but quite the opposite. Without the proposed project, these communities may be forced to impose moratoriums of new sewer connections, effectively halting growth with the service area. The negative economic effects of such a moratorium would be significant and wide-spread.

C5. Please describe any structures or equipment associated with the project that will be placed within or adjacent to the receiving water.

The outfall for treated effluent (Outfall 001) terminates on the bank of the Virgin River.

PART D – PARAMETERS OF CONCERN

The Antidegradation Review process requires the identification of the parameters of concern (POCs). POCs are measured characteristics of the discharge that exceed, or potentially exceed ambient concentrations. The list of POCs is ultimately used in the ADR process to select the least degrading project alternative. The following documents were reviewed to identify the Parameters of Concern: existing UPDES Permit, DWQ Wasteload Analysis, and EPA Form 2A that was submitted as part of the permit renewal application.

Upon review of these documents the following POC were identified:

Parameters of Concern

No.	Pollutant	Ambient Concentration	Estimated Effluent Concentration	Comment
1	Biochemical Oxygen Demand		12.0 mg/l	See Note 1 below.
2	Total Suspended Solids		17.0 mg/l	See Note 1 below.
3	E-Coli		126 NO./100 mL	Existing UPDES Permit
4	Total Phosphorus		2.5 mg/l (until Jan 2025) 1.0 mg/l (after)	SGRWRF has received variance from TBPEL until Jan 1, 2025.
5	Dissolved Oxygen		5.5 mg/L	Existing UPDES Permit
6	Total Dissolved Solids		1937 mg/L	Existing UPDES Permit per 1996 Variance.
7	Ammonia Summer Fall Winter Spring		 1.9 mg/l 3.9 mg/l 6.9 mg/l 5.7 mg/l	See Note 1 below.
8	Temperature		27 Degrees Celsius	Waste Load Analysis
9	pH		6.5-9.0	Existing UPDES Permit

Note 1 – The estimated concentrations were calculated based upon maintaining current permitted loads to Virgin River increasing flows from 17.0 mgd to 25.2 mgd.

The following metals were evaluated and determined to not be considered Parameters of Concern.

Parameters of Not of Concern

No.	Parameter	Justification
1	Arsenic	Historical low concentrations in effluent.
2	Cadmium	Historical low concentrations in effluent.
3	Copper	Historical low concentrations in effluent.
4	Cyanide	Historical low concentrations in effluent.
5	Lead	Historical low concentrations in effluent.
6	Mercury	Historical low concentrations in effluent.
7	Molybdenum	Historical low concentrations in effluent.
8	Nickel	Historical low concentrations in effluent.
9	Selenium	Historical low concentrations in effluent.
10	Silver	Historical low concentrations in effluent.
11	Zinc	Historical low concentrations in effluent.

PART E – ALTERNATIVE ANALYSIS REQUIREMENTS OF A LEVEL II ANTIDEGRADATION REVIEW

The St. George Regional Water Reclamation Facility Expansion Master Plan completed an Alternative Analysis for the proposed expansion. The analysis evaluated the following treatment alternatives to meet current and future treatment requirements:

- Additional oxidation ditches
- Modified Staged Aeration
- Conventional Activated Sludge with Primary Clarifiers.
- Membrane Bioreactor Activated Sludge.

Each of these alternatives were evaluated based upon economic and non-economic criteria as required in Part E. The alternative evaluation was summarized in Chapter 2 of the 2008 St. George Regional Water Reclamation Facility Master Plan prepared by Bowen, Collins & Associates. Attachment E1 includes a copy of Chapter 2.

SUPPORTING DOCUMENT C1

FUTURE WASTEWATER FLOW EVALUATIONS AND GROWTH PROJECTS

The following section is from the 2019 St. George City Sewer Master Plan prepared by Bowen, Collins & Associates.

CHAPTER 3
WASTEWATER FLOW EVALUATION AND GROWTH PROJECTIONS

INTRODUCTION

A key aspect of the master planning process is developing projections of population growth within the City's service area. Population projections have a direct impact on important components of the master plan, including the projected timing of capital improvements. Over-estimating population growth projections may lead to poorly timed capital improvement projects for the City, which results in aggressive future rate and impact fee increases that may not actually be necessary. The opposite is true for under-estimating growth, which could leave the City without the necessary financial backing to carry out required capital improvements as well as not providing sufficient lead time for projects.

The purpose of this chapter is to develop growth projections for the City by analyzing historical growth trends as well as reviewing population projections developed by local planning authorities and other national and state planning agencies. Since the City of St. George provides sewer collection and treatment services to the Washington, Santa Clara, and Ivins, growth projections from each respective community has been incorporated into this study based on the information found in each communities respective Sewer Master Plan or Impact Fee Facilities Plan These projections, together with an analysis of existing wastewater production trends, have been used to project future wastewater production demand on the City's system.

HISTORICAL GROWTH TRENDS

The City of St. George has seen significant growth in the last few decades. Table 3-1 summarizes population growth for St. George from the year 1990 to 2010 based on data available from the United States Census Bureau.

Table 3-1
U.S. Census Bureau Historical Population Growth for St. George

Year	City of St. George Population	% Growth
1990	28,572	
2000	49,663	73.8%
2010	72,897	46.8%

As shown in Table 3-1, the City of St. George saw a significant boom in growth from 1990 to 2000, continuing on into the following decade. Using the information provided in Table 3-1, Table 3-2 shows the average yearly growth rate for St. George over each respective decade.

Table 3-2
Average Annual Growth Rate[1] in St. George from 1990 to 2010

Time Period	Average Annual Growth Rate[1]
1990-2000	5.7%
2000-2010	3.3%

[1] Represents the average annual growth rate based on U.S. Census records

While the data from the census provides a reliable, high-level overview of growth information for the City in historic 10-year increments, historic annual growth in the area can be monitored in more detail by looking at the increase in new service connections each year (determined by the City approving building permits). Multiplying the number of new service connections by the average household size in the City provides an estimate for population growth from year to year. The most recent U.S. Census Bureau estimate for average household size in St. George is 2.88 persons/household. To see how this compares to other communities near St. George, Table 3-3 provides a summary of average household size estimates for other cities in the Southern Utah/Southern Nevada area. As shown in the table, St. George is just below the average for household size in the region.

Table 3-3
Average Household Size Comparison

City	U.S. Census Estimate for Average Household Size
St. George, UT	**2.88**
Washington City, UT	2.99
Ivins City, UT	2.78
Hurricane, City, UT	2.9
Santa Clara City, UT	3.75
Cedar City, UT	3.0
Mesquite, NV	2.34
Average	**2.95**

Table 3-4 shown below shows the records of new building permits issued within the City from 2014 to 2018.

Table 3-4
Building Permits Issued in the City of St. George (2014 – 2017)

	2014	**2015**	**2016**	**2017**	**2018**
Single Family	576	741	790	944	942
Townhomes	110	46	46	102	274
Apartment/Duplex	2	2	1	15	11
Mobile Homes	1	3	1	1	6
Condos	12	0	1	35	20
Commerical/Industrial	119	109	25	117	201
Miscellaneous/Additions*	655	685	900	742	805
Hospital/Interior Finish	0	1	2	3	18
Institutes/Schools/Day Care	1	1	0	0	0
Public/Airport/Parks	12	6	16	1	3
Religious	0	3	1	1	2
Subtotal – All Permits	**1,488**	**1,597**	**1,783**	**1,961**	**2,282**
Residential	701	792	839	1,097	1,253
Non-Residential	132	120	44	122	224
Total, Excluding Home Add.	**833**	**912**	**883**	**1,219**	**1,477**

*Miscellaneous/Home Additions were not included in total number considering that they typically do not represent an increase in the population or water use.

Detailed water meter records from the City and data from the Washington County Recorder indicate that at the end of 2017 there were a total of 33,107 residential connections and 2,293 permanent non-residential connections (commercial, industrial, institutional, etc.). Using the U.S. Census Bureau estimate for household size in St. George, the estimated total residential population in St. George as of 2017 was:

$$33{,}107\ residential\ connection\ x\ 2.88\frac{persons}{household} = \mathbf{95{,}349\ residents}$$

Note that this estimate does include the transient population in the area (i.e. second homes, short term rental units, etc.), but for the purposes of sewer system master planning, all of these units will be treated as if they were a primary residence. It should be noted that, based on County Recorder records, St. George is home to over 6,500 secondary residences that may be occupied for only a portion of the year. However, when comparing water use between primary residences and secondary residences, meter data records indicate that secondary homes use only 10% less water over the course of the year than primary residences, which supports to approach of treating all connections as if they were primary residences.

Table 3-5 outlines the estimated growth rate for St. George from the 2014-2018.

Table 3-5
Summary of Recent Historical Growth in the City of St. George (2014 – 2017)

Year	2014	2015	2016	2017	2018
New Residential Connections	701	792	839	1097	1253
Total Residential Connections	30,379	31,171	32,010	33,107	34,360
Growth Rate		**2.6%**	**2.7%**	**3.4%**	**3.8%**
New Non-Residential Connections	132	120	44	122	224
Non-Residential Connections	2,037	2,157	2,201	2,323	2,547
Growth Rate		**5.89%**	**2.04%**	**5.54%**	**9.6%**

As shown in Table 3-5, the residential growth rate steadily increased over the past 5 years, with an estimated rate of 3.43% from 2016 – 2017 and 3.8% from 2017-2018, while non-residential growth fluctuated from year to year. Growth in St. George recently caught national attention as it was identified as the fastest growing metropolitan area in the country, in which the US Census estimated a 4% growth rate from 2016 – 2017 (which included not only St. George but also the majority of Washington County).

Considering that there are a number of large developments currently planned or under construction in the area, including the large master-planned South Block area, it is reasonable to assume that the City will continue to grow at a relatively aggressive rate into the foreseeable future. Through correspondence with City management, the City has elected to use the population projections developed for the Governor's Office of Management and Budget (GOMB), which match historical growth trends relatively well. Table 3-6 summarizes the growth projections from the GOMB for St. George. These projections form the basis of growth projections used in this report, with a minor modification that is discussed in the following section.

Table 3-6
GOMB Growth Projections for St. George City

Year	2010	2020	2030	2040	2050	2060
St. George Population	72,897	103,851	148,078	196,206	249,421	307,037
Average Annual Growth Rate		3.60%	3.61%	2.85%	2.43%	2.10%

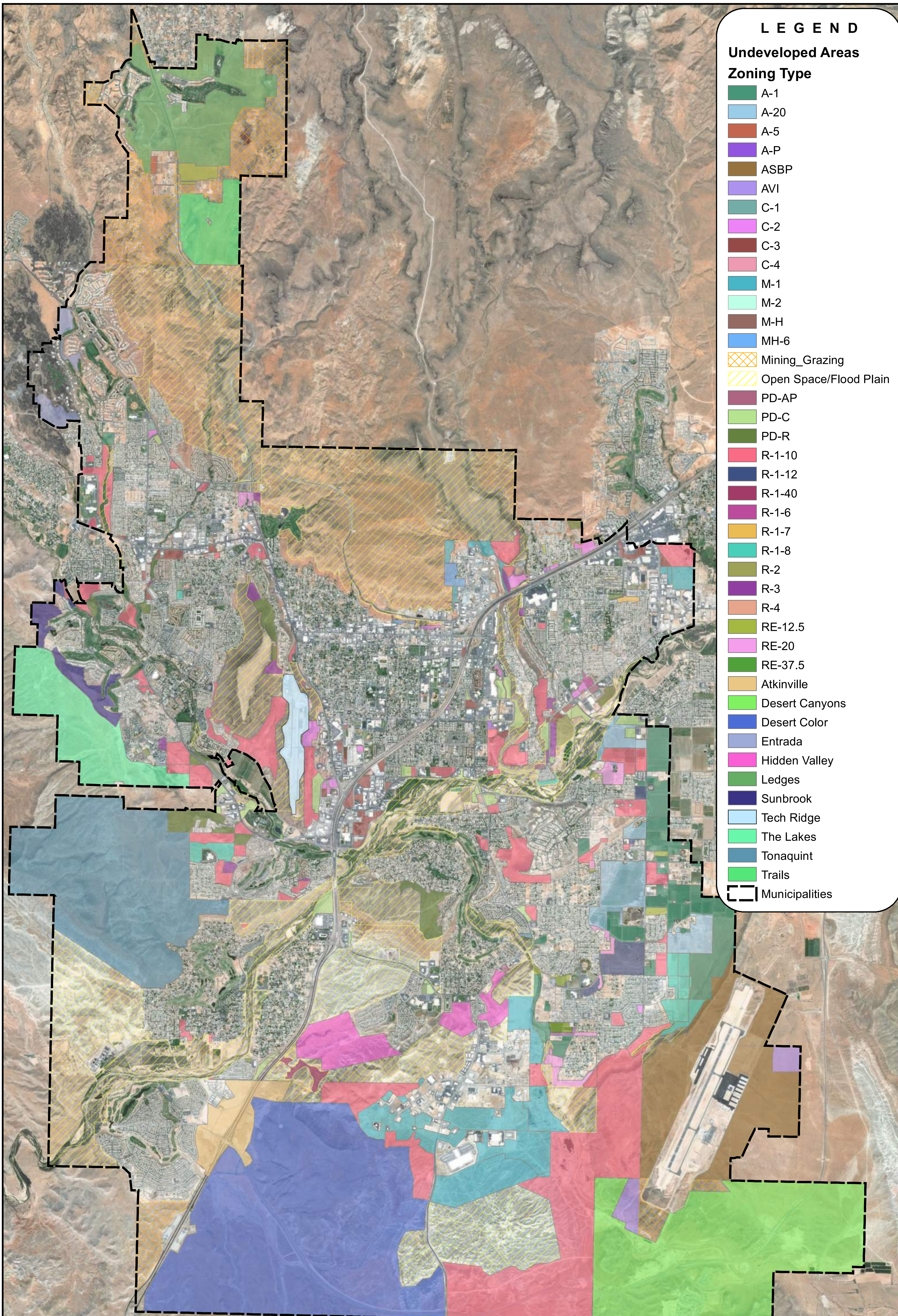
ESTIMATED BUILDOUT POPULATION

The build-out population (the population when all developable land in the City has been developed) of St. George has been estimated using the City's current land use and zoning plans. The land use and zoning plans identify the location and type of development that has been approved for specific areas throughout the City. The City's General Plan describes the difference between the zoning map and land use map:

The Zoning Map…and the Land Use Plan…work hand-in-hand with each other. The Land Use Plan indicates general density ranges and indicates how development is to be located on the land, with special regard to preserving special natural features. The Zones in the Zoning Map are legal designations that assign a specific overall density to a specific tract of land.

Through coordination with City management, the buildout population estimate for St. George was developed using portions of each plan. In some areas, the Land Use Plan provides a more accurate representation of future development density, while the Zoning Plan provides more detailed information in other areas. In this sense, buildout population estimates were developed using a "composite" land use/zoning plan. In addition to the general Land Use and Zoning plans, another component considered in this analysis are Planned Development Areas, or "PD"s, which are specific areas of the City that have an established and approved number of development units. PD's have been accounted for in the estimation of buildout population.

In order to estimate the service area population at full buildout for the City, the currently undeveloped areas of the City needed to be identified and separated from the currently developed areas. This was done using Geographic Information System (GIS) mapping tools to "clip out" areas of the City which are currently developed from the overall land use and zoning plan, leaving only the undeveloped areas with their associated land use and zoning type and respective area. This is illustrated in Figure 3-1 (colored areas are those have are yet to be developed or that represent permanent open space or other preservation areas. Using the result of this exercise, Table 3-7 provides a summary of the estimated service area population that will added when all undeveloped land in the City is developed.



BOWEN COLLINS & ASSOCIATES

ST. GEORGE CITY

SEWER MASTER PLAN

CURRENTLY UNDEVELOPED AREAS OF THE CITY

NORTH:

NORTH

SCALE:

0 2,500 5,000 Feet

FIGURE NO.

3-1

S:\St. George City\001-18-02 Culinary Water, Sewer, and Secondary Irrigation Master Plan\Sewer\4.0 GIS\4.4 Figures\Figure 3-1 - Undeveloped Areas of the City.mxd aanderson 5/24/2019

Table 3-7
Evaluation of Undeveloped Land by Land Use/Zoning Category

Zoning Code	Development Description	Area (Acres)	Density (Units Per Acre)	Number of Units	Estimated Added Residential Population[1]
A-1	Agricultural Use, Min. 40,000 SF	776.3	1.00	776.3	2,236
A-20	Agricultural Use, Min 20 Acres	408.4	0.05	20.4	59
A-5	Agricultural Use, Min 5 Acres	10.3	0.20	2.1	6
A-P	Administrative and Professional, No Min Area	4.0	5.00	19.8	
ASBP	Airport Supporting Business Park	1,118.4	2.00	2,236.7	
AVI	Airport Vicinity Industrial	134.1	1.00	134.1	
C-1	Commercial, No Min Area	5.7	2.00	11.5	
C-2	Commercial, No Min Area	99.4	2.50	248.5	
C-3	Commercial, No Min Area	161.3	3.00	483.9	
C-4	Commercial, No Min Area	0.0	3.50	0.2	
M-1	Manufacturing, No Min Area	1,025.9	0.50	513.0	
M-2	Manufacturing, Min 40,000 SF	0.1	7.50	0.7	
M-H	Mobile Home	2.3	6.00	13.8	40
MH-6	Mobile Home Min 6,000 SF	33.3	6.00	199.9	576
Mining_Grazing	Mining/Grazing, No Area Min	1,252.9	0.00	0.0	
OS	Open Space, No Min Area	9,824.6	0.00	0.0	
PD-AP	Planned Development - Admin & Professional Office	12.9	2.00	25.9	
PD-C	Planned Development - Comm	239.2	2.00	478.3	
PD-R	Planned Development - Res	341.9	4.00	1,367.5	3,938
R-1-10	Single Family Res. Min 10,000 SF	3,044.7	3.20	9,743.1	28,060
R-1-12	Single Family Res. Min 12,000 SF	130.7	2.80	366.1	1,054
R-1-40	Single Family Res. Min 40,000 SF	39.0	1.00	39.0	112
R-1-6	Single Family Res. Min 6,000 SF	7.0	7.00	49.0	141
R-1-7	Single Family Res. Min 7,000 SF	9.6	6.00	57.5	166
R-1-8	Single Family Res. Min 8,000 SF	216.0	3.70	799.0	2,301
R-2	Multi-Unit Res. Min 6,000 SF	32.9	7.00	230.0	663
R-3	Multi-Unit Res. Min 6,000 SF	97.5	13.00	1,267.3	3,650
R-4	Multi-Unit Res. Min 6,000 SF	0.0	20.00	0.0	0
RE-12.5	Residential Estate Min 12,500 SF	113.7	3.00	341.1	982
RE-20	Residential Estate Min 20,000 SF	132.3	2.00	264.5	762
	Vacant Lots Not in a Planned Development	NA	NA	758	2,183
	TOTAL	**19,275**		**20,447**	**46,929**
Atkinville	Planned Development	Not Applicable	varies	1,057	3,044
Desert Canyons	Planned Development	Not Applicable	varies	7,267	18,193
Desert Color	Planned Development	Not Applicable	varies	10,108	26,173
Entrada	Planned Development	Not Applicable	varies	324	933
Hidden Valley	Planned Development	Not Applicable	varies	400	1,152
Ledges	Planned Development	Not Applicable	varies	2,125	6,120
Stone Cliff	Planned Development	Not Applicable	varies	211	608
Sunbrook	Planned Development	Not Applicable	varies	593	1,708
Sun River	Planned Development	Not Applicable	varies	100	288
Tech Ridge (Old Airport)	Planned Development	Not Applicable	varies	3,500	6,912
The Lakes	Planned Development	Not Applicable	varies	3,196	9,204
Tonaquint	Planned Development	Not Applicable	varies	1,445	4,162
Trails	Planned Development	Not Applicable	varies	923	2,658
	TOTAL			**31,249**	**81,156**
	GRAND TOTAL			**51,696**	**128,085**

[1]Non-residential land use do not represent an increase is residential population. However, non-residential development does increase water use, which is accounted for using the ERU methodology.

As shown in Table 3-7, the remaining areas of the City to be developed are estimated to increase the City population by **128,085**, resulting in a total build-out population of:

$$95{,}349\ residents\ (existing) + 128{,}085\ (future) = \mathbf{223{,}434\ residents}$$

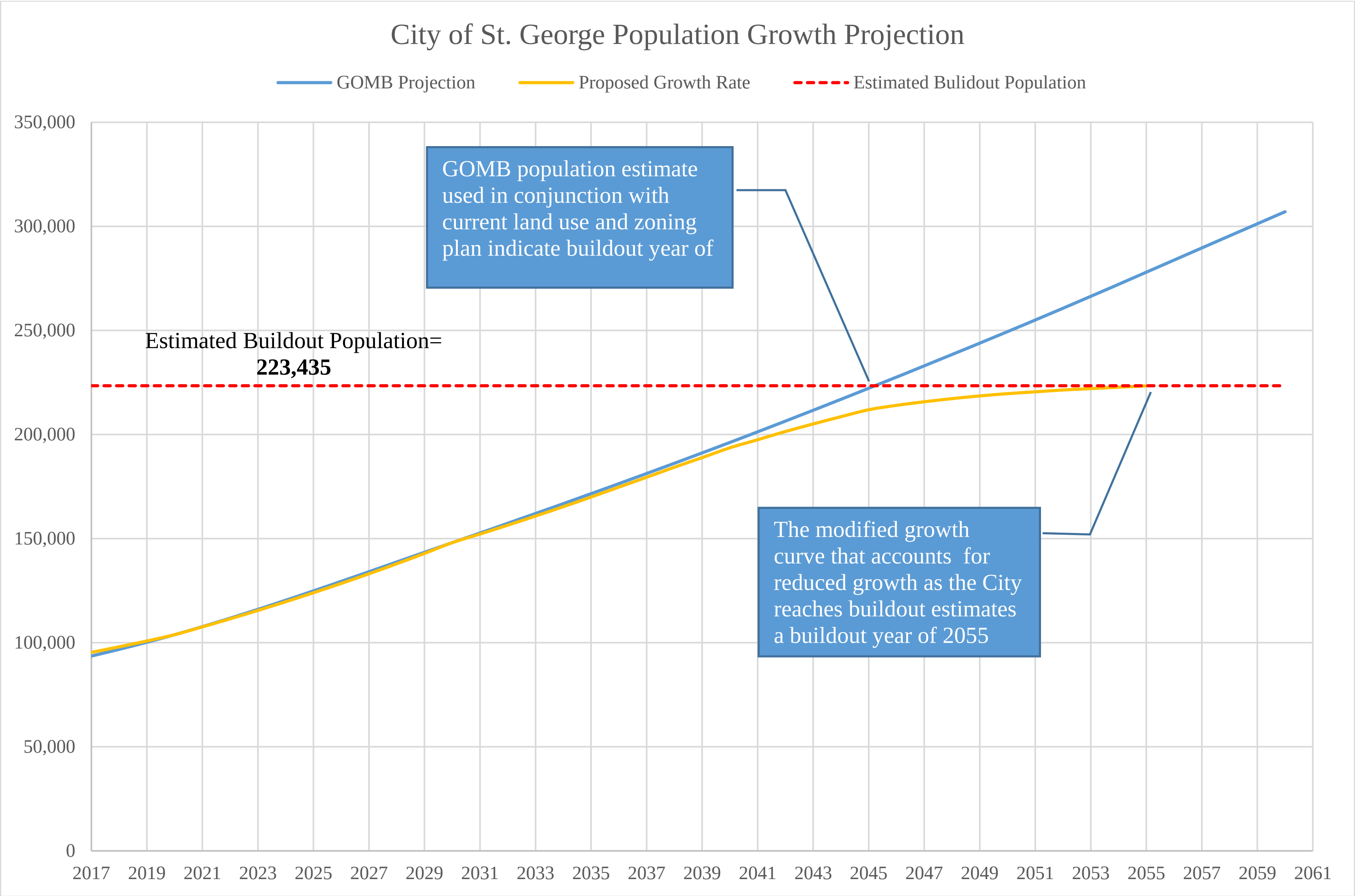
Using this build-out population estimate, Table 3-8 and Figure 3-2 provide the estimated population growth projection for the City. As previously mentioned, the City has elected to utilize the population projections development for the GOMB. Based on the GOMB growth estimates and the City's current land use plan, St. George would reach its full buildout capacity by approximately 2043. However, in reality, population growth tends to slow as it reaches its full carrying capacity (i.e. growth does not abruptly stop at full buildout; the growth rate will gradually slow as buildout is approached). This considered, Table 3-8 and Figure 3-2 display 2 growth curves for reference:

- **Governor's Office of Management and Budget**: This growth curve displays the actual growth projection developed for the GOMB. As shown, the full buildout population is reach by the year 2043. Based on the current land use evaluation for the City, it appears that the GOMB growth projections may over-estimate the total buildout population of the City, so some adjustment of the projection as it reaches the estimated buildout population is necessary.
- **Modified GOMB Project Adjusted after 2030 (Recommended for Planning):** This modified growth curve uses the growth projections developed for the GOMB through the year 2030 followed by a gradual decrease in the annual growth rate to produce a more realistic outlook through buildout. Using this approach, it is estimated that the City will reach buildout by the year 2055. It should be emphasized that buildout estimates are just that – an estimate. Changes in land use and zoning plans, City annexations, etc. will all influence how large the City will actually become. For this reason, master plans should be updated frequently enough to keep up with revised development plans in the City.

Table 3-8
St. George Population Growth Estimate

Year	Population	Notes
2017	95,349	
2018	**98,028**	**Existing Population**
2019	100,822	
2020	103,851	
2021	107,600	
2022	111,484	
2023	115,509	
2024	119,679	
2025	123,999	
2026	128,475	
2027	133,113	
2028	**137,919**	**10-Year Growth Projection**
2029	142,898	
2030	148,056	
2031	152,202	
2032	156,463	
2033	160,844	
2034	165,348	
2035	169,978	
2036	174,737	
2037	179,455	
2038	184,300	
2039	188,908	
2040	193,631	
2041	197,503	
2042	201,453	
2043	205,079	
2044	208,566	
2045	**211,903**	**GOMB Projection - Estimated Buildout Year**
2046	214,022	
2047	215,734	
2048	217,244	
2049	218,548	
2050	219,640	
2051	220,519	
2052	221,401	
2053	222,065	
2054	222,731	
2055	**223,435**	**Modified GOMB Projection - Estimated Buildout Year**

Figure 3-2
Population Growth Projections for the City of St. George



EVALUATION OF HISTORICAL WATER USE IN THE CITY

Utah Administrative Code R317-3 titled "Design Requirements for Wastewater Collection, Treatment and Disposal Systems" provides guidelines for estimating per capital wastewater production for the purpose of sizing sewer collection and treatment systems. The codes states that, "*New sewer systems shall be designed on the basis of an annual average daily rate of flow of 100 gallons per capita per day* ***unless there are data to indicate otherwise***. *The per capita rate of flow includes an allowance for infiltration/inflow".*

The design guidelines presented in the code are typically conservative when compared to actual sewer flows in a collection system. For this reason, sewer flows specific to the City of St. George have been developed and used in this master plan study. As previously mentioned, per capita sewer flows from other communities will be incorporated into this study based on their current sewer master plans.

Sewer flows are the combination of three components:

- Domestic flow
- Infiltration
- Inflow

The following sections of this chapter outline how each of these flow components have been accounted for in this study.

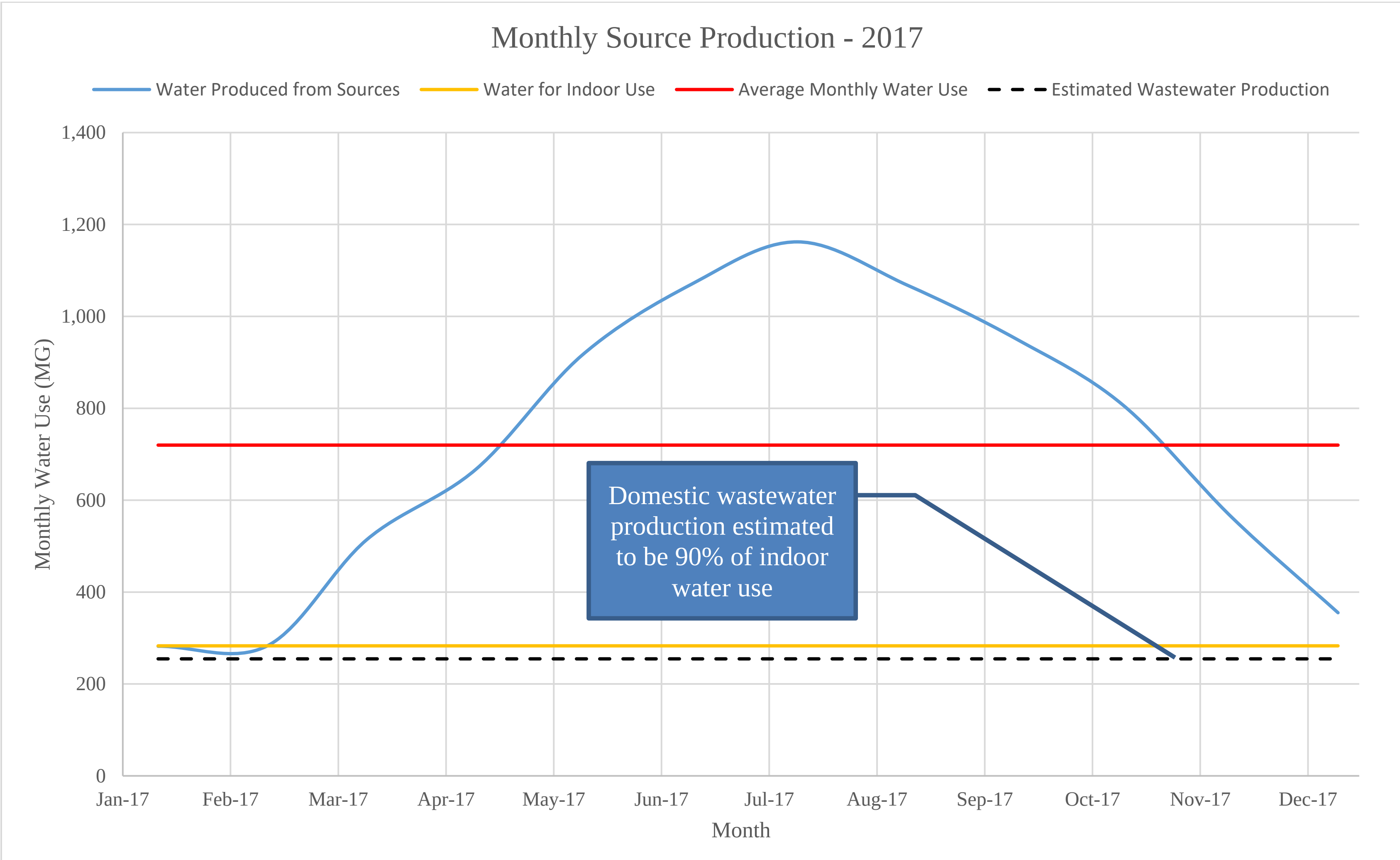
Domestic Wastewater Flow

Domestic wastewater is categorized as flow that intentionally enters the collection system from a home, business, or other connection. Ideally, domestic wastewater should make up the majority of flow in the sewer collection system. Wastewater flow from individual homes is not metered, but it can be estimated as a percentage of the metered culinary water use during winter months when outdoor irrigation is not occurring. As part of the St. George Water Master Plan, a detailed metered water use evaluation was carried out (see Chapter 3 in St. George Water Master Plan). Based on this evaluation, it was determined that average daily water use per residential connection (indoor and outdoor use) in St. George is **493 gallons/day (gpd)**.

Since this estimate is an average daily water use over the course of the year, 493 gpd includes both indoor and outdoor water use. In order to determine to amount of water which contributes to flow in the wastewater collection and treatment system, only the indoor component of water use should be considered (i.e water used for irrigation does not end up, at least directly, in the sewer collection system). Water use records indicate that over the course of the year, approximately 51% of water is used outdoors and 49% of water is used indoors. This concept is illustrated in Figure 3-3. The figure displays the monthly water produced (in million gallons) from sources that service St. George in the year 2017. The figure displays the following:

- Monthly water produced for the system (indoor and outdoor water use)

Figure 3-3
Monthly Source Production Data for 2017



- Average monthly water produced for system (indoor and outdoor water use)
- Estimated indoor water used in system
- Estimated water contributing to sewer flows

As indicated in the figure, it has been estimated that approximately 90% of water used indoors end up in the sewer collection system. Under these assumptions, average annual wastewater production per residential connection is:

$$Average\ Daily\ Indoor\ Water\ Use\ (Res. Connection) = 493\ gpd\ x\ 0.49 = \mathbf{242\ gpd}$$

$$Average\ Daily\ Domestic\ Flow\ per\ Connection\ (Res.) = 242\ gpd\ x\ 0.9 = \mathbf{217\ gpd}$$

As shown above, it is estimated that the average daily domestic wastewater flow per residential connection is 217 gpd. In wastewater planning, it is typical to project sewer flow in terms of "peak month, average day" demand, which is the average daily demand during the peak flow month of the year. Through an evaluation of the City's flow data at the SGWRF, it is estimated that peak month, average day flow is 3% higher than average daily flow. This considered, the estimated peak month, average day flow per ERU is:

$$Peak\ Month, Average\ Day\ Flow\ per\ Res. Connection = 217\ gpd\ x\ 1.03 = \mathbf{224\ gpd}$$

Infiltration

Beyond domestic wastewater production, the second component of wastewater flow that must be considered is infiltration. Infiltration is defined as water that enters into the sewer system which is not directly or indirectly related to either domestic wastewater or to a specific storm event. This flow can enter as a result of open pipe joints, cracks in pipes, pipes poorly connected at manholes, leaky lateral connections, root damage, etc. Infiltration is generally a function of the groundwater level, which typically fluctuates depending on the climate and season. While infiltration rates may change seasonally, they generally remain constant during a single 24-hour period. Temporary increases in the amount of water that enters the system after a storm because of an increase in ground water will be considered as inflow (as discussed in a subsequent section).

Factors that can affect infiltration include pipe age, material, and the number and condition of lateral connections. Age can contribute to infiltration in two ways. First, older pipes are more likely to be in poor condition. Cracks, separated joints, and other defects can contribute significantly to increased infiltration. Second, older pipes do not have the benefit of improvements in construction techniques that have occurred over time. Gasketed pipe joints, rubber boots at manholes and laterals, and other improvements have contributed greatly to reducing system infiltration.

Due to the many factors that influence infiltration rates, it can be a difficult aspect of sewer flow to accurately quantify. Temporary flow monitoring at various locations in the system can help identify areas of excessive groundwater infiltration. For planning purposes, infiltration in the ACSSD system was estimated using the ASCE recommended daily infiltration allowance for new sewer systems of 400 gallons per inch diameter of pipe per mile of pipe. From previous planning experience, this equates to approximately 10% - 20% of domestic wastewater flows. For this study, it has been estimated that infiltration is equal to approximately 10% of domestic flow per residential connection, which equates to 23 gpd per connection. Therefore, the combined sewer flow (domestic & infiltration) per residential connection is estimated to be:

$$Total\ Flow\ per\ Residential\ Connection = 224\ gpd + 23\ gpd = \mathbf{247\ gallons\ per\ day}$$

Inflow

The third and final component of wastewater flow that must be considered for wastewater master planning is inflow. Inflow is defined as any water that enters the sewer system which is directly or indirectly related to a storm event. It can come directly from storm water runoff through improper connections to the storm water system, missing or leaky manhole covers, roof drains connected to the system, etc. Storm events can also cause the ground water level to raise temporarily, which can cause an increase in flow in the sewer system through the same mechanisms that result in groundwater infiltration during dry weather (cracked pipes, leaky laterals, etc.). Any temporary increase in sewer flow due to raising levels of ground water as a result of rain is considered inflow. Without a significant amount of rainfall and sewer flow monitoring data, it is difficult to accurately identify the quantity and location of inflow in the system. For this reason, inflow has not been directly included in wastewater projections. Instead, a conservative amount of capacity will be reserved in collection pipes to account for inflow events. This is discussed in further detail in Chapter 4.

DETERMINING TOTAL SERVICE AREA ERUS

Total wastewater production is a combination of flows from not only residential connections, but includes flow from commercial, industrial, and institutional connections as well. These different sewer service connections often possess unique characteristics, such as total volume of flow, patterns of flow, and strength of wastewater. For planning purposes, these different components of the system are converted to one common unit of measurement: the Equivalent Residential Unit, or ERU. Using the ERU as a unit of measurement in planning allows for the standardization of different types of connections (i.e. converting commercial or institutional connections into an equivalent residential unit). This method simplifies the planning process and provides a means of converting a non-residential population into an equivalent residential population.

The total number of sewer ERUs for the sewer collection and treatment service area are shown in Table 3-9. The ERU count for St. George is based upon the meter evaluation found in Chapter 3 of the St. George Water Master Plan. The following should be noted about the development of sewer system ERUs in St. George:

- Non-residential sewer ERUs have been adjusted to reflect a 75% non-consumptive water use rather than the 90% non-consumptive use assumed for residential connections.
- Meter categories that do not contribute to sewer flows have been excluded from the total ERU count. This includes the following categories:
    - Construction Water – construction water is used for watering roads, washing equipment, and other activities that do not directly contribute to sewer flows.

- Government – Per discussion with City personnel, this category is primarily irrigation for golf courses and parks. While a small portion of water use may contribute to wastewater flows, such as park bathrooms, the vast majority of water used from category is for irrigation and therefore does not directly enter the sewer collection system.

Sewer ERUs for Washington, Ivins, and Santa Clara have been pulled from each City's respective sewer master plan.

Table 3-9
Total ERUs on St. George Sewer Service Area (Baseline 2017)

City	ERUs
St. George	40,827
Washington	8,979
Ivins	3,717
Santa Clara	2,054
Total	**55,577**

PROJECTED WASTEWATER FLOWS

Table 3-10 provides a summary of wastewater flow projections (domestic flow and infiltration) for the sewer service area through buildout. ERU projections in the table are based upon the individual growth projections and buildout years for each respective City in the service area. It should be noted that the total peak month, average day sewer flow shown in the table is higher than the recorded flows at the SGWRF. Indoor water use estimates as well as temporary sewer monitoring efforts carried out by the City provide compelling evidence that the recorded flows at the plant are lower than they actually are. While the exact source of this error is not known exactly, it could be attributed in part to the following:

- The flow measurement apparatus at the treatment plant may be inaccurate.
- There may be exfiltration in certain areas of the collection system where wastewater is leaking out of pipes.

Whatever the cause may be, it was decided to use the more conservative total flow estimate for planning. As part of the ongoing upgrades at the SGWRF, the City will be installing new metering equipment that will provide a more accurate read on flows entering the plant.

Table 3-10
Wastewater Flow Projections for St. George Service Area[1]

Year	St George ERUs	Washington ERUs	Ivins ERUs	Santa Clara ERUs	Total Sewer ERUs	Peak Month, Average Day Flow (MGD, Domestic & Infiltration)
2017	40,827	8,979	3,717	2,054	55,577	**13.73**
2018	41,974	9,428	3,979	2,156	57,537	**14.21**
2019	43,170	9,899	4,138	2,264	59,471	**14.69**
2020	44,466	10,394	4,241	2,377	61,478	**15.19**
2021	46,071	10,914	4,411	2,496	63,891	**15.78**
2022	47,734	11,459	4,587	2,621	66,401	**16.40**
2023	49,457	12,032	4,771	2,752	69,012	**17.05**
2024	51,242	12,634	4,961	2,890	71,727	**17.72**
2025	53,092	13,266	5,160	3,034	74,552	**18.41**
2026	55,009	13,929	5,197	3,186	77,320	**19.10**
2027	56,995	14,625	5,405	3,345	80,371	**19.85**
2028	59,052	15,357	5,567	3,512	83,488	**20.62**
2029	61,184	16,124	5,734	3,688	86,731	**21.42**
2030	63,393	16,931	5,835	3,872	90,031	**22.24**
2031	65,192	17,777	6,010	4,066	93,045	**22.98**
2032	67,042	18,666	6,190	4,269	96,168	**23.75**
2033	68,945	19,599	6,376	4,483	99,403	**24.55**
2034	70,901	20,579	6,567	4,707	102,755	**25.38**
2035	72,913	21,608	6,764	4,942	106,228	**26.24**
2036	74,983	22,689	6,995	**5,189**[1]	109,856	**27.13**
2037	77,051	23,823	7,205	5,189	113,268	**27.98**
2038	79,175	25,014	7,421	5,189	116,799	**28.85**
2039	81,230	26,265	7,644	5,189	120,328	**29.72**
2040	83,340	27,578	7,768	5,189	123,875	**30.60**
2041	85,167	28,957	8,001	5,189	127,314	**31.45**
2042	87,037	30,405	8,241	5,189	130,872	**32.33**
2043	88,808	31,925	8,488	5,189	134,411	**33.20**
2044	90,546	33,521	8,743	5,189	138,000	**34.09**
2045	92,249	35,197	9,005	5,189	141,641	**34.99**
2046	93,546	36,957	**9,477**[1]	5,189	145,169	**35.86**
2047	94,717	38,805	9,477	5,189	148,188	**36.60**
2048	95,835	40,745	9,477	5,189	151,247	**37.36**
2049	96,900	42,783	9,477	5,189	154,349	**38.12**
2050	97,910	44,922	9,477	5,189	157,498	**38.90**
2051	98,864	47,168	9,477	5,189	160,699	**39.69**
2052	99,840	49,526	9,477	5,189	164,033	**40.52**
2053	100,759	52,003	9,477	5,189	167,428	**41.35**
2054	101,701	54,603	9,477	5,189	170,970	**42.23**
2055	**102,797**[1]	56,787	9,477	5,189	174,250	**43.04**
2056	102,797	59,058	9,477	5,189	176,522	**43.60**
2057	102,797	61,421	9,477	5,189	178,884	**44.18**
2058	102,797	63,878	9,477	5,189	181,341	**44.79**
2059	102,797	66,433	9,477	5,189	183,896	**45.42**
2060	102,797	**68,916**[1]	9,477	5,189	186,379	**46.04**

[1] Bold text indicates the estimated buildout year for each city.

LOCATION OF GROWTH OVER 10 YEAR PLANNING WINDOW

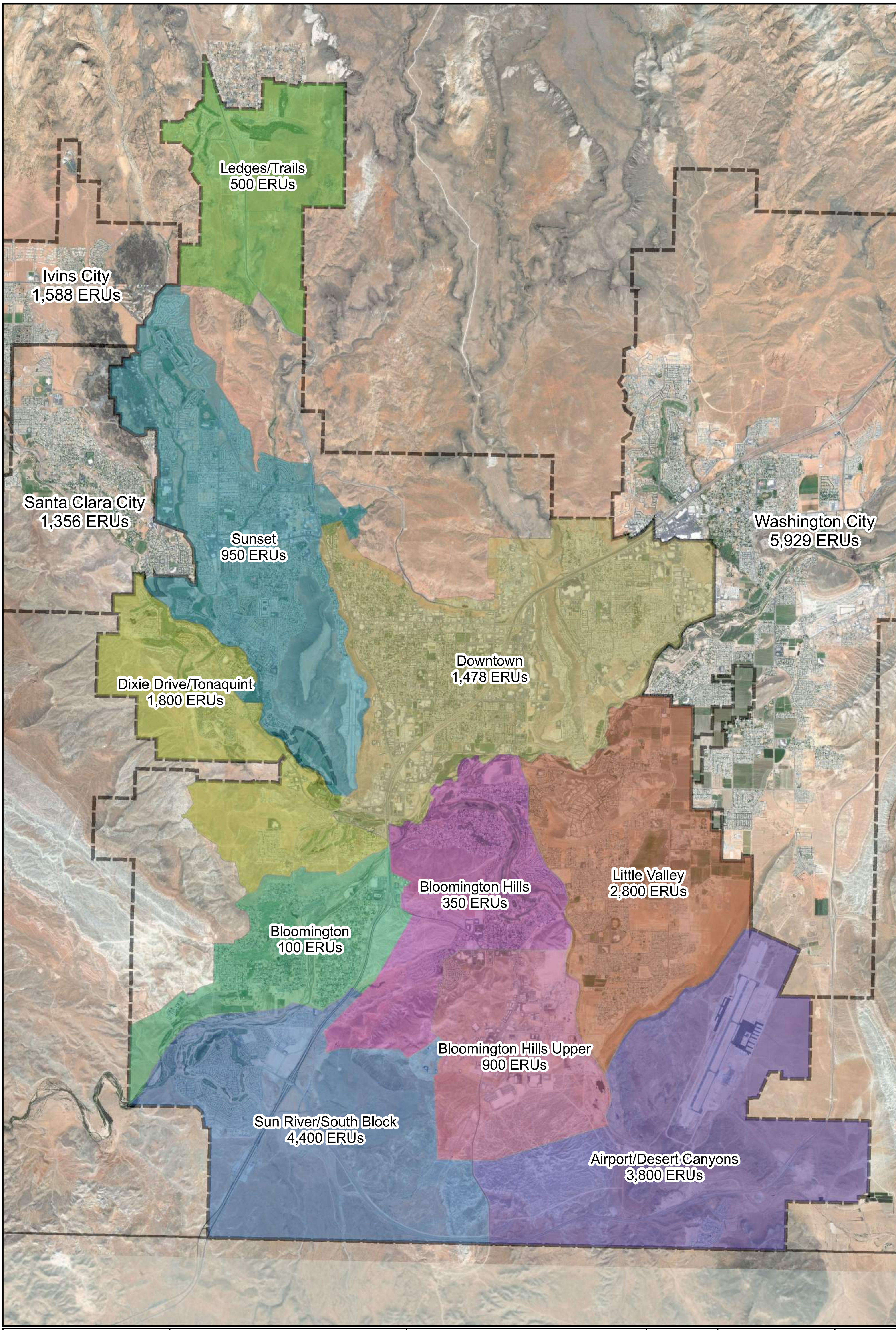
To the extent possible, it is helpful in planning to understand the timing and location of growth within the service area, particularly within the 10-year growth window. While it is impossible to predict the exact location and timing of all growth which will occur in the City, reasonable estimates can be made by evaluating recent growth trends and identifying “hotspots” in the system (areas experiencing development). Through discussions with City staff, hotspots within the City service area have been identified and growth has been divided between different regions. The estimated distribution of growth for St. George is shown in Table 3-11. Distribution of growth for Washington, Ivins, and Santa Clara was estimated using engineering and planning judgment. The regions shown in Table 3-11 are represented in Figure 3-4.

Table 3-11
Estimated Distribution of Growth over 10-Year Planning Window

Region	10 Year Growth in ERUs	% of 10 Year Growth
Ledges/Trails	500	2%
Sunset	950	4%
Dixie Drive/Tonaquint	1,800	7%
Downtown	1,478	6%
Bloomington	100	<1%
Bloomington Hills	350	1%
Little Valley	2,800	11%
Bloomington Hills Upper	900	3%
Sun River/South Block	4,400	17%
Airport/Desert Canyons	3,800	15%
Washington City	5,929	23%
Ivins City	1,588	6%
Santa Clara City	1,356	5%
Total	**25,951**	

STATE OF UTAH WATER CONSERVATION GOAL

The State of Utah set a water conservation goal in the year 2000 to reduce per capita water usage by 25% by the year 2025, measured from usage in the year 2000. Because water conservation is typically achieved primarily through the reduction of outdoor water use, no further reduction in sewer flows due to conservation was assumed for the planning window of this study. It is recommended that the City continue to track city-wide water usage and adjust projections accordingly in future master plans to account for any changes in per capita water use patterns.



BOWEN COLLINS & ASSOCIATES	CITY OF ST. GEORGE SEWER MASTER PLAN	ESTIMATED 10-YEAR GROWTH DISTRIBUTION	NORTH:	SCALE: 0 2,750 5,500 Feet	FIGURE NO. 3-4

S:\St. George City\001-18-02 Culinary Water, Sewer, and Secondary Irrigation Master Plan\Sewer\4.0 GIS\4.4 Figures\Figure 3-4 - 10 Year Growth Areas.mxd aanderson 8/6/2019

SUPPORTING DOCUMENT E1

ALTERNATIVE ANALYSIS

The following section is from the 2008 St. George Regional Water Reclamation Facility Master Plan prepared by Bowen, Collins & Associates.

CHAPTER 2
LIQUID TREATMENT PROCESS ALTERNATIVES

INTRODUCTION

Currently the SGRWRF uses the extended aeration activated sludge process to treat the wastewater. This process requires the use of large basins and aeration equipment to produce relatively long hydraulic and solids retention times. As described below, this is a stable and reliable process which has functioned effectively over the past 18 years. Expanding liquid treatment capacity will impact related downstream processes such as final clarification and ultraviolet disinfection. These processes are not discussed in depth because it is anticipated that the expansion would require the addition of modules similar to those already in place. Modifications, should there be any, can easily be implemented in the design process. The cost of expanding these processes was accounted for in the cost estimate of the expansion.

ALTERNATIVES

Four alternative processes were selected for evaluation. They include the following:

- Oxidation Ditch. Extended aeration activated sludge process currently employed at the SGRWRF, Timpanogos Special Service District near American Fork, Ashley Valley in Vernal, and numerous other plants in Utah.
- Modified Staged Aeration Activated Sludge. Currently being implemented in Henderson Water Reclamation Facility, Henderson, Nevada, and at the South Valley Water Reclamation Facility in West Jordan.
- Conventional Activated Sludge with Primary Clarifiers (CAS). Currently used at Central Valley Water Reclamation Facility, West Valley City.
- Membrane Bioreactor Activated Sludge. Typically used for smaller plants or where higher effluent quality is required. Plants in Hyrum, Oakley, Jordanelle Special Service District (JSSD) near Kamas, and South Valley Sewer District (SVSD) in Riverton are either operating, under construction, or being designed using this process.

These processes were selected to represent a spectrum of treatment technologies available for the City's plant that are widely used and accepted both in Utah and elsewhere. These processes are known to provide reliable and flexible treatment performance and operations. Each alternative offers differing construction and operating cost requirements to consider. Effluent quality and solids production will vary, although all are expected to meet required performance standards. Finally, each process offers other advantages and disadvantages that must be factored into the selection.

ELEMENTS COMMON TO ALL ALTERNATIVES

Each of the alternatives has a number of basic process and non-process elements that are shared in common with all the other processes, and which are similar or identical from process to process. These elements are listed as follows:

- Headworks
- Influent Pump Station (For the CAS process, this pump station is relocated downstream of the primary clarifiers and called the Primary Effluent Pump Station).
- RAS/WAS Pump Station (Internal to membrane bioreactor process; not a separate structure).
- Ultraviolet (UV) Disinfection Facility
- Post Aeration Basin
- Utility Water Pump Station
- River Outfall
- Solids Dewatering Facility (CAS process dewaters digested combined primary and waste activated sludge. All others dewater waste activated sludge).
- Solids Transport Equipment
- Administration Building
- Maintenance Building
- Chemical Building

The following processes are common to at least three of the processes.

- Secondary Clarifiers (Not required by membrane bioreactor).
- Aerated Sludge Holding Basins (Not used with CAS process).

OXIDATION DITCH PROCESS

The oxidation ditch process was developed in Holland many years ago, and has found wide application in the U.S. over the past 25 years, principally in the form of the "Carrousel" configuration licensed by Door Oliver Eimco. Oxidation ditches use the extended aeration activated sludge process that includes longer hydraulic and solids residence times, with microorganisms that live in the endogenous respiration growth phase. (Typical hydraulic residence times range from 12 to 24 hours, and solids retention time (SRT) from 18 to 30 days.) This is a stable growth phase, and when combined with the long residence times, creates a stable and flexible process that adapts well to changing environmental conditions and wastewater characteristics, and is less easily upset by rapid changes or introduction of toxic and/or highly degradable compounds.

The "Carrousel' configuration uses one or more slow speed vertical turbine aerators providing both mixing and aeration to furnish dissolved oxygen to sustain the microorganism population, plus keep the mixed liquor contents well suspended and transported throughout the basin.

The SGRWRF plant and many others in Utah and throughout the U. S. rely on this proven process. Other oxidation ditch aeration technologies such as horizontal brush aerators are also used, such as in the Timpanogos Special Service District (TSSD) plant in American Fork. However, these are less common in Utah than the vertical aerators.

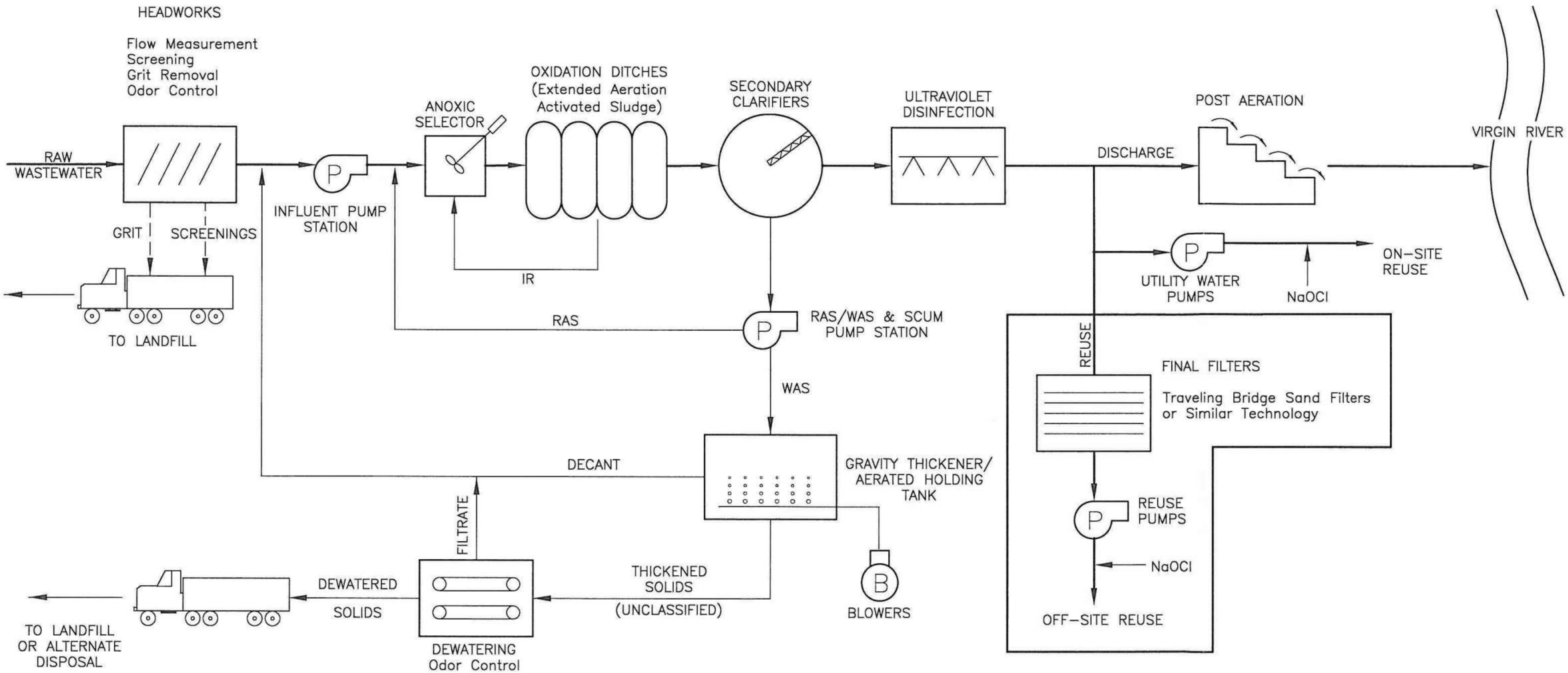
Due to greater SRTs, the extended aeration process provides sufficient residence time for nitrifying microorganisms to develop. These organisms break down ammonia nitrogen (nitrification) in the wastewater and remove it to sufficiently low levels to meet standards for discharge to the Virgin River. Thus, processes for additional nitrogen removal are generally unnecessary. Such a process is an anoxic basin preceding the oxidation ditches where highly nitrified mixed liquor and RAS are mixed with the incoming wastewater so that microorganisms can grow that use the oxygen from the nitrified mixed liquor and release nitrogen to the atmosphere.

However, this type of "pre-anoxic" basin also has the effect of "selecting" the organisms that the low dissolved oxygen environment favors, and limits growth of other organisms that require dissolved oxygen for their metabolism. The favored organisms can thrive on both nitrate oxygen as well as dissolved oxygen. These "facultative" organisms settle more readily than the obligate aerobic organisms, and this phenomenon results in improved secondary clarifier performance and/or higher clarifier capacities.

Currently, the SGRWRF employs a single pre-anoxic selector basin through which all flow into the bio-reactors passes. Additionally, oxidation ditches three and four have individual anoxic selector basins. According to SGRWRF staff, these basins do experience higher levels of nitrification/denitrification when compared to oxidation ditches one and two which do not have individual anoxic selector basins.

Figure 2-1 is a flow diagram for the oxidation ditch process that shows all the proposed major process elements discussed above. For graphical purposes the anoxic selector basin is shown separately from the oxidation ditches. But in reality, the processes are both contained within a single structure with multiple basins. No internal recycle pump is indicated because recycle is controlled by diverting a portion of the mixed liquor in the oxidation ditch into the selector basin via gates and gravity flow.

Table 2-1 contains a summary of advantages and disadvantages for the oxidation ditch process. Some of the basic design criteria for preliminary sizing and cost estimates for the oxidation ditch process are shown in Table 2-2.



ASSOCIATED FACILITIES (NOT SHOWN)

Administration Building
Maintenance Building
Blower Building

IR = INTERNAL RECYCLE
RAS = RETURN ACTIVATED SLUDGE
WAS = WASTE ACTIVATED SLUDGE
NaOCl = SODIUM HYPOCHLORITE

BOWEN COLLINS & Associates, Inc. Consulting Engineers

Figure 2–1
OXIDATION DITCH PROCESS FLOW DIAGRAM
SGRWRF EXPANSION MASTER PLAN

Table 2-1

Oxidation Ditch Process Advantages and Disadvantages

Advantages	Disadvantages
Widely accepted in Utah	Requires more ground area due to larger tankage
Stable (not easily upset)	Higher construction cost due to larger tankage
Simple to operate	Higher operating cost to aerate/mix larger tank volumes
Excellent effluent quality	Vertical aerators may emit higher noise levels
Inherent nitrification capability for ammonia removal	Unclassified residual solids may required further offsite treatment prior to disposal or reuse
Low odors	
Primary clarifiers not used which reduces construction cost and odors	

Table 2-2

Oxidation Ditch Process Design Criteria

Criteria	Value
Solids Retention Time (SRT)	18 days
Hydraulic Residence Time (HRT)	20 hours
Mixed Liquor Suspended Solids (MLSS)	3500 mg/L
Anoxic Selector HRT	1 hour
Aerated Solids Holding Basin HRT/SRT	3 days
Secondary Clarifier Surface Overflow Rate (SOR)	600 gal/sf/day
Secondary Clarifier Solids Loading Rate	20 lbs/sf/day

STAGED AERATION PROCESS

Staged aeration is a more conventional (not extended aeration) activated sludge process as the organisms are generally kept in the log growth and stable growth phases through use of lower SRTs compared to oxidation ditches. Hydraulic residence times are also shorter. Typical hydraulic residence times range from 8 to 12 hours, and SRTs from 8 to 16 days when nitrification is required. Longer SRTs are required to grow and sustain nitrifying organisms, similar to the oxidation ditches. While this feature is not particularly "inherent" to staged aeration, selection of the appropriate SRT will ensure that the nitrifying capability for reduction of ammonia concentrations and loads is provided.

The aeration intensity is "staged", that is more oxygen is provided in the earlier stages of the process when more food is available to the organisms and the oxygen demand is higher, and less oxygen is provided in later stages where less food is available. This is somewhat similar to the older "step" or "tapered" aeration approaches, except that staged aeration attempts to create several larger zones of more uniform aeration and mixing within each zone, with these intensities decreasing zone by zone through the process.

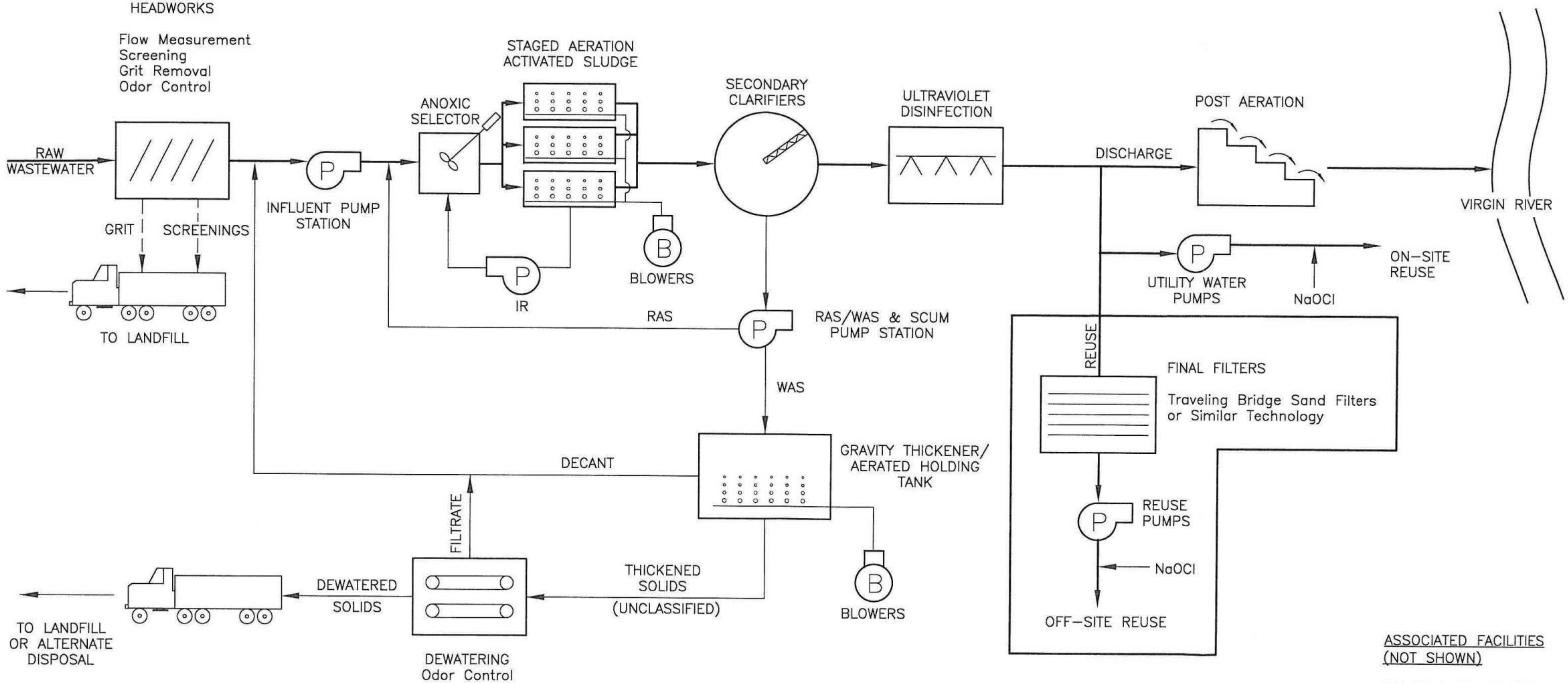
In the past, conventional activated sludge processes were considered more difficult to operate than oxidation ditches or other extended aeration or fixed film processes. Operators were often required to monitor the incoming wastewater and the process more closely and make more frequent adjustments in order to maintain the viability and performance of the process, avoid upsets, and deal with changes in influent characteristics. Sometimes upsets occurred and performance deteriorated despite the operators best efforts.

However, with the addition of anoxic selectors (as described above for the oxidation ditch alternative), it has been discovered by preferentially selecting the facultative organisms, that conventional activated sludge processes are more stable and easier to operate. Thus, little process performance and/or flexibility is sacrificed by using a staged aeration process as compared to oxidation ditches when anoxic selectors are employed. Anoxic selectors also provide the same improved settleability benefit and increased secondary clarifier performance for the staged aeration process as for other processes.

Figure 2-2 is a flow diagram for the staged aeration process and shows all the major process elements. This diagram is almost identical to the oxidation ditch diagram with the following exceptions. External blowers and submerged fine bubble diffusers are used to achieve staging of the aeration and mixing intensity instead of vertical turbines. The submerged fine bubble diffusers also provide more efficient oxygen transfer. Finally, the aerated solids holding tank is larger in order for it to provide additional solids stabilization time, and effectively increase the SRT to a level similar to the oxidation ditch. In this way, solids from the staged aeration process should have similar stability and be able to be disposed of the same way as the oxidation ditch process.

Primary clarifiers, anaerobic digesters and related solids treatment and handling facilities may or may not be employed with a staged aeration process. Use of primary clarifiers and associated processes and equipment has the advantage of reducing the BOD load on the staged aeration process so that its size and cost can be reduced, although not proportionately to the additional cost of the clarifiers and digesters.

The larger advantage of the anaerobic digesters is the ability to generate methane gas that can be used to power equipment at the plant and reduce electrical power costs which are a major component of the overall operating costs. The other significant advantage is that the anaerobic digestion process generates Class B solids that are more readily dewater-able, and also qualify for certain types of reuse such as restricted land application that non-digested solids can not be used for.



IR = INTERNAL RECYCLE
RAS = RETURN ACTIVATED SLUDGE
WAS = WASTE ACTIVATED SLUDGE
NaOCl = SODIUM HYPOCHLORITE

ASSOCIATED FACILITIES (NOT SHOWN)

Administration Building
Maintenance Building
Blower Building

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Figure 2–2
STAGED AERATION PROCESS FLOW DIAGRAM
SGRWRF EXPANSION MASTER PLAN

The overall construction cost including primary clarifiers and anaerobic digesters is higher than without them. But of greater concern is the potential for odors associated with primary clarifiers and anaerobic processing of primary solids. The clarifiers can be covered and ventilated, and the gasses scrubbed prior to exhausting to the atmosphere. The same can be done for the dewatering facility. The digesters themselves are generally sealed, but odors tend to escape. Digesters also require occasional cleaning, and the contents emptied out, thus creating another avenue for odor escape.

Because of odor concerns and projected higher construction costs, it was decided not to include primary clarifiers and related solids treatment and handling facilities with the staged aeration process. This keeps the staged aeration process similar to the oxidation ditches for purposes of comparison. Extended aeration processes such as oxidation ditches generally do not include primary clarifiers in order to decrease costs and increase simplicity. In addition, the higher SRTs employed by these processes tend to create solids that are already semi-digested that are not readily amenable to further treatment by anaerobic digestion.

Note that it has been proposed for the SGRWRF to change from the oxidation ditch process to the staged aeration process in order to increase treatment capacity without immediate construction of additional bioreactors. This change would require that one of the gravity thickeners be retrofitted as an aerated sludge holding basin to provide increased SRTs and solids stability, with eventual construction of separate aerated holding basins as needed.

Table 2-3 contains some of the relative advantages and disadvantages for the staged aeration process. Some of the basic design criteria used for preliminary sizing and cost estimates for the staged aeration process are shown in Table 2-4.

Table 2-3
Staged Aeration Process Advantages and Disadvantages

Advantages	Disadvantages
Less ground area required due to smaller tankage	Staged aeration has not been used in Utah, although Provo employs conventional activated sludge
Reduced operating costs required for aerating smaller tank volume and more efficient aeration system	Actual power cost savings may not be as high as predicted if oxidation ditch alternative is operated at low dissolved oxygen levels
Lower construction costs for smaller tankage	Unclassified residual solids require further offsite treatment prior to disposal or reuse
Improved noise control	Vertical aerators may emit higher noise levels
Stable (not easily upset)	Unclassified residual solids may required further offsite treatment prior to disposal or reuse
Simple to operate	
Excellent effluent quality	
Nitrification for ammonia removal	
Low odors	

Table 2-4
Staged Aeration Process Design Criteria

Criteria	Value
Solids Retention Time (SRT)	10 days
Hydraulic Residence Time (HRT)	12 hours
Mixed Liquor Suspended Solids (MLSS)	3500 gm/L
Anoxic Selector HRT	1 hour
Aerated Solids Holding Basin HRT/SRT	7 days
Secondary Clarifier Surface Overflow Rate (SOR)	600 gal/sf/day
Secondary Clarifier Solids Loading Rate	20 lbs/sf/day

CONVENTIONAL ACTIVATED SLUDGE WITH PRIMARY CLARIFIERS (CAS)

Primary Clarifiers

The first difference noted in this process is the use of primary clarifiers that are required in order to reduce the BOD and TSS loading to the CAS process. Otherwise, serious problems such as odors, plugging and poor performance can result. Raw wastewater solids are settled out by gravity in the primary clarifiers, and primary effluent is pumped to the activated sludge tanks. Removal of large portions of the BOD reduces the load on downstream processes which helps improve their performance and/or reduce their size and cost. The disadvantage is that primary clarifiers can substantially increase the potential for odor generation and require costly measures to control these odors. The filters can be covered and ventilated, and the gasses scrubbed before exhausting to the atmosphere.

Raw Sludge Pump Station

Use of the primary clarifiers also requires a primary sludge pump station to transfer the primary solids to the anaerobic digesters for treatment. The primary sludge pump station also pumps both scum and waste activated solids to the anaerobic digesters from the primary clarifiers where they are co-removed with the raw solids.

Anaerobic Digesters

Raw sludge and co-removed waste activated sludge and scum are treated and stabilized in the anaerobic digesters. This process reduces the volatile content of the solids and meets Class B requirements that enable more flexibility in disposing of the solids by restricted land application techniques or other methods. These solids also dewater more effectively than waste activated solids alone. The performance of the dewatering facility can be improved and the size and cost of the facility reduced as a result. A major benefit provided by the anaerobic digesters is generation of methane gas that can be burned to generate power to help run the treatment plant and offset power costs. A disadvantage is the increased potential for odors as discussed previously.

Primary Effluent Pump Station

The primary effluent pump station replaces the influent pump station used in the other process alternatives, and is relocated down stream of the primary clarifiers. In this location the pump station also serves to provide recycle pumping to the trickling filters from both the trickling filter effluent and the solids contact basin RAS, if desired. Flow requirements for the primary effluent pump station are greater than for the influent pump station which only pumps the raw wastewater flow, and the total dynamic head (TDH) requirements are also assumed to be greater due to the height of the filters to which the primary effluent pump station discharges.

Solids Contact Basins

The solids contact basins are essentially a short term activated sludge process where remaining BOD and TSS are encouraged to come into contact with a suspended growth microorganism population for removal and improved overall process performance. The basins include a RAS/WAS pump station like other activated sludge processes, and blowers and diffusers to provide dissolve oxygen and mixing. The existing oxidation ditches at the SGRWRF would continue to serve as solids contact basins for this phase of the treatment process.

Figure 2-3 is a flow diagram for the conventional activated sludge process and shows all the major process elements. Table 2-5 contains some of the relative advantages and disadvantages for the CAS process. Some of the basic design criteria used for preliminary sizing and cost estimates for the CAS process are shown in Table 2-6. Figure 2-3 is a flow diagram for the conventional activated sludge process and shows all the major process elements.

Table 2-5
Conventional Activated Sludge Process Advantages and Disadvantages

Advantages	Disadvantages
Lower aeration cost due to small activated sludge (solids contact) basin volumes	Larger land area required for more numerous process structures
Operating cost reduction due to onsite generation of power from anaerobic digester methane production	Higher expected construction cost due to numerous process structures, especially anaerobic digesters
Process is used on two large plants in Utah, and a third large plant is being designed	Greater odor potential from primary clarifiers and anaerobic digesters.
Low noise potential	Process operation may be more complex
Relatively stable and reliable process	Nitrification capability of process may be questionable
Good effluent quality	
Class B solids generated by anaerobic digestion process – more disposal options	

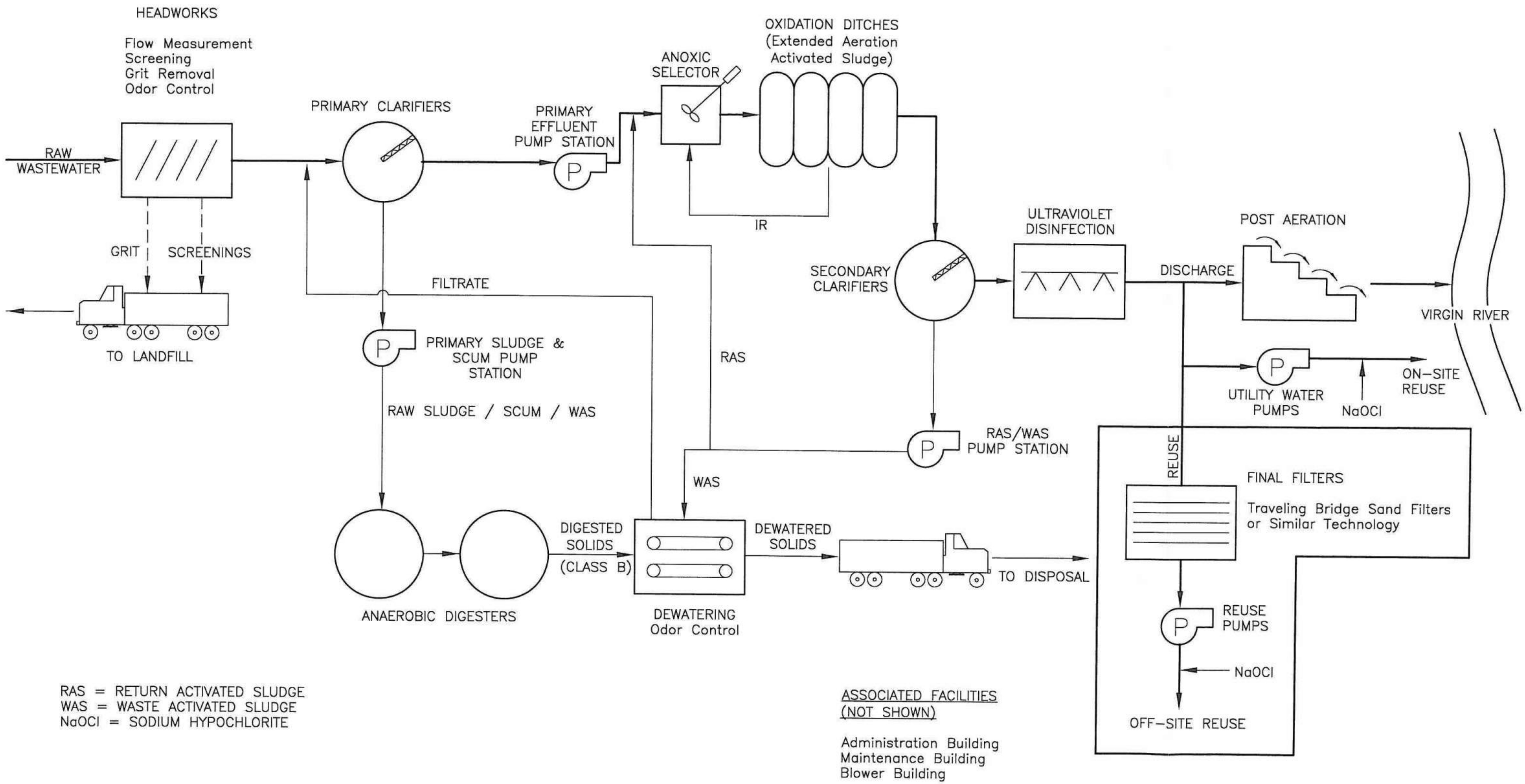

Figure 2–3
CONVENTIONAL ACTIVATED SLUDGE PROCESS FLOW DIAGRAM
SGRWRF EXPANSION MASTER PLAN

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Table 2-6
Conventional Activated Sludge Process Design Criteria

Criteria	Value
Primary Clarifier Hydraulic Loading Rate (HLR)	1000 gpd/sf
Primary Clarifier BOD Removal	35%
Solids Contact Basin SRT	2 – 4 days
Solids Contact Basin HRT	0.5 hours
Solids Contact Basin MLSS	2500 mg/L
Secondary Clarifier Surface Overflow Rate (SOR)	600 gal/sf/day
Secondary Clarifier Solids Loading Rate	20 lbs/sf/day

MEMBRANE BIOREACTOR PROCESS

The membrane bioreactor process (MBR) also uses a variation of activated sludge to biologically break down the wastewater constituents, but the major difference is that membranes are used to separate the liquid effluent from the mixed liquor instead of secondary clarifiers. The membrane modules are submerged directly in the aerobic reactor and draw "clarified" effluent from the reactor on a continuous basis. This can be accomplished with or without pumping, but it is assumed that pumping is required for purposes of this evaluation. Effluent quality is very high.

As a result of using membranes to separate the solids from the effluent, much higher mixed liquor concentrations can be maintained as they will not affect settleability. The aerobic reactor basins can be much smaller, substantially reducing land area requirements. The requirement for no secondary clarifiers and no final filters also greatly reduces land area needs.

The MBR process is relatively new, having only been in use for about 10 years in the U. S. There is currently one small operating MBR plant in Utah, and several are in development. Equipment purchase costs are high for this process due to the membrane modules, and operating costs are also high due to membrane replacement requirements. There are several operating plants the size of the proposed SGRWRF facility in the U.S. However, MBRs have typically been used for plants under 2 mgd in capacity due to economic considerations. These plants find more extensive use where very high effluent quality is desired, such as for reuse, infiltration basins, aquifer storage and recovery (ASR) projects, etc.

Several manufacturers currently offer membranes for this purpose, the three most prominent being: Zenon, Siemens, and Kubota. Although some similarities between manufacturers exist their membrane types and configurations are proprietary. Use of MBRs generally requires selection of a membrane technology and then working with a manufacturer-recommended design that accommodates their proprietary membrane type and configuration. A proposal prepared by Kubota was used to develop the basic design and cost information for this study.

Figure 2-4 is a flow diagram for the MBR process. Note that the secondary clarifiers and final filters are omitted as discussed previously. The MBR process is shown within the dashed outlined area as separate basins, but in reality a single structure with multiple compartments is used. The pre-aeration basins are provided to increase the HRT/SRT more economically rather than increasing the volume of the membrane bioreactor basins. Internal recycle pumps double as RAS/WAS pumps since there are no separate secondary clarifiers from which solids removal is required. The remainder of the treatment process is similar to both the oxidation ditch and staged aeration alternatives.

Table 2-7 presents some of the relative advantages and disadvantages for the MBR process. Some of the basic design criteria used for preliminary sizing and cost estimates for the MBR process are shown in Table 2-8.

Table 2-7
Membrane Bioreactor Process Advantages and Disadvantages

Advantages	Disadvantages
Lower aeration/mixing cost due to smaller activated sludge basin volumes	No large operating plants in Utah
Less land area required due to smaller activated sludge basins, no secondary clarifiers and no final filters	Process has not been used for plants of this size in the U.S. Only one this size in the world
Very high effluent quality, without final filters or clarifiers	High equipment cost due to membrane modules
Nitrification for ammonia removal	Unclassified residual solids require further offsite treatment prior to disposal or reuse
Low noise potential	High operating cost due to replacement of membranes
Relatively stable and reliable process	Process operation may be more complex due to monitoring and replacement of membranes
Low odor potential	

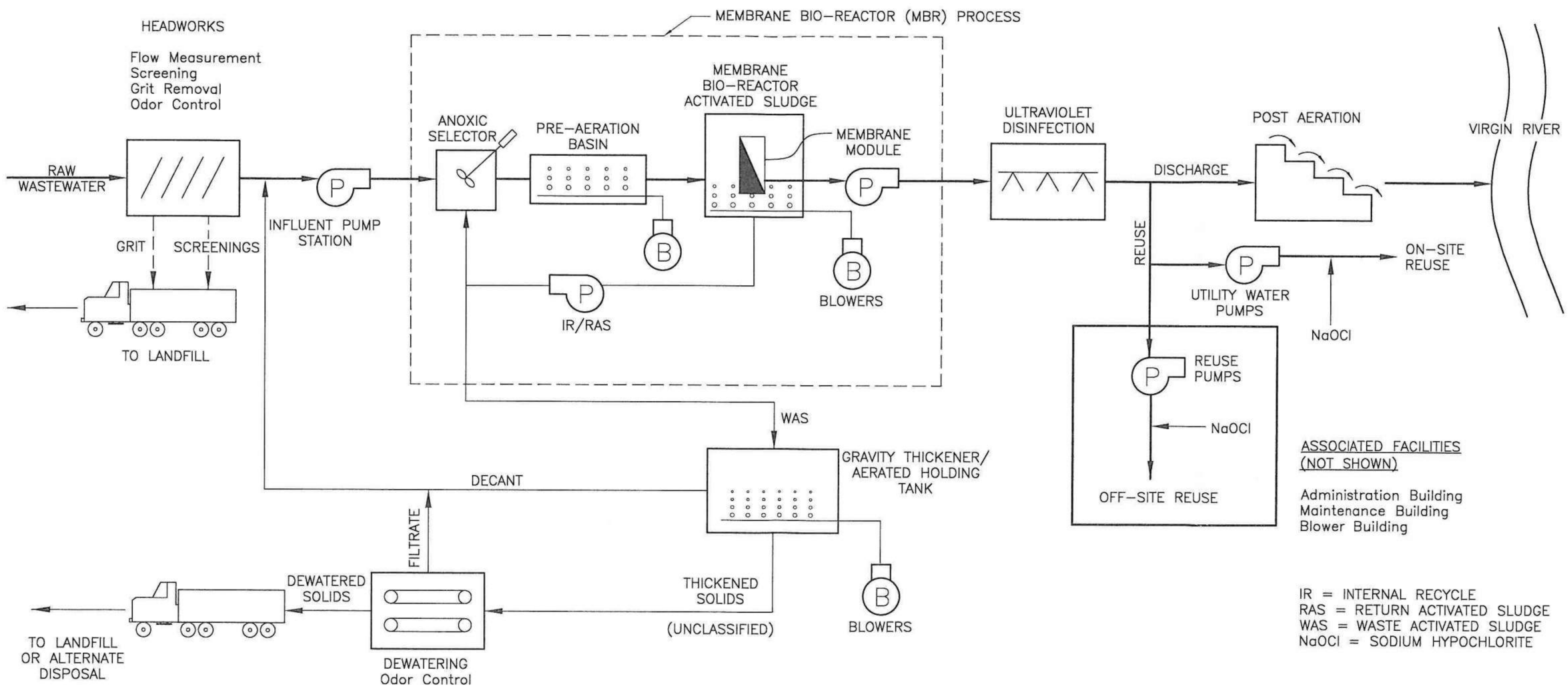

Figure 2–4
MEMBRANE BIO–REACTOR PROCESS FLOW DIAGRAM
SGRWRF EXPANSION MASTER PLAN

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Table 2-8
Membrane Bioreactor Process Design Criteria

Criteria	Value
Solids Retention Time (SRT)	15 – 26 days
Hydraulic Residence Time (HRT)	4 hours
Mixed Liquor Suspended Solids (MLSS)	12,000 mg/L
Anoxic selector HRT	0.8 hr
Membrane Flux Rate	12.4 gal/sf/day
Aerated Solids Holding Basin HRT/SRT	3 days (not by Kubota)

COST ESTIMATES AND ECONOMIC COMPARISON

Construction Cost Estimates

Planning level construction cost estimates were developed using methods intended to provide reasonable and conservative values, suitable for discussion and comparison of treatment process alternatives for this study. Actual plant construction costs will vary from the figures presented, depending on the final plant sizing and design criteria, selection of equipment, architectural and structural features, specific site development requirements, and a number of other factors that are not readily predicted at the planning stage of this project.

Detailed planning level construction cost estimates are presented in Appendix C. Costs are shown by process element or other major structure, with markups for site development, yard piping, electrical and instrumentation.

The site development markup cost is intended to include all on-site civil and drainage improvements required at the site such as berms, grading, paving, curb/gutter/sidewalk, access road, wetlands and limited river channel improvements, fencing, limited filling, utility service connections, and miscellaneous related improvements.

Estimated costs range from $56.7 million for the staged aeration plant, to $116.5 million for the membrane bio-reactor plant. The oxidation ditch plant is estimated to cost approximately 7 percent more than the staged aeration plant at $60.9 million, with the CAS plant at about $88.7 million.

It is predictable that the staged aeration and oxidation ditch plants would be comparable in cost due to their similarities, with the staged aeration costs somewhat lower due to the requirement for less concrete tankage. It is also predictable that both the CAS and MBR processes would be more costly due to large mechanical equipment costs for the MBR process, and a greater number of process structures and related mechanical, site development and yard piping costs for the CAS process.

The oxidation ditch and staged aeration plants are the least expensive to construct and the small difference in estimated construction costs between the two is within the estimating variability contained in the analysis. Thus, other factors also should be considered when deciding between these processes such as potential operating costs, and process familiarity and reliability.

The CAS and MBR process construction costs are 56 and 105 percent higher, respectively, than staged aeration costs, but differences in operating costs and other factors should be considered when evaluating these alternatives.

OPERATING COST ESTIMATES

The following operating cost estimates were developed from similar wastewater treatment facilities currently operating in Utah, and other sources as noted. Figures shown are for overall operating costs, including solids treatment and disposal. Predicted flow values from Chapter 1 were used for each year of operation.

Oxidation Ditch Process

A survey of four oxidation ditch wastewater treatment plants in Utah (St. George, Timpanogos, SVWRF and Ashley Valley) revealed operating costs ranging from $702 per million gallons (MG) treated per year ($702/MG/yr) for the SVWRF, to $1674/MG/yr for Ashley Valley. Of the four plants, SVWRF is the largest at nearly 30 mgd, and Ashley Valley is the smallest at just under 2 mgd. This difference reflects predictable increased operating economies of scale for larger facilities.

The SVWRF plant is closest in size to the future facility, and its operating costs should be the most representative of an oxidation ditch facility required to treat expected flows. Based on $702/MG/yr, for a 20-year analysis period and a discount rate of two percent, the present worth of the annual cost is $67.3 million.

Staged Aeration Process

Currently, there are no staged aeration treatment plants in Utah from which to draw comparative operating data, although the SVWRF and TSSD are in the process of conversion. However, they are similar to the oxidation ditch plants, with expected operating costs somewhat lower due to reduced aeration requirements and increased oxygen transfer efficiency. All other costs should be the same. If power costs constitute 40 percent of plant operating costs, and the staged aeration process is 20 percent more efficient, then overall operating costs for a staged aeration plant would be about 8 percent less than a comparable oxidation ditch plant. An 8 percent reduction in overall operating costs for the SVWRF would result in a value of $646/MG/yr which, for a 25 mgd plant at a two percent discount rate and a 20 year present worth period equates to $61.9 million.

CAS Process

The Central Valley CAS plant in South Salt Lake City with a current flowrate of approximately 52 mgd, reported operating costs for the last three years ranging from $398 to $431/MG/yr, with an average of $410/MG/yr during that time. For comparison, the Central Weber trickling filter plant in Ogden, Utah (35 mgd) reported a cost of $352/MG/yr for the last two years. This seems to compare well with the Central Valley costs, and accounts for the lack of solids contact facilities at the Central Weber plant. The Salt Lake City CAS treatment plant reported operating costs of $383/MG/yr, with a flow of 28.9 mgd, and very small solids contact basins. All three of these plants utilize anaerobic digestion for solids treatment. Assuming $410/MG/yr for CAS operating costs for a 25.0 mgd plant are $39.3 million.

MBR Process

For the MBR process, operating costs similar to those of the staged aeration process are assumed, plus the cost of membrane cleaning and replacement. Membrane cleaning costs of $6000 per year are assumed, plus replacement of 10,000 membrane cartridges per year at $60/cartridge, starting after the eighth year of operation. Labor for membrane replacement is estimated at 0.04 hrs/cartridge (16 hrs per cassette of 400 cartridges) and $25/hr.

Crane and operator costs of $300/hr are assumed, with eight hours per cassette required. This results in costs that are approximately 9% higher for MBR than for the staged aeration process or $710/MG/yr. The 20-year present worth at two percent discount rate is $68.1 million.

ECONOMIC COMPARISON

The primary criterion of the currently proposed expansion is the ability to maximize treatment capacity within existing basins to limit costs. Table 2-9 contains the present worth cost information from the above discussion. The data indicates that both the oxidation ditch and staged aeration process selections are more cost effective than either the CAS or MBR processes when considering construction costs alone. However, the CAS process costs less to operate due to reduced aeration requirements and production of methane gas for energy generation for use on site. This benefit causes the CAS process to be more competitive with the oxidation ditch and staged aeration processes on a present worth basis. The MBR process is more costly to both construct and operate due to membrane equipment and replacement costs. The previous construction cost estimates do not attempt to take into account the differences in land requirements for the different processes. Such consideration would favor the MBR process due to its smaller footprint, but would not be expected to offset the higher construction and operating costs. Consequently, MBR processes are not recommended for the SGRWRF expansion as they are the most costly to construct and operate and would require extensive modifications to existing basins for process conversion.

Table 2-9
Economic Comparison of Treatment Process Alternatives
($1,000,000)

Process	Construction Cost	Annual Operating Cost ($/MG/yr)	Total Present Worth Cost (20 Yrs)
Oxidation Ditch	$60.8	$702	$128.2
Staged Aeration	$56.7	$646	$118.7
Conventional Activated Sludge	$88.7	$410	$128.1
Membrane Bioreactor	$116.5	$710	$184.6

The oxidation ditch and staged aeration alternatives are preferred due to their lower initial costs, and the staged aeration facility should be less costly to operate. The present worth cost of the staged aeration plant is approximately 7.5 percent lower than the oxidation ditch plant. The CAS operating costs are even lower than the staged aeration process, which results in a present worth cost that is only about 8 percent higher as compared to the 56 percent estimated construction cost differential between the two alternatives.

NON-ECONOMIC ISSUES

Acceptance, reliability, experience and general confidence must be considered in making the final process choice. Many successful oxidation ditch wastewater treatment plants have been operating for up to 20 years or more in Utah, but there are no staged aeration plants. There is only one larger non-oxidation ditch activated sludge plant in Utah, although there are staged aeration plants operating in neighboring states. Two large CAS plants currently operate in Utah, and a large two-stage trickling filter facility is being converted to the CAS process.

The long-term success of oxidation ditch plants in Utah and elsewhere in the U. S. speaks well of the performance and stability of this process. However, both initial and operating costs are somewhat higher than for some competing processes as demonstrated above. Larger plants typically find improved economies through use of alternative processes such as staged aeration or CAS, and it is less common to find oxidation ditch facilities larger than 5 to 10 mgd capacity. (The South Valley WRF plant was the largest of its kind in the U. S. when it began operations in 1986 at 12.25 mgd). The CAS process has also found acceptance both in and outside of Utah.

Table 2-10 presents a brief comparison of some of the attributes of the oxidation ditch, staged aeration and CAS processes for consideration.

Table 2-10
Comparison of Three Treatment Processes

Criteria	Oxidation Ditch	Staged Aeration	Conventional Activated Sludge
Initial Construction Cost	Moderate	Lower	Higher
Operating Cost	Higher	Moderate	Lower
Process Used in Utah	Widely Used	No Installations	Several Installations
Predicated Performance and Reliability (effluent quality)	Excellent	Excellent	Good
Complexity of Operation	Lower	Moderate	Higher
Solids Disposal	Unclassified – fewer disposal options w/o additional treatment	Unclassified – fewer disposal options w/o additional treatment	Class B solids – more disposal options available
Odor Potential	Lower	Higher	Higher

Criteria	Oxidation Ditch	Staged Aeration	Conventional Activated Sludge
Noise Potential	Higher	Moderate	Lower
Vector Potential (filter flies)	Lower	Lower	Higher
Land Use Requirements	Moderate	Lower	Higher
Expandability	Similar	Similar	Similar

The CAS process has two key disadvantages including potential odors and the possibility for filter flies and/or other vectors to be generated. These concerns result in the possibility that the plant would have greater difficulty remaining a good neighbor to nearby residents, and that complaints could be generated and additional funds expended to try and mitigate odor and other problems.

The SGRWRF plant is located in a sensitive area, similar to the South Valley WRF, as compared to the predominantly commercial area where the Central Valley plant is located. Thus odor and vector potential is of great concern for the SGRWRF plant expansion. As a result, the CAS process is not recommended for the proposed expansion due to its greater odor and vector potential, as well as its higher initial and 20-year present worth costs.

LIQUID TREATMENT ALTERNATIVE SUMMARY

Both the oxidation ditch and staged aeration plants have low odor potential and are better suited for a more sensitive plant location. Construction, operating and present worth costs are all within seven to eight percent for these two alternatives, and other features of the facilities are quite similar. The oxidation ditch alternative has an advantage of being a more widely accepted and proven process in Utah, but staged aeration has lower estimated construction and operating costs. Both processes are expected to provide excellent performance and reliability and meet effluent discharge water quality standards. Figures 2-5 and 2-6 show conceptual layouts of what future expanded facilities may look like for both the oxidation ditch process and the staged aeration modifications to the existing process.

The estimated construction cost difference between the two plants is within normal estimating variability. The previous discussion points out that, under certain circumstances, operating costs for the two alternatives also could be very similar. Therefore, for all practical purposes, the two options may be viewed as economically equal, and SGRWRF staff may select the process in which it is most confident and best addresses its non-economic concerns. However, with construction cost being the deciding factor, the staged aeration alternative is the process of choice.

Figure 2-5
Future Facilities - Oxidation Ditch Process

SGRWRF Expansion
Master Plan

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Figure 2-6
Future Facilities - Staged Aeration Process

SGRWRF Expansion
Master Plan

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