consor

Clean Water Services

South Bull Mountain Sanitary Sewer Concept Plan

December 2023

PREPARED BY:

Consor
Point of Contact: Michael Carr, PE
One SW Columbia Street, Suite 1700
Portland, OR 97204
p: 503.225.9010
e: Michael.Carr@consoreng.com

PREPARED FOR:

Clean Water Services
Point of Contact: Jadene Stensland, PE
2550 SW Hillsboro Hwy
Hillsboro, OR 97213
p: 503.681.3600
e: jtstensland@cleanwaterservices.org

THIS PAGE INTENTIONALLY LEFT BLANK

South Bull Mountain Sanitary Sewer Concept Plan

Clean Water Services

December 2023

REGISTERED PROFESSIONAL
ENGINEER
58379
OREGON
JULY 21, 1998
MICHAEL L. CARR
RENEWS 12-31-2023

Consor

One SW Columbia Street
Suite 1700
Portland, OR 97204

THIS PAGE INTENTIONALLY LEFT BLANK

Table of Contents

Tables

Figures

Appendices

THIS PAGE INTENTIONALLY LEFT BLANK

CHAPTER 1

Introduction/Background

1.1 What is a Concept Plan?

The Sanitary Sewer Concept Plan is a planning document intended to provide Clean Water Services (District) staff with information needed for:

- Having substantive discussions with stakeholders discussing sanitary sewer service to new development in the study area.
- Understanding interconnectivity of the various conveyance facilities in the regional system.
- Documenting the discussions and decisions and evaluations that have been conducted.
- Providing a descriptive menu of options available for improvements to the regional system.
- Developing methods for monitoring development in the study area.
- Preparing updates to the 5-year capital improvement plan.
- Assessing priorities for new flow monitoring programs.

The Concept Plan is not an engineering study. It does not:

- Provide recommendations on pipe sizes.
- Provide recommendations for capacity improvements.

All sanitary sewer improvement projects described in this Concept Plan will be subject to the requirements of the District's current Design & Construction Standards (D&CS).

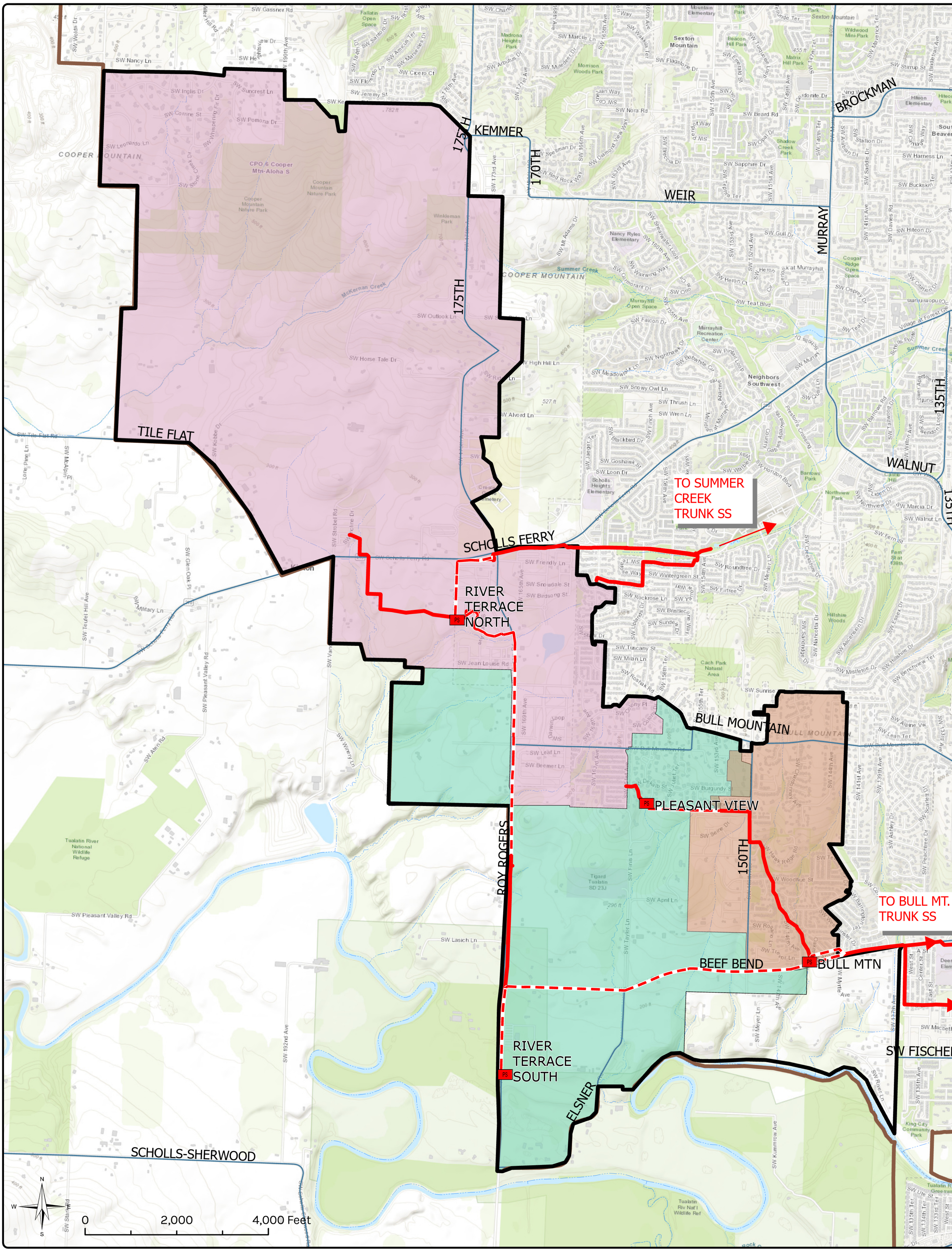
It is recognized that the material and recommendations presented in this Concept Plan may become obsolete due to changes in development and land use patterns occurring within and outside of the study area. Events may include significant changes in land use such as Urban Growth Boundary (UGB) expansions and changes to master plans for future development areas. The District should revisit the Concept Plan on a yearly basis to review and address any changes that have occurred in the study area.

1.2 Executive Summary

1.2.1 Regional Sanitary Sewer Concept Plan Study Area

The study area for the South Bull Mountain (SBM) Regional Sanitary Sewer is shown in **Figure 1-1**. It is 4,046 acres in size and is located on the west and south sides of Bull Mountain and Cooper Mountain. The study area is mainly comprised of three major planned development areas: Cooper Mountain (City of Beaverton), River Terrace (City of Tigard), and Kingston Terrace (City of King City), each comprised of smaller planned development areas (**Figure 1-2**). The concept plan builds upon prior District-led planning work completed for the area since 2016 and includes recent City-led master planning efforts for the planning areas described above.

C:\Users\Brad.Mercure\OneDrive - CONSOR Engineers, LLC\Desktop\CWS South Bull Mt\Figure 1-1 Study Area\Figure 1-1 Study Area.aprx 1/4/2024 4:52 PM Brad.Mercure



Legend

- Sanitary Pump Stations
- Sanitary Force Mains
- Sanitary Trunks
- Streams
- Sanitary System Study Area
- Urban Growth Boundary

Pump Station Service Area

- River Terrace South
- River Terrace North
- SW Bull Mountain

Clean Water Services   consor

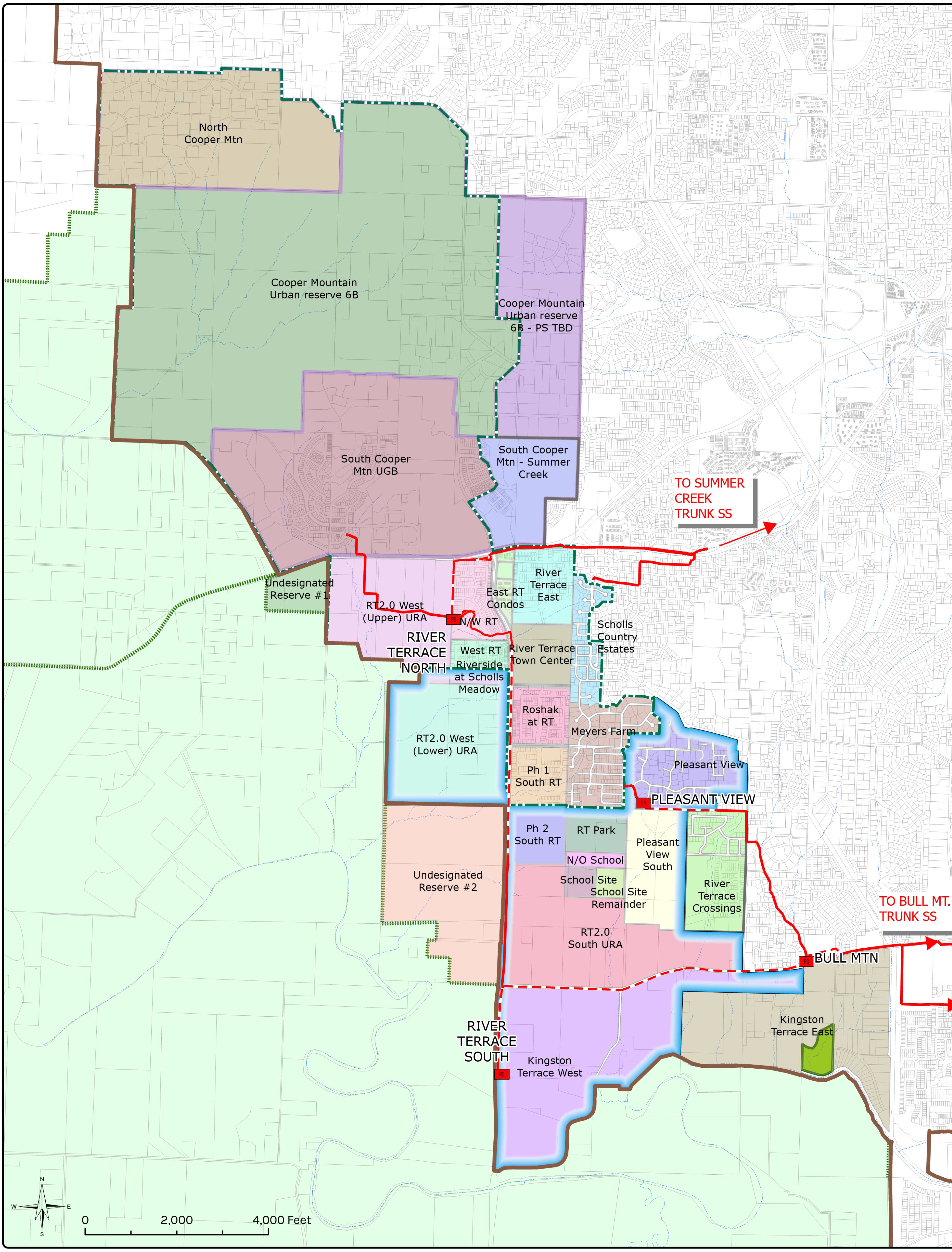
South Bull Mountain
Sanitary Sewer Concept Plan

Figure 1-1
Concept Plan Study Area

Project No: 22-3432   January 2024

Data Sources: Clean Water Services, Portland Metro RLIS, Pacific Community Design, Cooper Mountain Community Plan, World Topographic Map: Oregon Metro, Bureau of Land Management, State of Oregon, State of Oregon DOT, State of Oregon GEO, Esri Canada, Esri, HERE, Garmin, INCREMENT P, USGS, METI/NASA, EPA, USDA.
Coordinate System: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl
Disclaimer: Consor and Clean Water Services make no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes.
Notification of any errors is appreciated.

C:\Users\Brad.Mercure\OneDrive - CONSOR Engineers, LLC\Desktop\CWS South Bull Mt\Figure 1-2 Existing Neighborhoods\Figure 1-2 Existing Neighborhoods.aprx 1/4/2024 4:46 PM Brad.Mercure



Legend

Destination PS

- Gravity Service to existing network
- River Terrace South
- River Terrace North
- Sanitary Pump Stations
- Sanitary Force Mains
- Sanitary Trunks
- Streams
- Urban Growth Boundary
- Rural Reserve
- Bankston Family Trust Conservation Easement

Clean Water Services | consor

South Bull Mountain
Sanitary Sewer Concept Plan

Figure 1-2 Proposed Developments and Existing Neighborhoods In Study Area

Project No: 22-3432 January 2024

Data Sources:: Clean Water Services, Portland Metro RLIS, Pacific Community Design, Cooper Mountain Community Plan.
Coordinate System: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl
Disclaimer: Consor and Clean Water Services make no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes. Notification of any errors is appreciated.

1.2.2 Sanitary Sewer Concept Plan

The overall Sanitary Sewer Concept Plan is shown in **Figure 1-3**. The Concept Plan includes several regional sanitary sewer projects needed to serve significant growth projected for the study area. Four project options were identified and evaluated, and these are shown individually in **Figure 1-4** through **Figure 1-7**. The Concept Plan does not make a recommendation for a particular option; instead, it provides the District the flexibility to implement the most appropriate option based on how the project area develops.

1.2.2.1 River Terrace South Pump Station Bypass

The River Terrace South (RTS) Pump Station (PS) has a firm capacity of 3.7 million gallons per day (mgd) and is a key component of the SBM regional conveyance system. It currently receives flows from the River Terrace North (RTN) PS, but as development occurs in the region, flows to the RTS PS will eventually exceed its capacity.

The regional solution is to bypass flows from RTN PS away from the RTS PS. Options 1 and 2 extend the RTN PS force main directly to the Upper Tualatin Interceptor (UTI) in Beef Bend Road. Options 3 and 4 construct a new deep gravity trunk sewer from the RTN Force Main discharge manhole in Roy Rogers Road to the UTI in King City.

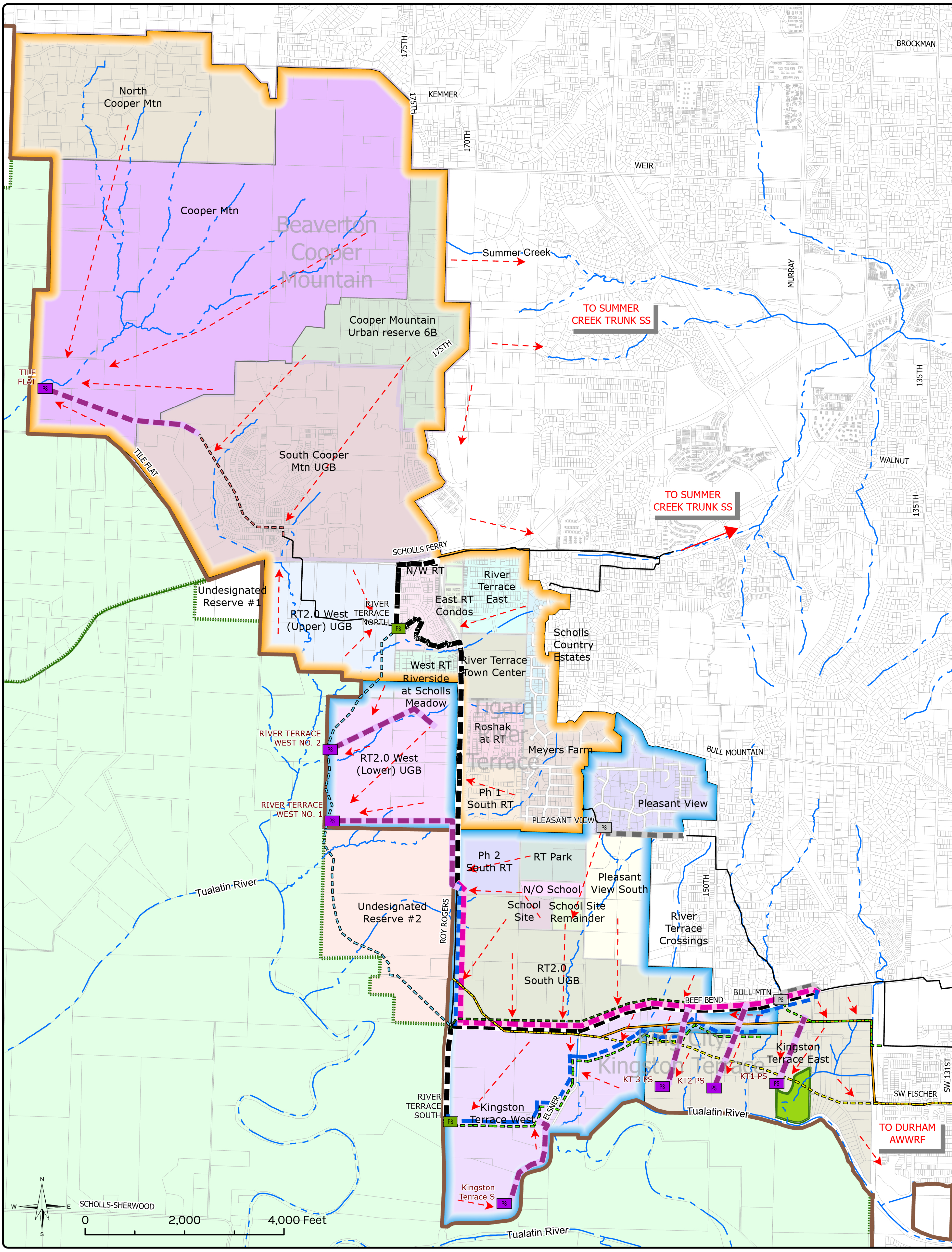
Evaluation criteria included factors such as lifecycle cost; land use; need for easements and rights-of-way; topographic constraints; permitting; construction risks; and implementation schedule.

Options 1 and 2 have the lowest capital costs to construct, the shortest implementation schedules, and are expected to have the least impact on natural resources and on overall operation and maintenance (O&M). They will require new pump stations to be built for the low-lying areas in East Kingston Terrace, which increases the overall life-cycle cost of the options.

Gravity sewer Options 3 and 4 have significantly higher capital cost, longer implementation schedules, and are considered more impactful to natural resources and O&M due to the need to cross several deep ravines. These facilities would likely be co-located with new roadways in the developing areas of Kingston Terrace, which could also reduce the need for easements and permitting and reduce impacts to natural resources and O&M if pipelines are co-implemented with roadway ravine crossings. Depending on the route chosen, the gravity trunk option may eliminate the need for some or all of the pump stations in East Kingston Terrace, which could significantly reduce the life-cycle cost of the project.

1.2.2.2 River Terrace North PS Capacity Upgrade

The East Basin Master Plan (EBMP) recommended that a capacity upgrade be implemented prior to construction of the Tile Flat PS. The RTN PS is currently configured with two 105-horsepower pumps, with room for a third similarly sized pump. The configuration of the upgrade will be dependent on whether the RTN Force Main is extended to bypass RTS PS (RTS Options 1 and 2), or if the regional gravity option through Kingston Terrace is constructed (RTS Options 3 and 4). If the RTN Force Main is extended, the RTN pumps will need to be replaced with larger horsepower units to overcome increased friction head. If a regional gravity sewer is installed to bypass flow around RTS PS, the existing pumps are expected to be sufficiently sized.



Legend

- River Terrace South
- River Terrace North
- District Pump Station
- Decommission Pump Station
- Future Pump Station
- Future Force Main
- Decommission Force Main
- Existing Force Main
- Existing Gravity Trunk
- Future Gravity Service (local flow direction)
- New Tile Flat Gravity Main
- River Terrace West Gravity Main Option
- Beef Bend Gravity Option
- New Kingston Terrace Gravity Main Option
- New Force Main SBM Option 1
- New Force Main SBM Option 2
- New Gravity Main SBM Option 3
- New Gravity Main SBM Option 4
- Rivers/Streams
- Urban Growth Boundary
- Rural Reserve
- Bankston Family Trust Conservation Easement

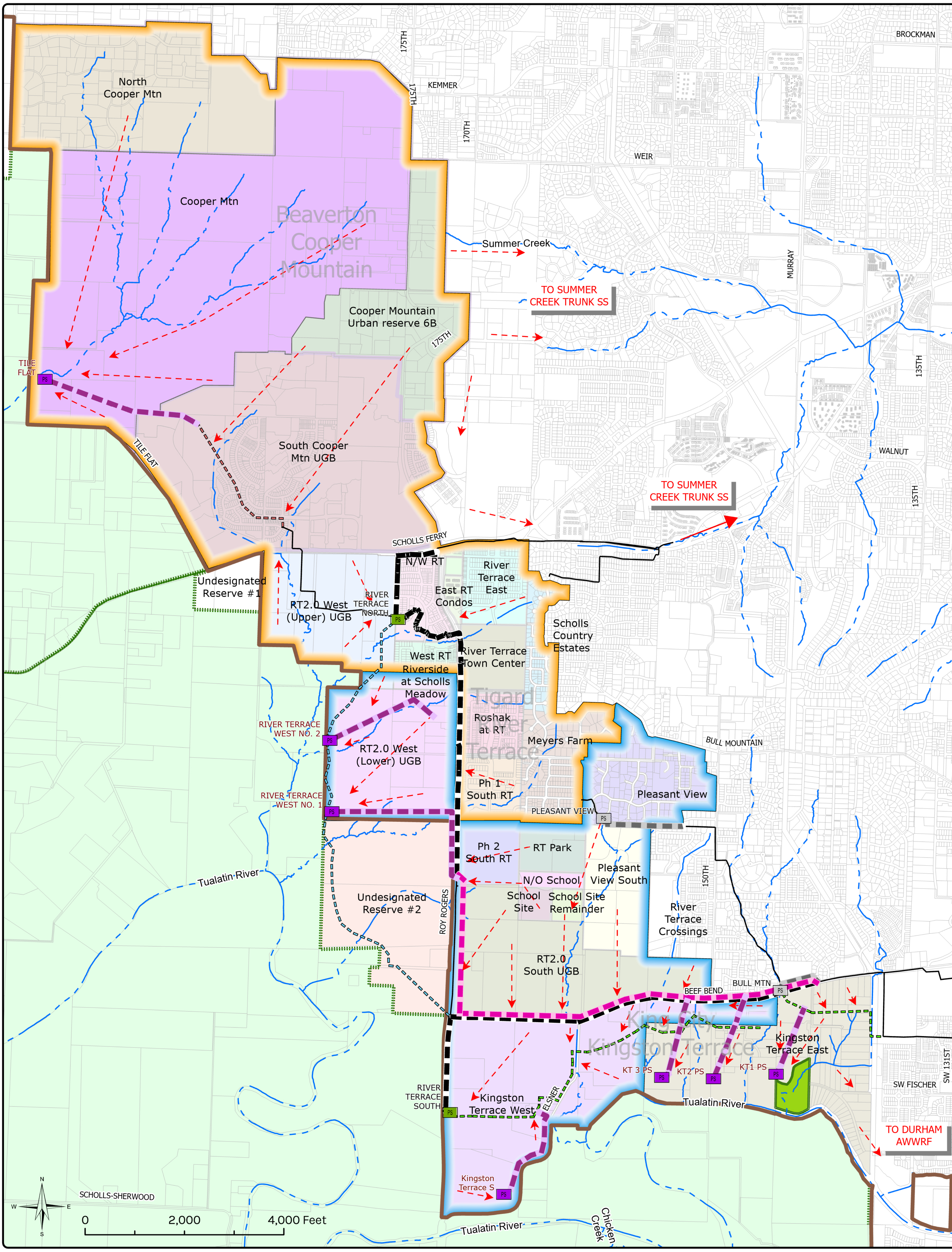
Clean Water Services consor

South Bull Mountain Sanitary Sewer Concept Plan

Figure 1-3 Regional Sanitary Sewer Concept Plan

Project No: 22-3432 January 2024

Data Sources: Clean Water Services, Portland Metro RLIS, Pacific Community Design, Cooper Mountain Community Plan.
Coordinate System: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl
Disclaimer: Consor and Clean Water Services make no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes. Notification of any errors is appreciated.



Legend

- River Terrace South
- River Terrace North
- District Pump Station
- Decommission Pump Station
- Future Pump Station
- Future Force Main
- Decommission Force Main
- Existing Force Main
- Existing Gravity Trunk
- Future Gravity Service (local flow direction)
- New Tile Flat Gravity Main
- River Terrace West Gravity Main Option
- New Kingston Terrace Gravity Main Option
- New Force Main SBM Option 1
- Rivers/Streams
- Urban Growth Boundary
- Rural Reserve
- Bankston Family Trust Conservation Easement

Clean Water Services

consor

South Bull Mountain Sanitary Sewer Concept Plan

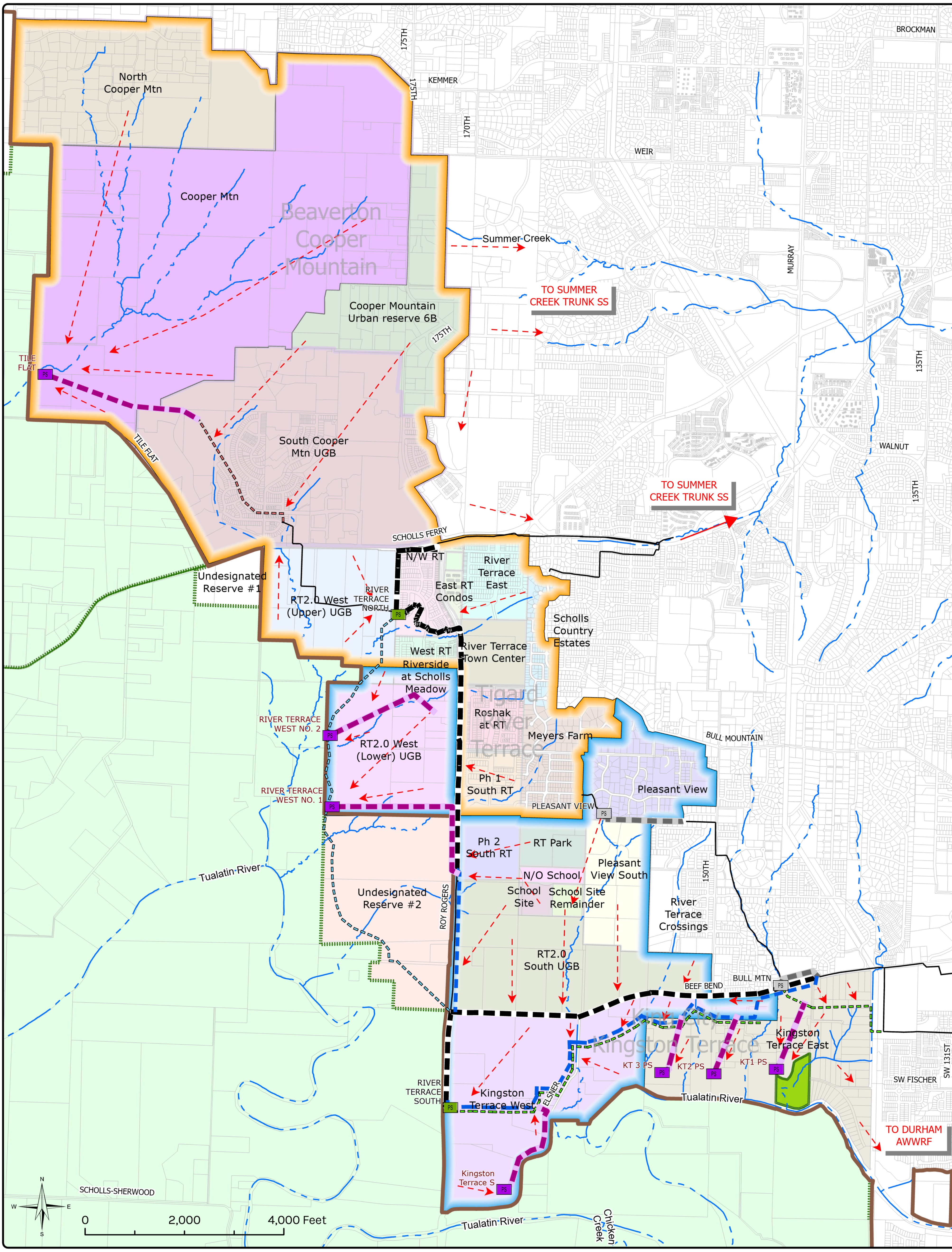
Figure 1-4 Regional Sanitary Sewer Option 1

Project No: 22-3432

January 2024

Data Sources: Clean Water Services, Portland Metro RLIS, Pacific Community Design, Cooper Mountain Community Plan.
Coordinate System: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl
Disclaimer: Consor and Clean Water Services make no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes. Notification of any errors is appreciated.

C:\Users\Brad.Mercure\OneDrive - CONSOR Engineers, LLC\Desktop\CWS South Bull Mt\South Bull Mt Concept Map\Option 2.aprx 1/5/2024 11:01 AM Brad.Mercure



Legend

- River Terrace South
- River Terrace North
- District Pump Station
- Decommission Pump Station
- Future Pump Station
- Future Force Main
- Decommission Force Main
- Existing Force Main
- Existing Gravity Trunk
- Future Gravity Service (local flow direction)
- New Tile Flat Gravity Main
- River Terrace West Gravity Main Option
- New Kingston Terrace Gravity Main Option
- New Force Main SBM Option 2
- Rivers/Streams
- Urban Growth Boundary
- Rural Reserve
- Bankston Family Trust Conservation Easement

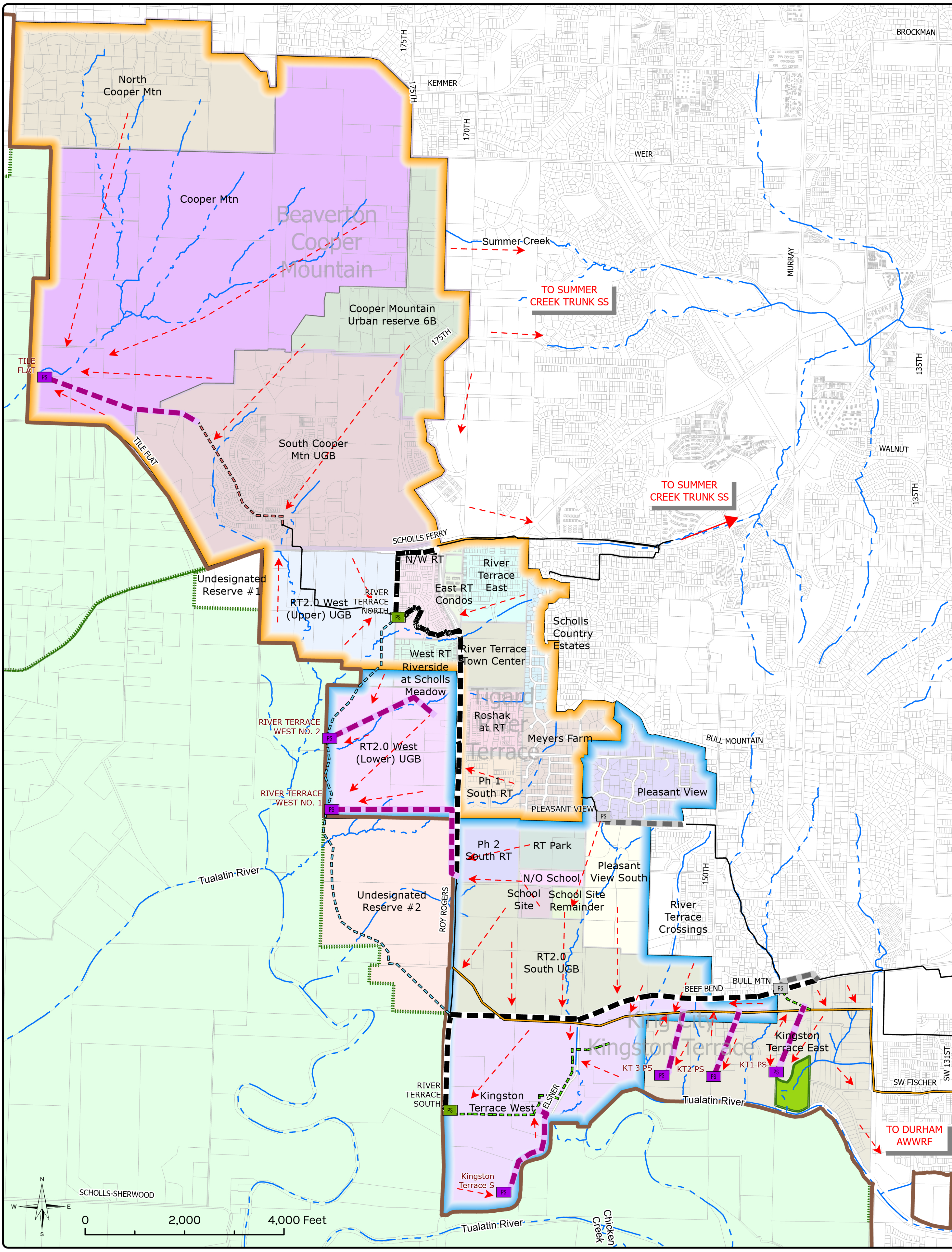
Clean Water Services consor

South Bull Mountain Sanitary Sewer Concept Plan

Figure 1-5 Regional Sanitary Sewer Option 2

Project No: 22-3432 January 2024

Data Sources: Clean Water Services, Portland Metro RLIS, Pacific Community Design, Cooper Mountain Community Plan.
Coordinate System: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl
Disclaimer: Consor and Clean Water Services make no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes. Notification of any errors is appreciated.



Legend

- River Terrace South
- River Terrace North
- District Pump Station
- Decommission Pump Station
- Future Pump Station
- Future Force Mains
- Decommission Force Main
- Existing Force Main
- Existing Gravity Trunk
- Future Gravity Service (local flow direction)
- New Tile Flat Gravity Main
- River Terrace West Gravity Main Option
- New Kingston Terrace Gravity Main Option
- New Gravity Main SBM Option 3
- Rivers/Streams
- Urban Growth Boundary
- Rural Reserve
- Bankston Family Trust Conservation Easement

Clean Water Services

consor

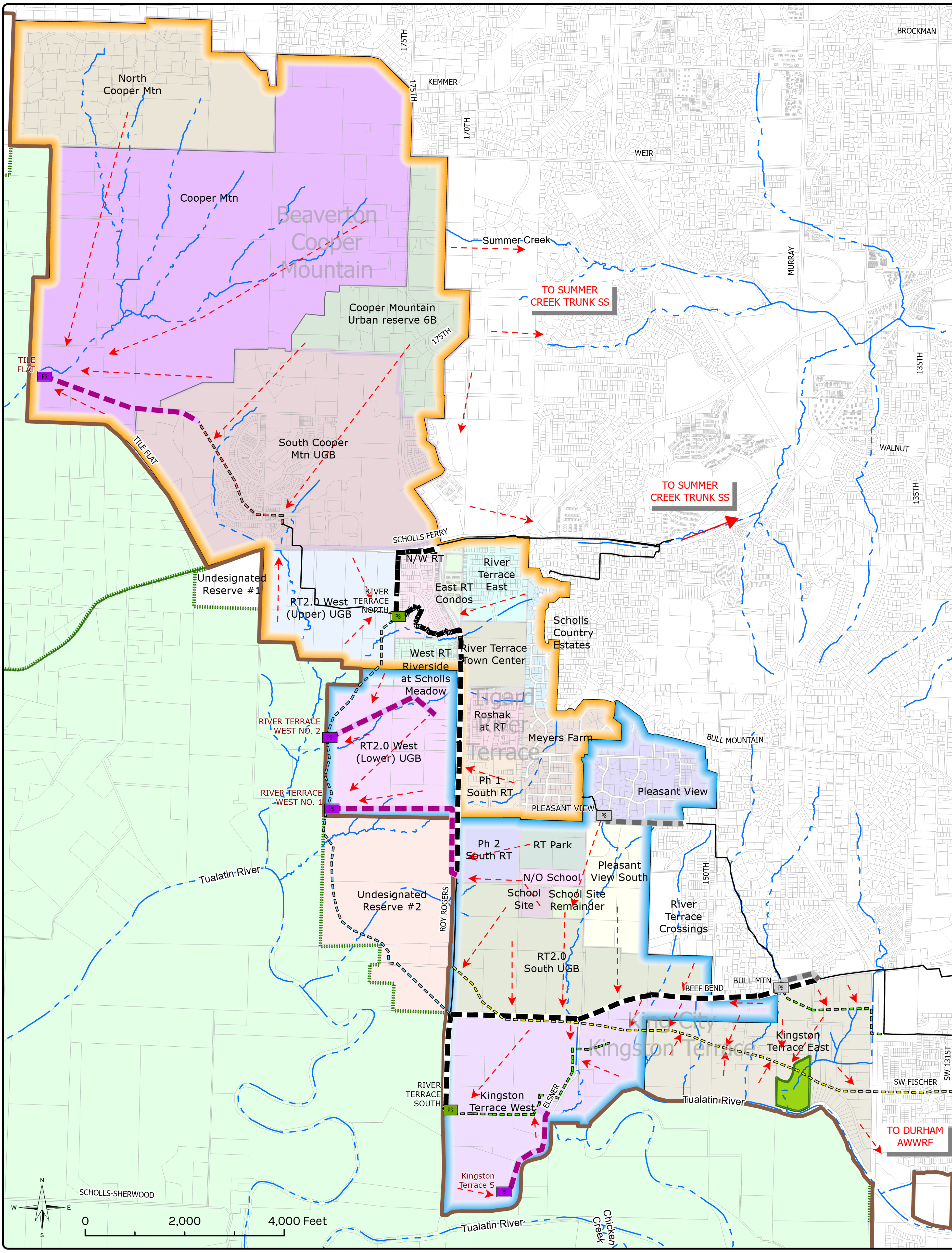
South Bull Mountain Sanitary Sewer Concept Plan

Figure 1-6 Regional Sanitary Sewer Option 3

Project No: 22-3432

January 2024

Data Sources: Clean Water Services, Portland Metro RLIS, Pacific Community Design, Cooper Mountain Community Plan.
Coordinate System: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl
Disclaimer: Consor and Clean Water Services make no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes.
Notification of any errors is appreciated.



Legend

- River Terrace South
- River Terrace North
- District Pump Station
- Decommission Pump Station
- Future Pump Station
- Future Force Main
- Decommission Force Main
- Existing Force Main
- Existing Gravity Trunk
- Future Gravity Service (local flow direction)
- New Tile Flat Gravity Main
- River Terrace West Gravity Main Option
- New Gravity Main SBM Option 4
- New Kingston Terrace Gravity Main Option
- Rivers/Streams
- Urban Growth Boundary
- Rural Reserve
- Bankston Family Trust Conservation Easement

Clean Water Services consor

South Bull Mountain Sanitary Sewer Concept Plan

Figure 1-7 Regional Sanitary Sewer Option 4

Project No: 22-3432 January 2024

Data Sources: Clean Water Services, Portland Metro RLIS, Pacific Community Design, Cooper Mountain Community Plan.
Coordinate System: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl
Disclaimer: Consor and Clean Water Services make no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes.
Notification of any errors is appreciated.

1.2.2.3 Pipeline Extension Projects for PS Decommissioning

Pleasant View and Bull Mountain PSs are candidates for decommissioning upon future construction of pipeline extensions to the stations.

Pleasant View PS is planned to be a permanent contributor to the RTS PS. To facilitate this, sanitary sewer infrastructure in River Terrace 2.0 (RT 2.0) and Kingston Terrace must be planned to convey flows from the Pleasant View basin to the RTS PS. Development Conditions of Approval in these areas should require extensions of sanitary sewer infrastructure to accommodate the upstream contributions. Decommissioning will remove flow from the Bull Mountain PS and will add flow to RTS PS, and timing should be considered when implementing other interconnected SBM projects such as the RTS PS Bypass Project, Kingston Terrace East gravity sewers, and the Bull Mountain PS decommissioning.

Decommissioning the Bull Mountain PS will require a new gravity sewer constructed in Kingston Terrace East to convey flows to the UTI system. Sizing should take into account the flows from Pleasant View PS, depending on if that station will be decommissioned before or after Bull Mountain PS. Development Conditions of Approval for the East Kingston Terrace area should require extensions of sanitary sewer infrastructure to accommodate connection to the Bull Mountain PS.

1.2.3 Concept Plan Implementation, By Area

The Concept Plan provides recommendations for each planned development area of the SBM study area.

1.2.3.1 City of King City – Kingston Terrace

The District currently owns and operates all sanitary sewer infrastructure in King City as authorized by an intergovernmental agreement (IGA). Most of the Kingston Terrace local sanitary system will be built by Kingston Terrace development as it occurs, with each development connecting to the District's regional sanitary system.

Final configuration of the local sanitary sewer system in Kingston Terrace will be influenced by the regional sanitary sewer infrastructure, and vice versa. It is recommended the District prepare a more localized sewer plan for the Kingston Terrace area in close coordination with the local development community. The localized sewer plan should look for opportunities to co-locate infrastructure with new or widened roads.

King City envisions development occurring in two phases, with more immediate development in the west and north, and slower, more incremental development in the eastern and southern portions of Kingston Terrace over a longer period.

Development of Kingston Terrace West requires a gravity trunk sewer from RTS PS routed east and north, with an ultimate buildout extension to parcels north of SW Beef Bend Road near SW 150th Avenue that naturally flow south. The District may opt to construct the gravity sewer in its entirety as part of Option 2 of the RTS PS Bypass Project, or it could be constructed as a separate trunk sewer project in conjunction with Option 1. The trunk sewer should be planned to receive flows from the future Kingston Terrace South PS that may be constructed to serve the area south of, and topographically isolated from, Kingston Terrace West.

The topography and natural resources make development of Kingston Terrace East less likely to occur in the near-term. However, the northern portion of Kingston Terrace East bordering Beef Bend Road is expected to develop sooner than the areas closer to the river. Service can be provided by a new gravity sewer extending east to the existing sewer at SW 137th and C Street. This sewer should be sized to receive all flows from the Bull Mountain PS upon its decommissioning and may be sized larger to be a portion of the trunk sewer described as Option 3 of the RTS PS Bypass.

Kingston Terrace East would be served by gravity through new sewers connecting into the existing sanitary system in King City. Due to deep ravines in the southern and western portions of Kingston Terrace East, some form of pumping will likely be required. Three small pump stations could be independently implemented over time. Concepts could include either separate force mains or a single shared force main leading either east or north, crossing under or over ravines by way of trenchless pipe installation, or elevated roadway and/or pedestrian bridges, respectively. It is recommended a more detailed planning study be performed by the District in partnership with the City of King City and local landowners.

1.2.3.2 City of Tigard – River Terrace

Sanitary sewer service for River Terrace 1.0 (RT 1.0) development has been planned by the City of Tigard, in coordination with the District, and is nearly complete. The RT 2.0 area consists of two distinct areas added to the UGB by the City of Tigard in 2022. These are referred to as RT 2.0 West and RT 2.0 South. The RT 2.0 West area is further divided into RT 2.0 West (Upper) and RT 2.0 West (Lower). Approximately 4,530 total dwelling units are being planned for in the RT 2.0 area, with 2,730 dwelling units in RT 2.0 West and 1,800 dwelling units in RT 2.0 South.

The City of Tigard intends to complete a Master Plan for the RT 2.0 areas by 2025. It is recommended the District coordinate closely with the City of Tigard during development of the Master Plan. As more detailed development plans are conceived and prepared, the District should review and update the RTS PS trigger plot to determine if and how this area may affect timing of the RTS PS Bypass Project.

The RT 2.0 West (Upper) area would be served by gravity via the existing 24-inch sewer trunk that flows southeast to the RTN PS. RT 2.0 West (Lower) will require at least one District-owned pump station along the area's western boundary, with a force main pumping to the existing 24-inch trunk sewer in Roy Rogers Road, where it would flow by gravity to RTS PS. Alternately, a gravity sewer could be constructed south to the intersection with Beef Bend Road in lieu of the pump stations. This trunk sewer would require the use of aerial pipe crossings of the ravines via pipe bridges. The City may further investigate this as part of the City's upcoming master plan project.

Portions of the RT 2.0 South area can be immediately served by the existing 24-inch Roy Rogers Trunk Sewer. Other parcels in RT 2.0 South will need new sewer infrastructure constructed to the existing RTS PS. Sanitary sewer may be extended to the Kingston Terrace West Trunk Sewer to RTS P S. Or, if development in Kingston Terrace has not yet occurred, pipe can be installed in Beef Bend Road to connect to the Roy Rogers Trunk Sewer.

1.2.3.3 City of Beaverton - Cooper Mountain

The City of Beaverton is currently planning for a total of over 7,000 dwelling units in the Cooper Mountain Community planning area. The City will complete the Cooper Mountain Utility Plan (CMUP) in 2024?

Due to topography, the western half of the planned area will require the Tile Flat Pump Station to be constructed near the intersection of Tile Flat and Grabhorn Roads. It would have a buildout capacity of up to 3.5 mgd and feature a force main running southeast, discharging to the 24-inch trunk sewer in the RTN PS basin. The District is currently conducting a siting study for the facility.

The District is recommended to coordinate closely with the City of Beaverton during sanitary sewer planning in the Cooper Mountain Area, and to continue preliminary design planning for the pump station in coordination with the City to help reduce the time needed to complete final design of the facility, prior to bidding and construction.

1.2.4 Trigger Plots

Flow trigger plots for the RTN and RTS PS were updated to reflect current conditions in the SBM area.

The trigger plots were developed to assist with forecasting of timing for implementing capacity improvements to RTN and RTS to serve development. Three growth scenarios were used to estimate the possible range of implementation times for the regional projects – a frontloaded growth scenario, a backloaded growth scenario, and a constant growth scenario.

The peak dry weather flow (DWF) flow trigger for the RTS PS is 2.2 mgd. Assuming an estimated buildout equivalent dwelling unit (EDU) count of 20,052 EDUs in 2050, the peak DWF trigger is reached in 2028 for the frontloaded Growth Scenario, 2038 for the Constant Growth Scenario, and 2046 for the Backloaded Growth Scenario. Observed DWFs have been increasing along a trendline approximating the backloaded to constant growth scenarios, pointing to a trigger date around 2038. Implementation of one of the RTS PS bypass project options will need to consider the timeline for implementation, ranging from three to six years for the four project options.

A similar analysis was conducted for the RTN PS, which has a peak DWF trigger of 1.6 mgd. The trigger plot shows the trigger being exceeded as soon as 2029 under the frontloaded scenario, 2040 under the constant growth scenario, and 2047 in the backloaded scenario. Observed DWFs have been trending similar to the backloaded to constant growth scenarios.

1.2.5 Regional Development Monitoring Methodologies

It is recommended the District monitor and track the progress of development in the SBM area to ensure that the regional concept plan may be planned and implemented in a logical and efficient manner. The District is essentially monitoring development progress through the collection and analysis of flow monitoring data at the pump stations. However, from a forecasting perspective, flow monitoring data is backward looking - it shows where development is currently generating wastewater, but not what will be generating wastewater in the near- to medium-term future.

To better predict when a capital project needs to be implemented, it is recommended the District develop methodologies for forecasting how flows will increase over time and by how much.

A methodology using geographic information system (GIS) analysis tools to review address and water meter billing data was explored. This methodology would allow the District to see where development was creating new addresses, where new water meters were being installed, and where water consumption data indicates the water meters are in use due to occupancy. Because the District does not furnish water, the methodology relies on obtaining the data from the cities of Tigard and Beaverton on a regular basis.

Other methodologies could be used that more directly track numbers of residential and commercial development in the SBM area. This data would also need to come from the cities, since the District doesn’t directly administer land use approvals and building permits. Frequent and sustained collaboration with the cities on development progress and status is recommended.

1.3 Study Area Description

1.3.1 General

The SBM Regional Sanitary Sewer Concept Plan study area is shown in **Figure 1-1**. It is approximately 4,046 acres in size and includes areas on the south and west slopes of Bull Mountain and southern slopes of Cooper Mountain. The study area includes portions of the cities of Beaverton, Tigard and King City, and unincorporated Washington County. A significant portion of the study area is inside the UGB, and a small portion is designated as Urban Reserve.

1.3.2 Existing Regional Conveyance System

The District's regional conveyance system serving the SBM Regional Sanitary Sewer study area features gravity sewer trunks 24 inches in diameter and larger and six existing pump stations with force mains. The regional conveyance system is shown in **Figure 1-1** and **Figure 1-2**. The pump station service areas are highlighted by color.

1.3.3 Planned Development Areas and Neighborhoods

The study area is primarily made up of three larger planned development areas – City of Beaverton's Cooper Mountain, City of Tigard River Terrace, and City of King City's Kingston Terrace. Each of these planned development areas are further divided into neighborhoods and local planning areas, these are indicated on **Figure 1-2**. The local planning areas were delineated during development planning at the local level, and their names have been preserved here for continuity. Most of the neighborhoods fall within either the RTN or RTS PS service area.

There are several smaller planning areas that are not part of the study area at this time but are shown on the map for clarity. These include two Undesignated Reserve areas along the west edge of the study area. These are not designated as either Urban or Rural Reserve areas by Metro, and their future development status is unclear. Also, two areas along the eastern edge of Cooper Mountain are also shown on the map. They are part of the City of Beaverton's Cooper Mountain community planning studies but are not part of the RTS PS service area.

1.3.4 Natural Areas – Bankston Conservation Easement

An area referred to as the Bankston Family Trust Conservation Easement is indicated on **Figure 1-2**. It is in the southeast corner of the study area in the Kingston Terrace East neighborhood. This area has been protected by a conservation easement which effectively restricts or prohibits urban development within its boundaries. This easement area is reflected in Kingston Terrace planning work being completed by the City of King City. It is shown due to Its relevance to the District's planning of regional facilities in the Kingston Terrace area.

1.4 Previous Regional Planning for SBM Study Area

The SBM Concept Plan builds upon the most recent planning work conducted for the area, the EBMP. The District began work on the EBMP in 2019, and completed and adopted the plan in 2022. The EBMP provides a comprehensive plan for conveyance and treatment of all sanitary sewer flow in the eastern portion of the District's service area, which is entirely tributary to the Durham Water Resource Recovery Facility.

The EBMP's recommendations for capital improvements are assumed to be valid for this Concept Plan. The Concept Plan attempts to update those portions of the EBMP that are included in the SBM study area.

Prior to the preparation of the EBMP, the District prepared the UTI Master Plan in 2017. The UTI Master Plan provided a detailed engineering evaluation of alternatives for increasing the regional conveyance capacity for new development anticipated in the Bull Mountain and South Cooper Mountain expansion areas. It provided recommendations for expanding the UTI system to provide additional capacity needed for growth in the SBM area. The UTI capacity improvements were implemented starting in 2018.

Prior to that, in 2014, the River Terrace Community Plan was completed by City of Tigard. It laid the foundation for sanitary sewer infrastructure in the West Bull Mountain area. This Master Plan recommended that two pump stations be constructed on the west side of Bull Mountain to provide service to the River Terrace community. The District recognized these two pump stations would be needed to provide a regionally based approach to sanitary sewer service to the area. The RTN PS was constructed in 2015, and the RTS PS was put into service in 2019.

1.5 Other Planning Documents

The SBM study area includes several large tracts of land that have been brought into the Metro UGB from urban reserves within the last 5 to 10 years. Significant planning work has been performed for these areas, more detailed planning is currently underway for some of these areas, and additional planning is anticipated in the near future. These plans may play a strong role in how the District proceeds with implementation of this SBM Regional Sanitary Sewer Concept Plan and may necessitate revisions to this Concept Plan.

The following planning documents are currently considered relevant to the SBM study area:

- *Cooper Mountain Community Plan*, City of Beaverton (in progress, completion scheduled in 2024)
- *Cooper Mountain Utility Plan*, City of Beaverton (in progress, completion scheduled in 2024)
- *River Terrace 2.0 Concept Plan*, City of Tigard (adopted September 2021)
- *River Terrace 2.0 Master Plan,* City of Tigard (planned, completion anticipated in 2025)
- *Kingston Terrace Master Plan*, City of King City (adopted July 2023)
- *King City Urban Reserve Area 6D Concept Plan, City of King City (adopted May 2018)*

CHAPTER 2

Concept Plan

2.1 Introduction

The Concept Plan for regional sanitary sewer service for the SBM area is shown as a map on **Figure 1-3**. Most of the Concept Plan involves new projects needed to provide capacity for significant residential and commercial development planned for the area. These growth-related projects are organized into the area's two major pump station basins, RTS and RTN. Also included are gravity sewer extension projects needed to allow decommissioning of existing pump stations, which is a goal of the District.

Where alternative regional projects to serve a particular area are available for implementation, the Concept Plan provides a description of the alternatives and the considerations for how one alternative may be preferable.

This section also provides discussion on implementation of the regional projects as they relate to the specific planning area or jurisdiction they are located in.

2.2 River Terrace South Service Area Growth Projects

2.2.1 River Terrace South Pump Station Bypass

The RTS PS was constructed in 2019 with a firm capacity of 3.7 mgd. RTS PS is a key component of the SBM regional conveyance system. It was designed to initially receive flow from the RTN PS, which allows the District to reduce flows in the Summerfield and Fanno basins and alleviate capacity restrictions there. The RTS PS basin is largely undeveloped at this time, but as development occurs in either the RTN or RTS service area, flows to the RTS PS will eventually exceed the RTS PS capacity. The regional solution to this, as described in the EBMP, is to bypass RTN PS flows away from the RTS PS.

The station currently receives flow from the RTN PS via its force main discharge into the 24-inch Roy Rogers Trunk. The RTS PS force main is approximately 9,000 linear feet (LF), running along Roy Rogers Road and Beef Bend Road and discharges into the Bull Mountain Trunk sewer at SW Myrtle Avenue and Beef Bend Road.

The EBMP describes two main alternatives for bypassing RTN PS flows away from RTS PS. The EBMP estimated the project need for 2024 based on development forecasts used in the plan, however development in the RTN and RTS service area has been much slower than forecast.

A primary task of the SBM Concept Plan was to further investigate, develop and evaluate options to bypass RTN flows around the RTS PS. Through consultation with District staff, four RTS PS bypass options were identified and evaluated. A brief description of each follows.

2.2.1.1 Option 1- Force Main Extension along Beef Bend Road

Option 1 would construct an extension of the existing 16-inch diameter RTN force main south along Roy Rogers Road and east along Beef Bend Road to the discharge at the head of the Bull Mountain Trunk.

The length of force main extension is estimated at 10,300 LF. It would be constructed parallel to the existing RTS Force Main in Beef Bend Road right-of-way. Room for the future RTN Force Main was considered when planning and designing the RTS Force Main, which is already located in Beef Bend Road and was completed in 2019. The District may have an opportunity to install the RTN Force Main in a widened Beef Bend Road right of way (ROW) in conjunction with road improvements that will likely occur with development in the immediate vicinity.

The upper portion of the Bull Mountain Trunk system was designed to receive the full buildout of the RTN PS service area through this option and necessary downstream capacity improvements were completed in 2020.

Option 1 is identified in the EBMP as DU21C-10b1 (option 2)

2.2.1.2 Option 2- Force Main Extension through Kingston Terrace

Option 2 involves constructing a new 16-inch diameter RTS Force Main from the RTS PS through Kingston Terrace to the Bull Mountain Trunk and repurposing the existing RTS Force Main in Beef Bend Road to convey RTN PS flows. An extension of the RTN Force Main down Roy Rogers Road to connect to the repurposed force main would be required. The overall length of the 16-inch force mains would be 12,100 LF. The end result of Option 2 is similar to Option 1, in that RTN and RTS flows both are pumped to Bull Mountain Trunk in separate force mains.

This option was conceived to capitalize on a potential opportunity to construct a parallel force main and gravity sewer in the interior roadways of Kingston Terrace West. It could take advantage of developer activities to secure easements and rights-of-way and share some cost of construction with other utilities that would be co-located within the same rights-of-way, and it could avoid disruptive construction activity in Beef Bend Road, which is currently a two-lane rural road. The option would likely require significant support and cooperation with the District by the local developers.

Option 2 was not identified in the EBMP.

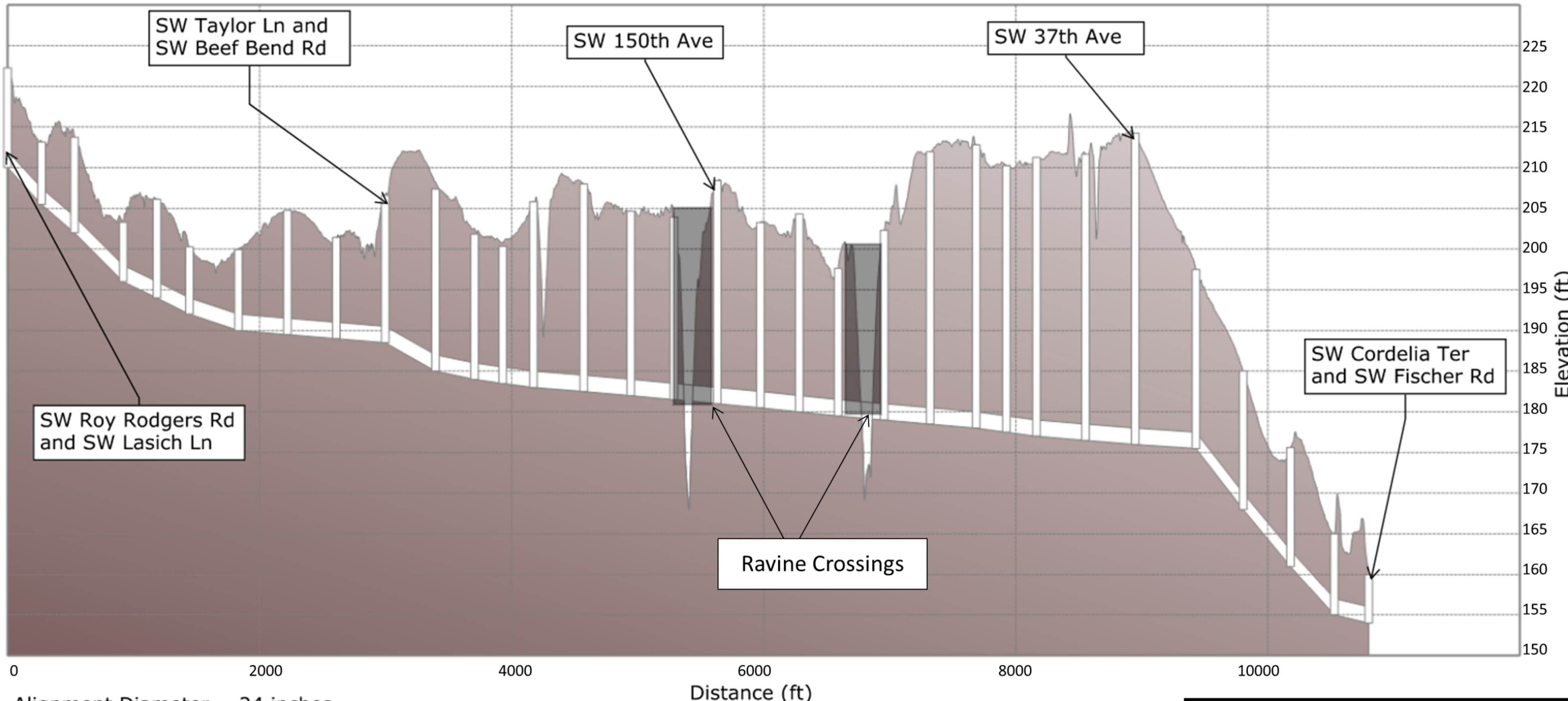
2.2.1.3 Option 3- Gravity Main Northern Route

Option 3 is a new gravity trunk sewer through the RT 2.0 South UGB and Kingston Terrace East and West areas, starting at SW Roy Rogers Road and discharging to the Bull Mountain Trunk system in SW 137th Avenue. The new trunk sewer would receive flow discharged from RTN Force Main plus flow from RTS PS basin areas located north of Beef Bend Road. This would effectively reduce the RTS PS service area to a smaller, localized area of Kingston Terrace West.

The Option 3 alignment was conceived to be co-located within a roadway alignment paralleling Beef Bend Road proposed in planning documents prepared by the City of King City. It serves in contrast to a similar but more southern roadway alignment described in Option 4 below.

Option 3 would involve two ravine crossings that would require a bridge structure to support the gravity pipeline, as indicated in **Figure 2-1**.

Option 3 is identified in the EBMP as DU21C-10b2 (option 2): King City Trunk (smaller size).



Alignment Diameter = 24 inches

consor CleanWater Services

South Bull Mountain Sanitary Sewer Concept Plan

Figure 2-1 Profile - Regional Sanitary Sewer Option 3 (Northern Route)

2.2.1.4 Option 4- Gravity Main Southern Route

Option 4 is a new gravity trunk sewer through the RT 2.0 South UGB and Kingston Terrace East and West areas, starting at SW Roy Rogers Road and discharging to the Bull Mountain Trunk system at SW 131st Avenue. and SW Fischer Road. Similar to Option 3, the trunk sewer would receive flow discharged from RTN Force Main plus flow from RTS PS basin areas located north of Beef Bend Road, reducing the RTS service area to a localized area of Kingston Terrace West.

The Option 4 alignment follows a similar path through RT 2.0 South and West Kingston Terrace, but takes a southern track through East Kingston Terrace, in the proposed roadway extension of SW Fischer Road. This alignment traverses lower elevations to minimize or eliminate the need for new future pump stations in lower central and east Kingston Terrace (shown as KT1, KT2 and KT3 PS with the other options).

Option 4 requires three ravine crossings with structures to support the pipeline (**Figure 2-2**).

Option 4 is identified in the EBMP as DU21C-10a (option 1): King City Trunk.

2.2.1.5 Qualitative Evaluation of Alternatives

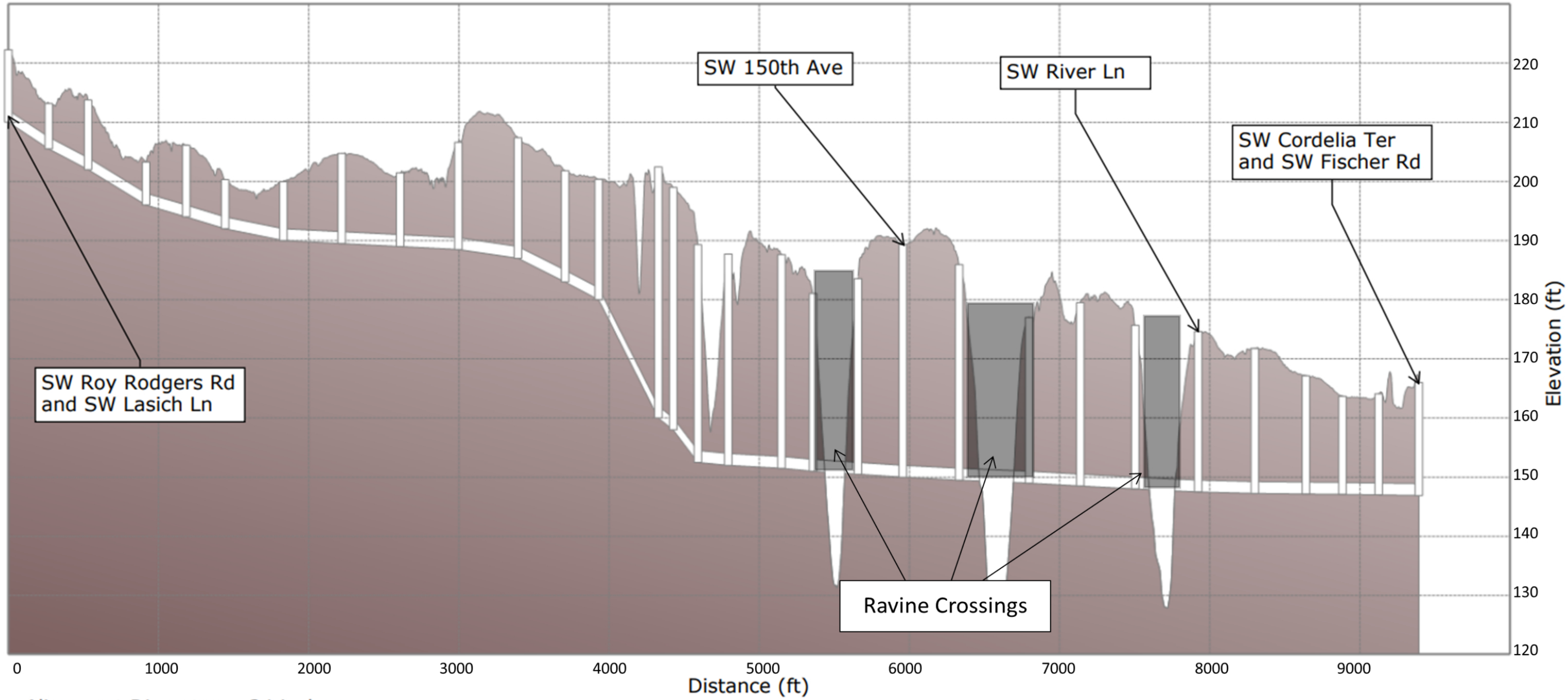
The four options were evaluated using several criteria developed by the project team that are considered relevant to the ultimate implementation of the project. The criteria cover aspects of budgeting, financing, planning, construction, operation, and maintenance of the infrastructure project. A summary of the criteria and evaluation results are provided below.

2.2.1.5.1 Cost

Estimates of present worth life-cycle costs, including capital cost and operations and maintenance cost, were developed for each option. The methodology for preparing estimates is described as follows:

Capital costs were prepared for each option by applying using the cost estimating methodology presented in Appendix 8A of the EBMP, which is consistent with Class 5 budget estimates. Costs were adjusted to 2023 dollars using ENR Construction Cost Index (CCI). The pump station unit costs provided in Appendix 8A were increased by a factor of 2 based on recent project experience and due to market conditions for procuring electrical equipment. Costs for the pipe bridges were developed using construction cost data for similar projects the District has recently constructed. Markups and indirect costs were applied using percentages provided in Appendix 8A, then adjusted for each option depending on the complexity of the option.

Annualized O&M costs were developed for the gravity and force main piping and the pump stations. Present worth life-cycle costs are based on an 80-year timeline with an interest rate of four percent was assumed. No residual values were assumed for the facilities at the end of their life.



Alignment Diameter = 24 inches

consor Clean Water Services

South Bull Mountain
Sanitary Sewer Concept Plan

Figure 2-2 Profile - Regional Sanitary Sewer Option 4 (Southern Route)

Table 2-1 summarizes the estimated total present worth life-cycle cost of each option. Detailed cost estimates for each option are included in **Appendix A**.

Table 2-1 | Summary of Life-Cycle Costs for Each Option

	Option 1 Force Main Extension - Beef Bend Road	Option 2 Force Main Extension - Kingston Terrace	Option 3[1] Regional Gravity-Northern Route	Option 4[1] Regional Gravity-Southern Route
Regional Project Capital Costs:				
Gravity Pipe	$5,608,000	$5,816,000	$12,748,000	$11,945,000
Force Main	$4,417,000	$5,133,000	$-	$ -
Bridges	$-	$-	$1,434,000	$5,905,000
Total Regional Project Capital Costs	**$10,025,000**	**$10,949,000**	**14,182,000**	**$17,850,000**
Present Worth Annual O&M	$2,319,000	$2,517,000	$2,012,000	$1,797,000
Total Life-cycle Cost	**$12,344,000**	**$13,466,000**	**$16,194,000**	**$19,647,000**
Local Project Capital Cost Add On:				
Local Pump Stations & FMs	$8,979,000	$9,016,000	$9,691,000	-
Present Worth Annual O&M (Local PS)	$4,540,000	$4,494,000	$4,511,000	-
Total Life-cycle Cost w/ Local PS's	**$25,863,000**	**$26,976,000**	**$30,396,000**	**$19,647,000**

Note:
1. Assumes gravity line is built in conjunction with local roadways.

2.2.1.5.2 Land Use

As of 2023, all options are within the UGB. All four options are conceived to be located within existing rights-of-way or co-located with other utilities with future roadways upon their land use approval. Therefore, no land use restrictions are anticipated for any of the options.

2.2.1.5.3 Easements/Condemnations

This criterion considers the potential for requiring easements across private land, and the potential for the need of condemnation of land to construct the future roadway. Option 1 would be within existing rights-of-way and would not require any easements. Option 2 would require easements for the force main through the Kingston Terrace area, but it is expected the force main would be routed within planned roadway alignments. Options 3 and 4 are expected to be routed in planned roadway alignments through both Kingston Terrace and the RT 2.0 South area; however, it is very possible that all roadway ROWs for the alignment will not be available at the time the project is to be implemented. Option 4 would also require an easement through the Bankston Conservation Easement, and obtaining an easement through this area is anticipated to be difficult. Condemnations may be required for Option 3 and are likely required for Option 4.

2.2.1.5.4 Pump Stations

Options 1, 2 and 3 would require pump stations to serve the lower areas in Kingston Terrace. Option 4 will be routed further south and is expected to eliminate the need for some or all of the pump stations in this area.

2.2.1.5.5 Ravine Crossings

Options 1 and 2 would not require ravine crossings. Option 3 would involve two ravine crossings that would require a bridge structure to support the gravity pipeline, as indicated in **Figure 2-1**. Option 4 has three ravine crossings requiring structures to support the pipeline (**Figure 2-2**).

2.2.1.5.6 Bankston Easement

Option 4 is the only option that would cross the Bankston Conservation Easement, which is intended to prohibit development-related activities within the easement boundary. The Bankston Easement will therefore likely impact the implementation of this option.

2.2.1.5.7 Cost Sharing

The potential for cost sharing between the District and cities/developers was assessed for each option. Option 1 is considered to have a low potential for cost sharing since it would be in existing rights-of-way and would mainly serve the regional system without also providing local gravity service. Options 2 through 4 are considered to have a medium-to-high potential for cost sharing since they are located in areas where major development will occur and would potentially be constructed in conjunction with development activity. Costs for elements of pipeline construction such as roadway pavement and traffic control could be shared with other utilities co-located in the same corridor.

2.2.1.5.8 Construction Challenges and Risks

Option 1 is considered to have a low risk since it is along existing rights-of-way, though construction could have a temporary but significant impact on traffic. Also considered low risk, Option 2 would have little-to-no impact on traffic, but it would require working closely with developers to assist in implementing a District-required project. Options 3 and 4 are considered high-risk because of the ravine crossings and the need for new roadways through rural and natural areas. Option 4 also would involve crossing the Bankston Conservation Easement which could be contentious.

2.2.1.5.9 Schedule

An implementation schedule was developed for each option, estimating each project's full lifecycle from planning through completion of construction. The implementation schedules take into account pre-design, final design, permitting, and easement acquisitions. Options 3 and 4 also considered District-led site preparations at the ravine crossings prior to construction. In addition, coordination with surface/storm water management/planning would be needed for Options 3 and 4 for the ravine crossings, which would happen throughout the design. A complex task of easement acquisition was added to Option 4 to account for the crossing through the Bankston Conservation Easement.

Table 2-2 below shows the implementation schedule for each option. Option 1 has the shortest implementation schedule, with an estimated 2.5 years to implement. Option 2 is estimated to require 4 years to implement, primarily due to the additional easement acquisition and permitting time. Option 3 is estimated to require 5 years to implement, and Option 6 has the longest estimated implementation time of 6 years.

Table 2-2 | Implementation Schedules for Each Option

Implementation Schedule for South Bull Mountain Regional Sewer Alternatives																
Years:	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**
Option 1 - FM Ext. Beef Bend Rd																
Planning	■															
Complete Predesign *(2.5 YEARS)*																
Permitting		■														
Easement Acquisition		■														
Complete Design		■	■													
Bid and Construction				■	■											
Option 2-FM Ext. Kingston Terrace[1]																
Planning	■	■														
Complete Predesign *(4 YEARS)*			■													
Easement Acquisition			■	■												
Permitting			■	■	■	■										
Complete Design						■										
Bid and Construction							■	■								
Option 3-Regional Gravity North[1]																
Planning *(5 YEARS)*	■	■														
Site Preparation	■	■	■	■	■	■										
Complete Predesign			■	■												
Easement Acquisition			■	■												
Permitting			■	■	■	■										
Stormwater/Surface Water Coordination			■	■	■	■										
Complete Design						■										
Bid and Construction							■	■	■	■						
Option 4-Regional Gravity South[1]																
Planning	■	■														
Site Preparation *(6 YEARS)*	■	■	■	■	■	■										
Complete Predesign			■	■												
Permitting			■	■	■	■										
Stormwater/Surface Water Coordination			■	■	■	■										
Easement Acquisition (Complex)			■	■	■	■	■	■								
Complete Design								■								
Bid and Construction									■	■	■	■				

[1]These options disregard the timing of any road right-of-way acquisition by King City, which may influence the project schedule.

2.2.1.5.10 Ease of Permitting

Option 1 is considered the easiest from a permitting standpoint since it will be located in existing ROW, with no lengthy natural resource or land use permitting processes anticipated. Options 2 through 4 are considered more difficult due to impacts on natural resources (see below). However, if roadways are developed in Kingston Terrace in conjunction with these options, it could reduce the permitting effort required by the District.

2.2.1.5.11 Potential Natural Resource Impact

Option 4 would have the most impact on natural resources since it would cross three ravines and the Bankston Conservation Easement. Option 3 would have the next highest impact with two ravine crossings. Option 2 may have some impact since it would route through undeveloped land, but the impacts would be less and could potentially be avoided. Option 1 is considered to have the least impact on natural resources since it would be in existing ROW.

2.2.1.5.12 Construction Impacts on Traffic

See Construction, Risks and Challenges above.

2.2.1.5.13 Impacts on Equipment O&M

Options 3 and 4 are considered to have the highest impact on O&M since they would have sections of piping located in ravines with steep areas. If the District builds pipe bridges over these ravines, there would be additional costs to the District for long-term maintenance. However, if a roadway is built by others as part of development, it could reduce the maintenance costs. Impacts on O&M for Options 1 and 2 are considered low since they will not be located in ravines.

2.2.1.5.14 Impacts on Stream Resiliency O&M

Impacts to streams are considered high for Options 3 and 4 since they both involve ravine crossings. Option 2 could potentially have some encroachment to streams, but it can potentially be avoided with routing or tunneling around. Option 1 is considered to have the lowest impact on streams since it would be in existing ROW.

2.2.1.5.15 Summary

Table 2-3 provides a summary of the qualitative criteria used in evaluating the options.

Table 2-3 | Qualitative Criteria Summary

Qualitative Criteria	Option 1: FM Extension on Beef Bend Road	Option 2: FM Extension through Kingston Terrace	Option 3: Regional Gravity - Northern Route	Option 4: Regional Gravity - Southern Route
Project Capital Cost	$10.0M	$10.9M	$14.2M	$17.8M
Portions outside UGB	No	No	No	No
Easements required	No	Yes	Yes	Yes
Condemnation needed	No	Not likely	Possible	Likely
Requires Pump Stations	Yes	Yes	Yes	No
Ravine Crossings	No	No	Yes	Yes
Impact Bankston Easement?	No	No	No	Yes
Potential for Cost Sharing?	Medium (developer, City)	High (developer)	Medium (developer, City)	Medium (developer, City)
Construction Challenges & Risks	Low (standard equip + materials; traffic control; constrained corridor)	Lowest (standard equip + materials; off-street; landowner participation)	High (depth; ravine crossings; dewatering)	Highest (depth; ravine crossings; dewatering)
Implementation Duration	Medium (County road coordination)	Medium (developer participation, easements)	Long (2 ravine crossings)	Very long (3 ravine crossings)
Ease of permitting	Easiest (County ROW Permit)	Less difficult (resources)	More difficult (land use, resources)	Most difficult (land use, resources)
Potential Natural Resource Impact	Low	Medium	High	Highest
Construction impacts on traffic	High	Medium	Low	Low
Impacts on equipment O&M	Lowest (in local, County roads)	Lowest (in local, County roads)	High (bridges; trails or local roads)	Highest (bridges; trails, local roads)
Impacts on stream resiliency O&M	Lowest	Medium (minor encroachments possible)	High (2 deep crossings)	Highest (3 deep crossings)

Note:
Green highlight indicates the most favorable conditions out of the options.
Red highlight indicates the least favorable conditions out of the options.

2.2.2 River Terrace North Pump Station Capacity Upgrade

The EBMP recommended that a capacity upgrade to RTN PS be implemented prior to construction of the Tile Flat PS in the City of Beaverton's Cooper Mountain Community Plan area. This EBMP Capital Improvement Plan (CIP) Project, labeled as DU21C-11, describes a pump replacement project needed to provide the necessary capacity upgrade.

The pump station is currently configured with two 105-horsepower pumps, with room for a third similarly sized pump. The primary force main is a 16-inch diameter PVC pipeline that discharges to the head of the 24-inch Roy Rogers Trunk sewer north of Lasich Lane. The station has a secondary 12-inch diameter force main available as a backup; it discharges to the Summerfield Trunk sewer in Scholls Ferry Road near the intersection with Roy Rogers Road.

The configuration of the RTN PS capacity upgrade will be dependent on whether the RTN Force Main is extended to bypass RTS PS (RTS Options 1 and 2), or if the regional gravity option through Kingston Terrace is constructed (RTS Options 3 and 4).

If the RTN Force Main is extended, the RTN pumps will need to be replaced with larger horsepower units to overcome the increased friction head from the additional pipeline length while also providing additional capacity.

If the RTN Force Main is not extended, and a regional gravity sewer is installed to bypass flow around RTS PS, the existing pumps are expected to be sufficiently sized for buildout flows as projected in the EBMP.

The District is also investigating the feasibility of utilizing both force mains to provide additional capacity in the future. This may provide a benefit of creating additional pumping capacity at the RTN PS without the need to upsize the pumps or construct the regional gravity option through Kingston Terrace.

Once flows from RTN PS are bypassed around the RTS PS, the RTS PS is projected to have sufficient capacity for buildout of the RTS service area.

2.2.3 Pipeline Extension Projects for Pump Station Decommissioning

The EBMP identified four pump stations in the SBM study area that are candidates for decommissioning, upon installation of a pipeline extending to the pump station from a downstream gravity sewer. The four stations are Pleasant View, Meyers Farm, Scholls Country Estates and Bull Mountain Pump Stations. A pipeline extension was constructed to Meyers Farm PS in 2023, and an extension to Scholls Country Estates is planned for 2024, therefore these two projects are not considered for this Concept Plan. Below is a description of the projects required to decommission the two other stations.

2.2.3.1 Pleasant View PS Decommissioning

The EMBP recommends decommissioning the existing Pleasant View PS once new downstream infrastructure is constructed to support it. Pleasant View PS is located on the slope of SBM in unincorporated Washington County and was constructed at the southernmost edge of the urban growth boundary.

The pump station has a firm capacity of 400 gpm. The pump station service area is considered to be built out. The facility currently pumps east to a District-owned trunk sewer running south and adjacent to SW 150th Avenue, which flows to the Bull Mountain PS.

The pump station is planned to be a permanent contributor to the RTS PS. The addition of RT 2.0 South to the UGB in 2022 will lead to urban development in the area south of Pleasant View PS. Sanitary sewer infrastructure in RT 2.0 and Kingston Terrace must be planned to convey flows from the Pleasant View basin to the RTS PS once Pleasant View PS is decommissioned. Land use actions by City of Tigard and King City should include Conditions of Approval to require extensions of sanitary sewer infrastructure to accommodate the upstream contributions, and conveyance facilities must be designed with the additional flow. Once infrastructure is in place, the District may decommission the facility in accordance with District policies and procedures.

It is important to note that Pleasant View PS decommissioning will remove flow from the Bull Mountain PS and will add flow to RTS PS. Timing of this project should be considered when performing detailed planning and design of other interconnected SBM projects such as the RTS PS Bypass Project, Kingston Terrace East gravity sewers, and the Bull Mountain PS decommissioning.

The City of Tigard will likely be responsible for the design and ownership of the infrastructure. Tigard is planning to begin a Master Plan process for the RT 2.0 South area, with work to start in 2024. The utilities portion of the Master Plan should incorporate the flow contributions from Pleasant View, as identified in the City's RT 2.0 Concept Plan prepared in 2021. This is further discussed below in the RT 2.0 section.

2.2.3.2 Bull Mountain PS Decommissioning

The EMBP recommends decommissioning the existing Bull Mountain PS upon construction of necessary downstream sewer infrastructure. Bull Mountain PS is located on Beef Bend Road near SW 146th Avenue. in the SBM area of unincorporated Washington County. It was constructed to receive sanitary sewer flows from development in City of Tigard and unincorporated Washington County.

The pump station has a firm capacity of approximately 1,500 gpm. The pump station service area is considered nearly built out.

The EBMP plans for flows from the Bull Mountain PS basin to be conveyed via new gravity sewer constructed in Kingston Terrace East, which will convey east to the existing Bull Mountain Trunk Sewer along SW 135th Avenue, and ultimately to Tualatin River Siphon in lower King City.

Sizing of infrastructure downstream of Bull Mountain PS upon decommissioning may need to take into account the flows from Pleasant View PS, depending on if that station will be decommissioned before or after Bull Mountain PS.

Gravity sanitary sewer infrastructure in Kingston Terrace should be sized and located to receive flows from the Bull Mountain PS. Land use actions by the City of King City should include Conditions of Approval to require extensions of sanitary sewer infrastructure to accommodate connection to the Bull Mountain PS, with conveyance facilities sized for the additional flow. Once infrastructure is in place, the District will decommission the facility in accordance with District policies and procedures.

2.3 Concept Plan Implementation, By Area

The following section presents background and recommendations for implementing the Concept Plan for each area of the SBM Study Area. These areas are organized by the relevant jurisdictions:

- City of King City – Kingston Terrace
- City of Tigard – River Terrace

- City of Beaverton – Cooper Mountain

2.3.1 City of King City - Kingston Terrace

The SBM Sanitary Sewer Concept Plan includes the entire 528-acre Kingston Terrace area located west of King City. It features two neighborhoods referred to here as Kingston Terrace East and Kingston Terrace West. The Kingston Terrace area was brought into the UGB in 2018, and the City completed and adopted the Kingston Terrace Master Plan (KTMP) in July 2023. The KTMP provides a framework for the addition of approximately 3,600 dwellings and 50,000 square feet of commercial space in four distinct neighborhoods.

The District currently owns and operates all sanitary sewer infrastructure in King City as authorized by an IGA. Most of the Kingston Terrace local sanitary system will be built by Kingston Terrace development as it occurs, with each development connecting to the District's regional sanitary system. The District is responsible for approving the design and construction of all local sanitary sewer. Final configuration of the local sanitary sewer system in Kingston Terrace will be influenced by the regional sanitary sewer infrastructure, and vice versa. Depending on development timing, local sewer infrastructure may define how the regional system is constructed. It is recommended the District prepare a more localized sewer plan for the Kingston Terrace area in close coordination with the local development community. The localized sewer plan should look for opportunities to co-locate infrastructure with new or widened roads.

The KTMP envisions development occurring in two phases, with more immediate development in the west and north, and slower, more incremental development in the eastern and southern portions of Kingston Terrace over a longer period of time. Recommendations for implementing local sanitary service for these two phases are further detailed below.

2.3.1.1 Phase 1 – More Immediate Development (Kingston Terrace West)

Kingston Terrace West extends east from Roy Rogers Road to approximately SW 150th Avenue, and Beef Bend Road south to the Tualatin River. It includes all of Main Street/Town Center and the western portion of the Beef Bend Neighborhood as outlined in the KTMP. The area has a small number of large parcels. Plans for near-term development have been discussed by landowners and King City. According to the 2023 KTMP, the northern half of Kingston Terrace West is expected to develop sooner than the areas closer to the river.

The area is entirely within the RTS PS service area, and sanitary service to this area will include new gravity sewers leading to the RTS PS through connection to the Roy Rogers Trunk Sewer. The RTS PS is constructed at depth sufficient to extend a gravity trunk sewer from RTS PS east and north towards parcels along Beef Bend near SW 150th Avenue. This gravity sewer is expected to be located within new roadways constructed for new development in this area as shown in Figure 6.4 of the KTMP. CWS may require portions of the trunk to be oversized to serve existing and future development north of SW Beef Bend Road that naturally flow south.

This sewer trunk may be constructed over time in conjunction with local development, proceeding west to east. Alternatively, the District may opt to construct the gravity sewer in its entirety as part of Option 2 of the RTS PS Bypass Project described above. Or it could be constructed as a separate trunk sewer project in conjunction with Option 1. If Options 3 or 4 were implemented, the western portion of the trunk sewer would be required.

In addition, the trunk sewer should be planned to receive flows from a future Kingston Terrace South PS, shown on the Concept Plan Map. The Kingston Terrace South area is a small developable area topographically isolated from the rest of Kingston Terrace West by a wide floodplain area. Sanitary sewer planning for Kingston Terrace identified the need for a pump station to serve development here. A new force main may be installed along Elsner Road to discharge to the gravity sewer, to be re-pumped by RTS PS.

2.3.1.2 Phase 2 – Incremental Development (Kingston Terrace East)

Kingston Terrace East extends from Beef Bend Road to the Tualatin River, and west to a drainage west of SW 150th Avenue. The area has significant natural resource areas, including the Bankston Family Trust Conservation Easement (shown on **Figure 1-3**). The area is divided topographically by several deep ravines draining off of Bull Mountain. The topography and natural resources make development less likely to occur in the near-term and create impediments to typical gravity sanitary service.

According to the 2023 KTMP, the northern portion of Kingston Terrace East bordering Beef Bend Road is expected to develop sooner than the areas closer to the river. Service to this area can be provided by a new gravity sewer extending east along the southern parcel lines, discharging to the existing sewer at SW 137th and C Street. This gravity sewer aligns mostly with the eastern-most portion of Option 3, Gravity Main Northern Route, one of the RTS PS Bypass options described above. Regardless of whether it is extended west as part of Option 3, or only serves local development along Beef Bend Road under Options 1, 2 or 4, this sewer should be sized to receive all flows from the Bull Mountain PS upon its decommissioning, as described as EBMP CIP Project DU21C-20 and earlier in this report.

In Kingston Terrace East, the Central Neighborhood and Rural Character Neighborhoods, as described in the KTMP, are expected to develop slowly and incrementally over time. The Rural Character Neighborhood can be served by gravity through new sewers connecting into the existing sanitary system in King City east of the BPA easement on the east side of SW 137th Avenue. For areas to the south that are lower in elevation, new sewer can be constructed to discharge into the existing sewer at SW Montague Way near SW 136th Avenue. These sewers could be co-located within new transportation connections to the City, as shown in Figure 6.5 of the KTMP.

2.3.1.2.1 KT-1, KT-2, KT-3 Pump Stations

The southern and western portions of Kingston Terrace East feature three well-defined terraces of developable land separated by deep ravines. When developed, these areas will be too low in elevation to be served by Option 3, and potentially by Option 4. To provide sanitary sewer service to these areas, some form of pumping will likely be required. In addition, pumping will be required for Option 1 and 2. Where feasible, gravity sewers may be co-located with new transportation facilities, as is planned for the Rural Character Neighborhood in the KTMP.

As identified on the Concept Plan map, three pump stations (KT-1, KT-2, and KT-3) could be independently implemented near the southern boundary of the developable area, with each having a single separate force main conveying flows north to a gravity sewer linked to the Bull Mountain Trunk system. Other pumping concepts could include a single shared force main leading either east or north, crossing under or over ravines by way of trenchless pipe installation, or elevated roadway and/or pedestrian bridges, respectively. If pump stations are needed, they would likely be developer-implemented, with capacities at 200 gpm or less, for each pump station.

A more detailed planning study for local sanitary sewer service in Kingston Terrace East is anticipated to be performed by the District in partnership with the City of King City and local landowners. These pump stations are identified in the EBMP as DU21C-10b3 (option 2).

2.3.2 City of Tigard - River Terrace

Tigard owns sanitary sewer pipelines smaller than 24 inches in diameter. The District owns and maintains all pipelines 24 inches and larger, and owns and operates all pump stations and associated force mains. It is currently expected that all new gravity sanitary sewer lines in the Tigard River Terrace region will be City-owned. Due to topography, the westernmost edge of Tigard River Terrace will require new sanitary pumping facilities.

2.3.2.1 River Terrace 1.0

The RT 1.0 development has been in construction since 2015. It features several distinct neighborhoods and developments south of Scholls Ferry Road. Sanitary sewer service for RT 1.0 development has been planned by the City of Tigard, in coordination with the District, and is nearly complete. Construction of the sanitary system for most of these areas is either complete or is underway.

Here are recommendations for the District to consider for further sanitary sewer planning of the RT 1.0 area.

- Areas of RT 1.0 north of Bull Mountain Road are all designated to flow to the RTN PS via City of Tigard-owned sewer trunk in Roy Rogers Road.
- The areas in RT 1.0 not yet constructed include Pleasant View South, and areas near the Ed Ruskin Elementary School, which are located north of RT 2.0 South. These areas are tributary to RTS PS and will flow south through the RT 2.0 South area. Sewers in RT 2.0 South must be sized to accommodate this flow.
- Scholls Country Estates PS is currently scheduled for decommissioning in 2024. This will result in additional flow to the RTN PS, and therefore to the RTS PS. Review of the RTS PS flow trigger and observed flow should be conducted prior to decommissioning.
- Sewer for Pleasant View South should be sized to convey flow from the to-be-decommissioned Pleasant View PS, located on SW Dozier Way just north of Pleasant View South (see Pleasant View PS Decommission Section).
- Note that flow to Pleasant View PS has been reduced significantly by the decommissioning of Meyers Farm PS, which used to pump to Pleasant View.
- Note also, that when Pleasant View PS is decommissioned, flow at the Bull Mountain PS will be reduced. Timing of decommissioning must be considered when design of Kingston Terrace East gravity sewer south of Beef Bend Road is designed (see Bull Mountain PS Decommission Section).

2.3.2.2 River Terrace 2.0

The RT 2.0 area consists of two distinct areas added to the UGB by the City of Tigard in 2022. These are referred to as RT2.0 West and RT 2.0 South. RT 2.0 West is further divided into RT 2.0 West (Upper) and RT 2.0 West (Lower).

A Concept Plan for RT 2.0 was completed by the City in 2021, prior to Metro's approval of the lands entering the UGB. The Plan included a description of existing and recommended sanitary sewer infrastructure for the areas, the primary purpose of which was to demonstrate feasibility of service by the City of Tigard and the District, and to estimate project costs to assist in financial planning.

The RT 2.0 Concept Plan estimated that approximately 4,530 total dwelling units should be planned for in the RT 2.0 area. Breaking down further, RT 2.0 West was estimated at 2,730 dwelling units, and RT 2.0 South at 1,800 dwelling units.

The City of Tigard intends to complete a Master Plan for the RT 2.0 areas by 2025. This plan will provide more detail on land use types and forms throughout the areas and will refine the number of dwelling units planned for the area. The master plan is expected to provide more detailed sanitary sewer infrastructure planning based on the more refined planning data. This may also be influenced by the progress of development in neighboring Kingston Terrace.

It is recommended the District coordinate closely with the City of Tigard during development of the Master Plan. Here are further recommendations for the City and the District to consider for sanitary sewer planning in the RT 2.0 Area. All areas of RT 2.0 will contribute to the RTS PS flow trigger. As more detailed development plans are conceived and prepared, the District should review and update the RTS PS trigger plot to determine if and how this area may affect timing of the RTS PS Bypass Project

2.3.2.2.1 River Terrace 2.0 West (Lower)

The RT 2.0 West (Lower) area is located southwest and downgradient of the RTN PS service area. The District completed the Upper Tualatin Master Plan in 2017 which designated this area to be part of the RTS PS service area.

The RT 2.0 Concept Plan and the EBMP have identified the need for pump stations to convey flow from the area to the RTS PS. The project is further described in the EBMP as CIP Project DU21C-12.

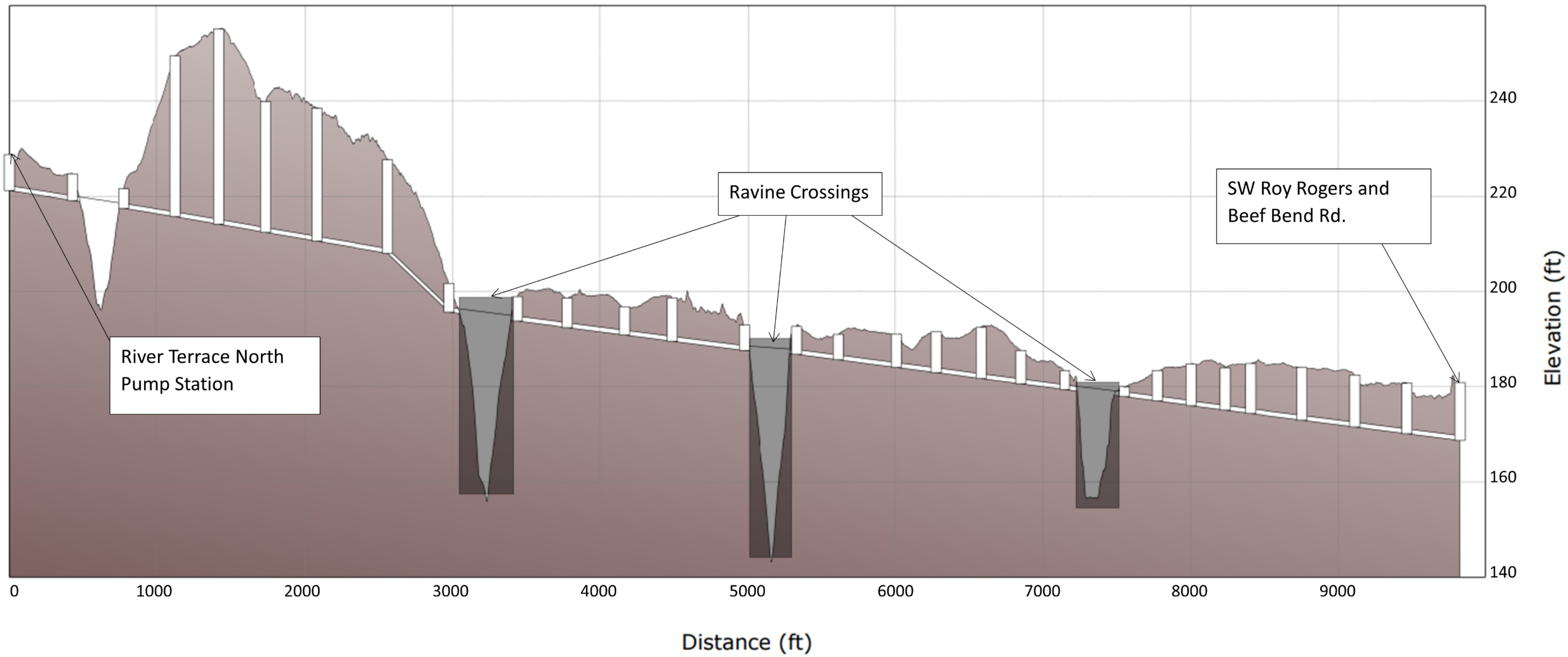
The area will require a District-owned pump station (River Terrace West No. 1) along the area's western boundary, with a force main pumping to the existing 24-inch trunk sewer in Roy Rogers Road, where it would flow by gravity to RTS PS. The RT 2.0 Concept Plan identified the potential need for a second pump station, River Terrace West No .2 PS, in the northern area due to topographic relief between the northern and southern portions of RT 2.0 West (Lower), with a force main discharging to a sewer leading to the No. 1 PS (as shown in the Concept Map).

The EBMP identified the potential of constructing a gravity sewer instead of the RTW No. 1 PS, conveying sanitary flow south and east to the Roy Rogers Trunk along a route that crosses two ravines in an area identified as Undesignated Reserve #2. A conceptual profile of the pipeline route was prepared for this study and is presented in **Figure 2-3**. The profile demonstrates that the pipeline route is feasible with the use of aerial pipe crossings of the ravines. These aerial crossings could be supported by pipe bridges, or a pedestrian pathway bridge that is used for a regional trail system.

Sanitary sewer planning for the area should be further investigated as part of the upcoming master plan project to be conducted by the City of Tigard for the new UGB areas.

Considerations for RT 2.0 West (Lower) are summarized as follows.

- Sanitary sewer will likely require new pumping facilities located along the western boundary of the area. Depending on configuration and timing of development in this area, one or two pump stations may be necessary to serve all parcels.
- A River Terrace West gravity sanitary sewer constructed along the west boundary should be considered as an alternative to the pump stations.



consor CleanWater Services

South Bull Mountain
Sanitary Sewer Concept Plan

Figure 2-3 Profile -
River Terrace West Gravity
Conveyance Alternative

2.3.2.2.2 River Terrace 2.0 West (Upper)

This area is mostly served already by an existing 24-inch sewer trunk that flows southeast to the RTN PS. Topography may dictate that new parcels in the southeast corner of RT 2.0 West (Upper) be connected to the existing gravity sewer in Jean Louise Road. This area could also be served by an extension of the gravity line discussed above for the RT2.0 West (Lower) area. This line would cross a ravine and require a bridge to support the pipe over the crossing.

2.3.2.2.3 River Terrace 2.0 South

The RT 2.0 South area is part of the RTS PS service area. It is bounded by City of Tigard's River Terrace to the north and east, Beef Bend Road to the south, Roy Rogers Road to the west. The topography is generally north to south. The 24-inch Roy Rogers Trunk Sewer is the only sanitary sewer facility currently in place to provide service to the RT 2.0 South area. Parcels directly fronting Roy Rogers Road may connect to the existing trunk sewer. All other parcels in RT 2.0 South will need new sewer infrastructure constructed.

The RT 2.0 Concept Plan shows the installation of gravity sewers extending north from Beef Bend Road into the newly developed areas. All gravity sewer planned for RT 2.0 South is expected to be less than 24 inches in diameter, and therefore will be planned, owned, and operated by City of Tigard. The EBMP and the RT 2.0 Concept Plan both identify the opportunity to decommission the Pleasant View PS through extension of local sewer north to the pump station site (see Pleasant View PS Decommission section). It is recommended that the District and the City of Tigard coordinate closely in planning sanitary sewer facilities in RT 2.0 South to ensure the facilities are sized and configured appropriately to accommodate the eventual decommissioning.

The RT 2.0 Concept Plan describes two alternatives for conveyance of these flows to the existing RTS PS. These alternatives are dependent on the timing of development of the Kingston Terrace West area relative to RT 2.0 South, and improvements to Beef Bend Road.

The first alternative assumes that development of the Kingston Terrace West has already occurred, along with construction of District-operated sanitary sewer infrastructure along and south of Beef Bend Road. Flows from RT 2.0 South can be conveyed across Beef Bend Road to connect to existing sanitary pipes. For this alternative to work, it is necessary that the Kingston Terrace West sanitary sewer system be planned to receive all flows from RT 2.0 South, including those from Pleasant View PS.

The second alternative assumes that development of RT 2.0 South occurs before development of Kingston Terrace and that the only conveyance system south of Beef Bend available is the Roy Rogers Trunk sewer. The RT 2.0 Concept Plan identified that a new 8-12-inch gravity collector sewer running east to west along Beef Bend Road could be constructed in conjunction with development along the north frontage of Beef Bend Road. This collector would be sized and configured to collect as much of RT 2.0 South as possible. The RT 2.0 Concept Plan identified that this collector sewer in Beef Bend may not have sufficient depth to serve the easternmost parcels of RT 2.0 South.

Considerations for RT 2.0 are summarized as follows:

- All gravity sewer planned for RT 2.0 South is expected to be less than 24 inches in diameter, and therefore will be planned, owned, and operated by City of Tigard.
- The 24-inch Roy Rogers Trunk Sewer is the only sanitary sewer facility currently in place to provide service to the RT 2.0 South area. Parcels directly fronting Roy Rogers Road may connect to the

existing trunk sewer. All other parcels in RT 2.0 South will need new sewer infrastructure constructed.

- Sanitary sewer in RT 2.0 South may be extended to the Kingston Terrace West Trunk Sewer to RTS, if it is constructed.
- Alternatively, the City of Tigard may construct a conveyance pipe in Beef Bend Road flowing west to discharge into the Roy Rogers Trunk Sewer. Pipe size for the Beef Bend Collector Sewer is estimated to range from 8- to 12-inches in diameter.
- Parcels in the far eastern portion of RT 2.0 South will likely need to connect to an extension of the Kingston Terrace West Trunk sewer, if topography does not allow gravity flow into the Bull Mountain PS service area.
- The District should continue to coordinate closely with the City of Tigard to refine sanitary sewer planning for the area as new developments in RT 2.0 South are proposed.

2.3.3 Beaverton - Cooper Mountain

The City of Beaverton is currently preparing a utility plan for Cooper Mountain Area, also referred to as URA 6B. When completed in 2024, the CMUP will provide a master plan for sanitary sewer infrastructure. The City is currently planning for a total of over 7,000 dwelling units in this area. Much of this area is rural in nature, with very few existing dwelling units, and has no public sanitary sewer infrastructure.

The City of Beaverton owns gravity sanitary sewer pipelines smaller than 24 inches in diameter. The District owns and maintains all gravity pipelines 24 inches and larger, and owns and operates all pump stations and force mains. It is currently expected that all new sanitary sewer lines in the Cooper Mountain Area will be City-owned. Due to topography, the western half of the planning area will require a new sanitary pump station. Referred to as the Tile Flat PS, it will be District-owned and operated and will be located in the southwest portion of the planning area near the intersection of Tile Flat and Grabhorn Roads.

2.3.3.1 Tile Flat Pump Station

Tile Flat PS is designated as EBMP CIP Project DU21C-14. The project would include a new District-operated pump station with a firm capacity ranging from 1.5 to 3.5 mgd. It would also include a force main running southeast within new rights-of-way to a receiving sewer in the South Cooper Mountain development area, which is tributary to the River Terrace North PS.

The District is currently conducting a siting study for the Tile Flat PS, for the purpose of recommending a preferred location for the pump station and force main facilities. Site acquisition and design of the project would follow upon further progress in development planning for the area. Design and construction of the project would be entirely District-led, with support from the City of Beaverton for coordinating and implementing in conjunction with local development.

The City currently estimates up to 6,000 dwelling units may be constructed in the Tile Flat PS service area, with firm capacity of up to 3.5 mgd required at buildout. The Cooper Mountain Area also includes the North Cooper Mountain (NCM) planning area located in the upper northwest corner. Much of this area is currently developed with single-family residential units on one-acre parcels. These lots are currently served by private septic systems, with no public sewer system. The southern portion of NCM would be tributary to the Tile Flat PS upon redevelopment with new public sanitary sewer conveyance. The future addition of

NCM to Tile Flat PS is being considered by the District in the siting study. The City of Beaverton anticipates that development could occur in the Tile Flat PS service area within 5 to 10 years.

The District has been coordinating closely with the City of Beaverton during development of the CMUP. Here are further recommendations for the City and the District to consider for sanitary sewer planning in the Cooper Mountain Area.

- Implementation of the Tile Flat PS is expected to require two to three years following the District's selection of a preferred site. The District is recommended to continue preliminary design planning for the pump station, in coordination with the City. This can help reduce the time needed to complete final design of the facility, prior to bidding and construction.

- The District should continue to coordinate with the City and the development community on interest and feasibility of development in the area and may consider phasing of pump station improvements over time, based on development timing.

THIS PAGE INTENTIONALLY LEFT BLANK

CHAPTER 3

Trigger Plots

3.1 Introduction

The District uses trigger plots as a flow forecasting tool to measure and forecast future flows in the service area to assist decision-making on which project alternatives to implement, and when. All capital projects proposed by the EBMP have DWF and wet weather flow (WWF) trigger plots.

In 2021, District staff reviewing RTS PS operational data noted that the observed DWF for both RTS and RTN PS were tracking well below the forecasted DWFs for that year as was presented in the EBMP. It was reasoned that the EBMP flow forecasting was assuming much faster rates of growth than were occurring in the SBM area.

Given the large discrepancy, the District requested the flow trigger plots for the RTN and RTS PS be updated to reflect current conditions in the SBM area. The following provides a description of the work performed to update the trigger plots.

3.2 Trigger Plots

The DWF Trigger is defined by the EBMP as the "maximum dry weather peak flow rate that leaves infrastructure with adequate capacity to convey the wet weather portion of the design storm event. The DWF trigger is intended to allow the District to monitor flow rates year-round when there is limited rainfall."

The WWF Trigger is defined as "firm capacity of a pump station or capacity of a gravity pipeline flowing at 105-percent of full flow capacity with consideration of surcharging up to the District's "IS" HGL code. The wet weather flow target is established for the 5-year storm condition."

Regulatory requirements state that the District's pump stations must provide firm capacity to convey the peak hour WWF rate. DWFs are generally much lower than the WWFs, and therefore do not approach the capacity of the pump station. However, for the SBM study area, there are benefits of using a DWF Trigger Plot:

- The DWF growth scenarios relate entirely to development, with flows directly correlated to growth in number of new dwelling units and commercial square footage added. Data measuring new development should be easily measured through building and planning department data, and by direct observation from GIS systems and satellite mapping.
- Observed DWF is easily calculated from summertime pump station flow monitoring data. Extrapolation for rainfall-induced flows under certain design storms is required to interpret observed WWF data.
- The development areas will be newly constructed with lower-than-average RDII rates in the initial years after construction. This may result in lower WWF rates that are not indicative of the advancing development in the basin over time.

3.2.1 Dry Weather Trigger Plots

The first step in updating the DWF trigger plots was to develop updated dry weather flow calculations for both current and buildout conditions of the study area based on current information regarding development.

The RTN PS and RTS service areas were divided into discrete planning units corresponding to a specific development area or existing pump station basin. Total EDUs and commercial acreage were estimated for each planning area using specific information provided by the local jurisdiction or by the development community, on aerial photos, and on available zoning and land use maps where applicable.

Table 3-1 summarizes the development assumptions for each planning area. Total EDUs at buildout were estimated at 12,528 EDUs for RTN PS, and 20,052 for RTS PS. Commercial acreages at buildout were estimated at 24 and 44 acres for RTN PS and RTS PS, respectively. A summary of EDUs and commercial acreage per pump station service area is provided in **Table 3-2**.

Table 3-1 | South Bull Mountain Planning Areas – Assumed Development Conditions at Buildout

Planning Area	Gross Area (Acre)	Total Net Area (ac)	Single-Family Units	Multi-Family Units	Commercial Acreage	Drains to
Scholls Country Estates PS	34	25.5	159	0	0	RTN
Meyers Farm PS	75	56.2	275	0	0	RTN
East RT Condos	5	3.8	0	141	0	RTN
Roshak Offsite	3	2.2	6	0	0	RTN
River Terrace Town Center	33	24.8	143	348	5	RTN
Roshak AT RT	40	30	271	0	0	RTN
PH 1 South RT	35	26.2	191	0	0	RTN
PH 2 South RT	35	26.2	162	0	0	RTS
RT Park	30	22.5	165	0	0	RTS
School Site Remainder	10	7.5	34	0	0	RTS
School Site	10	7.5	0	0	10	RTS
N/O School	10	7.5	48	0	0	RTS
Riverside at Scholls Meadow	10	7.5	79	0	0	RTN
West RT	18	13.5	137	0	0	RTN
N/W RT	75	56.2	275	0	0	RTN
River Terrace East (three Phases)	39	29.2	282	0	0	RTN
Pleasant View South	19	14.2	80	0	0	RTN
North Cooper Mountain	352	264	300	0	0	RTN
Cooper Mountain Urban Reserve 6B	527	395	3,833	1,128	10	RTN
South Cooper Mountain UGB	236	177	3,430	0	10	RTN
Pleasant View	102	76	193	0	0	RTS
RT2.0 West (Lower) URA	140	105	1,283	0	0	RTS
RT2.0 West (Upper) URA	144	108	1,450	0	0	RTN
RT2.0 South URA	205	154	1,813	0	0	RTS
Kingston Terrace West	272	204	1,404	0	6	RTS
Kingston Terrace East	227	170.2	1,196	0	4	RTS
Undesignated Reserve	196	147	1,226	0	0	RTS
Total	**2,882**	**2,161**	**18,435**	**1,617**	**44**	

Table 3-2 | Estimated EDUs, Commercial Development and Peak DWF at Buildout (2050)

Units at Buildout	RTN PS	RTS PS
Equivalent Dwelling Units (EDUs)	12,528	20,052
Commercial Area (Ac)	24	44

Buildout DWF was calculated for each planning area using the District's planning parameters, these are summarized in **Table 3-3**. The District's planning parameters are provided in **Table 3-4**.

Table 3-3 | Estimated DWF at Buildout -- RTN PS & RTS PS

Estimated Buildout Flow	RTN PS	RTS PS
Buildout Average DWF (mgd)	1.52	2.36
Buildout Peak DWF (mgd)	2.44	3.77

Table 3-4 | District Planning Parameters

Capacity Criteria	Data
People per Unit	2.1
Per Capita Sanitary Use (gpcd)	55
Employee Density per Acre	21
Sanitary Use per Employee	43
Dry Weather Flow Peaking Factor	1.6

The buildout DWF calculations were then used in developing DWF trigger plots for the RTS PS and RTS PS.

Preparing a methodology for forecasting flow increases from current conditions through buildout was the next critical step in developing the DWF trigger plots. It was first attempted to collect development forecasting data for each planning area, including number of EDUs and projected start, development duration and estimated buildout year. Known developers and city planning staff were consulted for the latest information. It was determined that the dates provided were generally very optimistic, which skewed forecasts to show much more flow occurring in 2022 than observed. This was similar to the forecasting provided by the EBMP. The second attempt was to assume a constant rate of population growth over time. This also proved to be very challenging, particularly because development patterns and population growth rates were highly volatile over the past five years.

Because of the large uncertainty, and the District's need to better understand how different growth rates might lead to different outcomes, the project team decided to develop three scenarios for growth in the study area. These would be used to estimate the range of triggers, attempting to "bookend" the forecasts.

The three growth scenarios are described as follows:

1. Constant growth trajectory – assumes the same number of dwelling units added to the service area every year.

2. Frontloaded growth – assumes a faster rate of development in the first several years, followed by rates, quickly tapering down to constant slow rate until buildout.

3. Backloaded growth – assumes a trajectory opposite of the frontloaded growth scenario, where the slow rate is used for the first several years, then ramping up to a faster rate until buildout.

It is assumed that the actual trajectory of development growth in the study area will fall within the bounds of the frontloaded and backloaded growth scenarios, though the actual trajectory is unpredictable at this stage.

Peak DWF was calculated for each year through buildout for each of the three growth scenarios, starting with the most recent year's DWF (2023) and extending through the assumed buildout year of 2050. The DWF calculation uses the annual allocation percentage assumed for that growth scenario to estimate the additional increase in flow attributed to development for that year. These allocation percentages are shown in **Table 3-5**.

For example, in 2024, for the constant growth scenario, 3.7 percent of the total buildout EDUs is added to the previous year's EDU total, and the average dry weather flow (ADWF) and peak DWF are calculated based on that year's new EDU total. Whereas for the backloaded growth scenario, one percent of the total buildout EDUs is added to last year's EDU total. In each of the three scenarios, the total percentage of EDUs from 2024 through 2050 sums to 100 percent.

Table 3-5 | Growth Scenarios – Percentages of Buildout EDUs Allocated Per Year

Year	Constant Growth	Frontloaded Growth	Backloaded Growth
2024	3.7%	12%	1%
2025	3.7%	12%	1%
2026	3.7%	12%	1%
2027	3.7%	10%	1%
2028	3.7%	10%	1%
2029	3.7%	7%	1%
2030	3.7%	7%	1%
2031	3.7%	5%	1%
2032	3.7%	5%	1%
2033	3.7%	2%	1%
2034	3.7%	2%	1%
2035	3.7%	1%	1%
2036	3.7%	1%	1%
2037	3.7%	1%	1%
2038	3.7%	1%	1%
2039	3.7%	1%	1%
2040	3.7%	1%	2%
2041	3.7%	1%	2%
2042	3.7%	1%	5%
2043	3.7%	1%	5%
2044	3.7%	1%	7%
2045	3.7%	1%	7%
2046	3.7%	1%	10%
2047	3.7%	1%	10%
2048	3.7%	1%	12%
2049	3.7%	1%	12%
2050	3.7%	1%	12%
TOTAL	**100%**	**100%**	**100%**

Peak DWF for each year through buildout was plotted on the applicable pump station's trigger plot. These trigger plots are further presented as follows.

3.2.1.1 River Terrace South PS Dry Weather Trigger Plot

The RTS PS DWF trigger plot prepared under this methodology is shown in **Figure 3-1**. The plot shows projected growth of peak DWF over time, from 2021 through buildout assumed in 2050, under each of the three growth scenarios. The DWF trigger of 2.2 mgd for the RTS PS is shown as a red line.

3.2.1.1.1 DWF Growth Scenarios

The estimated peak DWF through 2050 was calculated for the three growth scenarios and is shown on the RTS PS trigger plot. Assuming the total buildout EDU count of 20,052 EDUs, the constant growth rate equates to approximately 730 additional EDU per year. In contrast, the frontloaded growth starts with a rate of approximately 2,355 EDUs added per year for the first 3 years before tapering off to about 200 EDUs per year. Backloaded growth is the reverse of frontloaded, with about 200 EDUs added per year for the first 18 years until transitioning to fast growth of up to 2,355 EDUs added per year.

It is noted that these rates may be useful for quick comparison to development data that are expected to be available from local planning authorities.

As shown on the trigger plot, the three growth scenarios reach the 2.2 mgd DWF Trigger as follows:

- Frontloaded Growth Scenario 2028
- Constant Growth Scenario 2038
- Backloaded Growth Scenario 2046

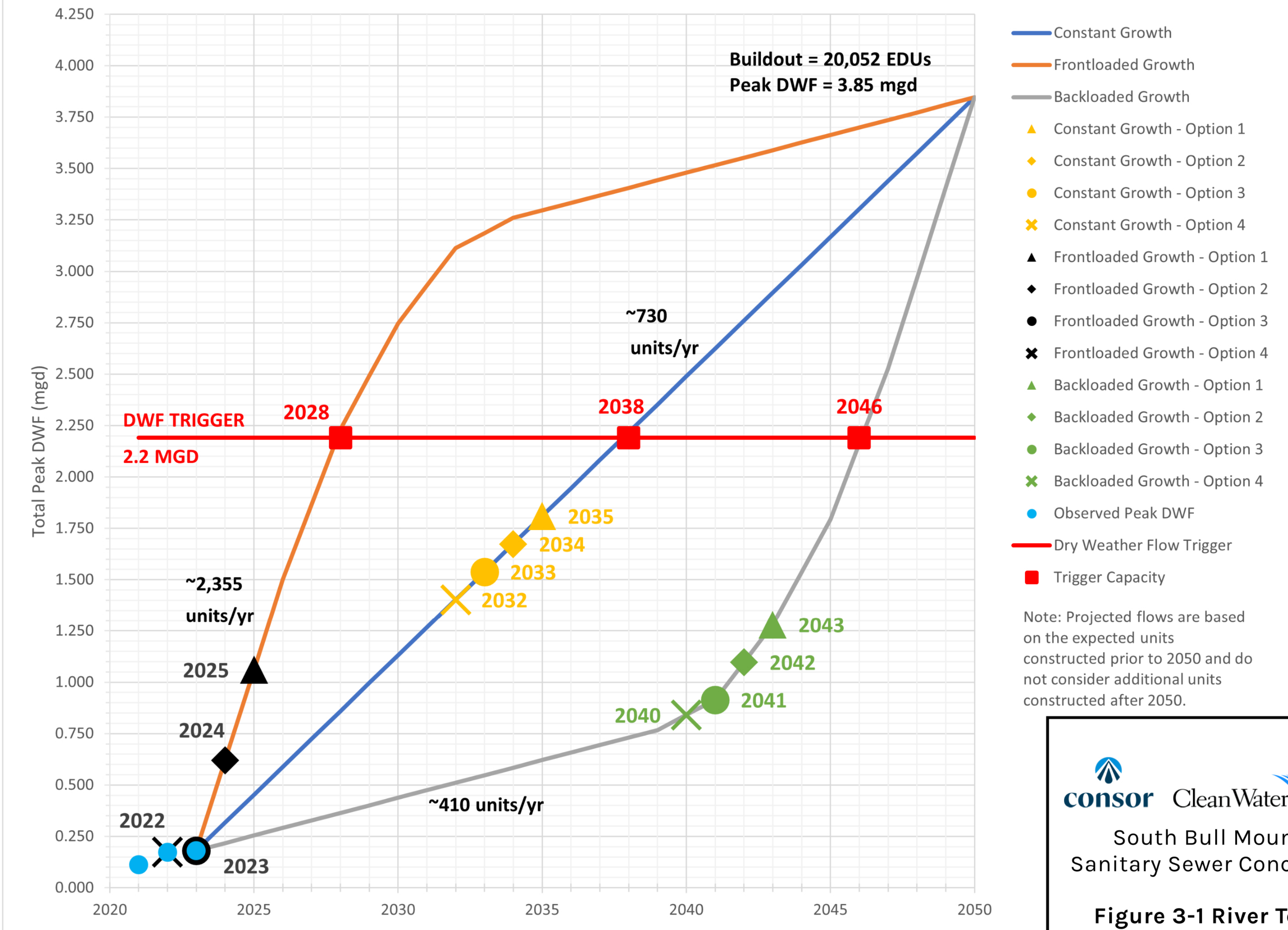
3.2.1.1.2 Observed DWF Data

The DWF growth projections were assumed to start in 2022 from the latest observed DWF data. Observed DWF for the RTS PS was estimated through evaluation of District pump station data provided by District staff for the years 2021 through 2023. ADWF was calculated for the dry weather months of July and August, and Peak DWF was calculated by applying the 1.6 dry weather peaking factor. The observed ADWF and peak DWF data for RTS PS are summarized in **Table 3-6**. These were also added to the trigger plot, shown as blue circles.

The percent change of calculated Peak DWF for the year compared to the 2.2 mgd DWF trigger is also shown in **Table 3-6**. It shows that between 2021 and 2022, the flow increase was approximately 2.7 percent of the 2.2 mgd trigger, and 0.4 percent of the trigger from 2022 to 2023. This demonstrates that flow growth in the basin has recently been slower than the constant growth scenario shown in **Table 3-5**.

Table 3-6 | RTS PS Observed DWF Data

Year	Observed ADWF (mgd)	Calculated Peak DWF (mgd)	% Increase Toward DWF Trigger
2021	0.070	0.112	--
2022	0.108	0.173	2.7%
2023	0.113	0.181	0.4%



consor Clean Water Services

South Bull Mountain
Sanitary Sewer Concept Plan

Figure 3-1 River Terrace South Pump Station Dry Weather Flow Trigger Plot

Project No: 22-3432

January 2024

3.2.1.1.3 Estimated Trigger Dates of Project Options 1 – 4

One of the available RTS PS Flow Bypass Project options should be implemented prior to the observed DWF reaching the DWF trigger. Each of the project options has an estimated timeline for implementation, ranging from 2.5 years for Option 1 to 6 years for Option 4, as described in Chapter 2. The estimated trigger date of each project option was then calculated for each of the three growth scenarios. These are plotted on the trigger plot, and further described below.

- *Constant Growth Scenario* – Estimated trigger dates for the four project options are shown in yellow. The dates range from 2032 for Option 4, to 2035 for Option 1.
- *Frontloaded Growth Scenario* – Estimated trigger dates for the four project options are shown in black. Option 1 and Option 2 have implementation trigger dates of 2024 and 2025, respectively. The trigger year for Options 3, is 2023, meaning the project should begin now if growth in the service area were to follow the frontloaded rate of 2,355 EDU per year. The trigger year for Option 4 is 2022.
- *Backloaded Growth Scenario* – Estimated trigger dates for the four project options are shown in green. The dates range from 2040 for Option 4 through 2043 for Option 1.

Interpretation of the trigger plot can be further explained with the following example: Assuming the District has selected Project Option 1 – Extend RTN Force Main in Beef Bend Road for implementation, under the Frontloaded Growth Scenario, project should be started in 2025, when the observed DWF rate was 0.985 mgd. Under a Constant Growth Scenario, the project would need to be started in 2036 when the observed DWF reached 1.3 mgd. Under the Backloaded Growth Scenario, the project would not need to be implemented until 2043, when the DWF was at 1.28 mgd but expected to increase rapidly.

It is noted that for Option 4 (Gravity Sewer – Southern Route) which has an implementation timeframe of 6 years, the project would need to start in 2032 under the Constant Growth Scenario. Under the Frontloaded Growth Scenario, it is already past the required start date and would not be considered as a feasible option for improvement.

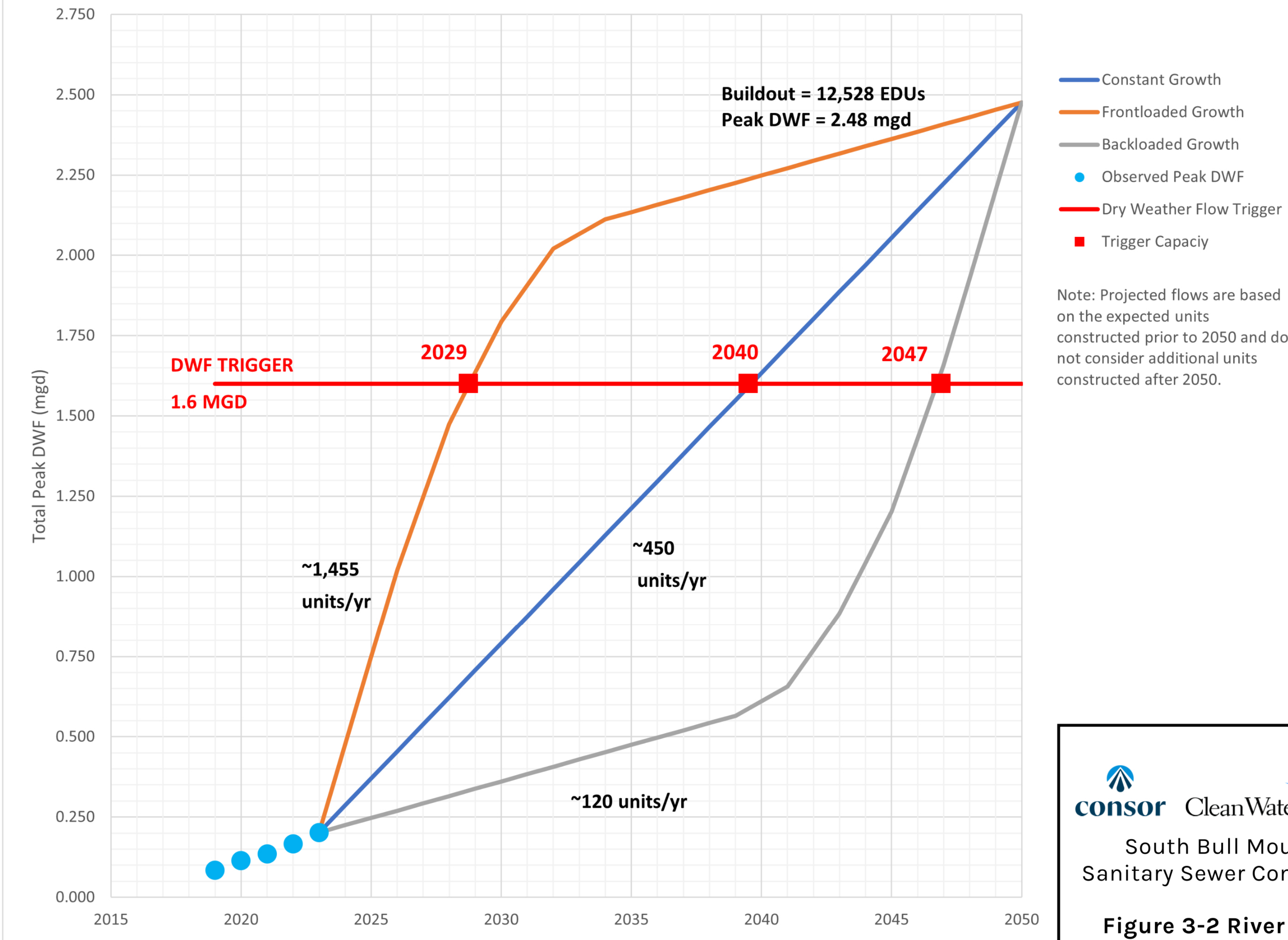
3.2.1.2 River Terrace North PS Dry Weather Trigger Plot

Similarly, a DWF trigger plot was prepared for RTN PS and is shown in Figure 3-2. The plot projects the estimated growth of peak DWF over time, from 2024 through buildout assumed in 2050. The DWF trigger for RTN PS is 1.6 mgd and is shown as a red line.

3.2.1.2.1 Observed DWF Data

Observed DWF for RTN PS was estimated from District pump station data provided by District staff. Data was available for the years 2019 through 2023. Similar to RTS PS, ADWF was calculated for the dry weather months of July through August, and the dry weather peaking factor of 1.6 was applied to estimate peak DWF. The observed ADWF and peak DWF for RTS PS are summarized in Table 3-7.

The observed DWF data is shown as blue circles on the trigger plot.



Note: Projected flows are based on the expected units constructed prior to 2050 and do not consider additional units constructed after 2050.

consor CleanWater Services

South Bull Mountain
Sanitary Sewer Concept Plan

Figure 3-2 River Terrace North Pump Station Dry Weather Flow Trigger Plot

Table 3-7 shows the percentage of the observed peak DWF increase relative to the 1.6 mgd DWF trigger. For the years 2020 through 2023, the annual increases have ranged from 1.3 percent to 2.2 percent, which is between the constant and backloaded growth scenarios.

Table 3-7 | RTN PS Observed DWF Data

Year	Observed ADWF (mgd)	Calculated Peak DWF (mgd)	% Increase Toward DWF Trigger
2019	0.053	0.084	--
2020	0.071	0.114	1.9%
2021	0.084	0.135	1.3%
2022	0.104	0.166	1.9%
2023	0.126	0.202	2.2%

3.2.1.2.2 DWF Growth Scenarios

The estimated peak DWF was calculated through 2050 for the three growth scenarios starting at the most recent observed DWF in 2023.

Assuming the total buildout EDU count of 12,528 EDUs, the constant growth rate is equivalent to approximately 450 EDU per year, with the frontloaded and backloaded growth scenarios ranging from 120 to 1,455 EDUs per year. This is evident in the trigger plot in **Figure 3-3**.

Under the three growth scenarios, peak DWF at the RTN PS reaches the 1.6 mgd flow trigger as follows:

- Frontloaded Growth Scenario 2029
- Constant Growth Scenario 2040
- Backloaded Growth Scenario 2047

It is evident in the plot that the observed DWF data has been following a trajectory between the Constant Growth and Backloaded Growth scenarios. Until a sustained increase in development in the RTN service area occurs, the RTN PS capacity upgrade project should not be necessary any sooner than 2040.

3.2.2 Wet Weather Flow Trigger Plots

The WWF trigger plots for the RTS PS and RTN PS were also developed by the District as an accompaniment to the dry weather trigger plots described above. The WWF trigger for each pump station is simply the firm capacity of the pump station. Because conveyance facilities are sized to handle peak WWFs, monitoring peak WWF relative to the WWF trigger is a more direct method of determining if a capacity improvement is needed. This methodology was utilized in the EBMP.

The disadvantage of WWF trigger plots is the higher level of analysis that is needed to convert observed WWF for a particular storm event to a peak WWF associated with a 5-year storm event. Oftentimes, an extrapolation is necessary.

The WWF trigger plots rely on the use of the peak DWF forecasting methods described in the previous section, then add the WWF contributions of rainfall-induced inflow and infiltration (RDI/I) and groundwater infiltration (GWI). Peak DWFs for the three growth scenarios. RDI/I was included in the trigger plots for both below and above the reduction thresholds.

Separate WWF trigger plots were developed for the three growth scenarios described above for DWF triggers. The WWF trigger plots prepared under this methodology show projected growth of peak WWF over time, from 2020 when observed DWF data is first available, through the year 2075 which assumes buildout and maximum degradation of the conveyance facilities with respect to GWI and RDI/I. In accordance with the EBMP, the trigger plot is also extended through the year 2075 with an additional factor attributable to climate change.

The trigger plots are shown in **Figure 3-3** and are further described in the following sections.

3.2.2.1 River Terrace South PS Wet Weather Trigger Plots

The WWF trigger of 3.7 mgd is shown as a red line on the trigger plots for the three growth scenarios. The three growth scenarios reach the WWF trigger approximately as follows.

- Frontloaded Growth Scenario 2028
- Constant Growth Scenario 2040
- Backloaded Growth Scenario 2050

3.2.2.2 River Terrace North PS Wet Weather Trigger Plot

Similarly, WWF trigger plots were prepared for RTN PS and are also shown in **Figure 3-3**. The DWF trigger for RTN PS is 2.7 mgd and is shown as a red line. Under the three growth scenarios, peak WWF at the RTN PS reaches the flow trigger as follows.

- Frontloaded Growth Scenario 2028
- Constant Growth Scenario 2040
- Backloaded Growth Scenario 2050

3.3 Summary & Recommendations

3.3.1 Flow Trigger Summary

Table 3-8 below provides a summary of the estimated DWF and WWF trigger timelines for the River Terrace South and North PS under the three growth scenarios.

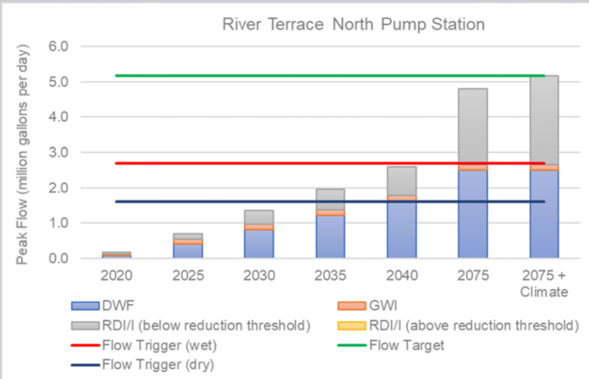
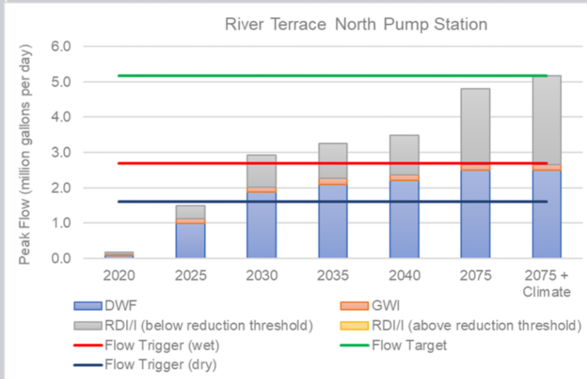
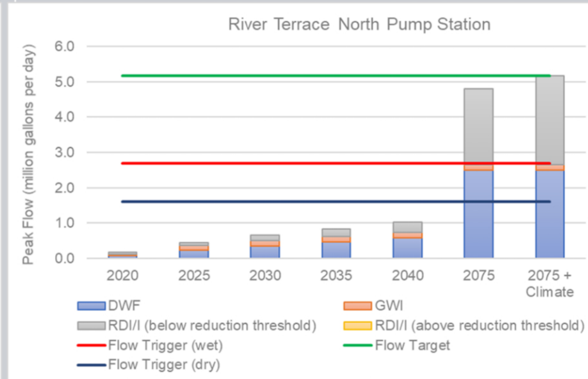
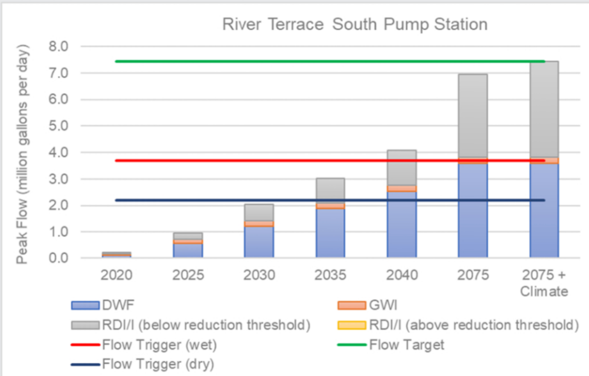
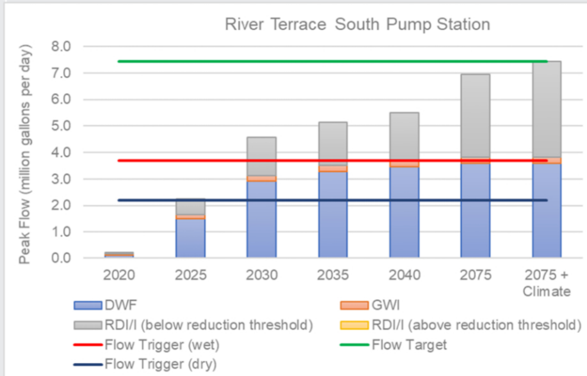
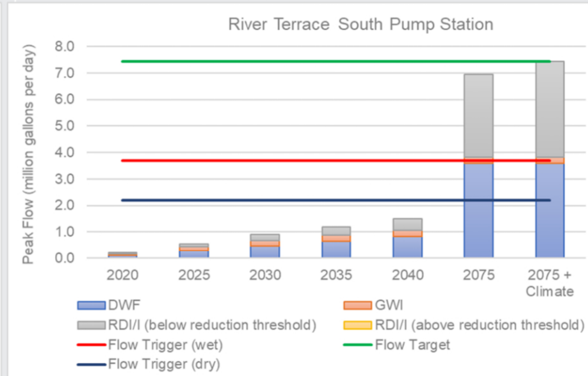
For the RTS PS, the earliest trigger expected under the frontloaded scenario would be in 2026 when the DWF trigger would be reached. The soonest the WWF trigger would be reached is 2028 under the same scenario. Under a constant growth scenario, the timeline extends to 2037 and 2040 for DWF and WWF triggers, and 2046 and 2050 for the backloaded scenario.

The RTN PS has the same trigger timelines for WWF as the RTS PS.

It is noted that the DWF trigger includes an allowance for peak WWF, which may be more conservative than the data used in the WWF trigger calculation. When the DWF trigger is reached, there may still be remaining capacity for the WWF contribution, depending on actual pipeline conditions and rates of wet-weather induced flow contributions.

Table 3-8 | Summary of Flow Trigger Years for RTS PS & RTN PS

Growth Scenario	River Terrace South PS		River Terrace North PS	
	DWF Trigger	WWF Trigger	DWF Trigger	WWF Trigger
Frontloaded Growth	2026	2028	2028	2028
Constant Growth	2037	2040	2040	2040
Backloaded Growth	2046	2050	2047	2050

	Constant Growth	Frontloaded Growth	Backloaded Growth
River Terrace North PS			
River Terrace South PS			

Ref.: Clean Water Services

consor CleanWater Services

South Bull Mountain
Sanitary Sewer Concept Plan

Figure 3-3 River Terrace North & South Pump Station Wet Weather Flow Trigger Plot

CHAPTER 4

Regional Development Monitoring Methodologies

4.1 Introduction

It was shown that the major regional sanitary sewer projects will have a multi-year timeframe to implement. The purpose of the trigger plots is to provide a tool for forecasting an estimated year when the projects would need to be implemented. However, they are only forecasts, and they utilize several assumptions regarding future development. These assumptions include:

- Number of EDUs constructable at buildout
- Rate of future development, both short- and long-term
- Unit flow rates for residential and commercial development

It is recommended the District monitor the progress of development in the SBM area to ensure that the regional Concept Plan and infrastructure is developed in a logical and efficient manner. The driving component for the area will be new development, most of which will be residential in nature. This monitoring is already occurring through the collection and analysis of flow monitoring data at the pump stations in selected locations in the collection system.

From a forecasting perspective, flow monitoring data is essentially backward looking, in that it demonstrates what is currently generating wastewater, not what will be generating wastewater in the near future. To better predict when a capital project needs to be implemented, it is necessary to better estimate how flows will increase over time and by how much. Other methodologies are needed.

During development of this concept plan, methodologies for monitoring the progress of development were discussed and evaluated for potential implementation by the District. These are discussed below.

4.2 Monitoring Methodologies

4.2.1 District Flow Meter Data

The District routinely collects flow data at all of their pump stations. At RTN and RTS PS, real-time data is continuously tracked and logged. This is considered to be very reliable data because the meters are permanently installed and are periodically serviced and adjusted.

The District currently analyzes pump station data periodically to recognize and monitor trends in flows and develop estimated rates of growth in the basin. This data can be used to estimate the total number of EDUs, using the District's unit flow rates. The District may periodically update the unit flow rates when the number of EDUs or population of the service area is known with some certainty. This is more readily possible with smaller pump station service areas.

4.2.2 City Water Meter Data

The Concept Plan development team also explored options to utilize water meter data that cities already collect and use in their daily operations. City water meter data can be collected and analyzed to track the progress of development in a designated planning area. The following methodology was developed for the purpose of tracking development in the SBM study area:

- Upon land use approval for residential development, a large parcel is subdivided into smaller parcels upon approval of the plat map. Individual addresses for each lot are assigned and these are periodically uploaded to Metro to include in their RLIS geodatabase. This data is available to the District in GIS shapefile format.
- Platting is commonly done before residential unit construction begins. Therefore, addresses are usually created several months prior to the occupancy of residences.
- The number of addresses within a designated study area can therefore be periodically quantified using GIS analysis tools. The change in the number of addresses can be tracked over time.
- Typically, new residences will each have their own water meter, identified with a specific account number. Accounts are associated with an address, to be utilized by billing departments. Water billing records also have water consumption data associated with the account.
- When a meter is shown to be installed at an address, this indicates construction of the lot is in progress.
- Meters that show non-zero water usage indicate that the lot is occupied and is generating wastewater.
- Cities collect water meter readings every few months for billing purposes. This data can be obtained in spreadsheet format and input into a GIS database.

In spring 2023, a mapping exercise was performed using address data obtained from Metro and water meter location and usage data obtained from the cities of Tigard and Beaverton. **Figure 4-1** shows the status of addresses and water meter data collected at that time. A red dot indicates an address with no associated water meter billing record, and a purple dot indicates an address with an active water meter.

It is evident that over time as growth occurs, development areas will transition from areas with no red dots (no addresses), to being populated with red dots as parcels are subdivided and addresses are assigned, to ending as purple dots as water meters are installed.

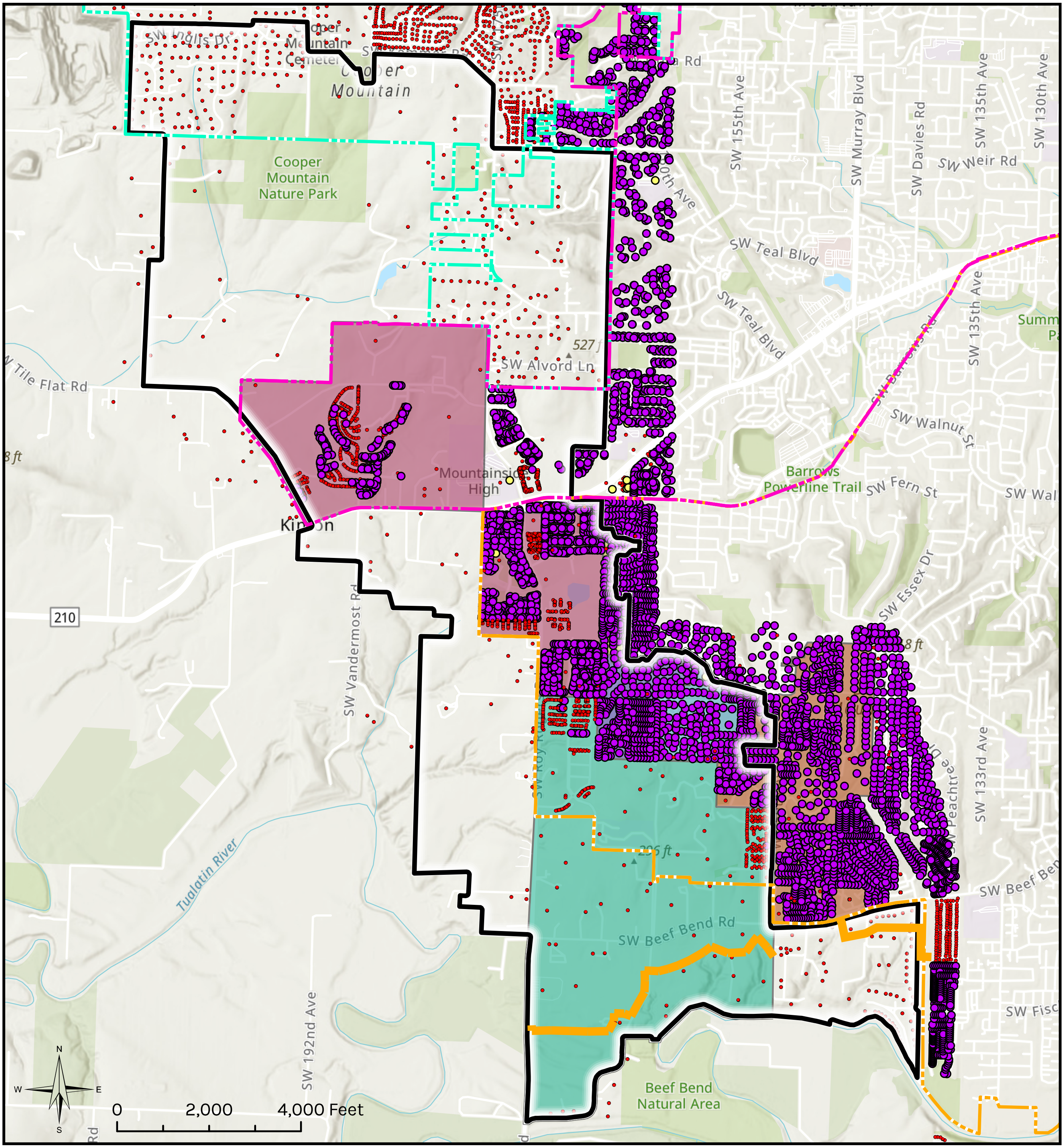
Stated another way, the addition of red dots (addresses) indicates the likelihood of new development in the coming months or years. The lack of red dots (addresses) in areas indicates that new residential development is likely to be at least one year out.

It was found that the water meter data was not consistent across the two cities, which introduced difficulties in obtaining and analyzing the data on a consistent basis. Over time, this process could be refined to better suit the needs of the District and could provide valuable planning information for District managers.

4.2.3 Development-Related Metrics

The cities of Tigard, Beaverton and King City directly receive land use applications for subdivisions, along with commercial and residential building permit applications. The planning and building departments of these cities already obtain information regarding future development that could be further processed for use in forecasting. The data needed would involve where future development may be proposed, the number of lots and the estimated timing. The status of the proposed developments should also be tracked.

It is recommended the District coordinate directly with the planning and building officials of the cities to understand what development-related metrics for the service area where data is available, and develop a system of obtaining the data on a periodic, routine, basis such as quarterly. The District could continue to coordinate with those departments and on how to refine the data, where it could better serve the District's needs in their on-going analysis.



Legend

Address/Water Meter Service Points
- Commercial Water Meter
- Residential Water Meter
- No Associated Water Meter

Water Service Area
- Beaverton
- City of Tigard
- Tualatin Valley Water District

Pump Station Service Area
- SW Bull Mountain
- Meyer's Farm
- Pleasant View
- River Terrace North
- River Terrace South
- Scholl's Country Estates
- Sanitary System Study Area

consor

Clean Water Services

South Bull Mountain Sanitary Sewer Plan

Figure 4-1
Mapped Water Meter Data (As of Spring 2023)

January 2024

Project No. 22-3432

E:\S_Bull_Mtn\GIS\SBM_working\SBM_wkshp3_working_v2.aprx 1/5/2024 4:53 PM Marshall.Kosaka

Data Sources: City of Beaverton, City of Tigard, Clean Water Services, METRO. Service Layer Credits World Topographic Map: Oregon Metro, Oregon State Parks, State of Oregon GEO, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA, USFWS;World Hillshade: Esri, NASA, NGA, USGS, FEMA

Coordinate System: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl

Disclaimer: Consor and CWS make no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes. Notification of any errors is appreciated.

APPENDIX A
RTS PS BYPASS OPTIONS
COST ESTIMATES

Date: 11/10/23
Project: Clean Water Services
South Bull Mountain Regional SanitarySewer Concept Plan
Job No.: N223432OR.00
Estimated By:BTM

Class 5 Budget Estimate
Option 1
Force Main Extension - Beef Bend Road

Item No.	Item	Quantity	Unit	Unit Price	Amount
	Construction Costs (Direct)				
1	16" Sewer Forcemain w/ Arterial Surface Restoration	10,300	LF	$197.64	$2,035,719
2	18" Gravity Sewer 10 ft depth w/ Local Surface Restoration	6,500	LF	$229.82	$1,493,811
3	18" Gravity Sewer 15 ft depth w/ Local Surface Restoration	2,600	LF	$281.53	$731,967
4	18" Gravity Sewer 20 ft depthw/ Local Surface Restoration	500	LF	$383.79	$191,897
5	Manhole 10 ft depth for 18" gravity sewer	21	EA	$5,860.33	$123,067
6	Manhole 15 ft depth for 18" gravity sewer	6	EA	$6,205.06	$37,230
7	Manhole 20 ft depth for 18" gravity sewer	1	EA	$6,434.88	$6,435
			Direct Costs (rounded)		**$4,620,000**
	Indirect Markups		**%**		**Total**
	Contractor General Conditions		10%	$ -	$ 462,000
	Contractor Overhead and Profit		20%	$ -	$ 924,000
	Engineering, Legal, Admin		25%	$ -	$ 2,541,000
	Total Indirect Costs			**$ -**	**$ 3,927,000**
	Construction Contingency		32%	$ -	$ 1,478,400
	TOTAL CONSTRUCTION PLUS INDIRECT (rounded)				**$ 10,025,000**
	Total Factor				**2.17**
	Present Worth O&M Costs:	**Cost/Year**	**Interest Rate**	**No. of Years**	**Amount**
	Gravity Pipe	$ 50,000	4%	80	$1,187,000
	Force Main	$ 47,000	4%	80	$1,132,000
			Present Worth O&M (rounded)		**$2,319,000**
			Lifecycle Cost:		**$12,344,000**

Add On:

Item No.	Item	Quantity	Unit	Unit Price	Amount
	Construction Costs (Direct)				
8	6" Force Main w/ Local Surface Restoration	4,500	LF	$119.50	$537,772
9	0.5 MGD Pump Station	3	EA	$1,200,000	$3,600,000
			Direct Costs (rounded)		**$4,138,000**
	Indirect Markups		**%**		**Total**
	Contractor General Conditions		10%	$ -	$ 413,800
	Contractor Overhead and Profit		20%	$ -	$ 827,600
	Engineering, Legal, Admin		25%	$ -	$ 2,275,900
	Total Indirect Costs			**$ -**	**$ 3,517,300**
	Construction Contingency		32%	$ -	$ 1,324,160
	TOTAL CONSTRUCTION PLUS INDIRECT (rounded)				**$ 8,979,000**
	Present Worth O&M Costs:	**Cost/Year**	**Interest Rate**	**No. of Years**	**Amount**
	Pump Stations	$ 182,000	4%	80	$4,354,000
	Force Main	$ 8,000	4%	80	$186,000
			Present Worth O&M (rounded)		**$4,540,000**
			Add On Lifecycle Cost:		**$13,519,000**

Total Lifecycle Cost: $25,863,000

Class 5 Budget Estimate
Option 2
Force Main Extension - Kingston Terrace West

Item No.	Item	Quantity	Unit	Unit Price	Amount
	Construction Costs (Direct)				
1	16" Sewer Forcemain w/ Local Surface Restoration	8,000	LF	$183.85	$1,470,800
2	16" Sewer Forcemain w/ Arterial Surface Restoration	4,100	LF	$197.64	$810,335
3	18" Gravity Sewer 10 ft depth w/ Local Surface Restoration	6,500	LF	$229.82	$1,493,811
4	18" Gravity Sewer 15 ft depth w/ Local Surface Restoration	2,600	LF	$281.53	$731,967
5	18" Gravity Sewer 20 ft depthw/ Local Surface Restoration	500	LF	$383.79	$191,897
6	Manhole 10 ft depth for 18" gravity sewer	21	EA	$5,860.33	$123,067
7	Manhole 15 ft depth for 18" gravity sewer	6	EA	$6,205.06	$37,230
8	Manhole 20 ft depth for 18" gravity sewer	1	EA	$6,434.88	$6,435
			Direct Costs (rounded)		**$4,866,000**
	Indirect Markups		**%**		**Total**
	Contractor General Conditions		10%	$ -	$ 486,600
	Contractor Overhead and Profit		20%	$ -	$ 973,200
	Engineering, Legal, Admin		35%	$ -	$ 3,162,900
	Total Indirect Costs			**$ -**	**$ 4,622,700**
	Construction Contingency		30%	$ -	$ 1,459,800
	TOTAL CONSTRUCTION PLUS INDIRECT (rounded)				**$ 10,949,000**
	Total Factor				**2.25**
	Present Worth O&M Costs:	**Cost/Year**	**Interest Rate**	**No. of Years**	**Amount**
	Gravity Pipe	$ 50,000	4%	80	$1,187,000
	Force Main	$ 56,000	4%	80	$1,330,000
				Present Worth O&M (rounded)	**$2,517,000**
				Lifecycle Cost:	**$13,466,000**

Add On:

No.	Item	Quantity	Unit	Unit Price	Amount
	Construction Costs (Direct)				
9	6" Force Main w/ Local Surface Restoration	3,400	LF	$119.50	$406,316
10	0.5 MGD Pump Station	3	EA	$1,200,000	$3,600,000
			Direct Costs (rounded)		**$4,007,000**
	Indirect Markups		**%**		**Total**
	Contractor General Conditions		10%	$ -	$ 400,700
	Contractor Overhead and Profit		20%	$ -	$ 801,400
	Engineering, Legal, Admin		35%	$ -	$ 2,604,550
	Total Indirect Costs			**$ -**	**$ 3,806,650**
	Construction Contingency		30%	$ -	$ 1,202,100
	TOTAL CONSTRUCTION PLUS INDIRECT (rounded)				**$ 9,016,000**
	Present Worth O&M Costs:	**Cost/Year**	**Interest Rate**	**No. of Years**	**Amount**
	Pump Stations	$ 182,000	4%	80	$4,354,000
	Force Main	$ 6,000	4%	80	$140,000
				Present Worth O&M (rounded)	**$4,494,000**
				Add On Lifecycle Cost:	**$13,510,000**

Total Lifecycle Cost: $26,976,000

Class 5 Budget Estimate
Option 3
Regional Gravity-Northern Route

Item No.	Item	Quantity	Unit	Unit Price	Amount
	Construction Costs (Direct)				
1	24" Gravity Sewer 10 ft depth w/ Arterial Restoration	1,400	LF	$293.02	$410,223
2	24" Gravity Sewer 10 ft depth w/ Local Restoration	1,900	LF	$278.08	$528,349
3	24" Gravity Sewer 15 ft depth w/ Local Restoration	2,600	LF	$341.28	$887,323
4	24" Gravity Sewer 20 ft depth w/ Local Restoration	2,700	LF	$438.95	$1,185,166
5	24" Gravity Sewer 25 ft depth w/ Local Restoration	1,100	LF	$509.04	$559,949
6	24" Gravity Sewer 30 ft depth w/ Local Restoration	400	LF	$598.67	$239,469
7	24" Gravity Sewer 35 ft depth w/ Local Restoration	1,600	LF	$679.11	$1,086,575
8	24" Gravity Sewer 40 ft depth w/ Local Restoration	300	LF	$759.55	$227,864
9	24" Bridge Pipe	200	LF	$57.45	$11,491
10	Pedestrian Bridge	3,000	SF	$200.00	$600,000
11	Manhole 10 ft depth for 24" gravity sewer	9	EA	$5,860.33	$52,743
12	Manhole 15 ft depth for 24" gravity sewer	7	EA	$6,205.06	$43,435
13	Manhole 20 ft depth for 24" gravity sewer	5	EA	$6,434.88	$32,174
14	Manhole 25 ft depth for 24" gravity sewer	7	EA	$6,779.60	$47,457
15	Manhole 30 ft depth for 24" gravity sewer	1	EA	$7,009.42	$7,009
16	Manhole 35 ft depth for 24" gravity sewer	1	EA	$7,354.14	$7,354
17	Manhole 40 ft depth for 24" gravity sewer	1	EA	$7,583.96	$7,584
				Direct Costs (rounded)	**$5,934,000**
	Indirect Markups		**%**		**Total**
	Contractor General Conditions		10%	$ -	$ 593,400
	Contractor Overhead and Profit		20%	$ -	$ 1,186,800
	Engineering, Legal, Admin		45%	$ -	$ 4,450,500
	Total Indirect Costs			**$ -**	**$ 6,230,700**
	Construction Contingency		34%	$ -	$ 2,017,560
	TOTAL CONSTRUCTION PLUS INDIRECT (rounded)				**$ 14,182,000**
	Total Factor				**2.39**
	Present Worth O&M Costs:	**Cost/Year**	**Interest Rate**	**No. of Years**	**Amount**
	Gravity Pipe	$ 84,000	4%	80	$2,012,000
				Present Worth O&M (rounded)	**$2,012,000**
				Lifecycle Cost:	**$16,194,000**

Add On:

Item No.	Item	Quantity	Unit	Unit Price	Amount
	Construction Costs (Direct)				
18	6" Force Main w/ Local Surface Restoration	3,800	LF	$119.50	$454,118
19	0.5 MGD Pump Station	3	EA	$1,200,000	$3,600,000
				Direct Costs (rounded)	**$4,055,000**
	Indirect Markups		**%**		**Total**
	Contractor General Conditions		10%	$ -	$ 405,500
	Contractor Overhead and Profit		20%	$ -	$ 811,000
	Engineering, Legal, Admin		45%	$ -	$ 3,041,250
	Total Indirect Costs			**$ -**	**$ 4,257,750**
	Construction Contingency		34%	$ -	$ 1,378,700
	TOTAL CONSTRUCTION PLUS INDIRECT (rounded)				**$ 9,691,000**
	Present Worth O&M Costs:	**Cost/Year**	**Interest Rate**	**No. of Years**	**Amount**
	Pump Stations	$ 182,000	4%	80	$4,354,000
	Force Main	$ 7,000	4%	80	$157,000
				Present Worth O&M (rounded)	**$4,511,000**
				Add On Lifecycle Cost:	**$14,202,000**

Total Lifecycle Cost: $30,396,000

Class 5 Budget Estimate
Option 4
Regional Gravity-Southern Route

Item No.	Item	Quantity	Unit	Unit Price	Amount
	Construction Costs (Direct)				
1	24" Gravity Sewer 10 ft depth w/ Arterial Restoration	1,400	LF	$293.02	$410,223
2	24" Gravity Sewer 10 ft depth w/ Local Restoration	1,800	LF	$278.08	$500,541
3	24" Gravity Sewer 15 ft depth w/ Local Restoration	1,700	LF	$341.28	$580,173
4	24" Gravity Sewer 20 ft depth w/ Local Restoration	1,500	LF	$438.95	$658,426
5	24" Gravity Sewer 25 ft depth w/ Local Restoration	800	LF	$509.04	$407,236
6	24" Gravity Sewer 30 ft depth w/ Local Restoration	1,500	LF	$598.67	$898,010
7	24" Gravity Sewer 35 ft depth w/ Local Restoration	900	LF	$679.11	$611,198
8	24" Gravity Sewer 40 ft depth w/ Local Restoration	700	LF	$759.55	$531,682
9	24" Bridge Pipe	600	LF	$57.45	$34,473
10	Pedestrian Bridge	12,000	SF	$200.00	$2,400,000
11	Manhole 10 ft depth for 24" gravity sewer	8	EA	$5,860.33	$46,883
12	Manhole 15 ft depth for 24" gravity sewer	5	EA	$6,205.06	$31,025
13	Manhole 20 ft depth for 24" gravity sewer	7	EA	$6,434.88	$45,044
14	Manhole 25 ft depth for 24" gravity sewer	4	EA	$6,779.60	$27,118
15	Manhole 30 ft depth for 24" gravity sewer	2	EA	$7,009.42	$14,019
16	Manhole 35 ft depth for 24" gravity sewer	5	EA	$7,354.14	$36,771
17	Manhole 40 ft depth for 24" gravity sewer	3	EA	$7,583.96	$22,752
			Direct Costs (rounded)		**$7,256,000**
	Indirect Markups		**%**		**Total**
	Contractor General Conditions		10%	$ -	$ 725,600
	Contractor Overhead and Profit		20%	$ -	$ 1,451,200
	Engineering, Legal, Admin		50%	$ -	$ 5,804,800
	Total Indirect Costs			**$ -**	**$ 7,981,600**
	Construction Contingency		36%	$ -	$ 2,612,160
	TOTAL CONSTRUCTION PLUS INDIRECT (rounded)				**$ 17,850,000**
	Total Factor			-	**2.46**
	Present Worth O&M Costs:	**Cost/Year**	**Interest Rate**	**No. of Years**	**Amount**
	Gravity Main	$ 75,000	4%	80	$1,797,000
				Present Worth O&M (rounded)	**$1,797,000**

Total Lifecycle Cost:	**$19,647,000**

South Bull Mountain Regional Sewer Options
Life-cycle Cost Analysis

	Option 1 Force Main Extension - Beef Bend Road	Option 2 Force Main Extension - Kingston Terrace West	Option 3[1] Regional Gravity-Northern Route	Option 4[1] Regional Gravity-Southern Route
Capital Costs:				
Gravity Pipe	$ 5,608,000	$ 5,816,000	$ 12,748,000	$ 11,945,000
Force Main	$ 4,417,000	$ 5,133,000	$ -	$ -
Bridges	$ -	$ -	$ 1,434,000	$ 5,905,000
Total Capital Costs	**$ 10,025,000**	**$ 10,949,000**	**$ 14,182,000**	**$ 17,850,000**
Present Worth Annual O&M	$ 2,319,000	$ 2,517,000	$ 2,012,000	$ 1,797,000
Total Life-cycle Cost	**$ 12,344,000**	**$ 13,466,000**	**$ 16,194,000**	**$ 19,647,000**
Capital Cost Add On:				
Local Pump Stations	$ 8,979,000	$ 9,016,000	$ 9,691,000	$ -
Present Worth Annual O&M Local PS's	$ 4,540,000	$ 4,494,000	$ 4,511,000	$ -
Total Life-cycle Cost w/ Local PS's	**$ 25,863,000**	**$ 26,976,000**	**$ 30,396,000**	**$ 19,647,000**

[1]Gravity line is built in conjunction with local roadways.

Unit Costs Bridges-Including Earthwork and Foundations

Project	Length ft	Width ft	ft^2	Bridge Type	Year	Construction Bid	$ per ft^2
Cornelius Pipe Bridge Heather to 15th	170	6	1020	Steel Truss-Pre manufactured	2019	$441,035 to $569,015	$432 to $558
Cornelius Pipe Bridge 15th to Emerald	75	6	450	Steel Truss-Pre manufactured	2019	$366,100 to $466,955	$814 to $1,038

Project	Length	Width		Bridge Type	Year	Construction Cost	$ per ft^2
Bethany Pedestrian Bridge	260	15	3900	Pre-manufactured	2019	$605,330	$155

Unit Costs Bridges-Just the Pre-manufactured bridge

Project	Length ft	Width ft	ft^2	Bridge Type	Year	Construction Bid	$ per ft^2
Cornelius Pipe Bridge Heather to 15th	170	6	1020	Steel Truss-Pre manufactured	2019	$300,000 to $380,250	$294 to $373
Cornelius Pipe Bridge 15th to Emerald	75	6	450	Steel Truss-Pre manufactured	2019	$95,000 to $150,000	$211 to $333

Project	Length	Width		Bridge Type	Year	Construction Cost	$ per ft^2
Bethany Pedestrian Bridge	260	15	3900	Pre-manufactured	2019	$440,330	$113

Indirect Cost Assumptions

Indirect Category	% of direct	
Contractor General Conditions	10	Assume 10% across board
Contractor Overhead and Profit	20	Assume 20% across board
Engineering/Legal/Admin		Percentage increases as complexity increases
Option 1	25	
Option 2	35	
Option 3	45	
Option 4	50	
Construction Contingency		based on lowest-highest of construction challenges/risks
Option 1	32	
Option 2	30	
Option 3	34	
Option 4	36	