EXHIBIT 24

COOPER MOUNTAIN UTILITY PLAN

FINAL | May 2024

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REGISTERED PROFESSIONAL ENGINEER 62947 OREGON JAN. 11, 2005 BRIAN M. GINTER RENEWS: 6-30-2025	7-3-24 REGISTERED PROFESSIONAL ENGINEER 84442PE OREGON DEC 17, 2014 JOSHUA M. OWENS EXPIRES: Dec 31, 2024	REGISTERED PROFESSIONAL ENGINEER 87384PE Emily Flock OREGON NOV. 13, 2018 EMILY C. FLOCK EXPIRES: 12-31-2025
Chapters 5-7	Chapters 3 and 7	Chapters 1, 2, 4, and 7

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Chapter 1: Background and Purpose

Introduction

In December 2018, the regional government Metro approved the City of Beaverton's (City) proposal to include Urban Reserve Area (URA) 6B, referred to as Cooper Mountain, in the Portland metro area Urban Growth Boundary (UGB). As a condition of UGB expansion the City must complete a comprehensive planning process for the Cooper Mountain area including consideration of future land uses, natural resource protection, and utilities. This comprehensive planning process includes both this Cooper Mountain Utility Plan (CMUP) and the Cooper Mountain Community Plan (CMCP) being conducted concurrently by MIG (previously Angelo Planning Group).

The CMUP will provide the City with stormwater, sewer, potable water, and non-potable water utility master plans including planning criteria, proposed alignment and facilities, and budget-level capital cost estimates. The evaluation for each utility will include assessing existing infrastructure, estimating flows or demands, evaluating alternative alignments, and sizing facilities. All analyses will emphasize compliance with regulatory requirements which will be summarized in the plan along with key intergovernmental agreements (IGAs) such as those with the regional sewer and stormwater agency Clean Water Services (CWS). The CMUP will solicit City and stakeholder input and develop consensus at key points in the master planning process in coordination with the CMCP.

Cooper Mountain Community Plan (CMCP)

Communication and collaboration between the CMCP and CMUP teams and processes were established from the beginning of both plans. The two planning efforts have run parallel to each other and provided input, review, and feedback to each other at key steps throughout the projects. The CMCP's vision is to, "create a community of walkable neighborhoods that honor the unique landscape and ensure a legacy of natural resource protection and connection" (CMCP draft, April 2023). Coordination between the CMUP team, CMCP team, and stakeholders has been integrated into both plans from the start. The CMCP provides a guiding blueprint for where and how housing, commercial, parks, and other lands will be developed; a connected transportation network; and natural resource protection and integration into the neighborhoods. This blueprint information informs and provides some bases of evaluation for the CMUP and the proposed utility approaches. Due to the concurrent timelines, the concepts for the CMCP are still undergoing refinement. The utility planning presented in the CMUP is based on the Draft CMCP Concept Plan presented in October 2022. The October 2022 draft established proposed roadway alignments, resource protection areas, likely park locations, and projected land use designations. Further refinements to the concept plan are not expected to substantially change the locations or intensity of development planned across Cooper Mountain. The October 2022 CMCP Draft Concept Map is available on the City website (https://www.beavertonoregon.gov/350/Cooper-Mountain-Community-Plan). Additional refinement, draft plans, and the City Council approval process for the CMCP are in progress as the CMUP project moves through similar stages.

Adoption of the CMCP is anticipated in 2024. Following adoption, the City will be establishing an implementation plan for the Cooper Mountain area that includes a funding plan and annexation strategy. Those plans will impact the schedule and timing to provide utility service to areas of future development.

Vision Statement & Guiding Principles

When developing utility concept layouts for a given area, there may be multiple ways to meet the technical requirements for utility service. The purpose of the vision statement and guiding principles is to establish base assumptions and City priorities for technical approaches and preferred types of facilities. The vision and guiding principles presented herein serve as the foundation for utility concept alternatives development and preferred approaches summarized in the CMUP.

Vision Statement

> *Develop an integrated plan for stormwater, sewer, potable water, and non-potable water utilities in Cooper Mountain that is coordinated with surrounding areas and jurisdictions, downstream facilities outside the planned service area, and consistent with the goals and vision of the concurrent CMCP. Provide planning-level cost analyses for delivering utility service to be coordinated with future development patterns. Consider opportunities for multi-use features which provide recreation or natural area protection concurrent with utility functions.*

Guiding Principles

The guiding principles for stormwater, sewer, potable water, and non-potable water are intended to provide a framework and guidance for development of utility service alternatives and preferred approaches. Site constraints and feasibility may impact the implementation of these principles and may require additional consideration and flexibility. Any such issues encountered will be addressed on a case-by-case basis in collaboration with the City, appropriate jurisdictional agencies, and goals of the CMCP. Guiding principles are summarized below.

- Support the vision established in the CMCP.
- Support land use goals established in the CMCP by planning for anticipated development.
- Comply with regulatory standards for state, regional, City, and other applicable agencies.
- Provide cost-effective utility service to all customers.
- Be conscientious of future operation and maintenance needs of proposed utilities.
- Coordinate with partner agencies to ensure long-term capacity and service by considering impacts upstream and downstream of the study area.
- Stormwater utility to work with, enhance, and protect existing natural features.
    - Tailor stormwater management systems to the topographic features of the Cooper Mountain area with regards to soil infiltration potential, erosion potential, landslide susceptibility, and connection to surface water.
- Provide cost-effective sewer service to customers by utilizing gravity conveyance networks to the extent feasible, limiting the need for pumping facilities, and

selecting sewer alignments in existing/proposed right-of-way for clear maintenance access.

- Promote efficient and resilient potable water service that preserves operational flexibility.
- Support the City's vision for managing the cost of potable water service by considering expansion of non-potable water irrigation service to portions of the planning area.

Utility Plan's Role

The analysis and proposed utility infrastructure presented in the CMUP aims to promote and support growth for the next 20 years or more across the Cooper Mountain area. Greenfield development provides unique opportunities to coordinate utilities – co-locating facilities, designing bridge crossings with utility needs in mind, identifying sites for stormwater facilities well in advance of the land planning process, etc. The CMUP provides the basis for development plans to consider future build-out conditions and adjacent developing areas when designing utility infrastructure. The CMUP focuses on regional, backbone utility systems to serve the entire study area. While local infrastructure will be necessary to serve all customers and connect to regional infrastructure, limited information is currently available to define a more detailed neighborhood utility grid. It is anticipated that a more detailed utility plan will continue to fill in as specific developments and associated local roadways are identified. Local infrastructure is not included in this plan and will be the responsibility of developers. The CMUP provides a regional framework to provide utilities across the study area. Minor modifications to the proposed infrastructure may occur as specific properties are developed. The regional view of the CMUP allows the City to evaluate individual development utility plans within the context of serving the entire Cooper Mountain area and make decisions to promote cost-effective, cohesive, and efficient utility service across the area.

Chapter 2: Study Area & Existing Infrastructure

Location & Topography

The CMUP study area incorporates the Cooper Mountain area (previously referred to as URA 6B) located east of the City. The study area occupies approximately 1,241 acres and is bordered to the north by SW Weir Road, SW Kemmer Road, and the North Cooper Mountain (NCM) area; to the east by the City; to the west by SW Grabhorn Road; and to the south by the South Cooper Mountain (SCM) area. The area was added to the region's UGB in 2018. The study area occupies a diverse landscape including gently sloped, lower elevation agricultural fields and meadows in the south and west, steeply sloped drainages and uplands in the central and eastern portions of the area, and a flatter, higher elevation area at the top of Cooper Mountain in the north. Land in the southwestern portion is roughly 230 feet in elevation, while land along SW Kemmer Road at the north end reaches approximately 790 feet in elevation. Slopes exceed 25% in areas associated with stream corridors, the historic landslide area near Summer Creek, and in a dispersed pattern of steep slopes in the southeast portion of the study area. The study area and its topography are shown in **Figure 2-1**.

Land Use

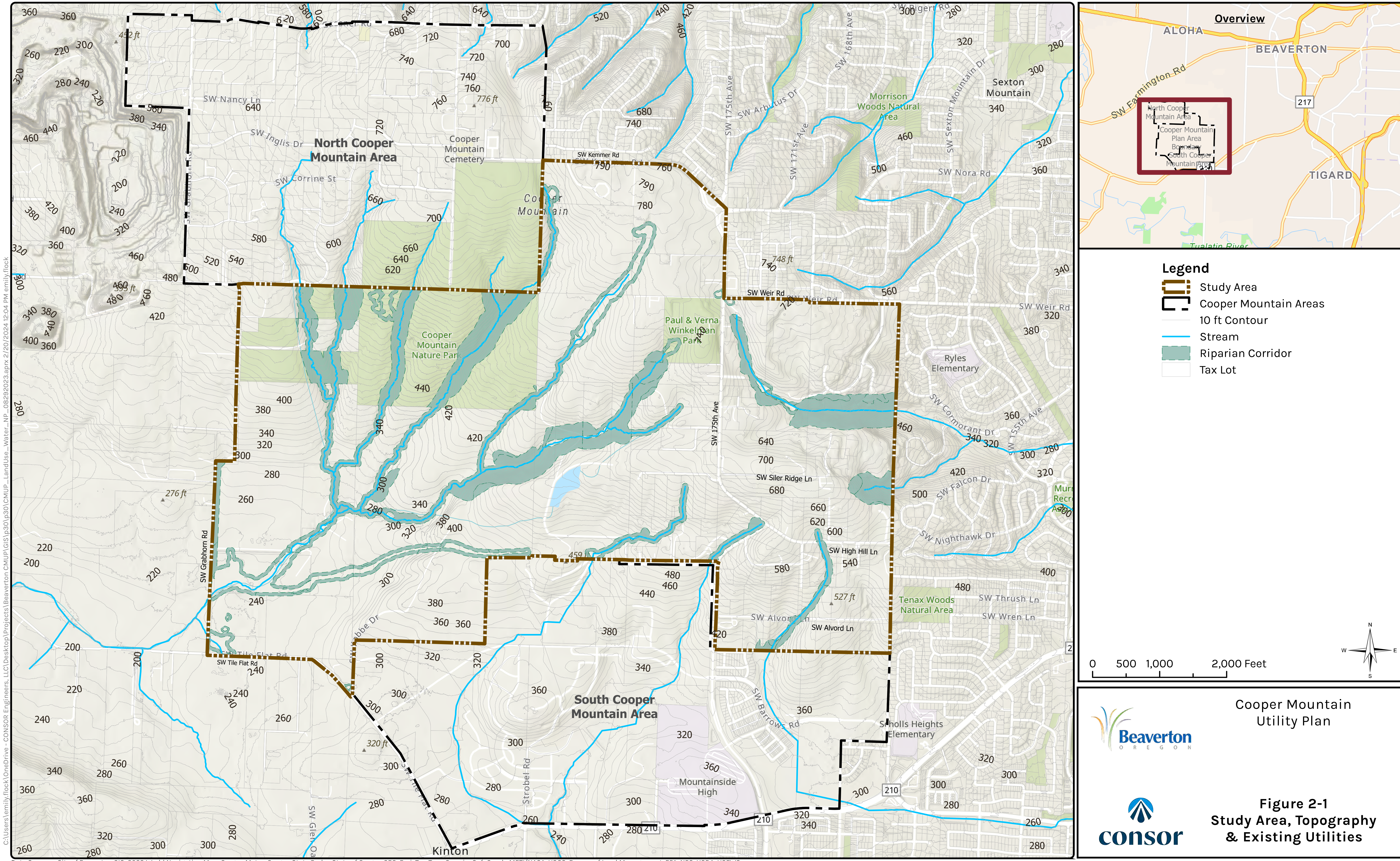
The following section summarizes existing land use and proposed land use within the study area and adjacent areas. Additional information on existing land use and development patterns can be found in the CMCP Existing Conditions Summary Report on the City website: (https://www.beavertonoregon.gov/386/Project-Documents).

Existing Land Use

Existing land use within the study area is primarily low-density, rural residential development and agriculture. The study area hosts large, working farms as well as forested area used for logging. The existing residential development, primarily in the east of the study area, consists of rural homes sites. Parkland also occupies a large area within the study area. In particular, the Cooper Mountain Nature Park occupies approximately 230 acres in the northeast of the study area.

Adjacent Areas

The NCM area, located to the northeast of the study area, is largely built out and consists of single-family homes on large lots. This area also contains a portion of the Cooper Mountain Nature Park that straddles the border of the NCM area and the study area. The SCM area, located to the south of the study area, was annexed to the City of Beaverton in 2013. The area is primarily mixed residential use with the high school in the south of the area. The City borders the study area to the east. This portion of the City consists primarily of single-family residential development.



Cooper Mountain Utility Plan

Figure 2-1 Study Area, Topography & Existing Utilities

Project No. 20-2755

May 2024

Data Sources: City of Beaverton GIS, 2023;World Navigation Map: Oregon Metro, Oregon State Parks, State of Oregon GEO, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS
World Topographic Map: Esri Community Maps Contributors, 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:
Disclaimer: Consor and CLIENT 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.

The area to the west of the study area is considered unincorporated Washington County. This area contains Rural Reserve Areas and is characterized by agricultural uses with limited low-density residential development in the form of rural homesteads.

Proposed Land Use

The October 2022 CMCP Draft Concept Map identified proposed land use and established proposed roadway alignments, resource protection areas, likely park locations, and projected areas for different types of development. The October 2022 Concept Map was informed by the CMCP project goals, community member engagement, equity considerations, and City Council direction. While further refinements to the Concept Plan are expected as the CMCP is finalized, these refinements are not expected to substantially change the locations or intensity of development planned across Cooper Mountain. The CMUP evaluations used the October 2022 Concept Map as the basis for proposed land use. This proposed land use within the study area is illustrated in **Figure 2-2**.

Natural Resources

The Cooper Mountain area includes approximately eight miles of streams that provide important aquatic habitat to a variety of amphibian and wildlife species. According to Oregon Department of Fish and Wildlife (ODFW) fish distribution maps, these streams do not support anadromous fish species, listed by the Endangered Species Act (i.e., salmon and steelhead). The lower reaches of McKernan Creek are most likely to support native fish, including resident cutthroat trout, due to the channel size and perennial flow. These streams are fairly small (2-3 feet wide and 4-12 inches deep) with relatively high gradients and their upper reaches likely flow only seasonally. Portions of streams have also been rerouted, piped, and/or ditched due to the historically agricultural land use. The higher gradient streams and associated riparian areas provide habitat to a variety of birds, amphibians, and macroinvertebrates (DEA 2020).

There has been some disturbance and alteration of several of the streams within the Cooper Mountain area; however, there are also streams with fairly intact riparian corridors. For example, McKernan Creek, which flows primarily through a deep, forested ravine, generally has greater bank and sediment stability, recruitment of woody debris and coarse organic materials, and overall habitat complexity compared to other more altered streams. However, vegetation within the steeper, forested stream corridor areas is generally less disturbed than the vegetation within the flatter stream corridor areas (DEA 2020).

The Cooper Mountain development area contains approximately 23 acres of wetlands, based on field surveys and data extrapolation for properties that could not be accessed. Emergent wet prairie wetland area is found within the Nature Park, but some portions of this wetland have been planted to create a scrub-shrub community. Other wetlands were largely associated with riparian corridors and agricultural fields (DEA 2020).

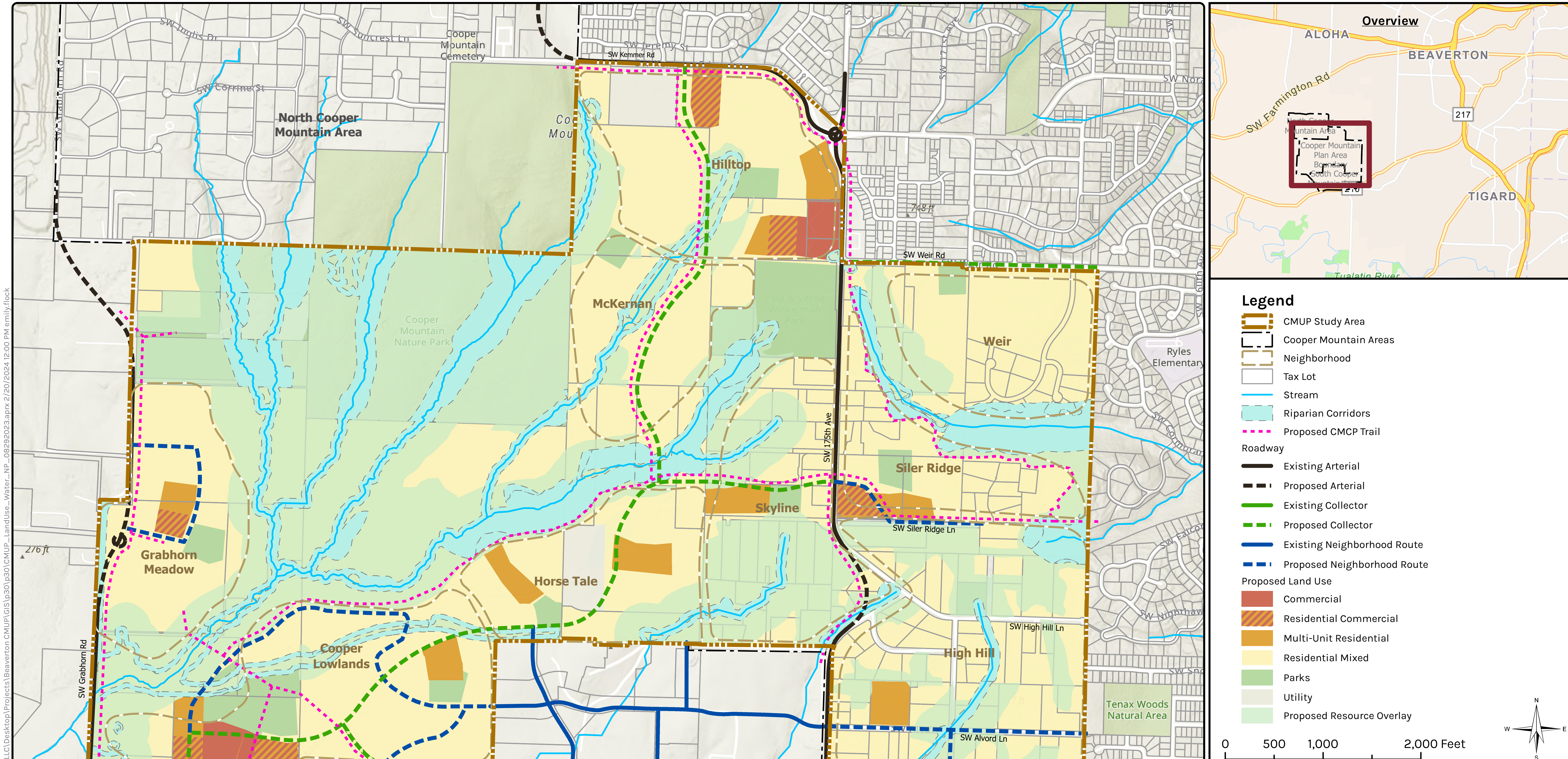


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Figure 2-2
Proposed Land Use
(CMCP Draft Concept Map, October 2022)

Project No. 20-2755

May 2024

Data Sources: City of Beaverton GIS, 2023; Cooper Mountain Community Plan (CMCP) Draft Concept Map, October 2022;World Navigation Map: Oregon Metro, Oregon State Parks, State of Oregon GEO, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS
World Topographic Map: Esri Community Maps Contributors, 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:

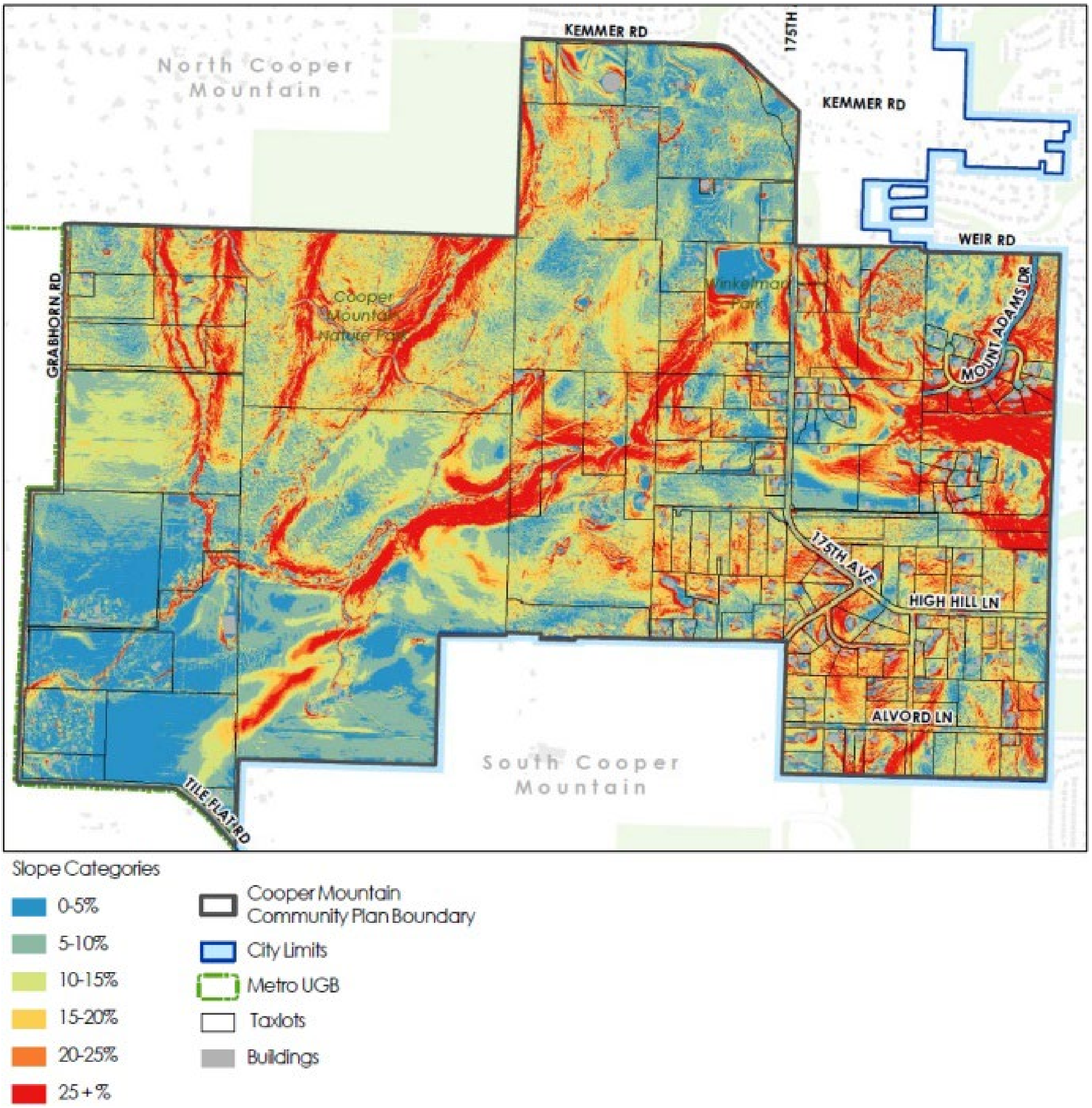
Soils in the study area are predominantly silt loams. The major soil types include Cornelius & Kinton silt loams, Cascade silt loams, Saum silt loam, and Delena silt loam. The drainage classes range from poorly drained to well drained, with the majority of the Cooper Mountain area being moderate to poorly drained. The eastern area of the basin near Summer Creek has evidence of historical landslides and erosion.

Additional information on natural resources in the study area can be found in the CMCP Existing Conditions Summary Report on the City website (https://www.beavertonoregon.gov/386/Project-Documents).

Slopes

Varied, hilly terrain and steep slopes characterize the Cooper Mountain area. The highest ground elevations in the study area are in the northeast, along Kemmer Road. Gentler slopes are found near the higher elevation area along Kemmer Road and the lower elevation area in the southwest along SW Tile Flat Road and SW Grabhorn Road. Slopes exceed 25 percent in areas associated with stream corridors, particularly Summer Creek drainage in the east, and in a dispersed pattern of steep slopes in the southeast portion of the study area near SW Alvord Lane and SW High Hill Lane. A slope analysis from the CMCP Existing Conditions Report (2020) is shown in **Figure 2-3**.

Figure 2-3 | Slope Categories



Source: CMCP Existing Conditions Report (2020), Metro RLIS

Natural Hazards

This section provides a brief overview of natural hazards in the study area. The CMCP Existing Conditions Summary Report contains more details on documented natural hazards and is available on the City website (https://www.beavertonoregon.gov/386/Project-Documents).

The Oregon Department of Geology and Mineral Industries (DOGAMI) provides landslide and geologic-related data for land use planning. A majority of the study area has moderate to high landslide susceptibility. There have been historical landslides in the area: two east of SW 175th Avenue and south of SW Weir Road in the Summer

Creek drainage where the susceptibility rating is very high. The earthquake liquefaction hazard is high in the low-laying area in the southwest along SW Tile Flat Road and SW Grabhorn Road.

Existing Utility Service

Stormwater

There is currently no public stormwater service in the Cooper Mountain area, with most runoff being conveyed via overland flow and natural drainages to receiving creeks. Any built stormwater infrastructure connected to the Cooper Mountain Nature Park is owned by CWS.

Sewer

There is currently no public sewer service in the Cooper Mountain area. Public sewer service is provided for developments to the east in the City. Public sanitary sewer service is being installed in the SCM area and should be complete prior to future development in the study area. CWS is also planning to construct a new sanitary sewer pump station and force main near SW Tile Flat Road (see Chapter 4 for additional information).

Potable Water

There is currently limited public potable water service in the Cooper Mountain area. Tualatin Valley Water District (TVWD) provides service to customers outside of City limits generally east of 175th Avenue as well as customers north of where Weir Road would be if it extended due west to Cooper Mountain Nature Park. Public potable water service is provided for developments to the east in the City. Public potable water service has been planned and is beginning to be provided for the SCM area.

Non-Potable Water

There is currently no public non-potable water service in the study area. Public non-potable water service has been planned and is under construction in the SCM area.

Chapter 3: Stormwater Utility

Introduction

Protection and enhancement of the natural resources in the study area are important goals for the CMUP and CMCP while accommodating urban uses. Stormwater management plays an essential role in realizing these goals. Protection and uplift of natural resources are also high priorities for the Cooper Mountain Nature Park. The park supports a variety of endangered and sensitive plant, animal, and amphibian species within the acres of tree groves, prairie, and fish-bearing streams. In addition, there are considerable high-quality upland habitat areas under private ownership in the study area, centered around the various stream corridors. A local wetland inventory (LWI) was completed as part of the CMCP and found wetlands are generally located along stream corridors, particularly at the top of Cooper Mountain near Weir Road and at the low point near SW Grabhorn Road.

The study area is within the Tualatin River watershed, predominantly split between the McKernan Creek Basin and the Summer Creek Basin. Most of the study area drains to McKernan Creek, which generally flows southwest before confluence with the Tualatin River. The study area is characterized by its varied, hilly terrain and steep slopes, which lead to concerns for erosion and slope stability. Topography of the area is shown in **Figure 2-1**. The soils in the area have varying capacity for infiltration but are estimated to have relatively low infiltration rates. As noted in the **Existing Utility Service Section**, there is no existing public stormwater service in the study area, with most runoff being conveyed via overland flow and natural drainages to receiving creeks and water bodies. A small stormwater system located north of SW Kemmer Road collects runoff from the housing development to the northeast of the main entrance to the Cooper Mountain Nature Park and conveys it into the park. The parking lot of the Cooper Mountain Nature Park includes low impact development approaches (LIDA) facilities that are owned by CWS.

Natural resource conservation and preservation within natural drainageways were prioritized throughout the stormwater utility planning process with restoration to prevent further degradation of natural resources using either resilient stream corridors (RSC) or local interventions. This chapter summarizes the planning criteria, applicable regulations and requirements, preliminary design approach, and proposed infrastructure for the conventional stormwater approach. A resilient stream corridor approach (see Resilient Stream Corridor Cooper Mountain Stormwater Management Memo (Wolf Water Resources, 2024) for additional information) may be used alongside conventional stormwater management practices to provide additional stormwater mitigation and promote stream health and resiliency.

Planning Criteria

There are multiple ways to meet the technical requirements for stormwater service within a given area. The following criteria establish City priorities for technical approaches and preferred types of facilities. These criteria are intended to provide a framework and guidance for the stormwater utility development and preferred approaches.

- Work with, enhance, and protect existing natural features for stormwater management.
- Support land use goals established in the CMCP by sizing stormwater conveyance and management facilities to support anticipated development.
- Comply with City and CWS design standards for stormwater management.
- Minimize cost and effort for stormwater management maintenance through sub-basin strategies that consolidate regional stormwater features using a conventional approach, RSC approach, or combination of approaches.
- Plan for impacts and costs associated with other jurisdictional permitting and facility design requirements when developing stormwater management approaches. Project using federal funds are required to meet federal standards such as SLOPES V.

Existing Conditions

The Cooper Mountain area contains a network of creeks and unnamed tributaries. The Project is within the Tualatin River drainage, and all tributaries in the area eventually discharge to Tualatin River. There are several privately owned and maintained culverts. There is no existing public infrastructure for the stormwater conveyance in the project area. This study does not evaluate the capacity of existing private culverts. It is assumed that these existing structures will be removed during development and replaced to accommodate the larger road network.

A majority of the Project area drains to McKernan Creek or one of its several tributaries, which converge and drain to the southwest. The area east of SW 175th Ave and north of SW High Hill Ln generally drains to tributaries of Summer Creek. This study did not have property access to conduct onsite investigations of these tributaries, but it was determined from aerial topography and photography that the Summer Creek tributaries are generally located in steep ravines with heavy forest cover. Small areas along the southern boundary of the study area drain to existing small unnamed tributaries that drain to the south. These tributaries flow through areas of South Cooper Mountain that are currently being developed. See Chapter 2 of this report for existing area mapping and additional information on existing topography, land use, and natural resources in the Project area.

Stream Corridors

A primary goal of stormwater management is to protect the stream corridors by providing water quality treatment to prevent pollutants from reaching the stream and by providing flow control to reduce erosive flows that can cause significant channel and stream corridor degradation. While conventional stormwater management can reduce the rate of erosion, it does little to restore stream corridors that are already in poor condition. Stream corridors in poor condition are more likely to erode if the flow is already concentrated in an incised channel, disconnecting the channel flow from floodplain roughness and increasing velocities. Therefore, it is generally prudent to implement measures to stabilize the stream corridor as part of the development plan to prevent more severe issues later.

In April 2020, Wolf Water Resources (W2r) staff investigated the stream corridor conditions associated with the McKernan Creek drainage. This effort was designed to support the development of an RSC stormwater management alternative and an overall stormwater plan for the Cooper Mountain area. The assessment collected existing conditions observations related to riparian vegetation health, stream incision, and infrastructure concerns. With limited landowner access, the field investigation was not comprehensive of the project area.

Within the McKernan Creek drainage, a consistent pattern of stream corridor conditions was observed based on watershed position. The following sections summarize representative conditions for each watershed position.

Headwaters

The headwater reaches are characterized by confined valley bottoms and steep slopes. Above SW Horse Tale Drive the headwaters conditions are degraded, likely due to development activities including the SW Horse Tale Drive crossing and forest clearing. This stream reach lacks woody riparian vegetation and is generally comprised of a native and non-native mix of herbaceous plants. The lack of in-channel woody root structure, forested adjacent hillslopes, and steep grades have resulted in an incised channel (**Figure 3-1**).

The headwaters within the Nature Park are densely forested and covered in native understory vegetation. Channel substrate is comprised of large to small gravels mixed with fines and organic material. Stream reaches are either connected or moderately disconnected from adjacent floodplain (**Figure 3-2**).

Figure 3-1 | Incised and deforested stream corridor upstream of SW Horse Tale Dr. (45.441833, -122.864777)

Figure 3-2 | Stable corridor within the Nature Park (45.444754, -122.871042)

Mid-Reach

The mid-reach of the McKernan Creek drainage becomes moderately steep and less confined. It is also where the tributary headwaters confluence to form the mainstem, McKernan Creek. Adjacent land uses include light residential and small agricultural operations. This use has encroached on the floodplain and channelized the creek in many areas to reduce localized historic flooding or maximum land use practices. Stream reaches in the section are characterized as inset floodplains with channelized flow paths that are deeply incised (**Figure 3-3**). Forest cover in this reach is consistent but is also complimented by extensive non-native species in the understory (**Figure 3-4**).

Figure 3-3 | Mid-reach stream channel incision (45.439707, -122.879043)

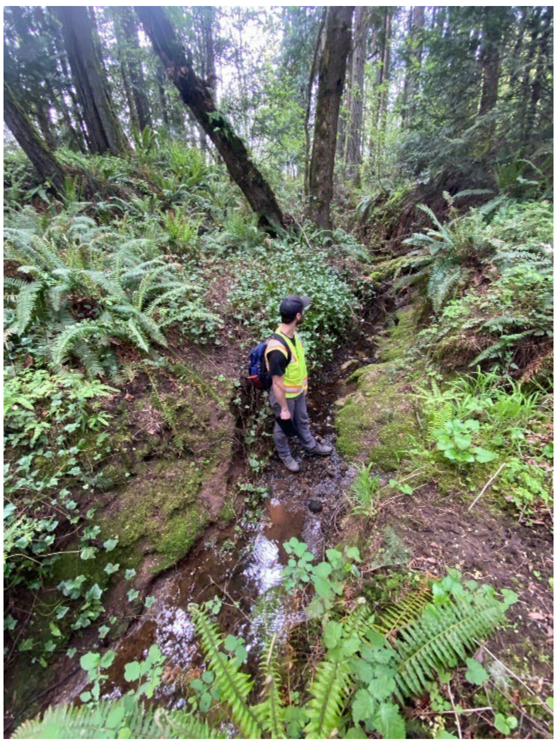


Figure 3-4 | Private road crossing and channel incision (45.438127, -122.879317)

Mainstem

The lower reach of McKernan Creek is low gradient with a broad floodplain. A narrow riparian corridor flanks the creek, which is otherwise boarded by agricultural fields. Historical straightening of the channel and basin landcover change has resulted in concentrated flows and stream incisions (**Figure 3-5**). Channel substrate in this reach is highly erodible as it is dominated by fine sediments. More recently, beavers have become active in this reach (**Figure 3-6**). This has impounded streamflow and increased floodplain connectivity.

Figure 3-5 | Mid-reach stream channel incision (45.439707, -122.879043)

Figure 3-6 | Private road crossing and channel incision (45.438127, -122.879317)

Standards and Regulations

Development within Cooper Mountain requires compliance with applicable City, CWS, and other regulatory stormwater standards as summarized below. Additional standards incorporated into the stormwater management alternatives are also summarized below.

Clean Water Services

Clean Water Services (CWS) holds the Municipal Separate Storm Sewer System (MS4) permit for urbanized Washington County and the City is a partner on that permit. The City reviews plans within its jurisdiction against City and CWS stormwater and sewer regulations, whereas CWS oversees the overall MS4 requirements and has permitting authority. CWS is ultimately responsible for identifying strategies for preventing or reducing water quality and hydromodification impacts related to its MS4 discharges. Therefore, potential water quality and hydromodification effects must be assessed in the Cooper Mountain area and strategies developed to address these effects in compliance with the MS4 permit. These strategies can include LIDA, traditional collection and conveyance, and regional stormwater management facilities.

According to CWS Design & Construction (D&C) Standards, Resolution and Order 2019-05 (Clean Water Services, 2019a), most anticipated developments in Cooper Mountain would be considered a "large project" with more than 80,000 square feet of new or redeveloped impervious area. All developments which creates or modifies more than 1,000 square feet of impervious surface are required to implement or fund techniques to reduce impacts to the downstream receiving water body, which includes water quality treatment as well as water quantity control in the form of detention and potentially retention, per CWS D&C Standards Section 4.08. CWS requires flow control facilities to be sized by matching Developed Mitigated runoff conditions to Existing

Conditions using one of two methods: Flow Duration Curve-Matched Detention or Peak-Matched Detention. For new development, CWS defines the existing conditions as the condition of the site just prior to development. For this study, the existing conditions are defined as the uses and activity in 2020. In addition, development projects may be eligible for fee-in-lieu of constructing facilities to address detention and/or hydromodification standards.

CWS also requires flow control for protection of the stream and conveyance systems. The prescribed approaches and performance requirements are determined by the Hydromodification Risk Level, Development Class, and project size. CWS allows for alternative performance-based approaches that can meet the requirements and are permittable, including RSCs. CWS is in coordination with NMFS to allow for stream and floodplain enhancement techniques that meet the intention of SLOPES V criteria. Most of the drainages in the area are classified as a High Hydromodification Risk Level until they converge at McKernan Creek, which is classified as a Moderate Hydromodification Risk Level.

According to the D&C Standards Section 1.06, alternative approaches may also be considered on a case-by-case basis. These alternative approaches include stream and floodplain enhancement techniques (Clean Water Services, 2019b).

Beaverton Engineering Design Manual Section 550- SLOPES V

Section 550 of the City's 2019 Engineering Design Manual (EDM) outlines "surface water runoff management for SLOPES V requirements", referencing the U.S. Army Corps of Engineers (USACE) Standard Local Operating Procedures for Endangered Species V (SLOPES V) requirements. Section 500 of the EDM states the following:

"Development in the Cooper Mountain Planning area shall provide surface water runoff management (quality and quantity) in compliance with section 550 of this document."

Under the City's SLOPES V interpretation, stormwater facilities must limit discharge to match pre-developed discharge rates using a continuous simulation for flows between 50% of the 2-year event and the 10-year flow event. The City's SLOPES V interpretation was intended as an interim design standard until CWS adopted standards for hydromodification. Currently, projects that meet the CWS hydromodification requirement (updated in 2019) will meet the SLOPES V requirements.

In addition to meeting the flow duration requirement, the City requires the facilities to be designed so that the post-development (Developed Mitigated) discharge rates do not exceed the pre-development (Historic Forested) discharge rates based on a single 25-year, 24-hour stormwater event.

Floodplain Regulations

Though Cooper Mountain is currently in Washington County, the utility plan assumes annexation by the City, at which time the City floodplain ordinance will apply. The National Flood Insurance Program regulatory floodplain has not been mapped in the area.

The City of Beaverton Development Code – Floodplain Regulations (Section 60.10) prohibits development in the floodway unless the development meets certain exemptions:

- Hydrological and hydraulic analysis demonstrating the proposed encroachment would not increase flood levels during the base flood discharge.
- The development is one of the following: Stormwater outfall pipes and other drainage improvements, bridges, culverts, public utility lines, trails or bike paths, roads and other uses identified on the City's Transportation Plan, stream habitat restoration including vegetated corridor enhancement, grading associated with the preceding items.

Given that the streams are generally steep, confined, and have small catchment areas it is anticipated that the floodplain will be within the vegetated corridor or other natural resources setbacks or preservation areas. Development within the floodplain is anticipated to be limited to utility and roadway crossings, stormwater outfalls, and pedestrian trails and structures.

Cooper Mountain Land Use Ordinances

Upon annexation, the City's EDM and CWS standards will govern stormwater management in the CMUP area. New development code for the Cooper Mountain area will be included as part of the community plan. This document includes recommendations and supporting information that may be used to assist the City in code development.

The overall stormwater management approach has been planned and designed with the intention of protection and enhancement of natural resource areas, provisions of parks and open spaces, and management of stormwater at the regional-scale, site-scale, and street-scale per the CMCP. The proposed development code supports the use of large scale, regional stormwater facilities by allowing those facilities to be constructed within upland habitat areas that would otherwise be restricted from major development.

Protection of Waters of the State/U.S.

Work within wetlands or waterways will trigger coordination with federal and state regulatory agencies responsible for protection of Waters of the State/U.S. These agencies include USACE, Oregon Department of State Lands (DSL), Oregon Department of Environmental Quality (DEQ), National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), the Oregon State Historic Preservation Office (SHPO), and Oregon Department of Fish and Wildlife (ODFW). Some key regulations from these agencies are described below.

Under Section 404 of the Clean Water Act (CWA), USACE regulates the discharge of dredged or fill material into waters of the U.S., including wetlands. Discharges of fill material generally include, without limitation, any placement of fill that is necessary for construction of any type of structure, development, property protection, reclamation, or other work involving the discharge of fill or dredged material. Endangered Species Act (ESA) compliance is triggered by the need for a USACE permit.

For projects with a federal nexus and design elements that would add impervious area, ESA compliance would be met through the programmatic biological opinion, SLOPES V Stormwater, Transportation, and Utilities (STU). According to SLOPES V STU, water quantity control in the form of detention is required with facility sizing based on matching pre-development and post-development discharge rates, using a continuous simulation for flows between 50 percent of the 2-year flow rate and the 10-year flow rate. This flow control sizing is consistent with CWS flow control for hydromodification standards, so will be met by projects meeting the CWS standards.

CWS has been coordinating with NMFS, the regulatory agency that issues SLOPES V STU, to demonstrate that resilient stream corridor approaches for stream and floodplain enhancement will meet the intent of the SLOPES V requirements for flow control. The reception from NMFS to this approach has been positive but a final decision is still in process.

Under Section 401 of the CWA, an activity involving a discharge into waters of the U.S. authorized by a federal permit must also receive water quality certification (WQC) through DEQ. The issuance of a WQC means that the activity will comply with the water quality standards and any established effluent limitations of the certifying authority. The long-term operation of the stormwater system associated with the development will be covered under the MS4 permit.

The Oregon Removal/Fill Law, which is administered by DSL, requires a permit for removal/fill of 50 cubic yards or more in waters of the state (e.g., wetlands and waterways).

Goal 5

In addition, local governments must inventory and include protections for natural resources, including waters of the state, through Oregon's land use planning Goal 5. Goal 5 includes cities or counties performing local wetland inventories to assist in the development planning decisions. City and county planners use wetland inventories to decide when to send a wetland land use notice to DSL. DSL's response can then be used to make design decisions based on the likelihood of waters of the state to be present within the proposed impact areas and help to determine when a removal/fill permit is necessary (Department of State Lands, 2020). A local wetland inventory and habitat survey was performed within Cooper Mountain, in accordance with Goal 5, and the results are presented in the Natural Resources Report for the CMCP (DEA, 2020).

Basis of Analysis

- The CMUP evaluation and proposed infrastructure is based on the various regulatory context and requirements and assumptions summarized as follows:
- The Cooper Mountain development is required to assess potential hydromodification effects and develop stormwater management strategies and approaches to address the effects per the CWS MS4 permit.
- The City requires that the Cooper Mountain area provide water quantity control per SLOPES V guidance.
- SLOPES V and other flow control strategies are intended to protect streams from erosion due to development by decreasing runoff peaks and volumes.

- The City will be the floodplain management agency after annexation. The Cooper Mountain area is not currently mapped, and flood modeling and mapping would be required for any developments that are near streams by completing a Flood Study. Floodplain mapping/study is not currently included in the CMUP and the City will evaluate floodplain mapping in the future.
- Large detention ponds may be located in areas where they meet both stormwater and green space requirements to reduce the impact of large stormwater ponds on developable land. According to the SCM Community Plan, large detention ponds as Regional Stormwater Strategies had been identified for water quantity management; however, other approaches may be more conducive to protecting and enhancing natural resource areas and allowing for more developable land.
- Any work in waterways or wetlands will require compliance with CWA Section 404/401 and removal/fill regulations.
- A local wetland inventory was performed for the Cooper Mountain area in compliance with Oregon's land use planning Goal 5.

As the project moves forward, this regulatory context will be used to develop a stormwater management strategy in coordination with CWS, the City, Washington County, DEQ, DSL, USACE, NMFS, and other regulatory agencies as required.

The recommended basis for stormwater management facility sizing includes the flow control and water quality standards provided as part of the MS4 Permit and the City's SLOPES V directive. The most stringent standards apply. The recommended approach is to use continuous simulation model to size stormwater facilities to the following standards:

- Flow durations for the developed condition should be at or below the flow durations for the pre-developed (Historic Forested) condition for all flows between half of the 2-year peak flow and the 10-year peak flow.
- Peak flow rates for the developed condition should be at or below the peak flow rates for the pre-developed (Historic Forested) condition for the 25-year peak flow.
- Treat the water quality volume or the water quality flow rate.

Pond sizing is based on the most conservative sizing approach, comparing developed flow mitigation to the historic forest condition. However, this level of flow control may not be required in all areas of the study area if the development conditions do not trigger a federal nexus for SLOPES review. The Tualatin River Urban Stormwater Tool (TRUST) was used in this analysis for preliminary stormwater management facility sizing that meets the above standards because it uses the required continuous flow analysis to compare flow duration curves for pond sizing.

Conventional Approach

The conventional stormwater approach utilizes LIDA for stormwater management. The following sections provide descriptions and high-level study area considerations for distributed LIDA, regional LIDA, and conveyance systems. The conventional stormwater approach for a study area this size is often a combination of all three types of facilities.

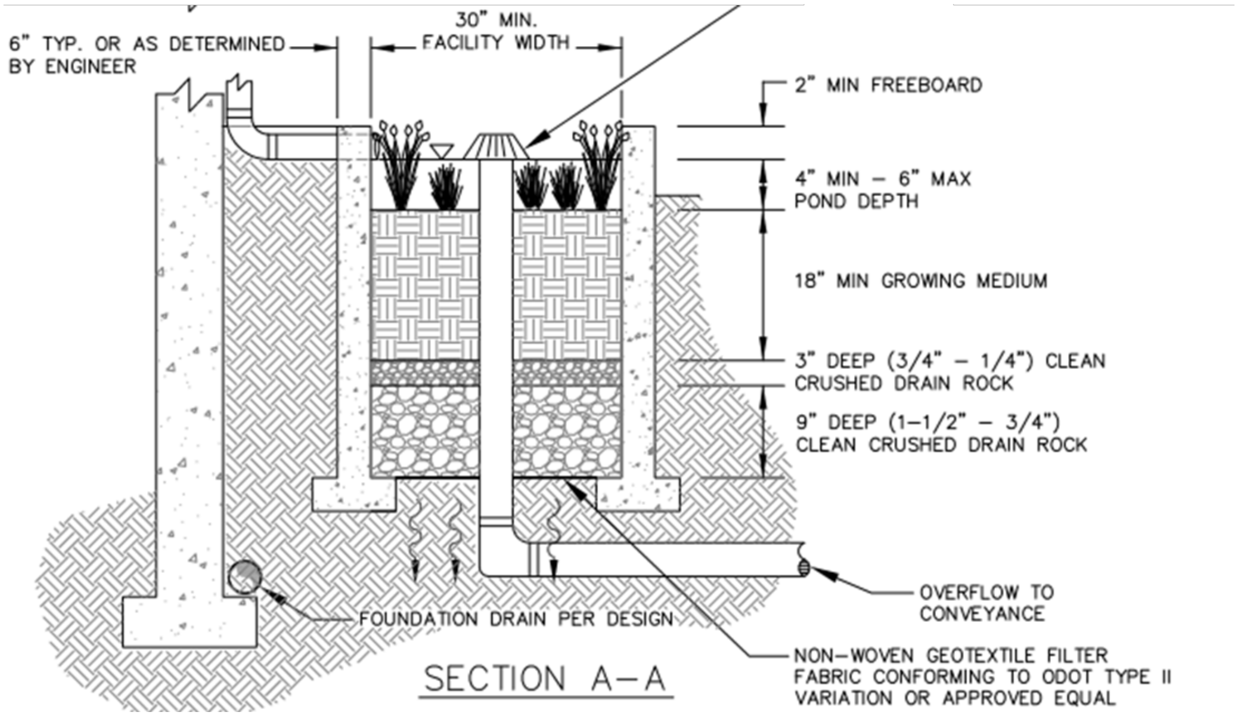
LIDA includes vegetated facilities, such as detention ponds, and approaches that promote infiltration and reduce impervious surface area such as porous pavement, street trees, and structural soils (see CWS D&C Standards 2019 Table 4-3). Distributed LIDA is generally applied at the collection level prior to entering the conveyance system. Regional LIDA is generally applied at the outfall level prior to discharging into the receiving stream, which prevents the mixing of treated water and untreated water. The advantage of distributed LIDA is that stormwater management can occur completely on-site and does not require coordination with other private or public-led improvements. Distributed LIDA requires increased maintenance to manage multiple facilities and can sometimes lead to parallel conveyance systems. The advantage of regional LIDA is that it requires less space overall and simplifies operations and maintenance (O&M) and associated costs. However, regional LIDA requires additional coordination and planning to select facility sites that can manage runoff from larger areas.

Distributed LIDA Facilities

Distributed LIDA facilities are smaller facilities spread through the development provide stormwater management at the point of collection. These provide an opportunity to reduce impervious area, reduce runoff through detention and infiltration, and more closely mimic the natural hydrology, while also providing water quality benefits and green space. Non-infiltrating facilities can also be used to detain and treat stormwater runoff. Several LIDA techniques can be applied to a site, including street trees, green roofs, porous pavement, flow-through planters, infiltration planters/rain gardens, vegetated filter strips, and swales. These applications can have added community benefits if they are incorporated into the design as community features and green spaces.

Distributed LIDA facilities can be incorporated as part of development to provide flow control and water quality treatment. Incorporating these facilities gives additional flexibility as they can be used for both private and public developments and can manage runoff from small areas throughout a development. Distributed LIDA may also be beneficial in areas where runoff cannot be easily conveyed to the regional detention facility. Installing distributed LIDA facilities on some uphill properties has the added benefits of reducing regional detention facility size and/or improving water quality of receiving streams. **Figure 3-7** illustrates a privately owned structural infiltration planter LIDA facility cross-section.

Figure 3-7 | LIDA Facility Cross-Section



Source: Clean Water Services Standard Details Drawing No. 720

Considerations that impact feasibility and effectiveness of distributed LIDA in Cooper Mountain include:

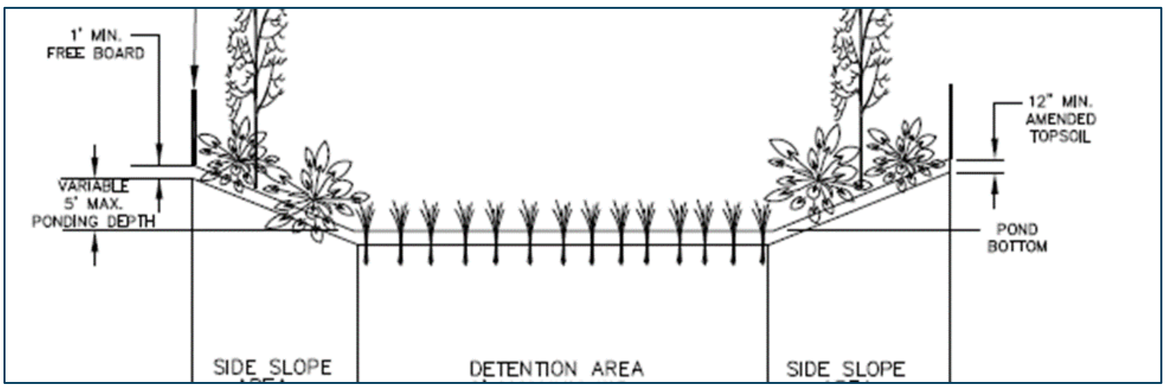
- Current standards for LIDA detention facility sizing may not provide enough/additional benefit to have a long-term positive/net-zero impact on receiving streams given the erosive nature of existing flows.
- While LIDA facilities have flexibility in terms of technique and location, the existing topography and steep slopes greatly impact constructability. Locating these facilities on developable land decreases the available buildable footprint.
- Runoff retention through infiltration may prove challenging in areas where fine-grained soils and ground conditions prevent adequate infiltration and drawdown time for water quantity benefits.
- Infiltration also could impact slope stability due to concentrated inputs.
- Location of LIDA within the planter strip of the right-of-way may be infeasible with high density development due to increased use of this area for driveways, sidewalks, street trees, and utilities.

Distributed LIDA facilities are recommended in areas where they can easily be incorporated into parking lots or common areas, such as in commercial or multi-family development areas. Distributed LIDA may also be beneficial in areas where runoff cannot be easily conveyed to the regional detention facility, such as along some roadways. These facilities will be less feasible in high density single-family residential areas where tight driveway spacing, utility connections, and high tree planting requirements will utilize most of the available planter space within the ROW. These residential areas will likely be better served by regional detention facilities as described in the following section.

Regional Stormwater Management Facilities

Regional stormwater management facilities such as detention ponds provide storage of stormwater runoff before discharging via flow control outlets to receiving conveyance or downstream water bodies. **Figure 3-8** shows a schematic cross section of a detention pond. Detention facilities are sized based on upland development contributing area and adhere to applicable design standards. These facilities may be designed to meet all water quality and flow control requirements, or they can be coupled with upland LIDA facilities to reduce required treatment and/or storage volume. They may also be coupled with in-stream improvements such as RSCs to enhance stream health and resiliency.

Figure 3-8 | Detention Facility Cross-Section



Source: Clean Water Services Standard Details Drawing No. 700

Considerations that impact feasibility and effectiveness of detention facilities in Cooper Mountain include:

- Current standards for detention facility sizing may not provide enough/additional benefit to have a long-term positive/net-zero impact on receiving streams given the erosive nature of existing flows.
- The location of these facilities could limit buildable land. Runoff retention through infiltration may prove challenging in areas where fine-grained soils and ground conditions prevent adequate infiltration and drawdown time for water quality and quantity benefits.
- Sufficiently large detention facilities may not be feasible due to steep slopes of the existing topography. Multiple detention ponds may be needed to serve development areas.
- Grading and infiltration on steep slopes can impact slope stability.
- Underground detention storage presents similar challenges in terms of constructability of large facilities in areas with steep slopes. Underground detention storage is also more difficult to maintain than surface-level vegetated facilities.

Conveyance

A stormwater collection and conveyance system will be required to convey flows from developed areas to LIDA, regional stormwater management facilities, and receiving waters. This conveyance infrastructure would utilize the Cooper Mountain topography to convey flows within the proposed roadway network, maintaining natural drainage flow paths to the maximum extent practicable. Infrastructure sizing would be based on applicable design standards for development flows.

Local stormwater collection and conveyance systems for neighborhoods and roadways will be the designed and constructed as part of individual developments or arterial roadways. Collection systems should discharge to stormwater management facilities as described in the **Proposed Approach: Regional Stormwater Management Facilities Section**. The design of the conveyance systems must comply with the standards of the EDM.

Considerations that impact the design and construction of piped conveyance in Cooper Mountain include:

- Steep slopes and topography could impact constructability and access for O&M. This will be most challenging from the detention pond to the outfall.
- New outfalls will be installed within natural resource areas and will likely require environmental permitting, revegetation, and potential mitigation.

Proposed Approach: Regional Stormwater Management Facilities

Preliminary stormwater management sizing was developed for the study area using the conventional approach. This preliminary sizing assumes the use of regional stormwater management facilities in the form of detention ponds to meet both water quality and flow control requirements. Experience within the region has found that water quality treatment in the form of swales or bioretention filtration media can be incorporated into ponds that are sized to meet flow control requirements to be more space-efficient.

The proposed stormwater infrastructure herein focuses on regional facilities to serve subbasins across the study area. This analysis provides a framework that may be adjusted to suit the needs and goals for each development. Regional facilities may be split into multiple facilities, combined with channel improvements, and supplemented with smaller upstream facilities. While local infrastructure will be necessary to serve all customers and provide conveyance to regional facilities, limited information is currently available to define a more detailed neighborhood utility grid. A more detailed utility plan will continue to fill in as specific developments and associated local roadways are identified. Local stormwater infrastructure is not included in this plan and will be the responsibility of developers. The infrastructure proposed in this section provides a regional framework to provide stormwater management across the study area.

Pond and Outfall Placement

Proposed ponds were placed throughout the study area based on topography and natural drainage outfall locations. A total of 30 ponds were designed along with a preliminary piping schematic to convey flows from the stormwater ponds to an outfall location in the appropriate stream tributary. Ponds were located at areas that were relatively flat and downstream of the proposed neighborhood boundaries.

The proposed ponds and outfall locations are shown in **Figure 3-9**. These locations are schematic and based largely on desktop studies with the intention of showing the approximate top area required for the pond. Additional area will be required for pond grading, access roads, and other site features. The outfall locations were approximated based on topography. Each location will require in-field assessment before construction to ensure stream and riparian area impacts are minimized. All outfalls will be constructed with engineered energy dissipation. Revegetation and other rehabilitation or natural resource enhancement efforts will likely be required in the buffer areas. Final pond location, shape, and additional area required for site improvement and final grading on slopes will be determined during future analysis and design efforts.

Subcatchment Delineation

Subcatchments were delineated to assess the drainage area to each proposed pond's outfall as well as for several downstream points of compliance (POCs). Each subcatchment delineation was completed for both a pre-developed and a post-developed condition. Pre-developed subcatchment areas are based primarily on existing topography, while post-developed condition drainage pathways are also informed by taxlot boundaries.

The subcatchment delineations were used to develop several development scenarios. The scenarios are briefly described below. The details and use of these scenarios in analysis will be described later in this report.

The pre-developed delineation land areas were used to represent multiple scenarios:

- Pre-developed (Historic Forested). This scenario represents the land area prior to any development, with all land assumed to be forested.
- Existing (2020 Conditions). This scenario represents the land use at the commencement of this study in 2020. Developed areas were considered to be impervious and agricultural areas were considered to be pasture.

The post-developed delineation land areas were used to represent multiple scenarios:

- Developed Mitigated. This scenario represents the proposed condition after development. All development areas are fully built out and all proposed regional flow control ponds are in place.
- Developed Unmitigated. This scenario represents the same buildout condition as described above but without flow control ponds in place.
- Developed Water Quality. This scenario represents the same buildout condition but with regional facilities sized to provide water quality treatment without any flow control/hydromodification/water quantity standards.

Proposed land use information was provided from the CMCP and overlaid with the subbasin boundaries developed in the Geographic Information System (GIS) program. The values in **Table 3-1** were used to calculate a weighted average to represent the percent impervious for the relevant scenarios. Areas that are not impervious are assumed to be lawn in the developed scenarios and pasture, forest, or a combination of both in the Existing and Historic Forest Scenarios.

Table 3-1 | Impervious Area Estimates for Proposed Land Use Types

Land Use Type	Estimated Percent Impervious[1]
Commercial	56%
Mixed Family (MF)	65%
Mixed	55%
Mixed Residential (MR)	51%
Park	10%
Utility	100%

Note:

1. Estimated percent impervious values represent net areas, which include roadways, greenspace, tree canopy, etc.

Preliminary Pond Sizing Methodology

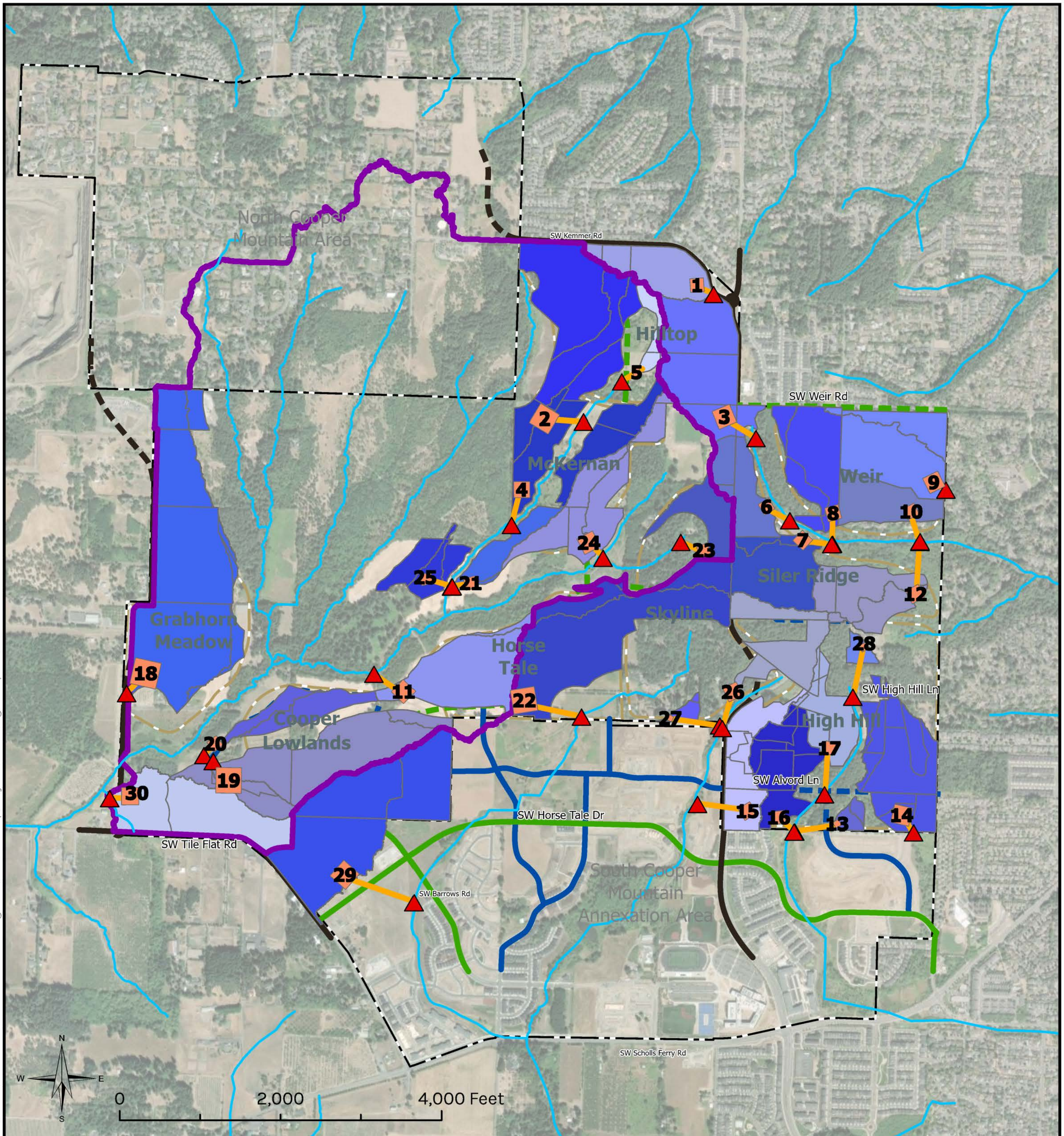
Each proposed pond was sized as a regional stormwater facility, as described in this section. These ponds sizes are preliminary and are based on multiple assumptions that are subject to change during development as site-specific investigations occur. Developers may choose to utilize multiple smaller facilities, or otherwise reduce the size of the ponds by implementing other LIDA techniques such as upstream distributed LIDA (e.g. stormwater planters or bioswales).

Model Inputs

Preliminary pond sizing was completed using TRUST. The TRUST model outputs are included as **Appendix A**. Preliminary regional pond sizing was developed using a flow duration comparison of the Historic Forested and the Developed Mitigated scenarios.

Subbasins were delineated topographically as described in the **Subcatchment Delineation Section**. Each Historic Forested subbasin was entered into the "predeveloped" tab as a forested condition with hydrologic soil class C. The area was entered as flat, moderate, or steep depending on whether the slope of the subbasin averaged between 0-5%, 5-15%, or greater than 15%, respectively (**Figure 2-3** shows an overview of slope categories within the study area). Each Developed Mitigated subbasin was entered in the "mitigated" tab in the model. All Developed Mitigated impervious areas were entered as "impervious, flat", with the assumption that most developed impervious land would be flattened to approximately 0-5% slopes during construction. The remaining pervious area was entered into the model as a lawn area with hydrologic soil class C with the flat, moderate, or steep designation in accordance with existing topography.

Table 3-2 below shows the corresponding Historic Forested and post-development areas for each pond. The contributing areas for existing and proposed conditions may be viewed in **Figure 3-9** and **Figure 3-10**, Respectively. Note that the post-development areas relate to the Developed Mitigated scenario for pond sizing but also relate to other developed scenarios. The Existing (2020 Conditions) land areas are included as well as a point of comparison.



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Legend

- Pond Footprint, Aprrox Top Area
- Storm Pipes
- Outfall
- Stream
- McKernan Drainage Boundary

Existing Pond Basin

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30

Cooper Mountain Utility Plan

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Figure 3-9
Existing Pond Basins

Project No. 20-2755

May 2024

Data Sources: City of Beaverton, October 2022; Service Layer Credits: World Imagery: Maxar
Coordinate System:
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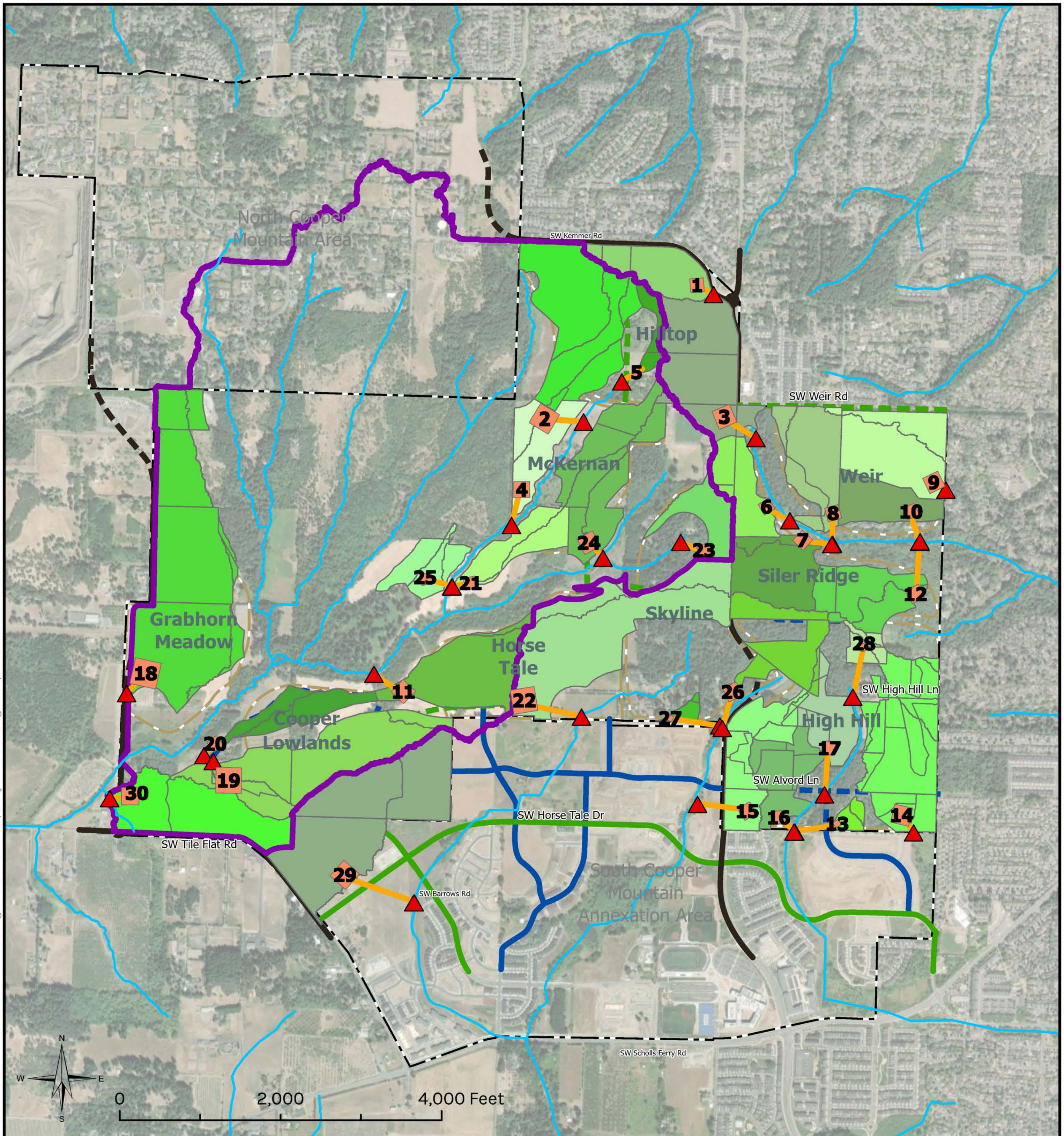

Legend

- Pond Footprint, Aprrox Top Area
- Storm Pipes
- Outfall
- Stream
- McKernan Drainage Boundary

Proposed Pond Basin

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30

Cooper Mountain Utility Plan

consor

Beaverton OREGON

Figure 3-10
Proposed Pond Basins

Project No. 20-2755

Data Sources: City of Beaverton, October 2022; Service Layer Credits: World Imagery: Maxar

Coordinate System:

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May 2024

Each Developed Mitigated area was routed to a pond. Each pond was assumed to be 5-feet deep, with 4-feet of active storage and 1-foot of freeboard. The side slopes were entered as 3:1 horizontal to vertical. This pond design matches the CWS Standard Drawing Number 700 and does not utilize an underdrain. Soil conductivity was calculated by using data from the United States Department of Agriculture Soil Survey Geologic Database (SSURGO) and a weighted average by area. The calculated average of 0.5 inches per hour (in/hr) was used as the infiltration rate for the pond facilities. The actual infiltration rates at the facility locations will need to be measured for final pond sizing and design.

Developers may choose to alter the pond depths, side slopes, or use an underdrain as part of the design. If site-specific geotechnical investigation determines that an area is not suitable for infiltration, the pond may be lined with an impermeable liner and infiltration removed from the pond sizing, likely resulting in a larger pond. These pond criteria modifications may result in altered pond sizing for site-specific designed facilities. The preliminary pond evaluations are intended to be representative at the planning level.

Table 3-2 | Pre-developed and Post-developed Land Areas

Pond	Total Historic Forested or Existing (2020 Conditions)	Historic Forested or Existing (2020 Conditions) Slope	Existing (2020 Conditions) Impervious Area	Total Post-Developed Area	Post-Developed Impervious Area	Post-Developed Slope
1	15.44	8%	1.16	15.44	8.28	8%
2	42.93	12%	2.37	43.59	25.44	12%
3	34.49	9%	1.54	35.25	15.93	9%
4	28.11	11%	0.11	15.22	7.61	10%
5	4.11	7%	0.09	3.95	1.65	7%
6	14.00	15%	1.72	14.00	5.43	15%
7	19.91	14%	0.77	19.91	9.24	14%
8	21.31	14%	0.32	21.31	8.38	14%
9	27.84	16%	2.03	27.84	14.06	16%
10	13.57	18%	3.37	13.57	6.93	18%
11	26.98	12%	0.01	26.98	14.59	12%
12	19.44	17%	1.69	19.44	9.83	17%
13	2.71	9%	0.06	2.71	1.35	9%
14	30.46	15%	1.26	41.03	13.76	14%
15	16.18	15%	3.98	19.43	8.66	16%
16	19.19	18%	2.26	15.53	6.54	18%
17	12.74	15%	2.38	12.25	5.68	16%
18	77.47	8%	1.48	77.47	32.35	8%
19	42.23	10%	4.87	42.23	22.34	10%
20	11.91	6%	1.27	11.91	6.13	6%
21	8.25	15%	0.00	13.25	6.63	14%
22	53.29	12%	1.50	53.29	29.70	12%

Pond	Total Historic Forested or Existing (2020 Conditions)	Historic Forested or Existing (2020 Conditions) Slope	Existing (2020 Conditions) Impervious Area	Total Post-Developed Area	Post-Developed Impervious Area	Post-Developed Slope
23	10.77	12%	0.57	10.77	5.10	12%
24	25.00	13%	0.11	31.64	15.94	13%
25	11.02	11%	0.00	11.02	5.39	11%
26	16.13	14%	1.49	17.02	7.07	13%
27	1.91	11%	0.38	1.91	0.94	11%
28	2.28	13%	0.11	4.31	2.04	12%
29	55.09	6%	2.49	55.09	16.18	6%
30	30.01	5%	5.17	30.01	14.78	5%

Notes:

1. All areas are presented in acres.
2. Post-Developed areas relate to the Developed Mitigated, Developed Unmitigated, and Developed Water Quality scenarios as described in other sections of this report.
3. The Historic Forested and Developed Mitigated scenarios were used for pond sizing.

Iterative Pond Sizing

Each pond was sized within the TRUST tool using the Auto Pond feature. To meet all requirements, the peak flow rates and durations were checked for each pond outfall to ensure the following:

- Developed Mitigated durations were at or below the Historic Forested durations for all flows between half of the 2-year peak flow and the 25-year peak flow.
- Developed Mitigated peak flow rates were at or below the Historic Forested peak flow rates for all flows between half of the 2-year peak flow to the 10-year peak flow, and the 25-year peak flow.

Pond sizing that meets the above conditions will meet the CWS MS4 hydromodification requirements as well as the SLOPES V requirements for flow control.

Water Quality

Water quality can be co-located with detention ponds if all water quality criteria are met. Water quality treatment can be provided by either volume-based facilities, such as an extended dry basin, or flow rate-based facilities, such as vegetated swales or rain gardens. Preliminary sizing was performed by providing the water quality volume below the lowest orifice of the detention pond to allow the use of the AutoPond feature in TRUST. The appropriate water quality treatment facility will be determined during design to factor in site specific conditions. Flow rate-based facilities may be advantageous in areas with little to no infiltration capacity where standing water or slow pond drawdowns will inhibit plant growth.

The water quality volume was evaluated for each subbasin based on the CWS Design and Construction Standards Chapter 4. The water quality volume is defined in section 4.08.5 as the volume of water that is produced by the water quality storm and equals 0.36 inches over the impervious area that is required to be treated.

Runoff can receive sufficient treatment through natural infiltration processes, settlement, and biological processes from the plants within an appropriately designed pond. Water quality thresholds were achieved by designing each pond to fully infiltrate the water quality volume through the soils before any flows are discharged through the outflow structure. After the water quality volume was calculated for each subbasin and the ponds were preliminarily sized for flow control, the outflow orifice was placed above the elevation where the water quality volume was met within the pond. The ponds were again iteratively sized to meet the flow control requirements described in the **Iterative Pond Sizing Section**. **Table 3-3** shows the impervious area and water quality volume used for each pond along with the proposed pond area.

Table 3-3 | Estimated Water Quality Volumes

Pond	Developed Mitigated Impervious Area (Acres)	WQ Volume (CF)	Orifice Height Above Pond Bottom (ft)	Pond Bottom Area (SF)	Min Volume Under Orifice (CF)	WQ Volume Met?
1	8.28	10,800	0.65	19,600	12,700	Yes
2	25.37	33,200	0.60	60,000	36,000	Yes
3	15.53	20,300	0.55	42,000	23,100	Yes
4	13.74	18,000	0.75	25,600	19,200	Yes
5	1.70	2,200	0.65	3,600	2,300	Yes
6	5.43	7,100	0.50	14,900	7,400	Yes
7	9.24	12,100	0.60	21,600	13,000	Yes
8	8.38	10,900	0.55	20,700	11,400	Yes
9	14.06	18,400	0.60	32,400	19,400	Yes
10	6.93	9,100	0.65	15,400	10,000	Yes
11	14.59	19,100	0.60	33,100	19,900	Yes
12	9.83	12,800	0.60	22,500	13,500	Yes
13	1.35	1,800	0.75	2,500	1,900	Yes
14	11.02	14,400	0.40	40,000	16,000	Yes
15	7.11	9,300	0.50	19,600	9,800	Yes
16	8.26	10,800	0.70	16,400	11,500	Yes
17	5.93	7,700	0.65	12,500	8,200	Yes
18	32.35	42,300	0.55	88,800	48,800	Yes
19	32.61	42,600	0.55	82,900	45,600	Yes
20	6.13	8,000	0.60	13,500	8,100	Yes
21	4.08	5,300	0.40	13,700	5,500	Yes
22	29.70	38,800	0.55	73,400	40,400	Yes
23	5.10	6,700	0.60	11,400	6,900	Yes
24	12.77	16,700	0.50	35,000	17,500	Yes
25	5.39	7,000	0.60	12,100	7,300	Yes
26	6.64	8,700	0.50	24,600	12,300	Yes
27	0.94	1,200	0.80	1,600	1,300	Yes
28	1.02	1,300	0.40	3,600	1,400	Yes
29	16.18	21,100	0.50	52,400	26,200	Yes
30	14.78	19,300	0.60	34,200	20,500	Yes

Notes:

1. Many subbasin drainage area have large commercial/multifamily areas. Final sizing will depend on the quantity of contributing area managed with onsite LIDA. All pond sizes shown are estimates/representations of one possible solution for the contributing area.

Flow Control

An outflow orifice and notched overflow riser were designed as part of each pond to regulate outflow to meet the flow control requirements. Proposed ponds were designed such that stormwater durations for the Developed Mitigated peak runoff were equal to or less than the durations of the Historic Forested flows between half of the 2-year to the 25-year peak flow events to meet the MS4 Permit flow control requirements. The Developed Mitigated discharge rates were also limited to the Historic Forested discharge rates for the storm intervals described in the SLOPES V requirements. The duration and flow control comparisons for each POC may be found in **Appendix A**. The 25-year flows are compared for the Historic Forested and Developed Mitigated conditions at each pond outfall.

Each pond area was compared to the contributing impervious area and the overall contributing area to calculate an approximate sizing factor. The estimated pond bottom areas, top areas, contributing areas, and calculated sizing factors are summarized in **Table 3-4**. Using this information, future developers can expect that the pond bottom area will need a footprint of approximately 7-11% of the contributing impervious area, or 4-6% percent of the total contributing area. This sizing factor assumes a pond design in accordance with CWS Standard Drawing Number 700. Each pond has side slopes that are 3-feet horizontal to 1-foot vertical with a maximum ponding depth of 5-feet. The resulting pond sizes are shown in **Table 3-4**.

Table 3-4 | Pond Area Sizing Factors

Pond	Pond L (ft)	Pond Bottom Area (SF)	Pond Top Area (SF)	Developed Mitigated Impervious Area (Acres)	Developed Mitigated Area, Total (Acres)	Sizing Factor (Impervious Area)	Sizing Factor (Total Area)
1	140	19,600	28,900	8.28	15.44	8.02%	4.30%
2	245	60,025	75,625	25.37	43.59	6.84%	3.98%
3	205	42,025	55,225	15.53	35.25	8.16%	3.60%
4	170	28,900	40,000	13.74	15.22	6.69%	6.03%
5	60	3,600	8,100	1.70	3.95	10.93%	4.71%
6	122	14,884	23,104	5.43	14.00	9.77%	3.79%
7	147	21,609	31,329	9.24	19.91	7.78%	3.61%
8	144	20,736	30,276	8.38	21.31	8.30%	3.26%
9	180	32,400	44,100	14.06	27.84	7.20%	3.64%
10	124	15,376	23,716	6.93	13.57	7.85%	4.01%
11	182	33,124	44,944	14.59	26.98	7.07%	3.82%
12	150	22,500	32,400	9.83	19.44	7.57%	3.83%
13	50	2,500	6,400	1.35	2.71	10.88%	5.42%
14	200	40,000	52,900	11.02	41.03	11.02%	2.96%
15	140	19,600	28,900	7.11	19.43	9.33%	3.41%
16	128	16,384	24,964	8.26	15.53	6.94%	3.69%
17	112	12,544	20,164	5.93	12.25	7.81%	3.78%
18	298	88,804	107,584	32.35	77.47	7.64%	3.19%

Pond	Pond L (ft)	Pond Bottom Area (SF)	Pond Top Area (SF)	Developed Mitigated Impervious Area (Acres)	Developed Mitigated Area, Total (Acres)	Sizing Factor (Impervious Area)	Sizing Factor (Total Area)
19	288	82,944	101,124	32.61	42.23	7.12%	5.50%
20	116	13,456	21,316	6.13	11.91	7.98%	4.11%
21	117	13,689	21,609	4.08	13.25	12.15%	3.74%
22	271	73,441	90,601	29.70	53.29	7.00%	3.90%
23	107	11,449	18,769	5.10	10.77	8.45%	4.00%
24	187	34,969	47,089	12.77	31.64	8.46%	3.42%
25	110	12,100	19,600	5.39	11.02	8.34%	4.08%
26	157	24,649	34,969	6.64	17.02	12.09%	4.72%
27	40	1,600	4,900	0.94	1.91	11.93%	5.90%
28	60	3,600	8,100	1.02	4.31	18.16%	4.32%
29	229	52,441	67,081	16.18	55.09	9.52%	2.80%
30	185	34,225	46,225	14.78	30.01	7.18%	3.54%

Notes:

1. Contributing drainage area has large commercial/multifamily areas. Final sizing will depend on the quantity of contributing area managed with onsite LIDA. All pond sizes shown are estimates/representations of one possible solution for the contributing area.
2. Sizing factor is calculated as the percentage pond top area compared to either the post-developed impervious area or the full post-developed area.

Discharge Conveyance Design

Preliminary discharge conveyance sizing was completed using the TRUST outputs for peak flow rates from each pond. Manning's calculations showed that 18-inch diameter piping would be sufficient to convey the 100-year flow rates from each pond to the receiving stream, therefore cost estimates are based on 18-inch piping. While conveyance piping is generally designed using the 25-year flow rate, the 100-year rate was used as a more conservative approach for this level of design. The estimated pipe length between the approximated pond and outfall locations are included in **Table 3-5** below. The lengths listed represent rough estimates and additional field exploration will be required to locate final ponds and outfalls. Outfall details were not within the scope of the CMUP evaluation but is assumed that outfall protection will be needed for discharges to the existing creeks.

Table 3-5 | Estimated Conveyance Pipe Length

Pond and Outfall ID	Length from Pond to Outfall (Feet)
1	210
2	460
3	380
4	440
5	300
6	330
7	360

Pond and Outfall ID	Length from Pond to Outfall (Feet)
8	360
9	170
10	380
11	420
12	570
13	520
14	270
15	590
16	250
17	570
18	310
19	320
20	200
21	220
22	730
23	300
24	280
25	310
26	440
27	600
28	610
29	830
30	170
TOTAL	**11,900**

Local stormwater collection and conveyance systems will be installed for neighborhoods and roadways during development. This local infrastructure is not included in this plan and will be the responsibility of developers. Local collection systems should discharge to stormwater management facilities as described in the **Proposed Approach: Regional Stormwater Management Facilities Section**. The design of the conveyance systems must comply with the standards of the EDM.

Implementation Considerations

Each preliminary pond design presented in this report is representative of a potential pond design for a given area. Additional analysis will be needed to assess the final pond sizing during design phases. The following factors should be considered during the final design process and may affect the final pond siting and sizing.

- Soil infiltration rates will need to be confirmed at each pond location. Infiltration rates greater than 0.5 in/hr could result in a smaller pond size, and rates lower than 0.5 in/hr could result in a larger pond. An underdrain and larger outflow orifice size may be required for low infiltration rates for the pond to drain in sufficient time to maintain plants, public safety, and the treatment and detention capacity for subsequent storms.
- Site-specific geotechnical investigations are needed to determine if the site is suitable for pond construction and possibly infiltration.
- Distributed LIDA may be used upstream of the regional facilities. These distributed systems may reduce the need for downstream storage and/or treatment, which could result in smaller pond sizing.
- Large regional ponds may be split into multiple, smaller facilities to meet the needs of a particular area or development.
- Large regional ponds may need to be split into more, smaller facilities due to siting concerns such as maintenance access, steep slopes, insufficient soil infiltration capacity, riparian area impact, phasing of development and associated transportation and drainage network, etc.
- Stormwater outfalls should be installed at locations with limited stream incision and erosion, which may require downstream placement of outfalls. Outfalls should be combined where possible.
- Ponds should be located such that they maintain natural flow paths to the maximum extent practicable. Larger ponds are needed when the contributing area to a water body is increased from the predeveloped condition, as more storage is needed to meet hydromodification requirements.
- Areas that are suitable for pond construction should be identified early in the planning process. In many cases, the most cost-effective strategy will be to drain multiple properties to a single pond.
- A Reimbursement District may be established to pay for construction of ponds that are sized to meet build-out conditions of multiple properties.
- To minimize impact to developable areas, stormwater facilities may be located in the upland portion of the natural resources overlay provided that native plants are used and there is no removal of large trees (more discussion below).

The City is designating a resource overlay that will limit development in riparian and upland areas and consider what uses will be allowed in upland areas. Vegetated stormwater facilities are one type of use that can be designed to support upland habitat goals. Allowing vegetated stormwater facilities in upland habitat areas helps to balance land development potential with stormwater management strategies so that areas that are less desirable from a habitat standpoint are more available for developed land uses. Stormwater management facilities can also provide a buffer or transition zone between developed areas and the protected natural resource area. Stormwater facilities located in upland areas should be planted with native vegetation so they are creating additional habitat value. Impacts to riparian areas should be limited where possible. These facilities should visually blend with the natural resource areas. Fencing should be discouraged. Trees should be located outside the treatment area but could be strategically located to provide shade for open water areas. Hard surfaces for access to the facilities should be outside of the natural resources overlay to the maximum extent practicable. There is potential for pedestrian trails to be used for maintenance access provided they are constructed to the City standards.

The number of subcatchments developed with the preliminary ponds (**Figure 3-9**) is representative of the large number of creeks and tributaries throughout the study area. It is important to maintain the existing drainage basins as part of the stormwater management approach. This may mean that developments need multiple ponds or multiple pond discharges to maintain discharge flows to the appropriate natural drainages.

The conventional stormwater management design provides the City with a high-level plan basis to serve the Cooper Mountain area. As City reviews and works with individual development plans, they can reference this document to review within the context of larger drainage basins presented. This larger context aims to allow the City to make decisions to promote cost-effective, cohesive, and efficient stormwater management across the study area.

Downstream Evaluation

The potential for stream degradation resulting from system-wide impacts of the combined individual pond analysis was evaluated by comparing flow rates at Downstream Points of Compliance along the McKernan Stream Corridor and at locations where flow leaves the study area by natural drainage. The Points of Compliance accounted for runoff generated by contributing areas that will not be developed and therefore are not considered in the Pond Sizing.

Downstream Points of Compliance

The development scenarios were further examined at several locations within the creeks themselves. Downstream points of compliance (POCs) to evaluate the system-wide impacts of the stormwater approach were established at 16 locations across the project site, labeled A-P. These locations and their contributing basins under Existing (Pre-developed) and Proposed (Post-developed) conditions may be viewed in **Figure 3-11** and **Figure 3-12** respectively. These POC locations include contributions of in-stream flow, flows from undeveloped areas that are not intercepted by the ponds (e.g. riparian corridors and undevelopable land), and outflows from adjacent ponds. The McKernan Creek reaches of interest are represented by POC's B, C, D, E, and F from downstream to upstream. The hydrology results are shown in **Table 3-6** to **Table 3-10**. The Post-Developed Mitigated flows generally show a decrease from the Pre-developed (Historic Forested) flows, indicating that the conventional flow control approach provides downstream benefits. The Existing flows are generally about four times higher than the pre-developed flows for the 2-year event and about two times higher for the 10-year to 100-year events. This indicates that the existing stream corridor may be experiencing an altered flow regime and some stream resilience efforts are likely necessary to support long term stream heath.

The Historic Forested and Developed Mitigated scenarios are the primary considerations for compliance. The comparison between these two models (**Table 3-11** and **Figure 3-11**) shows that the flow rates in stream are decreased in the Developed Mitigated scenario from the Historic Forested scenario at all locations. Comparison with the existing condition also provides additional insight for comparison. At POC B, all flow rates for the Post-development (Mitigated) condition are lower than those for the related Existing (2020 Condition), which indicates that downstream culvert under Grabhorn Road should not need to be replaced to accommodate the Developed Mitigated flow condition.

Table 3-6 | POC B Flow Rates in CFS for three scenarios

Recurrence Interval	Pre-Developed (Historic Forested)	Existing (2020 Condition)	Post Developed - Mitigated
2-yr	11.2	41.6	12.7
5-yr	24.9	62.9	21.2
10-yr	34.3	74.3	27.7
25-yr	45.2	85.7	36.5
50-yr	52.4	92.5	43.5
100-yr	58.6	98.0	50.9

Table 3-7 | POC C Flow Rates in CFS for three scenarios

Recurrence Interval	Pre-Developed (Historic Forested)	Existing (2020 Condition)	Post Developed - Mitigated
2-yr	9.8	37.5	9.1
5-yr	21.8	56.6	17.2
10-yr	30.0	66.9	22.8
25-yr	39.6	77.2	29.7
50-yr	45.8	83.3	34.5
100-yr	51.2	88.2	39.1

Table 3-8 | POC D Flow Rates in CFS for three scenarios

Recurrence Interval	Pre-Developed (Historic Forested)	Existing (2020 Condition)	Post Developed - Mitigated
2-yr	4.1	14.4	3.5
5-yr	9.1	24.0	6.1
10-yr	12.6	29.4	8.1
25-yr	16.5	35.1	10.8
50-yr	19.1	38.5	13.0
100-yr	21.4	41.4	15.2

Table 3-9 | POC E Flow Rates in CFS for three scenarios

Recurrence Interval	Pre-Developed (Historic Forested)	Existing (2020 Condition)	Post Developed - Mitigated
2-yr	3.4	11.9	2.6
5-yr	7.4	19.5	5.1
10-yr	10.2	23.8	6.7
25-yr	13.5	28.2	8.4
50-yr	15.6	30.9	9.5
100-yr	17.4	33.1	10.5

Table 3-10 | POC F Flow Rates in CFS for three scenarios

Recurrence Interval	Pre-Developed (Historic Forested)	Existing (2020 Condition)	Post Developed - Mitigated
2-yr	1.1	4.1	1.0
5-yr	2.5	6.8	1.9
10-yr	3.4	8.3	2.4
25-yr	4.4	9.9	3.1
50-yr	5.1	10.9	3.5
100-yr	5.7	11.7	3.8

Table 3-11 | Flow Control Standards Verification

POC	Historic Forested 25-Year Flow Rate (CFS)	Developed Mitigated 25-Year Flow Rate (CFS)
A	51.87	38.76
B	45.23	36.48
C	39.58	29.71
D	16.55	10.82
E	13.48	8.43
F	4.4	3.08
G	7.65	4.21
H	10.68	5.66
I	2.67	1.94
J	5.37	3.35
K	3.16	1.96
L	3.58	2.3
M	1.91	1.07
N	0.83	0.47
O	1.63	1.23
P	2.96	1.85

Erosion Thresholds

The McKernan Creek flows were combined with the channel geometry (**Table 3-12**) to determine unit stream power and velocity to evaluate the erosion thresholds (**Table 3-13**). To calculate the velocity a rectangular channel was assumed for the application of Manning's equation. The resulting stream power and velocity values were then compared to established values for stream stability. For Unit Stream Power thresholds see the Resilient Stream Corridors Cooper Mountain Alternative Stormwater Management Memo (W2r, 2024). For velocity thresholds see Fischenich, Craig (2001) *Stability Thresholds for Stream Restoration Materials*, USACE Research and Development Center ERDC TN-EMRRP-SR-29.

Table 3-12 | McKernan Creek Channel Geometry

POC	Length (ft)	Avg Slope (ft/ft)	Top Width (ft)	Manning's n
F	2571	0.063	4.8	0.04
E	2493	0.042	6.6	0.04
D	452	0.027	8.8	0.04
C	1809	0.012	10.9	0.04
B	1098	0.011	12	0.04

Table 3-13 | Erosion Thresholds for Unit Stream Power and Velocity

Erosion Threshold	Unit Stream Power (LB*FT/S)		Velocity (FT/S)	
	Min	Max	Min	Max
Low		0.7		2.0
Mid	0.7	1.7	2.0	4.0
High	1.7	4.1	4.0	8.0
Major	4.1		8.0	

The unit stream power and velocity results for POCs B to F along McKernan Creek are summarized in **Table 3-14** to **Table 3-18** respectively. Stream reaches falling within these erosion thresholds will generally require the following level of intervention for restoration and stabilization.

Low: Vegetation management and local beaver dam analogs

Mid: Vegetation management, local beaver dam analogs and local stability design with bioengineering and channel roughness.

High: Vegetation management, local beaver dam analogs and reach-wide bioengineering with local channel fill and channel spanning grade control.

Major: Vegetation management, local beaver dam analogs and reach-wide bioengineering with coarse bed material and channel spanning grade controls

Table 3-14 | POC B Unit Stream Power and Velocity for three scenarios

Recurrence Interval	Unit Stream Power (LB*FT/S)			Velocity (FT/S)		
	Pre-Dev (Historic Forested)	Existing (2020 Condition)	Post-Dev Mitigated	Pre-Dev (Historic Forested)	Existing (2020 Condition)	Post-Dev Mitigated
2-yr	0.64	2.38	0.73	2.14	3.50	2.25
5-yr	1.42	3.60	1.21	2.90	4.06	2.73
10-yr	1.96	4.25	1.58	3.26	4.31	3.01
25-yr	2.59	4.90	2.09	3.61	4.53	3.34
50-yr	3.00	5.29	2.49	3.81	4.65	3.56
100-yr	3.35	5.61	2.91	3.96	4.74	3.77

Table 3-15 | POC C Unit Stream Power and Velocity for three scenarios

Recurrence Interval	Unit Stream Power (LB*FT/S)			Velocity (FT/S)		
	Pre-Dev (Historic Forested)	Existing (2020 Condition)	Post-Dev Mitigated	Pre-Dev (Historic Forested)	Existing (2020 Condition)	Post-Dev Mitigated
2-yr	0.68	2.57	0.63	2.17	3.57	2.10
5-yr	1.50	3.89	1.18	2.93	4.14	2.68
10-yr	2.06	4.60	1.57	3.29	4.38	2.98
25-yr	2.72	5.30	2.04	3.64	4.61	3.28
50-yr	3.15	5.72	2.37	3.84	4.73	3.47
100-yr	3.52	6.06	2.68	3.99	4.82	3.62

Table 3-16 | POC D Unit Stream Power and Velocity for three scenarios

Recurrence Interval	Unit Stream Power (LB*FT/S)			Velocity (FT/S)		
	Pre-Dev (Historic Forested)	Existing (2020 Condition)	Post-Dev Mitigated	Pre-Dev (Historic Forested)	Existing (2020 Condition)	Post-Dev Mitigated
2-yr	0.79	2.76	0.67	2.15	3.47	2.01
5-yr	1.75	4.60	1.17	2.92	4.19	2.50
10-yr	2.41	5.64	1.55	3.29	4.52	2.79
25-yr	3.17	6.72	2.07	3.65	4.81	3.11
50-yr	3.66	7.38	2.48	3.86	4.98	3.33
100-yr	4.10	7.92	2.92	4.02	5.11	3.54

Table 3-17 | POC E Unit Stream Power and Velocity for three scenarios

Recurrence Interval	Unit Stream Power (LB*FT/S)			Velocity (FT/S)		
	Pre-Dev (Historic Forested)	Existing (2020 Condition)	Post-Dev Mitigated	Pre-Dev (Historic Forested)	Existing (2020 Condition)	Post-Dev Mitigated
2-yr	1.33	4.72	1.04	2.52	4.07	2.29
5-yr	2.95	7.74	2.03	3.42	4.88	2.96
10-yr	4.06	9.44	2.65	3.85	5.24	3.28
25-yr	5.35	11.21	3.35	4.27	5.57	3.58
50-yr	6.19	12.27	3.79	4.50	5.75	3.75
100-yr	6.92	13.15	4.16	4.69	5.89	3.89

Table 3-18 | POC F Unit Stream Power and Velocity for three scenarios

Recurrence Interval	Unit Stream Power (LB*FT/S)			Velocity (FT/S)		
	Pre-Dev (Historic Forested)	Existing (2020 Condition)	Post-Dev Mitigated	Pre-Dev (Historic Forested)	Existing (2020 Condition)	Post-Dev Mitigated
2-yr	0.93	3.35	0.79	2.11	3.45	1.98
5-yr	2.01	5.56	1.54	2.84	4.17	2.56
10-yr	2.75	6.82	2.01	3.20	4.49	2.84
25-yr	3.60	8.13	2.52	3.54	4.79	3.10
50-yr	4.15	8.93	2.85	3.74	4.95	3.24
100-yr	4.63	9.59	3.13	3.89	5.08	3.36

The velocity results indicate that the pre-developed condition was largely in the "Mid" erosion threshold, which is consistent with the steep streams in erodible silt materials. This result emphasizes the importance of healthy riparian vegetation for channel stability, including larger tree roots within the channel bed to prevent erosion. These conditions may have existed in a fully forested watershed. The results also show that the existing condition is largely in the "High" erosion threshold and the streams will likely require some level of intervention to achieve the pre-developed level of stability. Without establishing healthy riparian vegetation, the streams are likely to continue to erode, even after the flow control mitigation is complete. **It is recommended that the City supplements the CWS vegetated corridor requirements to include repair of local channel and bank erosion and evaluate the need for a reach-scale resilient stream corridor project once the reach ownership has been consolidated into an accessible greenway.** This will prevent costly future repairs that would be required if the erosion continues.

Additional scenarios are included in **Appendix A** for consideration and use in future analysis; Developed Unmitigated and Developed Water Quality. The Developed Unmitigated condition removes the ponds from the scenario, showing what the stream flows would look like if the area is developed and there is no stormwater mitigation. The

Developed Water Quality scenario uses the water quality sizing methodology from the CWS stormwater manual to size rain gardens, which were included in place of the ponds; this scenario shows the results of providing water quality management but not flow control. Final stormwater facility designs and locations will ultimately be up to the individual developers, who may decide to pursue alternative methodologies for compliance. These additional scenarios provide preliminary analysis for potential alternative sizing methodologies that may be used in the future. Results from all scenarios may be viewed in **Appendix A.**

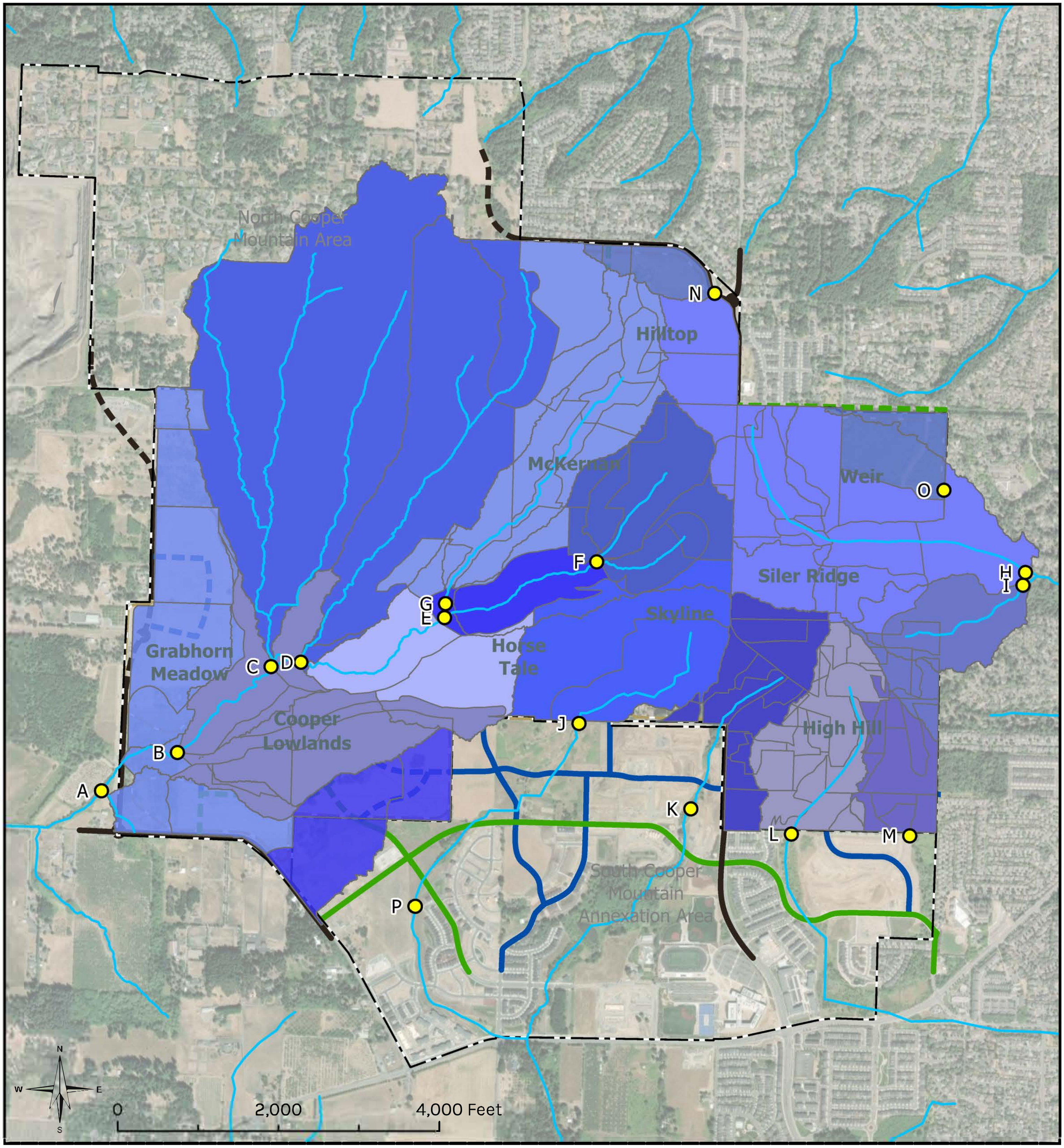
Climate Change

While this plan does not specifically evaluate the impacts of climate change, there is general consensus in the stormwater industry that the frequency and intensity of storm events is going to increase. Those changes will likely result in higher rates of runoff and increased flows to natural systems, even without future development. The stormwater facility types proposed in this plan are those that are most resilient to a changing climate. Large ponds have freeboard capacity to manage larger storms without overwhelming the system; orifices can be modified in the future by the City to adjust discharge rates; overflow structures allow for automatic response to large events.

Conclusions

The development of the Cooper Mountain Project area will require management and mitigation of stormwater runoff. Much of the mitigation strategy will remain up to the individual developers, however considerations and preliminary analysis of potential management strategies have been included in this report. Results indicate that regional stormwater facilities can result in significant improvement to the existing creeks hydrology and streams that run through the project area, slowing flows and reducing erosion potential from existing conditions. Pond sizing for 30 regional facilities to accomplish stormwater management for the full project area have been provided. The pond sizes provided meet the current applicable regulatory requirements and generally improve in-stream conditions. The cumulative impact of the ponds will be to reduce the in-stream flows to pre-developed historic forested conditions. However, the existing stream flows are two to four times higher than the historic conditions and until most of the flow control ponds are built the streams are likely to continue to erode.

While these improvements are promising, additional in-stream work should be considered. The existing geology, known conditions of incised stream channels, and calculated mid to high erosion thresholds under Historic Forested conditions indicate that additional mitigation may be needed to protect and improve the quality of the streams. Healthy riparian vegetation is critical for stream stability in this system, without the vegetation the streams are likely to continue to erode even after flow control is provided. The results from this analysis may be used to produce a preliminary strategy for stream restoration or enhancement. It is recommended that the City works with CWS to evaluate and restore the stream reaches after ownership and/or easements have been consolidated by development activities. This will allow the agencies to determine the restoration needs based on actual performance of the ponds with the more detailed hydrology and hydraulics analysis available from the development review.



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Legend

- POCs
- Stream

Existing POC

A, B, C, D, E, F, G, H, I, J, K, L, M, O, N, P

Cooper Mountain Utility Plan

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Figure 3-11
Existing POC Basins

Project No. 20-2755

May 2024

Data Sources: City of Beaverton, October 2022; Service Layer Credits: World Imagery: Maxar
Coordinate System:
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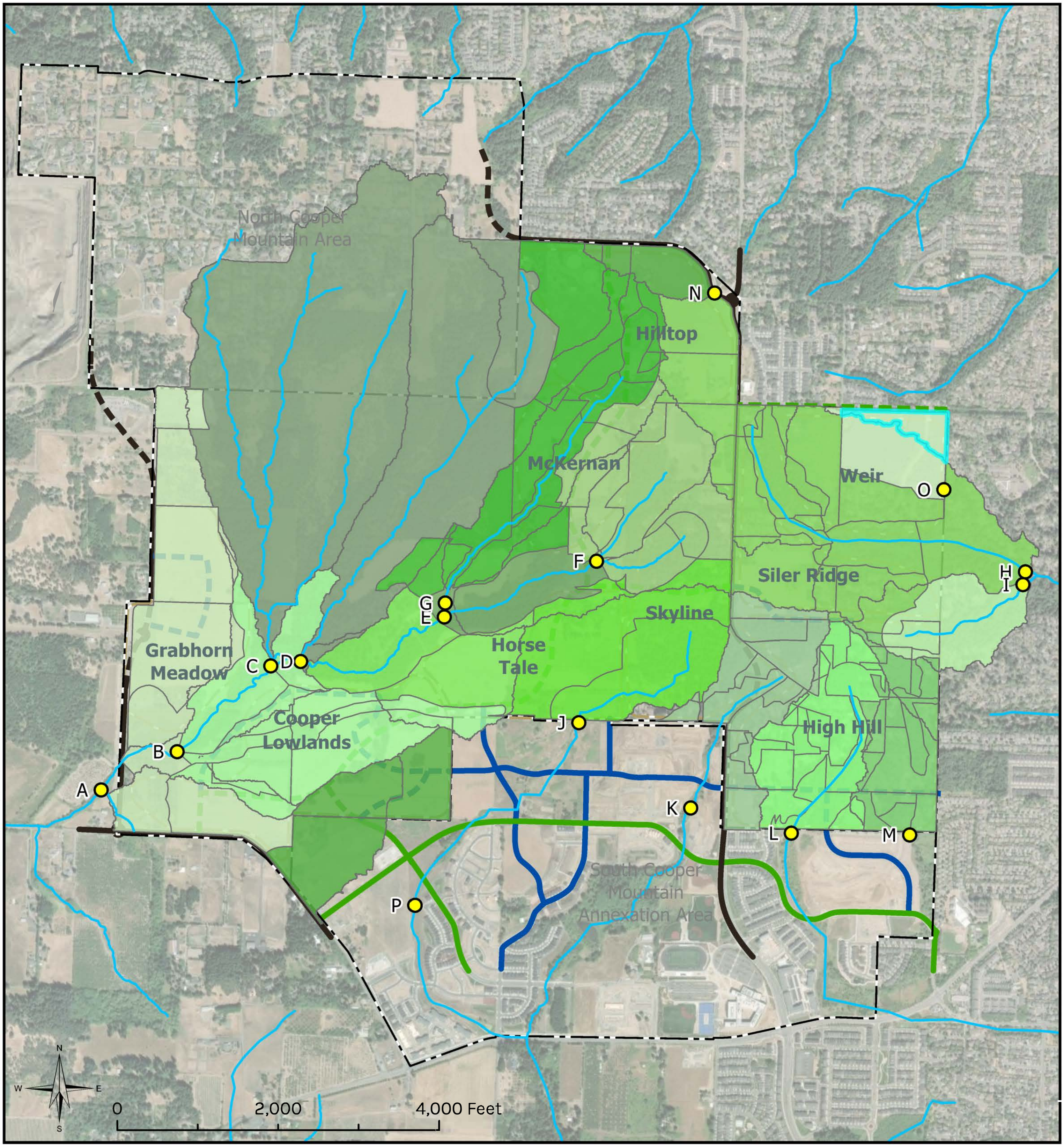

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Legend

- POCs
- Stream

Proposed POC

A	C	H	M
B	D	I	N
	E	J	O
	F	K	P
	G	L	

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Figure 3-12
Proposed POC Basins

Project No. 20-2755

May 2024

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Chapter 4: Sewer Utility

Introduction

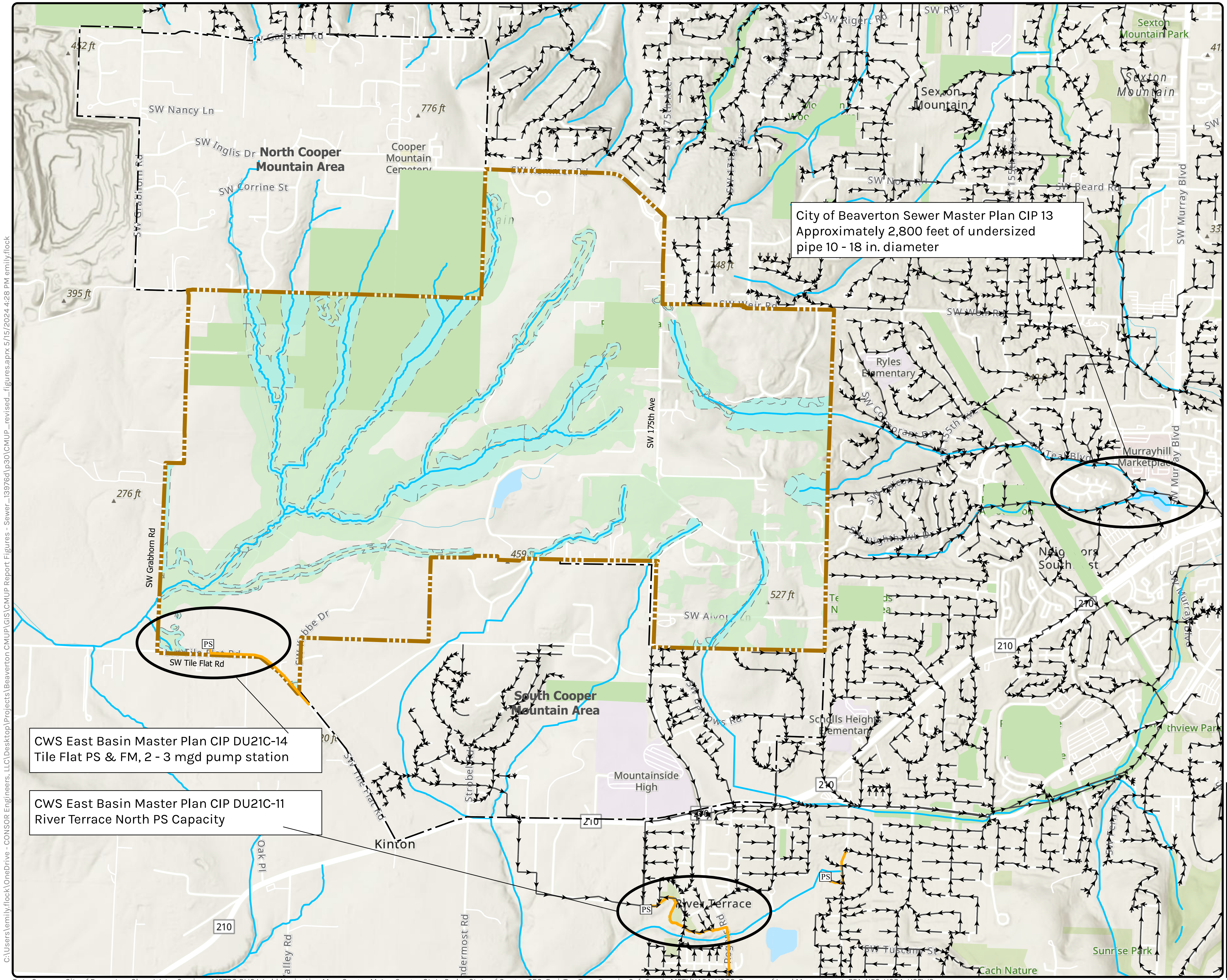
The City has long had an intergovernmental agreement (IGA) with Clean Water Services (CWS) for the cooperative operation of sewer facilities. At the time of this study, the City and CWS were negotiating the terms of the IGA. The assumptions in this study are based on the IGA in place as of 2020. The existing IGA establishes a service boundary relative to city limits and outlines division of responsibilities within and outside of the boundary. For the purposes of the CMUP, it is assumed the study area will be within city limits at time of development. Within city limits, the City owns and operates lines up to and including 12-inch diameter, owns and operates but does not pay to move or replace lines over 12-inch up to 24-inch diameter, and does not own or operate lines equal to or larger than 24-inch diameter. Pump stations are owned and operated by CWS. There is currently no existing public sewer service in the study area.

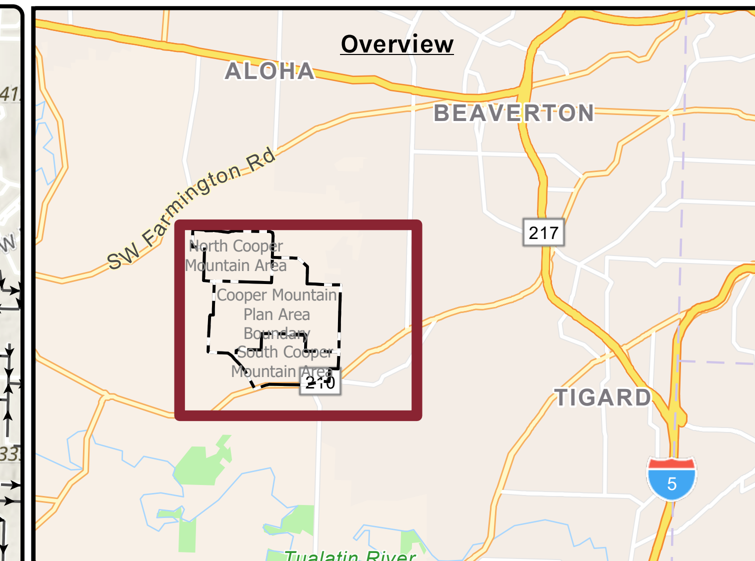
The Cooper Mountain Area lies within CWS' East Basin. CWS has adopted the 2021 East Basin Master Plan (EBMP) which documents sanitary sewer master planning efforts for the East Basin. The EBMP documented the projected buildout units in the Cooper Mountain and NCM areas and identified deficiencies and capital improvement projects for CWS's infrastructure that are required to serve the projected growth in the basin. The 2019 City Sewer Master Plan (SMP) also estimated projected buildout units in the Cooper Mountain and NCM and analyzed potential deficiencies and capital projects required to serve the projected growth. The CMCP process has provided updated land use and housing unit assumptions for the Cooper Mountain area since both the EBMP and City SMP were completed. The CMUP analysis and recommendations are based on the October 2022 CMCP Concept Map Plan and CMCP estimated housing units for each neighborhood area by land use. The study area with existing sewers and planned capital improvement projects is shown in **Figure 4-1**. Planned and under construction sewers were considered as existing for this effort and are shown as such in maps.

This chapter summarizes the planning criteria, estimated flows, and proposed infrastructure to provide cost effective sewer service to the study area. It was assumed that the Cooper Mountain Sanitary Pump Station (CMSPS, previously called the Tile Flat PS in the CWS EBMP) will be operational prior to any development west of SW 175th Avenue.

Previous Planning Studies

The CWS EBMP and City SMP previous planning efforts accounted for future development and associated sewer flows for the CMUP study area as a whole. The plans do not include clear information on the assumed distribution of flows across the study area. The CMUP estimated sewer flows for the overall study area generally follow the assumptions from the previous planning efforts. Proposed flows to CMSPS are similar to the proposed Tile Flat PS capacity (2-3 MGD) identified in the EBMP and the proposed sewer basin delineations are generally in alignment with the previous planning studies.





Legend
- CMUP Study Area
- PS Pump Station
- Force Main
- Gravity Main
- Parks and Natural Areas
- Stream
- Riparian Corridors
- Resource Overlay

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Beaverton OREGON

consor

Cooper Mountain Utility Plan

Figure 4-1 Existing Collection System and Planned CIP Projects

Project No. 20-2755

May 2024

Data Sources: City of Beaverton, Clean Water Services, METRO RLIS;World Navigation Map: Oregon Metro, Oregon State Parks, State of Oregon GEO, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS
World Topographic Map: Esri Community Maps Contributors, 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:
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The CMCP assumptions regarding buildout of the contributing NCM area have increased compared to the previous studies It is unclear if contributing area delineation has changed significantly since the previous studies. The NCM area is still planned to flow by gravity to the proposed conveyance line along Grabhorn Road and to the planned CMSPS.

Planning Criteria

There are often multiple ways to meet the technical requirements for sewer service within a given area. The following criteria establish City priorities for technical approaches and preferred types of facilities. These are intended to provide a framework and guidance for the sewer utility development and preferred approach.

- Minimize long-term maintenance costs by utilizing gravity conveyance networks to the extent feasible and eliminating the need for pumping facilities.
- Sewer alignments located in existing/proposed road right-of-way to the extent feasible.
- Sewer alignments consider topography and avoid excessive depths while complying with the minimum cover per CWS Design Standards.
- Sewer alignments and sizing consider likely trunk sewer locations to facilitate future maintenance and replacement needs.

Basis of Analysis

Planning Flow Criteria

It is important to both the City and CWS that there are consistent planning flow criteria across planning studies, when possible, to develop consistent utility planning for areas. CWS developed a Draft Sanitary Conveyance System Capacity Analysis Criteria Technical Memorandum (CWS Tech Memo) in August 2022 to document planning flow criteria for sewer planning studies and provide consistent guidance to its partners. The CWS Tech Memo is based on the EBMP analyses with some updates from CWS staff and data. Based on coordination with CWS and City staff, planning flow criteria used in the CMUP evaluation were selected to align with the CWS Tech Memo. People per household, residential average dry weather flow (ADWF) rate, peaking factors, groundwater infiltration (GWI) rate, and rainfall driven infiltration and inflow (RDII) rate are based on the CWS Tech Memo and are summarized below in **Table 4-1**. These criteria are used to calculate an estimated residential sewer flow for a given number of housing units in a development.

Table 4-1 | Sanitary Conveyance Analysis Criteria - Residential

Assumption, Input, or Flow Category	Value
People per household[1]	2.6
Sanitary use per person (gpcd) – East Basin	73.9
Max Hour Peaking Factor (Average DWF/WWF to Peak DWF/WWF)	1.6[2]
Peak GWI Rate (gpnad)	200
Peak RDII Rate (gpnad) for new development (<10 years old)	2,500
Net Acreage Factor	0.8

Notes:

1. Household is interpreted as an equivalent dwelling unit (EDU) for this analysis.
2. An average weekday/weekend peaking factor was developed for this area in the East Basin Master Plan.

Acronyms: gpcd – gallons per capita per day, DWF – dry weather flow, WWF – wet weather flow, GWI – groundwater infiltration; gpnad – gallons per net acre per day, RDII – rainfall derived infiltration and inflow

In addition to residential development, the CMCP estimates areas of commercial and mixed residential commercial land use in the study area. Based on coordination with members of the CMCP team, it is assumed commercial activity in the study area will be similar to that of SCM. Estimates of employment and commercial sewer flows were based on estimates and methods from the 2015 South Cooper Mountain Sewer Plan and are summarized in **Table 4-2**.

Table 4-2 | Sanitary Conveyance Basis of Analysis Criteria - Commercial

Assumption, Input, or Flow Category	Value
Jobs per acre	41.88
Commercial sanitary use (gallons per job per day)	45.79
Percentage of commercial use in mixed residential commercial land use	10%

Infrastructure Design Criteria

The sanitary sewer service in Cooper Mountain is expected to convey flow to the City's existing infrastructure to the east and to the south in SCM in addition to CWS' planned CMSPS in the southwest of the Cooper Mountain area. To integrate proposed facilities with existing infrastructure, the proposed sewer alignments will comply with CWS Design Standards and reference the SMP planning criteria for sewer conveyance design. CWS Design Standards and the City's SMP Design Criteria are summarized in **Table 4-3**.

Table 4-3 | CWS Design Standards and the City's Sanitary Master Plan Design Criteria

Assumption, Input, or Flow Category	Value
Maximum d/D[1]	<=0.8
Gravity Pipeline Minimum Cleansing/Scouring Velocity (fps)	2.0[2]
Gravity Pipeline Maximum Velocity (fps)	< 15.0
Force Main Minimum Cleansing/Scouring Velocity (fps)	3.5
Force Main Maximum Velocity (fps)	8.0

Assumption, Input, or Flow Category	Value
Manning's n Coefficient	0.013
Minimum Pipe Diameter (in)	8
Minimum Slope, 8-inch Pipe (ft/ft)	0.004[3]
Maximum Slope (ft/ft)	0.2[4]
Minimum Pipe Cover in Paved Areas (in)	48
Minimum Cover in Unpaved Areas (in)	36
Downstream Pipe Offset (ft)	0.2

Notes:
1. Depth/Diameter.
2. When flowing full or half full.
3. All pipes, regardless of diameter, are designed to the minimum slope for 8-inch diameter pipe.
4. Without the use of anchor walls or metal pipe slope anchors.

Estimated Flows

The CMCP defined neighborhoods within the study area and proposed land use for the areas within each neighborhood, shown in **Figure 2-2**. Buildable land by neighborhood and land use type and assumed housing densities per land use type are based on the Draft CMCP Concept Plan presented in October 2022. The October 2022 draft established proposed roadway alignments, resource protection areas, likely park locations, and projected land use designations. The October 2022 Draft Concept Plan land use included a Conservation Neighborhood overlay (primarily over Mixed Residential designated areas) that assumed lower density development. The designation was intended to result in development sensitive to natural resources, steep slopes, wildlife corridors, and existing tree canopy. While further refinements to the Concept Plan are expected as the CMCP is finalized, these refinements are not expected to substantially change the locations or intensity of development planned across Cooper Mountain. Housing densities by land use are summarized in **Table 4-4.**

Table 4-4 | Community Plan Residential Development Densities

Land Use	Density (EDU/ac)	Net Density (EDU/ac)
Conservation Neighborhood	7	5.6
Mixed Residential	10	8
Mixed Residential/Commercial[1]	30	24
Multifamily[2]	30	24

Notes:
1. Assumed 90% of the total area is residential use and 10% of the area is commercial use.
2. Net density in the Hilltop and Lowlands neighborhoods are 48 units/ac and 36 units/ac, respectively.

Estimated flows for the study area are based on proposed land use for each neighborhood, buildable land, housing densities, and the criteria summarized in the **Planning Criteria Section**. The criteria used and resulting estimated ADWF flows and peak total flows by proposed neighborhood are summarized in **Table 4-5**. The Cooper Mountain Nature Park, Resource Overlay areas, rights-of-way, area set aside for utilities, and existing and proposed parks are not considered in the estimation of sanitary sewer flows.

North Cooper Mountain Contributing Area

A portion of the NCM area is expected to contribute sewer flow to the study area in the future per the CWS' Rosedale Pump Station Siting Study (2023). The timing of this flow being redirected through the study area, as well as the level of redevelopment within the NCM area at that time, is uncertain. Based on discussions with CWS and the City, this plan accounts for projected build-out development in the contributing portion of NCM.

This is a conservative approach and allows proposed conveyance lines in major arterials (Grabhorn Road) to be sized for projected buildout flows. Developers that install those oversized conveyance lines may be eligible for system development charges (SDC) credits. In the short term, these lines may be oversized and could require more frequent cleaning and maintenance attention to maintain capacity until buildout in NCM increases flows to promote more efficient flushing.

Table 4-5 | Sewer Flow Estimates

Neighborhood	Land Use	Acres	Net Acres	Housing Density	EDU	Population	Employees	Residential ADWF (gpd)	Commercial ADWF (gpd)	Total ADWF (gpd)	Peak ADWF (gpd)	Peak GWI (gpd)	Peak RDII (gpd)	Peak Total Flow (gpd)
Grabhorn Meadow	Conservation Neighborhood	14.2	10.7	6	80	208	-	15,371	-	15,371	24,594	2,136	21,363	48,093
	Mixed Residential	2.4	1.8	24	58	151	-	11,159	-	11,159	17,854	358	3,581	21,793
	Mixed Residential/Commercial	1.8	1.3	24	38	99	8	7,316	366	7,682	12,292	264	2,637	15,192
	Multifamily	55.2	41.4	8	442	1,150	-	84,985	-	84,985	135,976	8,278	82,777	227,030
	Subtotal	**73.6**	**55.2**		**618.0**	**1,608**	**8**	**118,831**	**366**	**119,198**	**190,716**	**11,036**	**110,357**	**312,109**
High Hill	Conservation Neighborhood	60.3	45.2	6	338	879	-	64,958	-	64,958	103,933	9,045	90,453	203,431
	Multifamily	3.8	2.8	24	91	237	-	17,514	-	17,514	28,023	566	5,659	34,247
	Subtotal	**64.1**	**48.1**		**429**	**1,116**	**-**	**82,472**	**-**	**82,472**	**131,956**	**9,611**	**96,111**	**237,678**
Hilltop	Commercial	5.3	4.0	-	-	-	222	-	10,165	10,165	16,265	794	7,941	24,999
	Mixed Residential	5.5	4.1	48	262	682	-	50,400	-	50,400	80,640	818	8,181	89,638
	Mixed Residential/Commercial	6.5	4.9	24	141	367	28	27,121	1,282	28,403	45,445	977	9,770	56,193
	Multifamily	54.4	40.8	8	435	1,131	-	83,581	-	83,581	133,729	8,153	81,534	223,416
	Subtotal	**71.6**	**53.7**		**838**	**2,180**	**250**	**161,102**	**11,448**	**172,550**	**276,079**	**10,742**	**107,425**	**394,247**
Horse Tale	Mixed Residential	6.2	4.7	24	150	390	-	28,821	-	28,821	46,114	933	9,331	56,378
	Multifamily	39.7	29.8	8	318	827	-	61,115	-	61,115	97,784	5,960	59,600	163,344
	Subtotal	**46.0**	**34.5**		**468**	**1,217**	**-**	**89,936**	**-**	**89,936**	**143,898**	**6,893**	**68,931**	**219,722**
Lowlands	Commercial	6.0	4.5	-	-	-	253	-	11,585	11,585	18,536	905	9,050	28,490
	Conservation Neighborhood	35.9	26.9	6	201	523	-	38,650	-	38,650	61,840	5,384	53,837	121,061
	Mixed Residential	12.0	9.0	36	433	1,126	-	83,211	-	83,211	133,138	1,801	18,015	152,954
	Mixed Residential/Commercial	4.9	3.7	24	106	276	21	20,396	962	21,358	34,173	736	7,357	42,265
	Multifamily	81.0	60.7	8	648	1,685	-	124,522	-	124,522	199,234	12,147	121,465	332,846
	Subtotal	**139.8**	**104.9**		**1,388**	**3,610**	**274**	**266,779**	**12,546**	**279,325**	**446,921**	**20,972**	**209,724**	**677,617**
McKernan	Conservation Neighborhood	16.3	12.3	6	92	240	-	17,736	-	17,736	28,378	2,451	24,508	55,337
	Mixed Residential	33.2	24.9	8	266	692	-	51,139	-	51,139	81,822	4,977	49,769	136,568
	Subtotal	**49.5**	**37.1**		**358**	**932**	**-**	**68,875**	**-**	**68,875**	**110,200**	**7,428**	**74,277**	**191,905**
North Cooper Mountain	Projected Density[1]	284	213	11	2,259	5,874	-	434,089	-	434,089	694,542	42,615	426,150	1,163,307
	Subtotal	**284.1**	**213.1**		**2,259**	**5,874**	**-**	**434,089**	**-**	**434,089**	**694,542**	**42,615**	**426,150**	**1,163,307**
Siler Ridge	Mixed Residential	1.3	1.0	24	32	84	-	6,208	-	6,208	9,932	200	1,999	12,131
	Mixed Residential/Commercial	2.7	2.0	24	59	154	12	11,381	549	11,930	19,088	403	4,030	23,521
	Multifamily	26.9	20.2	8	216	562	-	41,532	-	41,532	66,451	4,042	40,422	110,915
	Subtotal	**31.0**	**23.2**		**307**	**800**	**12**	**59,120**	**549**	**59,669**	**95,471**	**4,645**	**46,451**	**146,567**
Skyline	Conservation Neighborhood	14.2	10.7	6	80	208	-	15,371	-	15,371	24,594	2,132	21,316	48,041
	Mixed Residential	4.2	3.2	24	102	266	-	19,657	-	19,657	31,452	632	6,323	38,407
	Multifamily	7.0	5.3	8	57	149	-	11,011	-	11,011	17,618	1,055	10,546	29,218
	Subtotal	**25.5**	**19.1**		**239**	**623**	**-**	**46,040**	**-**	**46,040**	**73,664**	**3,818**	**38,184**	**115,666**
Weir	Conservation Neighborhood	2.6	1.9	6	14	37	-	2,734	-	2,734	4,375	388	3,885	8,648
	Mixed Residential	0.1	0.1	24	2	6	1	443	46	489	783	12	118	912
	Mixed Residential/Commercial	32.6	24.4	8	261	679	-	50,178	-	50,178	80,285	4,885	48,855	134,025
	Subtotal	**35.2**	**26.4**		**277**	**722**	**1**	**53,356**	**46**	**53,402**	**85,443**	**5,286**	**52,857**	**143,586**
	Total	**820.3**	**615.2**		**7,181**	**18,682**	**545**	**1,380,600**	**24,956**	**1,405,555**	**2,248,889**	**123,047**	**1,230,468**	**3,602,403**

Note:

1. Projected density from Rosedale PS Siting Study, CWS 2023

Alternatives Evaluation

An evaluation of sewer alignments in existing and proposed roadways versus alignments within stream corridors was completed in the initial phases of the CMUP. The alternative to locate sewer lines along stream corridors was largely correlated with a potential RSC stormwater approach (see **Chapter 3** for discussion of stormwater approaches). As the CMUP evaluation progressed, a number of reasons for generally locating sewer alignments in proposed roadways and not stream corridors were identified which are summarized in the following paragraph.

Sewer alignments along existing and proposed roadways place sewer trunklines more centrally located within development areas identified by the CMCP. The topography of much of Skyline and High Hill and portions of Horse Tale and Cooper Lowlands slope to the south/southwest away from stream corridors. Locating sewer trunklines in the stream corridors could result in local sewer lines being deep or steep to connect to trunklines. Alignments sited within stream corridors create additional construction and maintenance challenges and increase costs.

Portions of the Siler Ridge and Weir neighborhoods are recommended to be served by sewer alignments in stream corridors on the eastern side of the study area. These areas are challenging to serve by gravity based on the topography. The proposed infrastructure to serve these areas is discussed in more detail in the following section.

Proposed Sewer Infrastructure

The proposed sewer alignments consist of approximately 41,000 ft of PVC pipe ranging in diameter from 8 inches to 18 inches. The proposed alignment lengths and diameters are summarized in **Table 4-6** and are separated by connection point to the downstream system. The alignments tributary to CMSPS are further separated at junctions between branches of the alignment. The alignments and connection points are shown in **Figure 4-2**. Invert elevations and depths assumptions at key locations in the proposed collection system are summarized below.

North Cooper Mountain Connection on SW Grabhorn Road: The invert elevation of the proposed North Cooper Mountain connection point is approximately 422 feet at a depth of approximately nine feet. The low point of the North Cooper Mountain Area expected to flow to the proposed system is approximately 60 feet higher than the ground elevation at the connection point. It is expected that this proposed depth is sufficient to serve the North Cooper Area. However, the specific depth should be evaluated in the next phase of design.

CMSPS4 Crossing of McKernan Creek: CMSPS4 crosses McKernan Creek at an elevation of approximately 550 ft at a depth of approximately 8 feet. The alignment was developed based on preliminary roadway profiles of Route 1. Changes to the proposed roadway or the type of crossing over McKernan Creek may necessitate revisions to the proposed gravity main profile. The topography upstream and downstream of the McKernan Creek along the proposed alignment is expected to have sufficient elevation to accommodate revisions to the proposed profile.

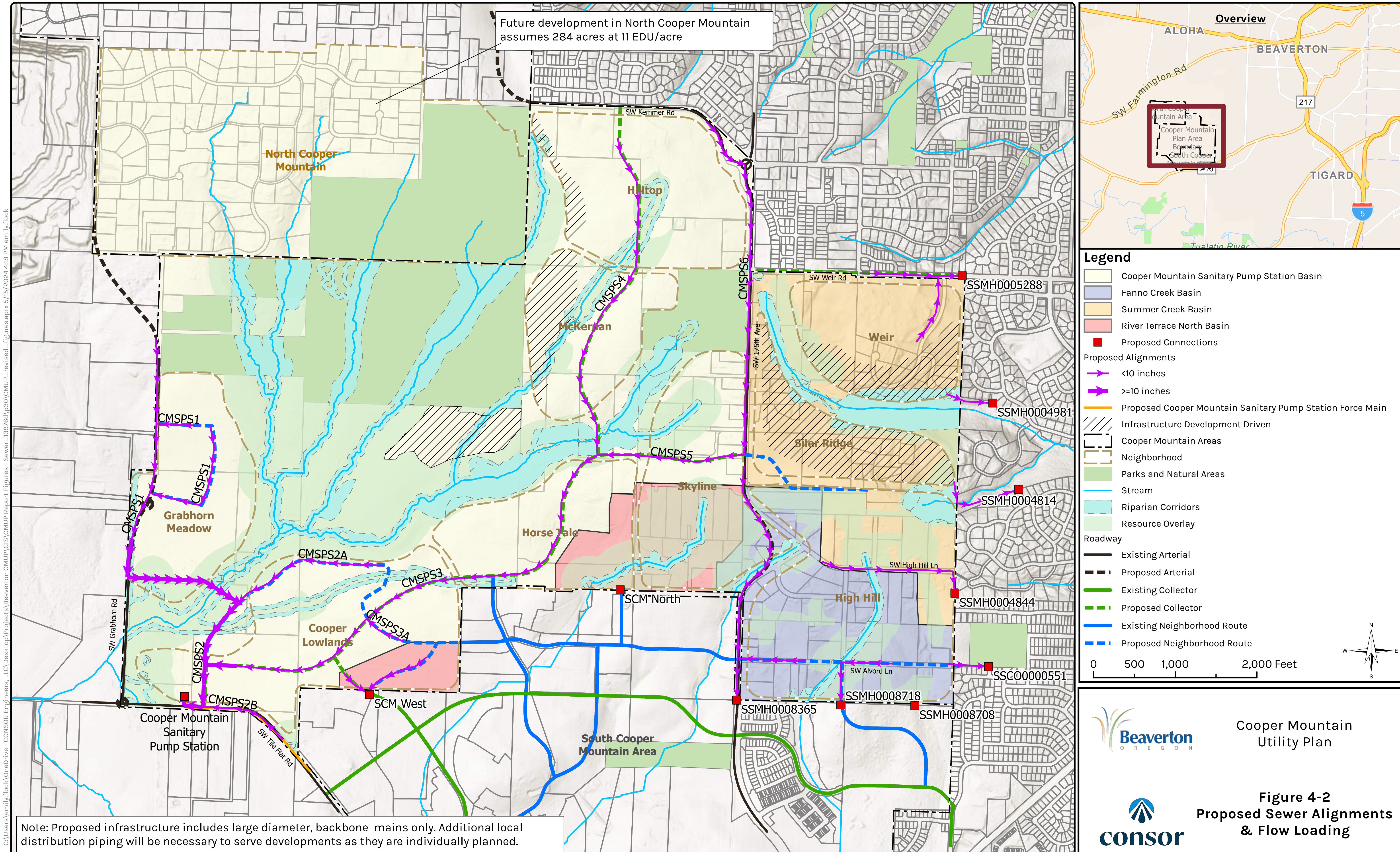

Figure 4-2
Proposed Sewer Alignments & Flow Loading

Project No. 20-2755 May 2024

Data Sources: City of Beaverton, METRO RLIS;World Navigation Map: Oregon Metro, Oregon State Parks, State of Oregon GEO, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS
World Hillshade: Esri, NASA, NGA, USGS, FEMA
Coordinate System: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl
Disclaimer: Consor and City of Beaverton 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.

Siler Ridge at SW 175th Avenue: Alignments CMSPS5 and CMSPS6 meet at SW 175th Avenue near the southwest corner of the proposed Siler Ridge neighborhood. The invert elevation is approximately 655 feet at a depth of approximately 30 feet. An increase in ground elevation between SW Weir Road and this point contributes to relatively deep sewer depths for the is portion of the CMSPS6 alignment. Grond surface elevations were taken from 2ft contour data for the project area. Specific depths should be evaluated from surveyed road profiles in the next phase of design. Should sewer alignments at this depth be infeasible from a maintenance or constructability aspect, gravity alignment running through the Siler Ridge neighborhood, either to the east near Creek or to the south paralleling SW 175th Avenue, may allow for a shallower sewer alignment.

CMSPS1 Crossing of McKernan Creek: CMSPS1 crosses McKernan Creek at an elevation of approximately 222 feet at a depth of approximately 13 feet. This alignment is sited along a proposed trail and is co-located with a planned water main serving the Grabhorn Meadows neighborhood. Co-location of the water main with this proposed alignment or changes to the proposed trail location may drive changes to the sewer profile. Specific depth of the crossing should be evaluated during design of the trail and during the next phase of design for the sewer alignment.

Table 4-6 | Proposed Sewer Alignment Summary

Collection System Basin	Alignment	Diameter (in)	Length (ft)
Cooper Mountain Sanitary Pump Station (CMSPS)	CMSPS1	8	4,676
		10	480
		15	1,424
		Subtotal	6,579
	CMSPS2	15	899
		18	853
		Subtotal	1,752
	CMSPS2A	8	1,956
	CMSPS2B	8	1,119
	CMSPS3	8	5,715
		10	397
		Subtotal	6,112
	CMSPS3A	8	533
	CMSPS4	8	4,187
	CMSPS5	8	1,811
	CMSPS6	8	4,316
		Basin Subtotal	28,365
Fanno Creek	SSCO0000551	8	497
	SSMH0008365	8	3,921
	SSMH0008718	8	1,156
		Basin Subtotal	5,574
Summer Creek	SSMH0004814	8	1,056
	SSMH0004844	8	1,888
	SSMH0004981	8	589
	SMH0005288	8	2,140

Collection System Basin	Alignment	Diameter (in)	Length (ft)
		Basin Subtotal	5,672
River Terrace North	SCM_West	8	1,292
		Total	40,903

Previous Planning Study Considerations

As discussed in previous sections, the estimated sewer flows for the study area are on the same order of magnitude as those identified in previous planning studies (CWS EBMP and City SMP). On a study area wide basis, projected flows are on the same order of magnitude as those presented in the EBMP and City SMP and downstream analyses in these previous studies are assumed to still be relevant and representative of future flow estimates downstream of the study area. The downstream capacity related deficiencies identified in the EBMP and City SMP are summarized in the following paragraphs and shown in **Figure 4-1**. Further capacity evaluation of systems downstream of proposed sewer infrastructure was not within the scope of the CMUP. It is recommended that each development evaluates and confirms the downstream capacity of the system to which it plans to connect.

The SMP identified one capacity related deficiency downstream of the CMUP study area proposed connections. Approximately 1,700 ft of pipe in the Murrayhill Pond Area along and near SW Teal Boulevard, SW Osprey Drive and, SW Murray Boulevard is deficient for modeled flows representing SMP existing conditions. The SMP identified an improvement (CIP-13) to address this deficiency consisting of approximately 2,800 ft of pipe with diameters ranging from 10 inches to 18 inches. It is recommended the City monitor and analyze the existing system between the proposed eastern connections and the Murrayhill Pond area to ensure the SMP proposed improvements provide adequate capacity as the study area develops. Similar monitoring analysis is also recommended for proposed connections to the City's system in SCM. It is recommended the City incorporates the revised unit projections in future planning efforts to evaluate the capacity of the receiving collection system in more detail.

The EBMP identified two capacity related projects downstream of proposed connections which are likely to be directly impacted by development in the project area: the CMSPS and force main (referred to as Tile Flat PS) and capacity upgrades at the River Terrace North Pump Station (RTNPS). The RTNPS serves areas outside the project area and the remaining capacity at the station is impacted by both development within and adjacent to the study area. It is recommended that the RTNPS capacity be evaluated as tributary areas within the CMUP project area develop.

Challenging to Sewer Areas

Areas within the Hilltop, McKernan, Siler Ridge, and Weir neighborhoods and an area outside of the proposed CMCP neighborhoods were identified as challenging to serve via gravity alignments located within the roadway and are shown in **Figure 4-2**.

Solutions to serve these areas are discussed below. These alignments generally serve localized development (Weir and Siler Ridge), require greater depths to support topographically challenging areas (McKernan and Hilltop), and may have increased permitting or acquisition challenges due to private property or ecologically sensitive areas (Siler Ridge and Weir).

Hilltop

The hard to sewer area identified in the Hilltop neighborhood is located on the eastern edge of the neighborhood. A branch of McKernan Creek runs between the proposed alignment (TF4) and this area; local sewers will need to cross McKernan Creek. The proposed TF4 alignment was assumed to be 10 ft deeper than necessary, where possible, to provide sufficient elevation for local sewers to cross the creek. The proposed TF4 alignment in the Hilltop neighborhood has sufficient grade to allow further depth should it be needed to serve these areas.

McKernan

The hard to sewer area identified in the McKernan neighborhood is located on the eastern edge of the neighborhood. A branch of McKernan Creek runs between the proposed alignment (TF4) and this area; local sewers will need to cross McKernan Creek. The proposed TF4 alignment was assumed to be 10 ft deeper than necessary, where possible, to provide sufficient elevation for local sewers to cross the creek. The proposed TF4 alignment in the northern portion of the McKernan neighborhood has sufficient grade to allow further depth should it be needed to serve these areas.

Siler Ridge

To serve the hard to sewer area within the Siler Ridge neighborhood, an alignment is proposed to convey flow east to the City's existing collection system (SSMH004814). Portions of this alignment are sited on private property, within the vegetative corridor, on steep slopes, and may require crossing a seasonal creek. Implementation would require the acquisition of easements, increased environmental permitting, and additional construction considerations to mitigate steep slopes or a potential creek crossing. This alignment may also have maintenance challenges related to access to the alignment.

Weir

To serve the hard to sewer area within the Weir neighborhood, an alignment is proposed to convey flow east to the City's existing collection system (SSMH004981). The alignment is sited on private property with portions within the vegetative corridor and on steep slopes. Implementation would require the acquisition of easements, increased environmental permitting, and additional construction considerations to mitigate steep slopes. This alignment may also have maintenance challenges related to access to the alignment.

South of Cooper Mountain Nature Park

There is an area of potential development located just south of Cooper Mountain Nature Park. This area is topographically downslope of the McKernan neighborhood and will be challenging to serve through gravity. The area is situated between branches of McKernan Creek to the south and to the west. Gravity service to this area would have to cross McKernan Creek and would likely require a deep alignment sited within the vegetative corridor and on steep slopes. The proposed alignment TF3 is topographically higher than the elevation of McKernan Creek adjacent to it. A gravity alignment serving this area would likely need to travel a long distance down the vegetative corridor to connect to TF2A. TF2A may also need to be sited deeper to accommodate this. Alternatively, a gravity alignment could run the length of the McKernan Creek vegetative corridor and connect near the proposed CMSPS.

Both solutions are associated with significant challenges and costs for construction, maintenance, and permitting. This area could also be served by a small lift station which would require coordination and approval from CWS. The force main would need to cross McKernan Creek but could do so via a future roadway serving development. This infrastructure is technically feasible but would require a large capital investment. If developers decide to construct in these areas, the infrastructure needed to connect to the proposed infrastructure will be the responsibility of the developer.

Construction of Trunk Sewers in Vegetated Corridors

Strategies used by other developments to address construction of trunk sewers in vegetated corridors include:

- Take advantage of the opportunity to enhance degraded vegetated corridor sections by constructing a sewer in the area and restoring the impact area with an enhancement of the corridor.
- Constructing neighborhood trails in or adjacent to a vegetated corridor enables dual construction of the trail and sewer while also providing access for long-term maintenance of the sewer.
- Consider minimizing the number of sewers crossing creeks by constructing parallel lines longitudinally on both sides of the creek and predetermining a minimal number of creek crossing locations. The more crossings that exist, the more likely you are to encounter exposed and threatened exposed sewers resulting from erosion and downcutting of the creeks.

Cooper Mountain Sanitary Pump Station (CMSPS)

The CMSPS is assumed to be located east of the intersection of SW Grabhorn Road and SW Tile Flat Road. CWS will construct, own, and operate the pump station and force main and is in the process of conducting a siting study for the pump station. This location is the preferred alternative identified in the ongoing siting study and minimizes the number of sewer pipes across McKernan Creek and results in a reasonable wet well depth that provides service to both the north and south sides of McKernan Creek. The proposed alignments and development tributary to the pump station generates an estimated peak total flow of approximately 2.9 million gallons per day (MGD).

It is anticipated that CWS will begin construction of the CMSPS and force main in 2025 with the pump station becoming operational in 2026. No development within the CMSPS basin can proceed until the CMSPS is constructed and operational. A significant portion of the study area lies outside the CMSPS basin and is tributary to the Summer Creek and Fanno Creek trunks and the River Terrace North Pump Station. Development in these areas does not rely on the CMSPS. The CMSPS basin and basins tributary to existing downstream collection system are shown in **Figure 4-2**.

Implementation Considerations

The following section describes implementation considerations for sewer service within the study area.

Providing sewer service across all neighborhoods of Cooper Mountain will require coordination between developing areas. Major sewer conveyance lines must be constructed through lower developments (Cooper Lowlands and Horse Tale) to provide sewer service to McKernan, Hilltop, and portions of Skyline. Land use approvals for these neighborhoods should include conditions to install the necessary regional infrastructure. Developers may be eligible for SDC credits or have the option to establish a reimbursement district if they are installing infrastructure to serve uphill or downhill developing areas.

The analysis and proposed utility infrastructure presented in the CMUP aims to promote and support growth for the next 20 years or more across the Cooper Mountain area. This plan includes the backbone of a regional system to serve the Cooper Mountain area. While local infrastructure will be necessary to serve all customers, limited information is currently available to define a more detailed neighborhood utility grid. It is anticipated that a more detailed utility plan will continue to fill in as specific developments and associated local roadways are identified. Local sewer infrastructure is not included in this plan and will be the responsibility of developers. The following sections describe the alignments required to serve the proposed neighborhoods in Cooper Mountain and are organized by areas that can develop now and areas that require future infrastructure before development can occur.

Areas that Can Develop Now

The Siler Ridge and Weir neighborhoods and portions of the High Hill and Skyline neighborhoods are served by proposed alignments, shown in **Figure 4-2**, which discharge to existing infrastructure owned by the City and can develop with implementation of the alignments discharging to the following connection points:

- SSMH0005288
- SSMH0004981
- SSMH0004814
- SSMH0004844
- SSCO000551
- SSMH0008365

Areas That Require Future Infrastructure to Develop

The Cooper Lowlands, Grabhorn Meadow, Hilltop, Horse Tale, and McKernan neighborhoods and portions of the High Hill and Skyline neighborhoods are served by proposed alignments which discharge to planned future infrastructure and are unable to develop until this future infrastructure is in place. The alignments described in this section reflect the current collections system at this point in time. Development in the South Cooper Mountain area and the CMSPS is ongoing. As the system is configured in this plan, the alignments discharging to planned future infrastructure are summarized in **Table 4-7**.

Table 4-7 | Future Infrastructure Required for Development

Alignment/Connection Point	Neighborhoods Served	Development Requirements
SSMH0008708	High Hill	Planned sewer service in SCM must be extended to the proposed connection point.
SSMH0008718	High Hill	Planned sewer service in SCM must be extended to the proposed connection point.
SCM North	Horse Tale Skyline	Planned sewer service in SCM must be extended to the proposed connection point.
SCM West	Cooper Lowlands	Planned sewer service in SCM must be extended to the proposed connection point.
CMSPS1	Grabhorn Meadow North Cooper Mountain	CMSPS and crossing of McKernan Creek at proposed trail
CMSPS2	Cooper Lowlands	CMSPS
CMSPS2A	Cooper Lowlands	CMSPS and CMSPS2
CMSPS2B	Cooper Lowlands	CMSPS and CMSPS2
CMSPS3	Cooper Lowlands Horse Tale	CMSPS and CMSPS2
CMSPS3A	Cooper Lowlands	CMSPS, CMSPS2, and CMSPS3
CMSPS4	Hilltop McKernan	CMSPS, CMSPS2, CMSPS3, and bridge crossing of McKernan Creek
CMSPS5	Skyline	CMSPS, CMSPS2, and CMSPS3
CMSPS6	Hilltop Skyline	CMSPS, CMSPS2, CMSPS3, and CMSPS5

The timing of future development is unknown and development timelines will vary across the study area. The proposed alignments were configured to leverage capacity at the proposed CMSPS and limit impacts to capacity for existing City infrastructure. Depending on the pace and timing of development, alternative routes of the proposed alignments may allow areas to develop before the proposed downstream infrastructure exists, as shown in this plan.

Much of the sewer service for the study area will be served by the CMSPS that is being implemented by CWS. CWS is currently completing the CMSPS Siting Study with construction anticipated in 2025 and the pump station becoming operational in 2026. This plan assumes the CMSPS will be completed in advance of any proposed land use plans and development in the Cooper Mountain Planning Area.

CWS will not construct or allow a temporary pump station due to environmental, permitting or financial challenges of a roadway bridge crossing McKernan Creek. Alternative means of crossing McKernan Creek, even on a temporary basis until a roadway bridge is built, may include a sewer constructed by boring under the creek, a siphon, or a pipe bridge.

Chapter 5: Potable Water Utility

Introduction

This chapter summarizes the existing conditions, planning criteria, estimated demands, and proposed infrastructure to provide efficient and resilient potable water service to the study area while preserving operational flexibility. The CMUP is a high-level analysis intended to identify key considerations and opportunities in planning for potable water utility service in Cooper Mountain. Proposed infrastructure is based on existing City potable water infrastructure and the current planning information available in coordination with the CMCP. Proposed infrastructure focuses on storage and pumping requirements and large diameter transmission piping along the proposed roadway alignments from the CMCP. Although local distribution piping will be necessary to serve all customers and to provide system looping, limited information is currently available to define a more detailed neighborhood utility grid. It is anticipated that more detailed utility planning will continue to fill in as specific developments and associated local roadways are identified.

The SCM Concept Plan (DEA, 2014) area covered nearly 2,300 acres and included NCM, the study area (referred to as Urban Reserve Area), and SCM to provide a holistic vision that integrated the three subareas. The SCM Concept Plan anticipated future development in the three subareas over a 50-year period. NCM area was included in the overall potable water system planning as part of the SCM Concept Plan and included proposed transmission main looping from SW Kemmer Road west to SW Grabhorn Road (through NCM) and south to connect with transmission mains serving the western portion of the CMUP study area. The CMUP focuses planning efforts on the study area (**Figure 2-1**) and does not extend through NCM. However, the proposed potable water infrastructure aims to allow for operational flexibility and expandability depending on the long-term needs that develop by including transmission mains at the study area boundary that could be extended in the future, particularly to the northwest and west from the corner of SW Tile Flat Road and SW Grabhorn Road. It is recommended that transmission main looping to the northwest through NCM be re-evaluated during any NCM planning process.

Existing Conditions

While the City does not currently provide any potable water service to customers in the study area, there is some existing potable water infrastructure within the study area. **Figure 5-1** shows the existing potable water infrastructure in the study area. The existing infrastructure provides potable water supply to pressure zones within the city limits to the east and south of the study area. Currently, potable water is pumped from the Sexton Mountain Reservoirs (near Murray Boulevard and Sexton Mountain Drive) to the Cooper Mountain Reservoirs (CMR) 1 and 2 at SW Kemmer Road and SW 182nd Avenue. CMR 1&2 supply water to the 794 pressure zone through a 20-inch diameter main that continues east on SW Kemmer Road and a 24-inch diameter main that continues south on SW 175th Avenue. A 16-inch diameter main east from the 24-inch diameter main in SW Weir Road. These 794 pressure zone mains provide supply to lower zones through multiple PRV facilities. Existing pressure zones surrounding the study area are shown in **Figure 5-1**.

Map Redacted.
Existing potable water infrastructure can be viewed through the City of Beaverton's online map gallery at https://beaverton.maps.arcgis.com/home/index.html

Legend

- Study Area
- Stream
- Riparian Corridor
- Tax Lot
- Existing Reservoir
- Existing Potable Main

Existing Potable Pressure Zone

- 410
- 450
- 470
- 550
- 675
- 750
- 794

0 500 1,000 Feet

N
W E
S

Cooper Mountain
Utility Plan

Beaverton
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Figure 5-1
Existing Potable Water Infrastructure

Project No. 20-2755

February 2024

Planning Criteria

This section documents the planning criteria used to evaluate and develop proposed potable water infrastructure to serve the CMUP study area. Criteria are established for service pressures, distribution system piping, and storage and pumping facilities. Recommended water needs for emergency fire suppression are also presented.

The water distribution system should be capable of operating within certain performance limits under varying customer demand and operational conditions. The performance criteria are consistent with the City 2019 WSMP, with a few modifications based on the *2020 Washington State Water System Design Manual* and the Tualatin Valley Fire & Rescue (TVFR) guidelines, which have been updated since the WSMP adoption. Required fire flow and pump station firm capacity criteria have been updated to reflect the latest versions of these references. Performance criteria is described in the following sections and summarized in **Table 5-1**.

Service Pressures and Distribution Piping

The potable water system must provide adequate pressure at customer connections. Per the Beaverton Engineering Design Manual (EDM), the acceptable service pressure range under normal (average day demand, ADD) operating conditions is 60 to 95 pounds per square inch (psi). Where mainline pressures exceed 80 psi, services must be equipped with individual pressure reducing valves (PRVs) to maintain their static pressures at no more than 80 psi in compliance with the Oregon Plumbing Specialty Code. The distribution system is divided into various pressure zones, based on ground elevation, to meet these service pressure requirements. Each pressure zone provides potable water at a specific hydraulic grade line (HGL) measured in feet elevation. The HGL is set by either a finished water storage reservoir overflow elevation, a PRV pressure setting, or a constant pressure pump station discharge head.

The distribution system will be sized for PDD + fire flow demands. The system should provide the required fire flow to a given location while, at the same time, supplying PDD to other services in the system. The system should meet this criterion with flow velocity in the distribution system of less than 5 feet per second (fps).

Required Fire Flow

While the water distribution system provides water for domestic uses, it is also expected to provide water for fire suppression. Fire flow requirements are typically much greater in magnitude than the PDD in any local area. Adequate hydraulic capacity must be provided for these potentially large fire flow demands. Emergency response in the City is provided by TVFR. TVFR fire flow guidelines are consistent with the 2019 Oregon Fire Code (OFC). The maximum TVFR fire flow guideline is 3,000 gallon per minute (gpm). This maximum fire flow requirement is appropriate for high density residential and commercial developments, as well as institutional and public facilities, such as, schools or community centers. It is recommended the proposed CMUP infrastructure be sized for this maximum fire flow requirement since land use in the study area is subject to shift and change. During subsequent design phases, transmission piping that does not supply lower hydraulic grade pressure zones, should be re-evaluated for the maximum fire flow required for land use or zoning it supplies.

Storage Capacity

The City's water storage reservoirs should provide capacity for three purposes: operational storage, fire storage, and standby (emergency) storage. A brief discussion of each storage element is provided below. Additionally, dead storage and headroom for seismic sloshing should also be included in storage volume calculations. Adequate storage capacity must be provided for each pressure zone. Storage volume for pressure zones served through PRVs or by constant pressure pump stations is provided in the upstream pressure zone supplying the PRV or pump station.

Operational Storage

Operational storage is the volume of water dedicated to supplying demand fluctuations, in excess of PDD, throughout the day. Operational storage is also used to provide turnover in the reservoir during low demand periods. It is recommended that the City plan for operational storage equal to approximately 25 percent of PDD. This is consistent with the WSMP.

Fire Storage

Water stored for fire suppression is typically provided to meet the single most severe fire flow demand within each pressure zone. As stated previously, it is recommended to plan for the maximum required fire flow for any future development of 3,000 gpm for a recommended duration of 3 hours. The recommended fire storage volume is estimated by multiplying the fire flow rate by the duration of that flow. Thus, it is recommended that the City plan for a fire storage volume of 0.54 million gallons (MG) in the Cooper Mountain zones.

Emergency Storage

Emergency storage is provided to supply water from storage during emergencies such as pipeline failures, equipment failures, power outages or natural disasters. The amount of emergency storage provided can be highly variable depending upon an assessment of risk and the desired degree of system reliability. For the City system, an emergency storage volume of 2 x ADD is recommended. This is consistent with the WSMP.

Pump Stations

Pumping capacity requirements vary depending on how much storage is available, the number of pumping facilities serving a pressure zone, and the zone's maximum fire flow requirement. Pumping recommendations are based on firm capacity which is defined as a pump station's capacity with the largest pump out of service.

Constant Pressure Pumping

Although it is desirable to serve water system customers by gravity from storage it may be challenging to maintain service pressures in zones where the reservoir is located at or near the ground elevations of the zone. Constant pressure stations are commonly used to serve customers at the highest elevations in a water service area where only an elevated reservoir would be capable of providing the necessary head to achieve adequate service pressures by gravity. The highest elevations on Cooper Mountain require this approach as well as a portion of the Grabhorn Meadows area.

Constant pressure stations which provide the sole source of supply to a zone are only recommended for residential developments with a small number of services in an area which will not be looped with adjacent pressure zones in the future. It is recommended that pump stations which are the sole source of supply to a constant pressure zone have adequate firm pumping capacity to meet peak hour demand (PHD) while simultaneously supplying the largest fire flow demand in the zone.

Backup Power

It is recommended that pump stations supplying gravity storage reservoirs include, at a minimum, manual transfer switches and connections for a portable back-up generator. The emergency storage volume in each reservoir will provide short term water service reliability in case of a power outage at the pump station. Back-up power generators with automatic transfer switches are recommended for all constant pressure pump stations which serve as the sole source of supply to a zone. On-site back-up generators should also be considered for pump stations critical to the City's operations.

Summary of Planning Criteria

The recommended potable water infrastructure for the study area is based on the planning criteria described in the preceding sections and summarized in **Table 5-1**.

Table 5-1 | Planning Criteria for Potable Water System

System Component	Criteria	Value	Source
Service Pressure	Normal Range	60-95 psi	2019 WSMP; EDM, Chapter VI Water System
Distribution Main	Maximum Flows	PDD + fire flow (1,750 - 3,000 gpm fire flow)	2022 Oregon Fire Code, Tualatin Valley Fire & Rescue Fire Code
	Acceptable Flow Velocities	<5 fps during fire flow	EDM, Chapter VI Water System
Storage	Operational	25% of PDD	2019 WSMP
	Fire	3,000 gpm x 3 hours (max fire flow req'd)	
	Emergency (Standby)	2 x ADD	
Pump Station (sole source of supply to zone)	Firm Capacity	PDD + fire flow	2020 Washington Water System Design Manual
	Backup Power	Minimum – automatic transfer switch and on-site generator	2019 WSMP
Pump Station (supplying storage)	Firm Capacity	PDD	2020 Washington Water System Design Manual
	Backup Power	Minimum – manual transfer switch and connection for portable generator	2019 WSMP

Note:

1. ADD – average day demand, PDD – peak day demand, PHD – peak hour demand; EDM – City Engineering Design Manual; WSMP – Water System Master Plan

Estimated Water Demands

Water demand refers to all finished water required by the system including residential, commercial, industrial, and institutional uses. Water demands are described using three water use metrics: average daily demand (ADD), peak day demand (PDD), and peak hour demand (PHD). Each of these metrics is stated in gallons per unit time such as millions of gallons per day (MGD) and in gallons per capita per day (gpcd). Peaking factors are used to convert between ADD, PDD, and PHD.

- ADD is the total annual water volume used system-wide divided by 365 days per year.
- PDD is the largest daily water volume for a given year. In western Oregon, PDD typically occurs each year between June 1st and September 30th.
- PHD is estimated as the largest hour of demand on the peak water use day.

For the purposes of the CMUP, water demand within the study area is assumed to correlate with proposed land use from the CMCP. Buildable land by neighborhood and land use type and assumed housing densities per land use type are based on the Draft CMCP Concept Plan presented in October 2022. The October 2022 draft established proposed roadway alignments, resource protection areas, likely park locations, and projected land use designations. The October 2022 Draft Concept Plan land use included a Conservation Neighborhood overlay (primarily over Mixed Residential designated areas) that assumed lower density development. The designation was intended to result in development sensitive to natural resources, steep slopes, wildlife corridors, and existing tree canopy. While further refinements to the Concept Plan are expected as the CMCP is finalized, these refinements are not expected to substantially change the locations or intensity of development planned across Cooper Mountain. Housing densities by land use are summarized in **Table 5-2**.

Table 5-2 | Housing Densities by Land Use Type

Land Use	Housing Density (EDU/ac)
Multifamily	24
Multifamily/Commercial	24
Residential Mixed	8
Conservation Residential	5.6

Projected residential water demand is estimated using a combination of housing units, people per unit, and demand per capita assumptions. The Joint Water Commission (JWC), a water authority that serves as the primary supply for the City water system, completed a Water Management Conservation Plan (WMCP) in 2021. The JWC WMCP includes evaluations of water demand by type and updated per capita unit demands for each member agency it supplies water to. The CMUP demand estimates use criteria from the JWC WMCP to evaluate residential and irrigation demands for the study area. Commercial water demand is estimated using jobs per acre and demand per job assumptions from the CMCP team. These assumptions are summarized in **Table 5-3.**

Table 5-3 | Estimated Demand Assumptions

Criteria	Value	Source
People per housing unit	2.14	2019 WSMP
Residential demand per capita (gpcd)	60	2021 Joint Commission WMCP
Commercial demand (gpad)	2,130	41.9 jobs/acre and 45.8 gpd/job
Irrigation usage	10%	2021 Joint Commission WMCP

Projected ADD is developed using the assumptions and criteria summarized above. PDD and PHD are estimated from ADD using peaking factors developed in the 2019 WSMP. The peaking factor for ADD:PDD is 1.9 and for PDD:PHD is 2.4. Projected ADD, PDD, and PHD by proposed pressure zone are summarized in **Table 5-4**. The projected ADD, PDD, and PHD for the total CMUP study area are similar to the projected demands in the 2019 WSMP for the area.

Table 5-4 | Estimated Potable Demands

Zone	Average Day Demand (ADD) (MGD)	Peak Day Demand (PDD) (MGD)	Peak Hour Demand (PHD) (MGD)
470	0.16	0.30	0.73
550	0.09	0.17	0.40
550 West (Grabhorn BPS)	0.03	0.05	0.12
675	0.08	0.16	0.38
750	0.05	0.10	0.24
794	0.09	0.18	0.43
Upper BPS	***0.21***	***0.40***	***0.97***
850	0.09	0.16	0.39
930	0.13	0.24	0.58
TOTAL	**0.72**	**1.36**	**3.27**

Note:
ADD:PDD peaking factor of 1.9 and PDD:PHD peaking factor of 2.4 (aligns with 2019 WSMP).

Proposed Potable Water Infrastructure

The proposed potable water infrastructure presented in this chapter aims to promote efficient and resilient drinking water service that preserves operational flexibility. The performance criteria summarized in **Table 5-1** and estimated water demands in **Table 5-4** provided the basis for developing the proposed potable water infrastructure.

Potable water in the CMUP area will be served through an expansion of existing pressure zones, booster pump stations (BPS), and PRVs. Storage for the area will be provided by a proposed 550 zone reservoir, known as CMR 3, and the existing 794 zone CMR 1&2 on SW Kemmer Road at the northern boundary of the study area. The distribution system will be an extension of existing zones, where possible, in both the SCM area (470, 550, and 675 zones) and the western edge of the current City water service area (675, 750, and 794 zones).

The City planned for the existing 24-inch diameter main on SW 175th Avenue to provide initial potable water supply to much of the CMUP area. This transmission main allows for potable water service to a wide range of developable area with the construction of distribution piping and PRV facilities. The City does not have to depend on construction of an additional reservoir or BPS to provide potable water service to a majority of the study area.

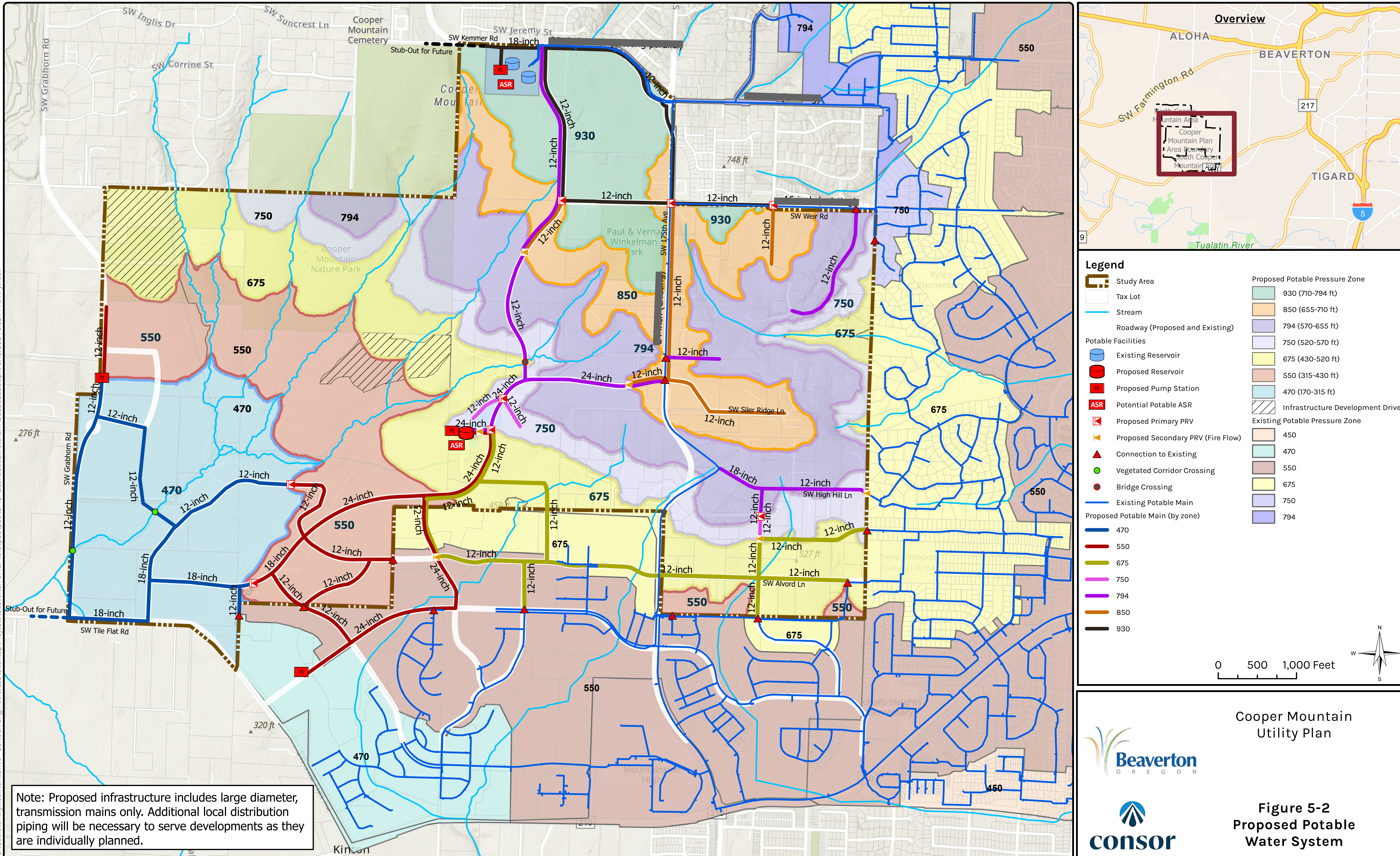
As mentioned at the beginning of the chapter, proposed alignments are for large transmission piping only. Additional local distribution piping will be required to supply all anticipated customers and system looping and will be the responsibility of the developers. Proposed infrastructure to serve the CMUP study area is shown in **Figure 5-2** and described in the following sections.

Pressure Zones

The CMUP study area will be served by extension of existing pressure zones where possible. Pressure zone boundaries are approximate based on GIS contour data and service pressure criteria summarized in the **Service Pressures and Distribution Piping Section**. **Figure 2-1** shows the existing topography of the area used to evaluate proposed pressure zone boundaries. The 470, 550, 675, a small portion of 750, and 794 zones will extend from existing pressure zones either in the SCM area or western edge of the existing City system. There is a small portion of 550 zone (550 West) in the Grabhorn Meadows area that will be served by a small BPS rather than extending 550 zone piping across McKernan Creek and up to the area. Part of the proposed 750 zone will not be adjacent to the existing 750 zone and will be served by PRVs from the 794 zone. There are two new, proposed pressure zones in the study area, the 850 and 930 zones. These two zones include elevations that are too high to be served by CMR 1 and 2. Proposed pressure zones with approximate ground elevations served and supply notes are summarized in **Table 5-5**.

Table 5-5 | Proposed Pressure Zones and Supply

Proposed Pressure Zone	Approx. Ground Elevations Served (ft)	Supplied By
930	710-790	Proposed Upper BPS
850	655-710	PRVs from 930 zone (from proposed Upper BPS)
794	570-655	CMR 1 and 2
750	520-570	PRVs from 794 zone (and connections to existing system)
675	430-520	PRVs from 750 zone (and connections to existing system)
550	315-430	CMR 3 (and connections to existing system)
550 West	315-430	Proposed West BPS
470	170-315	PRVs from 550 zone (and connections to existing system)



Cooper Mountain Utility Plan

Beaverton OREGON

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Figure 5-2 Proposed Potable Water System

Project No. 20-2755

May 2024

Data Sources: City of Beaverton, 2023;World Navigation Map: Oregon Metro, Oregon State Parks, State of Oregon GEO, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS
World Topographic Map: Esri Community Maps Contributors, 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:
Disclaimer: Consor and CLIENT make no representations, expressed 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.

Distribution System

Proposed distribution piping focuses on large-diameter transmission piping along the proposed roadway alignments from the CMCP and connecting the storage and pumping facilities described earlier in this chapter. Limited information is currently available to define a more detailed neighborhood utility grid. It is anticipated that more detailed utility planning will continue to fill in as specific developments and associated local roadways have been identified. Local distribution system infrastructure will be the responsibility of the developers. Distribution system looping through some future developments may impact the sizing and alignments of those currently proposed. Proposed pipe sizing is based on the planning criteria presented in the **Planning Criteria Section** and is shown on **Figure 5-2**.

930 and 850 Zones

The proposed 930 and 850 pressure zones will be supplied by a proposed Upper Pressure Zone BPS located at the CMR 1&2 Site. The shell of this pump station building was constructed with CMR 2, anticipating future services to the CMUP area. The transmission piping for these two pressure zones will generally be connected to 794 zone with PRVs at various locations for pressure relief and supplemental supply to 794 zone, if needed.

794 Zone

The 794 zone will be supplied by transmission piping extending south from the existing CMR 1&2 Reservoirs, with connections to existing 794 zone piping extending down SW 175th Avenue. In order to serve some isolated portions of the750 and 675 zones (noted on map) between McKernan tributaries, a small PRV (or individual PRVs) are proposed to serve development, if it occurs.

750 Zone

The 750 zone will be Supplied through PRVs from 794 zone and connection to the existing 750 zone in the NE corner of the CMUP study area.

675 Zone

The 675 zone will be supplied through PRVs from the 750 zone and connection to the existing 675 zone in the SE corner of the CMUP study area and SCM area.

550 Zone

The 550 zone will be supplied by the proposed CMR 3 Reservoir and connection to the existing 550 zone serving the SCM area.

470 Zone

The 470 zone will be supplied by PRVs from the 550 zone and connection to the existing 470 zone in the SCM area. The 470 zone will extend to the western limits of the CMUP study area, across McKernan Creek, to serve the proposed Grabhorn Meadows neighborhood.

Grabhorn Meadow Area

Proposed 470 zone piping along SW Grabhorn Road and the proposed trail across McKernan Creek will provide looped supply to lower portions of the Grabhorn Meadow area. The proposed West BPS will serve northern properties at higher elevations than can be served by the 470 zone (approximately 315-430 feet elevation). There is not a cost-effective way to provide potable water service to properties at elevations higher than approximately 430 feet in the western portion of the study area. If developers want to construct at these higher elevations, they will be responsible for assessing how to connect to the proposed public water service, providing a plan for City review and approval, and constructing the infrastructure required.

Hard to Serve Areas

There are two areas in the study area that would require significant infrastructure specifically to serve the area. This infrastructure is technically feasible but would require a large capital investment for the limited development potential of the areas. If developers decide to construct in these areas, the infrastructure needed to connect to the proposed infrastructure will be the responsibility of the developer. These two areas are described below.

The first is the open area directly south of Cooper Mountain Nature Park, situated between branches of McKernan creek to the south and to the west. Potable water service could be provided to the eastern portion of this area with PRVs from the 750 zone to the northeast and local distribution piping. Providing potable water service to the western portion of this area could require a creek crossing, additional pipelines, and PRV station to connect to the proposed zones to the northeast. The surrounding areas between the branches of McKernan Creek are proposed Resource Overlay areas with limited development expected. Any service in these areas is anticipated to be provided by local distribution infrastructure and was not evaluated further in this study.

The second area is where ground elevations are higher than approximately 430 feet on the western side of Cooper Mountain Nature Park. This area would be part of the 675 zone and would require additional pumping and dedicated parallel piping from the West BPS to this area. The alternative to loop the proposed transmission main on SW Kemmer Road through NCM was discussed during the planning process. This option would result in significant impacts to the Cooper Mountain Nature Park and extend beyond the study area boundary. For the CMUP, it was decided to prioritize natural resource protection and focus on looping transmission mains to the south of the nature park. It is recommended that transmission main looping to the northwest through NCM be re-evaluated during any NCM planning process. This potential transmission looping through NCM could provide an alternative path to supply service to the area proposed to be served by the West BPS.

Storage

CMR 3 Site

The proposed CMR 3 Reservoir will serve the 550 and 470 zones by gravity. The proposed CMR 3 BPS will pump supply from the CMR 3 Reservoir up to CMR 1&2 Reservoirs through 794 zone piping. In addition, a PRV between 794 zone and 550 zone piping provides ability to feed CMR 3 from CMR 1&2 if needed. This model of operation may be required, depending on the timing of construction of the Tile Flat BPS (described below) which will supply water to CMR 3.

Currently, the primary supply of potable water for SCM comes from CMR 1&2 through the 24-inch diameter main along SW 175th Avenue. The 24-inch diameter main is an important source for fire protection in SCM, especially for the Mountainside High School and other multi-story developments. There is significant energy loss resulting from supply through 24-inch diameter, 794 zone main to provide potable water to SCM, which is mostly in the 550 zone. The proposed CMR 3 will provide a more energy efficient source of potable water for SCM and generally the proposed 550 and 470 zones in the Cooper Mountain area.

Pumping Facilities

CMR 1&2 Site

The proposed Upper BPS, partially constructed with the CMR 2 project, will provide constant pressure supply to the 930 and 850 zones. This pump station will be sized to meet peak day domestic demand and fire flow requirements for the two pressure zones.

CMR 3 Site

The proposed CMR 3 BPS will pump supply from the CMR 3 Reservoir up to CMR 1&2 Reservoirs through 794 zone piping. This BPS will allow supply from the future connection with Willamette Water Supply System (WWSS) (described below) to be pumped to CMR 1&2 Reservoirs.

Grabhorn Meadows (West)

The proposed West BPS in the northwest corner of the study area would be required to supply 550 zone development on the west side of McKernan Creek. This pump station will be sized to meet peak day domestic demand fire flow requirements for the 550 zone areas of the Grabhorn Meadows neighborhood.

Future Connection with Willamette Water Supply System

The proposed Tile Flat BPS would pump WWSS water from the City's supply connection to the WWSS transmission main, up to the proposed CMR 3 Reservoir. The pumped WWSS supply would be transmitted through proposed 550 zone transmission piping through the SCM 550 zone. The proposed Tile Flat BPS and CMR 3 will provide a more energy efficient potable water supply to the 550 and lower zones in the study area and SCM than the current process to supply potable water from CMR 1&2. The Tile Flat BPS will be needed once the WWSS is operational, which is anticipated in mid-2026.

Implementation Considerations

The City planned for the existing 24-inch diameter main on SW 175th Avenue to provide initial potable water supply to much of the CMUP area. This transmission main allows for potable water service to a wide range of developable area in the 794 and lower zones with the construction of distribution piping and PRV facilities. The City is not required to complete construction of the Tile Flat BPS, CMR 3 site, or the Upper BPS to begin providing potable water service to a majority of the study area.

The analysis and proposed utility infrastructure presented in the CMUP aims to promote and support growth for the next 20 years or more across the Cooper Mountain area. The proposed potable infrastructure focuses on the regional, transmission system to serve the entire study area. While local infrastructure will be necessary to serve all customers and provide system looping, limited information is currently available to define a more detailed neighborhood utility grid. It is anticipated that a more detailed utility plan will continue to fill in as specific developments and associated local roadways are identified. Local distribution infrastructure is not included in this plan and will be the responsibility of developers. The infrastructure proposed in this section provides a regional framework to provide utilities across the study area. Minor modifications to the proposed infrastructure may occur as specific properties are developed. It is recommended proposed pipe and facility sizing be confirmed during the design phase of specific developments and as associated local roadways are identified. The goal of the regional proposed potable infrastructure is to provide the City with an overall plan to serve the Cooper Mountain area that individual development utility plans can be compared with and allow the City to make decisions to promote cost-effective, cohesive, and efficient potable water service across the area.

Greenfield development provides unique opportunities to coordinate utilities but also challenges. One primary challenge is how to coordinate individual developments to build and connect the overall regional infrastructure required to serve all areas. Potable water systems are interconnected, so to serve any specific area often requires additional infrastructure outside of the area to provide potable water service. Generally, infrastructure from a development to transmission piping connected to the supply source is required to provide operational service to the site. Depending on the phasing and locations of development, certain upstream infrastructure will be required to provide service to the development. Within the CMUP study area, proposed zones 550 and 470 will be challenges to serve without adequate looping with SCM infrastructure and/or the construction of the CMR 3 Reservoir. For zones served by a BPS, development cannot be served without the construction of the BPS. In the CMUP study area, proposed zones 930 and 850 are contingent on the construction of the Upper BPS for service. Similarly, the proposed 550 West zone is contingent on construction of the West BPS for service.

Chapter 6: Non-Potable Water Utility

Introduction

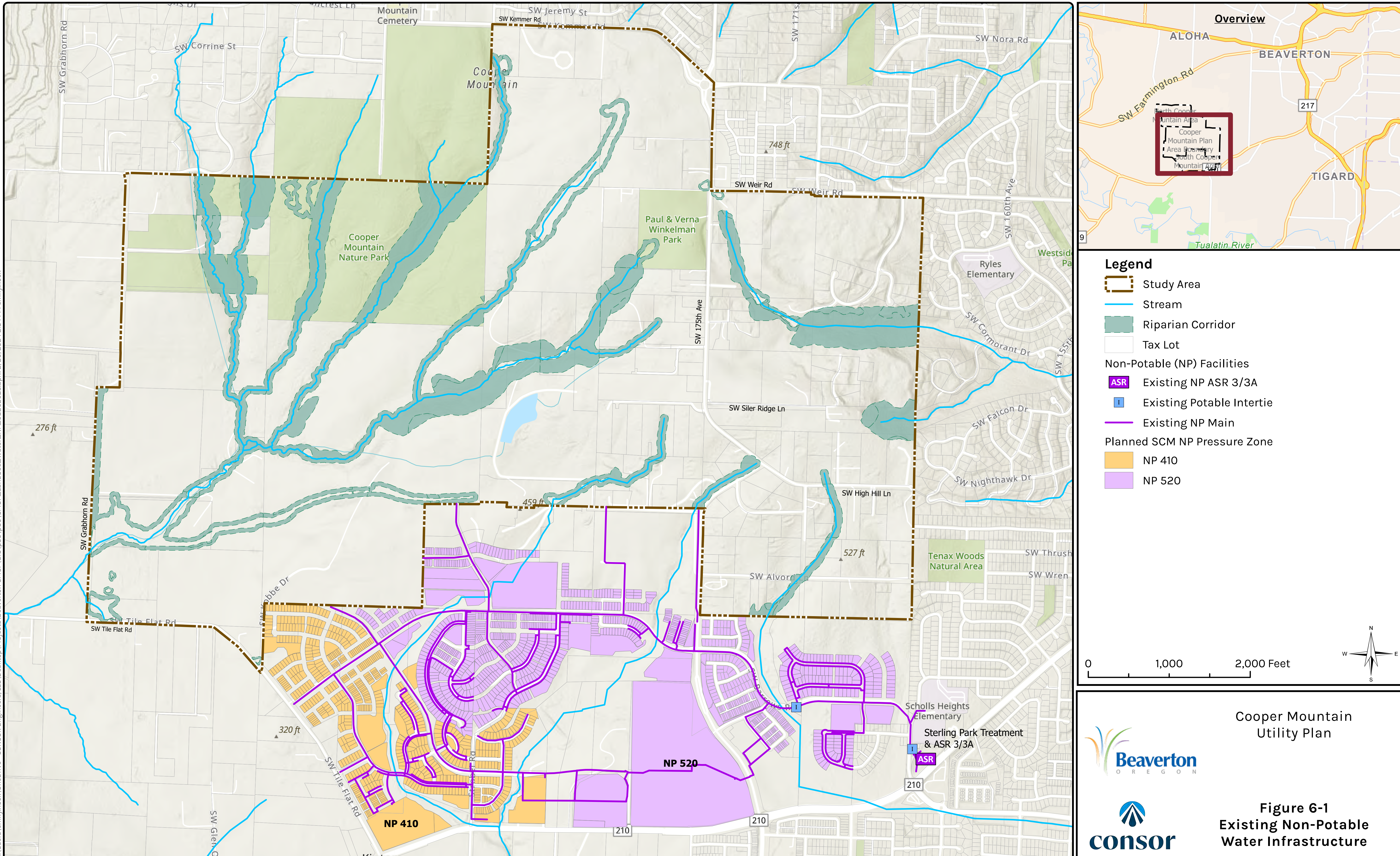
The City has begun development of a non-potable water (purple pipe) system to supply irrigation water to new customers in the SCM area to offset the need for additional potable water supply to meet irrigation demand. This non-potable water system and expansion in the CMUP study area support the City's vision for managing the cost of potable drinking water service by expanding non-potable water irrigation service as outlined in City Council Ordinance 4781. The non-potable water utility and planned non-potable water system to serve the SCM area is summarized in the supply analysis portion of the City WSMP. The CMUP reviews the planned SCM non-potable water system and evaluates the feasibility of expanding the non-potable water utility into the CMUP study area. As discussed with City staff, non-potable water system expansion should support lower service costs and reduced maintenance needs by minimizing storage and pumping facilities needed to supply non-potable water system service pressure.

This chapter summarizes the planning criteria, estimated demands, feasibility, and proposed infrastructure to provide non-potable water service to the study area. The CMUP is a high-level analysis intended to identify key considerations and opportunities in planning for non-potable water utility service in Cooper Mountain. Proposed infrastructure is based on existing and planned City non-potable water infrastructure and current planning information available in coordination with the CMCP. There is currently no non-potable water infrastructure in the study area. The non-potable water infrastructure in SCM is in various stages of construction and planned to extend through all SCM neighborhoods as shown in **Figure 6-1**. The Sterling Park Treatment and aquifer storage and recovery (ASR) 3/3A facility that is being constructed to provide non-potable water supply to the system is also shown in **Figure 6-1**.

Proposed infrastructure focuses large diameter transmission piping along the proposed roadway alignments from the CMCP. Although local non-potable water distribution piping will be necessary to serve all customers and to provide system looping, limited information is currently available to define a more detailed neighborhood utility grid. Local infrastructure will be the responsibility of developers. It is anticipated that more detailed utility planning will continue to fill in as specific developments and associated local roadways have been identified.

SCM Non-Potable Water System Overview

The planned non-potable (purple pipe) water system in SCM is currently under construction and shown in **Figure 6-1**. The initial phase of the non-potable water system is anticipated to be online in summer 2024. Non-potable water distribution mains have been installed and continue to be constructed throughout SCM developments to serve new customers. Non-potable water and potable drinking water cannot share the same pipes due to water quality and public health standards. A parallel distribution system is needed in areas with non-potable water service. Purple pipe refers to the non-potable water distribution pipe material which is colored purple to distinguish it from parallel potable drinking water piping and prevent accidental cross connections in the future.



Cooper Mountain Utility Plan

Figure 6-1
Existing Non-Potable Water Infrastructure

Project No. 20-2755

May 2024

Data Sources: City of Beaverton, 2023; World Navigation Map: Oregon Metro, Oregon State Parks, State of Oregon GEO, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS
World Topographic Map: Esri Community Maps Contributors, 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
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The existing aquifer storage and recovery (ASR) 3/3A well site will be the initial supply for non-potable irrigation water in SCM. The well was not developed as a potable drinking water source due to taste and odor water quality issues which is not a concern for irrigation uses. ASR is a natural storage system whereby treated water is injected into underground aquifers and stored for later use. Water is stored during the winter months when excess surface water supplies are available and customer demands are low. Water stored in the aquifers is then withdrawn through pumping during the high-demand summer season. The nearby Sterling Park Stormwater Treatment System (ASR 3/3A Facility) will treat urban stormwater runoff (collected in a detention pond) and recharge the ASR wells during the wet season. The initial phases of ASR 3/3A well site is anticipated to provide a recovery capacity of approximately 1,000 gpm (0.7 MGD) which will meet the estimated peak non-potable water demands for future development of the SCM area.

Planning Criteria

This section documents the planning criteria used to evaluate and develop proposed non-potable water infrastructure to serve the CMUP study area. The non-potable water distribution system should be capable of operating within certain performance limits under varying customer demand and operational conditions. The performance criteria are consistent with the City 2019 WSMP and the SCM non-potable water system design. Performance criteria is described in the following sections and summarized in **Table 6-1**.

Service Pressures and Distribution Piping

The non-potable water system must provide adequate pressure at customer connections. For the purposes of planning and pressure zone layout, acceptable service pressure range under average demand operating conditions is 45 to 85 pounds per square inch (psi). Where mainline pressures exceed 80 psi, services must be equipped with individual pressure reducing valves (PRVs) to maintain their static pressures at no more than 80 psi in compliance with the Oregon Plumbing Specialty Code. Similar to the potable water utility, the non-potable water distribution system is divided into various pressure zones, based on ground elevation, to meet these service pressure requirements. Each pressure zone provides non-potable water at a specific hydraulic grade line (HGL) measured in feet elevation. The HGL is set by either a storage reservoir overflow elevation, a PRV pressure setting, or a constant pressure pump station discharge head.

The non-potable water distribution system will be sized for estimated peak hour irrigation demands as described in the following section. The system should meet peak hour demands with flow velocity in the distribution system of less than 5 feet per second (fps).

Table 6-1 | Planning Criteria for Non-Potable Water System

Component	Criteria	Value
Service Pressure	Normal Range	45-85 psi
Distribution Main	Maximum Flows	Peak hour irrigation demands
	Acceptable Flow Velocities	<5 fps during peak flow

Note:
psi – pounds per square inch; fps – feet per second

Estimated Demands

Non-potable water irrigation demands are highly variable and are challenging to predict. This section summarizes the assumptions developed to estimate non-potable water demands for the study area. The demand assumptions used for development of the SCM non-potable water system were reviewed and many used for this evaluation. As the SCM non-potable water system comes online and operational, it would be useful for the City to track usage data to better understand and characterize non-potable water demands for use in estimating and designing system expansions, such as in the CMUP area.

Irrigation needs are generally characterized by irrigated area and watering requirements for vegetation. Percent pervious area by land use type was used to assess anticipated irrigated areas in the Cooper Mountain area. The percent pervious area by land use type matches those assumptions from the stormwater utility analysis. Additionally, it was assumed that only 75 percent of pervious area would be irrigated. **Table 6-2** lists the assumed percent of area irrigated by land use type.

Table 6-2 | Percent Area Irrigated by Land Use Assumptions

Land Use Type	Area Irrigated (%)
Commercial	33%
Conservation Residential	49%
Multifamily	26%
Mixed	34%
Mixed Residential	37%
Park	68%
Utility	0%

Note:
Cooper Mountain Nature Park was assumed to not be irrigated.

Irrigation requirements were assumed to be one inch per week which is a typical recommendation for lawns. The irrigation season was assumed to be from May 1 through August 31. An ADD to PHD peaking factor of 4.2, which matches assumptions used in the SCM non-potable water demand analysis. Estimated daily and peak hour irrigation demands by potential pressure zone are summarized in **Table 6-3**. This evaluation considers the demands if the system were to be expanded across all neighborhoods of the study area. Additional feasibility considerations are presented in the **Feasibility of Non-Potable Water System Expansion Section**.

Table 6-3 | Estimated Non-Potable Water Demands

NP Pressure zone	Buildable Area (ac)	Daily Irrigation Demand (gpd)	Daily Irrigation Demand (gpm)	Daily Irrigation Demand (gpd)	Peak Hour Demand (gpm)	Seasonal Volume (MG)
Lower zones	*147.7*	*235,872*	*164*	*990,662*	*688*	*29.0*
NP 410	116.5	190,920	133	801,862	557	23.5
NP 520	31.2	44,952	31	188,800	131	5.5
Upper zones	*176.2*	*273,679*	*190*	*1,149,451*	*798*	*33.7*
NP 563	23.9	35,022	24	147,094	102	4.3
NP 655	83.3	122,989	85	516,554	359	15.1
NP 748	69.1	115,667	80	485,802	337	14.2
Total	**323.9**	**509,551**	**354**	**2,140,112**	**1,486**	**62.7**

Feasibility of Non-Potable Water System Expansion

One of the primary considerations of expanding the non-potable water system is source options. As described in the beginning of the chapter, the SCM non-potable water system is planned to be supplied by an existing ASR well (that is not adequate for potable water supply) with treated stormwater as a recharge source. The City is investigating potential for a new, potable ASR well on the CMR 3 site. The City would prioritize a potable ASR well if the water quality and supply on the CMR 3 site are conducive for this to improve City potable water resiliency. If the City finds potable ASR not to be feasible at the CMR 3 site, they could evaluate the option of constructing a non-potable water ASR well. For the purposes of the CMUP, it is assumed that a potable ASR well on the CMR 3 site will be feasible.

It is technically feasible to provide a non-potable water service distribution system across all of the Cooper Mountain area. However, providing non-potable water service to upper zones NP 563, NP 655, and NP 748 (elevations higher than the SCM system is planned to serve) would require significant investment in new infrastructure. To serve these upper zones, an additional source, additional storage reservoir or ASR system, and an additional BPS would be required in addition to transmission mains and PRV facilities. A map of the preliminary transmission mains and PRV facilities developed as part of the feasibility evaluation are illustrated in **Appendix B**. This would require a significant capital investment to provide a non-potable water system to a small number of neighborhoods. As an alternative, those neighborhoods can meet irrigation demands through the potable water system. As stated above, there are no current locations the City is looking at to develop a new, non-potable water ASR site near the study area. Without a supply source for non-potable expansion and the significant capital cost required, it is not recommended the non-potable water system be expanded to the upper zones (NP 563, NP 655, and NP 748) of the Cooper Mountain area.

The following section outlines the proposed infrastructure to extend the non-potable water system to the lower zones (NP 410 and NP 520) in the Cooper Mountain planning area.

Proposed Non-Potable Water Infrastructure

It is proposed that non-potable water infrastructure be planned for the areas that can be served through an expansion of existing and planned non-potable water infrastructure in SCM (lower zones NP 410 and NP 520). These zones generally correspond with the Grabhorn Meadow and Cooper Lowlands neighborhoods. The following sections describe the proposed pressure zones and infrastructure to provide non-potable water service to these areas.

As mentioned at the beginning of the chapter, proposed alignments are for large transmission piping only. Additional local distribution piping will be required to supply all anticipated customers and system looping and will be the responsibility of the developers. Proposed non-potable water infrastructure to serve the recommended portions of the CMUP study area is shown in **Figure 6-2** and described in the following sections.

Pressure Zones

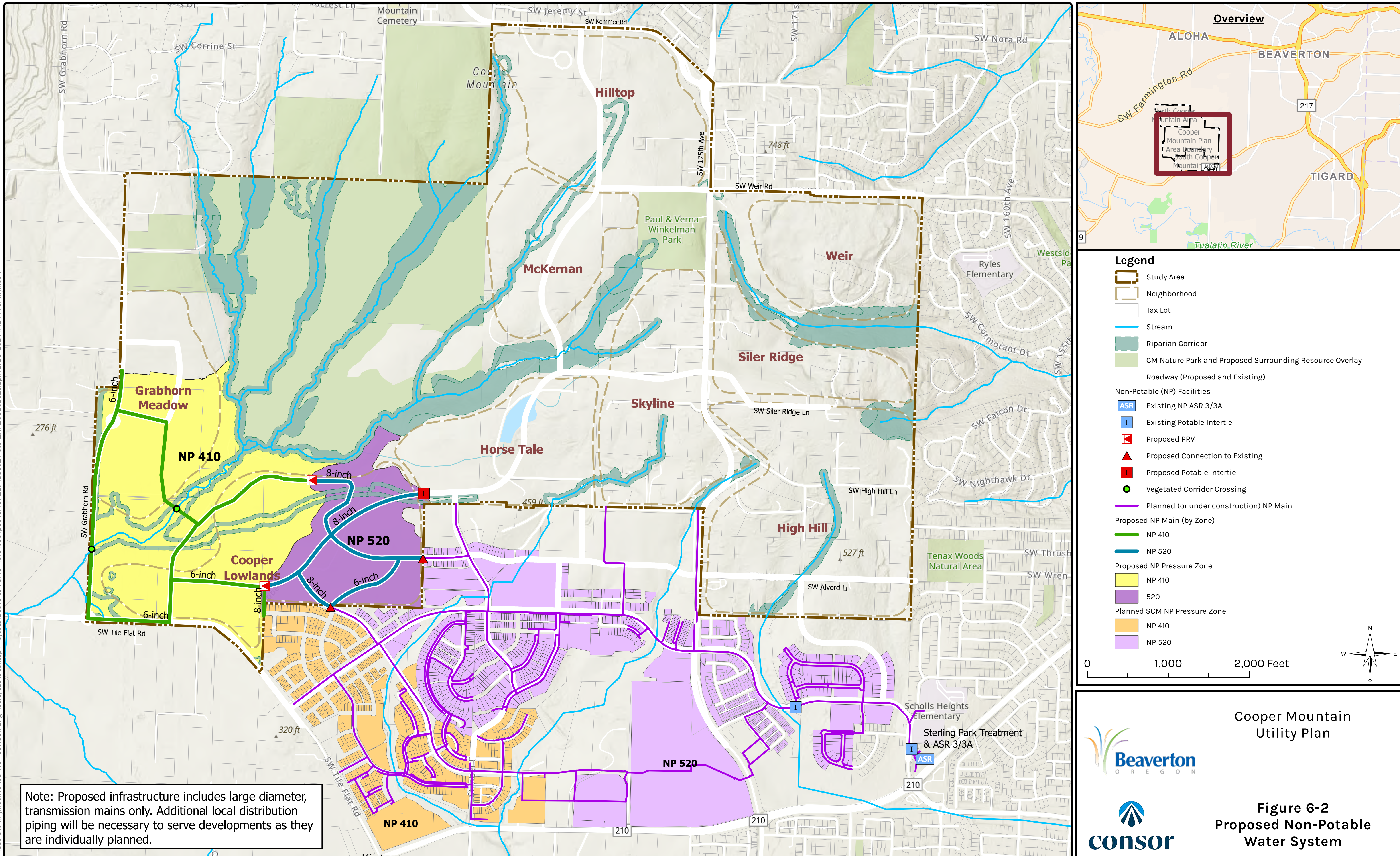
The CMUP study area will be served by extension of existing and planned non-potable water pressure zones from the SCM area. Pressure zone boundaries are approximate based on GIS contour data and service pressure criteria summarized in the **Planning Criteria Section**. Proposed non-potable water pressure zones with approximate ground elevations served are summarized in **Table 6-4**.

Table 6-4 | Proposed Non-Potable Water Pressure Zones

Proposed Non-Potable Water Pressure Zone	Approx. Ground Elevations Served (ft)
NP 520	310-400
NP 410	215-310

Distribution System

Proposed non-potable water distribution piping focuses on large transmission piping along the proposed roadway alignments from the CMCP, connecting to the planned non-potable water system in SCM. Limited information is currently available to define a more detailed neighborhood utility grid. It is anticipated that more detailed utility planning will continue to fill in as specific developments and associated local roadways have been identified. Local non-potable water distribution system infrastructure will be the responsibility of the developers. Non-potable water distribution system looping through some future developments may impact the sizing and alignments of those currently proposed. Proposed pipe sizing is based on the planning criteria presented in the **Planning Criteria Section** and is shown on **Figure 6-2.**



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Data Sources: City of Beaverton, 2023; World Navigation Map: Oregon Metro, Oregon State Parks, State of Oregon GEO, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS
World Topographic Map: Esri Community Maps Contributors, 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
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NP 520 and NP 410 zones

The proposed NP 520 and NP 410 pressure zones will connect to the planned non-potable water system in SCM. The NP 410 zone will be supplied through PRVs various locations from the NP 510 zone. Proposed non-potable water infrastructure is shown in **Figure 6-2**. There is a proposed intertie with the potable water system between the northeast boundary between Horse Tale and Cooper Lowlands. This intertie would connect to the proposed potable 550 zone to provide supplementary supply if needed. The SCM non-potable water system is planned to operate in a similar manner, connected to the potable zone 550 in the SCM area with a potable intertie facility.

Non-Potable Water Source

The proposed NP 520 and NP 410 zones will be extensions of the planned SCM non-potable water system. As discussed in the **SCM Non-Potable Water System Overview Section**, the SCM non-potable water source will be the Sterling Treatment Park and NP ASR 3/3A. Actual irrigation demands of SCM and future development in the study area are not known at this time. Non-potable water irrigation demands are highly variable and are challenging to predict. The proposed non-potable water lower zone (NP 520 and NP 410) extensions in the study area are proposed to maximize use of the non-potable source (Sterling Treatment Facility and NP ASR 3/3A) in accordance with City Council goals (Ordinance 4781). As the SCM non-potable water system comes online and operational, it would be useful for the City to track usage data to better understand and characterize non-potable water demands for use in estimating and designing system expansions, such as in the CMUP area. Future evaluation is needed to identify if an additional source of non-potable water is feasible within the study area.

Implementation Considerations

The analysis and proposed utility infrastructure presented in the CMUP aims to promote and support growth for the next 20 years or more across the Cooper Mountain area. The proposed non-potable water infrastructure focuses on the large transmission system to serve portions of the study area. While local infrastructure will be necessary to serve all customers and provide system looping, limited information is currently available to define a more detailed neighborhood utility grid. It is anticipated that a more detailed utility plan will continue to fill in as specific developments and associated local roadways are identified. Local distribution infrastructure is not included in this plan and will be the responsibility of developers. The infrastructure proposed in this section provides a regional framework to provide non-potable water service across the lower elevations of the study area. Minor modifications to the proposed infrastructure may occur as specific properties are developed. It is recommended proposed pipe and facility sizing be confirmed during the design phase of specific developments and as associated local roadways are identified. The goal of the regional proposed non-potable water infrastructure is to provide the City with an overall plan to serve the Cooper Mountain area that individual development utility plans can be compared with and allow the City to make decisions to promote cost-effective, cohesive, and efficient potable water service across the area.

Greenfield development provides unique opportunities to coordinate utilities but also challenges. One primary challenge is how to coordinate individual developments to build and connect the overall regional infrastructure required to serve all areas. Non-potable water systems are interconnected, so to serve any specific area often requires additional infrastructure outside of the area to provide potable water service. Generally, infrastructure from a development to transmission piping connected to the supply source is required to provide operational service to the site. Depending on the phasing and locations of development, certain upstream infrastructure will be required to provide service to the development. For the non-potable water system to provide non-potable source water to users, the non-potable water system in SCM will need to be operational and connected to the Cooper Mountain non-potable water infrastructure. The proposed potable water intertie in the study area would provide (potable) supply water to the non-potable water system if the SCM system is not operational or does not have supply to meet non-potable water demands.

Chapter 7: Cost Estimates

Introduction

This chapter summarizes the approach used to develop cost estimates for the proposed infrastructure to serve the CMUP study area and presents cost estimates by utility.

Basis of Cost Estimates

All cost estimates for projects presented in this CMUP are planning level costs approximately equivalent to Association for the Advancement of Cost Engineering Class 5 estimates. Cost estimates of this type are classified as order-of-magnitude cost estimates, which assume a 0 to 2 percent level of project definition to reflect the significant number of unknowns in project scope and conditions. Correspondingly, Class 5 cost estimates have a wide accuracy range to reflect these uncertainties at the master planning stage; actual costs may vary from these by minus 50 percent to plus 75 percent:

- **Low End Accuracy Range**: -20 to -50 percent (i.e. the low end of the accuracy range for a $1 million cost estimate is $0.5 to $0.8 million).
- **High End Accuracy Range**: +30- to +75 percent (i.e. the high end of the accuracy range for a $1 million cost estimate is $1.3 to $1.75 million).

All costs are in 2023 dollars, and the Engineering News-Record's Seattle, WA Construction Cost Index for August 2023 was 15171.86. The estimates are subject to change as the project designs mature. Cost estimates represent opinions of cost only, acknowledging that final costs of individual projects will vary depending on actual labor and material costs, market conditions for construction, regulatory factors, final project scope, project schedule, and other factors.

Direct Construction Cost Development

Direct construction costs were developed using historical project data and general market trends. Direct construction cost estimates focused on major facilities and equipment and include allowances for additional civil, mechanical, electrical, and instrumentation requirements.

Cost Factors

To estimate total project costs for the CMUP, cost factors were added to the direct construction cost estimates.

Table 7-1 summarizes the cost factors used in this evaluation. Property acquisition costs are included for proposed facility sites, except stormwater ponds which are assumed will be on developer dedicated property. Project costs do not include easement or right-of-way costs.

Table 7-1 | Cost Factors

Cost Element	Cost Factor
Mobilization	10%
Traffic Control & ESC	5%
Contingency	30%
Engineering Design, Legal, Admin.	30%
Environmental & Permitting	3% (stormwater only)
Property Acquisition	$15/SF

Stormwater Utility

Conventional

Cost estimates for the conventional stormwater approach as described in **Chapter 3** are summarized in this section. The proposed stormwater infrastructure is shown **Figure 3-10** and includes 30 stormwater ponds as well as their associated outfall piping and structures. Additional site area will be required at each pond location to accommodate additional grading or retain wall to construct the pond on a slope, and for site improvements such as access roads, fences, and landscape buffer areas. Cost factors as a percentage of the pond cost were calculated to account for the additional grading cost (**Table 7-2**). The additional grading factor is based on the land slope of the pond locations; the factor increases as the land slope increases. Additional site improvement costs (**Table 7-3**) were also included to account for maintenance access roads, fencing, landscaping outside of the pond area, etc.

Table 7-2 | Grading Cost Adjustment Factors Applied to Pond Cost

Land Slope at Pond Site	Grading Cost Adjustment Factor
<5%	N/A
5%-10%	30%
>10%	50%

Table 7-3 | Site Improvement Cost Adjustment Factors Applied to Pond Cost

Pond Size by Top Area	Site Improvement Lump Sum Cost
Small and Medium Ponds (<80,000 SF)	$75,000
Large Ponds (>80,000 SF)	$100,000

Full cost estimates are available in **Appendix C**.

Table 7-4 | Conventional Stormwater Estimated Cost Summary

Pond and Outfall ID	Estimated Cost
1	$1,537,000
2	$3,621,000
3	$3,365,000
4	$2,616,000
5	$773,000
6	$1,665,000
7	$2,115,000
8	$2,058,000
9	$2,991,000
10	$1,737,000
11	$2,861,000
12	$2,313,000
13	$857,000
14	$3,165,000
15	$2,147,000
16	$1,709,000
17	$1,683,000
18	$4,786,000
19	$4,540,000
20	$1,232,000
21	$1,512,000
22	$5,483,000
23	$1,198,000
24	$2,872,000
25	$1,237,000
26	$2,357,000
27	$853,000
28	$988,000
29	$3,487,000
30	$2,201,000
TOTAL (McKernan Creek Only)	**$27,248,000**
TOTAL	**$69,959,000**

Sewer Utility

Cost estimates for the sanitary sewer infrastructure proposed in **Chapter 4** to serve the study area are summarized in this section. The proposed infrastructure is shown in **Figure 4-2** and includes 161 manholes and approximately 41,000 feet of pipe ranging in diameter from 8 to 18 inches and at depths up to approximately 30 feet. The cost estimates are organized by the connection point to the downstream system. The alignment tributary to the CMSPS is further separated into segments that generally break at the planned neighborhoods. Full cost estimates are available in **Appendix C** and summarized in **Table 7-5**.

Table 7-5 | Sanitary Sewer Cost Summary

Alignment	Description	Total Project Cost
CMSPS1	Trunkline running south along SW Grabhorn Road and west across the Grabhorn Meadow neighborhood and across McKernan Creek at the proposed trail	$5,708,000
CMSPS2	Trunkline from McKernan Creek trail crossing to the Cooper Mountain Sanitary Pump Station	$2,062,000
CMSPS2A	Trunkline in Northern Cooper Lowlands area	$1,151,000
CMSPS2B	Trunkline along SW Tile Flat Road east of main trunkline through Cooper Lowlands	$1,151,000
CMSPS3	Central trunkline along E-W collector road through Cooper Lowlands and Horse Tale neighborhoods	$4,124,000
CMSPS3A	Short spur off main Cooper Lowlands trunk in the east of the neighborhood	$311,000
CMSPS4	Central trunkline along N-S collector road, including crossing of McKernan Creek	$3,967,000
CMSPS5	Trunkline from convergence of Hilltop/McKernan and Horse Tale Trunk to SW 175th Avenue	$1,309,000
CMSPS6	Trunkline in SW 175th Avenue, including repair to arterial roads	$5,264,000
SSMH0004981	Connection from Weir neighborhood east, through riparian area, to existing Summer Creek system	$472,000
SSMH0005288	Connection from Weir neighborhood north to existing Summer Creek system along SW Weir Road and SW Mount Adams Drive, including arterial road repair	$2,522,000
SSMH0004814	Connection from Siler Ridge neighborhood east, through riparian area, to existing Summer Creek system	$2,396,000
SSMH0004844	Connection from High Hill neighborhood east to existing Summer Creek system along SW High Hill Lane, including local road repair	$1,477,000
SSCO0000551	Connection from High Hill neighborhood east to existing Summer Creek system	$347,000
SSMH0008718	Connection from High Hill neighborhood south, along SW Alvord Lane and through riparian area, to existing system, including local road repair	$763,000
SSMH0008365	Connection from High Hill and Skyline neighborhoods south along SW 175th Avenue and west along SW Alvord Lane to existing South Cooper Mountain system, including arterial and local road repair	$3,224,000

Alignment	Description	Total Project Cost
SCM_West	Connection for small portion of Cooper Lowlands neighborhood to connect into South Cooper Mountain system.	$794,000
Total		**$37,042,000**

Pipeline construction costs are for PVC pipe and include general markups for earthwork and construction, trench repair, erosion and traffic control, mobilization, and contractor overhead. Pipeline construction costs do not include property acquisition costs or easement or right-of-way costs. Roadway resurfacing unit costs assume open trench construction with resurfacing for half of the roadway. Alignments sited within proposed roadways do not include road repair costs as it was assumed installation will occur in coordination with construction of the roadway. Additional environmental permitting and restoration costs were not included for alignments within the riparian zone when sited within the roadway; it is assumed these costs are accounted for in the roadway construction. Where open trench construction may not be possible, individual project cost estimates were modified, as needed, to reflect costs for boring or other construction methods.

Potable Water Utility

Cost estimates for the potable water infrastructure proposed in **Chapter 5** to serve the study area are summarized in this section. The proposed infrastructure is shown in **Figure 5-2** and includes transmission mains, three booster pump stations, one storage reservoir, two ASR facilities, and 14 PRV stations. The cost estimates have been split into three groups based on the primary source serving pressure zones and a fourth group for City-wide capacity and storage facilities. PRV stations have been included with the downstream distribution mains they serve. The following summarizes the infrastructure by group.

- Upper BPS Zones (930 and 850 Zones)
  - Distribution mains
  - Upper BPS
  - Three PRV stations serving the 850 Zone
- Middle CMR 1&2 Zones (794, 750, and 675 Zones)
  - Distribution mains
  - CMR 3 BPS
  - Seven PRV stations serving the zones
- Lower CMR 3 Zones (550 and 470 Zones)
  - Distribution mains
  - West BPS
  - Four PRV stations serving the zones
- City-Wide Capacity and Storage
  - CMR 3 Reservoir

- CMR 3 ASR
- Tile Flat BPS
- ASR 7A (CMR 1&2 site)

Pipeline construction costs are for ductile iron pipe and include general markups for earthwork and construction, erosion and traffic control, fittings and valves, mobilization, and contractor overhead. Pipeline construction costs do not include property acquisition costs or easement or right-of-way costs. Roadway resurfacing unit costs assume open trench construction with trench patches and do not include full street resurfacing. Alignments sited within proposed roadways do not include road repair costs as it was assumed installation will occur in coordination with construction of the roadway. Additional environmental permitting and restoration costs were not included for alignments within the riparian zone when sited within the roadway; it is assumed these costs are accounted for in the roadway construction. Where open trench construction may not be possible, individual project cost estimates were modified, as needed, to reflect costs for boring or other construction methods.

Full cost estimates are available in **Appendix C** and summarized in **Table 7-6**.

Table 7-6 | Potable Water Cost Summary

Project	Description	Total Project Cost
Upper Zones		
930 Zone	Transmission lines through 930 Zone and repair to impacted arterial roads.	$11,800,000
850 Zone	Transmission lines through 850 Zone, including three PRVs, and repair to impacted arterial roads.	$8,780,000
Upper BPS (4,000 gpm)	BPS at CMR 1&2 site to provide constant pressure supply to 930 and 850 Zones. Site development and pump building were constructed as part of the CMR 1&2 Reservoir project.	$3,000,000
	Upper Zones Subtotal	$23,580,000
Middle Zones		
794 Zone	Transmission lines from CMR 1&2 Reservoirs through 794 Zone, including two PRVs, one crossing of McKernan Creek (assumed to be co-located with collector road), and repair to impacted local roads.	$16,970,000
750 Zone	Transmission lines through 750 Zone, including two PRVs and repair to impacted local roads.	$2,080,000
675 Zone	Transmission lines through 675 Zone, including two PRVs and repair to impacted local roads.	$14,140,000
CMR 3 BPS (3,900 gpm)	BPS at CMR 3 site to pump water from CMR 3 Reservoir up to CMR 1&2 Reservoirs.	$5,160,000
	Middle Zones Subtotal	$38,350,000

Project	Description	Total Project Cost
Lower Zones		
550 Zone	Transmission lines through 550 Zone, including two PRVs, and repair to impacted arterial roads.	$19,490,000
470 Zone	Transmission lines through 470 Zone, including two PRVs, one crossing of McKernan Creek at SW Grabhorn Rd and one at pedestrian bridge, and repair to impacted arterial and local roads.	$16,100,000
West BPS (3,100 gpm)	BPS in Grabhorn neighborhood to supply 550 West Zone.	$5,220,000
	Lower Zones Subtotal	$40,810,000
City-Wide Capacity and Storage		
CMR 3 Reservoir (5.0 MG)	New 5.0 MG reservoir to expand storage and supply the lower zones on Cooper Mountain.	$29,200,000
CMR 3 Site ASR	New ASR facility for potable water storage and recovery.	$13,050,000
Tile Flat BPS (3,900 gpm)	BPS near SW Tile Flat Rd to pump water from City's future connection to WWSS transmission main up to CMR 3 Reservoir.	$5,650,000
ASR 7A	Proposed new ASR facility for potable water storage and recovery at CMR 1&2 site.	$6,412,000
	City-Wide Capacity and Storage Subtotal	$54,312,000
	Total Potable Cost	**$157,052,000**

Non-Potable Water Utility

Cost estimates for the non-potable water infrastructure proposed in **Chapter 4** to serve the study area are summarized in this section. The proposed infrastructure is shown in **Figure 6-2** and includes transmission mains, PRV stations, and potable water system interties. The cost estimates have been split into two groups based on the primary source serving pressure zones. PRV stations have been included with the downstream mains they serve.

Pipeline construction costs are for PVC pipe and include general markups for earthwork and construction, erosion and traffic control, fittings and valves, mobilization, and contractor overhead. Pipeline construction costs do not include property acquisition costs or easement or right-of-way costs. Roadway resurfacing unit costs assume open trench construction with trench patches and do not include full street resurfacing. Alignments sited within proposed roadways do not include road repair costs as it was assumed installation will occur in coordination with construction of the roadway. Additional environmental permitting and restoration costs were not included for alignments within the riparian zone when sited within the roadway; it is assumed these costs are accounted for in the roadway construction. Where open trench construction may not be possible, individual project cost estimates were modified, as needed, to reflect costs for boring or other construction methods.

Full cost estimates are available in **Appendix C** and summarized in **Table 7-7** below.

Table 7-7 | Non-Potable Water Cost Summary

Pressure Zones		Total Project Cost
NP 520 Zone	Distribution lines through NP 520 Zone, including intertie to potable water system between Cooper Lowlands and Horse Tale neighborhoods.	$6,290,000
NP 410 Zone	Distribution lines through NP 410 Zone, including two PRVs, one crossing of McKernan Creek at SW Grabhorn Rd and one at pedestrian bridge, and repair to impacted arterial roads.	$12,950,000
	Total Non-Potable Water Cost	**$19,240,000**

Appendix A: Stormwater Modeling Results

TRUST Model Results

CMUP

4/26/2024

All Values in CFS

POC	A	Historic Forested	Existing (2020 Conditions)	Developed Mitigated	Developed Unmitigated	Developed Water Quality
2	Year	12.74	47.93	13.52	46.08	28.60
5	Year	28.45	72.24	22.43	60.66	40.98
10	Year	39.27	85.17	29.23	70.46	50.44
25	Year	51.87	98.18	38.76	83.05	63.92
50	Year	60.09	105.85	46.51	92.60	75.14
100	Year	67.26	112.12	54.79	102.30	87.41

POC	B	Historic Forested	Existing (2020 Conditions)	Developed Mitigated	Developed Unmitigated	Developed Water Quality
2	Year	11.18	41.56	12.68	42.25	26.35
5	Year	24.88	62.88	21.24	55.98	37.99
10	Year	34.29	74.26	27.65	65.25	46.92
25	Year	45.23	85.71	36.48	77.21	59.70
50	Year	52.37	92.47	43.52	86.30	70.36
100	Year	58.59	98.01	50.93	95.56	82.06

POC	C	Historic Forested	Existing (2020 Conditions)	Developed Mitigated	Developed Unmitigated	Developed Water Quality
2	Year	9.83	37.46	9.11	25.86	17.53
5	Year	21.81	56.65	17.24	35.67	26.41
10	Year	30.03	66.88	22.84	42.80	33.33
25	Year	39.58	77.18	29.71	52.56	43.30
50	Year	45.80	83.26	34.54	60.38	51.68
100	Year	51.22	88.24	39.06	68.70	60.92

POC	D	Historic Forested	Existing (2020 Conditions)	Developed Mitigated	Developed Unmitigated	Developed Water Quality
2	Year	4.13	14.44	3.48	23.15	13.11
5	Year	9.14	24.01	6.11	28.87	17.89
10	Year	12.57	29.44	8.09	32.40	21.42
25	Year	16.55	35.11	10.82	36.65	26.29
50	Year	19.14	38.54	12.98	39.68	30.24
100	Year	21.40	41.39	15.24	42.62	34.47

POC	E	Historic Forested	Existing (2020 Conditions)	Developed Mitigated	Developed Unmitigated	Developed Water Quality
2	Year	3.36	11.89	2.61	19.09	10.78
5	Year	7.44	19.49	5.10	23.78	14.71
10	Year	10.23	23.77	6.68	26.68	17.60
25	Year	13.48	28.22	8.43	30.16	21.60
50	Year	15.59	30.89	9.53	32.65	24.84
100	Year	17.43	33.11	10.48	35.06	28.31

POC	F	Historic Forested	Existing (2020 Conditions)	Developed Mitigated	Developed Unmitigated	Developed Water Quality
2	Year	1.13	4.09	0.97	5.87	5.86
5	Year	2.46	6.79	1.88	7.60	7.53
10	Year	3.36	8.33	2.45	8.70	8.71
25	Year	4.40	9.93	3.08	10.05	10.27
50	Year	5.07	10.90	3.48	11.03	11.50
100	Year	5.66	11.70	3.82	11.99	12.78

POC	G	Historic Forested	Existing (2020 Conditions)	Developed Mitigated	Developed Unmitigated	Developed Water Quality
2	Year	1.97	7.34	1.32	14.21	10.42
5	Year	4.28	11.64	2.56	17.26	13.05
10	Year	5.85	14.01	3.35	19.06	14.86
25	Year	7.65	16.44	4.21	21.15	17.23
50	Year	8.82	17.89	4.76	22.60	19.06
100	Year	9.84	19.08	5.22	23.98	20.95

POC	H	Historic Forested	Existing (2020 Conditions)	Developed Mitigated	Developed Unmitigated	Developed Water Quality
2	Year	2.75	12.06	1.89	17.26	17.59
5	Year	5.97	17.68	3.54	21.58	21.84
10	Year	8.16	21.12	4.55	24.25	24.74
25	Year	10.68	25.12	5.66	27.47	28.53
50	Year	12.32	27.87	6.34	29.77	31.44
100	Year	13.74	30.42	6.93	32.01	34.43

POC	I	Historic Forested	Existing (2020 Conditions)	Developed Mitigated	Developed Unmitigated	Developed Water Quality
2	Year	0.69	3.03	0.50	0.50	0.50
5	Year	1.49	4.45	1.08	1.08	1.08
10	Year	2.04	5.35	1.48	1.48	1.48
25	Year	2.67	6.42	1.94	1.94	1.94
50	Year	3.08	7.17	2.23	2.23	2.23
100	Year	3.44	7.89	2.49	2.49	2.49

POC	J	Historic Forested	Existing (2020 Conditions)	Developed Mitigated	Developed Unmitigated	Developed Water Quality
2	Year	1.38	5.33	1.05	8.87	8.83
5	Year	3.01	8.18	2.04	11.05	10.67
10	Year	4.11	9.71	2.67	12.40	11.91
25	Year	5.37	11.27	3.35	14.01	13.49
50	Year	6.20	12.19	3.79	15.16	14.68
100	Year	6.91	12.94	4.16	16.28	15.90

POC	K	Historic Forested	Existing (2020 Conditions)	Developed Mitigated	Developed Unmitigated	Developed Water Quality
2	Year	0.81	3.99	0.59	4.57	4.65
5	Year	1.77	5.64	1.10	5.78	5.87
10	Year	2.41	6.69	1.47	6.54	6.71
25	Year	3.16	7.94	1.96	7.45	7.83
50	Year	3.64	8.84	2.33	8.10	8.69
100	Year	4.06	9.70	2.69	8.74	9.58

POC	L	Historic Forested	Existing (2020 Conditions)	Developed Mitigated	Developed Unmitigated	Developed Water Quality
2	Year	0.92	4.08	0.73	5.06	5.18
5	Year	2.00	5.98	1.41	55.98	6.50
10	Year	2.74	7.17	1.83	65.25	7.41
25	Year	3.58	8.60	2.30	77.21	8.61
50	Year	4.13	9.61	2.59	86.30	9.54
100	Year	4.60	10.57	2.84	95.56	10.49

POC	M	Historic Forested	Existing (2020 Conditions)	Developed Mitigated	Developed Unmitigated	Developed Water Quality
2	Year	0.49	1.95	0.29	4.03	3.90
5	Year	1.07	2.93	0.61	5.29	5.10
10	Year	1.46	3.45	0.83	6.08	5.94
25	Year	1.91	3.97	1.07	7.04	7.06
50	Year	2.20	4.27	1.23	7.73	7.93
100	Year	2.45	4.52	1.37	8.39	8.83

POC	N	Historic Forested	Existing (2020 Conditions)	Developed Mitigated	Developed Unmitigated	Developed Water Quality
2	Year	0.21	0.92	0.12	2.31	2.43
5	Year	0.46	1.37	0.22	2.79	2.93
10	Year	0.63	1.65	0.32	3.07	3.26
25	Year	0.83	1.97	0.47	3.40	3.69
50	Year	0.96	2.19	0.61	3.63	4.02
100	Year	1.07	2.40	0.77	3.84	4.35

POC	O	Historic Forested	Existing (2020 Conditions)	Developed Mitigated	Developed Unmitigated	Developed Water Quality
2	Year	0.42	1.75	0.28	4.04	1.87
5	Year	0.91	2.62	0.55	4.91	2.54
10	Year	1.24	3.16	0.81	5.43	3.04
25	Year	1.63	3.80	1.23	6.03	3.74
50	Year	1.88	4.24	1.64	6.45	4.32
100	Year	2.09	4.65	2.12	6.85	4.94

POC	P	Historic Forested	Existing (2020 Conditions)	Developed Mitigated	Developed Unmitigated	Developed Water Quality
2	Year	0.75	3.04	0.48	5.65	2.65
5	Year	1.65	4.64	0.90	7.32	3.97
10	Year	2.26	5.59	1.27	8.35	4.99
25	Year	2.96	6.66	1.85	9.60	6.46
50	Year	3.42	7.35	2.37	10.49	7.69
100	Year	3.82	7.98	2.98	11.35	9.04

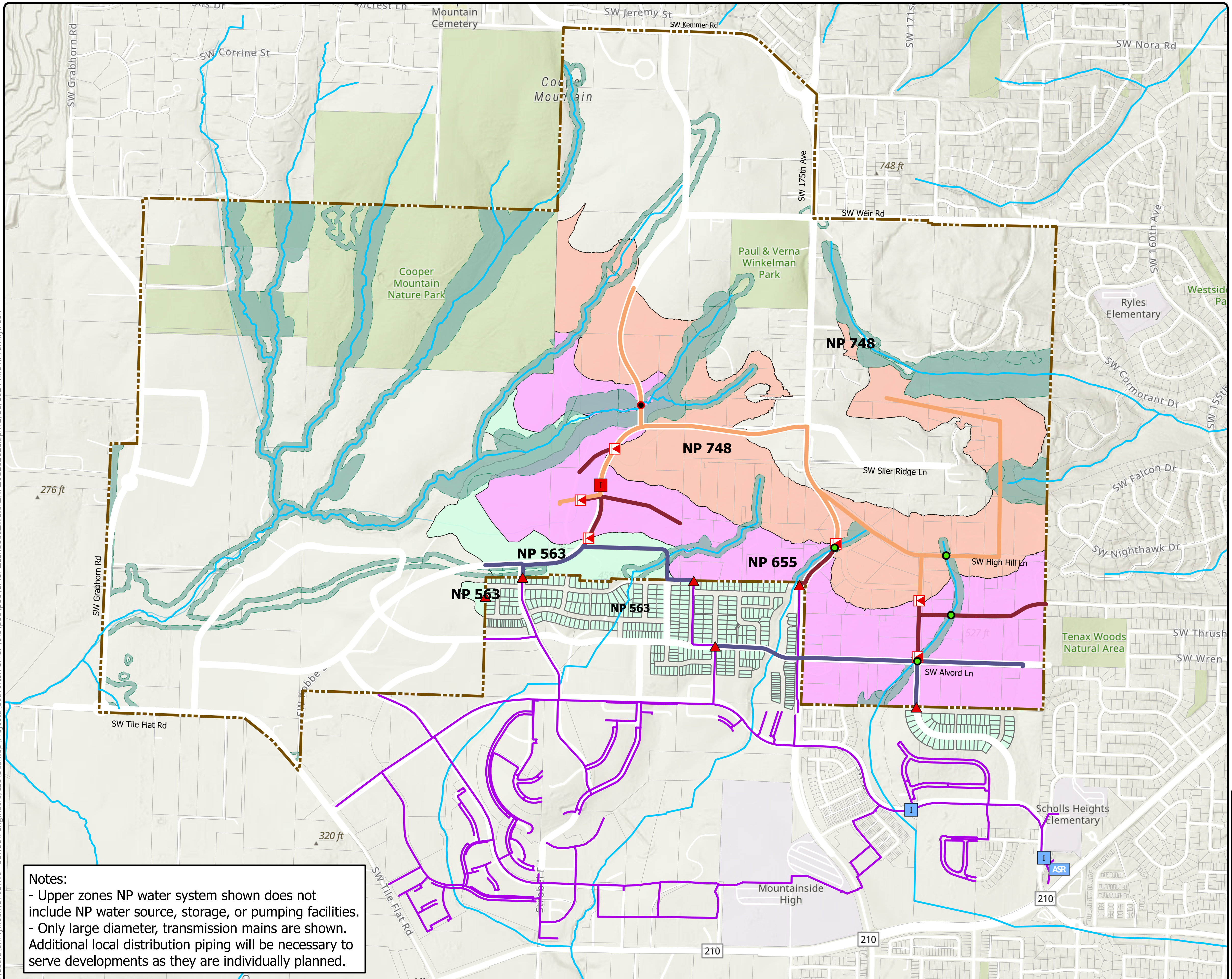
TRUST2019

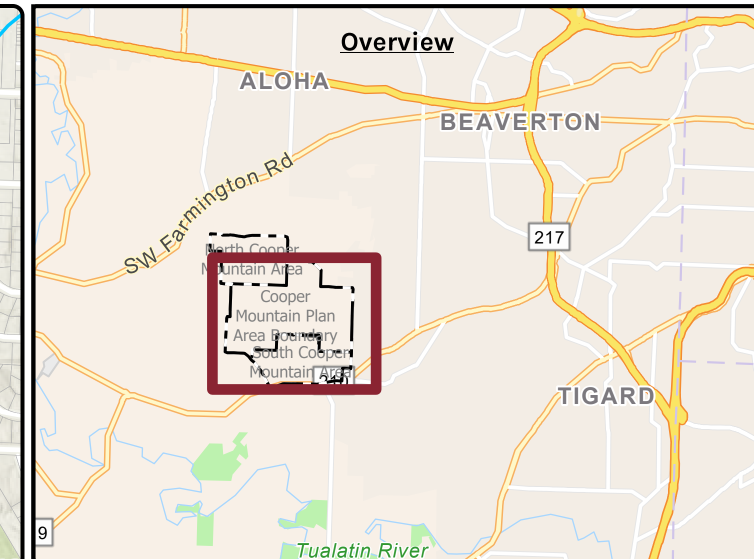
PROJECT REPORT

Due to the large nature of the file, the TRUST modeling data report is available from City of Beaverton upon request.

Appendix B: Non-Potable

Cooper Mountain Utility Plan





Notes:
- Upper zones NP water system shown does not include NP water source, storage, or pumping facilities.
- Only large diameter, transmission mains are shown. Additional local distribution piping will be necessary to serve developments as they are individually planned.

Legend

- Study Area
- Tax Lot
- Stream
- Riparian Corridor
- Roadway (Proposed and Existing)
- Planned (or under construction) NP Main

Non-Potable (NP) Facilities
- Existing NP ASR 3/3A
- Existing Potable Intertie
- Upper Zones PRV
- Upper Zones Connection to Existing
- Upper Zones Potable Intertie
- Vegetated Corridor Crossing
- Bridge Crossing

Upper Zones NP Main (by Zone)
- NP 563
- NP 655
- NP 748

Upper NP Pressure Zone
- NP 563
- NP 655
- NP 748

0 1,000 2,000 Feet

Cooper Mountain Utility Plan

Beaverton OREGON

consor

Appendix B
Upper Zones Non-Potable Water Infrastructure Not Recommended

Project No. 20-2755

February 2024

Data Sources: City of Beaverton, 2023; World Navigation Map: Oregon Metro, Oregon State Parks, State of Oregon GEO, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS
World Topographic Map: Esri Community Maps Contributors, 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:

Appendix C: Cost Estimate Details

Stormwater (Conventional)	Quantity	Unit	Unit Cost	Cost	Mob. (10%)	Traffic Control & ESC (%)	Traffic Control & ESC ($)	Construction Subtotal	Contingency (30%)	Construction Total	Engineering, Legal, Admin (30%)	Environmental & Permitting (%)	Environmental & Permitting ($)	Total Project Cost
Outfall 1														
Pond, by Top Area	28900	SF	$ 20	$ 578,000	$ 57,800	5%	$ 28,900	$ 664,700	$ 199,500	$ 864,200	$ 259,300	3%	$ 26,000	$ 1,150,000
Pond Grading Adjustment (<5%, No Adjustment)	0	LS	$ -	$ -	$ -	5%	$ -	$ -	$ -	$ -	$ -	3%	$ -	$ -
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	210	LF	$ 350	$ 73,500	$ 7,400	5%	$ 3,700	$ 84,600	$ 25,400	$ 110,000	$ 33,000	3%	$ 3,300	$ 147,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 887,400	$ 266,400	$ 1,153,800	$ 346,300		$ 34,800	**$1,537,000**
Outfall 2														
Pond, by Top Area	75700	SF	$ 20	$ 1,514,000	$ 151,400	5%	$ 75,700	$ 1,741,100	$ 522,400	$ 2,263,500	$ 679,100	3%	$ 68,000	$ 3,011,000
Pond Grading Adjustment (<5%, No Adjustment)	0	LS	$ -	$ -	$ -	5%	$ -	$ -	$ -	$ -	$ -	3%	$ -	$ -
Pond Site Improvements Adjustment, Large Ponds	1	LS	$ 100,000	$ 100,000	$ 10,000	5%	$ 5,000	$ 115,000	$ 34,500	$ 149,500	$ 44,900	3%	$ 4,500	$ 199,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	460	LF	$ 350	$ 161,000	$ 16,100	5%	$ 8,100	$ 185,200	$ 55,600	$ 240,800	$ 72,300	3%	$ 7,300	$ 321,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 2,093,100	$ 628,100	$ 2,721,200	$ 816,600		$ 81,900	**$3,621,000**
Outfall 3														
Pond, by Top Area	55300	SF	$ 20	$ 1,106,000	$ 110,600	5%	$ 55,300	$ 1,271,900	$ 381,600	$ 1,653,500	$ 496,100	3%	$ 49,700	$ 2,200,000
Pond Grading Adjustment (5% to 10% Slopes, Pond Cost +30%)	1	LS	$ 331,800	$ 331,800	$ 33,200	5%	$ 16,600	$ 381,600	$ 114,500	$ 496,100	$ 148,900	3%	$ 14,900	$ 660,000
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	380	LF	$ 350	$ 133,000	$ 13,300	5%	$ 6,700	$ 153,000	$ 45,900	$ 198,900	$ 59,700	3%	$ 6,000	$ 265,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 1,944,600	$ 583,400	$ 2,528,100	$ 758,700		$ 76,100	**$3,365,000**
Outfall 4														
Pond, by Top Area	40000	SF	$ 20	$ 800,000	$ 80,000	5%	$ 40,000	$ 920,000	$ 276,000	$ 1,196,000	$ 358,800	3%	$ 35,900	$ 1,591,000
Pond Grading Adjustment (5% to 10% Slopes, Pond Cost +30%)	1	LS	$ 240,000	$ 240,000	$ 24,000	5%	$ 12,000	$ 276,000	$ 82,800	$ 358,800	$ 107,700	3%	$ 10,800	$ 478,000
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	440	LF	$ 350	$ 154,000	$ 15,400	5%	$ 7,700	$ 177,100	$ 53,200	$ 230,300	$ 69,100	3%	$ 7,000	$ 307,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 1,511,200	$ 453,500	$ 1,964,700	$ 589,600		$ 59,200	**$2,616,000**
Outfall 5														
Pond, by Top Area	8100	SF	$ 20	$ 162,000	$ 16,200	5%	$ 8,100	$ 186,300	$ 55,900	$ 242,200	$ 72,700	3%	$ 7,300	$ 323,000
Pond Grading Adjustment (<5%, No Adjustment)	0	LS	$ -	$ -	$ -	5%	$ -	$ -	$ -	$ -	$ -	3%	$ -	$ -
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	300	LF	$ 350	$ 105,000	$ 10,500	5%	$ 5,300	$ 120,800	$ 36,300	$ 157,100	$ 47,200	3%	$ 4,800	$ 210,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 445,200	$ 133,700	$ 578,900	$ 173,900		$ 17,600	**$773,000**
Outfall 6														
Pond, by Top Area	23100	SF	$ 20	$ 462,000	$ 46,200	5%	$ 23,100	$ 531,300	$ 159,400	$ 690,700	$ 207,300	3%	$ 20,800	$ 919,000
Pond Grading Adjustment (5% to 10% Slopes, Pond Cost +30%)	1	LS	$ 138,600	$ 138,600	$ 13,900	5%	$ 7,000	$ 159,500	$ 47,900	$ 207,400	$ 62,300	3%	$ 6,300	$ 276,000

Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	330	LF	$ 350	$ 115,500	$ 11,600	5%	$ 5,800	$ 132,900	$ 39,900	$ 172,800	$ 51,900	3%	$ 5,200	$ 230,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 961,800	$ 288,700	$ 1,250,500	$ 375,500		$ 37,800	**$1,665,000**
Outfall 7														
Pond, by Top Area	31400	SF	$ 20	$ 628,000	$ 62,800	5%	$ 31,400	$ 722,200	$ 216,700	$ 938,900	$ 281,700	3%	$ 28,200	$ 1,249,000
Pond Grading Adjustment (5% to 10% Slopes, Pond Cost +30%)	1	LS	$ 188,400	$ 188,400	$ 18,900	5%	$ 9,500	$ 216,800	$ 65,100	$ 281,900	$ 84,600	3%	$ 8,500	$ 375,000
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	360	LF	$ 350	$ 126,000	$ 12,600	5%	$ 6,300	$ 144,900	$ 43,500	$ 188,400	$ 56,600	3%	$ 5,700	$ 251,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 1,222,000	$ 366,800	$ 1,588,800	$ 476,900		$ 47,900	**$2,115,000**
Outfall 8														
Pond, by Top Area	30300	SF	$ 20	$ 606,000	$ 60,600	5%	$ 30,300	$ 696,900	$ 209,100	$ 906,000	$ 271,800	3%	$ 27,200	$ 1,205,000
Pond Grading Adjustment (5% to 10% Slopes, Pond Cost +30%)	1	LS	$ 181,800	$ 181,800	$ 18,200	5%	$ 9,100	$ 209,100	$ 62,800	$ 271,900	$ 81,600	3%	$ 8,200	$ 362,000
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	360	LF	$ 350	$ 126,000	$ 12,600	5%	$ 6,300	$ 144,900	$ 43,500	$ 188,400	$ 56,600	3%	$ 5,700	$ 251,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 1,189,000	$ 356,900	$ 1,545,900	$ 464,000		$ 46,600	**$2,058,000**
Outfall 9														
Pond, by Top Area	44100	SF	$ 20	$ 882,000	$ 88,200	5%	$ 44,100	$ 1,014,300	$ 304,300	$ 1,318,600	$ 395,600	3%	$ 39,600	$ 1,754,000
Pond Grading Adjustment (10%+ Slopes, Pond Cost +50%)	1	LS	$ 441,000	$ 441,000	$ 44,100	5%	$ 22,100	$ 507,200	$ 152,200	$ 659,400	$ 197,900	3%	$ 19,800	$ 878,000
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	170	LF	$ 350	$ 59,500	$ 6,000	5%	$ 3,000	$ 68,500	$ 20,600	$ 89,100	$ 26,800	3%	$ 2,700	$ 119,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 1,728,100	$ 518,600	$ 2,246,700	$ 674,300		$ 67,600	**$2,991,000**
Outfall 10														
Pond, by Top Area	23800	SF	$ 20	$ 476,000	$ 47,600	5%	$ 23,800	$ 547,400	$ 164,300	$ 711,700	$ 213,600	3%	$ 21,400	$ 947,000
Pond Grading Adjustment (5% to 10% Slopes, Pond Cost +30%)	1	LS	$ 142,800	$ 142,800	$ 14,300	5%	$ 7,200	$ 164,300	$ 49,300	$ 213,600	$ 64,100	3%	$ 6,500	$ 285,000
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	380	LF	$ 350	$ 133,000	$ 13,300	5%	$ 6,700	$ 153,000	$ 45,900	$ 198,900	$ 59,700	3%	$ 6,000	$ 265,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 1,002,800	$ 301,000	$ 1,303,800	$ 391,400		$ 39,400	**$1,737,000**
Outfall 11														
Pond, by Top Area	45000	SF	$ 20	$ 900,000	$ 90,000	5%	$ 45,000	$ 1,035,000	$ 310,500	$ 1,345,500	$ 403,700	3%	$ 40,400	$ 1,790,000
Pond Grading Adjustment (5% to 10% Slopes, Pond Cost +30%)	1	LS	$ 270,000	$ 270,000	$ 27,000	5%	$ 13,500	$ 310,500	$ 93,200	$ 403,700	$ 121,200	3%	$ 12,200	$ 538,000
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	420	LF	$ 350	$ 147,000	$ 14,700	5%	$ 7,400	$ 169,100	$ 50,800	$ 219,900	$ 66,000	3%	$ 6,600	$ 293,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 1,652,700	$ 496,000	$ 2,148,700	$ 644,900		$ 64,700	**$2,861,000**

Outfall 12														
Pond, by Top Area	32400	SF	$ 20	$ 648,000	$ 64,800	5%	$ 32,400	$ 745,200	$ 223,600	$ 968,800	$ 290,700	3%	$ 29,100	$ 1,289,000
Pond Grading Adjustment (5% to 10% Slopes, Pond Cost +30%)	1	LS	$ 194,400	$ 194,400	$ 19,500	5%	$ 9,800	$ 223,700	$ 67,200	$ 290,900	$ 87,300	3%	$ 8,800	$ 387,000
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	570	LF	$ 350	$ 199,500	$ 20,000	5%	$ 10,000	$ 229,500	$ 68,900	$ 298,400	$ 89,600	3%	$ 9,000	$ 397,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 1,336,500	$ 401,200	$ 1,737,700	$ 521,600		$ 52,400	$2,313,000
Outfall 13														
Pond, by Top Area	6400	SF	$ 20	$ 128,000	$ 12,800	5%	$ 6,400	$ 147,200	$ 44,200	$ 191,400	$ 57,500	3%	$ 5,800	$ 255,000
Pond Grading Adjustment (<5%, No Adjustment)	0	LS	$ -	$ -	$ -	5%	$ -	$ -	$ -	$ -	$ -	3%	$ -	$ -
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	520	LF	$ 350	$ 182,000	$ 18,200	5%	$ 9,100	$ 209,300	$ 62,800	$ 272,100	$ 81,700	3%	$ 8,200	$ 362,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 494,600	$ 148,500	$ 643,100	$ 193,200		$ 19,500	$857,000
Outfall 14														
Pond, by Top Area	52900	SF	$ 20	$ 1,058,000	$ 105,800	5%	$ 52,900	$ 1,216,700	$ 365,100	$ 1,581,800	$ 474,600	3%	$ 47,500	$ 2,104,000
Pond Grading Adjustment (5% to 10% Slopes, Pond Cost +30%)	1	LS	$ 317,400	$ 317,400	$ 31,800	5%	$ 15,900	$ 365,100	$ 109,600	$ 474,700	$ 142,500	3%	$ 14,300	$ 632,000
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	270	LF	$ 350	$ 94,500	$ 9,500	5%	$ 4,800	$ 108,800	$ 32,700	$ 141,500	$ 42,500	3%	$ 4,300	$ 189,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 1,828,700	$ 548,900	$ 2,377,600	$ 713,600		$ 71,600	$3,165,000
Outfall 15														
Pond, by Top Area	28900	SF	$ 20	$ 578,000	$ 57,800	5%	$ 28,900	$ 664,700	$ 199,500	$ 864,200	$ 259,300	3%	$ 26,000	$ 1,150,000
Pond Grading Adjustment (5% to 10% Slopes, Pond Cost +30%)	1	LS	$ 173,400	$ 173,400	$ 17,400	5%	$ 8,700	$ 199,500	$ 59,900	$ 259,400	$ 77,900	3%	$ 7,800	$ 346,000
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	590	LF	$ 350	$ 206,500	$ 20,700	5%	$ 10,400	$ 237,600	$ 71,300	$ 308,900	$ 92,700	3%	$ 9,300	$ 411,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 1,239,900	$ 372,200	$ 1,612,100	$ 483,900		$ 48,600	$2,147,000
Outfall 16														
Pond, by Top Area	25000	SF	$ 20	$ 500,000	$ 50,000	5%	$ 25,000	$ 575,000	$ 172,500	$ 747,500	$ 224,300	3%	$ 22,500	$ 995,000
Pond Grading Adjustment (5% to 10% Slopes, Pond Cost +30%)	1	LS	$ 150,000	$ 150,000	$ 15,000	5%	$ 7,500	$ 172,500	$ 51,800	$ 224,300	$ 67,300	3%	$ 6,800	$ 299,000
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	250	LF	$ 350	$ 87,500	$ 8,800	5%	$ 4,400	$ 100,700	$ 30,300	$ 131,000	$ 39,300	3%	$ 4,000	$ 175,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 986,300	$ 296,100	$ 1,282,400	$ 384,900		$ 38,800	$1,709,000
Outfall 17														
Pond, by Top Area	20200	SF	$ 20	$ 404,000	$ 40,400	5%	$ 20,200	$ 464,600	$ 139,400	$ 604,000	$ 181,200	3%	$ 18,200	$ 804,000
Pond Grading Adjustment (5% to 10% Slopes, Pond Cost +30%)	1	LS	$ 121,200	$ 121,200	$ 12,200	5%	$ 6,100	$ 139,500	$ 41,900	$ 181,400	$ 54,500	3%	$ 5,500	$ 242,000
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000

18-inch pipe	570	LF	$ 350	$ 199,500	$ 20,000	5%	$ 10,000	$ 229,500	$ 68,900	$ 298,400	$ 89,600	3%	$ 9,000	$ 397,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 971,700	$ 291,700	$ 1,263,400	$ 379,300		$ 38,200	**$1,683,000**
Outfall 18														
Pond, by Top Area	107600	SF	$ 20	$ 2,152,000	$ 215,200	5%	$ 107,600	$ 2,474,800	$ 742,500	$ 3,217,300	$ 965,200	3%	$ 96,600	$ 4,280,000
Pond Grading Adjustment (<5%, No Adjustment)	0	LS	$ -	$ -	$ -	5%	$ -	$ -	$ -	$ -	$ -	3%	$ -	$ -
Pond Site Improvements Adjustment, Large Ponds	1	LS	$ 100,000	$ 100,000	$ 10,000	5%	$ 5,000	$ 115,000	$ 34,500	$ 149,500	$ 44,900	3%	$ 4,500	$ 199,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	310	LF	$ 350	$ 108,500	$ 10,900	5%	$ 5,500	$ 124,900	$ 37,500	$ 162,400	$ 48,800	3%	$ 4,900	$ 217,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 2,766,500	$ 830,100	$ 3,596,600	$ 1,079,200		$ 108,100	**$4,786,000**
Outfall 19														
Pond, by Top Area	101200	SF	$ 20	$ 2,024,000	$ 202,400	5%	$ 101,200	$ 2,327,600	$ 698,300	$ 3,025,900	$ 907,800	3%	$ 90,800	$ 4,025,000
Pond Grading Adjustment (<5%, No Adjustment)	0	LS	$ -	$ -	$ -	5%	$ -	$ -	$ -	$ -	$ -	3%	$ -	$ -
Pond Site Improvements Adjustment, Large Ponds	1	LS	$ 101,200	$ 101,200	$ 10,200	5%	$ 5,100	$ 116,500	$ 35,000	$ 151,500	$ 45,500	3%	$ 4,600	$ 202,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	320	LF	$ 350	$ 112,000	$ 11,200	5%	$ 5,600	$ 128,800	$ 38,700	$ 167,500	$ 50,300	3%	$ 5,100	$ 223,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 2,624,700	$ 787,600	$ 3,412,300	$ 1,023,900		$ 102,600	**$4,540,000**
Outfall 20														
Pond, by Top Area	21400	SF	$ 20	$ 428,000	$ 42,800	5%	$ 21,400	$ 492,200	$ 147,700	$ 639,900	$ 192,000	3%	$ 19,200	$ 852,000
Pond Grading Adjustment (<5%, No Adjustment)	0	LS	$ -	$ -	$ -	5%	$ -	$ -	$ -	$ -	$ -	3%	$ -	$ -
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	200	LF	$ 350	$ 70,000	$ 7,000	5%	$ 3,500	$ 80,500	$ 24,200	$ 104,700	$ 31,500	3%	$ 3,200	$ 140,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 710,800	$ 213,400	$ 924,200	$ 277,500		$ 27,900	**$1,232,000**
Outfall 21														
Pond, by Top Area	21600	SF	$ 20	$ 432,000	$ 43,200	5%	$ 21,600	$ 496,800	$ 149,100	$ 645,900	$ 193,800	3%	$ 19,400	$ 860,000
Pond Grading Adjustment (5% to 10% Slopes, Pond Cost +30%)	1	LS	$ 129,600	$ 129,600	$ 12,960	5%	$ 6,500	$ 149,060	$ 44,800	$ 193,860	$ 58,200	3%	$ 5,900	$ 258,000
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	220	LF	$ 350	$ 77,000	$ 7,700	5%	$ 3,900	$ 88,600	$ 26,600	$ 115,200	$ 34,600	3%	$ 3,500	$ 154,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 872,560	$ 262,000	$ 1,134,560	$ 340,600		$ 34,300	**$1,512,000**
Outfall 22														
Pond, by Top Area	90600	SF	$ 20	$ 1,812,000	$ 181,200	5%	$ 90,600	$ 2,083,800	$ 625,200	$ 2,709,000	$ 812,700	3%	$ 81,300	$ 3,603,000
Pond Grading Adjustment (5% to 10% Slopes, Pond Cost +30%)	1	LS	$ 543,600	$ 543,600	$ 54,400	5%	$ 27,200	$ 625,200	$ 187,600	$ 812,800	$ 243,900	3%	$ 24,400	$ 1,082,000
Pond Site Improvements Adjustment, Large Ponds	1	LS	$ 100,000	$ 100,000	$ 10,000	5%	$ 5,000	$ 115,000	$ 34,500	$ 149,500	$ 44,900	3%	$ 4,500	$ 199,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	730	LF	$ 350	$ 255,500	$ 25,600	5%	$ 12,800	$ 293,900	$ 88,200	$ 382,100	$ 114,700	3%	$ 11,500	$ 509,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 3,169,700	$ 951,100	$ 4,120,800	$ 1,236,500		$ 123,800	**$5,483,000**
Outfall 23														
Pond, by Top Area	18800	SF	$ 20	$ 376,000	$ 37,600	5%	$ 18,800	$ 432,400	$ 129,800	$ 562,200	$ 168,700	3%	$ 16,900	$ 748,000

Pond Grading Adjustment (<5%, No Adjustment)	0	LS	$ -	$ -	$ -	5%	$ -	$ -	$ -	$ -	$ -	3%	$ -	$ -
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	300	LF	$ 350	$ 105,000	$ 10,500	5%	$ 5,300	$ 120,800	$ 36,300	$ 157,100	$ 47,200	3%	$ 4,800	$ 210,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 691,300	$ 207,600	$ 898,900	$ 269,900		$ 27,200	**$1,198,000**
Outfall 24														
Pond, by Top Area	47100	SF	$ 20	$ 942,000	$ 94,200	5%	$ 47,100	$ 1,083,300	$ 325,000	$ 1,408,300	$ 422,500	3%	$ 42,300	$ 1,874,000
Pond Grading Adjustment (5% to 10% Slopes, Pond Cost +30%)	1	LS	$ 282,600	$ 282,600	$ 28,300	5%	$ 14,200	$ 325,100	$ 97,600	$ 422,700	$ 126,900	3%	$ 12,700	$ 563,000
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	280	LF	$ 350	$ 98,000	$ 9,800	5%	$ 4,900	$ 112,700	$ 33,900	$ 146,600	$ 44,000	3%	$ 4,400	$ 195,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 1,659,200	$ 498,000	$ 2,157,200	$ 647,400		$ 64,900	**$2,872,000**
Outfall 25														
Pond, by Top Area	19600	SF	$ 20	$ 392,000	$ 39,200	5%	$ 19,600	$ 450,800	$ 135,300	$ 586,100	$ 175,900	3%	$ 17,600	$ 780,000
Pond Grading Adjustment (<5%, No Adjustment)	0	LS	$ -	$ -	$ -	5%	$ -	$ -	$ -	$ -	$ -	3%	$ -	$ -
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	310	LF	$ 350	$ 108,500	$ 10,900	5%	$ 5,500	$ 124,900	$ 37,500	$ 162,400	$ 48,800	3%	$ 4,900	$ 217,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 713,800	$ 214,300	$ 928,100	$ 278,700		$ 28,000	**$1,237,000**
Outfall 26														
Pond, by Top Area	35000	SF	$ 20	$ 700,000	$ 70,000	5%	$ 35,000	$ 805,000	$ 241,500	$ 1,046,500	$ 314,000	3%	$ 31,400	$ 1,392,000
Pond Grading Adjustment (5% to 10% Slopes, Pond Cost +30%)	1	LS	$ 210,000	$ 210,000	$ 21,000	5%	$ 10,500	$ 241,500	$ 72,500	$ 314,000	$ 94,200	3%	$ 9,500	$ 418,000
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	440	LF	$ 350	$ 154,000	$ 15,400	5%	$ 7,700	$ 177,100	$ 53,200	$ 230,300	$ 69,100	3%	$ 7,000	$ 307,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 1,361,700	$ 408,700	$ 1,770,400	$ 531,300		$ 53,400	**$2,357,000**
Outfall 27														
Pond, by Top Area	4900	SF	$ 20	$ 98,000	$ 9,800	5%	$ 4,900	$ 112,700	$ 33,900	$ 146,600	$ 44,000	3%	$ 4,400	$ 195,000
Pond Grading Adjustment (<5%, No Adjustment)	0	LS	$ -	$ -	$ -	5%	$ -	$ -	$ -	$ -	$ -	3%	$ -	$ -
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	600	LF	$ 350	$ 210,000	$ 21,000	5%	$ 10,500	$ 241,500	$ 72,500	$ 314,000	$ 94,200	3%	$ 9,500	$ 418,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 492,300	$ 147,900	$ 640,200	$ 192,200		$ 19,400	**$853,000**
Outfall 28														
Pond, by Top Area	8100	SF	$ 20	$ 162,000	$ 16,200	5%	$ 8,100	$ 186,300	$ 55,900	$ 242,200	$ 72,700	3%	$ 7,300	$ 323,000
Pond Grading Adjustment (<5%, No Adjustment)	0	LS	$ -	$ -	$ -	5%	$ -	$ -	$ -	$ -	$ -	3%	$ -	$ -
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	610	LF	$ 350	$ 213,500	$ 21,400	5%	$ 10,700	$ 245,600	$ 73,700	$ 319,300	$ 95,800	3%	$ 9,600	$ 425,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000

							Subtotal	$ 570,000	$ 171,100	$ 741,100	$ 222,500		$ 22,400	$988,000
Outfall 29														
Pond, by Top Area	67100	SF	$ 20	$ 1,342,000	$ 134,200	5%	$ 67,100	$ 1,543,300	$ 463,000	$ 2,006,300	$ 601,900	3%	$ 60,200	$ 2,669,000
Pond Grading Adjustment (<5%, No Adjustment)	0	LS	$ -	$ -	$ -	5%	$ -	$ -	$ -	$ -	$ -	3%	$ -	$ -
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	830	LF	$ 350	$ 290,500	$ 29,100	5%	$ 14,600	$ 334,200	$ 100,300	$ 434,500	$ 130,400	3%	$ 13,100	$ 578,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 2,015,600	$ 604,800	$ 2,620,400	$ 786,300		$ 78,800	$3,487,000
Outfall 30														
Pond, by Top Area	46300	SF	$ 20	$ 926,000	$ 92,600	5%	$ 46,300	$ 1,064,900	$ 319,500	$ 1,384,400	$ 415,400	3%	$ 41,600	$ 1,842,000
Pond Grading Adjustment (<5%, No Adjustment)	0	LS	$ -	$ -	$ -	5%	$ -	$ -	$ -	$ -	$ -	3%	$ -	$ -
Pond Site Improvements Adjustment, Small to Medium Ponds (<80K SF)	1	LS	$ 75,000	$ 75,000	$ 7,500	5%	$ 3,800	$ 86,300	$ 25,900	$ 112,200	$ 33,700	3%	$ 3,400	$ 150,000
Pond Flow Control and Outlet Structure	1	EA	$ 30,000	$ 30,000	$ 3,000	5%	$ 1,500	$ 34,500	$ 10,400	$ 44,900	$ 13,500	3%	$ 1,400	$ 60,000
18-inch pipe	170	LF	$ 350	$ 59,500	$ 6,000	5%	$ 3,000	$ 68,500	$ 20,600	$ 89,100	$ 26,800	3%	$ 2,700	$ 119,000
Outfall Protection	1	EA	$ 15,000	$ 15,000	$ 1,500	5%	$ 800	$ 17,300	$ 5,200	$ 22,500	$ 6,800	3%	$ 700	$ 30,000
							Subtotal	$ 1,271,500	$ 381,600	$ 1,653,100	$ 496,200		$ 49,800	$2,201,000
Total McKernan Creek Stormwater (Conventional) Cost														$27,248,000
Total Stormwater (Conventional) Cost														$69,959,000

Sewer	Quantity	Unit	Unit Cost	Cost	Mob. (10%)	Traffic Control & ESC (%)	Traffic Control & ESC ($)	Construction Subtotal	Contingency (30%)	Engineering, Legal, Admin (30%)	Total Project Cost	Notes
CMSPS1												Includes costs for repair of existing road. Includes potential trenchless crossing of McKernan Creek and environmental permitting for bore and receiving pits.
8 inch PVC pipe up to 10 ft deep	1,087	LF	$280	$304,237	$30,424	5%	$15,212	$349,872	$104,962	$104,962	$559,795	
8 inch PVC pipe 10-20 ft deep	1,414	LF	$375	$530,208	$53,021	5%	$26,510	$609,739	$182,922	$182,922	$975,582	
10 inch PVC pipe up to 10 ft deep	357	LF	$350	$124,800	$12,480	5%	$6,240	$143,520	$43,056	$43,056	$229,633	
10 inch PVC pipe 10-20 ft deep	123	LF	$498	$61,310	$6,131	5%	$3,065	$70,506	$21,152	$21,152	$112,810	
15 inch PVC pipe up to 10 ft deep	330	LF	$400	$131,867	$13,187	5%	$6,593	$151,647	$45,494	$45,494	$242,635	
15 inch PVC pipe 10-20 ft deep	873	LF	$566	$494,183	$49,418	5%	$24,709	$568,310	$170,493	$170,493	$909,296	
Bore Pit/Receiving Pit Based on 20 FT deep	1	EA	$75,000	$75,000	$7,500	5%	$3,750	$86,250	$25,875	$25,875	$138,000	
Trenchless Pipe up to 24 inches Based on 20 ft deep	250	LF	$1,575	$393,750	$39,375	5%	$19,688	$452,813	$135,844	$135,844	$724,500	
Riparian Zone Permitting and Restoration	1	EA	$70,000	$70,000				$70,000			$70,000	
Standard 4 ft manhole up to 10 ft deep	8	EA	$10,000	$80,000	$8,000	5%	$4,000	$92,000	$27,600	$27,600	$147,200	
Standard 4 ft manhole 10-20 ft deep	13	EA	$15,000	$195,000	$19,500	5%	$9,750	$224,250	$67,275	$67,275	$358,800	
Arterial Road Repair	2,980	LF	$226	$673,510	$67,351	5%	$33,675	$774,536	$232,361	$232,361	$1,239,258	
								Subtotal			$5,708,000	
CMSPS2												Includes costs for repair of existing road.
15 inch PVC pipe 10-20 ft deep	899	LF	$566	$508,627	$50,863	5%	$25,431	$584,921	$175,476	$175,476	$935,873	
18 inch PVC pipe 10-20 ft deep	226	LF	$450	$101,655	$10,166	5%	$5,083	$116,903	$35,071	$35,071	$187,045	
18 inch PVC pipe greater than 20 ft deep	627	LF	$600	$376,013	$37,601	5%	$18,801	$432,415	$129,725	$129,725	$691,865	
Standard 4 ft manhole up to 10 ft deep	4	EA	$10,000	$40,000	$4,000	5%	$2,000	$46,000	$13,800	$13,800	$73,600	
Standard 4 ft manhole 10-20 ft deep	3	EA	$15,000	$45,000	$4,500	5%	$2,250	$51,750	$15,525	$15,525	$82,800	
Arterial Road Repair	220	LF	$226	$49,621	$4,962	5%	$2,481	$57,064	$17,119	$17,119	$91,303	
								Subtotal			$2,062,000	
CMSPS2A												
8 inch PVC pipe up to 10 ft deep	1,876	LF	$280	$525,216	$52,522	5%	$26,261	$603,999	$181,200	$181,200	$966,398	
8 inch PVC pipe 10-20 ft deep	81	LF	$375	$30,254	$3,025	5%	$1,513	$34,792	$10,437	$10,437	$55,666	
Standard 4 ft manhole up to 10 ft deep	7	EA	$10,000	$70,000	$7,000	5%	$3,500	$80,500	$24,150	$24,150	$128,800	
								Subtotal			$1,151,000	
CMSPS2B												Includes costs for repair of existing road.
8 inch PVC pipe up to 10 ft deep	922	LF	$280	$258,160	$25,816	5%	$12,908	$296,884	$89,065	$89,065	$475,014	
8 inch PVC pipe 10-20 ft deep	198	LF	$375	$74,250	$7,425	5%	$3,713	$85,388	$25,616	$25,616	$136,620	
Standard 4 ft manhole up to 10 ft deep	4	EA	$10,000	$40,000	$4,000	5%	$2,000	$46,000	$13,800	$13,800	$73,600	
Arterial Road Repair	1,120	LF	$226	$253,120	$25,312	5%	$12,656	$291,088	$87,326	$87,326	$465,741	
								Subtotal			$1,151,000	
CMSPS3												
8 inch PVC pipe up to 10 ft deep	3,530	LF	$280	$988,400	$98,840	5%	$49,420	$1,136,660	$340,998	$340,998	$1,818,656	
8 inch PVC pipe 10-20 ft deep	2,186	LF	$375	$819,750	$81,975	5%	$40,988	$942,713	$282,814	$282,814	$1,508,340	
10 inch PVC pipe 10-20 ft deep	398	LF	$498	$198,204	$19,820	5%	$9,910	$227,935	$68,380	$68,380	$364,695	
Standard 4 ft manhole up to 10 ft deep	13	EA	$10,000	$130,000	$13,000	5%	$6,500	$149,500	$44,850	$44,850	$239,200	
Standard 4 ft manhole 10-20 ft deep	7	EA	$15,000	$105,000	$10,500	5%	$5,250	$120,750	$36,225	$36,225	$193,200	
								Subtotal			$4,124,000	
CMSPS3A												
8 inch PVC pipe up to 10 ft deep	533	LF	$280	$149,240	$14,924	5%	$7,462	$171,626	$51,488	$51,488	$274,602	
Standard 4 ft manhole up to 10 ft deep	2	EA	$10,000	$20,000	$2,000	5%	$1,000	$23,000	$6,900	$6,900	$36,800	
								Subtotal			$311,000	
CMSPS4												Includes cost of potential trenchless crossing of McKernan Creek and environmental permitting for bore and receiving pits.
8 inch PVC pipe 10-20 ft deep	4,088	LF	$375	$1,533,000	$153,300	5%	$76,650	$1,762,950	$528,885	$528,885	$2,820,720	
Standard 4 ft manhole 10-20 ft deep	13	EA	$15,000	$195,000	$19,500	5%	$9,750	$224,250	$67,275	$67,275	$358,800	
Bore Pit/Receiving Pit Based on 20 FT deep	1	EA	$75,000	$75,000	$7,500	5%	$3,750	$86,250	$25,875	$25,875	$138,000	
Trenchless Pipe up to 24 inches Based on 20 ft deep	200	LF	$1,575	$315,000	$31,500	5%	$15,750	$362,250	$108,675	$108,675	$579,600	
Riparian Zone Permitting and Restoration	1	EA	$70,000	$70,000				$70,000			$70,000	
								Subtotal			$3,967,000	
CMSPS5												

Sewer	Quantity	Unit	Unit Cost	Cost	Mob. (10%)	Traffic Control & ESC (%)	Traffic Control & ESC ($)	Construction Subtotal	Contingency (30%)	Engineering, Legal, Admin (30%)	Total Project Cost	Notes
8 inch PVC pipe up to 10 ft deep	864	LF	$280	$241,920	$24,192	5%	$12,096	$278,208	$83,462	$83,462	$445,133	
8 inch PVC pipe 10-20 ft deep	810	LF	$375	$303,750	$30,375	5%	$15,188	$349,313	$104,794	$104,794	$558,900	
8 inch PVC pipe greater than 20 ft deep	138	LF	$475	$65,550	$6,555	5%	$3,278	$75,383	$22,615	$22,615	$120,612	
Standard 4 ft manhole up to 10 ft deep	3	EA	$10,000	$30,000	$3,000	5%	$1,500	$34,500	$10,350	$10,350	$55,200	
Standard 4 ft manhole 10-20 ft deep	3	EA	$15,000	$45,000	$4,500	5%	$2,250	$51,750	$15,525	$15,525	$82,800	
Standard 4 ft manhole greater than 20 ft deep	1	EA	$25,000	$25,000	$2,500	5%	$1,250	$28,750	$8,625	$8,625	$46,000	
								Subtotal			$1,309,000	
CMSPS6												
8 inch PVC pipe up to 10 ft deep	2,536	LF	$280	$710,080	$71,008	5%	$35,504	$816,592	$244,978	$244,978	$1,306,547	Includes costs for repair of existing road.
8 inch PVC pipe greater than 20 ft deep	1,780	LF	$475	$845,500	$84,550	5%	$42,275	$972,325	$291,698	$291,698	$1,555,720	
Standard 4 ft manhole up to 10 ft deep	18	EA	$10,000	$180,000	$18,000	5%	$9,000	$207,000	$62,100	$62,100	$331,200	
Standard 4 ft manhole greater than 20 ft deep	6	EA	$25,000	$150,000	$15,000	5%	$7,500	$172,500	$51,750	$51,750	$276,000	
Arterial Road Repair	4,316	LF	$226	$975,416	$97,542	5%	$48,771	$1,121,728	$336,519	$336,519	$1,794,765	
								Subtotal			$5,264,000	
SSMH0004981												
8 inch PVC pipe up to 10 ft deep	294	LF	$280	$82,446	$8,245	5%	$4,122	$94,813	$28,444	$28,444	$151,701	Includes costs for environmental permitting for alignments within the riparian zone.
8 inch PVC pipe 10-20 ft deep	294	LF	$375	$110,419	$11,042	5%	$5,521	$126,982	$38,094	$38,094	$203,171	
Standard 4 ft manhole up to 10 ft deep	1	EA	$10,000	$10,000	$1,000	5%	$500	$11,500	$3,450	$3,450	$18,400	
Standard 4 ft manhole 10-20 ft deep	1	EA	$15,000	$15,000	$1,500	5%	$750	$17,250	$5,175	$5,175	$27,600	
Clearing and Grubbing	0.34	AC	$2,500	$850	$85	5%	$43	$978	$293	$293	$1,564	
Riparian Zone Permitting and Restoration	1	EA	$70,000	$70,000				$70,000			$70,000	
								Subtotal			$472,000	
SSMH0005288												
8 inch PVC pipe up to 10 ft deep	592	LF	$280	$165,760	$16,576	5%	$8,288	$190,624	$57,187	$57,187	$304,998	Includes costs for repair of existing road.
8 inch PVC pipe 10-20 ft deep	1,549	LF	$375	$580,875	$58,088	5%	$29,044	$668,006	$200,402	$200,402	$1,068,810	
Standard 4 ft manhole up to 10 ft deep	2	EA	$10,000	$20,000	$2,000	5%	$1,000	$23,000	$6,900	$6,900	$36,800	
Standard 4 ft manhole 10-20 ft deep	8	EA	$15,000	$120,000	$12,000	5%	$6,000	$138,000	$41,400	$41,400	$220,800	
Arterial Road Repair	2,141	LF	$226	$483,866	$48,387	5%	$24,193	$556,446	$166,934	$166,934	$890,313	
								Subtotal			$2,522,000	
SSMH0004814												
8 inch PVC pipe up to 10 ft deep	392	LF	$280	$109,760	$10,976	5%	$5,488	$126,224	$37,867	$37,867	$201,958	Includes costs for potential trenchless crossing of Creek and environmental permitting for bore and receiving pits.
8 inch PVC pipe 10-20 ft deep	2,147	LF	$375	$805,125	$80,513	5%	$40,256	$925,894	$277,768	$277,768	$1,481,430	
Bore Pit/Receiving Pit Based on 20 FT deep	1	EA	$75,000	$75,000	$7,500	5%	$3,750	$86,250	$25,875	$25,875	$138,000	
Trenchless Pipe up to 24 inches Based on 20 ft deep	100	LF	$1,575	$157,500	$15,750	5%	$7,875	$181,125	$54,338	$54,338	$289,800	
Standard 4 ft manhole up to 10 ft deep	1	EA	$10,000	$10,000	$1,000	5%	$500	$11,500	$3,450	$3,450	$18,400	
Standard 4 ft manhole 10-20 ft deep	7	EA	$15,000	$105,000	$10,500	5%	$5,250	$120,750	$36,225	$36,225	$193,200	
Clearing and Grubbing	0.61	AC	$2,500	$1,525	$153	5%	$76	$1,754	$526	$526	$2,806	
Riparian Zone Permitting and Restoration	1	EA	$70,000	$70,000				$70,000			$70,000	
								Subtotal			$2,396,000	
SSMH0004844												
8 inch PVC pipe up to 10 ft deep	907	LF	$280	$253,960	$25,396	5%	$12,698	$292,054	$87,616	$87,616	$467,286	Includes costs for repair of existing road.
8 inch PVC pipe 10-20 ft deep	981	LF	$375	$367,875	$36,788	5%	$18,394	$423,056	$126,917	$126,917	$676,890	
Standard 4 ft manhole up to 10 ft deep	4	EA	$10,000	$40,000	$4,000	5%	$2,000	$46,000	$13,800	$13,800	$73,600	
Standard 4 ft manhole 10-20 ft deep	3	EA	$15,000	$45,000	$4,500	5%	$2,250	$51,750	$15,525	$15,525	$82,800	
Clearing and Grubbing	0.15	AC	$2,500	$375	$38	5%	$19	$431	$129	$129	$690	
Local Road Repair	1,618	LF	$59	$95,462	$9,546	5%	$4,773	$109,781	$32,934	$32,934	$175,650	
								Subtotal			$1,477,000	
SSCO0000551												
8 inch PVC pipe up to 10 ft deep	249	LF	$280	$69,720	$6,972	5%	$3,486	$80,178	$24,053	$24,053	$128,285	
8 inch PVC pipe 10-20 ft deep	249	LF	$375	$93,375	$9,338	5%	$4,669	$107,381	$32,214	$32,214	$171,810	
Standard 4 ft manhole up to 10 ft deep	1	EA	$10,000	$10,000	$1,000	5%	$500	$11,500	$3,450	$3,450	$18,400	
Standard 4 ft manhole 10-20 ft deep	1	EA	$15,000	$15,000	$1,500	5%	$750	$17,250	$5,175	$5,175	$27,600	

Sewer	Quantity	Unit	Unit Cost	Cost	Mob. (10%)	Traffic Control & ESC (%)	Traffic Control & ESC ($)	Construction Subtotal	Contingency (30%)	Engineering, Legal, Admin (30%)	Total Project Cost	Notes
Clearing and Grubbing	0.29	AC	$2,500	$725	$73	5%	$36	$834	$250	$250	$1,334	
								Subtotal			$347,000	
SSMH0008718												
8 inch PVC pipe up to 10 ft deep	1,026	LF	$280	$287,280	$28,728	5%	$14,364	$330,372	$99,112	$99,112	$528,595	Includes costs for repair of existing road.
8 inch PVC pipe 10-20 ft deep	131	LF	$375	$49,125	$4,913	5%	$2,456	$56,494	$16,948	$16,948	$90,390	
Standard 4 ft manhole up to 10 ft deep	4	EA	$10,000	$40,000	$4,000	5%	$2,000	$46,000	$13,800	$13,800	$73,600	
Clearing and Grubbing	0.30	AC	$2,500	$750	$75	5%	$38	$863	$259	$259	$1,380	
Local Road Repair	634	LF	$59	$37,406	$3,741	5%	$1,870	$43,017	$12,905	$12,905	$68,827	
								Subtotal			$763,000	
SSMH0008365												
8 inch PVC pipe up to 10 ft deep	2,692	LF	$280	$753,760	$75,376	5%	$37,688	$866,824	$260,047	$260,047	$1,386,918	Includes costs for repair of existing road.
8 inch PVC pipe 10-20 ft deep	1,231	LF	$375	$461,625	$46,163	5%	$23,081	$530,869	$159,261	$159,261	$849,390	
Standard 4 ft manhole up to 10 ft deep	12	EA	$10,000	$120,000	$12,000	5%	$6,000	$138,000	$41,400	$41,400	$220,800	
Standard 4 ft manhole 10-20 ft deep	4	EA	$15,000	$60,000	$6,000	5%	$3,000	$69,000	$20,700	$20,700	$110,400	
Arterial Road Repair	1,360	LF	$226	$307,360	$30,736	5%	$15,368	$353,464	$106,039	$106,039	$565,542	
Local Road Repair	836	LF	$59	$49,324	$4,932	5%	$2,466	$56,723	$17,017	$17,017	$90,756	
								Subtotal			$3,224,000	
SCM_West												
8 inch PVC pipe up to 10 ft deep	1,292	LF	$280	$361,760	$36,176	5%	$18,088	$416,024	$124,807	$124,807	$665,638	
Standard 4 ft manhole up to 10 ft deep	7	EA	$10,000	$70,000	$7,000	5%	$3,500	$80,500	$24,150	$24,150	$128,800	
								Subtotal			$794,000	
								Total Sewer Cost			$ 37,042,000	

Potable	Quantity	Unit	Unit Cost	Cost	Mob. (10%)	Traffic Control & ESC (%)	Traffic Control & ESC ($)	Construction Subtotal	Contingency (30%)	Engineering, Legal, Admin (30%)	Total Project Cost	Notes
Upper Zones												
930 Zone												
18-inch Pipe	1,100	LF	$655	$720,500	$72,050	5%	$36,025	$830,000	$250,000	$250,000	$1,400,000	
12-inch Pipe	7,900	LF	$560	$4,424,000	$442,400	5%	$221,200	$5,090,000	$1,530,000	$1,530,000	$8,200,000	
Arterial Road Repair	5,200	LF	$226	$1,175,200	$117,520	5%	$58,760	$1,360,000	$410,000	$410,000	$2,200,000	
850 Zone												
12-inch Pipe	6,100	LF	$560	$3,416,000	$341,600	5%	$170,800	$3,930,000	$1,180,000	$1,180,000	$6,290,000	
PRV Station	3	EA	$200,000	$600,000	$60,000	5%	$30,000	$690,000	$210,000	$210,000	$1,110,000	
Arterial Road Repair	3,300	LF	$226	$745,800	$74,580	5%	$37,290	$860,000	$260,000	$260,000	$1,380,000	
Upper BPS (4,000 gpm)	1	LS	--	$1,600,000	$160,000	0%	$0	$1,760,000	$600,000	$600,000	$3,000,000	Pumps,MCC, Electrical, Mechanical, Controls
								Subtotal			$23,580,000	
Middle Zones												
794 Zone												
24-inch Pipe	3,200	LF	$775	$2,480,000	$248,000	5%	$124,000	$2,860,000	$860,000	$860,000	$4,580,000	
18-inch Pipe	700	LF	$655	$458,500	$45,850	5%	$22,925	$530,000	$160,000	$160,000	$850,000	
12-inch Pipe	9,000	LF	$560	$5,040,000	$504,000	5%	$252,000	$5,800,000	$1,740,000	$1,740,000	$9,280,000	
PRV Station	3	EA	$200,000	$600,000	$60,000	5%	$30,000	$690,000	$210,000	$210,000	$1,110,000	
Bridge Crossing	300	LF	$500	$150,000	$15,000	5%	$7,500	$180,000	$60,000	$60,000	$300,000	
Local Road Repair	4,100	LF	$112	$459,200	$45,920	5%	$22,960	$530,000	$160,000	$160,000	$850,000	
750 Zone												
12-inch Pipe	1,200	LF	$560	$672,000	$67,200	5%	$33,600	$780,000	$240,000	$240,000	$1,260,000	
PRV Station	2	EA	$200,000	$400,000	$40,000	5%	$20,000	$460,000	$140,000	$140,000	$740,000	
Local Road Repair	300	LF	$112	$33,600	$3,360	5%	$1,680	$40,000	$20,000	$20,000	$80,000	
675 Zone												
12-inch Pipe	12,500	LF	$560	$7,000,000	$700,000	5%	$350,000	$8,050,000	$2,420,000	$2,420,000	$12,890,000	
PRV Station	2	EA	$200,000	$400,000	$40,000	5%	$20,000	$460,000	$140,000	$140,000	$740,000	
Local Road Repair	2,400	LF	$112	$268,800	$26,880	5%	$13,440	$310,000	$100,000	$100,000	$510,000	
CMR 3 BPS (3,900 gpm)	1	LS	--	$2,800,000	$280,000	5%	$140,000	$3,220,000	$970,000	$970,000	$5,160,000	
								Subtotal			$38,350,000	
Lower Zones												
550 Zone												
24-inch Pipe	7,400	LF	$775	$5,735,000	$573,500	5%	$286,750	$6,600,000	$1,980,000	$1,980,000	$10,560,000	
18-inch Pipe	1,000	LF	$655	$655,000	$65,500	5%	$32,750	$760,000	$230,000	$230,000	$1,220,000	
12-inch Pipe	5,900	LF	$560	$3,304,000	$330,400	5%	$165,200	$3,800,000	$1,140,000	$1,140,000	$6,080,000	
PRV Station	2	EA	$200,000	$400,000	$40,000	5%	$20,000	$460,000	$140,000	$140,000	$740,000	
Arterial Road Repair	1,000	LF	$226	$226,000	$22,600	5%	$11,300	$260,000	$80,000	$80,000	$420,000	
Local Road Repair	2,200	LF	$112	$246,400	$24,640	5%	$12,320	$290,000	$90,000	$90,000	$470,000	
470 Zone												
18-inch Pipe	3,700	LF	$655	$2,423,500	$242,350	5%	$121,175	$2,790,000	$840,000	$840,000	$4,470,000	
12-inch Pipe	7,300	LF	$560	$4,088,000	$408,800	5%	$204,400	$4,710,000	$1,420,000	$1,420,000	$7,550,000	
PRV Station	2	EA	$200,000	$400,000	$40,000	5%	$20,000	$460,000	$140,000	$140,000	$740,000	
Bore Pit/Receiving Pit Based on 20 ft deep	2	EA	$75,000	$150,000	$15,000	5%	$7,500	$180,000	$60,000	$60,000	$300,000	
Trenchless Pipe up to 24-inch Based on 20 ft deep	350	LF	$1,575	$551,250	$55,125	5%	$27,563	$640,000	$200,000	$200,000	$1,040,000	potential trenchless crossing of McKernan creek at Grabhorn Rd and trail crossing
Vegtated Corridor Permitting and Restoration	2	EA	$70,000	$140,000	-	0%	$0	$140,000	-	-	$140,000	
Arterial Road Repair	4,200	LF	$226	$949,200	$94,920	5%	$47,460	$1,100,000	$330,000	$330,000	$1,760,000	
Local Road Repair	400	LF	$112	$44,800	$4,480	5%	$2,240	$60,000	$20,000	$20,000	$100,000	
West BPS (3,100 gpm)	1	LS	--	$2,600,000	$260,000	5%	$130,000	$2,990,000	$900,000	$900,000	$4,790,000	
West BPS Property Acquisition	21,780	SF	$15	$326,700	--	--	--	$326,700	$100,000	--	$430,000	0.5 acre BPS Site
								Subtotal			$40,810,000	

Potable	Quantity	Unit	Unit Cost	Cost	Mob. (10%)	Traffic Control & ESC (%)	Traffic Control & ESC ($)	Construction Subtotal	Contingency (30%)	Engineering, Legal, Admin (30%)	Total Project Cost	Notes
City-Wide Capacity and Storage												
CMR 3 Reservoir (5.0 MG)	1	LS	--	$13,500,000	$1,350,000	5%	$680,000	$15,530,000	$4,700,000	$4,700,000	$24,930,000	
CMR 3 Property Acquisition	217,800	SF	$15	$3,267,000	--	--	--	$3,267,000	$1,000,000	--	$4,270,000	5 acre Reservoir Site
CMR 3 Site ASR	1	LS	--	$7,000,000	$700,000	5%	$350,000	$8,050,000	$2,500,000	$2,500,000	$13,050,000	
Tile Flat BPS (3,900 gpm)	1	LS	--	$2,800,000	$280,000	5%	$140,000	$3,220,000	$1,000,000	$1,000,000	$5,220,000	
Tile Flat BPS Property Acquisition	21,780	SF	$15	$326,700	--	--	--	$326,700	$100,000	--	$430,000	0.5 acre BPS Site
ASR 7A (CMR 1&2 Site)	1	LS	--	--	--	--	--	--	--	--	$6,412,000	City provided project (includes design, permitting, contingency)
								Subtotal			$54,312,000	
								Total Potable Cost			$157,052,000	

Non-Potable	Quantity	Unit	Unit Cost	Cost	Mob. (10%)	Traffic Control & ESC (%)	Traffic Control & ESC ($)	Construction Subtotal	Contingency (30%)	Engineering, Legal, Admin (30%)	Total Project Cost	Notes
NP 520 Zone												
8-inch Pipe	5500	LF	$484	$2,662,000	$266,200	5%	$133,100	$3,070,000	$921,000	$921,000	$4,920,000	
6-inch Pipe	1100	LF	$442	$486,200	$48,620	5%	$24,310	$560,000	$168,000	$168,000	$900,000	
Potable Intertie	1	EA	$250,000	$250,000	$25,000	5%	$12,500	$290,000	$87,000	$87,000	$470,000	
								Subtotal			$6,290,000	
NP 410 Zone												
8-inch Pipe	2400	LF	$484	$1,161,600	$116,160	5%	$58,080	$1,340,000	$402,000	$402,000	$2,150,000	
6-inch Pipe	8400	LF	$442	$3,712,800	$371,280	5%	$185,640	$4,270,000	$1,281,000	$1,281,000	$6,840,000	
Bore Pit/Receiving Pit Based on 20 FT deep	2	EA	$75,000	$150,000	$15,000	5%	$7,500	$180,000	$54,000	$54,000	$290,000	
Trenchless Pipe up to 24-inch Based on 20 ft deep	350	LF	$1,575	$551,250	$55,125	5%	$27,563	$640,000	$192,000	$192,000	$1,030,000	potential trenchless crossing of McKernan creek at Grabhorn Rd and trail crossing
Vegtated Corridor Permitting and Restoration	2	EA	$70,000	$140,000	-	0%	$0	$140,000	-	-	$140,000	
PRV	2	EA	$200,000	$400,000	$40,000	5%	$20,000	$460,000	$138,000	$138,000	$740,000	
Arterial Road Repair	4200	LF	$226	$949,200	$94,920	5%	$47,460	$1,100,000	$330,000	$330,000	$1,760,000	
								Subtotal			$12,950,000	
								Total Non-Potable Cost			$19,240,000	