Storm Drainage/Surface Water Management Master Plan

City of Cornelius

May 2004

Final Report

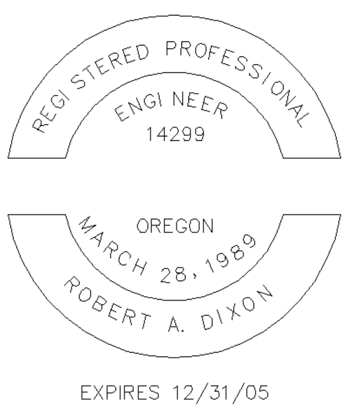
Updated and Revised by
Cornelius Development and Operations Department
And
Cornelius Public Works Committee

Adopted by Cornelius City Council, 6/7/04, Ordinance 850

Certificate of Engineer

City of Cornelius
Storm Drainage/Surface Water Management Master Plan
May 2004

The material and data contained in this report were prepared under the direction and supervision of the undersigned, whose seal as a professional engineer, licensed to practice in the State of Oregon, is affixed below.



Robert A. Dixon, P.E.
Oregon No. 14299 PE

City Engineer
Cornelius, Oregon

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The City of Cornelius is located in western Washington County, within the Portland metropolitan area. The city is bounded on the north, south, and east by Council Creek, the Tualatin River, and tributaries to each of these major drainages. Approximately 240 acres remain vacant within the city's 1,200 acres. Under the Metro 2040 plan, the City has provided for a 20-year supply of developable land within the Urban Growth Boundary.

A storm sewer master plan is needed by the City to provide staff a tool to guide development within the City. We have incorporated the following objectives into this master plan:

- Provide solutions to the existing problems of flooding and inadequate storm drainage systems.
- Guide expansion and extension of the storm sewer system to serve future growth.
- Provide a review of the current funding for the storm sewer program and define possible funding options.

The base model for the storm sewer master plan is the existing storm sewer system, as of April 2000. The Oregon Department of Transportation (ODOT) and Clean Water Services (CWS, formerly Unified Sewerage Agency or USA) each have jurisdiction over portions of the Cornelius storm sewer system. In order to satisfy the design requirements of these agencies, both the Rational Method and the SCS Urban Hydrograph, have been used to calculate the runoff created by the appropriate design storms. The capacity of the existing pipe system to carry the calculated runoff has been computed using the Manning's Formula for pipe capacity. All of the system modeling and analysis has been run under the HYDRA software program from Pfizer, Inc.

The first analysis in this study evaluates the capacity of the existing system to carry runoff from existing development conditions. The second analysis in this study evaluates the capacity of the existing system to carry runoff from full development conditions. A baseline indicator of 200 percent of capacity is used to evaluate where problem areas are within the existing system. In most cases, problem areas are related to current development conditions. Additional runoff due to full development conditions was found to produce minimal upsizing needs. The worst problem areas within the City storm sewer system are summarized below.

<u>Tarrybrooke Basin</u>
The Tarrybrooke storm sewer system drains most of the western side of Cornelius and a portion of Forest Grove. Minor improvements have been made within this basin recently to accommodate the full development condition. These include Tarrybrooke Park, Emmaus Christian School and South First Avenue improvements. Additionally, the storm line in S. Heather street serving Neil

Armstrong School and Cornelius was upsized to 30" as part of the Joint Water Commission's NTL2B 72" waterline construction in 2002. These improvements have provided a proportionate improvement to the down stream reaches of the Tarrybrooke Basin, but the majority of the upstream system remains significantly under capacity. The recommended solution is option 1c at an estimated cost of $580,601.

Central Cornelius Basin

The Central Cornelius storm sewer basin is located east of Tarrybrooke basin and serves the original areas of Cornelius. As is often the case in older sections of towns, the infrastructure is not sized to carry current or future development loadings. Two main trunk storm sewers from separate areas along Baseline Street to a point at South 12th Avenue and Dogwood Street. Both are undersized to accommodate existing development. The western trunk is further complicated by parallel systems to handle the extra runoff. The recommended fix is to replace both of these trunk lines with new systems. Designing the systems with consistent slopes may minimize the pipe diameters needed. The replacement of both trunk storm sewer systems is estimated at $1.29 million.

19th Avenue Basin

The 19th Avenue basin is located east of the Central Cornelius basin. The main trunk of the storm sewer in this basin is also undersized for current development south of Baseline Street. The recommended trunk option has an estimated cost of $906,763.

As stated previously, this master plan also provides recommendations on accommodating future development in both piped storm sewers and water quality facilities. Major areas of storm sewer improvement related to development are located along North Adair Avenue and Baseline Street. Existing roadside ditches will need to be replaced with a piped storm system to accommodate frontage improvements such as bike lanes and sidewalks.

The City of Cornelius does not currently own or maintain regional water quality facilities. The following three locations and types of improvements have been identified in the master plan:

- Simply Organic Nursery at South 12th Avenue and Elder Street
- Steamboat Park at the end of South 15th Court
- Orchard Park at the end of South 15th Avenue

The total cost of all recommended capital improvements is approximately $5.75 million, including improvements necessary for estimated future development. At the current revenue levels, the City can only make minor improvements to the existing system to accommodate existing development conditions. The recommended projects have been prioritized emphasizing lines that are at 200% of capacity or more, the potential to enhance economic development, opportunity to partner with private development, and the location of the line hydraulically in its drainage basin.

To determine the best options to fund the recommended improvements, a comprehensive utilities rate study for water, sewer, and storm drainage is scheduled for late Summer 2004. This comprehensive study will evaluate utility system Master Plans, utility Operational and Equipment Plans, and the ability to fund these plans at current monthly user rates and SDC rates. All three utilities, water, sewer, and storm drainage, will be evaluated at the same time. Where rates are insufficient, the study will recommend various financial alternatives for the City Council's consideration.

CHAPTER 1
INTRODUCTION

1.1 Introduction

The City of Cornelius (City) retained LDC Design Group, Inc. (LDC) to prepare an updated storm drainage/surface water management (SD/SWM) master plan to inventory and evaluate the existing SD/SWM system and plan for its sustainability and its projected growth. The LDC effort resulted in the "Storm Drainage/Surface Water Management Master Plan for the City of Cornelius, October 25, 2001" (LDC 2001 Report). The LDC 2001 Report was never adopted by the Cornelius City Council. The Cornelius Development and Operations Department, the Cornelius Public Works Committee, and the Cornelius Planning Commission have updated and made minor modifications to the LDC 2001 Report to produce the Storm Drainage/Surface Water Management Master Plan for the City of Cornelius, May 2004, Final Report (2004 Plan). The most significant changes to the LDC 2001 Report involve changes to the recommended capital improvement plan reflecting improvements made since 2001 and updating the major options (projects) costs to 2004 dollars. The planning period for the 2004 Plan is 20 years, through to 2024.

1.2 Authorization

The 2004 Plan has been prepared under the authority of the Cornelius City Council with supervision and review by the Cornelius Public Works Committee and the Cornelius Planning Commission.

1.3 Study Objectives

In coordination with the City staff the following objectives have been identified for this study:

- Inventory the existing SD/SWM system.
- Evaluate the existing SD/SWM system for current and projected future needs.
- Provide a plan for the SD/SWM system's sustainability and projected expansion.

1.4 Study Scope

The scope of work is divided into the following work items:

1. Development of an inventory of existing drainage facilities within the study area.
2. Development of design criteria for analysis of existing facilities and design for future facilities.
3. Analysis of the existing system under existing and future development conditions.
4. Development of a plan showing the recommended improvements to the storm drainage system incorporating existing facilities wherever possible.
5. Preparation of cost estimates for the recommended improvements.
6. Integration of the most beneficial storm sewer improvements into a Capital Improvement Program.
7. Analysis of the current funding structure and recommendations for additional options.
8. Preparation of a storm drainage/surface water management master plan.

CHAPTER 2
STUDY AREA

2.1 Study Area

The City of Cornelius is situated in western Washington County, in the Tualatin River Valley. Cornelius is located three miles west of Hillsboro, the County seat, and twenty-five miles southwest of Portland (see Figure 2-1). The population of the City has grown from 6,148 in 1990 to 9,652 in 2000, an increase of 57 percent.

Based on certified census results on July 1, 2000, and the Portland State University 2003 estimate, the City's projected population for 2004 is 10,450. Assuming a slow to moderate growth rate yields a 2024 population of 20,000. The intermediate population projections are: 2009-12,000; 2014-14,000; and 2019-16,500. However, to accommodate this growth, the UGB will have to extend beyond its current boundary.

The study area is wholly contained within the current urban growth boundary (UGB) as established in the comprehensive plan (see Figure 2-2). The City of Cornelius UGB contains approximately 1,260 acres.

The study area is drained by Council Creek and an unnamed tributary, Job's ditch (a tributary to the Tualatin River), and the Tualatin River.

Major transportation routes that affect the study area are the Tualatin Valley Highway, the Oregon Electric Railroad (OERR) right-of-way, located north of the Tualatin Valley Highway, and the Southern Pacific Railroad right-of-way (SPRR), located south of the Tualatin Valley Highway.

2.2 Topography

The City of Cornelius is located in the flat lowlands of western Tualatin Valley. The topography of the area is characterized by a wide expanse of flat land averaging 170 feet in elevation. The elevations vary from 180 feet at the OERR right-of-way to 150 feet at the waterways.

The study area slopes to the north, south, and west toward the surrounding waterways. The area slopes at an average grade of 0.8 percent, from 180 feet to 150 feet in a distance of 3500 feet.

2.3 Floodplain

The approximate 100-year floodplain elevation for the waterways are listed in Table 2-1:

Table 2-1 Floodplain Elevation (1)	
Waterway	**Floodplain Elevation (Feet)**
Council Creek and Unnamed Tributary	151
Job's Ditch	146
Tualatin River	153 - 148

(1) Federal Emergency Management Agency, Flood Insurance Rate Map, 1982.

2.4 Geology

The City of Cornelius lies on a terrace in the Tualatin River Basin. This terrace is made up of alluvial material of clay, silt, fine sand, and few gravel beds and lenses ranging in depth from 30 feet to 1400 feet.

Soils found within the study area are mostly Aloha, Quatama, and Woodburn series silt and clay loams. The Aloha series consists of somewhat poorly drained soils that formed in alluvium or lacustrine silt on broad valley terraces. The Quatama series consists of moderately well drained soils that formed in mixed, loamy alluvium on old terraces. The Woodburn series consists of moderately well drained soils that formed in old alluvium on low, broad valley terraces. These soil types exhibit high seasonal water tables, poor permeability, saturate easily, and can cause appreciable runoff from undeveloped lands. These soils are acidic in nature and may be moderately corrosive to concrete pipes.

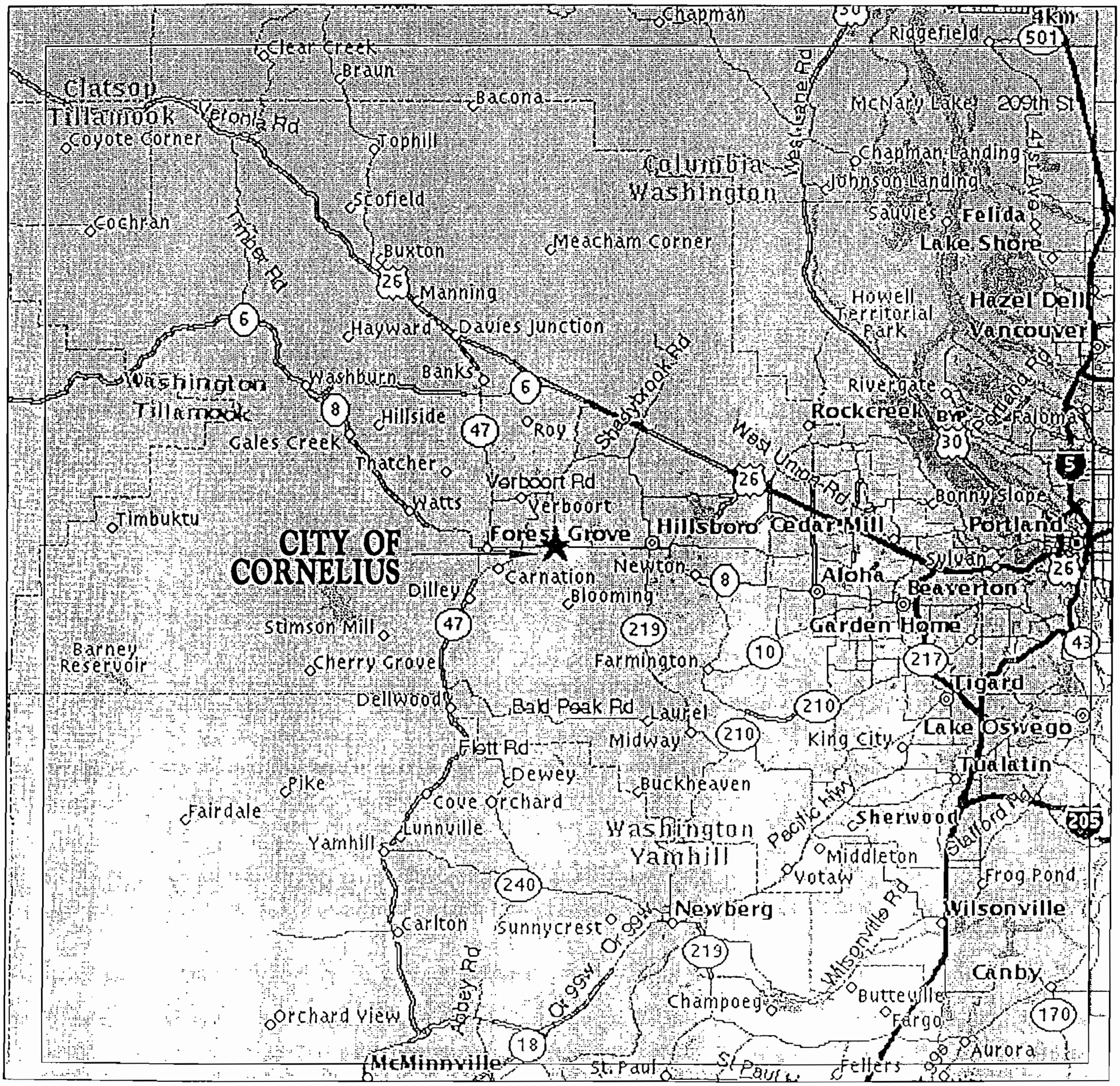
Ground water normally occurs at an elevation of approximately 4 feet below ground surface. Dry wells have not been a satisfactory option in the City.

CITY OF CORNELIUS

GEOGRAPHIC LOCATION

(NOT TO SCALE)

2-1



PREPARED FOR:

CITY OF CORNELIUS
PUBLIC WORKS
1300 SOUTH KODIAK CIRCLE
CORNELIUS, OREGON 97113
PHONE: (503) 357-3011

IDC Design Group Inc.
Planners Engineers Surveyors
3300 N.W. 211th TERRACE
HILLSBORO, OREGON 97124
PHONE: (503) 858-4242
FAX: (503) 645-5500
www.idcdesign.com

DRAWING TITLE:

CITY OF CORNELIUS
GEOGRAPHIC LOCATION

CADFILE: 0005EX03.dwg

JOB NO.: 3-0005

DRAWING NO. 1 OF 1

FIGURE 2-2

CITY OF CORNELIUS
PUBLIC WORKS DEPARTMENT
1300 SOUTH KODIAK CIRCLE
CORNELIUS, OR 97113
(503) 357-3011

CITY OF CORNELIUS
STORM SEWER
MASTER PLAN
INDEX MAP

CITY OF CORNELIUS
GROWTH BOUNDARY

IDC Design Group Inc.
Planners
Engineers
Surveyors
3300 N.W. 211TH TERRACE
HILLSBORO, OREGON 97124
PHONE:(503) 858-4242
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2-2

2.5 Climate

The City of Cornelius is located approximately 45 miles inland from the Pacific Ocean. Seasonal changes are gradual; however, the characteristics of each season are well defined. The average daily temperature ranges from 44°F to 82°F; record temperatures range from -18°F to 108°F. The average annual rainfall recorded at a Washington County Valley Flood station is forty-two (42) inches. Seventy-four (74) percent of the average annual precipitation occurs between September and March. Snowfall is infrequent and seldom remains on the ground for more than a few days.

2.6 Land Use and Urban Growth Boundary

The City of Cornelius has 1,213 gross acres of land within the City limits. The urban growth boundary (UGB) contains an additional 47 developable acres. At the present time, it is estimated that only 244 acres (20%) of vacant land remain within the City limits for future development. The majority of the available land within the City is zoned commercial and industrial; the undeveloped land outside the City and inside the UGB is zoned residential. No substantial increase in the UGB is anticipated for the next five to ten years.

In order to comply with the METRO Regional Growth Management Framework (the 2040 plan), the City of Cornelius has recently revised its Comprehensive Plan to accommodate intensification of development within the constrained UGB to minimize consumption of rural resource lands. Minimum density requirements in residential zones have been established. A Main Street District has been created and more intense mixed uses are being allowed. Zoning requirements are being adjusted to accommodate in-fill development on remnant parcels.

Table 2-2 provides a listing of the current zones and zoning requirements within the study area.

Table 2-2 City of Cornelius Land Use and Zoning Districts		
Zone	**Code Reference**	**Zoning Requirements**
Multi-Family Residential A-2	11.20.30	Maximum Density = 14 dwellings/ net acre (1) Minimum Lot = 3,100 ft^2 single family Minimum Lot = 2,330 ft^2 per multiple family unit Maximum Lot Coverage = 55%
Highway Commercial C-2	11.20.50	No Minimum Lot Size
General Industrial M-1	11.20.70	No Minimum Lot Size
Mobile Home Park MHP	11.20.20	Average Density = 10 dwellings/ gross acre 20 % Landscaping per Gross Acre
Single Family Residential R-7	11.20.00	Maximum Density = 5 dwellings/net acre[1] Minimum Lot = 6,000 ft^2
Core Commercial-Employment CE	11.20.60	20 % Landscaping

(1) A net acre excludes roads, open space, flood plains, riparian setbacks, and slopes greater than 25%. A net acre is equivalent to 32,670 square feet.

Main Street District		
Civic (MSC)	11.20.80C	No Minimum Lot Size 10% Landscaping per Lot
General Employment (MSGE)	11.20.80GE	No Minimum Lot Size 10% Landscaping per Lot
Mixed Use (MSMU)	11.20.80MU	No Minimum Lot Size 10% Landscaping per Lot
Retail (MSRC)	11.20.80RC	No Minimum Lot Size 10% Landscaping per Lot

CHAPTER 3
ANALYSIS AND DESIGN CRITERIA

3.1 General Master Plan Data

3.1.1 Computer Modeling

The computer software program HYDRA by Pizer, Inc. has been utilized for the Cornelius hydrologic and hydraulic calculations. HYDRA is a command driven DOS program that can be used for both Rational Method and Santa Barbara Urban Hydrograph calculations. This is very important since two different drainage analysis and design philosophies govern the City of Cornelius' storm sewer system.

3.1.2 Drainage Analysis and Design Philosophies

Storm sewer systems within the right-of-way on North Adair Avenue and Baseline Street shall be designed according to the Oregon Department of Transportation (ODOT) District 2A standards. The general design standards are incorporated in an ODOT Hydraulics Manual prepared by the Salem Hydraulics Unit. District 2A maintenance staff have additional requirements that either supplement or replace portions of the Hydraulics Manual. A brief description of the ODOT design standards is included in Appendix A.

The remainder of the storm sewer system shall be designed to the Clean Water Services agency standards. The current CWS standard is entitled Design and Construction Standards for Sanitary Sewer and Surface Water Management, as adopted by Resolution and Order CWS 04-9. The City of Cornelius has minor additional requirements that supplement these standards. A brief description of the Cornelius design standards is included in Appendix A.

3.1.3 Development Conditions

The existing storm sewer system shall be evaluated under current and future development conditions.

3.1.4 Drainage Basins

The record rainfall and flooding experienced in 1996 provided numerous opportunities to delineate the drainage basins by observing the runoff paths. The basins and sub basins have been set according to topography and location of manholes and inlets.

3.1.5 Land Use

The storm sewer model for existing development conditions is based upon an estimate of the existing impervious surface. The amount of impervious surface has been estimated from recent aerial photos of the City.

The storm sewer model for future development conditions is based on criteria that all basins are fully developed in accordance with the City of Cornelius current zoning ordinances. Table 3-1 illustrates the impervious surface percentages developed for each zone.

Table 3-1 Impervious Surface Percentages By Zone

Zone	**Code Reference** (1)	**Percent Impervious** (2)
Multi-Family Residential A-2	11.20.30	61
Highway Commercial C-2	11.20.50	90
General Industrial M-1	11.20.70	90
Mobile Home Park MHP	11.20.20	80
Single Family Residential R-7	11.20.00	66
Core Commercial- Employment CE	11.20.60	80
Main Street District		
Civic (MSC)	11.20.80C	90
General Employment (MSGE)	11.20.80GE	90
Mixed Use (MSMU)	11.20.80MU	90
Retail (MSRC)	11.20.80RC	90

(1) City of Cornelius, “Land Use and Zoning Districts.”
(2) Estimated from aerial photography.

3.1.6 Hydrologic Group Classification

Hydrologic group classifications are a baseline descriptor of the infiltration rates of soils; a value of "A" indicates a low runoff potential (high infiltration rate) while "D" indicates a high runoff potential (low infiltration rate).

The main soil types, and their respective hydrologic groups, present in the City of Cornelius are shown in Table 3-2.

Table 3-2 City of Cornelius Soil Runoff Potential (1)	
Soil Name and Number	**Hydrologic Group**
Aloha, 1	C (moderately high runoff potential)
Quatama, 37	C (moderately high runoff potential)
Woodburn, 45	C (moderately high runoff potential)

(1) USDA, "Soil Survey of Washington County, Oregon," July 1982.

For the purpose of our analysis, the hydrologic group for the City of Cornelius is "C".

3.2 Hydrologic Analyses

Two different hydrologic analysis methods are used on this project to satisfy the governing agencies. Soil Conservation Method (SCS) has been modified but CWS requires the use of the Santa Barbara Urban Hydrograph to calculate the flow requirements for storm sewers. The Oregon Department of Transportation (ODOT), however, requires that the Rational Method be used to calculate the peak flow requirements for storm sewers within their right of way. Their right of way consists of North Adair Street, Baseline Street and Tualatin Valley Highway.

The SCS Method generally has been used to analyze the remainder of the storm sewers.

Where a basin includes areas within both jurisdictions, both analysis methods were used throughout the basin. Flow/capacity relationship and project recommendations for specific sections of sewer were related to the analysis required for the specific sewer and its jurisdiction.

3.2.1 SCS Method, as modified by the Santa Barbara Urban Hydrograph.

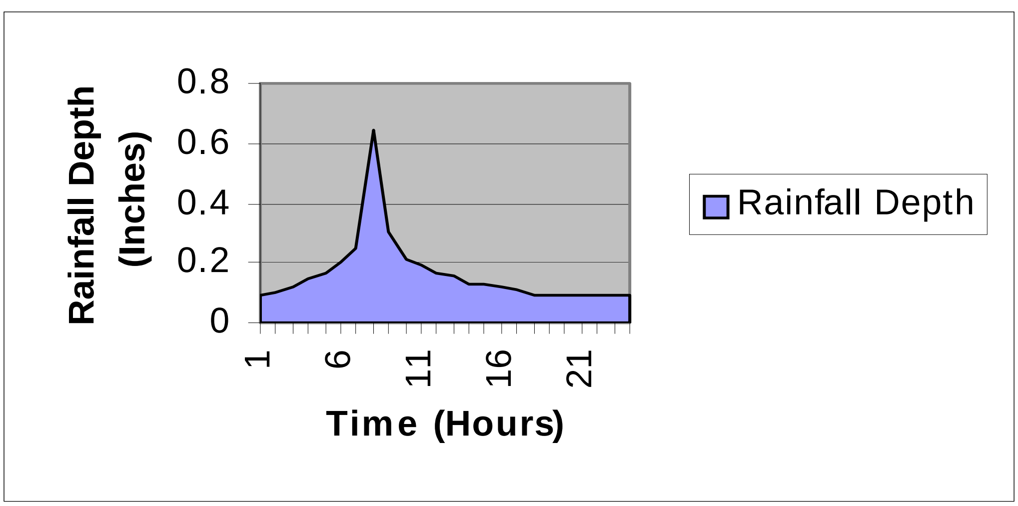
The SCS Method is based on long term stream flow records for areas with measurable watershed characteristics. Peak and/or total runoff from an area are calculated from rainfall intensity and for design storm, the land use and infiltration characteristics of the soil, and the time of concentration determined by the slope, length of flow path and roughness of flow surfaces.

3.2.1.1 Design Storm

The design storm for pipe conveyance systems has been set by CWS as the 25-year, 24-hour storm. The total rainfall associated with this storm is 3.9 inches. The pipe systems must be able to transport the peak flow associated with this storm. Flow depths above the pipe crown are not allowed if this causes flooding of homes and businesses.

HYDRA imposes the design storm using both the total rainfall and a hyetograph of the rainfall distribution. The hyetograph mimics the quantity of rainfall that falls during a storm in the Pacific Northwest over 24 hours. This rainfall distribution (shown in Figure 3-1) is based on the standard SCS Type 1A rainfall distribution.

Figure 3-1
25-Year Event Rainfall Distribution



3.2.1.2 SCS Curve Number

The method uses Curve Numbers to describe runoff potential for various areas, based upon the soil type and land use.

3.2.1.3 Land Use

In HYDRA, each sub basin is divided into pervious and impervious portions. The basins and sub basins have been analyzed based upon total development of the areas. The Curve Numbers shown in Table 3-3 describe the runoff potential for the hydrologic group "C" soils in Cornelius.

Table 3-3 Master Plan Curve Numbers

Land Coverage Description	Curve Number
Impervious areas such as roofs and paved roadways	98
Open spaces and lawns in fair condition with grass cover on 50 to 75 percent of the area	79

3.2.1.4 Time of Concentration

Time of concentration is the time it takes the entire sub basin to contribute runoff. The minimum allowable time of concentration under CWS guidelines is 5 minutes; this time is normally realized in a highly developed urban area. The maximum allowable time of concentration is 100 minutes, which is normally realized in a rural area. The City of Cornelius falls in between these extremes in development and time of concentration. A majority of the basins do not have paved or channelized system directing the runoff into the storm drainage system. The path of flow is not straight and smooth.

For future conditions, a general time of concentration of 15 minutes has been chosen for the Hydrograph Method. This time is representative and provides calculated solutions for the generalized runoff condition without requiring multiple alternative solutions for each possible combination of surface, inlet, gutter, ditch and other facility modification.

3.2.2 Rational Method

The Rational Method, the analysis method required for sewers within ODOT jurisdiction, is very effective for predicting a conservative peak flow to be used in sizing storm sewer facilities. The maximum drainage basin area allowed for each calculation differs between agencies and engineers. ODOT allows the drainage area to be a maximum of 300 acres.

The Rational Formula uses rainfall intensity, the drainage area, and a runoff coefficient to determine the peak runoff anticipated from a drainage basin.

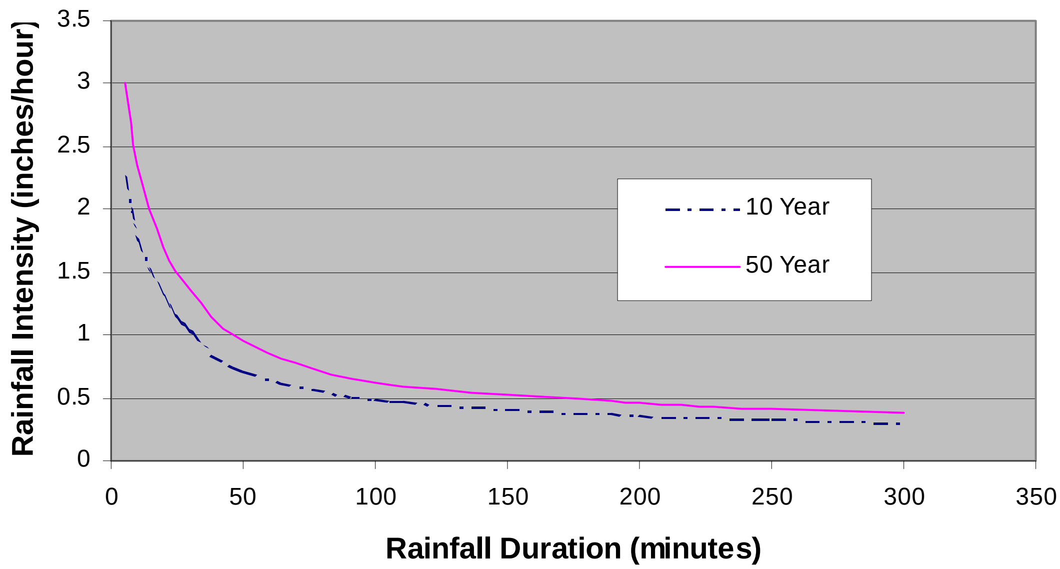
3.2.2.1 Design Storm

ODOT requires that storm sewers be designed to convey runoff from a 10-year frequency storm except at low points. Storm sewers conveying runoff from low points must be designed for the 50-year storm frequency.

3.2.2.2 Rainfall Intensity

The rainfall intensity is the rate of rainfall for a given duration, or time of concentration. The design storm will influence the intensity; a 10-year design storm has a lower intensity than a 50-year storm. The intensity – duration – frequency (IDF) curve for Cornelius rainfall zone (Zone 8) is included as Figure 3-2.

Figure 3-2
Rainfall Intensity – Duration – Frequency Curves (1)



ODOT, Hydraulics Manual, January 1990.

3.2.2.3 Runoff Coefficient

The runoff coefficient represents the ratio of runoff to rainfall. To simplify the choice of a coefficient, ODOT has provided average values for different levels of development. For the flat surfaces, which comprise most of Cornelius, the following table lists the coefficients used in the analysis.

Table 3-4 Runoff Coefficients (1)	
Development	**Runoff Coefficient**
Dense Residential: 6 to 15 units / acre	0.70
Normal Residential: 3 to 6 units / acre	0.50
City Business Areas	0.80

(1) ODOT, Hydraulics Manual, January 1990.

3.2.2.4 Time of Concentration

Time of concentration is the time it takes the entire sub basin to contribute runoff. The ODOT procedure requires an iterative process to determine the time of concentration. In this master plan analysis, the slope and length of each sub basin has been provided in the model and HYDRA has calculated the time of concentration.

3.3 Hydraulic Analysis and Design

3.3.1 Manning's Formula for Flow Capacity

Flow was calculated using the Manning's Formula, where the rate of flow depends on the cross-section area of the flowing water, wetted perimeter of the channel, slope of the channel and the roughness of the channel surface.

The Manning's n value is a descriptor of the roughness of a pipe. This value varies according to the type of pipe, and the age of the pipe. Conservative values, shown in Table 3-5 have been chosen for the analysis and design of the storm sewer system.

Table 3-5 Master Plan Pipe Roughness Factors (1)

Closed Conduit Flowing Partly Full (Gravity)	**Minimum Manning's n**	**Maximum Manning's n**	**Study Manning's n**
Analysis Values			
Concrete sewer with manholes, inlets, etc.	0.013	0.017	0.015
Corrugated metal storm drain (CMP)	0.021	0.030	0.024
Polyvinyl Chloride (PVC)	0.008	0.011	0.011
Design Values			
Concrete / PVC	0.008	0.015	0.013

(1) ODOT, Hydraulics Manual, January 1990; Chow, Open-Channel Hydraulics, 1959.

3.3.2 Minimum Velocity and Slope

The required minimum velocity is three feet per second when flowing full. The minimum slope shall maintain this velocity condition.

3.3.3 Flow Depth Versus Diameter

Maximum discharge in a storm sewer occurs at approximately 94 percent of capacity, assuming a constant Manning's n; maximum discharge occurs at 81 percent of capacity, assuming a variable Manning's n. The study value for maximum discharge used is 90 percent of capacity.

3.3.4 Channel Geometry

For the purpose of this analysis, the geometry of the ditches and swales throughout the City of Cornelius has been standardized. The maximum allowable velocity in the ditches is set at five (5) feet per second, assuming uniform grass coverage. The side slopes acceptable to CWS are a minimum of two horizontal to one vertical (2H:1V). The bottom width is set at 2 feet minimum. The Manning's n value is set at 0.080 for excavated channels (not maintained) with dense weeds as high as flow depth.

CHAPTER 4
EXISTING STORM DRAINAGE FACILITIES

4.1 General

4.1.1 Existing Storm Drainage Facilities

The City of Cornelius has over twenty-five drainage sub basins within its city boundaries that drain to Council Creek and the Tualatin River. The drainage basins are shown in Figure 4-1.

Cornelius' storm drainage system consists of open channels with culverts and storm sewers in various states of repair. Along North Adair Street and
Baseline Street, there is typically an open channel / culvert system along undeveloped parcels; in areas of development, there is typically a shallow storm sewer system. In the older residential sections of Cornelius, the drainage system may be a conglomeration of unmaintained ditches and culverts, and some storm sewer trunk lines. New residential areas in Cornelius are exclusively drained through a piped storm sewer system.

Drainage problems are usually identified where flooding has been observed and reported by residents and city staff, but problems may also be present where conditions exist that would produce backup in the network of piping and ditches under a design storm condition less frequent than previously observed, or under conditions of future development. Future development conditions may also occur upstream, causing an increase in the runoff to the specific facility or in another section of the system, causing a backup in the facilities downstream of the specific facility. Sometimes, too, the problems may not be due solely to the sizes of pipes but may have resulted from system defects that can be alleviated by special maintenance.

Storm water studies attempt to identify the problems under specific design conditions in several steps:

1. Maps are prepared showing the existing system and pipeline capacities are calculated based on the existing size, slope and condition, including known interferences (blockages, collapsed pipe, etc.

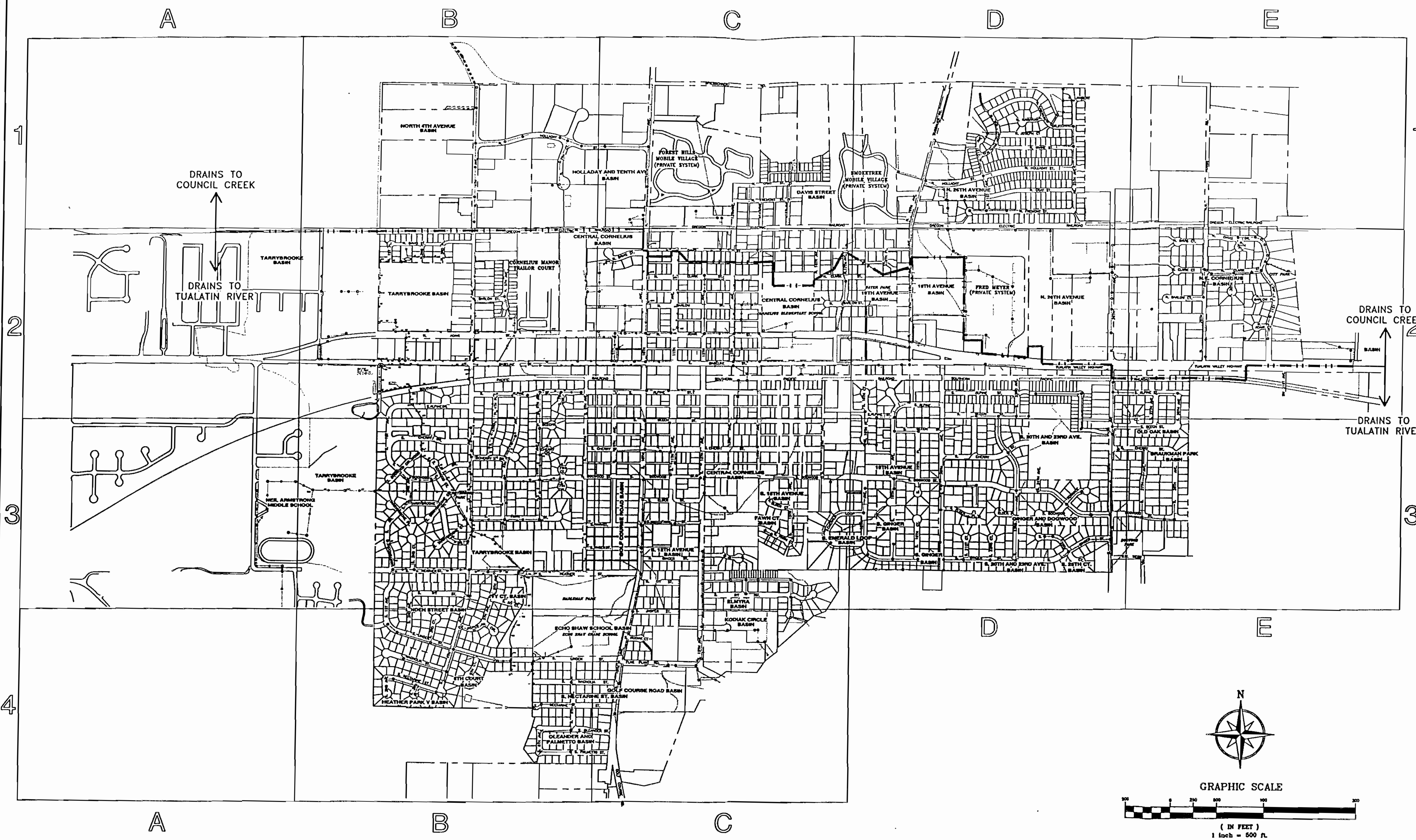


FIGURE 4-1

CITY OF CORNELIUS
PUBLIC WORKS DEPARTMENT
1300 SOUTH KODIAK CIRCLE
CORNELIUS, OR 97113
(503) 357-3011

CITY OF CORNELIUS
STORM SEWER
MASTER PLAN
INDEX MAP

EXISTING DRAINAGE
BASINS

Planners
Engineers
Surveyors

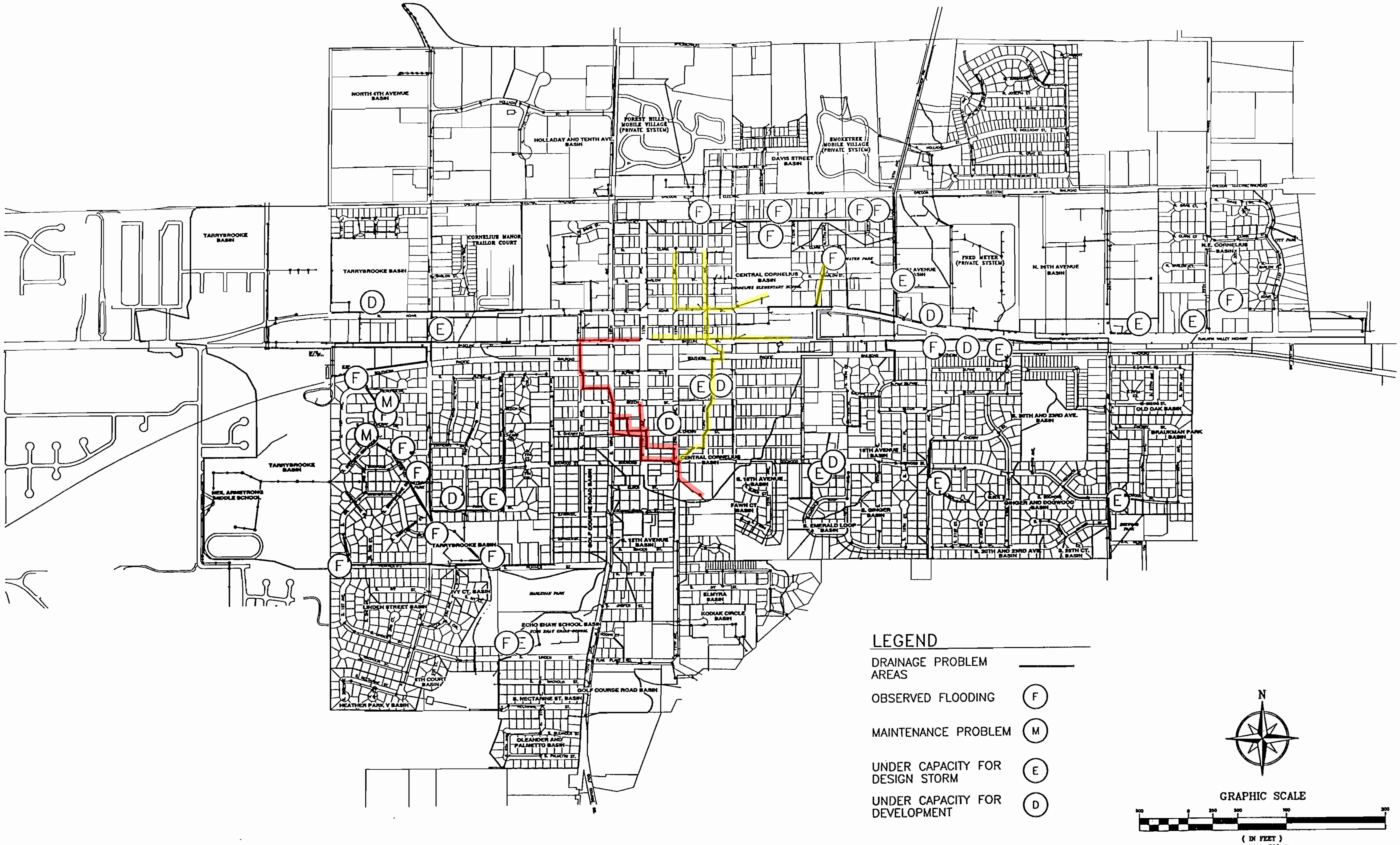
3-0005

4-1

2. The areas draining to each part of the system are outlined and the existing land uses are categorized as to the percent of impervious area and the relative runoff potential of the remaining pervious areas, the time between the onset of rainfall and the time at which the peak rate of runoff will enter the storm water facility in question is determined, and the relationship is made between the runoff time-duration-design storm probability.
3. The design storm probability is selected, usually specified by the regulatory agency, and the design flow rates for the existing conditions are calculated with the specified method of hydrologic analysis. The design storm probability, also referred to as the return period, is the average time between storms having the same magnitude. Another way to say this is that *on the average* one expects a 25-year storm to occur once every twenty-five years, or there is a four percent chance in any given year. However, it is important to remember that it is possible to have two “25-year” storms in the same year or consecutive years.
4. The same design storm is then applied, through the hydrologic analysis, to the drainage area after it would be developed under planned zoning conditions.
5. These design flows are then compared to the calculated capacity of the existing system to determine if it has sufficient capacity to carry the flow, either within the pipeline without any flow backup, or whether there will be some downstream flow backup that may not interfere with overall service.

The software used for this analysis was the same as used for the 1997 preliminary draft storm sewer plan. Although software revisions that permit calculation of the theoretical water levels in individual manholes are available, this study was authorized to proceed with the existing software and, as in the 1997 draft, the standard for “interference” with overall service was defined as a design flow in excess of 200 percent of the specific pipeline capacity.

Drainage problem areas in Cornelius are shown in Figure 4-2, identified using the 25-year design storm. Future problem areas include areas where existing problems will increase in magnitude and where portions of the drainage system that have sufficient capacity will become incapable of carrying design flows produced under full-development conditions. Future problem areas were identified assuming no improvements to the existing system.



LEGEND

DRAINAGE PROBLEM AREAS

OBSERVED FLOODING (F)

MAINTENANCE PROBLEM (M)

UNDER CAPACITY FOR DESIGN STORM (E)

UNDER CAPACITY FOR DEVELOPMENT (D)

FIGURE 4-2

CITY OF CORNELIUS
PUBLIC WORKS DEPARTMENT
1300 SOUTH KODIAK CIRCLE
CORNELIUS, OR 97113
(503) 357-3011

CITY OF CORNELIUS
STORM SEWER
MASTER PLAN
INDEX MAP

DRAINAGE PROBLEM AREAS

Design Group
Planners
Engineers
Surveyors

3-0005

4-2

More detailed maps of the existing storm drainage facilities are shown on 24" x 36" sheets on file at the City Department of Public Works. The corresponding storm sewer analysis and design reports for the existing system are included in Appendix B to this report and submitted in a separate binder.

The following basin and sub basin descriptions in Sections 4.2 and 4.3 address only those areas where the existing storm sewer does not meet the City's design requirements.

4.2 Tualatin River Basins

4.2.1 Tarrybrooke Basin

The Tarrybrooke drainage basin encompasses approximately 220 acres within the City of Cornelius. One-third of the basin is located north of the SPRR right-of-way. Much of the flow in the system originates in the City of Forest Grove and enters the Cornelius system at three different locations.

Drainage from the City of Forest Grove's northeastern industrial area enters the Cornelius system at South 1st Avenue. The drainage from the northern sub basins and the City of Forest Grove pass under the SPRR in a 3-foot by 3-foot concrete box culvert. From this point, the storm sewer passes through fully developed residential properties. The main storm sewer line from the SPRR culvert to the storm sewer downstream of Tarrybrooke Park flows at more than two hundred percent of capacity under existing development and design storm conditions. This area experienced severe flooding during the February 1996 and December 1996 storms.

The second Forest Grove drainage system is both a piped and overland flow drainage system from Neil Armstrong Middle School. The piped system drains the school building, adjacent grounds and parking area. The surface drainage is from about 24 acres into the west side of the basin near Dogwood Place west of Tarrybrooke Park.

The third drainage system, the overland surface flow from the school property, enters the Tarrybrooke system in Cornelius at Heather Street. A large portion of this drainage has been redirected from its natural drainage path to flow into the Heather Street system. A berm was constructed along the School's southern property line when the Homestead subdivision was developed; the purpose of this berm appears to be to stop the natural drainage from entering the subdivision area. The design flow in the storm sewer on Heather Street is more than two hundred percent of the sewer's capacity under existing development conditions.

The Tarrybrooke storm sewer system becomes an open channel system south of Heather Street. Drainage flows through the Heather Park wetlands north and south of Linden Street before outfalling through a constructed channel to the Tualatin River.

4.2.2 Central Cornelius Basin

The Central Cornelius basin encompasses 160 acres. The basin is divided about evenly between the northern and southern sub basins. This basin is almost completely developed. Infill development within the highway corridor and on larger residential lots will be the main form of future growth.

The majority of the western trunk line from Baseline Street to South 12th Avenue and South Dogwood Street is undersized. It appears that in the past the City tried to remedy the situation by constructing a parallel system from South 10th Avenue and South Cherry Street to South 12th Avenue and South Dogwood Street. Both systems now operate at an excess of 200 percent of capacity under design storm conditions.

From South 13th Avenue and South Cherry Street to South 12th Avenue and South Dogwood Street, this system is operating at an excess of 200 percent of capacity. The eastern trunk line, for the most part, operates within its capacity under design storm conditions.

The final area of concern in this basin is the point of outfall. The piped drainage system currently traverses and outfalls on private property on the east side of South 12th Avenue and South Elder Street.

4.2.3 19th Avenue Basin

This drainage basin encompasses 87 acres. Approximately half of the drainage basin is north of the SPRR right-of-way. The majority of the trunk sewer line from Baseline Street to its outfall exceeds 200 percent of capacity. The alignment of the trunk line currently traverses land that is outside of the public right-of-way and not within an easement.

4.2.4 Echo Shaw School Basin / Magnolia Street Basin

The Echo Shaw basin consists primarily of the Echo Shaw Middle School property. The storm sewer was recently upgraded from the south side of Linden Street to its outfall. A new outfall was created as a part of the improvements.

A small subdivision on South Magnolia Street has been included in the computations for the Echo Shaw basin. The Magnolia basin was a part of Echo Shaw before the improvements were made; Magnolia is now the only contributing area for the existing outfall that served both areas.

4.2.5 Ginger and Dogwood Basin

The Ginger and Dogwood basin covers approximately 25 acres of single-family residential property. About seven acres of the vacant Hillsboro School District property also drains through this basin. A portion of the storm sewer on Dogwood Street operates at flows of in excess of 200 percent of capacity under design storm conditions. When the school property develops, this storm sewer and a portion of the South 26th Avenue storm sewer will be more seriously undersized.

4.2.6 20th and 23rd Basin

The 20th and 23rd basin covers approximately 45 acres of mainly single-family residential property. About three acres of the vacant Hillsboro School District property also drains through this basin. A portion of the storm sewer on South 20th Avenue is undersized for current development.

Table 4-1 summarizes the storm sewer pipelines within the Tualatin River sub basins that exceed 200 percent of capacity under design storm conditions.

Table 4-1 Tualatin River Basin Facilities Exceeding 200% Capacity											
				Santa Barbara Hydrograph Method				Rational Method			
				Existing Development		Future Development		Existing Development		Future Development	
Basin	Link	Length	Diameter	% Capacity	Replacement Size	% Capacity	Replacement Size	% Capacity	Replacement Size	% Capacity	Replacement Size
Tarrybrooke	1	155	12	263	18	263	18	-	-	-	-
Tarrybrooke	3	81	18	-	-	-	-	515	36	541	36
Tarrybrooke	5	30	12	742	27	776	27	1963	42	2274	42
Tarrybrooke	9	60	24	-	-	-	-	268	36	309	42
Tarrybrooke	23	60	18	-	-	-	-	209	24	545	36
Tarrybrooke	24	60	18	-	-	-	-	209	24	545	36
Tarrybrooke	36	135	30	555	60	627	60	-	-	-	-
Tarrybrooke	37	184	30	457	54	512	60	-	-	-	-
Tarrybrooke	38	200	40	210	54	246	60	-	-	-	-
Tarrybrooke	39	200	40	220	54	246	60	-	-	-	-
Tarrybrooke	40	200	40	210	54	234	60	-	-	-	-
Tarrybrooke	41	100	40	220	54	246	60	-	-	-	-
Tarrybrooke	45	240	42	216	60	239	60	-	-	-	-
Tarrybrooke	46	70	42	223	60	247	60	-	-	-	-
Tarrybrooke	53	300	48	239	72	265	72	-	-	-	-
Tarrybrooke	60	200	12	338	24	338	24	-	-	-	-
Tarrybrooke	62	190	12	236	18	236	18	-	-	-	-
Tarrybrooke	63	300	12	260	18	260	18	-	-	-	-
Tarrybrooke	64	190	12	272	18	272	18	-	-	-	-
Tarrybrooke	67	290	12	378	24	378	24	-	-	-	-
Tarrybrooke	68	270	12	299	24	299	24	-	-	-	-
Tarrybrooke	72	200	12	203	18	205	18	-	-	-	-
Tarrybrooke	74	370	12	240	18	242	18	-	-	-	-
Tarrybrooke	77	360	10	510	24	533	24	-	-	-	-
Tarrybrooke	78	126	12	426	24	427	24	-	-	-	-

Table 4-1 Tualatin River Basin Facilities Exceeding 200% Capacity

				Santa Barbara Hydrograph Method				Rational Method			
				Existing Development		Future Development		Existing Development		Future Development	
Basin	Link	Length	Diameter	% Capacity	Replacement Size	% Capacity	Replacement Size	% Capacity	Replacement Size	% Capacity	Replacement Size
Tarrybrooke	85	230	12	321	24	321	24	-	-	-	-
Tarrybrooke	86	400	12	546	24	546	24	-	-	-	-
Tarrybrooke	87	200	12	657	27	657	27	-	-	-	-
Tarrybrooke	89	207	12	454	24	454	24	-	-	-	-
Tarrybrooke	90	363	12	463	24	474	24	-	-	-	-
Tarrybrooke	93	570	10	299	18	304	18	-	-	-	-
Tarrybrooke	94	92	10	316	18	341	18	-	-	-	-
Tarrybrooke	105	139	72	257	108	270	108	-	-	-	-
Central Cornelius	15	273	15	205	24	230	24	-	-	-	-
Central Cornelius	17	100	24	-	-	-	-	249	36	301	42
Central Cornelius	18	60	24	-	-	213	36	433	42	513	48
Central Cornelius	23	250	24	-	-	-	-	245	36	300	42
Central Cornelius	28	50	36	-	-	-	-	-	-	207	48
Central Cornelius	31	190	12	-	-	-	-	305	24	305	24
Central Cornelius	32	450	12	-	-	-	-	228	18	228	18
Central Cornelius	33	100	24	385	42	421	42	-	-	-	-
Central Cornelius	34	210	18	353	30	388	30	852	42	1007	48
Central Cornelius	38	120	18	282	27	314	30	-	-	-	-
Central Cornelius	40	250	18	500	36	554	36	-	-	-	-
Central Cornelius	42	157	24	254	36	281	36	-	-	-	-
Central Cornelius	50	137	24			209	36	-	-	-	-
Central Cornelius	51	122	36	265	36	292	36	-	-	-	-
Central Cornelius	55	110	18	400	36	441	36	-	-	-	-
Central Cornelius	57	120	18	854	42	940	42	-	-	-	-
Central Cornelius	58	128	18	274	27	301	30	-	-	-	-
Central Cornelius	61	187	15	334	24	368	27	-	-	-	-
Central Cornelius	62	177	15	277	24	305	24	-	-	-	-

Table 4-1 Tualatin River Basin Facilities Exceeding 200% Capacity											
				Santa Barbara Hydrograph Method				Rational Method			
				Existing Development		Future Development		Existing Development		Future Development	
Basin	Link	Length	Diameter	% Capacity	Replacement Size	% Capacity	Replacement Size	% Capacity	Replacement Size	% Capacity	Replacement Size
Central Cornelius	63	276	15	336	24	369	27	-	-	-	-
Central Cornelius	64	147	15	320	24	351	27	-	-	-	-
Central Cornelius	66	220	8	277	12	348	15	-	-	-	-
Central Cornelius	68	300	10	928	24	1164	27	-	-	-	-
Central Cornelius	71	60	15	-	-	234	24	407	27	638	36
Central Cornelius	72	120	18	-	-	-	-	-	-	257	27
Central Cornelius	73	320	18	-	-	-	-	219	27	305	30
Central Cornelius	74	320	18	-	-	-	-	244	27	330	30
Central Cornelius	78	330	18	-	-	-	-	-	-	208	24
Central Cornelius	86	160	10	257	15	277	15	-	-	-	-
Central Cornelius	87	270	15	-	-	-	-	-	-	329	24
Central Cornelius	88	160	24	-	-	-	-	-	-	278	36
Central Cornelius	90	130	24	-	-	-	-	281	36	416	42
Central Cornelius	91	320	8	-	-	-	-	210	12	210	12
Central Cornelius	95	50	24	-	-	-	-	245	36	340	42
Central Cornelius	103	60	24	344	42	394	42	839	54	1149	60
Central Cornelius	110	300	8	223	12	223	12	590	36	885	42
Central Cornelius	111	280	8	316	15	320	15	-	-	-	-
Central Cornelius	113	130	24	207	36	230	36	-	-	-	-
Central Cornelius	114	300	24	284	36	316	42	-	-	-	-
19th Avenue	8	50	18	-	-	-	-	-	-	213	24
19th Avenue	13	70	18	-	-	-	-	330	30	535	36
19th Avenue	21	625	12	229	18	229	18	739	27	739	27
19th Avenue	23	459	12	-	-	-	-	284	18	328	24
19th Avenue	24	490	12	-	-	-	-	469	24	550	24
19th Avenue	31	70	18	603	36	700	42	1450	54	2247	60
19th Avenue	32	236	18	237	27	276	27	-	-	-	-

Table 4-1 Tualatin River Basin Facilities Exceeding 200% Capacity											
				Santa Barbara Hydrograph Method				Rational Method			
				Existing Development		Future Development		Existing Development		Future Development	
Basin	**Link**	**Length**	**Diameter**	**% Capacity**	**Replacement Size**	**% Capacity**	**Replacement Size**	**% Capacity**	**Replacement Size**	**% Capacity**	**Replacement Size**
19th Avenue	40	190	24	228	36	253	36	-	-	-	-
19th Avenue	42	120	24	214	36	237	36	-	-	-	-
19th Avenue	45	80	24	-	-	202	36	-	-	-	-
19th Avenue	48	150	24	-	-	204	36	-	-	-	-
Echo Shaw School	2	122	10	-	-	223	15	-	-	-	-
Ginger & Dogwood	5	303	15	205	21	254	24	-	-	-	-
Ginger & Dogwood	7	300	18	-	-	225	27	-	-	-	-
20th and 23rd	15	290	12	217	18	221	18	-	-	-	-
20th and 23rd	18	260	15	213	21	213	21	-	-	-	-

4.3 Council Creek Basins

4.3.1 Davis Street Basin

The Davis Street drainage basin encompasses 38 acres; a majority of the basin is developed residential and industrial properties. The existing drainage system consists of under-capacity storm sewers along Davis Street from North 19th Avenue to North 10th Avenue except that part from N. 15th Avenue to N 13th Avenue that was constructed in 2000 under a CDBG project. The basin has two outfalls. The western outfall traverses multiple parcels of private property before it enters the Forest Hills Mobile Village. The exact location of the storm sewer in the mobile home park is unknown. The eastern outfall is constructed on North 15th Avenue and was constructed within the last few years to accept the full development condition runoff from this entire basin.

4.3.2 Northeast Cornelius Basin

This basin serves the eastern commercial area on the Tualatin Valley Highway and residential areas in the northeast corner of the City.

Table 4-2 summarizes the storm sewer pipelines within the Council Creek sub basins that exceed 200 percent of capacity under design storm conditions.

4.4 Water Quality Facilities

The City of Cornelius is required to have identified locations for future capital projects when system development fees are collected. At this time, the City does not own or maintain any water quality facilities.

Table 4-2 Council Creek Basin Facilities Exceeding 200% Capacity											
				Santa Barbara Hydrograph Method				Rational Method			
				Existing Development		Future Development		Existing Development		Future Development	
Basin	Link	Length	Diameter	% Capacity	Replacement Size	% Capacity	Replacement Size	% Capacity	Replacement Size	% Capacity	Replacement Size
Davis St.	2	151	8	294	12	369	15	-	-	-	-
Davis St.	3	180	8	508	15	637	18	-	-	-	-
Davis St.	4	187	8	327	15	410	15	-	-	-	-
Davis St.	5	349	8	730	18	916	24	-	-	-	-
Davis St.	6	275	8	1240	24	1556	24	-	-	-	-
Davis St.	7	359	8	855	18	1127	24	-	-	-	-
Davis St.	8	255	8	882	24	1169	24	-	-	-	-
Davis St.	9	150	10	385	18	512	24	-	-	-	-
Davis St.	10	250	10	437	18	587	24	-	-	-	-
Davis St.	11	60	12	249	18	347	24	-	-	-	-
Davis St.	13	90	12	261	18	359	24	-	-	-	-
Davis St.	14	75	12	258	18	354	24	-	-	-	-
Davis St.	15	130	15	211	24	278	24	-	-	-	-
Davis St.	19	65	12	-	-	234	18	-	-	-	-
Davis St.	23	268	8	-	-	233	10	-	-	-	-
Northeast Cornelius	8	485	12	-	-	-	-	-	-	350	24
Northeast Cornelius	13	170	12	227	18	281	18	-	-	-	-
Northeast Cornelius	15	30	12	-	-	239	18	-	-	-	-
Northeast Cornelius	50	40	12	-	-	-	-	228	18	239	18

CHAPTER 5
CAPITAL IMPROVEMENT PROGRAM

5.1 Design and Construction Costs

Master Plan level cost opinions have been prepared for each alternative improvement. Costs are based upon cost data compiled by various sources including the Engineering News Record, R.S. Means, Washington County, and past Cornelius projects. Costs are in year 2004 dollars[1].

Cost opinions include capital costs of pipes, channel improvements, street and sidewalk repair, manholes. These costs also include excavation and backfill, manholes, catch basins and surface repair. The costs include a 35 percent markup to account for surveying, engineering, administration, legal fees and contingencies. The unit costs used in the cost opinions are shown in Table 5-1. Easement or land acquisition, and maintenance costs are not included in the cost opinions. All Highway crossings are assumed to be open cut.

Table 5-1 Unit Costs

Item	Estimated Unit Construction Cost
Pipeline Diameter	
12”	$146 / LF
15”	$156 / LF
18”	$161 / LF
21”	$176 / LF
24”	$188 / LF
27”	$188 / LF
30”	$198 / LF
36”	$219 / LF
42”	$256 / LF
48”	$400 / LF
54”	$421 / LF
60”	$468 / LF
72”	$561 / LF
108”	$761 / LF
Water Quality Swale	$176 / LF
Water Quality Pond	$59 / CY

[1] Costs have been adjusted to 2004 dollars from a 2000 dollar base in the October 2001 SD/SWM report by applying an average 4% per year.

Cost opinions have been created based on the assumption that the storm sewer capital improvements will be constructed in a segmented fashion. The City can realize greater savings and a more functional storm sewer system if the storm sewer improvement project can encompass an entire area of undersized pipes.

The cost opinions included for each basin are the costs of associated improvements to serve the requirements of future development runoff conditions. The majority of costs would be necessary, however, to improve the system to serve just the existing development conditions.

5.2 Tualatin River Basins

The capital improvement program budget for the Tualatin River Basins is approximately $7 million, $2.7 million of which is related to future development.

5.2.1 Tarrybrooke Basin

The study considered five options for improving the storm sewer system in the Tarrybrooke Basin. The first three, 1a, 1b and 1c, are alternatives to each other and would alleviate the problems in the part of the system receiving flows from the City of Forest Grove.

- 1a) Full Bypass - Construct a joint bypass along the city limit line between Forest Grove and Cornelius from South 1st Avenue to the Tualatin River floodplain. The bypass system will consist of approximately 3,400 linear feet of 48-inch diameter pipe.
- 1b) Partial Bypass - Construct a 48-inch diameter storm sewer along the Forest Grove / Cornelius city limit line from South 1st Avenue to Heather Street, and replace the existing storm sewer on Heather Street with a 54-inch pipeline from the city limit to an outfall 600 feet east of South 4th Avenue.
- 1c) Heather Street System Replacement - Replace the main storm sewer from SPRR to South 4th Avenue and along Heather Street. (Note: A 30-in. storm sewer is to be constructed along Heather Street in the late summer of 2001.)

Two other options were also considered, carrying only runoff originating within Cornelius.

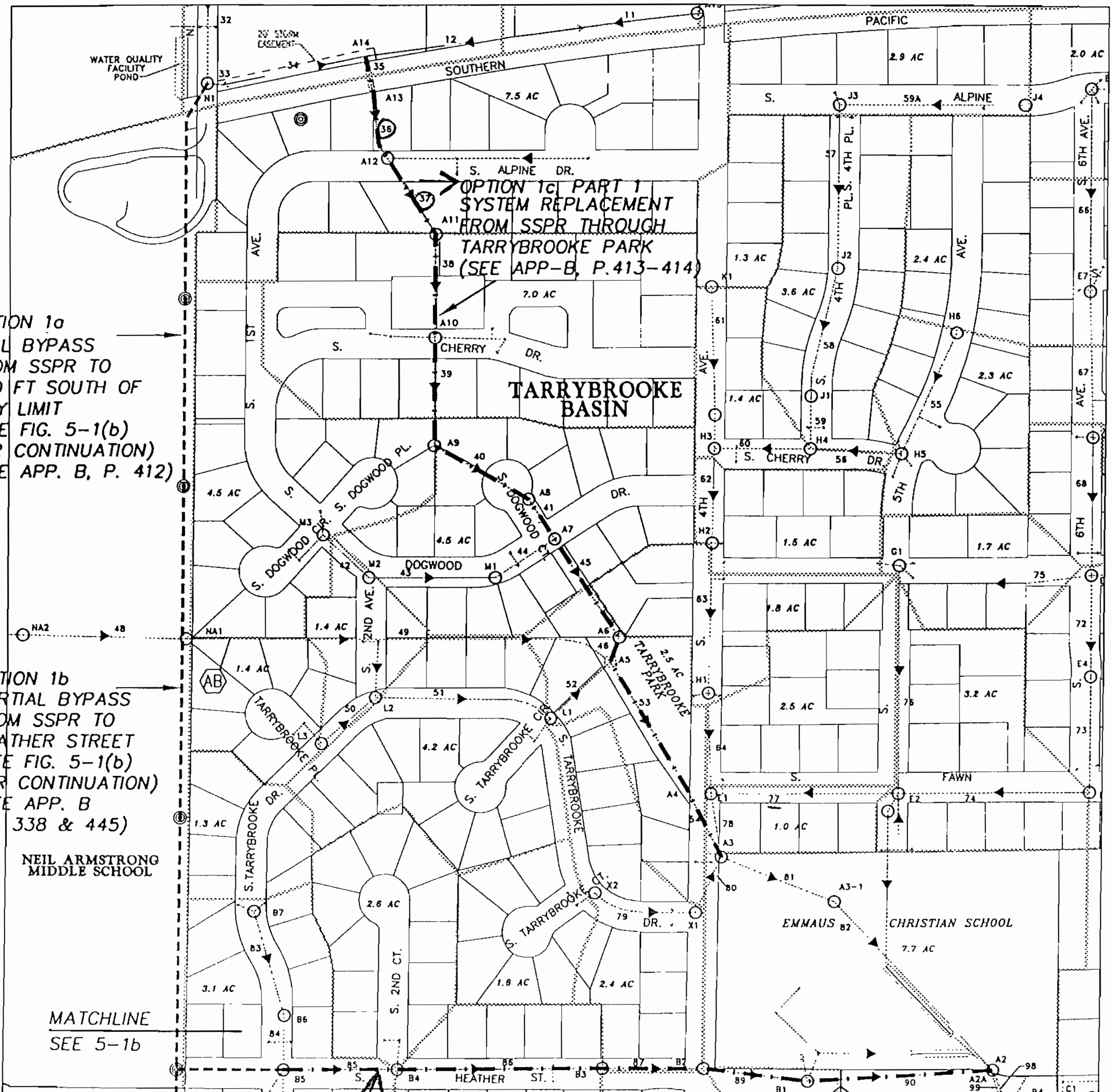
- 2) 4th Avenue – Construct a storm sewer from the north side of N. Adair Street at 4th Avenue south to the existing sewer along 4th Avenue and then south to the SPRR and west. The sewers would have diameters increasing from 30 to 42 inches.

3) Tualatin Valley Highway – Construct storm sewers along both sides of North Adair Street and Baseline Street west of 4th Avenue, and on one side of the street along North Adair Street and Baseline Street east of 4th Avenue.

Figures 5-1a, 5-1b, 5-2 and 5-3 illustrate the Tarrybrooke Basin storm sewer improvements options. Table 5-2 presents the opinions of project cost.

TARRYBROOKE BASIN IMPROVEMENTS
OPTIONS 1a, 1b & 1c

5-1a



LEGEND

O#	MANHOLE/NUMBER
#	EXISTING PIPELINE
◎	PROPOSED MANHOLE
- - - -	PROPOSED PIPE IMPROVEMENTS
— · —	PROPOSED PIPE REPLACEMENT
(AB)	ABANDON EXT'G PIPE/DITCH

GRAPHIC SCALE

(IN FEET)
1 inch = 300 ft.

PREPARED FOR:

CITY OF CORNELIUS
PUBLIC WORKS
1300 SOUTH KODIAK CIRCLE
CORNELIUS, OREGON 97113
PHONE: (503) 357-3011

LDC Design Group Inc.
Planners
Engineers
Surveyors
3300 N.W. 211Th TERRACE
HILLSBORO, OREGON 97124
PHONE: (503) 858-4242
FAX: (503) 645-5500
www.ldcdesign.com

DRAWING TITLE:

STORM SEWER CAPITAL IMPROVEMENTS
TARRYBROOKE BASIN
(NORTHERN SECTION)

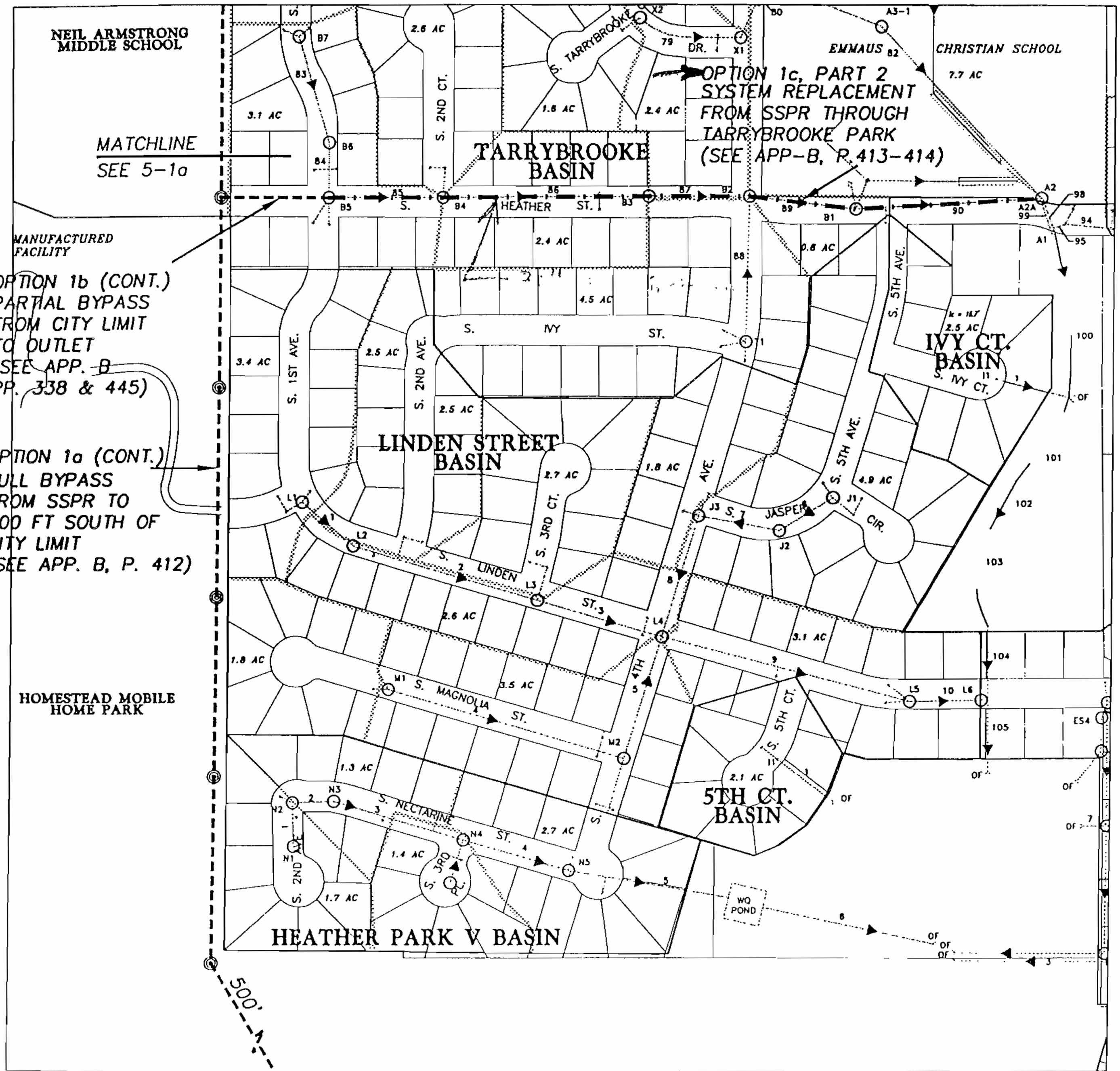
CADFILE: 0005EX01.dwg

JOB NO.: 2659

DRAWING NO. 1 of 4

TARRYBROOKE BASIN IMPROVEMENTS
(CONT. FROM 5-1a)

5-1b



LEGEND

- O# MANHOLE/NUMBER
- EXISTING PIPELINE
- PROPOSED MANHOLE
- - - - PROPOSED PIPE IMPROVEMENTS
- — · — PROPOSED PIPE REPLACEMENT
- (AB) ABANDON EXT'G PIPE/DITCH

N

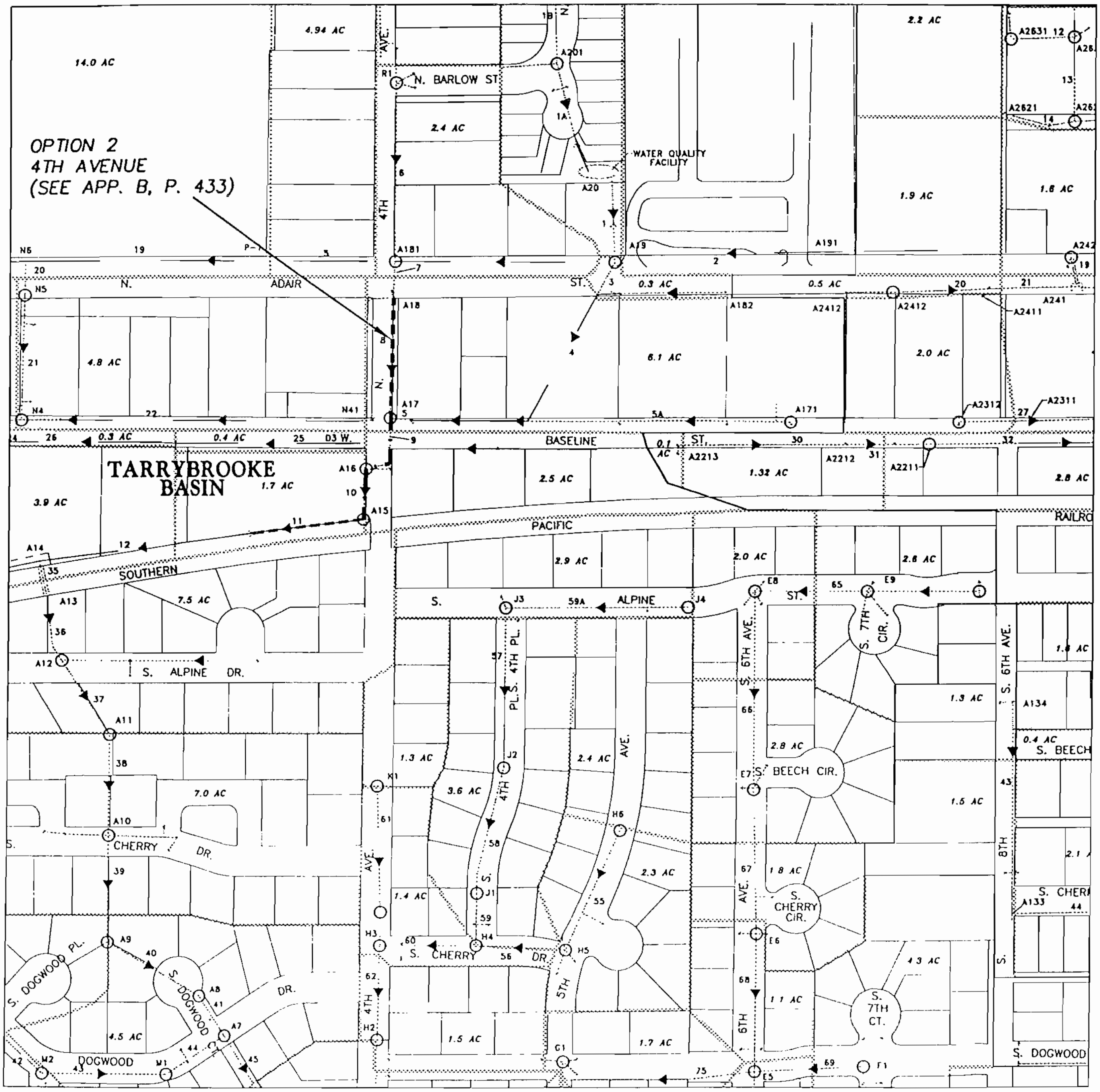
GRAPHIC SCALE
150 0 75 150 300
(IN FEET)
1 inch = 300 ft.

PREPARED FOR		DRAWING TITLE:	JOB NO.:
CITY OF CORNELIUS PUBLIC WORKS 1300 SOUTH KODIAK CIRCLE CORNELIUS, OREGON 97113 PHONE: (503) 357-3011	LDC Design Group Inc. Planners Engineers Surveyors 3300 N.W. 211Th TERRACE HILLSBORO, OREGON 97124 PHONE: (503) 858-4242 FAX: (503) 645-5500 www.ldcdesign.com	STORM SEWER CAPITAL IMPROVEMENTS TARRYBROOKE BASIN (SOUTHERN SECTION) CADFILE: 0005EX01.dwg	2659 DRAWING NO. 2 of 4

TARRYBROOKE BASIN IMPROVEMENTS

OPTION 2

5-2



LEGEND

O#	MANHOLE/NUMBER
#	EXISTING PIPELINE
◎	PROPOSED MANHOLE
- - -	PROPOSED PIPE IMPROVEMENTS
— · —	PROPOSED PIPE REPLACEMENT
(AB)	ABANDON EXT'G PIPE/DITCH

N

GRAPHIC SCALE

150 0 75 150 300

(IN FEET)
1 inch = 300 ft.

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CITY OF CORNELIUS
PUBLIC WORKS
1300 SOUTH KODIAK CIRCLE
CORNELIUS, OREGON 97113
PHONE: (503) 357-3011

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3300 N.W. 211Th TERRACE
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DRAWING TITLE:

STORM SEWER CAPITAL
IMPROVEMENTS
TARRYBROOKE BASIN

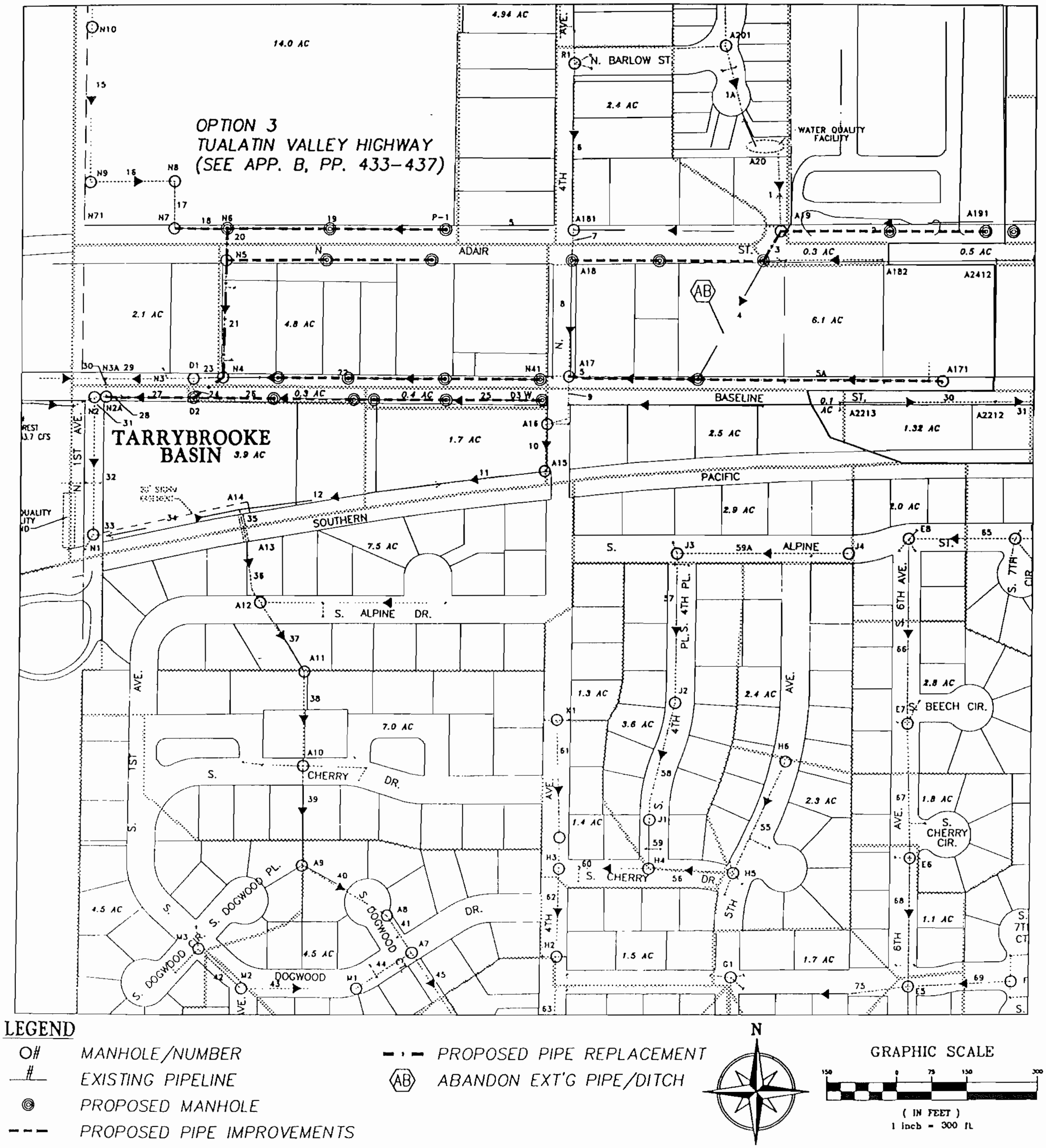
CADFILE: 0005EX01.dwg

JOB NO.: 2659

DRAWING NO. 3 OF 4

TARRYBROOKE BASIN IMPROVEMENTS
OPTION 3

5-3



PREPARED FOR

CITY OF CORNELIUS
PUBLIC WORKS
1300 SOUTH KODIAK CIRCLE
CORNELIUS, OREGON 97113
PHONE: (503) 357-3011

LDC Design Group Inc.
Planners Engineers Surveyors
3300 N.W. 211Th TERRACE
HILLSBORO, OREGON 97124
PHONE: (503) 858-4242
FAX: (503) 645-5500
www.ldcdesign.com

DRAWING TITLE:

STORM SEWER CAPITAL IMPROVEMENTS TARRYBROOKE BASIN

CADFILE: 0005EX01.dwg

JOB NO.: 2659

DRAWING NO. 4 OF 4

Table 5-2 Tarrybrooke Basin Improvements		
Option	**Storm Sewer Improvements**	**Project Cost Opinion**
1a.	Full Bypass	$1.65 million
or 1b.	Partial Bypass	$1.62 million
or 1c.	Heather Street System Replacement	$580,601
2.	4^{th} Avenue	$146,624
3.	Tualatin Valley Highway	$874,078

5.2.2 Central Cornelius Basin

Two sections of the storm sewer in the Central Cornelius basin are vastly undersized. It is recommended that the storm sewer in the following areas be replaced:

1) The western trunk storm sewer from 9th Avenue and Baseline Street to South 12th Avenue and South Dogwood Street. The storm sewer replacement would increase the capacity of the SPRR crossing and would keep the parallel system from South 10^{th} Avenue to South 12^{th} Avenue.

2) The eastern trunk storm sewer from the SPRR crossing near South 13^{th} Avenue to South 12th Avenue and South Dogwood Street. The storm sewer replacement would increase the capacity of the SPRR crossing and the downstream system.

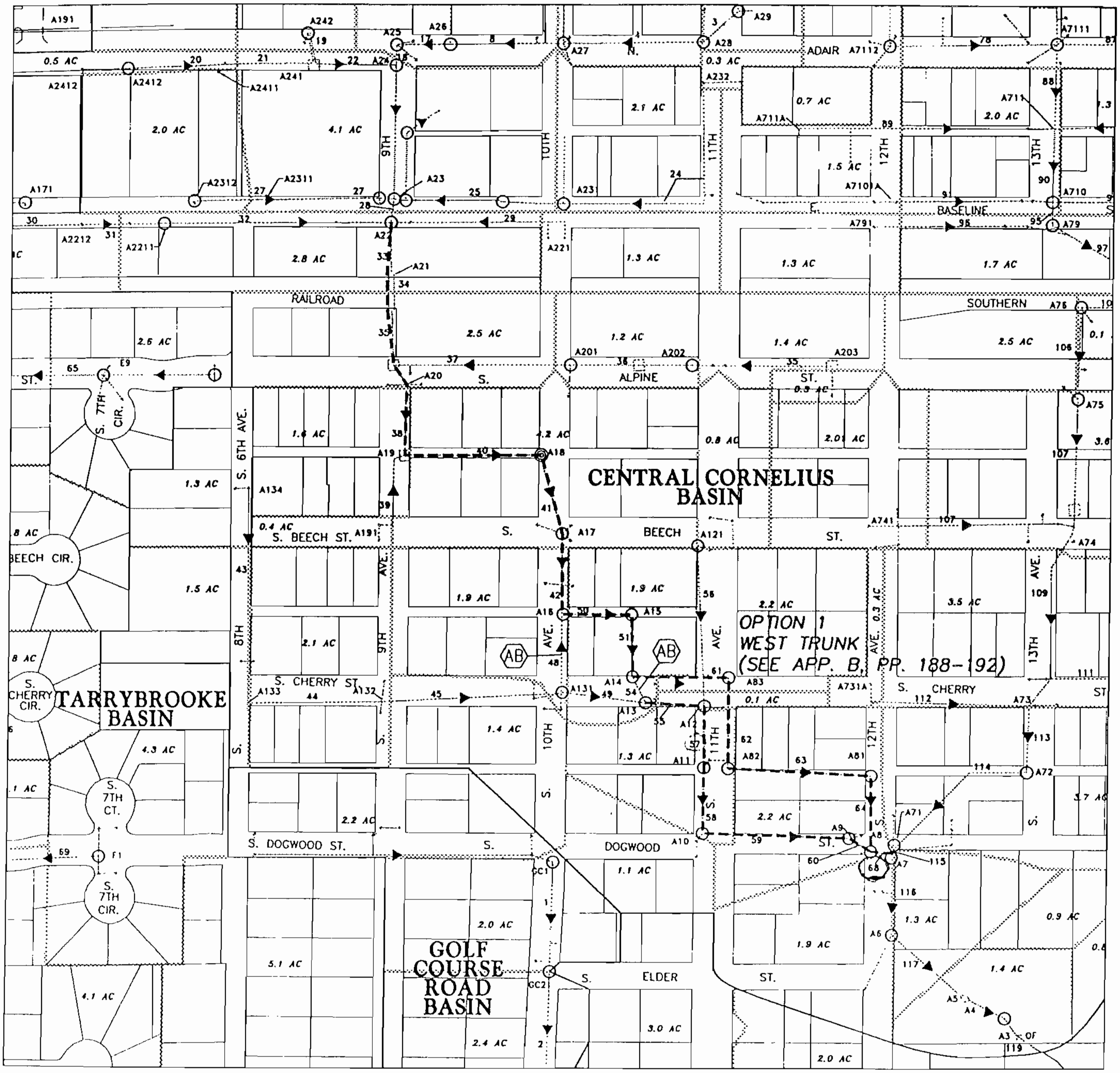
3) The storm sewer from North 17^{th} Avenue and Clark Street to Cornelius Elementary/Thriftway Market. The storm sewer replacement would replace currently undersized pipelines within the residential area east of the elementary school and the highway system within this basin.

Figures 5-4, 5-5 and 5-6 illustrate the recommended Central Cornelius Basin storm sewer improvements. Table 5-3 presents the opinions of project cost.

CENTRAL CORNELIUS BASIN IMPROVEMENTS

OPTION 1

5-4



LEGEND

O#	MANHOLE/NUMBER
#	EXISTING PIPELINE
◎	PROPOSED MANHOLE
- - -	PROPOSED PIPE IMPROVEMENTS
-·-	PROPOSED PIPE REPLACEMENT
(AB)	ABANDON EXT'G PIPE/DITCH

N

GRAPHIC SCALE

150 0 75 150 300

(IN FEET)
1 inch = 300 ft.

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STORM SEWER CAPITAL IMPROVEMENTS
CENTRAL CORNELIUS BASIN

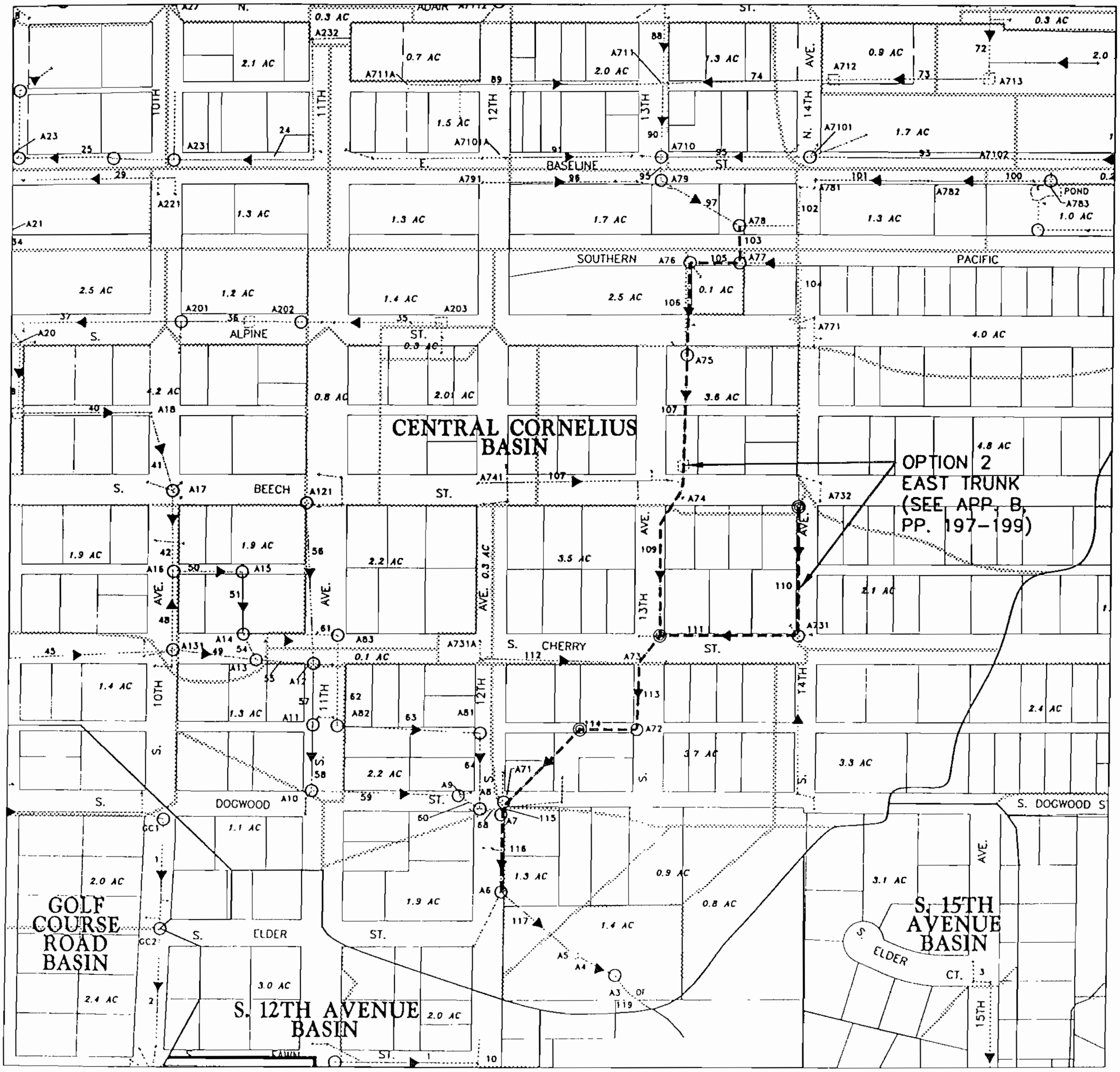
CADFILE: 0005EX01.dwg

JOB NO.: 2659

DRAWING NO. 1 OF 3

CENTRAL CORNELIUS BASIN IMPROVEMENTS
OPTION 2

5-5



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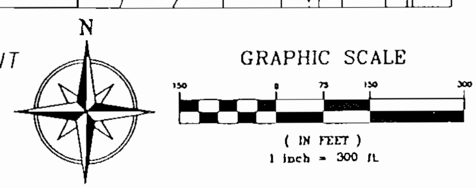
- # — EXISTING PIPELINE
- ◎ — PROPOSED MANHOLE
- - - - — PROPOSED PIPE IMPROVEMENTS
- — · — — PROPOSED PIPE REPLACEMENT
- (AB) — ABANDON EXT'G PIPE/DITCH



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CENTRAL CORNELIUS BASIN

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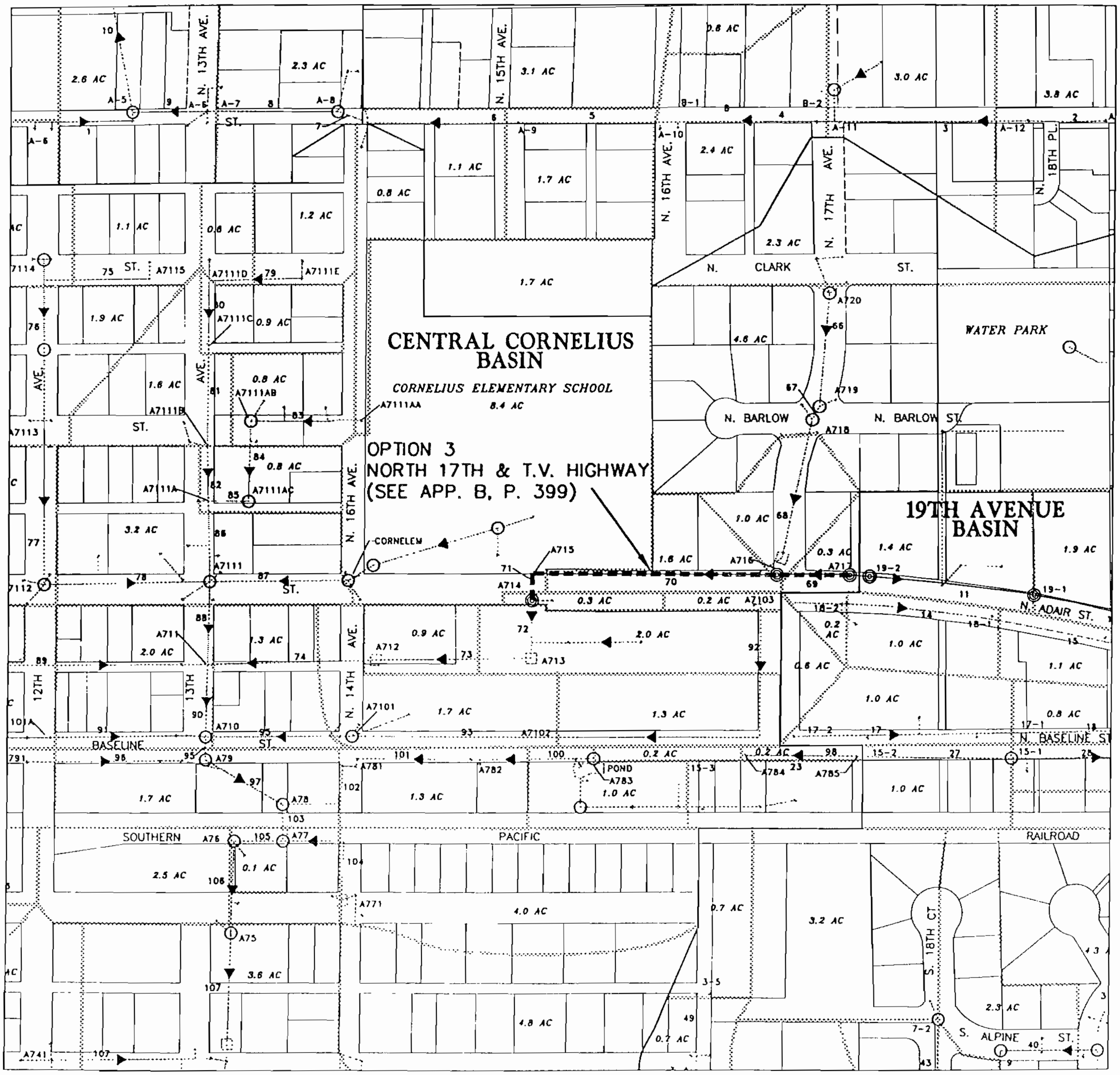
CENTRAL CORNELIUS BASIN IMPROVEMENTS

OPTION 3

5-6



LEGEND

O#	MANHOLE/NUMBER
#	EXISTING PIPELINE
◎	PROPOSED MANHOLE
- - -	PROPOSED PIPE IMPROVEMENTS
— · —	PROPOSED PIPE REPLACEMENT
(AB)	ABANDON EXT'G PIPE/DITCH

N

GRAPHIC SCALE

150 0 75 150 300

(IN FEET)
1 inch = 300 ft.

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CENTRAL CORNELIUS BASIN

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JOB NO.: 2659

DRAWING NO. 3 of 3

Table 5-3 Central Cornelius Basin Improvements		
Option	**Storm Sewer Improvements**	**Project Cost Opinion**
1	West Trunk	$614,290
2.	East Trunk	$515,110
3.	North 17th and Tualatin Valley Highway	$122,756

5.2.3 19th Avenue Basin

The main trunk sewer from the SPRR to South Dogwood Street east of South 16th Avenue is currently operating at more than 200 percent of capacity. Parts of this system are also located outside of public rights-of-way. The first option within this basin resolves the capacity and alignment issues by replacing the storm sewer from the SPRR to the outfall east of Emerald Loop. The second project would replace the existing drainage system on the Tualatin Valley Highway with a new system. The final improvement recommendation is the replacement of the storm sewer system on North 19th Avenue.

Figures 5-7, 5-8 and 5-9 illustrate the recommended 19th Avenue Basin storm sewer improvements. Table 5-4 presents the opinions of project cost.

Table 5-4 19th Avenue Basin Improvements		
Options	**Storm Sewer Improvements**	**Project Cost Opinion**
1.	South 19th Avenue Trunk	$906,763
2.	Tualatin Valley Highway	$701,172
3.	North 19th Avenue	$135,884

5.2.4 Echo Shaw School Basin

The storm sewer crossing Linden Street does not meet minimum size requirements. The 10-inch pipeline should be replaced with a 15-inch pipeline for future development.

Figure 5-10 illustrates the recommended Echo Shaw Basin storm sewer improvements. Table 5-5 presents the opinion of project cost.

19TH AVENUE BASIN IMPROVEMENTS
OPTION 1

5-7

LEGEND

- O# MANHOLE/NUMBER
- # EXISTING PIPELINE
- PROPOSED MANHOLE
- PROPOSED PIPE IMPROVEMENTS
- PROPOSED PIPE REPLACEMENT
- (AB) ABANDON EXT'G PIPE/DITCH

N

GRAPHIC SCALE

150 0 75 150 300

(IN FEET)
1 inch = 300 ft.

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IMPROVEMENTS
19TH AVENUE BASIN

CADFILE: 0005EX01.dwg

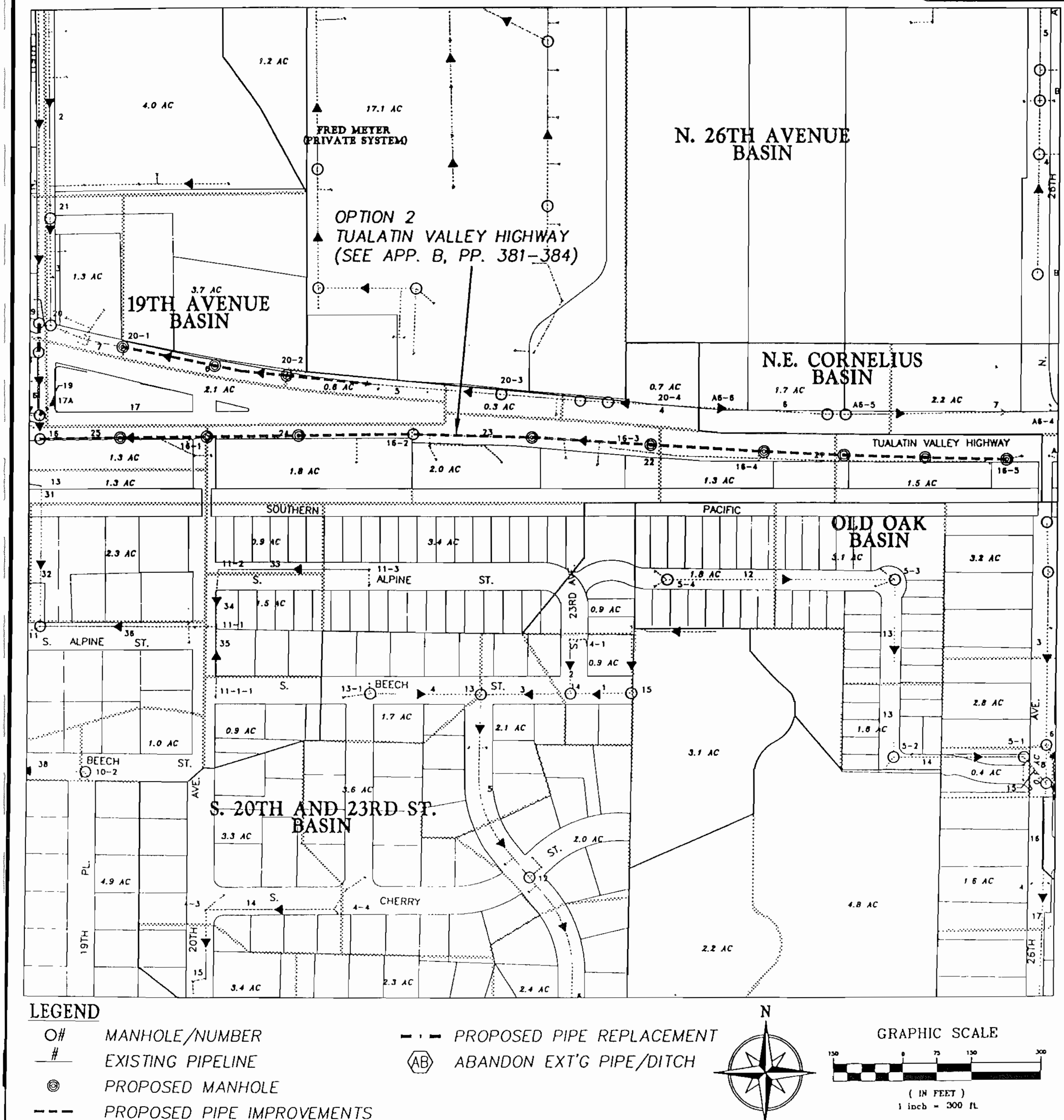
JOB NO.: 2659

DRAWING NO. 2 of 4

19TH AVENUE BASIN IMPROVEMENTS

OPTION 2

5-8



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STORM SEWER CAPITAL IMPROVEMENTS 19TH AVENUE BASIN

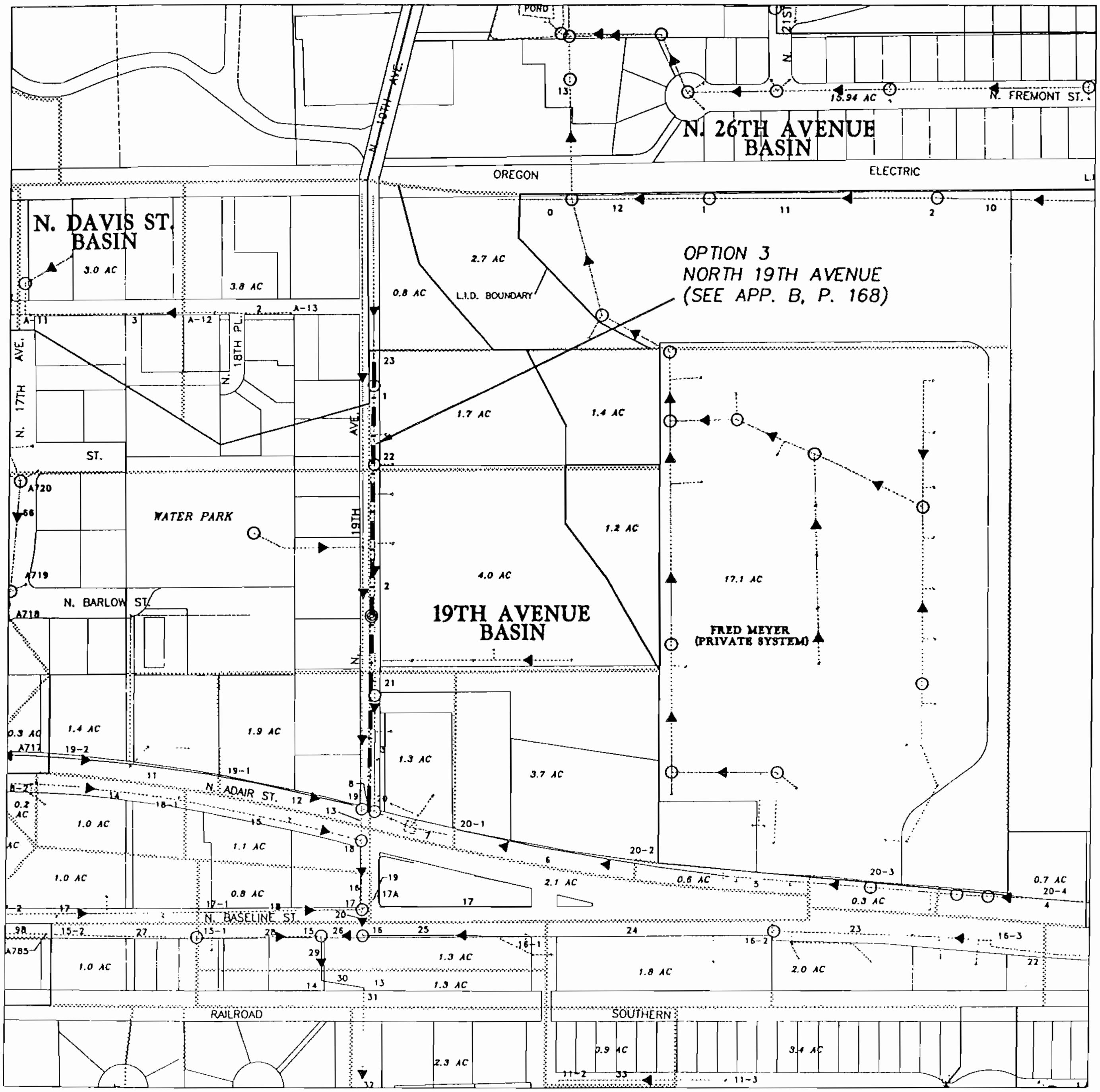
CADFILE: 0005EX01.dwg

JOB NO.: 2659

DRAWING NO. 3 of 4

19TH AVENUE BASIN IMPROVEMENTS
OPTION 3

5-9



LEGEND

O#	MANHOLE/NUMBER	— · —	PROPOSED PIPE REPLACEMENT
#	EXISTING PIPELINE	(AB)	ABANDON EXT'G PIPE/DITCH
◎	PROPOSED MANHOLE		
- - -	PROPOSED PIPE IMPROVEMENTS		

N

GRAPHIC SCALE

(IN FEET)
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19TH AVENUE BASIN

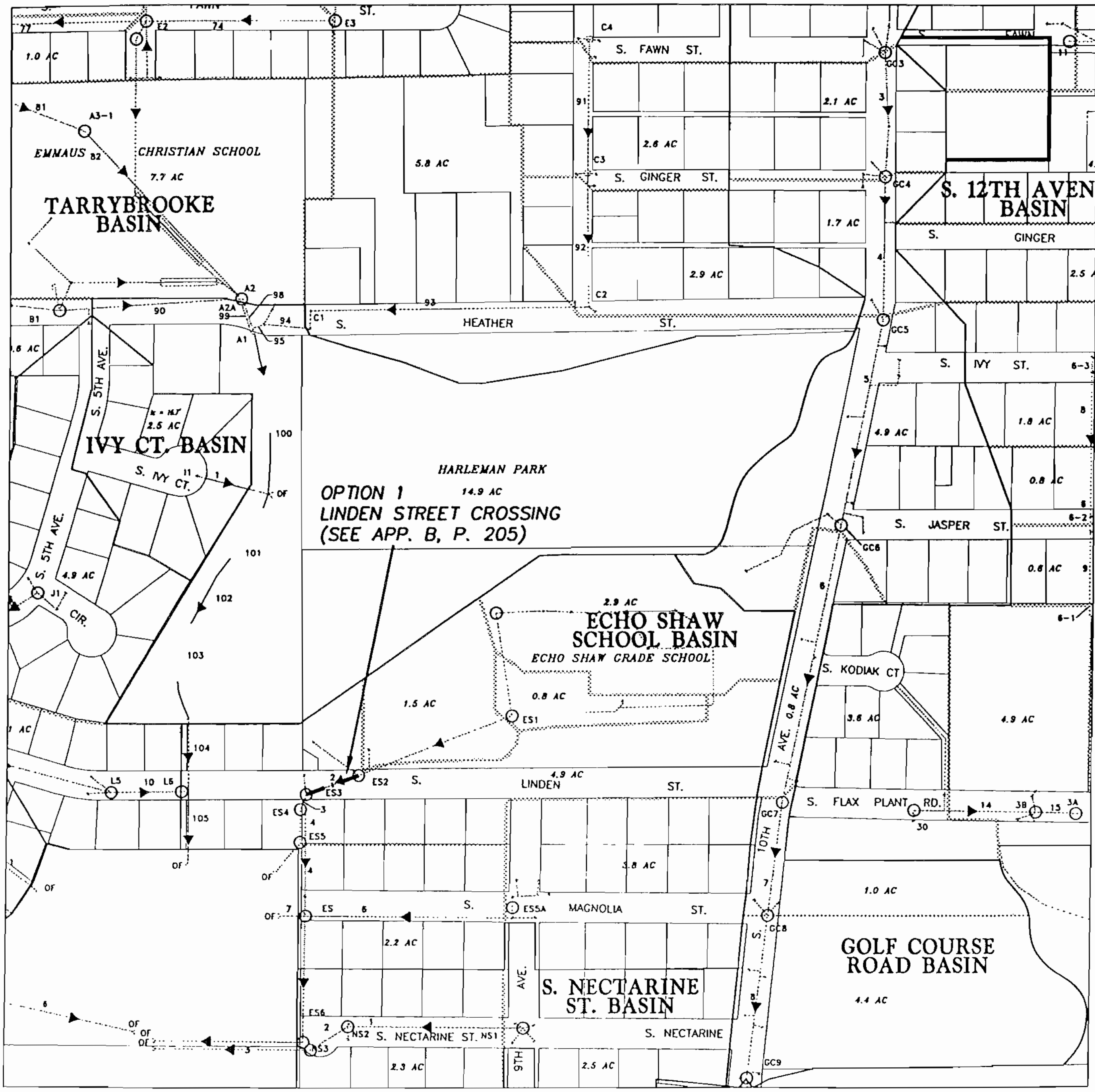
CADFILE: 0005EX01.dwg

JOB NO.: 2659

DRAWING NO. 4 of 4

ECHO SHAW BASIN IMPROVEMENTS
OPTION 1

5-10



LEGEND

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- PROPOSED MANHOLE
- - - - PROPOSED PIPE IMPROVEMENTS
- (AB) ABANDON EXT'G PIPE/DITCH
- — · — PROPOSED PIPE REPLACEMENT

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STORM SEWER CAPITAL IMPROVEMENTS
ECHO SHAW BASIN

CADFILE: 0005EX02.dwg

JOB NO.: 2659

DRAWING NO. 1 OF 1

Table 5-5 Echo Shaw Basin Improvements		
Option	**Storm Sewer Improvements**	**Project Cost Opinion**
1.	Linden Street Crossing	$18,984

5.2.5 Ginger and Dogwood Basin

The Dogwood storm sewer should be upgraded from a 15-inch diameter to a to a 24-inch diameter pipeline to accommodate future development.

The South 26th Avenue Storm Sewer should be upgraded to a 27-inch diameter pipeline to accommodate future development.

Figure 5-11 illustrates the Ginger and Dogwood Basin storm sewer improvements. Table 5-6 presents the opinions of project cost.

Table 5-6 Ginger and Dogwood Basin Improvements		
Options	**Storm Sewer Improvements**	**Project Cost Opinion**
1.	Dogwood Storm Sewer	$57,076
2.	S. 26th Avenue Storm Sewer	$56,511

5.2.6 20th and 23rd Basin

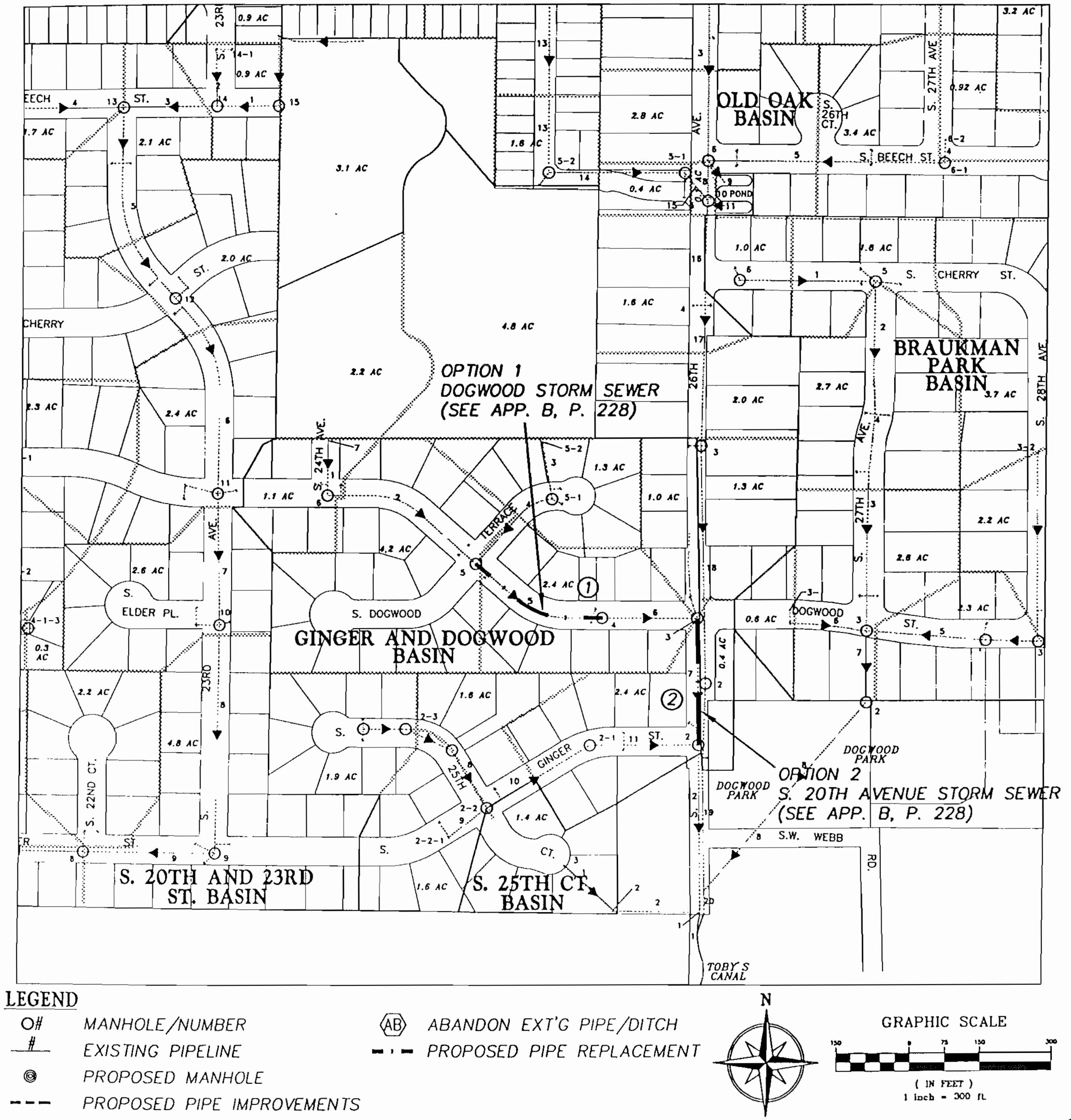
The storm sewer on South 20th Avenue from Cherry Street to Elder Place should be upgraded from 15-inch and 18-inch diameter to 18-inch diameter and 21-inch diameter, respectively to accommodate existing runoff. Future development is not expected to significantly affect the design flow.

Figure 5-12 illustrates the recommended 20th and 23rd Basin improvements.

GINGER AND DOGWOOD BASIN IMPROVEMENTS

OPTIONS 1 & 2

5-11



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STORM SEWER CAPITAL IMPROVEMENTS
GINGER AND DOGWOOD BASIN

CADFILE: 0005EX02.dwg

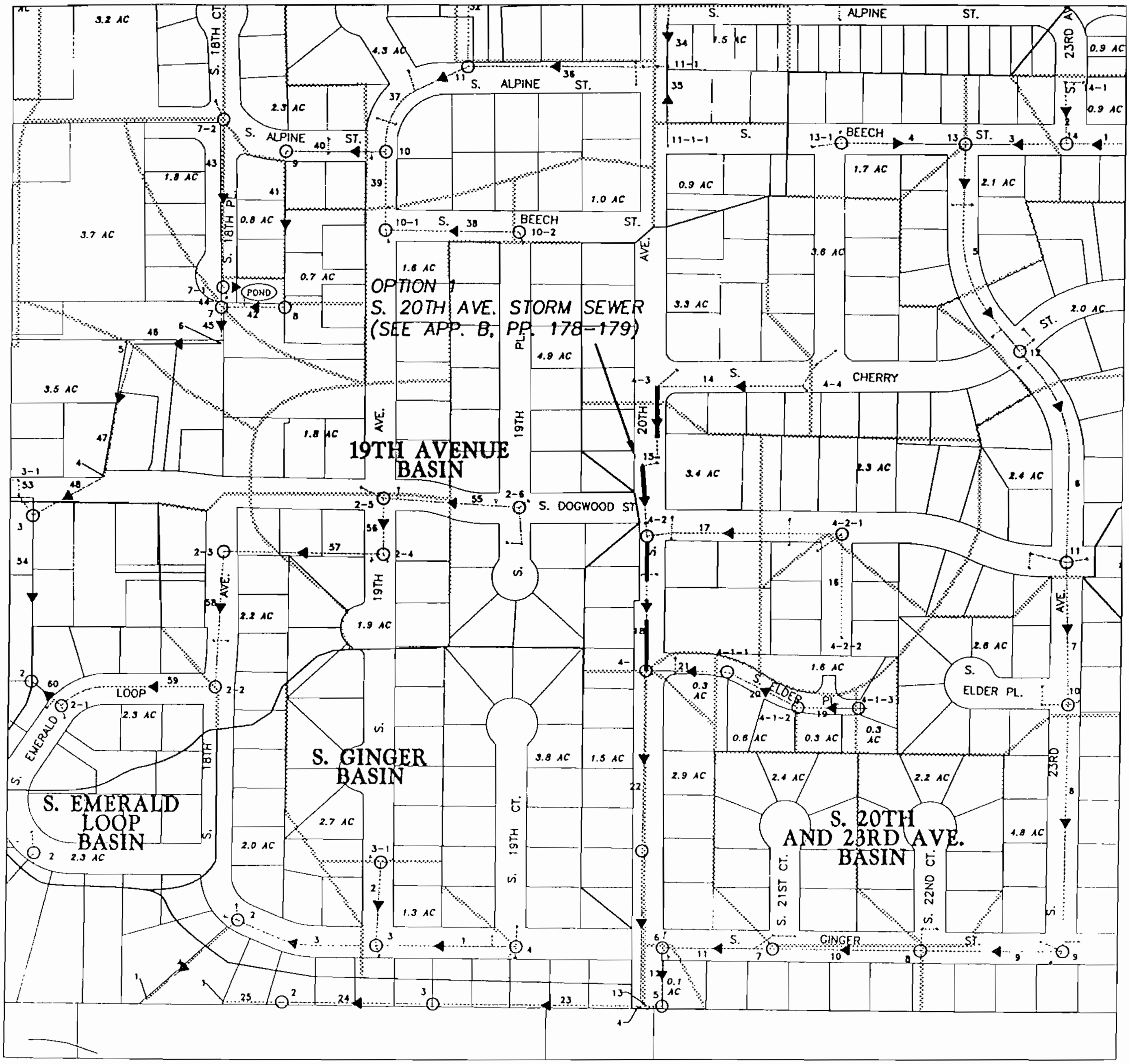
JOB NO.: 2659

DRAWING NO. 1 OF 1

S. 20TH AND 23RD AVENUES BASIN IMPROVEMENTS

OPTION 1

5-12



LEGEND

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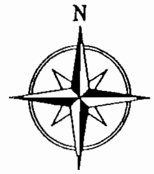
(AB)	ABANDON EXT'G PIPE/DITCH
— · —	PROPOSED PIPE REPLACEMENT



GRAPHIC SCALE

150 0 75 150 300

(IN FEET)
1 inch = 300 ft.

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STORM SEWER CAPITAL IMPROVEMENTS
S. 20TH AND 23RD AVENUES BASIN

CADFILE: 0005EX02.dwg

JOB NO.: 2659

DRAWING NO. 1 OF 1

Table 5-7 presents the opinion of project cost.

Table 5-7 20th and 23rd Basin Improvements		
Option	**Storm Sewer Improvements**	**Project Cost Opinion**
1.	S. 20th Avenue Storm Sewer	$92,453

5.3 Council Creek Basins

The capital improvement program budget for the Council Creek Basins is approximately $539,370.

5.3.1 Davis Street Basin

The Davis Street storm drainage system does not adequately capture and transport runoff; moreover, one of the outfall locations is located within private property outside a public easement. It is recommended that the storm sewer system along Davis Street be fully replaced and connected to the new outfall located off North 15th Avenue. The storm sewer would extend from North 10th Avenue to North 19th Avenue on Davis Street. A major portion of this trunk sewer was completed as the "North 13th Avenue and North Davis Street CDBG Street and Storm Sewer Improvements" after the preliminary report was completed. The cost estimates have been revised to show only that part of the work still required.

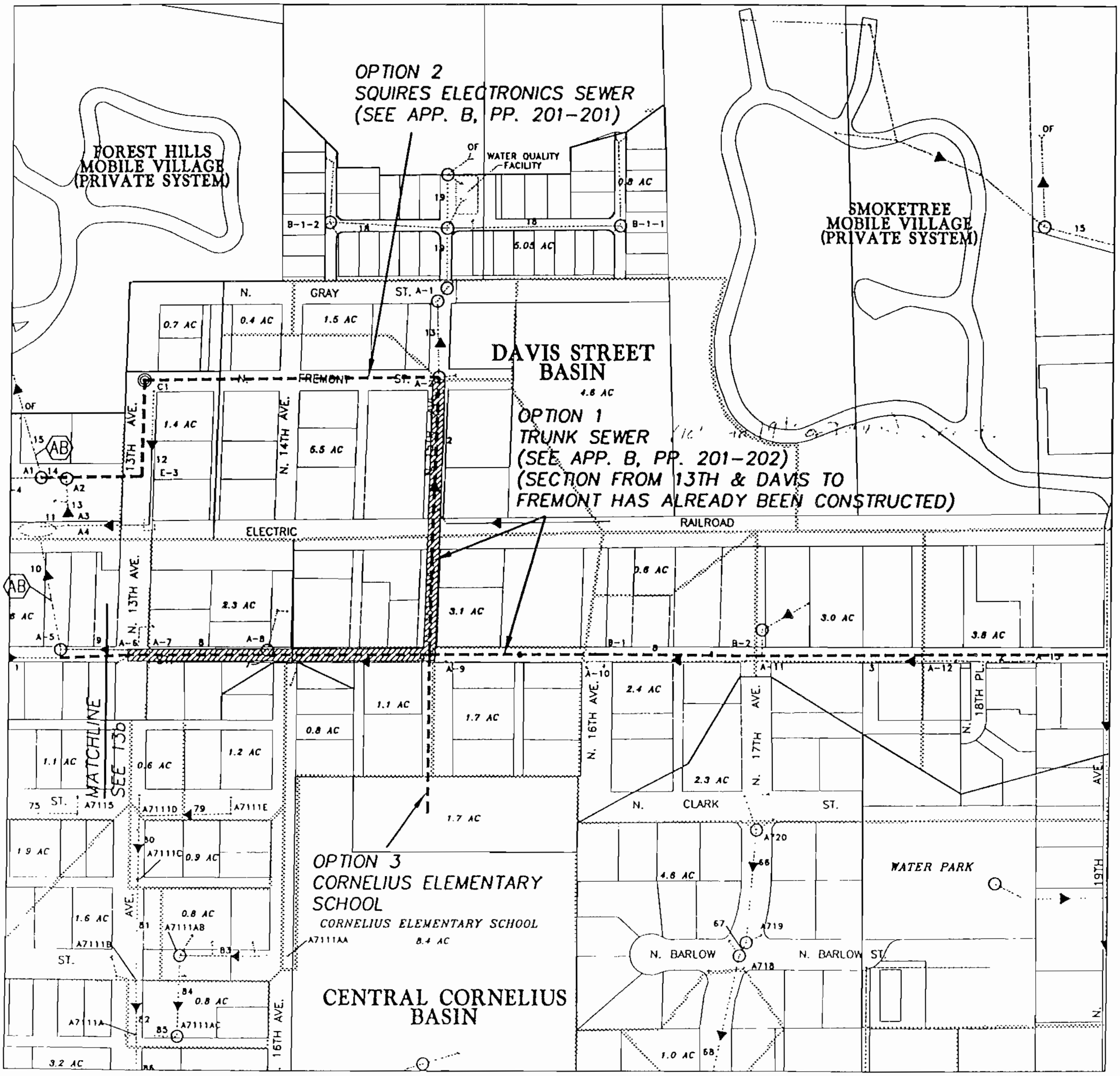
Branches will also extend along North Fremont Street to Squires Electronics on North 13th Avenue and to the northern area of Cornelius Elementary School. Figures 5-13a and 5-13b show the recommended system improvements for this basin. Table 5-8 presents the opinions of project cost.

Table 5-8 Davis Street Basin Improvements		
Options	**Storm Sewer Improvements**	**Project Cost Opinion**
1.	Trunk Sewer	$325,620
2.	Squires Electronics Sewer	$169,580
3.	Cornelius Elementary School	$43,875

N. DAVIS STREET BASIN IMPROVEMENTS

OPTIONS 1, 2 & 3

5-13a



LEGEND

O#	MANHOLE/NUMBER
#	EXISTING PIPELINE
◎	PROPOSED MANHOLE
- - -	PROPOSED PIPE IMPROVEMENTS
(AB)	ABANDON EXT'G PIPE/DITCH
— · —	PROPOSED PIPE REPLACEMENT
//////	PROPOSED PIPE REPLACEMENT/ IMPROVEMENTS COMPLETE

N

GRAPHIC SCALE

150 0 75 150 300

(IN FEET)
1 inch = 300 ft.

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STORM SEWER CAPITAL IMPROVEMENTS
DAVIS STREET BASIN
(EASTERN SECTION)

CADFILE: 0005EX02.dwg

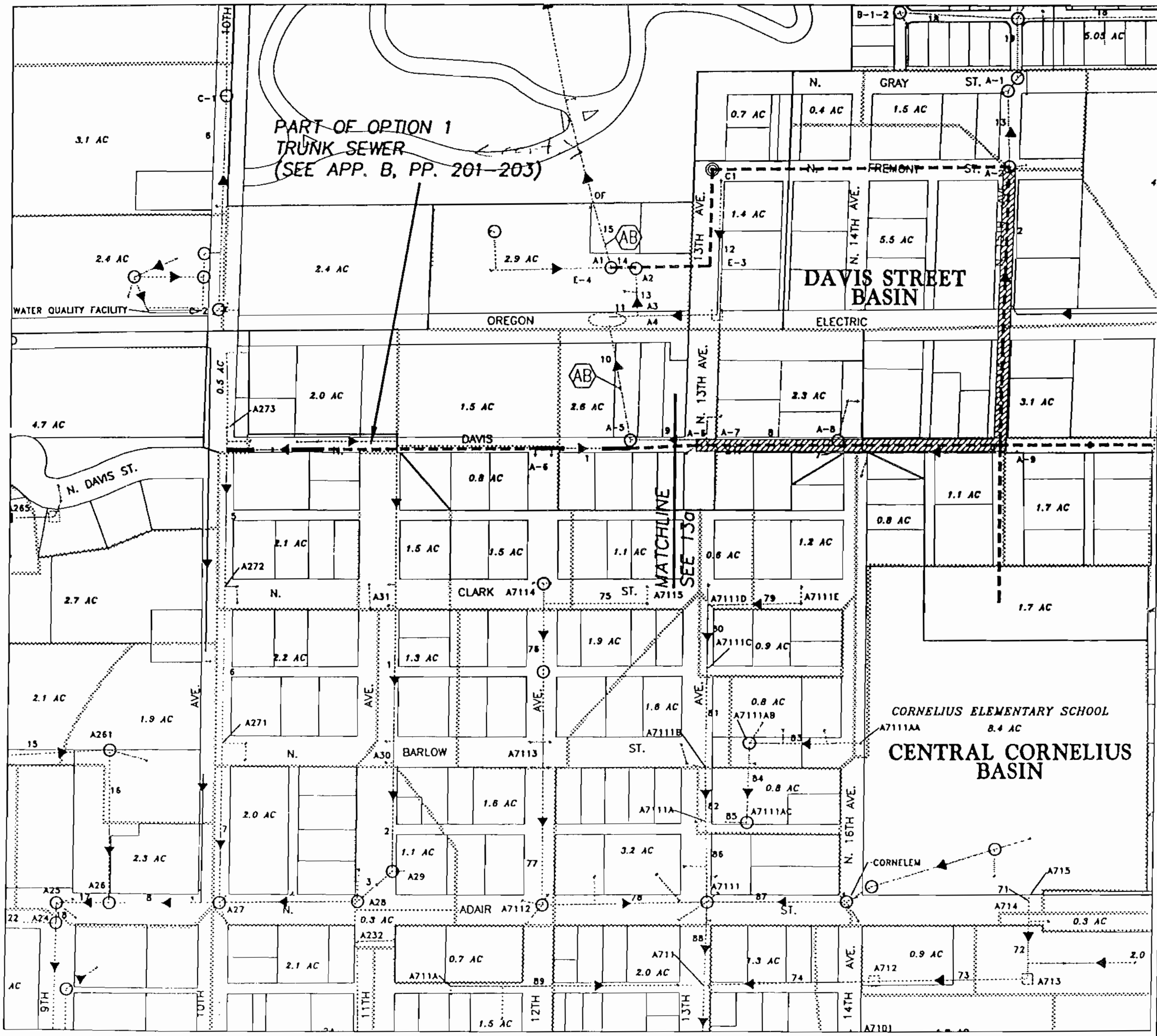
JOB NO.: 2659

DRAWING NO. 1 of 2

N. DAVIS STREET BASIN IMPROVEMENTS

OPTIONS 1, 2 & 3

5-13b



LEGEND

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- PROPOSED MANHOLE
- PROPOSED PIPE IMPROVEMENTS
- AB ABANDON EXT'G PIPE/DITCH
- PROPOSED PIPE REPLACEMENT
- PROPOSED PIPE REPLACEMENT/ IMPROVEMENTS COMPLETE

N

GRAPHIC SCALE

150 0 75 150 300

(IN FEET)
1 inch = 300 ft.

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DAVIS STREET BASIN
(WESTERN SECTION)

CADFILE: 0005EX02.dwg

JOB NO.: 2659

DRAWING NO. 2 of 2

5.3.2 Northeast Cornelius Basin

The drainage facilities in this basin are generally fully developed.

5.4 Water Quality Facilities

There is less need for a regional water quality facility for the sub basins that drain to Council Creek as compared to those draining to the Tualatin River. New development within the Council Creek sub basins will mainly occur on large parcels of land that can accommodate a water quality pond or swale. The one exception to this is the area south of the Tualatin Valley Highway that drains north. The storm sewers within the Council Creek sub basins are relatively new and are constructed at a depth that allows on-site water quality facilities to drain.

Development within the Council Creek sub basins will occur on smaller lots in commercial and residential areas; this size of the lots and the type of development may preclude the use of on-site water quality facilities. The existing storm sewers are also fairly shallow and new water quality facilities can not drain by gravity.

The City Engineer has identified the following locations for water quality facilities in the Tualatin River sub basins:

- Orchard Park
- Simply Organic Nursery
- Steamboat Park

Orchard Park is located at the end of South 15th Avenue in the South 15th Avenue basin. There are no existing water quality facilities within this 4.7-acre basin. A swale may be constructed at the outfall of the storm sewer before the wetlands to treat runoff from this residential basin.

Simply Organic Nursery is located on South 12th Avenue at the outfall of the Central Cornelius storm sewer. There are few water quality facilities (private or public) within this basin. The City is interested in acquiring the eastern portion of this lot for a new water quality facility. There is the potential that the lot could be subdivided into residential lots for the property owner to develop and a lot for the City's facility. This improvement would require that the existing 400 feet of storm sewer running diagonally through the property be replaced. A pond or swale could be constructed at a new outfall point that drains to the existing drainage way.

Steamboat Park is located at the southeastern end of the Elmyra Basin at the storm sewer outfall. The existing swale could be expanded and replanted to meet current standards to treat additional runoff from existing development within the basin.

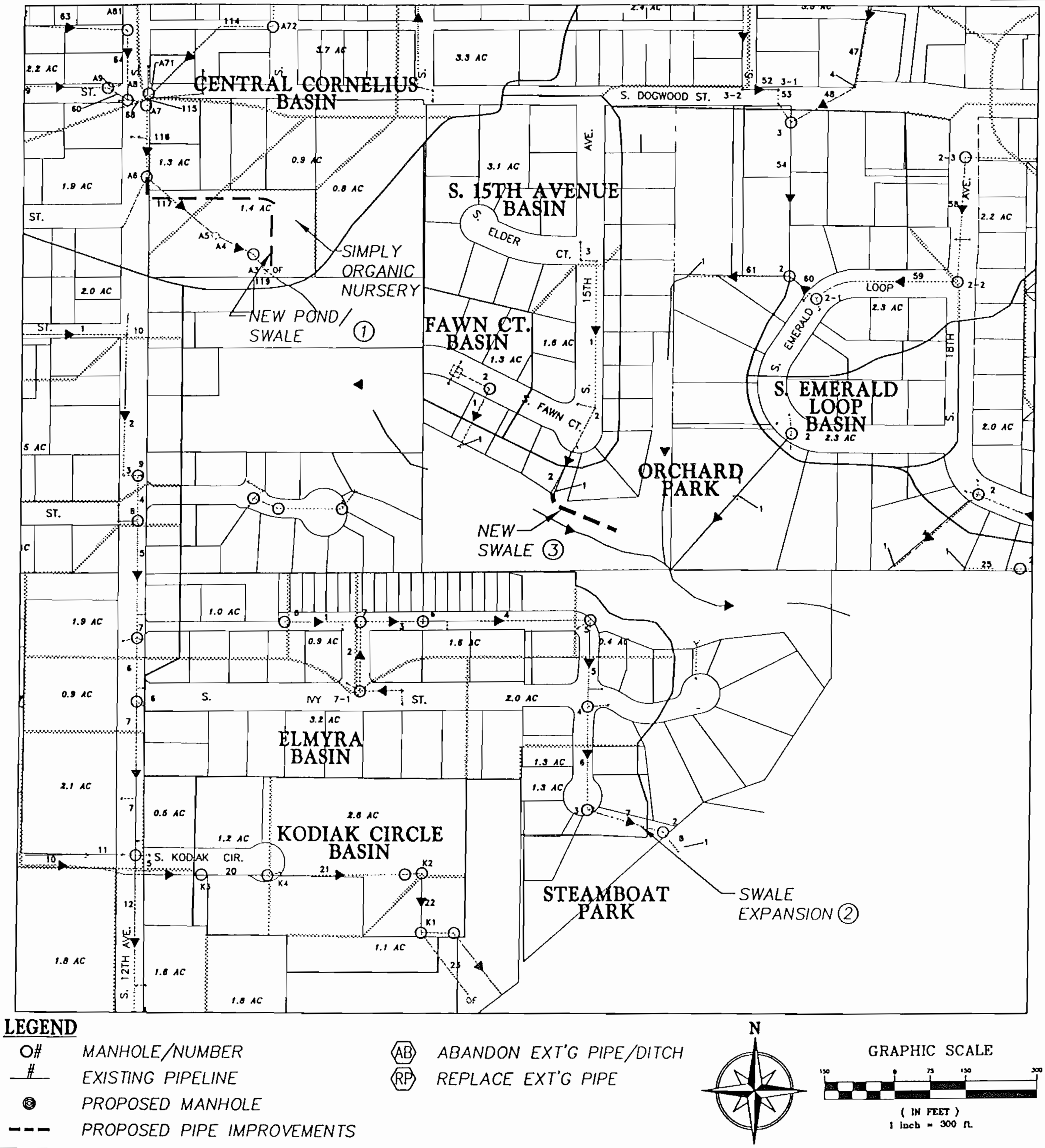
Figure 5-14 illustrates the water quality facility locations. Table 5-9 presents the opinions of project cost.

Table 5-9 Water Quality Facility Improvements

Options	Improvements	Project Cost Opinion
1.	Simply Organic Nursery Facility	$257,634
2.	Steamboat Park Facility	$9,360
3.	Orchard Park Facility	$17,550

WATER QUALITY IMPROVEMENTS
OPTIONS 1,2 & 3

5-14



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WATER QUALITY IMPROVEMENTS

CADFILE: 0005EX02.dwg

JOB NO.: 2659

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Summary of Project Options

Tables 5-10 and 5-11 summarize the individual sections of the storm sewer system listed in Tables 4-1 and 4-2 as having design flows exceeding 200 percent of pipe capacity, as well as the suggested "Basin Improvement Options" listed in this chapter. Table 5-10 also indicates which of the overloaded sections of storm sewer would be improved under a Basin Improvement Option.

Although it is ideal to address all lines having design flows exceeding 200% of pipe capacity, the policy decision has been made to generally address the Basin Improvement Options first, due to funding considerations. These Basin Improvement Options, plus water quality facilities and master plan updates are listed and prioritized in Table 5-11. The recommended options (projects) have been prioritized emphasizing lines that are at 200% of capacity or more, the potential to enhance economic development, opportunity to partner with private development, and the location of the line(s) hydraulically in its drainage basin. As such, the recommended Capital Improvement Program (CIP) summarized in Table 5-11 represents a very basic minimum program. The 2009 master plan update should carefully evaluate CIP projects completed in 2004-2008, re-evaluate and re-prioritize all SWM projects, and seek to add the numerous links over 200% of design capacity that are not addressed in the current recommended CIP.

The opinions of project cost are presented for the individual sections of pipeline for value of the existing pipeline size and for the proposed size to serve future design flows. The difference between these costs is the preliminary estimate for the value of the improvement that may be chargeable to System Development Charges. For those pipeline sections that have alternative diameters proposed, depending on whether the flow was estimated by the SCS Method or the Rational Method, the cost opinions are based on the pipeline diameters shown in **Bold** type or listed for the Basin Improvement.

Table 5-10
Individual Projects

Basin	Link Number	Existing Pipe Length (ft.)	Pipe Diameter (in.)	SCS Method % Existing Capacity	SCS Method Proposed Diameter	Rational Method % Existing Capacity	Rational Method Proposed Diameter	Cost Estimates[1] For Existing Capacity	Cost Estimates[1] For Proposed Capacity	See in alternate location
Tarrybrooke	1	155	**12**	263	**18**	771	27	$22,669	$25,026	
Tarrybrooke	3	81	18			515	36			Option 3
Tarrybrooke	5	30	12	742	27	1963	42			Option 3
Tarrybrooke	9	60	24			268	36			Option 2
Tarrybrooke	10	150	24			321	36			Option 2
Tarrybrooke	11	200	24			400	42			Option 2
Tarrybrooke	20	50	18				42			Option 3, #22
Tarrybrooke	21	260	18				36			Option 3, #24
Tarrybrooke	23	60	18			209	36			Option 3, #25
Tarrybrooke	24	60	18			209	36			Option 3
Tarrybrooke	36	135	30	555	60	866	60			Option 1c, #40
Tarrybrooke	37	184	30	457	60	726	54			Option 1c, #41
Tarrybrooke	38	200	40	210	60	333	54			Option 1c, #42
Tarrybrooke	39	200	40	220	60	354	54			Option 1c, #43
Tarrybrooke	40	200	40	210	60	337	54			Option 1c, #44
Tarrybrooke	41	100	40	220	60	354	54			Option 1c, #45
Tarrybrooke	45	240	42	216	60	354	60			Option 1c, #49
Tarrybrooke	46	70	42	223	60	366	60			Option 1c, #50
Tarrybrooke	53	300	**48**	239	**72**	403	90	$120,042	$168,480	
Tarrybrooke	60	200	**12**	338	**24**	764	24	$29,250	$37,674	
Tarrybrooke	62	190	**12**	236	**18**	539	24	$27,788	$30,677	
Tarrybrooke	63	300	**12**	260	**18**	590	24	$43,875	$48,438	
Tarrybrooke	64	190	**12**	272	**18**	621	24	$27,788	$30,677	
Tarrybrooke	67	290	**12**	378	**24**	829	27	$42,413	$54,627	
Tarrybrooke	68	270	**12**	299	**24**	658	27	$39,488	$50,860	
Tarrybrooke	72	200	**12**	203	**18**	428	24	$29,250	$32,292	
Tarrybrooke	74	370	**12**	240	**18**	508	24	$54,113	$59,740	
Tarrybrooke	77	360	**10**	510	**24**	1097	27	$67,813	$67,813	
Tarrybrooke	78	126	**12**	426	**24**	942	30	$18,428	$23,735	
Tarrybrooke	85	230	12	321	24	343	54			Option 1b, #86
Tarrybrooke	86	400	12	546	24	682	66			Option 1b, #87

[1]Costs have been adjusted to 2004 dollars from a 2000 dollar base in the October 2001 SD/SWM report by appliying an average 4% per year

Table 5-10

Individual Projects

Basin	Link Number	Existing Pipe Length (ft.)	Pipe Diameter (in.)	SCS Method % Existing Capacity	SCS Method Proposed Diameter	Rational Method % Existing Capacity	Rational Method Proposed Diameter	Cost Estimates[1] For Existing Capacity	Cost Estimates[1] For Proposed Capacity	See in alternate location
Tarrybrooke	87	200	12	657	27	909	66			Option 1b, #88
Tarrybrooke	89	207	12	454	24	696	66			Option 1b, #90
Tarrybrooke	90	363	12	463	24	720	66			Option 1b, #91
Tarrybrooke	93	570	**10**	299	**18**	603	24	$80,028	$92,032	
Tarrybrooke	94	92	**10**	316	**18**	576	24	$12,917	$14,854	
Tarrybrooke	105	139	**72**	257	**108**	423	132	$78,062	$105,710	
Central Cornelius	15	273	**15**	277	**24**	531	30	$42,482	$51,425	
Central Cornelius	17	100	**24**			249	**42**	$18,837	$25,623	
Central Cornelius	18	60	**24**		36	433	**48**	$11,302	$24,008	
Central Cornelius	23	250	**24**			245	**42**	$47,093	$64,058	
Central Cornelius	28	50	**36**				**48**	$10,940	$20,007	
Central Cornelius	31	190	**12**			305	**24**	$27,788	$35,790	
Central Cornelius	32	450	**12**			228	**18**	$65,813	$72,657	
Central Cornelius	33	100	24	385	42	932	60			Option 1
Central Cornelius	34	210	18	353	42	852	48			Option 1
Central Cornelius	38	120	18	282	30	672	42			Option 1
Central Cornelius	40	250	18	500	36	1196	54			Option 1
Central Cornelius	41	150	24		36	330	42			Option 1
Central Cornelius	42	157	24	254	36	600	54			Option 1
Central Cornelius	50	137	24		36	443	48			Option 1
Central Cornelius	51	122	24	265	36	620	54			Option 1
Central Cornelius	54	60	24			200	36			Option 1
Central Cornelius	55	110	18	400	36	929	48			Option 1
Central Cornelius	57	120	18	854	42	1990	60			Option 1
Central Cornelius	58	128	18	274	30	639	42			Option 1
Central Cornelius	59	283	24			305	42			Option 1
Central Cornelius	60	50	24			315	42			Option 1
Central Cornelius	61	187	15	334	27	782	36			Option 1
Central Cornelius	62	177	15	277	24	782	36			Option 1
Central Cornelius	63	276	15	336	27	783	36			Option 1

[1]Costs have been adjusted to 2004 dollars from a 2000 dollar base in the October 2001 SD/SWM report by appliying an average 4% per year

Table 5-10 Individual Projects										
		Existing		SCS Method		Rational Method		Cost Estimates[1]		
Basin	Link Number	Pipe Length (ft.)	Pipe Diameter (in.)	% Existing Capacity	Proposed Diameter	% Existing Capacity	Proposed Diameter	For Existing Capacity	For Proposed Capacity	See in alternate location
Central Cornelius	64	147	15	320	27	745	36			Option 1
Central Cornelius	66	220	**8**	277	**15**	532	24	$29,601	$29,260	
Central Cornelius	68	300	**10**	928	**27**	1648	36	$42,120	$48,300	
Central Cornelius	71	60	15		24	407	36			Option 3
Central Cornelius	72	120	**18**				**27**	$18,252	$22,604	
Central Cornelius	73	320	**18**			219	**30**	$48,672	$63,274	
Central Cornelius	74	320	**18**			244	**30**	$48,672	$63,274	
Central Cornelius	78	330	**18**				**24**	$50,193	$62,162	
Central Cornelius	86	160	**10**	257	**15**	672	24	$22,464	$24,898	
Central Cornelius	87	270	**15**				**24**	$42,015	$50,860	
Central Cornelius	88	160	**24**				**36**	$30,139	$35,006	
Central Cornelius	90	130	**24**			281	**42**	$24,488	$33,310	
Central Cornelius	91	320	**8**			210	**12**	$43,056	$46,800	
Central Cornelius	95	50	**24**			245	**42**	$9,419	$12,812	
Central Cornelius	103	60	24	344	42	839	60			Option 2
Central Cornelius	105	80	24			286	42			Option 2
Central Cornelius	106	175	24			360	48			Option 2
Central Cornelius	107	280	24			393	48			Option 2
Central Cornelius	109	310	24			407	48			Option 2
Central Cornelius	110	300	8	223	12	505	15			Option 2
Central Cornelius	111	280	8	316	15	704	18			Option 2
Central Cornelius	113	130	24	207	36	490	48			Option 2
Central Cornelius	114	300	24	284	42	670	54			Option 2
Central Cornelius	116	158	36			419	72			Option 2
19th Avenue	8	50	**18**				**24**	$7,605	$9,419	
19th Avenue	13	70	18			330	36			Option 2
19th Avenue	21	625	12	229	18	739	27			Option 2
19th Avenue	23	459	12			284	24			Option 2

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Table 5-10
Individual Projects

Basin	Link Number	Existing Pipe Length (ft.)	Pipe Diameter (in.)	SCS Method: % Existing Capacity	SCS Method: Proposed Diameter	Rational Method: % Existing Capacity	Rational Method: Proposed Diameter	Cost Estimates[1]: For Existing Capacity	Cost Estimates[1]: For Proposed Capacity	See in alternate location
19th Avenue	24	490	12			469	24			Option 2
19th Avenue	31	70	18	603	42	1450	48			Option 1
19th Avenue	32	236	18	237	27	570	42			Option 1
19th Avenue	37	245	24			241	42			Option 1
19th Avenue	40	190	**24**	228	**36**	534	54	$35,790	$41,570	
19th Avenue	41	280	**24**	172	**36**	405	48	$52,744	$61,261	
19th Avenue	42	120	**24**	214	**36**	502	54	$22,604	$26,255	
19th Avenue	45	80	**24**		**36**	415	48	$15,070	$17,503	
19th Avenue	48	150	**24**		**36**	407	48	$28,256	$32,819	
19th Avenue	49	120	**8**	1000	0	1000	0		$0	
Echo Shaw School	2	122	10		15					Option 1
Ginger & Dogwood	5	303	15	205	24					Option 1
Ginger & Dogwood	7	300	18		27					Option 2
20th and 23rd	15	290	12	217	18					Option 1
20th and 23rd	18	260	15	213	21					Option 1
Davis St.	1	800	8		12					Option 1
Davis St.	2	151	8	294	15					Option 1
Davis St.	3	180	8	508	18					Option 1
Davis St.	4	187	8	327	15					Option 1
Davis St.	5	349	8	730	24					Option 1
Davis St.	6	275	8	1240	24					Option 1
Davis St.	7	359	8	855						Done
Davis St.	8	255	8	882						Done
Davis St.	9	150	10	385	24					Option 1
Davis St.	10	250	10	437						Flow bypassed
Davis St.	11	60	12	249						Flow bypassed
Davis St.	13	90	12	261						Flow bypassed

[1]Costs have been adjusted to 2004 dollars from a 2000 dollar base in the October 2001 SD/SWM report by applying an average 4% per year

Table 5-10 Individual Projects										
		Existing		SCS Method		Rational Method		Cost Estimates[1]		
Basin	Link Number	Pipe Length (ft.)	Pipe Diameter (in.)	% Existing Capacity	Proposed Diameter	% Existing Capacity	Proposed Diameter	For Existing Capacity	For Proposed Capacity	See in alternate location
Davis St.	14	75	12	258						Flow bypassed
Davis St.	15	130	15	211						Flow bypassed
Davis St.	19	65	12							Private system
Davis St.	23	268	8							Private system
Northeast Cornelius	8	485	**12**		**15**		24	$70,931	$75,471	
Northeast Cornelius	13	170	**12**	227	**18**	538	27	$24,863	$27,448	
Northeast Cornelius	15	30	**12**		**18**	460	27	$4,388	$4,844	
Northeast Cornelius	44	4	18	1000	0	1000	0			Removed
Northeast Cornelius	46	160	48	1000	0	1000	0			Removed
Northeast Cornelius	50	40	12			228				Removed
Old Oak	9	55	**12**	325	**21**			$8,044	$8,249	
Old Oak	11	44	**12**	215	**21**			$6,435	$7,722	
	TOTAL COST OF INDEPENDENT STORM SEWER SECTIONS							$1,603,993	$1,941,324	
	DIFFERENCE CHARGEABLE TO SDC FUND								$337,331	
New Piping - Tarrybrooke Basin Bypass										
Option 1a										
Rational Method	33	340	0				54		$143,208	
Page 412	34	746	0				54		$314,215	
	37	867	0				54		$365,180	
	38	1456	0				54		$613,267	
	39	500	0				54		$210,600	
									$1,646,471	
Option 1b										
Rational Method	33	340	0				54		$143,208	

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Table 5-10
Individual Projects

Basin	Link Number	Existing Pipe Length (ft.)	Pipe Diameter (in.)	SCS Method: % Existing Capacity	SCS Method: Proposed Diameter	Rational Method: % Existing Capacity	Rational Method: Proposed Diameter	Cost Estimates[1]: For Existing Capacity	Cost Estimates[1]: For Proposed Capacity	See in alternate location
Pages 412, 445	34	746	0				54		$314,215	
	37	867	0				54		$365,180	
	38	225	0				54		$94,770	
	86	230	12				54	$33,638	$96,876	
	87	400	12				66	$58,500	$205,920	
	88	200	12				66	$29,250	$102,960	
	90	207	12				66	$30,274	$106,564	
	91	363	12				66	$53,089	$186,872	
								$204,750	**$1,616,566**	
Option 1c										
Rational Method	36	135	30				60	$26,694	$63,180	
Pages 439-440	37	184	30				54	$36,382	$77,501	
	38	200	40				54	$48,906	$84,240	
	39	200	40				54	$48,906	$84,240	
	40	200	40				54	$48,906	$84,240	
	41	100	40				54	$24,453	$42,120	
	45	240	42				60	$61,495	$112,320	
	46	70	42				60	$17,936	$32,760	
								$313,678	**$580,601**	
Option 2	8, now 7	250	18				30	$40,365	$49,433	
Page 433	9	60	24			Rational	36	$11,302	$13,127	
	10	150	24			Rational	36	$28,256	$32,819	
	11	200	24			SCS	42	$37,674	$51,246	
								$117,597	**$146,624**	
Option 3										
Rational Method	2	450	0				36		$98,456	
Pages 433-437	3	81	18				36	$13,078	$17,722	
	4	402	0				42		$103,004	

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Table 5-10 Individual Projects										
		Existing		SCS Method		Rational Method		Cost Estimates[1]		
Basin	Link Number	Pipe Length (ft.)	Pipe Diameter (in.)	% Existing Capacity	Proposed Diameter	% Existing Capacity	Proposed Diameter	For Existing Capacity	For Proposed Capacity	See in alternate location
	8	790	0				27		$148,812	
	18	120	0				36		$26,255	
	19	470	0				24		$88,534	
	20	50	18				42	$7,605	$12,812	
	21	456	0				12		$66,690	
	22	260	18				36	$39,546	$56,885	
	23	520	0				18		$83,959	
	24	60	18				36	$9,126	$13,127	
	25	60	18				36	$9,126	$13,127	
	26	400	0				12		$58,500	
	27	350	0				12		$51,188	
	28	160	0				36		$35,006	
								$78,481	**$874,078**	
New Piping - Central Cornelius Basin										
Option 1	33	100	36			Rational	60	$21,879	$46,800	
SCS, page 188-192	34	210	18			Rational	42	$31,941	$53,808	
Rational, Page 395	38	120	18			SCS	30	$18,252	$23,728	
	40	250	18			SCS	36	$38,025	$54,698	
	41	150	24			SCS	36	$28,256	$32,819	
	42	157	24			SCS	36	$29,574	$34,350	
	50	137	24			SCS	36	$25,807	$29,974	
	51	122	24			SCS	36	$22,981	$26,692	
	61	187	15			SCS	27	$29,099	$35,225	
	62	177	15			SCS	24	$27,543	$33,341	
	63	276	15			SCS	27	$42,948	$51,990	
	64	147	15			SCS	27	$22,875	$27,690	
	55	110	18			SCS	36	$16,731	$24,067	

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Table 5-10 Individual Projects										
		Existing		SCS Method		Rational Method		Cost Estimates[1]		
Basin	Link Number	Pipe Length (ft.)	Pipe Diameter (in.)	% Existing Capacity	Proposed Diameter	% Existing Capacity	Proposed Diameter	For Existing Capacity	For Proposed Capacity	See in alternate location
	57	120	18			SCS	42	$18,252	$30,748	
	58	128	18			SCS	30	$19,469	$25,309	
	59	283	24			SCS	30	$53,309	$55,958	
	60	50	24			SCS	30	$9,419	$9,887	
	59	43	36				48	$9,408	$17,206	
								$465,766	**$614,290**	
Option 2	Calc/Map									
SCS Method	97/103	60	24				42	$11,302	$28,080	
Pages 197-199	99/105	80	24				27	$15,070	$15,070	
	100/106	175	24				30	$32,965	$34,603	
	101/107	280	24				36	$52,744	$61,261	
	103/109	310	24				36	$58,395	$67,825	
	104/110	300	8				12	$40,365	$43,875	
	105/111	280	8				15	$37,674	$43,571	
	107/113	130	24				36	$24,488	$28,443	
	108/114	300	24				42	$56,511	$126,360	
	110/116	158	36				48	$34,569	$63,222	
	115	7	36				48	$1,532	$2,801	
								$365,613	**$515,110**	
Option 3										
Rational Method	63/69	170	0				12		$24,863	
Page 399	64/70	450	0				24		$84,767	
	65/71	60	15				36	$9,337	$13,127	
								$9,337	**$122,756**	
New Piping - 19th/SPRR/Emerald										
Option 1										
Rational Method	29	110	0				42		$28,185	
Pages 427-430	30	50	0				42		$12,812	

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Table 5-10 Individual Projects										
		Existing		SCS Method		Rational Method		Cost Estimates[1]		
Basin	Link Number	Pipe Length (ft.)	Pipe Diameter (in.)	% Existing Capacity	Proposed Diameter	% Existing Capacity	Proposed Diameter	For Existing Capacity	For Proposed Capacity	See in alternate location
	31	70	18				48	$10,647	$28,010	
	32	236	18				42	$35,896	$60,470	
	37	245	24				42	$46,151	$62,776	
	38	150	24				48	$28,256	$60,021	
	40	515	0				48		$206,072	
	42	308	0				48		$123,243	
	43	112	0				42		$28,698	
	45	263	15				48	$40,925	$105,237	
	46	314	15				48	$48,862	$125,644	
	47	96	18				42	$14,602	$24,598	
	62	160	24				42	$30,139	$40,997	
								$255,477	**$906,763**	
Option 2										
Rational Method	6	530	0				15		$82,473	
Pages 381-384	12	140	0				12		$20,475	
	13	70	18				36	$10,647	$153,317	
	19	390	18				18	$62,969	$62,969	
	21	625	12				15	$91,406	$97,256	
	22	263	0				18		$42,464	
	23	459	12				18	$67,129	$74,110	
	24	490	12				24	$71,663	$92,301	
	25	330	0				24		$62,162	
	26	69	0				30		$13,643	
								$303,814	**$701,172**	
Option 3										
SCS Method	1	220	12				12	$32,175	$32,175	
Page 168	2	400	15				12	$62,244	$58,500	
	3	280	18				18	$42,588	$45,209	

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Table 5-10 Individual Projects										
		Existing		SCS Method		Rational Method		Cost Estimates[1]		
Basin	Link Number	Pipe Length (ft.)	Pipe Diameter (in.)	% Existing Capacity	Proposed Diameter	% Existing Capacity	Proposed Diameter	For Existing Capacity	For Proposed Capacity	See in alternate location
								$137,007	**$135,884**	
New Piping - Echo Shaw Basin										
Echo Shaw School	2	122	10				15	**$17,129**	**$18,984**	
SCS Method										
Page 205										
New Piping - Ginger and Dogwood Basin										
SCS method										
Option 1, Page 228										
Ginger & Dogwood	5	303	15				24	**$47,150**	**$57,076**	
Option 2, Page 228										
Ginger & Dogwood	7	300	18				27	**$45,630**	**$56,511**	
New Piping - South 20th and 23rd Avenue										
Option 1	15	290	12	217			18	$42,413	$46,823	
SCS Method	18	260	15	213			21	$40,459	$45,630	
Pages 178-179								**$82,871**	**$92,453**	
New Piping - Davis Street Basin										
Option 1	1	800	8				12	$107,640	$117,000	
SCS Method	2	151	8	294			15	$20,317	$23,497	
Page 201-202	3	180	8	508			18	$24,219	$29,063	
	4	187	8	327			15	$25,161	$29,099	
	5	349	8	730			24	$46,958	$65,741	
	6	275	8	1240			24	$37,001	$51,802	

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Table 5-10
Individual Projects

Basin	Link Number	Existing Pipe Length (ft.)	Pipe Diameter (in.)	SCS Method % Existing Capacity	SCS Method Proposed Diameter	Rational Method % Existing Capacity	Rational Method Proposed Diameter	Cost Estimates[1] For Existing Capacity	Cost Estimates[1] For Proposed Capacity	See in alternate location
	9	50	10	385			24	$7,020	$9,419	
								$268,316	**$325,620**	
Option 2		170	0				12		$24,863	
SCS Method		330	0				15		$51,351	
Pages 201-202		300	0				15		$46,683	
		300	0				15		$46,683	
									$169,580	
Option 3										
SCS Method		300	0				12		**$43,875**	
Water Quality Facilities										
Option 1 - Simply Organic Nursery			0						**$257,634**	
Option 2 - Steamboat Park			0						**$9,360**	
Option 3 - Orchard Park			0						**$17,550**	

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Table 5-11
City of Cornelius
Summary of Recommended SWM Capital Improvement Program

CIP No.	Project	Recommended Ranking	Est.Total Cost in 2004 $	O&M Costs	SDC Eligible Costs	2004-2008	2009-2013	2014-2018	2019-2024
Collection System Pipelines									
P001	Davis Street, Option 1	1	$325,620	$268,316	$57,304	$325,620			
P002	19th Avenue, Option 1	2	$906,763	$255,477	$651,286	$906,763			
P003	Tarrybrooke, Option 1c (Alternative to 1a)	3	$580,601	$313,678	$266,923		$580,601		
P004	Central Cornelius, Option 1	5	$614,290	$465,766	$148,523		$614,290		
P005	Tarrybrooke, Option 3	6	$874,078	$78,481	$795,596			$874,078	
P006	Davis Street, Option 2	7	$169,580	$0	$169,580			$169,580	
P007	19th Avenue, Option 2	8	$701,172	$303,814	$397,358			$701,172	
P008	Tarrybrooke, Option 2	9	$146,624	$117,597	$29,027				$146,624
P009	Central Cornelius, Option 2	11	$515,110	$365,613	$149,497				$515,110
P010	19th Avenue, Option 3	12	$135,884	$135,884	$0				$135,884
P011	Echo Shaw	13	$18,984	$17,129	$1,855				$18,984
P012	Central Cornelius, Option 3	14	$122,756	$9,337	$113,420				$122,756
P013	20th and 23rd Avenue	15	$92,453	$82,871	$9,582				$92,453
P014	Ginger and Dogwood, Option 1	16	$57,076	$47,150	$9,926				$57,076
P015	Ginger and Dogwood, Option 2	17	$56,511	$45,630	$10,881				$56,511
P016	Davis Street, Option 3	18	$43,875	$0	$43,875				$43,875
Water Quality Facilities									
W001	Water Quality Facilities, Option 1	4	$257,634	$0	$257,634		$257,634		
W002	Water Quality Facilities, Option 2	10	$9,360	$0	$9,360				$9,360
W003	Water Quality Facilities, Option 3	19	$17,550	$0	$17,550				$17,550
Recommended Studies									
R001	SWM Master Plan 2009		$35,000	$17,500	$17,500		$35,000		
R002	SWM Master Plan 2014		$35,000	$17,500	$17,500			$35,000	
R003	SWM Master Plan 2019		$35,000	$17,500	$17,500				$35,000
Total			**$5,750,922**	**$2,559,243**	**$3,191,678**	**$1,232,383**	**$1,487,525**	**$1,779,830**	**$1,251,183**

NOTE: "option" in this useage refers to a grouping of several small projects to be done at one time for efficiency, cost effectiveness, and hydraulic continuity. Table 5-10 lists the specific smaller projects that make up each "option". Whenever possible, building a complete "option" is recommended vs. any of the individual small projects making up the "option."

Costs have been adjusted to 2004 dollars from a 2000 dollars base in the October 2001 SD/SWM report by applying an average 4% per year construction/engineering inflation cost for 2001-2004.

Chapter 6
Financial Review of CIP

6.1 Current Rates and Charges

The City currently maintains a storm drainage/surface water management (SD/SWM) fund, Fund #05 and a SD/SWM system development charges (SDC) fund, Fund #25 for its storm drainage and surface water management needs. The SD/SWM Fund #05 is the City's main account for tracking the operations of its SD/SWM system. Revenue sources for this fund include the City's rates and charges for SD/SWM service as well as other miscellaneous funds. Personal services, materials and services, and capital outlays are expenditures accounted for in the SD/SWM Fund #05.

The City also maintains a SD/SWM system development charges Fund #25. The source of funding for this account is from the collection of system development charges. The fund is used to pay for capital outlay programs that are growth related.

The proposed FY 2004-2005 city budget consolidates Funds #5 and #25 into a new single fund, Fund #4. Additionally, a SD/SWM fixed assets fund, Fund #15, is proposed to track all SD/SWM related fixed assets and capital projects.

6.2 Recommended Capital Improvements Program (CIP)

The SD/SWM Master Plan CIP is described in detail in Chapter 5 of this report. Many needed improvements are defined in the CIP. The capital improvements have been separated between those that are renewal and replacement and hence are paid for through monthly user rates and those which are growth related which can be funded via system development charges. A summary of the CIP for financial planning purposes is provided in Table 6-1.

Table 6-1
City of Cornelius
Recommended Capital Improvements Program Summary
(For Financial Planning Purposes)

Project Type	**2004-2008**	**2009-2013**	**2014-2018**	**2019-2024**
Operations Related Costs				
Collection System Pipelines	$523,793.00	$779,444.00	$382,295.00	$821,211.00
SWM Master Plan		17,500.00	17,500.00	$17,500.00
Total Operations Related	**$523,793.00**	**$796,944.00**	**$399,795.00**	**$838,711.00**
Growth Related Costs				
Collection System Pipelines	$708,590.00	$415,447.00	$1,362,535.00	$368,063.00
Water Quality Facilities	$0	257,634.00	$0	$26,910.00
SWM Master Plan	$0	17,500.00	$17,500.00	17,500.00
Total Growth Related	**$708,590.00**	**$690,581.00**	**$1,380,035.00**	**$412,473.00**
Total CIP	**$1,232,383.00**	**$1,487,525.00**	**$1,779,830.00**	**$1,251,184.00**

The complete CIP recommends $1,232,383.00 for the FY 2004-2008. For FY 2009-2013, $1,487,525.00; FY 2014-2018, $1,779,830.00; and FY 2019-2024, $1,251,184.00. It is important to note that these CIP cost are split between rate funded (O&M) and growth funded (SDC's). Both monthly water rates and water SDC fees will need to be increased to fund the recommended SD/SWM system CIP.

6.3 Comprehensive Utility Rate Study

To determine the best options to fund the recommended SD/SWM system CIP, a comprehensive utilities rate study for water, sewer, and storm drainage is scheduled for late Summer 2004. This comprehensive study will evaluate utility system Master Plans, utility Operational and Equipment Plans, and the ability to fund these plans at current monthly user rates and SDC rates All three utilities, water, sewer, and storm drainage, will be evaluated at the same time. Where rates are insufficient, the study will recommend various financial alternatives for the City Council's consideration.

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APPENDIX A

STORM SEWER DESIGN STANDARDS

STORM SEWER STANDARDS

A.1 Permitting Process

New development projects shall be submitted to the City or Agency staff to make a “pre-screening“ determination of whether your property is likely to require a site assessment under CWS’s Design and Construction Standards. The City or Agency staff will provide you with documentation of their determination.

If a pre-screening determines that it is likely that there are water quality sensitive areas on or near your site, an initial site assessment will be required. A natural resource assessment may also be required if water quality sensitive areas are present on or within 200 feet of your site. A Sensitive Area Certification form, Natural Resource Assessment, Alternative Analysis (if required), and a site plan must be submitted to CWS. Chapter 2 of CWS’s Design and Construction Standards describes these requirements. CWS will provide a Service Provider Letter when it has reviewed and concurred with your proposed site plan.

If the pre-screening determines that it is not likely that there are water quality sensitive areas on or near the property, you may proceed with the land use, site design, and building permit application processes.

Before obtaining your building permit or site development permit, you must submit your pre-screening determination or Service Provider Letter to CWS with the proposed site plan. CWS will review the information to verify that it meets the Agency’s requirements for water quality protection and issue a Storm water Connection Permit.

A.2 Design Standards

The following table provides an overview of the storm sewer design standards for use in the City of Cornelius.

Design Item	CWS / Cornelius	ODOT
Conveyance System Design Storm	24-hour, 25-year event	10-year event, 50-year event in sags
Catch Basin Design Storm	10-year event	5-minute, 10-year event; 5-minute, 50-year event in sags
Hydrologic Analysis Method	Santa Barbara Urban Hydrograph (SBUH)	Rational
Outfall Design Elevation	Above the mean low water level	Per Oregon Drainage Law
Downstream Analysis	1. To a point where the additional flow is 10% or less of the total tributary flow. 2. If the additional flow is <10% of the total tributary flow then the analysis extends a. ¼ mile, or b. Until the additional flow is <5% of the total tributary flow.	Per Oregon Drainage Law
Storm Sewer Collection System Type	1. Standard – Mainline shall not pass through catch basins. 2. Flow-through – Mainline may pass through catch basins (for use on arterial and collector streets only) and pollution control manholes.	1. Flow-through – Mainline may pass through sumped catch basins 2. Open Channel 3. Open Channel / Closed Conduit Combination
Pipeline Placement	1. 5 feet minimum from the curb line within the paved roadway, or 2. Parallel and behind the curb on arterial and collector streets	No Requirement
Manhole Spacing	Every 500 feet and at all grade and alignment changes	Every 250 feet and at all grade and alignment changes

Design Item	CWS / Cornelius	ODOT
Blind Connections	Acceptable for connections of laterals at least one pipe diameter smaller than the mainline. Acceptable methods in order of preference: 1. Tee 2. Inserta Tee 3. Saddle	Not Allowed
Catch Basin Laterals	10-inch diameter minimum	12-inch diameter minimum
Private Site Laterals	• All new development shall drain to the public system through a storm sewer lateral; curb openings will not be allowed. • Size laterals according to the Uniform Plumbing Code	• No requirement • 12" diameter minimum size
Trunk Storm Sewer	12-inch diameter minimum	12-inch diameter minimum
Type of Pipe (in order of preference)	1. PVC D3034 2. PVC C-900 3. (Pipeline shall be white to distinguish from sanitary sewer) 4. Ductile Iron 5. Concrete Tracer wire shall be installed with all non-conductive pipe.	RCP Cl. IV minimum Tracer wire shall be installed with all non-conductive pipe.
Type of Catch Basins (in order of preference)	1. CG-48 with manhole lid 2. CG-30 3. CG-2 All catch basins shall be sumped.	1. CG-3 2. CG-2, modified with 18" (450mm) sump 3. Other types as shown in 5.5.2 of the ODOT manual

Design Item	CWS / Cornelius	ODOT
Catch Basin Locations	1. Per design storm capacity and spacing needs. 2. Before to curb returns on street with 3%+ grade and 100'+ gutter drainage run. 3. Per ODOT	1. Low point in sag curve. 2. Upstream side of crosswalk or intersection. 3. At intersections with side streets that drain toward highway.

A.3 Design Manuals

1. Clean Water Services Design and Construction Standards for Sanitary Sewer and Surface Water Management-March 2004 - Resolution and Order No. CWS 04-9
    a. Chapter 2 CWS Administrative Provisions
    b. Chapter 3 Standard Design Requirements for Storm and Surface Water
    c. Appendix A – Hydrology and Hydraulics
    d. Appendix B – Water Quality and Quantity Facility Design

ODOT Hydraulics Manual