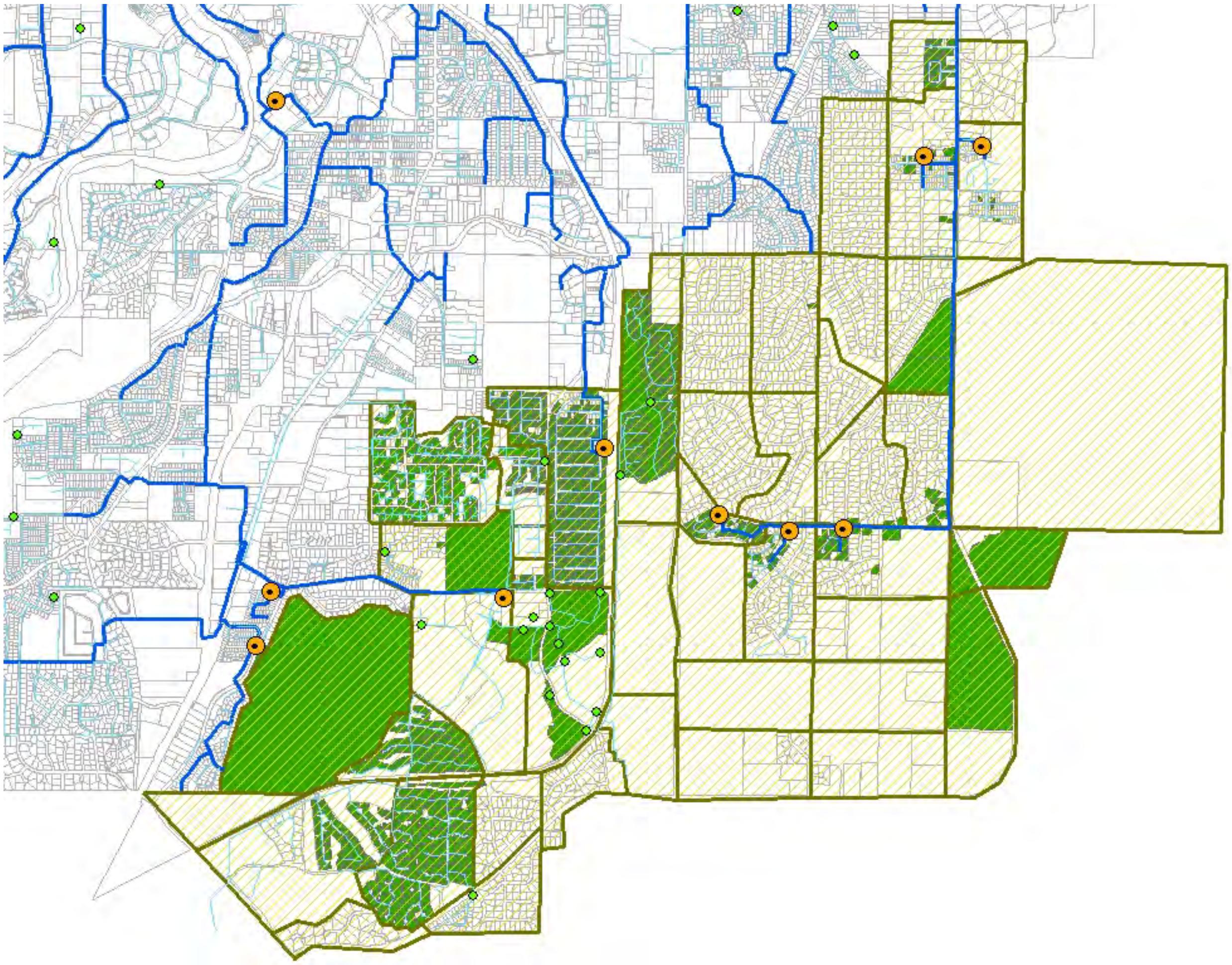

City of Bend
SE Area Interceptor
Preliminary Evaluation

December 2005

MWH

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SE Area Interceptor
Preliminary Evaluation

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MWH Americas, Inc.
111 SW 5th Ave, Suite 1770
Portland, OR 97204-3604

Table of Contents

BACKGROUND

The City of Bend, Oregon (City) has contracted with MWH Americas, Inc. (MWH) to perform a preliminary evaluation of the wastewater collection needs for the Southeast Area of Bend (SE Area). This evaluation is to provide a preliminary recommendation for the best long-term alternative for serving this area. In this evaluation, five alternatives were evaluated:

- Base Case – Existing Master Plan (2001 Sewer Collection System Master Plan – Revised 2003)
- New SE Bend Interceptor
- New SE Bend Interceptor with SE Satellite Plant
- Expansion of existing system capacity
- Expansion of existing system capacity with SE Satellite Plant

This preliminary recommendation will be refined during the final Sewer System Master Planning effort, but the preliminary recommendation will be followed during the current high rate of development of the SE Bend Area.

The goal of this project is to provide a long-term option for providing sewer service to the SE Bend Area. The City has observed some capacity limitations with the current collection system serving the area, mainly the Murphy Road pump station. Sewer service must also be provided to a recently approved development in this area. The long-term option must minimize the use of pump stations while providing the basis for meeting the short-term service needs in a cost effective manner.

STUDY AREA

The SE Bend study area was defined as the current and future areas that cannot flow by gravity into the existing sewer system. The required pumping of these flows provides an opportunity to direct this flow in another direction to provide short and long-term relief to the existing sewer system.

The current area that sewer service is provided by the City of Bend is 19,219-acres. Of that area, there are currently 7,134-acres that are hooked up to the existing sewer system as of February 2005. This is only 37% of the service area. The areas that are not served are either not developed or are unsewered with individual homeowners on septic tank.

The study area is a 4215-acre area that includes six of the modeled pump stations. The study area is shown in ***Figure 1-1***. One of these pump station basins is the Murphy Road Pump Station that is already at capacity. The Murphy Road Pump Station currently pumps to the west sending the flow through the core of the collection system through downtown Bend. There is currently a need to expand this station and add an additional force main.

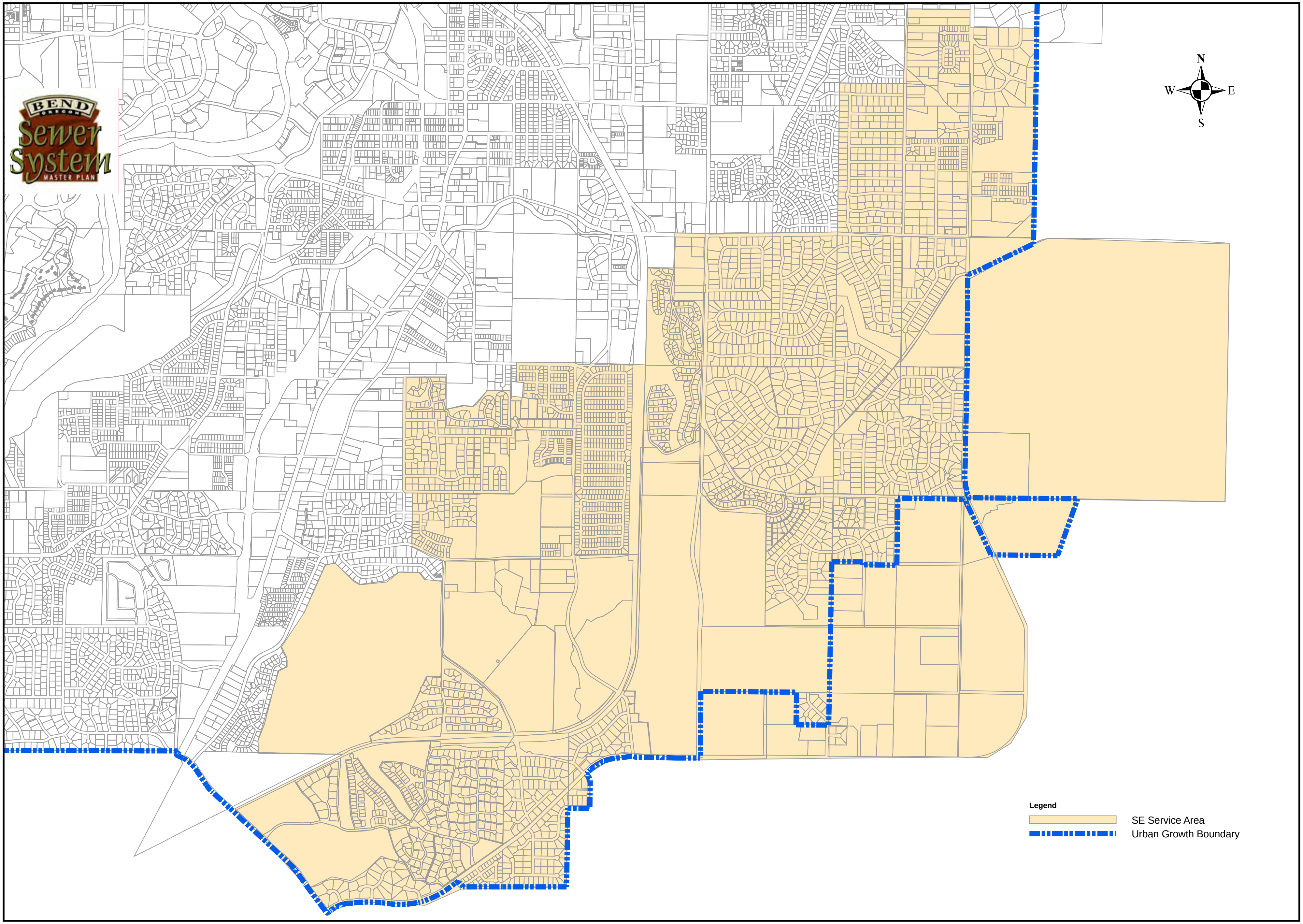

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Figure 1-1 Southeast Service Areas

Only 1182-acres of the study area are currently served by sewers. Of the 1182-acre sewered area, only 402-acres of parcels actually receive sewer service. This is 34% of the area that is served and only 10% of the SE Area. The areas that are not served are either not developed or are unsewered with individual homeowners on septic tank. ***Figure 1-2*** shows the SE area of study with the sewered parcels highlighted. Included in the sewered parcels shown on ***Figure 1-2*** are three relatively large areas that receive service, but are not high volume users for the size of the sites. These areas are the Bend Golf and Country Club, the High Desert Middle School and public facilities owned by Deschutes County. These parcels have been noted in ***Figure 1-3***. The volume of wastewater generated in these areas will be less than for residential development, but in the analysis performed in this study, the wastewater generated in these areas is based on the type of zoning outlined in the approved General Plan.

Figure 1-3 shows three areas that were given special consideration in this evaluation. The large sewered parcel on the SW corner of the study area is the Bend Golf and Country Club. This area is zoned RS in the General Plan. It was assumed that this area could be developed in the future, so flows were developed for this area at a residential density of 4.7 EDUs per acre. The area outlined in the center of the study area has been approved for development. The wastewater flows that were developed for this area were based on the residential densities that were proposed and approved for this development. The square mile area on the far eastern side of the study area is currently not within the Urban Growth Boundary (UGB), but has been included at the direction of the City staff as there are discussions currently underway to bring this area into the UGB. Wastewater flows for this area were based on the average residential density of 4.7 EDUs per acre.

PROJECT SCOPE AND ORGANIZATION

An evaluation of the proposed areas in the SE Bend Area was performed. Flows for the Year 2030 TAZ (Traffic Analysis Zones) growth projections and system build-out conditions were developed for the area. The influence of the proposed development on the existing infrastructure was determined and alternative to provide long-term sewer service to the area were developed. Using the build-out flows, the following alternatives were evaluated:

- Summer 2005 with no Inflow Downtown
- Summer 2005 with Inflow Downtown
- 2030 TAZ growth with Inflow Downtown
- 2030 TAZ – No North Area Flows with Inflow Downtown
- 2030 TAZ – No SE Area Flows with Inflow Downtown
- 2030 TAZ – No North and No SE Area Flows with Inflow Downtown
- 2030 TAZ – No North, no SE and No West Area Flows with Inflow Downtown
- Build-out Population Projections with Urban Reserves

The results of this evaluation are summarized in this report. The report has been organized as follows:

Section 1 – Introduction
Section 2 – Planning Criteria

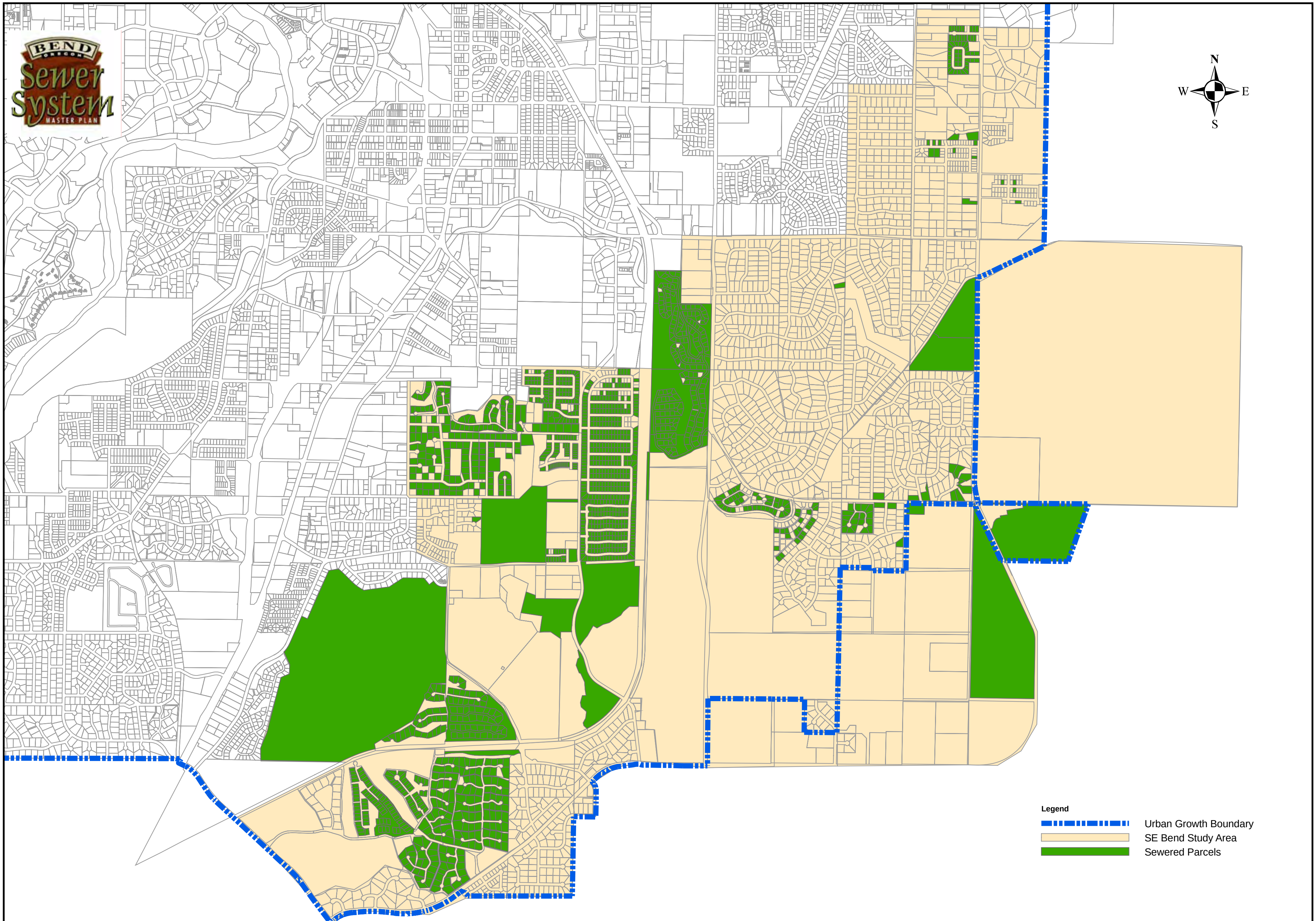

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Figure 1-2 SE Bend Study Area Sewered Parcels

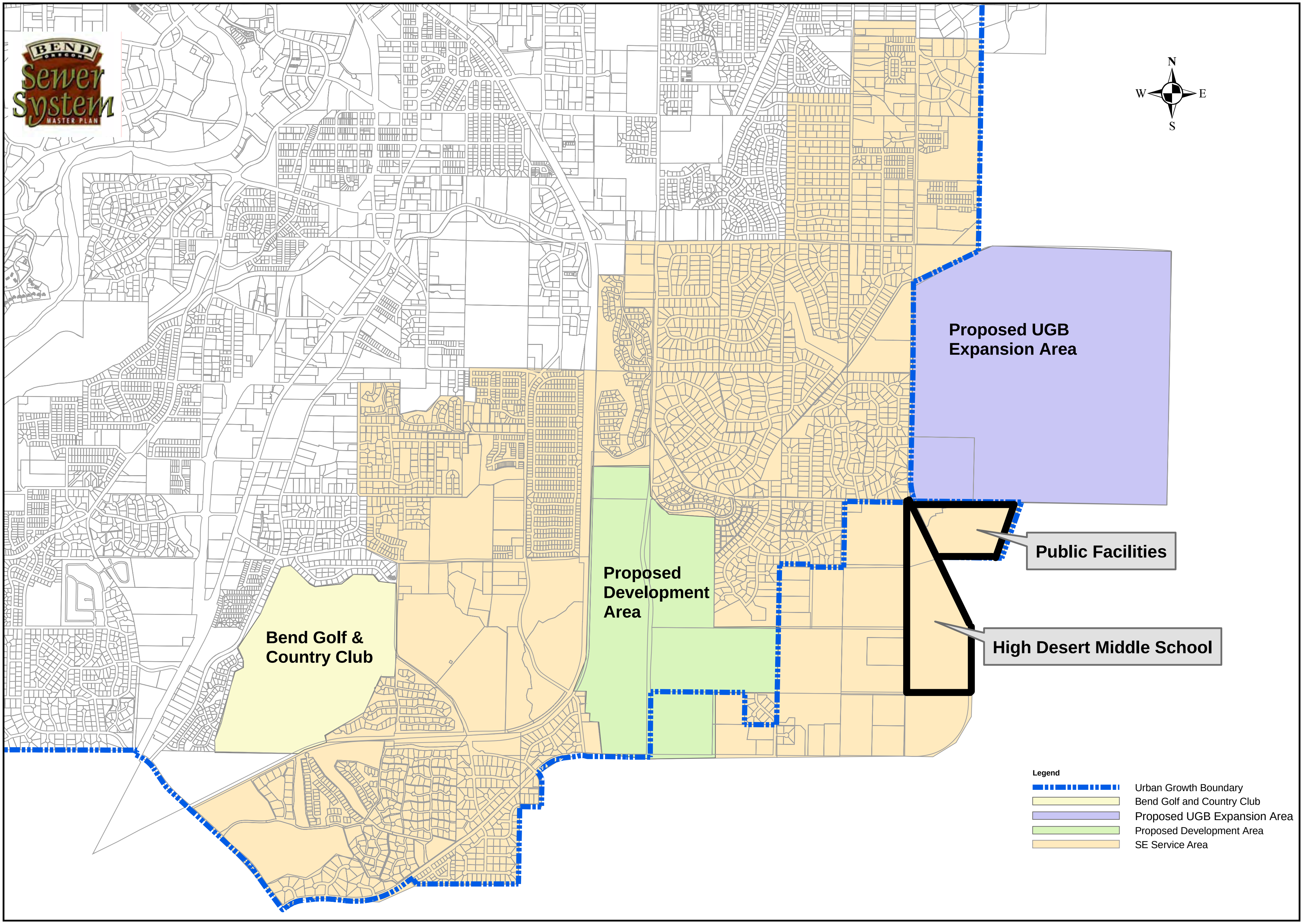

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Figure 1-3 Areas of Interest

Section 3 – Flow Development
Section 4 – Basis of Cost Estimating
Section 5 – SE Interceptor Alternative Development
Section 6 – Alternative Evaluation
Section 7 – Recommendations

The intent of the report is to provide City staff with a clear understanding of the options available to them for providing long-term sewer service to the SE Bend Area.

INTRODUCTION

A clear understanding of the planning area, growth projections and design criteria is essential in performing this evaluation. The growth rate and design criteria are used in the determination of the current and future capacity of the existing system as well as in determination of the size of new systems. The City has design standards for sewer systems that must be used by the development community. These criteria may be different than the criteria developed here. The design criteria used in this evaluation are to be used for planning and evaluation purposes only.

MWH provided a recommended list of design criteria to the City for review. The City staff reviewed these recommendations and provided modifications as necessary. The criteria used in this analysis are the design criteria confirmed by the City staff.

PLANNING AREA

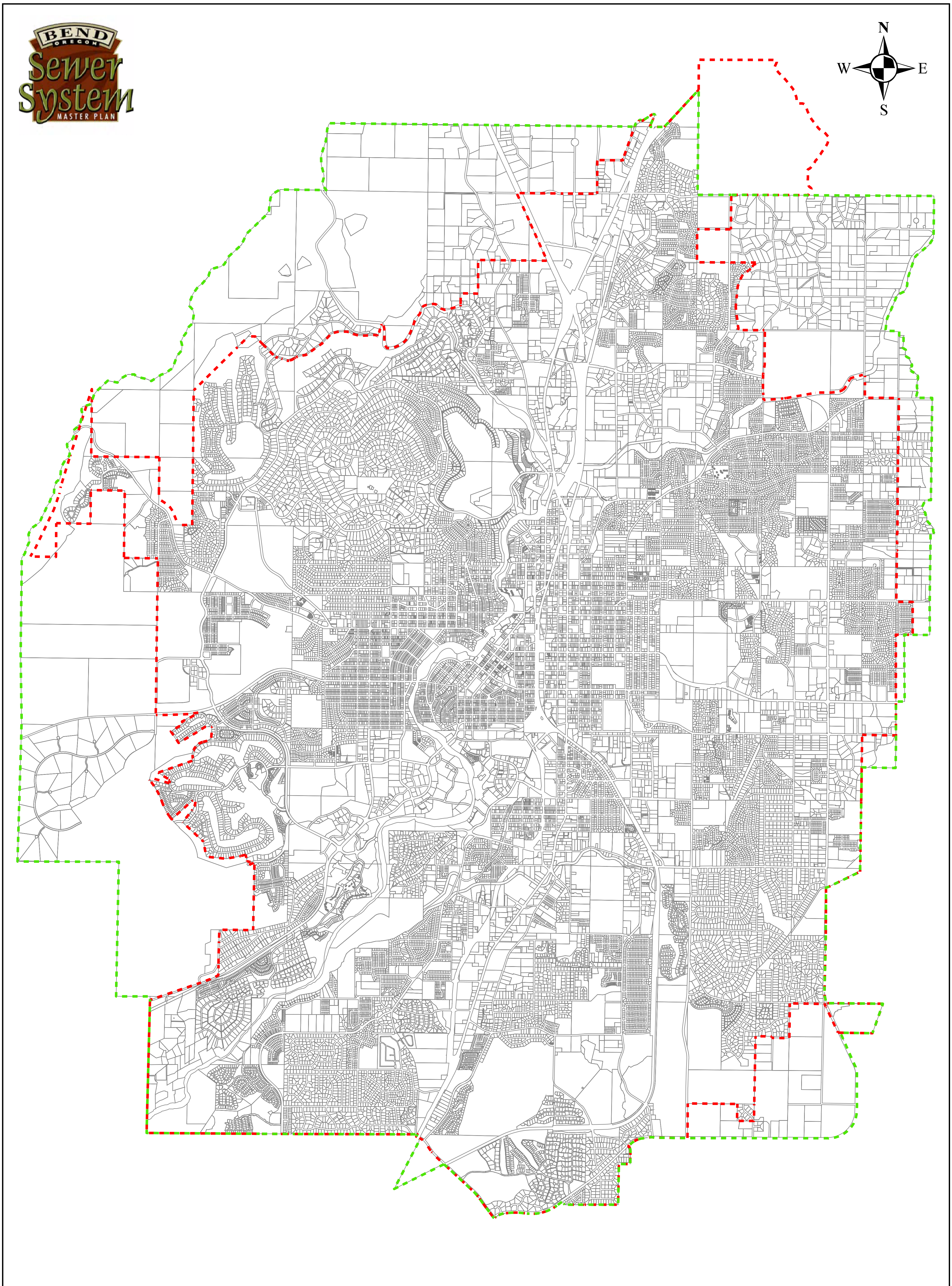
The planning area for this study includes all lands within the Urban Growth Boundary (UGB) and Urban Area Reserve (UR). These areas are shown in ***Figure 2-1***. Within these areas, the City's Planning Department has identified land use categories for development. These categories are presented in the City's General Plan that was finalized in 1998. All flows developed in this analysis were based on the planning area and land use categories identified in the approved General Plan.

GROWTH PROJECTIONS

The City of Bend in cooperation with Deschutes County has been working to develop population projections that can be used in long-term planning for the City. The most recent work that provides population projections is the Deschutes County Coordinated Population Forecast 2000 – 2025 (August 25, 2004). In this report, the population projections for the Bend UGB were developed. These projections and the applicable growth rates are shown in ***Table 2-1***.

Table 2-1
City of Bend
Population Forecast for Bend UGB

Year	Population	Annual Growth Rate
2000	52,800	-
2005	69,004	4.74%
2010	81,242	2.52%
2015	91,158	2.33%
2020	100,646	2.00%
2025	109,389	1.68%
2030	119,009	1.70%



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Legend
UGB
UAR

Figure 2-1 Urban Area Reserve and Urban Growth Boundries

There is concern that the growth rates used in this study are low, based on the recent growth history of the City. The average annual growth rate (AAGR) for the past 33 years has been 3.34% and for the past 23 years has been 3.76%. Most importantly, the AAGR since 1990 has been 5.33% and since 2000 has been 5.88%. The planned growth projections must be used in this study to be consistent with the City's other planning efforts, but there must be sensitivity to the system needs if the current growth rate continues at a rate higher than projected.

The City is currently evaluating the long-term growth through 2060 to determine the requirements for expansion of the URA. In this planning work, a preliminary evaluation shows the need for an additional 6,423 acres of land or urban reserves (URB-URA Subcommittee – Oct. 13, 2005 Memorandum). In addition, this planning work is being performed assuming residential density increases from the average of 4.7 EDUs per acre to 6.0 EDUs per acre.

An important factor the must be considered when planning for utilities is where the actual growth is projected to occur. The best planning document that projects where the growth will be occurring is the 2030 TAZ population projections. This information has been graphically summarized on ***Figure 2-2***. This growth information was used to determine the sub-basin 2030 populations to establish flows for the sewer system evaluations performed in this study. *An interesting point that needs to be addressed is that the 2030 TAZ population projections only address growth in the existing UGB and does not consider growth in the UAR.* The growth rates used in this analysis are based on the growth rates shown in ***Table 2-1***.

FLOW SCENARIOS TO BE MODELED

The system limitations can occur under a variety of scenarios. Two scenarios will be used in developing system limitations for the SE Bend Study Area. These scenarios are:

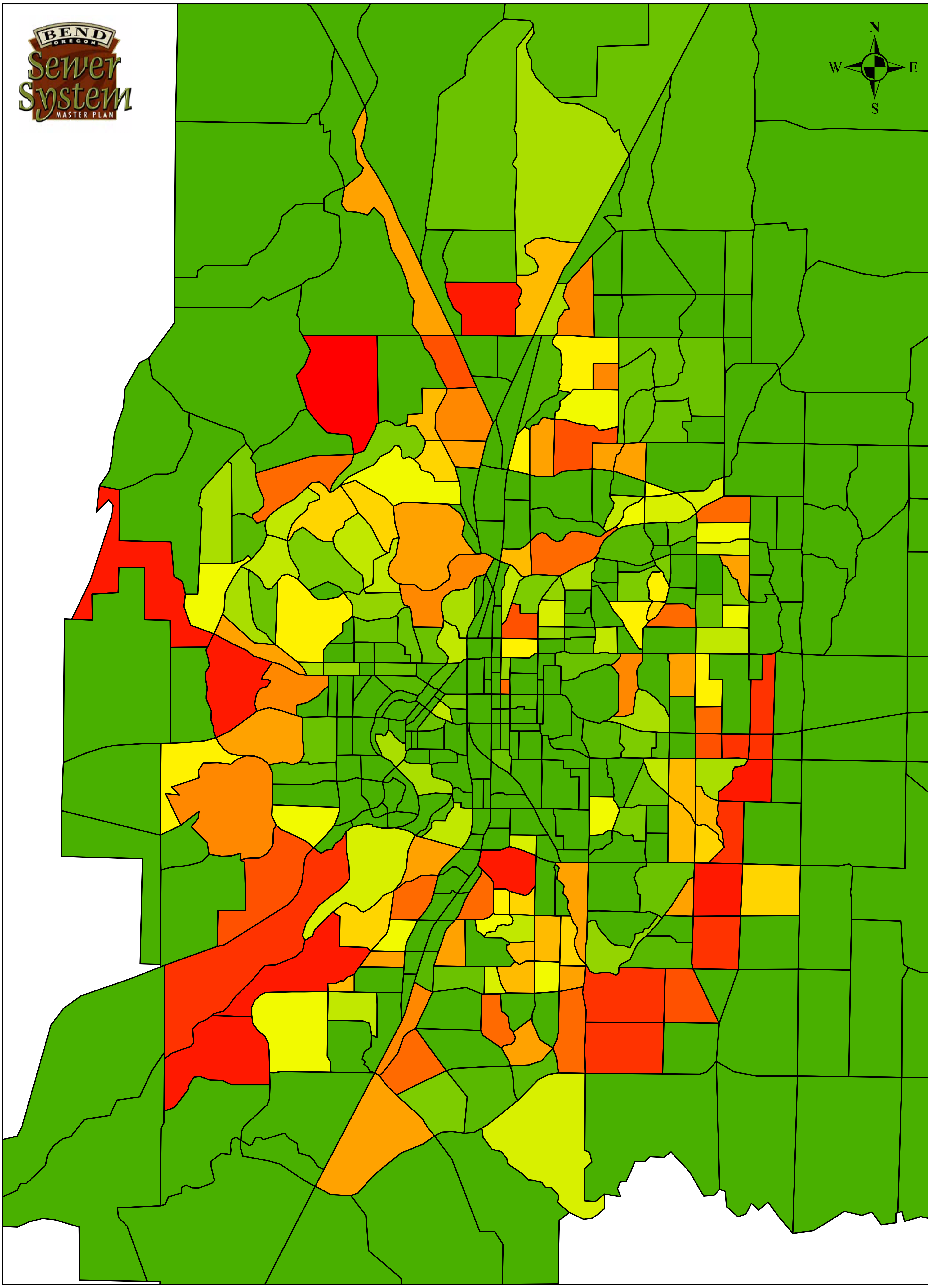
- Wintertime weekday base flow
- Summertime peak weekend flow
- Summertime peak weekend flow with system inflow

These flow scenarios will be used to perform this preliminary evaluation. Additional scenarios will be developed and used during the development of system limitations and alternative analysis when the master planning work is performed.

SYSTEM LIMITATION CRITERIA

MWH used the INFOSWMM model of the existing collection system to model the existing flows in the collection system. The model was developed and calibrated in Phase I of the Sewer System Master Plan Project using the flow monitor data that was collected.

The system limitation criteria that will be used to determine when a pump station, force main or gravity sewer is at capacity are:



MWH

Legend

CHANGEPOP							
-154	4 - 14	40 - 49	106 - 123	182 - 208	359 - 465	799 - 1332
-153 - 3	15 - 27	50 - 82	124 - 155	209 - 271	466 - 644	1333 - 2127
	28 - 39	83 - 105	156 - 181	272 - 358	645 - 798	2128 - 3580

Figure 2-2 Population Growth by TAZ in 2030

- A friction value of 0.013 (n = 0.013) will be used for all force mains and gravity sewers
- All pump station capacities will be at their current pump capacities with one pump out of service for required redundancy
- Force main capacity will a maximum velocity of 6-fps
- Force main minimum velocities of less than 2-fps will be noted
- Gravity sewer capacity will be based on a d/D (depth/diameter) of 0.80
- No surcharging of lines or manholes will be allowed under normal operating conditions
- Surcharging of manholes will be allowed during heavy rainfall when inflow occurs, but no overflows can occur

The model will be used to evaluate system flows. Any component that does not meet the system limitation criteria will be identified as being at capacity.

It should be noted that the d/D of 0.80 that will be used for the gravity sewer capacity is the maximum velocity for a gravity sewer. As the depth of flow in the gravity sewer gets greater than a d/D of 0.80, the velocity in the sewer is restricted by the greater headloss due to the increased wetted diameter. This is shown in ***Figure 2-3***.

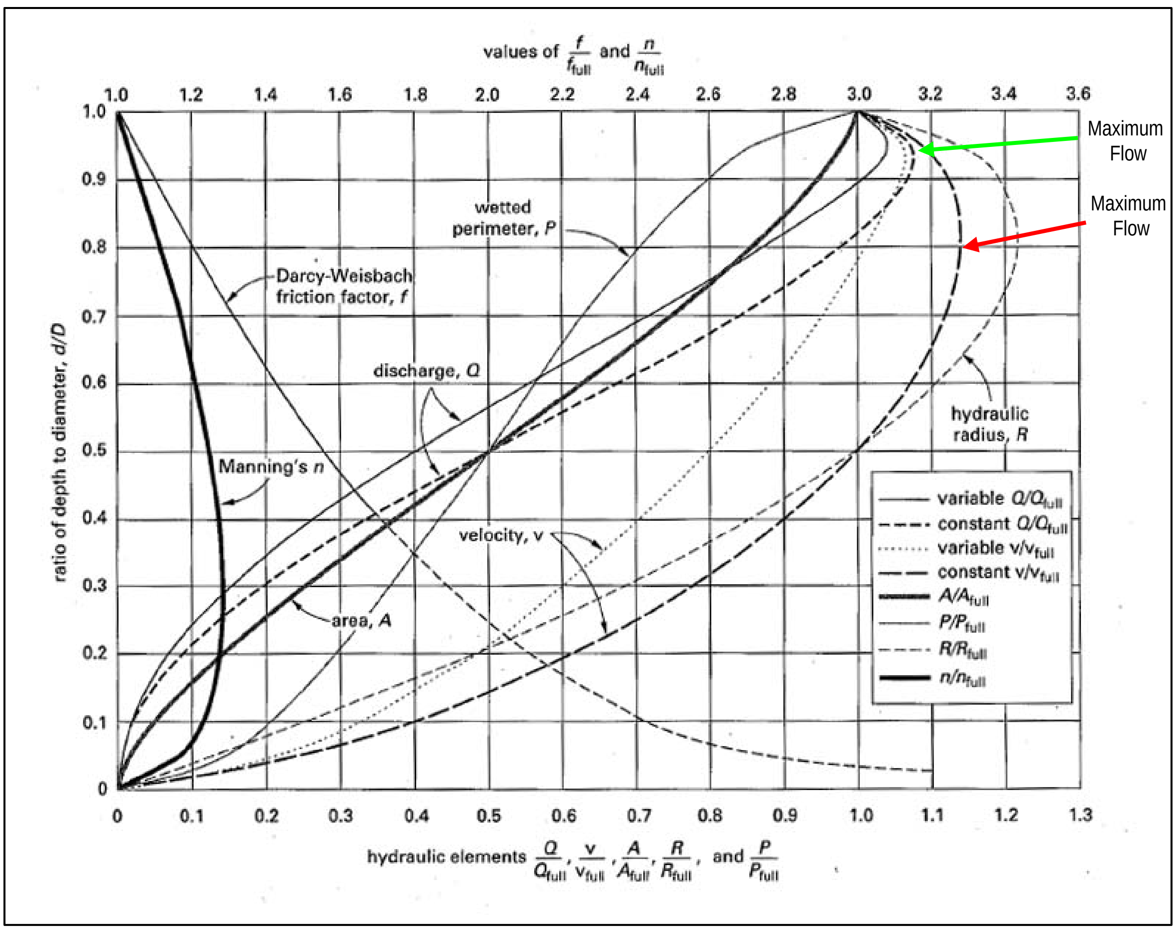


Figure 2-3: Hydraulic Elements Graph for Circular Sewers

The maximum flow in the sewer actually occurs at a d/D of 0.92. This is also shown in ***Figure 2-3***. The use of a d/D of 0.8 is conservative, leaving a small amount of additional sewer capacity (about 7%) in reserve.

INTRODUCTION

The SE Bend Study area from which sanitary sewage is generated was shown on ***Figure 1-1***. This area contains 4,215-acres, much of which is already developed in single-family residential use. Currently, only 1,182-acres is using City sewer service. The Comprehensive Plan documents indicate that future development will also be single family residential supplemented by some multifamily residential and commercial uses. The general allocation of land use is:

- Single Family Residential
  - Current 402-acres
  - Build-out 2900-acres
- Multifamily Residential
  - Current 0.54-acres
  - Build-out 0-acres

The General Plan land use information was used as the basis for developing flows for the SE Bend Study area.

FLOW DEVELOPMENT

The flows were developed based on the zoning outlined in the City of Bend General Plan. The basis of these flows was determined by applying unit flow values to the projected number of parcels based on the type of zoning.

Flow Development for Vacant Parcels

The wastewater flow from vacant parcels was based on the GENPLAN classification (General Plan Zone) to determine the future land use type. Based upon the preference of the City, the average densities were applied to residential parcels to determine the number of dwelling units for flow generation. In the case of the proposed development, the residential average densities proposed by the developer were used. Parcel size was used to calculate wastewater flows from non-residential land use types. The average and maximum residential densities for each General Plan land use code are shown in ***Table 3-1***.

Table 3-1
City of Bend
City of Bend General Plan Residential Densities
Used in Flow Development in this Study

Land Use Category	Land Use Designation	Average Density (DU/acre)	Maximum Density (DU/acre)
Residential Low Density	(RL)	1.7	2.2
Residential Standard Density	RS	4.7	7.3
Residential Medium Density	RM-10	8.0	10.0
Residential Medium Density	RM	14.5	21.7
Residential High Density	RH	32.4	43.0

Flow Development for Non-vacant but Sewered Parcels

The process for determining wastewater flow from small parcels (e.g., less than 0.5 acres) that are not vacant, but are unsewered will be identical to the process described above for sewered parcels. This process assumes that these small parcels are currently on septic systems, but may connect to the collection system at some point in the future without a change in land use. Wastewater flows from the larger parcels will be calculated using the methodology previously described for vacant parcels.

Residential and Non-residential Flow Factors

The number of dwelling units on a parcel or the parcel's acreage must be multiplied by a flow factor (representative of the parcel's land use) to determine the wastewater flow from each parcel. For residential parcels, typical per dwelling unit flow values for similar communities (e.g., 200 gpd/DU for single-family and 180 gpd/DU for multi-family) were used as a starting point and then refined.

For non-residential parcels, the City of Bend 2005 database of winter-quarter average water consumption for Sewer Service codes SO (Sewer Metered Old) and SM (Sewer Metered) was used to determine initial gpd/acre flow factors. The database was sorted using the LANDUSE field and then a flow factor calculated for each LANDUSE category by dividing the total average consumption by the total acreage. The results of these initial calculations are shown in ***Table 3-2***.

Table 3-2
City of Bend
Initial Non-Residential Flow Factors

Land Use	Flow Factor (gpd/acre)
Commercial	1,300
Industrial	700
Public	130
Other Improved	630

Note: Other Improved includes Non-Residential parcels such as Mixed-Use Riverfront and Mixed Employment classifications

Flow Calculations

Calculating wastewater flows based on parcel-level information provides the most accurate representation of flows entering a collection system, and allows greater flexibility during model calibration. All flows used in this analysis for existing development were developed at the parcel-level based on the zoning information outlined in the City's General Plan and the type of structures based on each taxlot based on the City's Residential Land Survey.

Flow Development for Sewered Parcels

The wastewater flows for parcels that are currently sewered were developed using a systematic approach. For Residential (Single-family) and Multi-family Residential parcels, the number of dwelling units on each residential parcel, as identified in the Residential Land Survey, was used. The number of dwelling units (DU) on each parcel was then multiplied by the calibrated flow factor (gallons per day/dwelling unit (gpd/DU)) that was calculated for each specific flow monitoring area. An example of the equation used to determine residential flows in each parcel is as follows:

$$Flow_{Parcel} = DU * Flow\ Factor\ (gpd/DU)$$

So, assuming there are 4 DU's on a parcel and a flow factor of 200 gpd/DU, the average residential flow from that particular parcel would be 800 gpd.

For Commercial, Industrial, Public, and Other Improved classifications shown in ***Table 3-2***, the parcel size (acres) was multiplied by a representative flow factor (gpd/acre) to determine the wastewater flow from each parcel. An example of the equation used to determine flows from these parcels is as follows:

$$Flow_{Parcel} = Acreage_{Parcel} * Flow\ Factor\ (gpd/acre)$$

As shown in ***Table 3-2***, a commercial parcel the flow factor of 1300 gpd/acre would be used. Then for a parcel of 15 acres and using the average commercial flow the flow for the parcel would be 19,500 gpd.

Flow Development for Vacant Parcels

It is necessary to develop flows for vacant parcels to perform projections of growth impacts in the future. The methodology for developing the flows for vacant parcels is similar, yet slightly different than for sewered parcels. The wastewater flow for vacant parcels used the zoning classification for the parcel that was specified in the General Plan. The average density as shown in ***Table 3-1*** is applied to residential parcels to determine the number of dwelling units for flow generation. Parcel size is used to calculate wastewater flows for each of the non-residential land use types. An example of the equation used to determine residential flows in each parcel is as follows:

$$Flow_{Parcel} = Acreage_{Parcel} * DU/acre * Flow\ Factor\ (gpd/acre)$$

So, assuming there is a 20 acre parcel and it is zoned for Residential Standard Density (RS), then the density of 4.7 DU/acre would be used. Using the residential flow factor of 200 gpd/DU, the average residential flow from that particular parcel would be 18,800 gpd. The same methodology for commercial property as shown above would be used.

Infiltration/Inflow Allowance

A very simple evaluation of the Infiltration/Inflow (I/I) was performed. The flow monitoring and system analysis that was performed in Phase I of the Sewer System Master Plan project showed that there was virtually no infiltration in the system. The only time that the sewer system and treatment plant receives high flows due to I/I is when a major rainstorm occurs.

During a heavy rainstorm, unusually high flows were observed in the system and at the treatment plant. ***Figures 3-1 and 3-2*** show the flows that were experienced at the treatment plant during storms occurring on April 23, 2005 and May 28, 2005. In both cases, the peak flows reached around 11-mgd at the treatment plant. This was an increase in flows over the normal plant diurnal curve shown in ***Figure 3-3*** of 3-mgd on April 23, 2005 and 4-mgd on May 28, 2005. Also apparent on these figures is the flow at the treatment plant increases quickly following the peak rainfall, arriving about 2 hours after the rainfall occurrence. The peak also lasts only a short time, about the same duration as the storm, where flows return to their normal flow rate.

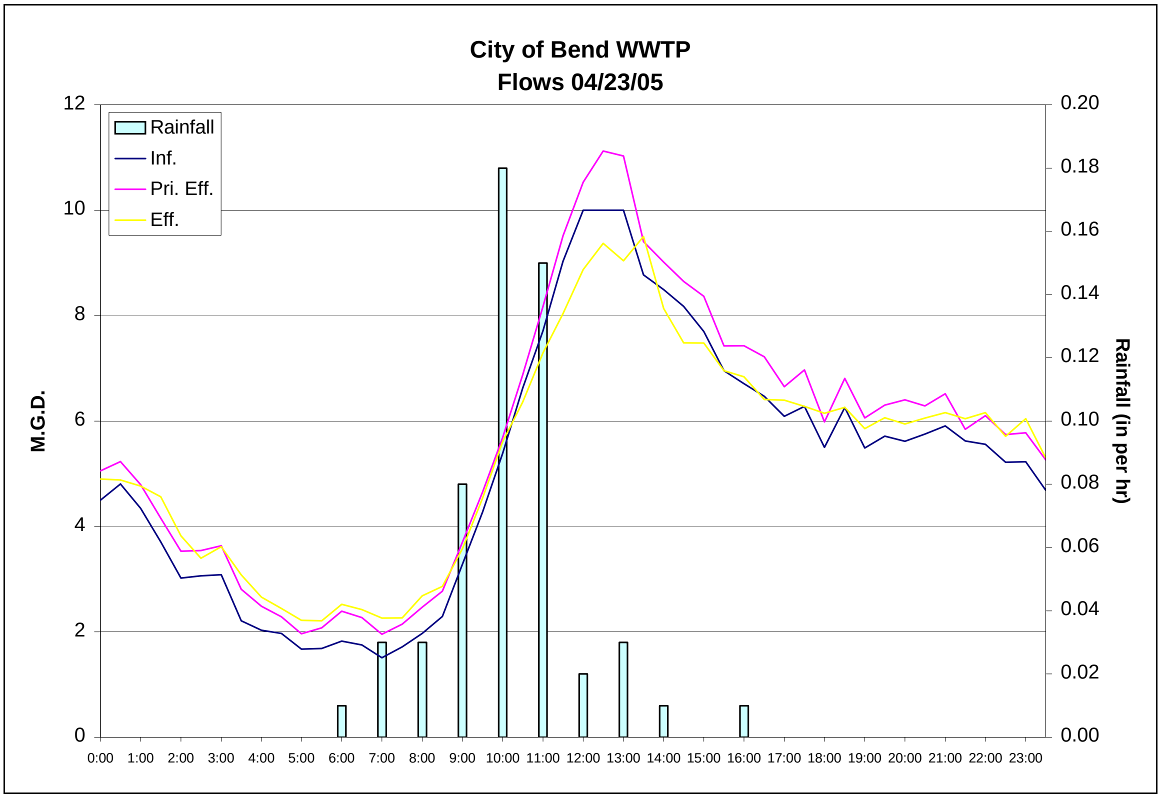


Figure 3-1: April 23, 2005 Storm Event

The flow characteristics represent an inflow occurrence. Discussions of this matter with City staff led to the fact that there is an area in downtown Bend that still has roof drain connections. This area identified by City staff is shown in ***Figure 3-4***. This area totals 357 acres. An inflow factor of 1000 gallons per acre per day (gpad) equates to an increase in flow at the treatment plant of 4-mgd for two hours. Based on this evaluation, an inflow of 1000 gpad was incorporated into the flows for the downtown inflow area.

The system was modeled for the current Summer 2005 conditions both with and without the downtown inflow. The results of these two model runs were plotted to show the system deficiencies. These plots are shown in ***Figures 3-5 and 3-6***. ***Figure 3-5*** shows the system deficiencies when the inflow is included in the system. This analysis shows that there are more deficiencies when inflow is included than when the inflow is removed in ***Figure 3-6***.

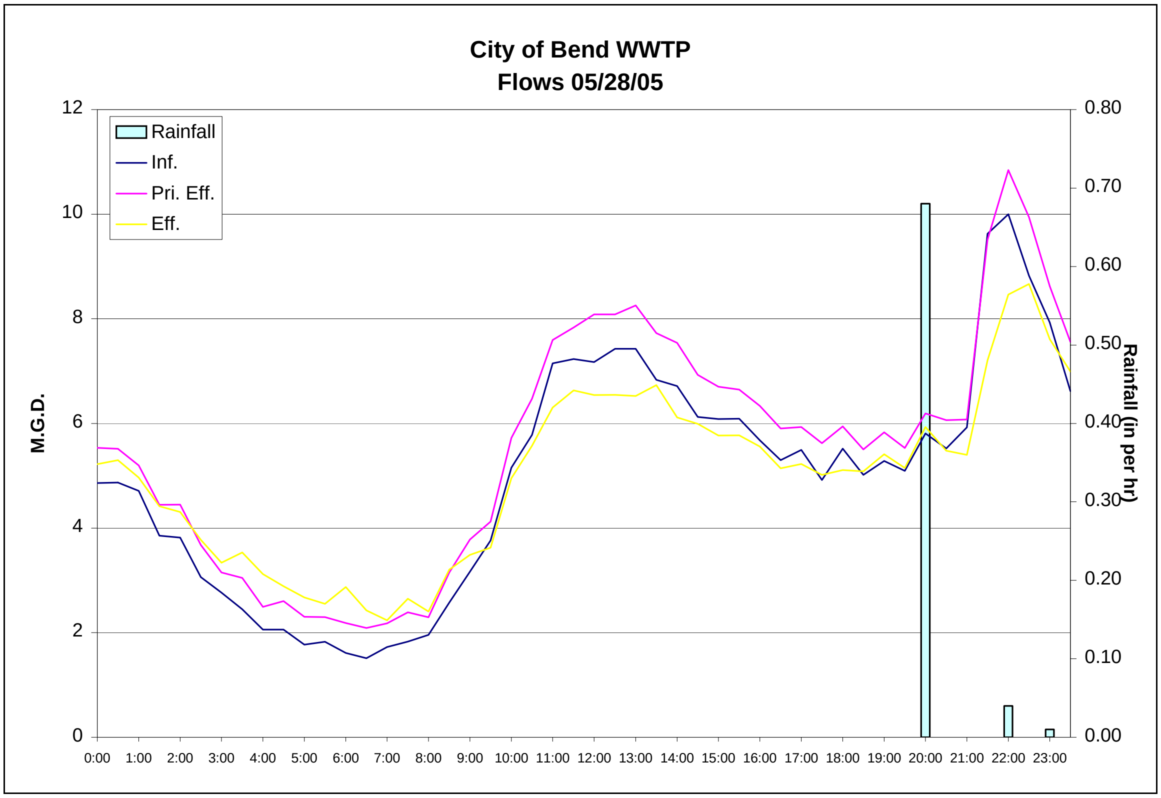


Figure 3-2: May 28, 2005

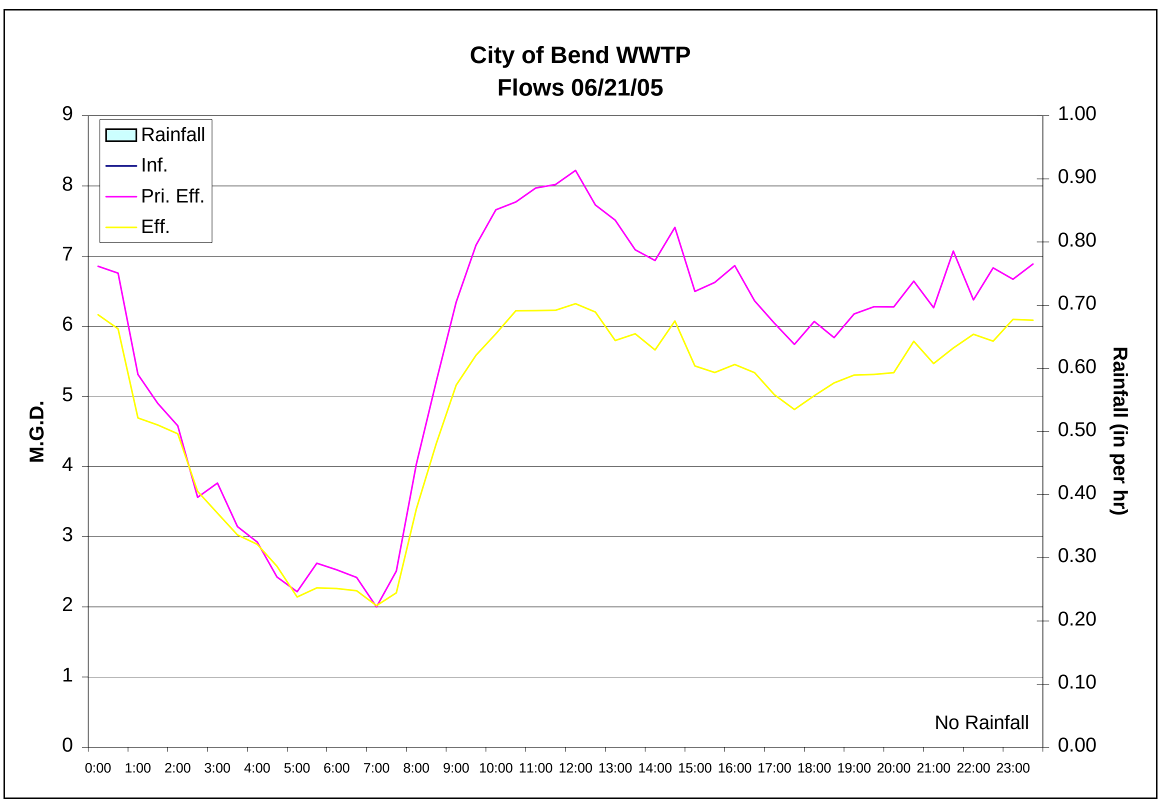


Figure 3-3: Typical Treatment Plant Diurnal Flow Curve

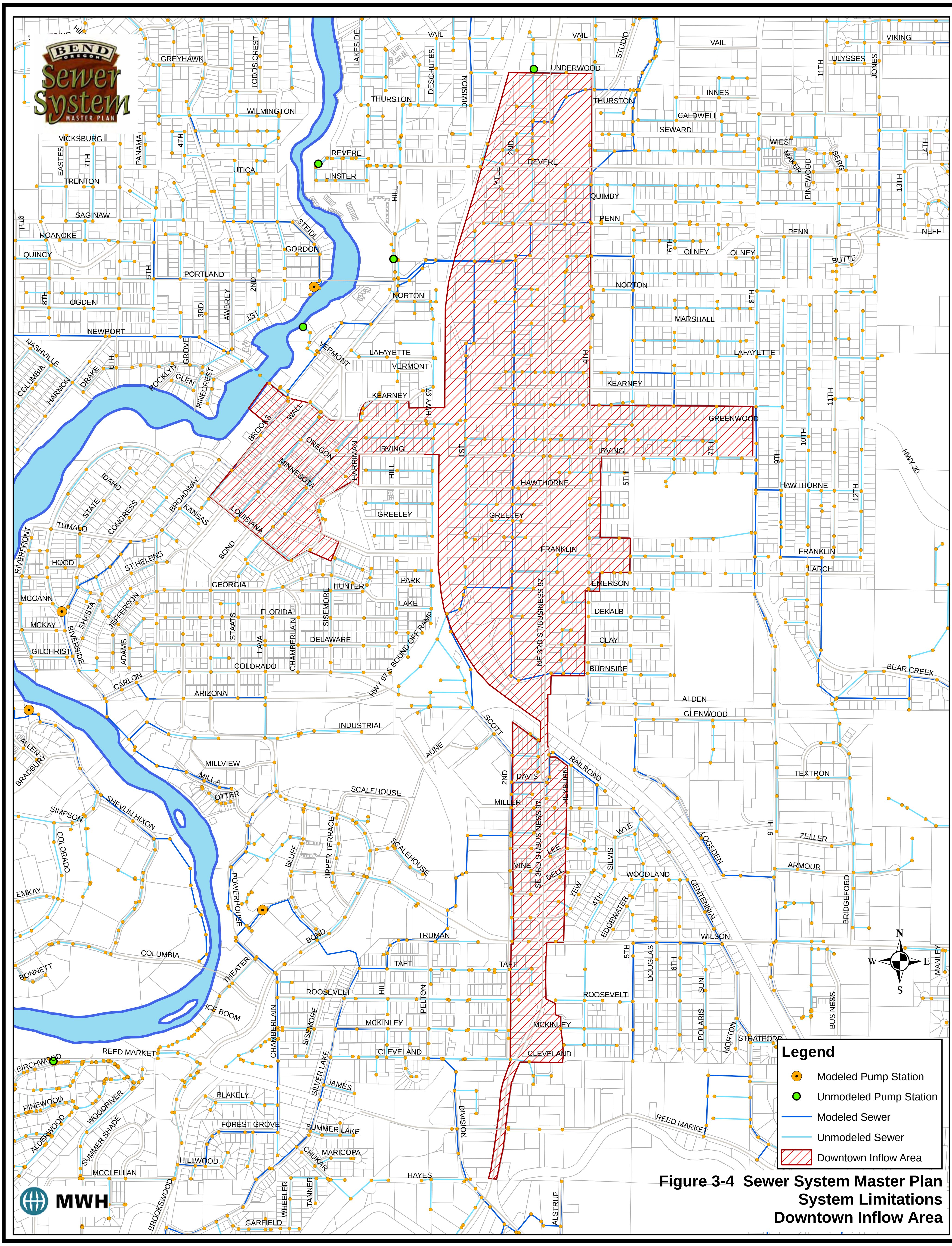


Figure 3-4 Sewer System Master Plan
System Limitations
Downtown Inflow Area

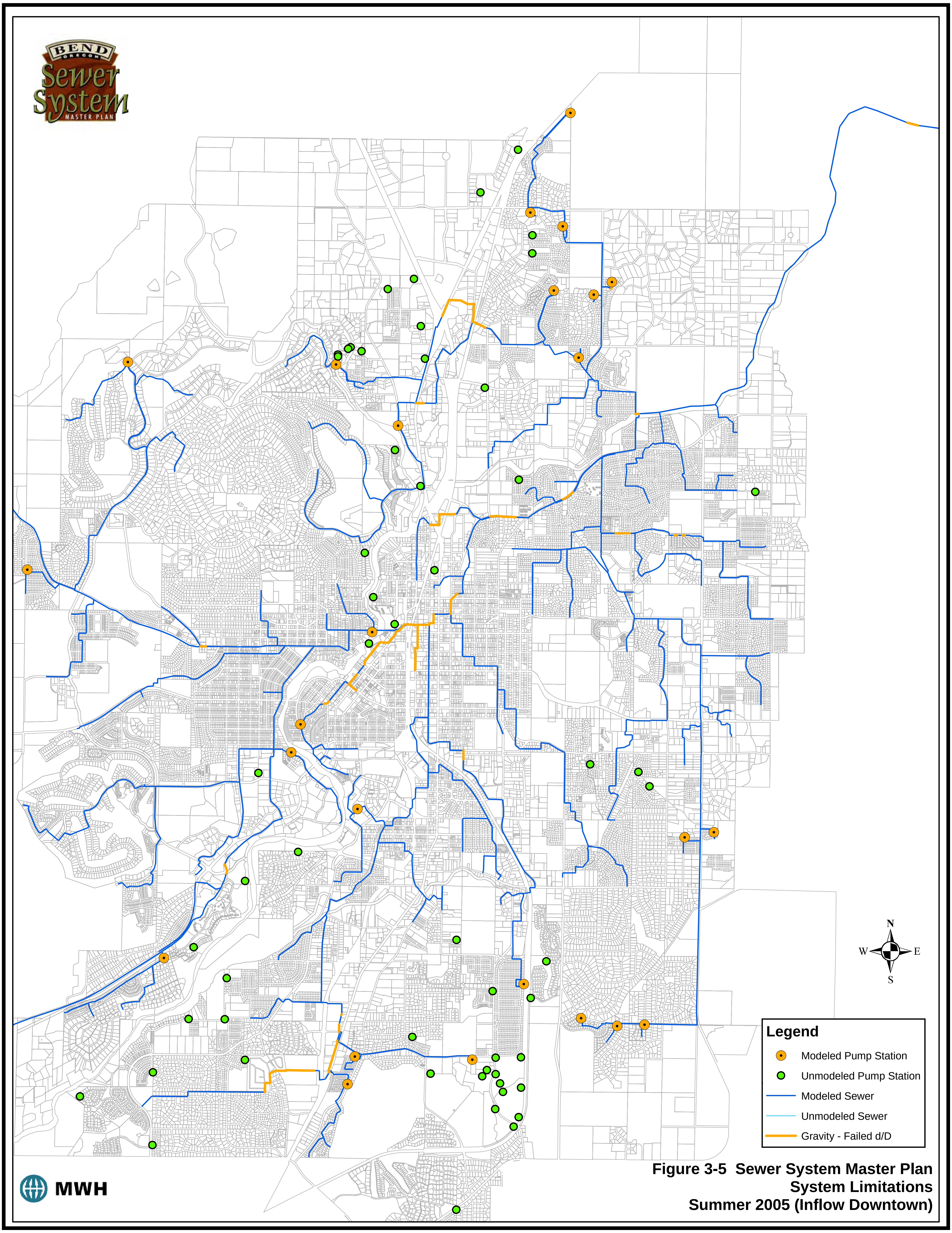


Figure 3-5 Sewer System Master Plan
System Limitations
Summer 2005 (Inflow Downtown)

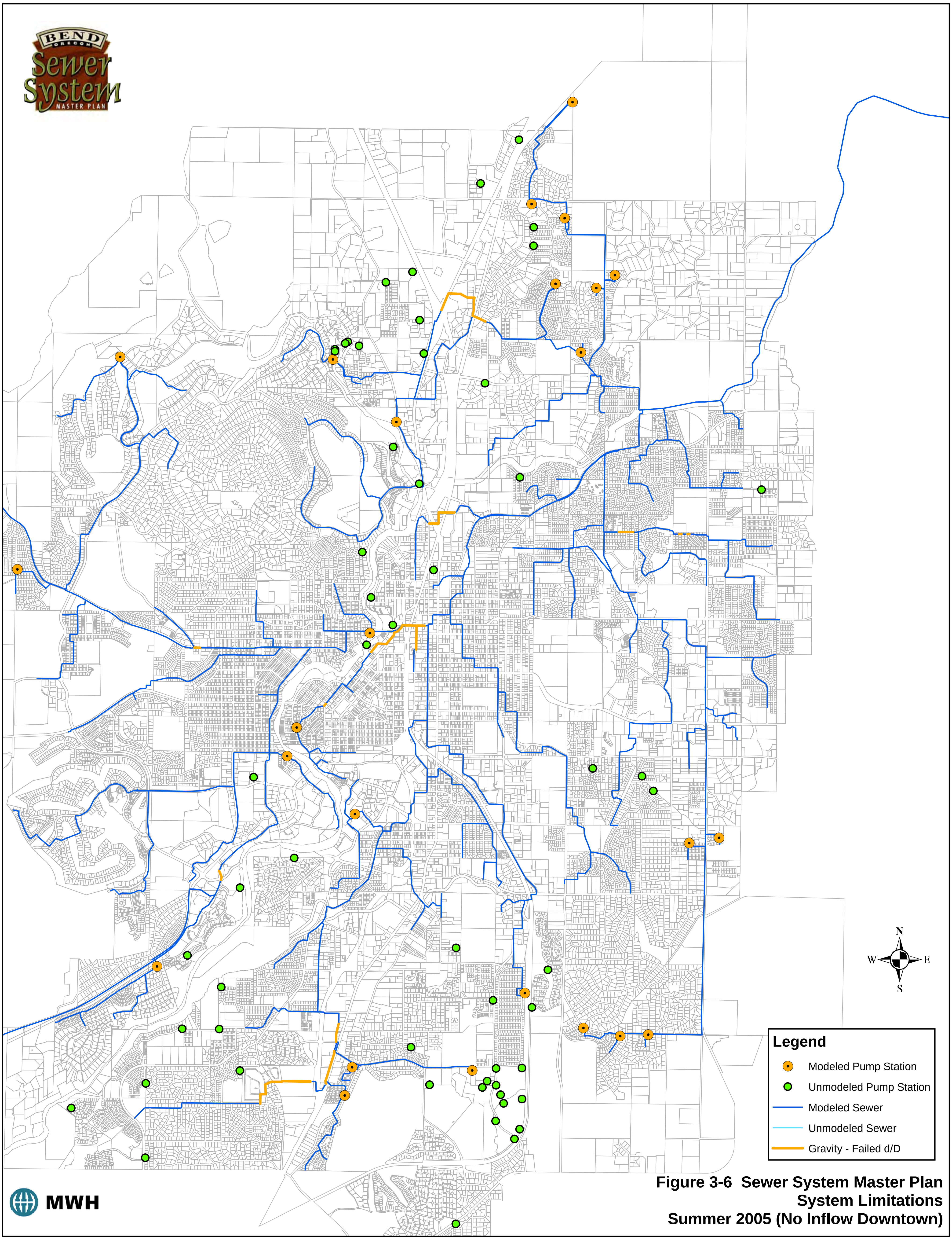


Figure 3-6 Sewer System Master Plan
System Limitations
Summer 2005 (No Inflow Downtown)

A closer look at the model results shows that the gravity sewer downstream of the Westside Pump Station discharge has very little slope which caused high depths in the sewer. During a rainfall when inflow occurs, the downstream gravity sewer restricts flow and caused increased depth in upstream sewers beyond those occurring on a regular basis. This analysis shows two things. The gravity sewer that is downstream of the Westside Pump Station discharge is currently limiting flow in the system and that this flow limitation further backs flow up into the system during rainfall events. The modeling did not show any overflows in the system, but a more detailed analysis of this area needs to be performed during the master planning of the system.

Summer Season Peaking Factor

The critical flow period will be the maximum summertime peak weekend flow. The model has been calibrated to a wintertime base flow with a weekend peaking noted. To determine a peaking factor for the summertime peak weekend, plant influent data for the years 1993 through 2004 were evaluated. This analysis is summarized on ***Table 3-3***. The maximum peaking factor occurred in 1996. This was due to a 2.6-inch rainfall when inflow was at a maximum.

The peaking factor typically ranges from 1.10 to 1.23 depending on the year. As a conservative measure, it is recommended that a summertime peak day peaking factor of 1.25 be applied to the wintertime weekday base flow to obtain the peak day flow.

SE AREA FLOWS

Flows for the SE Bend Study Area were developed using the General Plan zoning, unit flow values and peaking factors summarized above. The results of these calculations are summarized in ***Table 3-4***. This analysis showed that the wintertime base current average day flow for the SE Bend Area is 0.33-mgd with a diurnal peak of 0.59-mgd. After applying the summertime peaking factor, the current flows generated from this area is an average day flow of 0.41-mgd with a diurnal peak flow of 0.74-mgd. The buildout condition flows for the 4215 acres specified for the SE Bend Study Area are an average day flow of 3.84-mgd with a peak diurnal flow of 6.92-mgd. These flows are actually greater than those generated in the modeling. The modeled flows are based on the proposed growth projections and buildout values for the City. Estimated buildout flow for each of the six phases of the planned Pahlisch Homes development is also shown in ***Table 3-4***.

Table 3-4
City of Bend
Sewer System Master Plan
SE Interceptor Sizing

Condition	Acres	Flow		
		Average		Peak (mgd)
		(gpm)	(mgd)	
Current Condition				
Baseline – Winter	-	228	0.33	0.59
Summer Weekend	-	285	0.41	0.74
Buildout Condition				
Total SE Area	4215	2670	3.84	6.92
Bend Country Club	230	151	0.22	0.39
Proposed Development Area				
Phase I	75	50	0.07	0.13
Phase II	71	36	0.05	0.09
Phase III	26	16	0.02	0.04
Phase IV	71	54	0.08	0.14
Phase V	79	52	0.07	0.13
Phase VI	38	25	0.04	0.06
Total	360	233	0.34	0.60

Notes:
1) Daily Peaking Factor = 1.8
2) Summer Weekend Peaking Factor = 1.25

Table 3-3
Bend WWTP
Influent Data Analysis--flow, mgd
1993 - 2004

DAILY DATA

Statistic	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total	1181.3	1164.5	1222.1	1278.4	1322.8	1391.2	1453.6	1571.0	1553.9	1604.1	1699.20	1839.03
Max	4.05	4.31	3.98	5.78	4.31	4.85	4.74	4.98	5.05	5.08	5.09	6.16
Min	2.51	2.55	2.60	2.39	2.69	3.15	3.26	3.59	3.70	3.50	3.82	4.09
Mean	3.24	3.19	3.35	3.49	3.62	3.82	3.98	4.29	4.26	4.41	4.66	5.02
Median	3.23	3.15	3.34	3.49	3.60	3.78	3.95	4.31	4.27	4.41	4.66	5.00
90 Percentile	3.45	3.53	3.61	3.71	3.92	4.16	4.35	4.53	4.51	4.77	4.92	5.36
92 Percentile	3.49	3.57	3.65	3.75	3.94	4.20	4.37	4.56	4.56	4.80	4.96	5.39
98 Percentile	3.68	3.76	3.76	4.10	4.05	4.37	4.49	4.67	4.68	4.96	5.03	5.58
Std. Dev.	0.19	0.27	0.20	0.27	0.22	0.25	0.25	0.21	0.21	0.28	0.22	0.26
Count	365	365	365	366	365	364	365	366	365	364	365	366
Peaking factor	1.25	1.35	1.19	1.65	1.19	1.27	1.19	1.16	1.19	1.15	1.09	1.23

Notes:

1. Peaking factor is maximum daily flow/ average daily flow.
2. 1996 was a unique year due to the high one-time flow due to storm drainage on Nov. 18 with a 2.6-in rainfall.
3. The most recent daily peaking for 2004 was 1.23.
4. Conservative daily peaking factor would be 1.25.

INTRODUCTION

Planning level costs were developed for each of the alternatives that were evaluated. These costs are met to be used in the comparison of alternatives and are not to be used beyond the scope of this report. As an alternative is developed further and a specific route, construction requirements and easement requirements are specified, a cost estimate can be developed that can be used for project budgeting.

BASIS OF COST ANALYSIS

Estimates of the project costs associated with the alternatives were prepared during the evaluation process. All cost estimates prepared as a part of the planning effort are order-of-magnitude estimates as defined by the American Association of Cost Engineers (AACE). An order of magnitude estimate is one that is made without detailed engineering data and uses techniques such as cost curves and scaling factors from similar projects. The overall expected level of accuracy of the cost estimates presented is +50 percent to -30 percent. This is consistent with the guidelines established by the AACE for planning level studies.

Project Costs

The project costs presented in this plan include estimated construction dollars, easement procurement, contingencies, permitting, legal, administration and engineering fees. Construction costs are based on preliminary layouts and experience gained by the project team on the design of similar facilities.

The estimated construction costs prepared at the planning level are intended to represent average bidding conditions for projects that are similar in nature. With this in mind, it is understood that variations in the bidding environment at the time of project implementation will likely affect actual construction costs. Although estimated costs have been adjusted to account for known conditions at this time, they are reflective of planning level efforts and are not likely to be as accurate as costs developed during final design. For these reasons, construction costs may be lower or higher than estimated in this plan.

Preliminary cost estimates prepared during the planning effort include the costs to construct the improvements as well as a number of additional factors. This includes an allowance for the contractors overhead and profit and mobilization and demobilization costs.

The critical element in the development of costs was determining the unit cost for the new construction of gravity sewers. Recent contractor bids for smaller sewers were reviewed. The bid costs were highly variable between contractors and projects. Other projects that have been recently bid have shown that the cost of pipe has increased recently due to the increase in the cost of oil and concrete. For this evaluation, unit costs for gravity sewer replacement were developed for various pipe sizes. These costs are summarized in ***Table 4-1***. The unit cost for pipe replacement will be not have the easement cost.

Table 4-1
New Gravity Sewer Unit Costs for Estimating

Pipe Size (inch diameter)	Unit cost ($/ft)	Easement ($/ft)	Engineering @ 15%	Contingency At 30%	Total Cost ($)
8"	$ 125.00	$ 100	$ 18.75	$ 43.13	$ 286.88
10"	$ 150.00	$ 100	$ 22.50	$ 51.75	$ 324.25
12"	$ 200.00	$ 100	$ 30.00	$ 69.00	$ 399.00
18"	$ 250.00	$ 100	$ 37.50	$ 86.25	$ 473.75
24"	$ 300.00	$ 100	$ 45.00	$ 103.50	$ 548.50
36"	$ 400.00	$ 100	$ 60.00	$ 138.00	$ 698.00
48"	$450.00	$ 100	$67.50	$155.25	$ 672.75

Easements

The City will be required to obtain easements for any private properties that are crossed by new lines and facilities. No detailed analysis of easements was performed in the analysis of alternatives. The amount of easement required to construct and maintain new sewers will vary with the alignment alternative. The easements through public right-of-way such as streets, should be much easier for the City, but there may be more conflicts with other utilities in these right-of-ways that will create additional cost impacts.

For this analysis, a 20-foot wide easement for the length of the sewer with the exception of the last 1500-feet was assumed. The last 1500-feet were assumed to be the length of sewer that would be constructed on City-owned property. A unit cost of $5 per ft^2 of easement was used. This equates to an easement cost of $100 per foot of line.

Engineering, Administration and Legal

The engineering, administration and legal costs are required to provide geotechnical engineering of the sewer alignment, surveying of the alignment, design of the sewer, purchase of the easements and administering the project. Additional legal costs for easement problems were not included. For the projects identified in this evaluation, a unit cost of $70,000 was assumed for surveying and $60,000 for geotechnical investigation. Engineering was estimated at 15% of construction and administration and legal expenses were estimated at 5% of construction.

Contingency

The costs developed in this evaluation were done to compare conceptual alternatives. For this reason a fairly high contingency was applied on the total project cost. A contingency of 30% was applied on all projects.

Operation and Maintenance Costs

Operation and Maintenance (O&M) costs are based on estimated manpower needs, resource requirements and equipment replacement and maintenance costs. Labor costs were assumed to be salary costs times a multiplier of 1.4 for benefits. O&M costs were estimated using the following assumptions:

- Labor cost: Operations - $ 70,000 per year
  Maintenance - $ 70,000 per year
  Management - $98,000 per year
- Power cost: $0.065 per kilowatt-hour
- Bioxide cost: $ 1.25 per gallon

The O&M costs were calculated for each alternative based on the estimated flow for the year evaluated. Flows were increased on an annual basis based on the population growth rates specified in the November 2002 Deschutes County Coordinated Population Forecast 2000 – 2025. Electrical rates were increased at 5% per year and labor costs increased by a factor of 3% per year.

Present Worth Methodology

The economic evaluation of the alternatives presented in this plan is based in part on comparison of their estimated net present worth (NPW). An alternative's NPW is an estimate of the dollar value that would need to be invested in year zero, given an appropriate interest rate, in order to finance all capital and O&M costs that will be incurred over the planning period. Although all of the alternatives are assumed to have the same useful life over the planning period, they will each have different capital and O&M cost requirements. Determination of their NPW is a way to compare them on an equivalent basis.

Given estimates of project and O&M costs, the associated NPW is calculated by the equation:

$$NPW = PW_p + PW_{O\&M}$$

Where: PW_p = present worth of capital costs
$PW_{O\&M}$ = present worth of O&M costs incurred over the 50-year planning period

The length of the planning period used for the economic analysis is 50-years. The interest rate used to bring annual O&M costs and future capital costs back to their net present worth value is 4.0 percent. This represents the assumed rate used to finance the alternatives. Replacement costs were developed assuming that mechanical equipment would be replaced once every 20 years.

Section 5
SE Interceptor Alternative Development

INTRODUCTION

One option that can serve the SE Bend Study Area is a new interceptor on the east side of the City running from the SE area to the treatment plant. This interceptor can transport the flows from this service area while reducing impacts on the core sewer system through the downtown area of Bend. This interceptor will also provide opportunities for reducing the number of pump stations that are currently located in the SE Bend Area as well as the future pump stations that are planned for the area in the 2003 Sewer System Master Plan. A final advantage of this interceptor is that it will provide the opportunity to serve an expanding UGB on the east side of the City with a gravity collection system.

SE INTERCEPTOR ALTERNATIVES

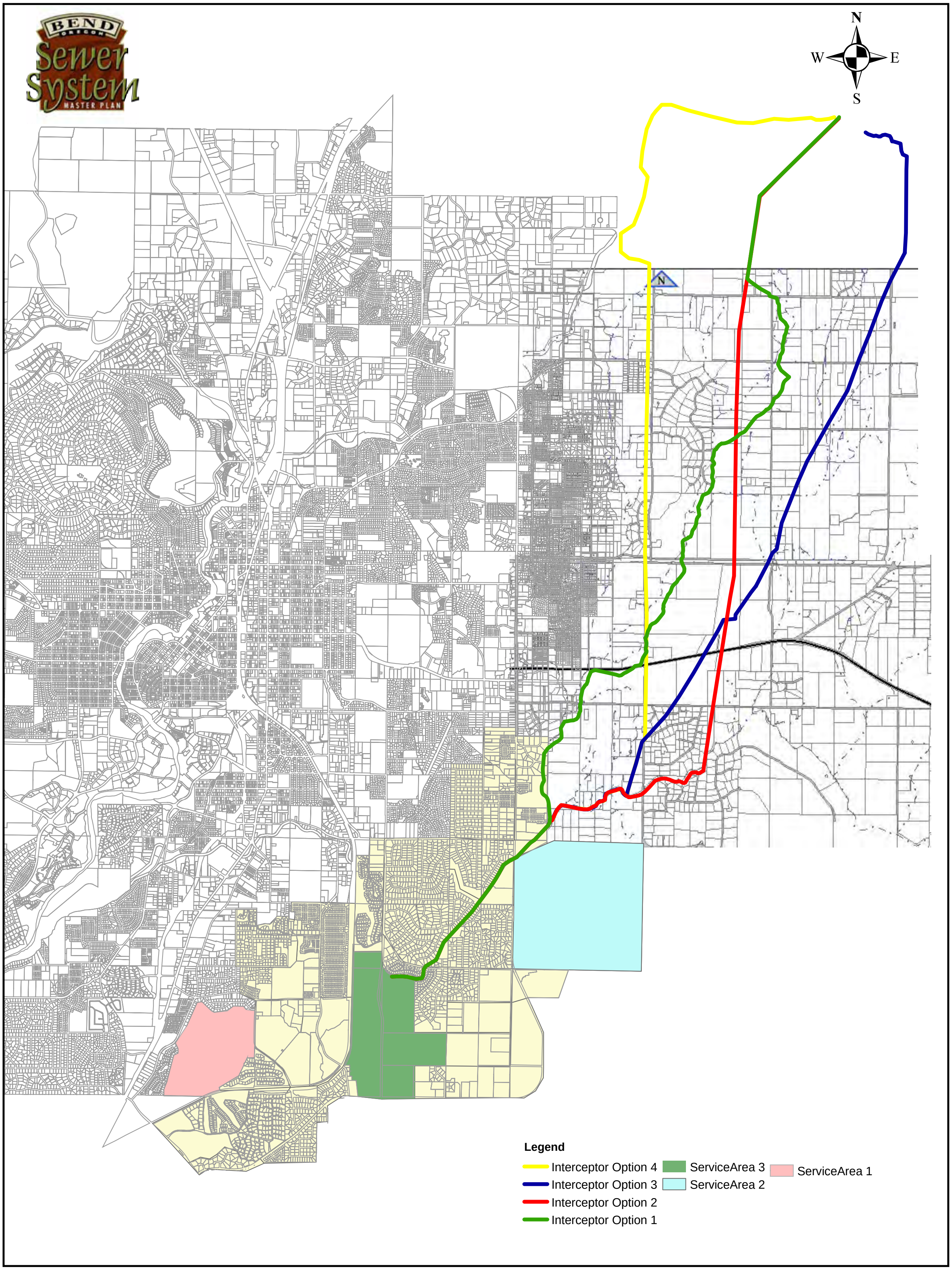
Several route options have been identified using both public and private land corridors. Each of the Route Options is shown on ***Figure 5-1***. These Route Options are:

- Route Option 1: The system of irrigation canals owned by the Central Oregon Irrigation District (COID) and a portion of the Main Canal owned by the North Unit Irrigation District (NUID).
- Route Option 2: A high-voltage electric transmission line corridor owned by Bonneville Power Authority and used by Central Electric Cooperative (CEC) and Pacific Corp.
- Route Option 3: An existing natural gas transmission pipeline corridor owned by TransCanada Gas,
- Route Option 4: Local road rights-of-way including a major portion of Hamby and Hamehook Roads.

Route Option 1 follows the Canal and is not as direct as either the TransCanada gas route or the BPA route. The canal routes are considered technically feasible since the canals are constructed to provide gravity flow from south to north, a valuable feature when considering gravity sanitary sewer trunk line.

Route Options 2 and 3 transverse much of the distance between the SE Bend Area and the wastewater treatment plant. These corridors are already dedicated to utility line use. It may be possible for the City to occupy a portion of the BPA easement however co-use of the TransCanada gas easement is highly unlikely. At this time, contact with TransCanada Gas has been made and the initial reaction from their local staff was not encouraging. Contact with BPA has been initiated with the response that locating a trunk sanitary sewer within their right-of-way may be possible. In either case, locating the sanitary trunk line parallel to but outside the existing easements is possible, given the ability to secure new easement from private landowners.

Route Option 4 incorporates rights-of-way for the road system currently developed in the study area, providing an option that will allow much of a new gravity sewer to be constructed



MWH

Figure 5-1 Sewer System Master Plan
City of Bend
Southeast Area Intercepter Options

within existing publicly owned corridors. Less direct than the natural gas route or the BPA route, right-of-way acquisition would be much less demanding and construction within existing rights-of-way may provide more direct service to commercial and residential developments along the route itself. This option also provides an opportunity to serve the developing northern areas of Bend including the areas north and west of Awbrey Butte. In addition, the northern reaches of the trunk sewer could be located in the North Unit Irrigation District canal easement, paralleling the existing line in that area.

All trunk sewer line options begin and end at the same points. The south terminus is located where the COID canal crosses 15th Street just south of Chloe Lane and all routes terminate at the wastewater treatment plant. Each of the four options are identical over the first 10,000 feet of line, extending from the beginning point and following the Central Oregon Irrigation District canal to a point near the intersection of Stevens Road and Arnold Market Loop Road where the routes diverge. Option 4, the local roads rights-of-way option will combine with the proposed North Interceptor and parallel the existing interceptor to the treatment plant. This alternative has the potential to provide cost savings with the sharing of costs with the North Interceptor project.

Distances cited in the following descriptions are measured over the complete length of each option. Preliminary routes and elevations were taken from USGS mapping and City of Bend base maps. Elevation contours on the USGS maps are 10' with a typical accuracy of +/- one-half contour.

Route Option No. 1 – Central Oregon Irrigation District Canal Route

This route option takes advantage of the irrigation canal system that delivers water to customers in the service area east of Bend. These canals generally flow from a southwest direction to the northeast, using the fall in topography to deliver water by gravity flow. This feature matches the desire to convey sanitary sewage by gravity also so the sewer route will benefit by aligning itself as closely as possible to the canal route. The final 1.5 miles of the route is located in the BPA transmission corridor because the canals do not extend to the existing wastewater treatment plant and the electric transmission line corridor provides a direct connection to the plant.

The irrigation canal system is located within a right-of-way owned by the COID and traverses a number of private properties. Use of this option will require permits from COID and possibly a number of the landowners along the canal route. Should it be necessary to locate the sanitary sewer parallel to but outside the canal easements, acquisition of new easements from the property owner(s) will be necessary. Very little of the COID canal system is located within public right-of-way.

While the topography lends itself to gravity flow when paralleling the canal system, special structures such as true or inverted siphons would be needed to cross other major utilities such as Highway 20, other major roads, or other larger utilities which themselves could not easily be relocated.

This route is approximately 9 miles long with 7.5 miles located along canal facilities and 1.5 miles located in the electric transmission easement corridor (Option 2). The length is a result of the circuitous route used by the canals to follow contours down-gradient. This also means that many more manholes will be needed and issues with easements will be more demanding. Use of this route will also require a horizontal separation from the canal of at least 20 feet and the sewer must be placed below the bottom of the canal at all times. Use of high-density polyethylene pipe (HDPE) will likely be required to limit the number of joints along the canals.

Route Option No. 2 – Central Electric Cooperative Transmission Route

This option combines use of the COID canal routes and the Central Electric Cooperative (CEC) right-of-way. Electric transmission lines along this route are owned by the CEC and Pacific Corp., however the land and right-of-way is owned by the Bonneville Power Administration (BPA).

This route option is the shortest of the four options at 8 miles and appears to be the most direct. This feature provides a lower construction cost and will likely involve fewer easements and right-of-way issues. As an established utility corridor, this route may be less impacting to surrounding land uses.

Disadvantages include overcoming issues with multiple utility owners and acquiring permits to locate a new sewer within their easements and rights-of-way. In relation to the other options, this is the most central in terms of east-west orientation and will be initially more remote from development but will be able to serve further to the east than Options 1 or 4. Since the electric transmission route was chosen for its direct routing, it will see more variation in ground elevations than would Option 1 so the sewer line will be subject to possibly deeper cuts and accompanying higher costs

Option 2 has a length of approximately 8.5 miles with about 5.3 miles located in the BPA right-of-way and 3.2 miles located along the COID canal.

Route Option No. 3 – TransCanada Gas Transmission Route

This option extends the sanitary sewer from the common beginning point to the gas line route, extending at the southern end of the route for approximately 2.5 miles along the COID canal system and for the northern 5 miles of the route along the TransCanada Gas line. The final mile of line into the treatment plant will be located in the Airport Road and across city-owned property to the wastewater treatment plant. The general orientation of the line is one veering somewhat to the east of the wastewater treatment plant, making it less accessible to future users in the northeast areas of the Bend service area.

Easements owned by the gas utility have been acquired from private property owners and typically are 80 feet wide on publicly owned land and 100 feet wide on private property. This easement contains two large diameter high-pressure gas transmission lines, a 36” line constructed in 1961 and a 42” line constructed in 1992. Gas company staff indicated that the company policy is to strongly discourage allowing paralleling use of their easements since that limits their own ability to add future facilities.

It is feasible to construct a trunk sewer line in easements paralleling the TransCanada Gas easement. This will involve acquiring at least 50 easements from property owners along the route. A typical permanent easement for a trunk sewer of this diameter will be 20 feet wide at the minimum. In some locations, additional temporary construction easements will also be required. The temporary easement areas may be able to be located on the gas company easement however.

Primary advantages of Option No 3 include the use of, or proximity to, the right-of-way currently in use by an existing utility. This may create less impact on surrounding land uses. This option also provides a reasonably direct route from the current city limits to the treatment plant. This route avoids much of the developed area making it more amenable to construction activities.

In addition to the issue of being granted use of the TransCanada Gas route itself, this route is relatively limited in its proximity to developing areas east of the city and will provide some areas of deeper cuts where topography does not provide constant downhill gradient.

Route Option No. 4 – Public Right-of-Way Route

Option 4 is the most westerly of the four routes, is also the longest at 10 miles. This route makes use of the COID canal route at the southern end, parallels the TransCanada gas line route for about one-half mile and extends for about 3.8 miles north along Ward and Hamby road. Ward Road turns into Hamby Road as it crosses Highway 20. The line along this route will join Hamby Road right-of-way near its intersection with Hurst Lane and will extend north along Hamby Road to Butler Market Road and then changing to Hamehook Road. The line will then follow Repine Drive unit it intersects with the North Unit Irrigation District (NUID) Main Canal. At this point it will join with the proposed North Interceptor and parallel the existing plant interceptor to the treatment plant.

This route contains more adverse grade along the alignment, requiring additional excavation for some sections. Until more specific geotechnical investigation can be done, the costs of this additional depth are not quantifiable. Once the line reaches the NUID Main Canal, it can likely be located parallel to the existing trunk sewer.

Since this route uses an existing public right-of-way, easement acquisition will be limited to the portion of the route parallel to the TransCanada gas line. A second, and perhaps more important advantage is that this route option shares the interceptor to the treatment plant with the proposed North Interceptor to the treatment plant. This route option will enable the city to construct a single large line into the treatment plant for the last 2.6 miles of line instead of conveying all the sewage from the northern service area in its own line.

Because of its location in an existing public right-of-way, this route will cause the most disruption to traffic along Hamby and Hamehook Roads during construction.

CAPITAL COSTS

Capital cost estimates for each option are provided in ***Table 5-1***. At this level of planning, estimates are typically done with a tolerance of +50 percent to -30 percent. Once a specific option is selected for more detailed study, refinement in the construction quantities may be done, more information on routing conflicts obtained and additional information on easement acquisition will be available. This information will provide the necessary detail for more precise estimates.

Table 5-1
SE Interceptor Alternatives Estimated Cost

Item	Option 1 Canal	Option 2 Power Line	Option 3 Gas Line	Option 4 Public Right-of-Way
Pipeline Length (ft)	46,675	45,910	45,480	51,650
Pipeline Construction Cost	$21,003,750	$20,659,500	$20,466,000	$23,242,500
Easements	$4,517,500	$4,441,000	$4,398,000	$200,000
Surveying	$70,000	$70,000	$70,000	$70,000
Geotechnical	$60,000	$60,000	$60,000	$60,000
Engineering (15%)	$3,150,563	$3,098,925	$3,069,900	$3,486,375
Contingency (30%)	$8,955,600	$8,808,720	$8,726,160	$8,466,300
Total	$38,807,600	$38,171,120	$37,813,360	$36,687,300

Several assumptions were also used to develop these estimates. They are:

- A pipeline cost of $450 per lineal foot was assumed for construction cost
- Easements will be purchased from private landowners
- No unusual legal issues will arise during design or construction
- A 30% allowance for contingencies will be applied to the estimated construction cost
- These estimates are intended for comparative purposes only and may vary outside the percentages stated above; once more detailed information is available.

It must be noted that these costs are based on the alignments that have been developed in this evaluation. The specific depth of the sewer, the geotechnical conditions and the required easements for these alternatives is unknown. Once the preferred routing is selected, a more detailed evaluation of the specific conditions can be performed and a more refined cost estimate can be developed.

An important point that needs to be made is the potential savings that can be realized with the sharing of the final 2.6 miles of line with the North Interceptor on Option 4. This shared cost is estimated to be $10,000 for this segment of line. If this cost is split between the two options at a 50/50 split, then the total cost for Option 4 would be $31,687,000 which would easily make it the lowest cost alternative.

INTRODUCTION

The intent of this analysis is to compare the various alternatives available to the City for providing sewer service to the SE Bend Area. The five alternatives that were evaluated are:

- Base Case – Existing Master Plan (2001 Sewer Collection System Master Plan – Revised 2003)
- Expansion of existing system capacity
- Expansion of existing system capacity with SE Satellite Plant
- New SE Bend Interceptor
- New SE Bend Interceptor with SE Satellite Plant

In this analysis, it is also important to consider the impact that the installation of the SE Bend Interceptor will have on the rest of the service area. This interceptor will not only be providing service to currently unsewered areas, but will provide relief to the plant interceptor and the gravity system through the main downtown area. A cost evaluation of the impacts that the addition of the SE Bend Interceptor will have will be based on the cost of construction the new interceptor compared to the Base Case Alternative, which is the 2003 Sewer System Master Plan.

ALTERNATIVE EVALUATION

The alternatives were developed so that the use of gravity systems could be maximized and O&M costs could be minimized. This was done by minimizing system flow rates through the construction of a satellite treatment facility, a new gravity system and or both. The five alternatives that were evaluated are discussed below.

Base Case – Existing Master Plan

The base case for this evaluation is the existing Sewer System Master Plan. This document is the 2001 Sewer Collection System Master Plan – Revised 2003 that was prepared by Century West Engineering. In this plan, pump stations were used in each development area to provide service as the areas were developed. This was done for the following reasons as stated in Section 6.2 of the plan:

> *"First, outlying areas are to be served to the fullest extent possible through the extension of existing facilities. Second, the use of basin pump stations and force mains was relied upon heavily as a means of providing service in outlying areas. This was done in an effort to avoid extensive rock excavation and deep street cuts anticipated with gravity sewers, and in an effort to moderate the proliferation of pump stations currently experienced by the City. In addition, the use of forcemains allows the alignments of trunklines to be set*

with less regard for terrain, resulting in shorter, more direct connections to outfall points than might otherwise e possible with gravity sewers."

This Master Plan estimates a total of $24,300,150 in capital improvements. Of these improvements, $11,774,400 was designated for the SE Bend Study Area. The pump stations and force mains recommended by the Master Plan are shown in ***Figure 6-1***. The cost for each of the basins is summarized in ***Table 6-1***, per the 2003 Master Plan.

The cost estimating done in the 2003 Master Plan used unit costs that were much less than those used in this study. Recent changes in the bid market resulting from increased cost of materials have resulted in increased costs for sewer construction. In addition, the recent bids received by the City and other entities in Central Oregon were based on unit costs that were much higher than those used in the 2003 Master Plan. Unit costs of recent bids for gravity sewers have been 2.5 to 3.0 times the unit costs used in the 2003 Master Plan. The impact of this could easily increase the 2003 Master Plan total cost to $30,000,000 to $36,000,000 instead of the $24,300,150 stated in the plan. *This would make the estimated construction cost for the North Service Area to actually be between $25,000,000 and $30,000,000.* The actual estimated cost for the improvements outlined in the 2003 Master Plan is also shown in ***Table 6-1***.

Table 6-1
2003 Sewer System Master Plan
Recommended SE Study Area Projects

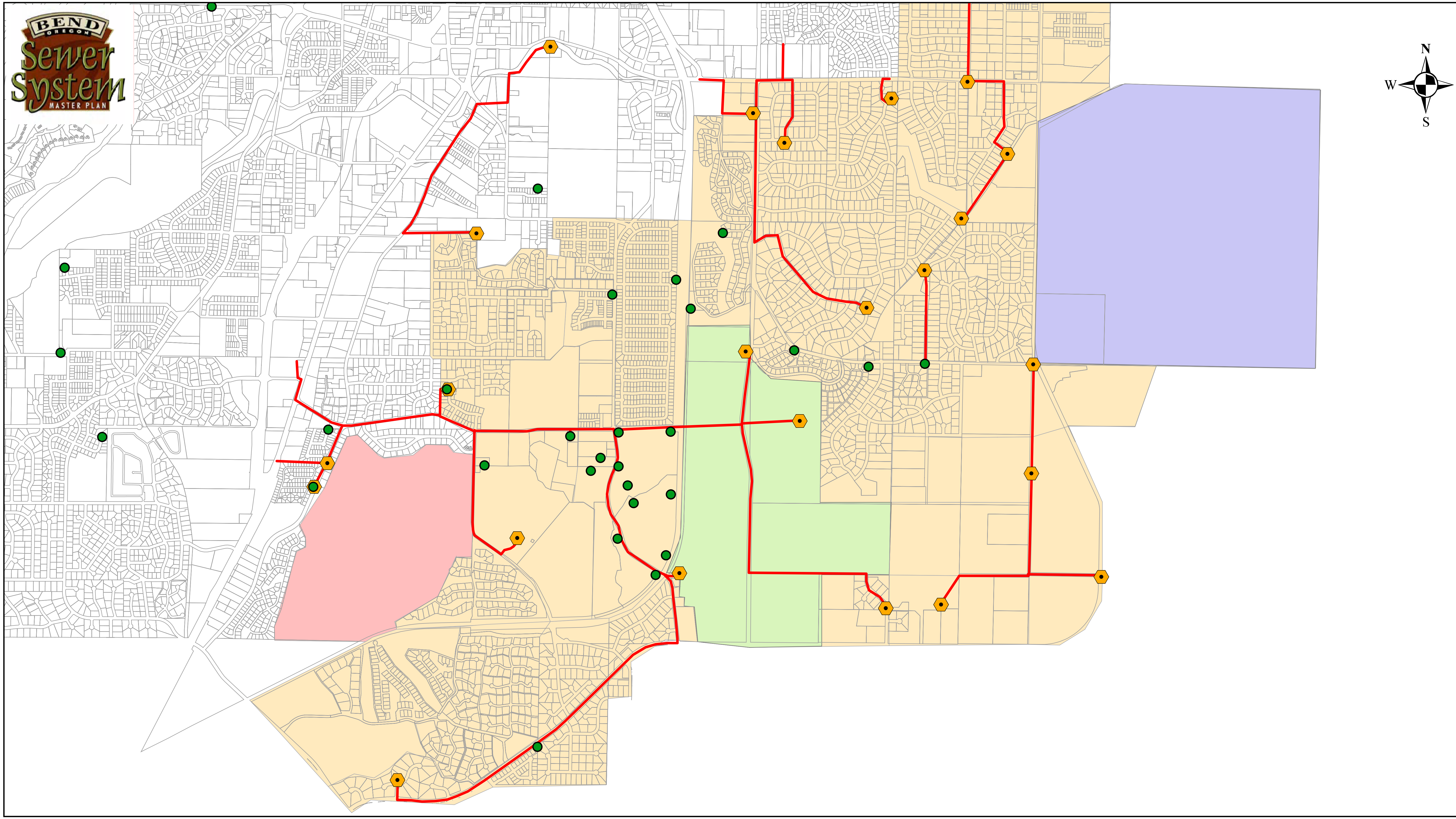
Area	Project/Basin Name	2003 Master Plan Cost Estimate	Estimated Actual Cost
2	27th Street Force Main	$ 2,816,400	$ 8,449,200
3	Pettigrew Force Main	$ 2,129,250	$ 6,387,750
4	Basins, 86,88,198,199	$ 1,868,250	$ 5,604,750
5	Murphy East	$ 1,618,500	$ 4,855,500
8	Parrell	$ 1,787,250	$ 5,361,750
9	Brosterhous/Murphy	$ 1,554,750	$ 4,664,250
Total SE Area Project Cost		**$ 11,774,400**	**$ 35,323,200**

The Master Plan recommends an additional 25 pump stations be added to the SE Bend Service Area. Of these 25 pump stations, 4 have already been constructed. This is in addition to the existing 86 pumps stations that the City operates and maintains and the additional 27 pump stations recommended in east and north Bend.

Expansion of Existing System Capacity

The existing sewer system was modeled for a variety of conditions under three scenarios to determine the relative cost to correct the system deficiencies that will occur under each of the scenarios. These scenarios are:

- Existing System with No Growth – 2005 flow conditions
- Growth at 5.8% AAGR – System grows through 2015 at the current growth rate of 5.8% AAGR



Legend

- ServiceArea 1
- ServiceArea 2
- ServiceArea 3
- Proposed Force Main
- Proposed Pumpstations
- Existing Pumpstations
- SE Study Area

Figure 6-1 2003 Master Plan Southeast Area

MWH

- 2030 TAZ Growth – System grows to 2030 according to the growth rate designated in the 2030 TAZ study

Model runs were then performed on each of these growth rates to predict the flow limitations in the existing system. The system evaluation under the 2030 growth scenario was then evaluated by removing flows from different areas of the city. This analysis provided the information necessary to evaluate the affects on the system of constructing the North Interceptor in various combinations with a new SE Interceptor and alternative service on the west side of the river. The scenarios that were evaluated are as follows:

- Existing System with No Growth – This is the current system under present day flows.
- 2010 City – This is the current urban growth area with a population growth between 2005 and 2010 at an AAGR of 5.8%.
- 2015 City – This is the current urban growth area with a population growth between 2005 and 2010 at an AAGR of 5.8%.
- 2030 TAZ – This is the current urban growth area with population growth projected in the specific areas of the City as specified in the 2030 TAZ analysis.
- 2030 TAZ no SE Area Flows– This is the current urban growth area with population growth projected in the specific areas of the City as specified in the 2030 TAZ analysis. In this analysis, the flows from the SE Area were removed from the model assuming a new SE Area Interceptor.
- 2030 TAZ no North Area Flows– This is the current urban growth area with population growth projected in the specific areas of the City as specified in the 2030 TAZ analysis. In this analysis, the flows from the North Area were removed from the model assuming a new North Area Interceptor and removal of the pump stations in the North Central Area sending the flow to the new interceptor by gravity.
- 2030 TAZ no North and SE Area Flows– This is the current urban growth area with population growth projected in the specific areas of the City as specified in the 2030 TAZ analysis. In this analysis, the flows from both the North and SE Areas were removed from the model assuming a new North and SE Area Interceptor.
- 2030 TAZ no North, SE and West Area Flows– This is the current urban growth area with population growth projected in the specific areas of the City as specified in the 2030 TAZ analysis. In this analysis, the flows from the North, SE and West Areas were removed from the model assuming a new North and SE Area Interceptor. Removal of the West area flows were based on removal of the flows from the Westside Pump Station.
- Build-out – This providing sewer service to the complete UGB area fully built out to the densities outlined in the General Plan.

The modeling of the existing system showed that there are currently various areas throughout the system that do not have the required capacity. As growth occurs in the system, additional deficiencies occur in addition to those that currently exist. The methods for mitigating the system deficiencies will be developed in Task 3 of the Sewer System Master Plan project. Identification of methods to mitigate these deficiencies was well beyond the scope of work for this analysis. In order to obtain some type of cost so that alternatives could be compared, a cost for each deficiency was developed assuming that the deficiency could be corrected by increasing the pipe diameter by one size. The unit cost values discussed in ***Section 4*** were used to develop the total mitigation cost. The estimated cost to mitigate the system deficiencies under each scenario is shown in ***Table 6-2***. Figures that graphically show the lines where deficiencies are occurring are shown in ***Appendix A***.

Table 6-2
Existing System Deficiency
Capacity Upgrade Cost Estimate

Scenario	Estimated Cost ($)
No Growth	
Existing System with No Growth	$1,414,000
Current City Growth at 5.8% AAGR	
2010 City	$20,747,000
2015 City	$37,507,000
2030 TAZ Planned Growth	
2030 TAZ	$35,729,000
2030 TAZ no SE Area Flows	$25,340,000
2030 TAZ no North Area Flows	$31,629,000
2030 TAZ no North with SE Interceptor	$21,833,000
2030 TAZ no North, SE and West Area Flows	$14,435,000
Existing UGB Build-out	
Build-out	$60,798,000

Expansion of Existing System Capacity with SE Satellite Plant

Another alternative that was developed was to construct a satellite treatment plant in the SE Bend Study Area that would treat a portion of or all of the flows generated in the area. This treatment plant would then provide recycled wastewater during the irrigation season and would discharge to groundwater during the non-irrigation season. This would require a new WPCF permit or a modification of the existing treatment plant permit allowing satellite facilities. Solids generated at the facility would need to be hauled to the treatment plant for processing. The collection system is too long and the flows are not high enough to provide acceptable transport of the solids to the treatment plant. Solids processing facilities would require a larger treatment plant site and would essentially be a new treatment plant.

The technology that is currently being successfully used and was used in this evaluation is the membrane bioreactor (MBR) technology. This is the same technology currently being used at the Eagle Crest Resort. The MBR technology provides a high quality effluent in a relatively small footprint.

It would be necessary to construct an MBR facility in the 1-mgd to 2-mgd size range to provide any benefit in the reduction of flows that would minimize the capacity deficiencies in the existing system. The cost of an MBR facility in this size range can be estimated at about $10.00 per gallon. This means that an MBR facility would cost in the range of $10M to $20M dollars. The infrastructure to collect and transport the flows to the satellite facility would still be required. The benefits of the satellite facility would be the opportunities to provide reuse water in the SE Bend area. The cost of a facility of adequate size to eliminate the system deficiencies is far greater than the cost to upgrade the lines to provided additional capacity. For this reason, this alternative was not developed further.

New SE Bend Interceptor

Four alternative routes for a new SE Bend Interceptor were identified in ***Section 5***. These route options were shown in ***Figure 5-1***. The estimated project costs for design and construction of the interceptor ranged from $36.6M to $38.8M.

The installation of an interceptor would provide an opportunity to remove most of the pump stations from the SE Bend Study Area and provide service to the area with gravity sewers. Some preliminary routings of gravity sewers to eliminate pump stations were developed based on topography. These preliminary routings are shown in ***Figure 6-2***. The estimated cost to construct these gravity trunk sewers is $11,000,000. This was based on 7-miles of 12-inch gravity sewer at a cost of $300 per lineal foot.

New SE Bend Interceptor with SE Satellite Plant

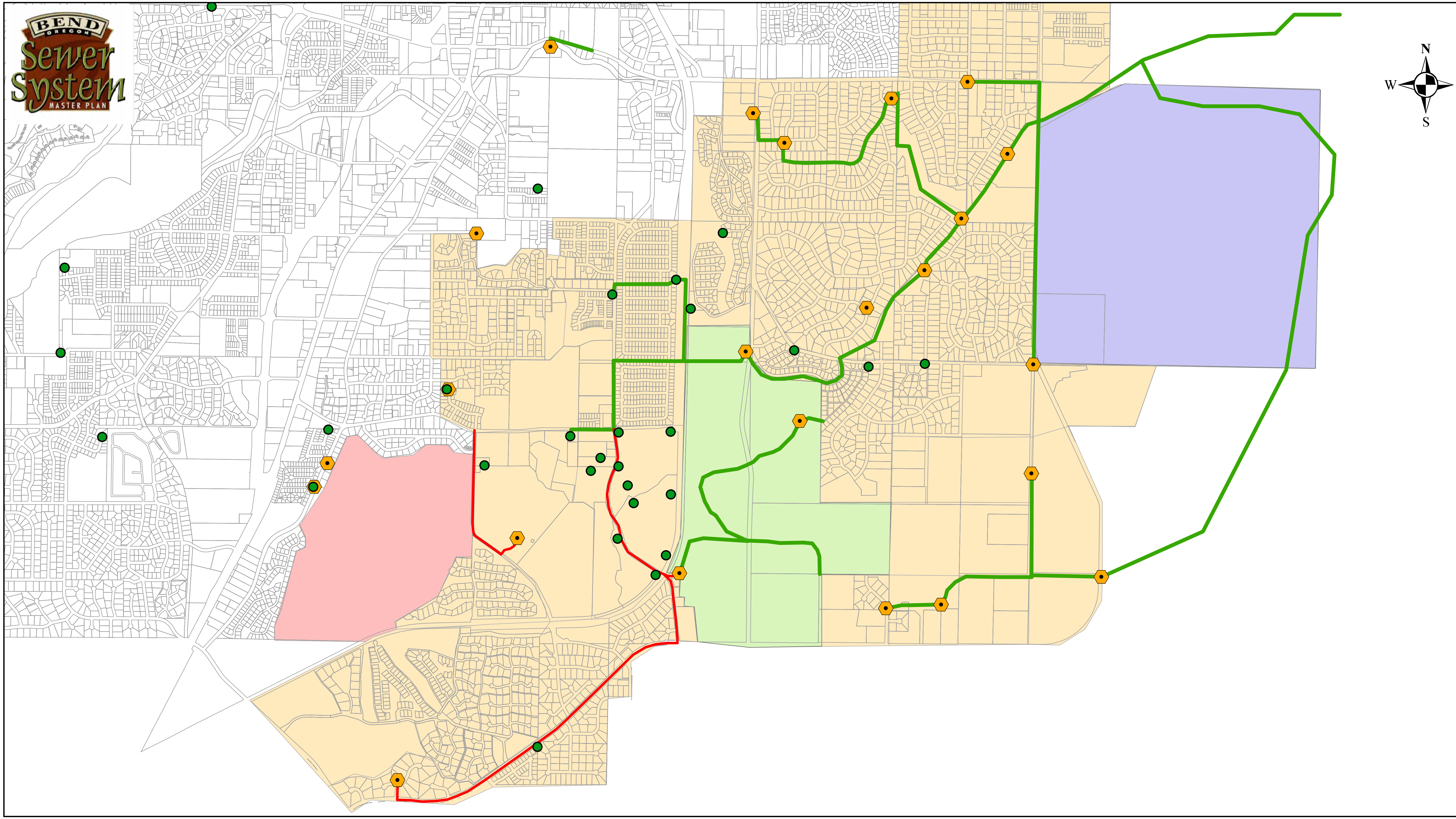
The option to construct a satellite treatment plant in SE Bend was also evaluated. As in the previous satellite plant alternative, the removal of 1-mgd to 2-mgd of flow from the interceptor is not a cost effective alternative. The lowering of the interceptor design flow by up to 2-mgd will not cause a large enough decrease in sewer diameter to provide a $20M benefit. For this reason, this alternative was not evaluated further.

ALTERNATIVE COST SUMMARIES

There appear to be four alternatives that can be compared for development of the system that a new SE Bend Interceptor will be a factor. These alternatives are:

- 2003 Master Plan – Construct the system following the Master Plan
- SE Bend Interceptor – Construct the system following the Master Plan with the exception of construction a new interceptor to provide service to the SE Bend Area. In addition, construct trunk sewers to remove as many of the existing and proposed pump stations as possible to provide a gravity system.
- North & SE Bend Interceptor – Construct the North Area and SE Area interceptors. Phase in trunk sewers to remove as many pump stations as possible.
- North & SE Bend Interceptors and Westside WWTP – Construct the North Area and SE Area interceptors. Phase in trunk sewers to remove as many pump stations as possible. Construct a new treatment plant on the west side of Bend to treat flows pumped by the Westside Pump Station

The costs for these four alternatives are summarized in ***Table 6-3***. This evaluation shows that the total capital and 20 Year Present Value costs for the SE Area Interceptor only alternative is relatively the same as the cost of the 2003 Master Plan. In addition, the 50-year Present Value analysis shows that the savings of operating the SE Area Interceptor vs. a large number of pump stations is substantially less by $63M over the 50-year operating period.



Legend

ServiceArea 1	Proposed Pumpstations	Existing Pumpstations	
ServiceArea 2	Gravity Sewer	SE Study Area	
ServiceArea 3	Force Main		

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Figure 6-2 Proposed Trunks
Southeast Area

This analysis showed that the capital costs for the SE Bend interceptor was in the same range as the 2003 Master Plan. Based on this cost analysis, it appears that even with the high cost of the interceptor, the savings in system development and mitigation of system deficiencies offset the capital costs.

Of greater significance is the potential cost savings that are possible with the construction of both the SE and North Area Interceptors. This analysis shows that this is the least cost alternative based on the 50-year present value by $90M over the 2003 Master Plan using pump stations and $28M less than constructing the SE Area Interceptor only.

Non-Cost Alternative Evaluation

There are also a number of non-cost variables that must be considered when evaluating the various alternatives. These are variables such as process risk, potential for permit violation, public safety, system redundancy and ease of operation. These non-process variables are summarized in ***Table 6-5***.

Table 6-3
Alternative Cost Evaluation
(million dollars)

Project Element	2003 Master Plan	SE Bend Interceptor	North & SE Bend Interceptor	North, SE Bend Interceptor & West Bend WWTP
Develop System	$75.000	$40.000	$25.000	$25.000
Mitigate System Deficiencies	$35.729	$25.340	$21.833	$14.435
Develop North Bend Basins	-	-	$14.853	$14.853
North Bend Interceptor	-	-	$25.528	$25.528
Develop SE Bend Basins	-	$11.000	$11.000	$11.000
SE Bend Interceptor	-	$36.687	$36.687	$36.687
West Bend WWTP	-	-	-	$20.000
North & SE Interceptor Shared Savings	-	-	($10.000)	($10.000)
Total Capital Cost	***$110.729***	***$113.027***	***$124.901***	***$137.503***
20 Year Present Value	$122.955	$122.415	$133.870	$148.236
50 Year Present Value	***$270.110***	***$207.111***	***$178.850***	***$200.141***

Table 6-4
Alternative Evaluation
Non-cost Variables

Variable	Base Case	North Bend Interceptor
Process Risk	There is a large amount of risk in operating an additional 25 pump stations. The pump stations that are planned are small will not have the redundancy and alarms that a larger station will.	There is little or no risk with a gravity system. System plugging is rare and is typically caused by poor construction. New gravity sewers of PVC have good seals and fewer joints than the older concrete gravity sewers resulting in less intrusion by tree roots.
Potential for Permit Violation	The pending CMOM regulation will have strict reporting criteria and penalties for system backups and overflows. The larger number of pump stations and sumps in the SE Area create a high potential for permit violation resulting form system backups and/or pump station overflows.	There is little risk of permit violation due to a backup or overflow in a gravity sewer system when compared to a system with many pump stations.
Public Safety	Any system backup or overflow can create a health hazard. Failure of a pump station or sump can result in a system backup or overflow onto private property.	There is little comparative risk of overflow or system backup in a gravity system.
System Redundancy	There is currently only one trunk sewer delivering all of the flow to the treatment plant. Failure of this sewer will result in the failure of the complete treatment system.	The addition of a second interceptor to the treatment plant will relieve the existing interceptor and a parallel routing can provide a redundant trunk sewer for a portion of the distance to the treatment plant.
Ease of Operation	The monitoring and maintenance of the large number of pump stations currently requires 3 full-time staff. Additional staff will need to be added to provide adequate monitoring and maintenance of the aging systems.	A gravity sewer system will require inspection once every 5-years. Continuous monitoring of the system is not required.
Growth Access	No facilities for growth	The construction of a North Interceptor will provide service to an expanded UGB on the north and northwest side of the City.
Share Components with North Interceptor	None	The SE Interceptor and North Interceptor will combine and provide a new interceptor to the treatment plant. The will relieve the future capacity issues with the existing interceptor.
Downtown Corridor	There will need to be upgrades in the Downtown area. These upgrades will disrupt business.	The North Interceptor will minimize flows through the Westside Pump station providing some relief to the downtown area.

Section 7
Recommendations

The selection of a long-term solution to provide sanitary sewer service to the SE Bend Study Area will not be an easy process. No matter which alternative is selected, there will be a considerable cost to construct and maintain the sewer system. The City needs to carefully evaluate each of the alternatives and gain a thorough understanding of the impacts that their selection will have on the long-term system operation and maintenance costs and system dependability. In order for the City to gain a better understanding of these alternatives, the following recommended steps are offered:

1. Contact management from each of the other utility agencies in the SE Interceptor alternative routing area. These include:

    a. Central Electric Cooperative (541.548.2144),
    b. North Unit Irrigation District (541.475.3625),
    c. TransCanada Gas (541.548.9243),
    d. Central Oregon Irrigation District (541.548.6047),
    e. Bonneville Power Administration (360.418.8008),
    f. Deschutes County (541.388.6581)
    g. Pacific Corp

2. Secure the services of a geotechnical engineering firm to provide a preliminary analysis of the construction issues for each route.

3. Research property along each route to ascertain the number and ownership types (public/private) for possible easement or right-of-way acquisition.

4. Confirm detailed elevations at key points along each route.

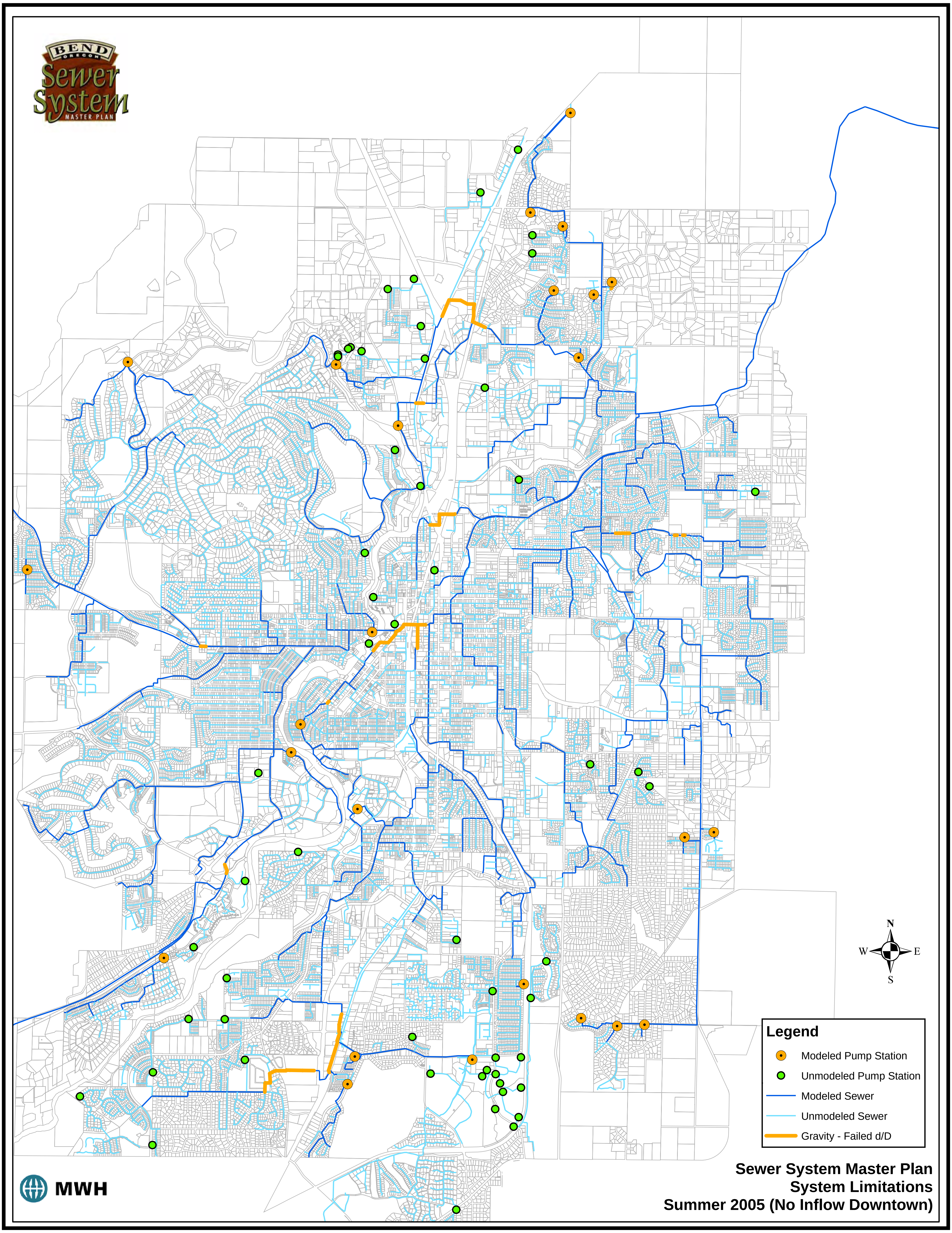
5. Investigate all major structural conflicts along each route to identify any that would cause a change in the route or otherwise negate use of the route for a gravity sewer.

6. Determine any required hydraulic changes in the Murphy Road Pump Station or other nearby pump stations that could possibly discharge to the new trunk line.

7. Narrow the route options to one or two for final analysis and decision.

The option of a SE Area Interceptor will be evaluated more thoroughly during the Sewer System Master Planning Process. During this evaluation, area plans and interceptor alternatives will be developed in more detail to allow for more a more detailed cost estimate and evaluation. The Sewer System Master Plan is projected to be complete by July 2006.

Appendix A
System Deficiencies


BEND OREGON
Sewer System
MASTER PLAN
N
W
E
S
Legend
Modeled Pump Station
Unmodeled Pump Station
Modeled Sewer
Unmodeled Sewer
Gravity - Failed d/D
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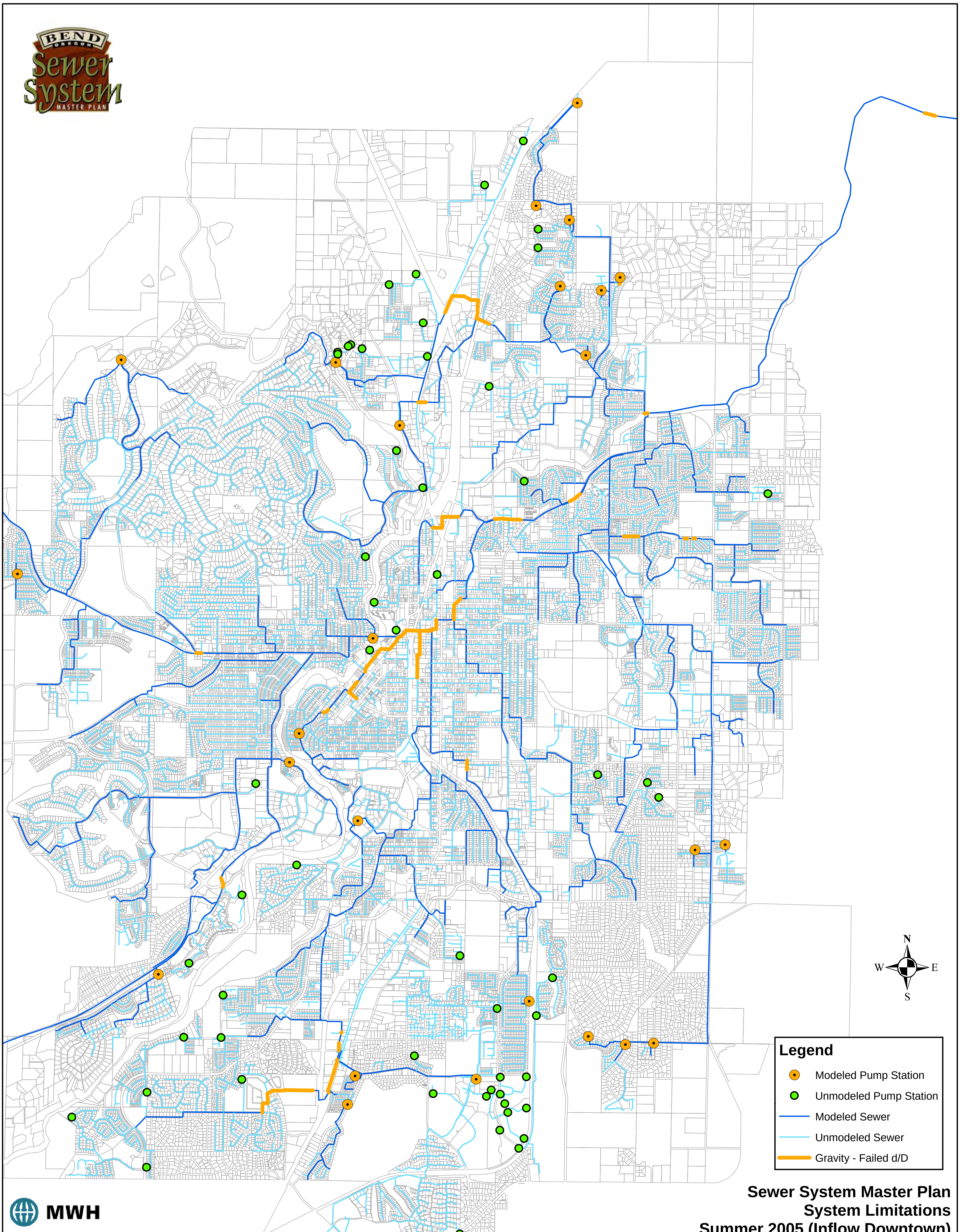
Sewer System Master Plan
System Limitations
Summer 2005 (No Inflow Downtown)



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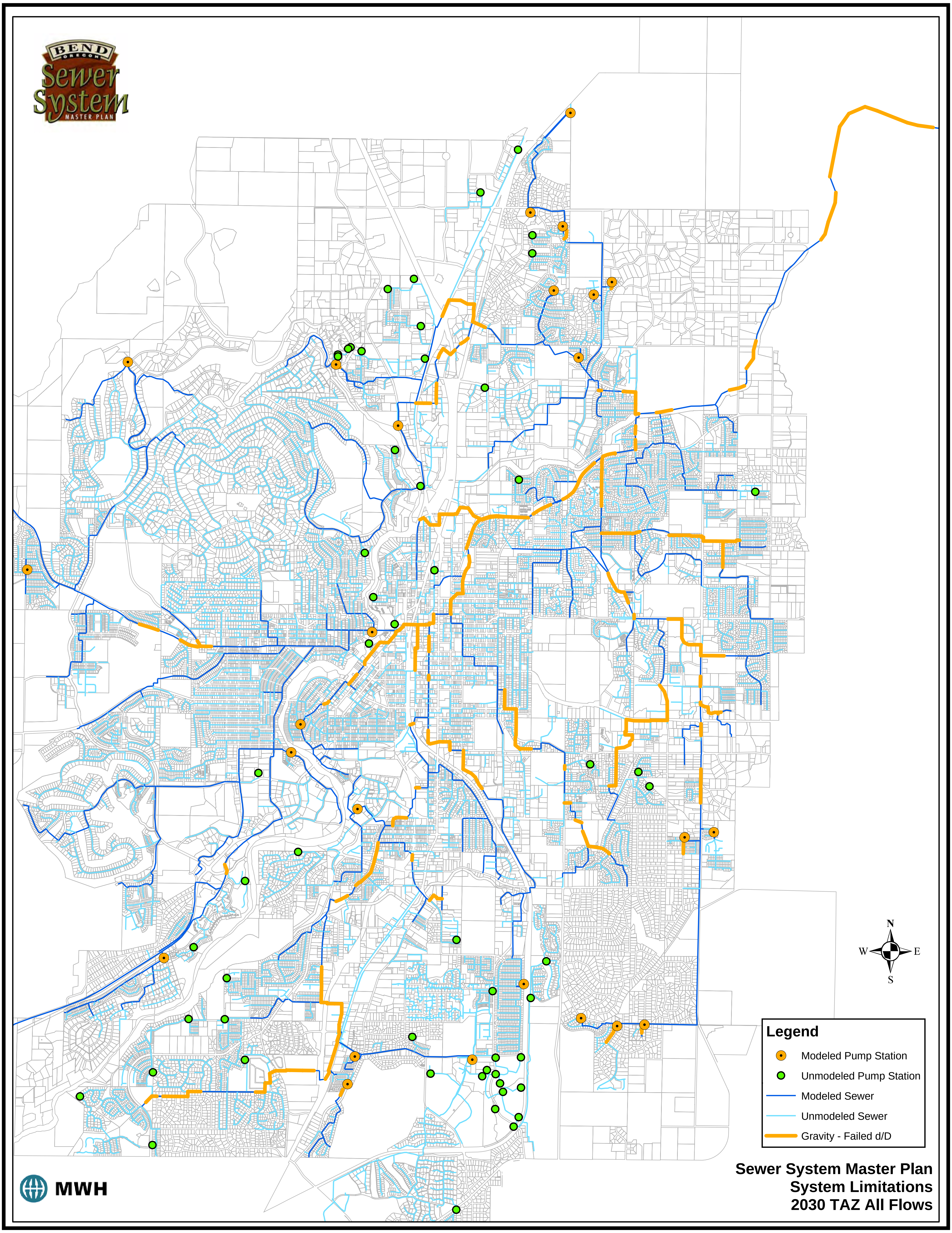
Sewer System Master Plan
System Limitations
Summer 2005 (Inflow Downtown)


BEND OREGON
Sewer System
MASTER PLAN
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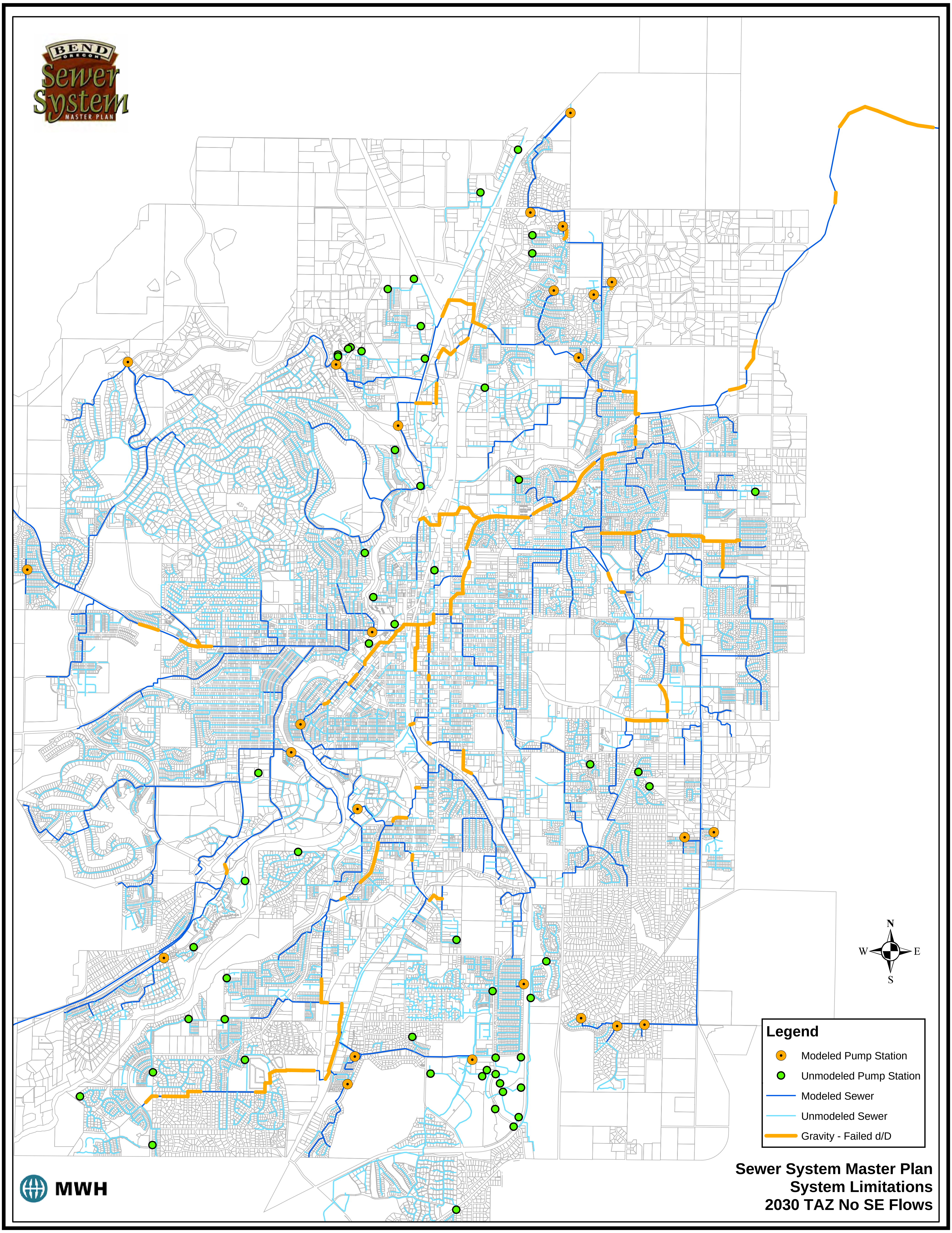
Legend
Modeled Pump Station
Unmodeled Pump Station
Modeled Sewer
Unmodeled Sewer
Gravity - Failed d/D
MWH
Sewer System Master Plan
System Limitations
2030 TAZ All Flows


BEND OREGON
Sewer System
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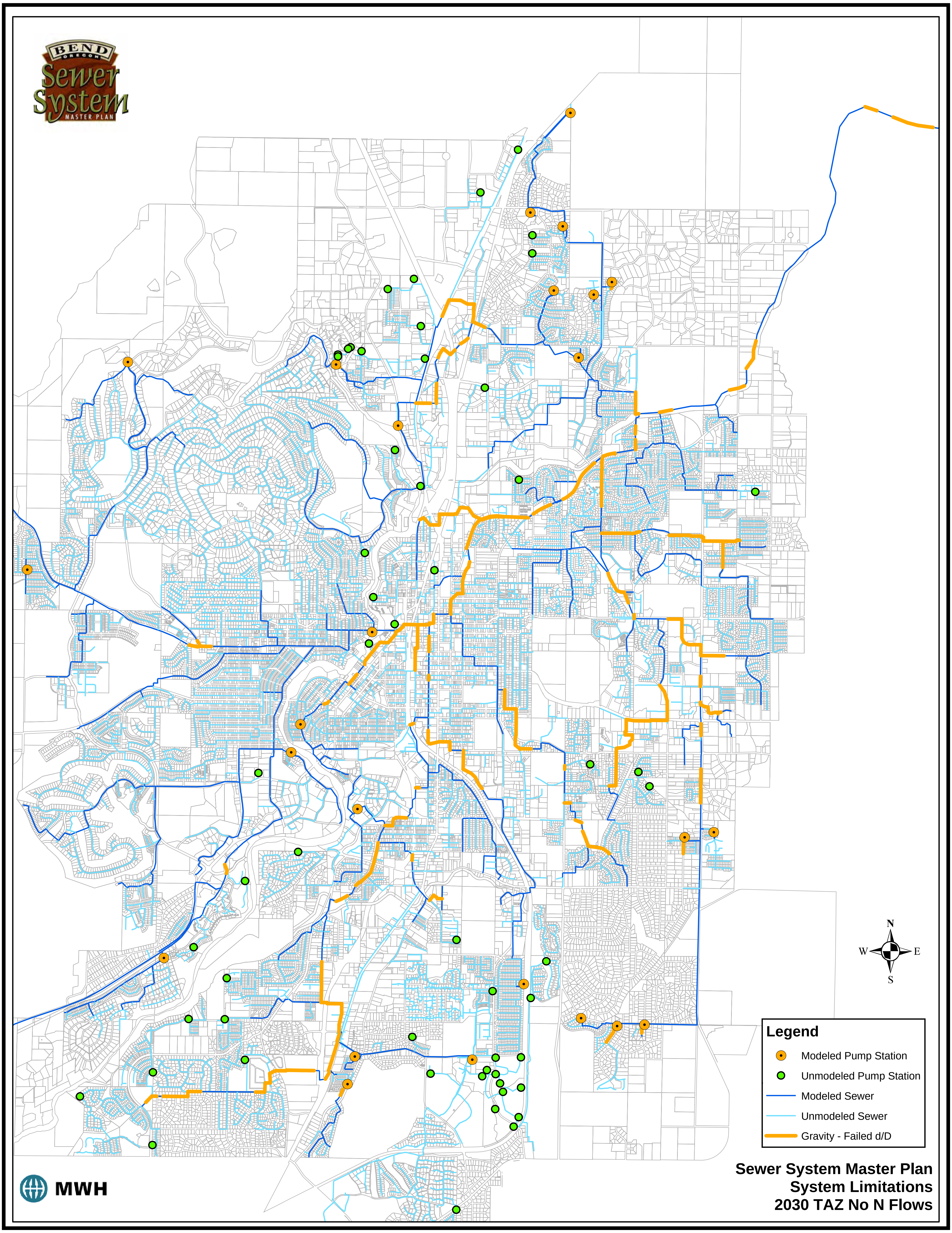
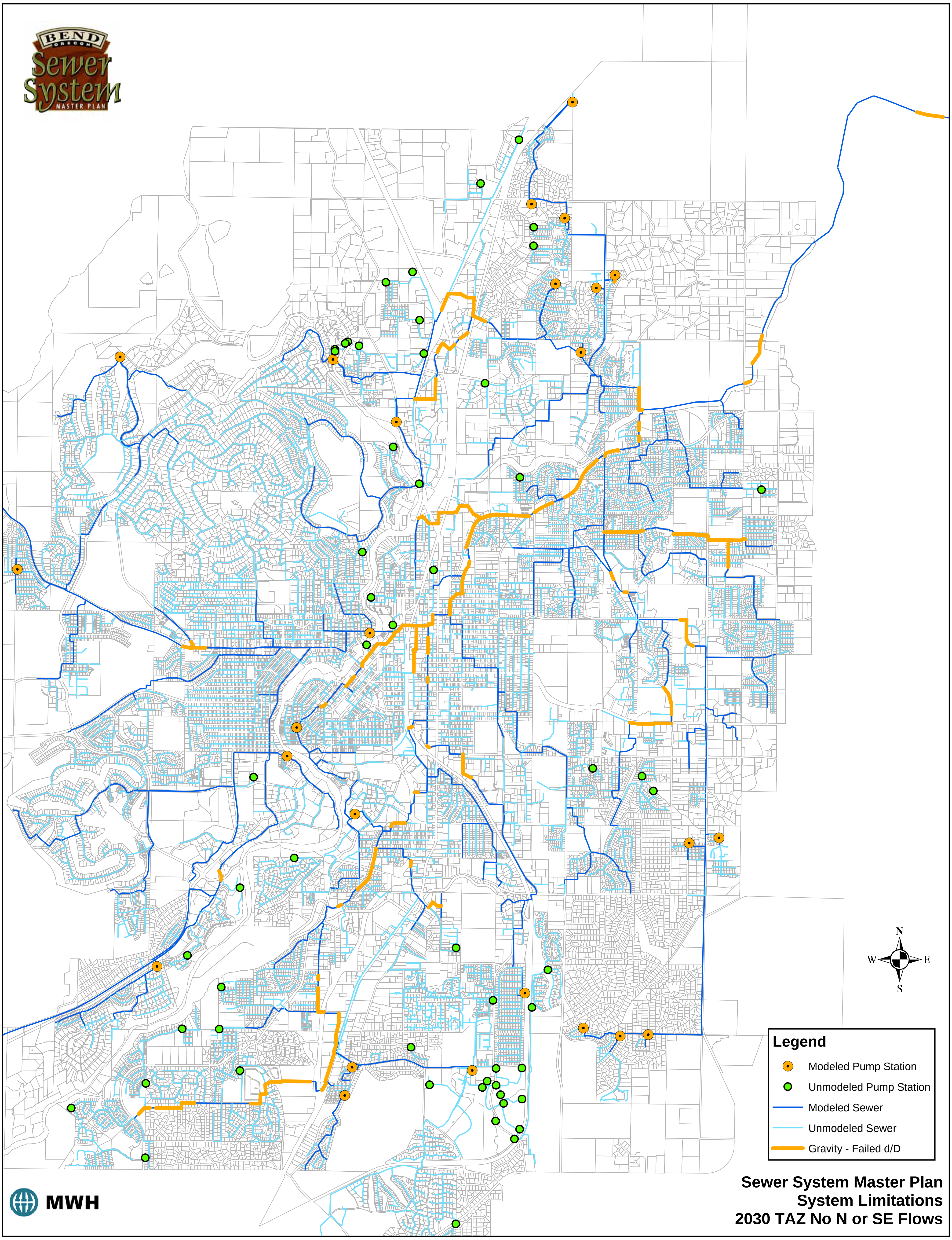
Legend
Modeled Pump Station
Unmodeled Pump Station
Modeled Sewer
Unmodeled Sewer
Gravity - Failed d/D
MWH
Sewer System Master Plan
System Limitations
2030 TAZ No SE Flows



Sewer System Master Plan
System Limitations
2030 TAZ No N Flows



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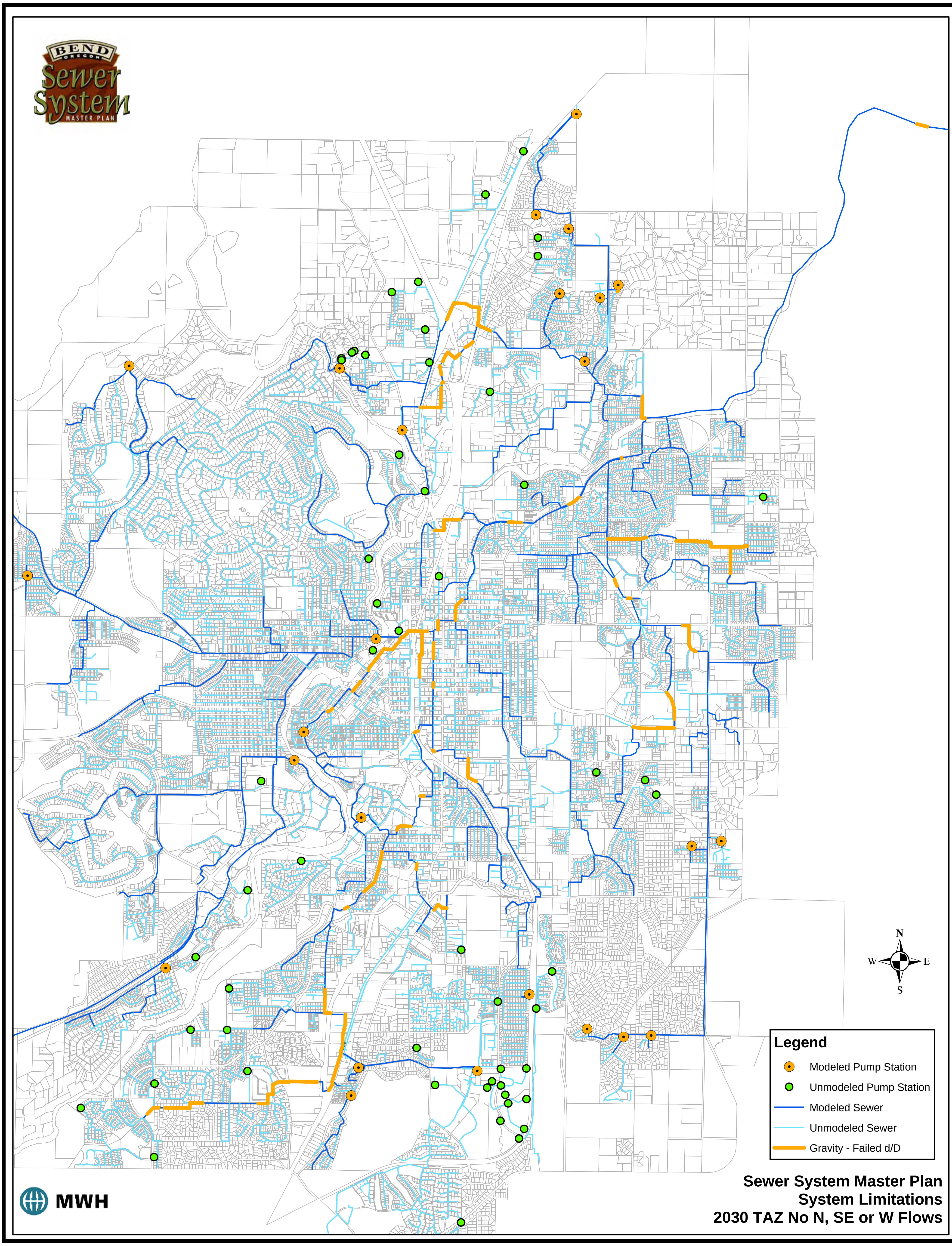
Sewer System Master Plan
System Limitations
2030 TAZ No N or SE Flows


BEND OREGON
Sewer System
MASTER PLAN
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Legend
Modeled Pump Station
Unmodeled Pump Station
Modeled Sewer
Unmodeled Sewer
Gravity - Failed d/D
MWH
Sewer System Master Plan
System Limitations
2030 TAZ No N, SE or W Flows