



Task 1.5 - Hamby Road Sewer Analysis

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Background

Consideration of adding the Hamehook/Hamby/Ward Road route to the Southeast Interceptor Concept Study options was proposed to the City in summer 2007 by stakeholders with an interest in providing sewer service to the Hamby Road area. After consideration of this proposal, the City Council asked that this option be included in the scope of work for the Southeast Interceptor for comparison with the Collection System Master Plan (CSMP) recommended route along SE 27th Street.

Figure 1 shows the proposed Hamby Road interceptor route, the current city limit line, the proposed Urban Growth Boundary (UGB), and the proposed Urban Reserve Area (URA) boundary.

Approach

The approach to performing this analysis included the following steps:

1. Gather information about the service area including topographic mapping, current and planned land use and populations, and existing utilities. The service area for the Hamby Road sewer was determined using P-line survey data and USGS topography data.
2. Determine the major and minor drainage basins tributary to a Hamby Road sewer.
3. Determine the land uses, zoning, current and future populations for each subbasin.
4. Input land use, and demographic and spatial data to the city's InfoSWMM hydraulic model; run model for buildout conditions to generate dry and wet weather flow, and report results. A spreadsheet was used to calculate the average dry weather flow based on catchment areas, zoning, and EDU's per acre.
5. Select sewer route alternatives near or within the Hamby Road corridor, analyze each alternative and prepare a recommendation for horizontal location.
6. Prepare a preliminary plan/profile drawing showing sewer depth, size, location and connection points for each subbasin.

7. Determine which, if any existing pump stations can be decommissioned through use of the Hamby Road sewer line.
8. Determine which existing deficiencies identified in the master plan can be eliminated by the Hamby Road alignment in lieu of the 27th alignment for the Southeast Interceptor.
9. Identify basins that contribute to overload of the Core system and can be routed to the Hamby Road alignment.
10. Propose connection plans for connecting the Hamby Road sewer to existing and/or future downstream interceptor lines.
11. Prepare a capital cost estimate for the pipeline route.
12. Prepare and submit a preliminary study draft for city staff review.
13. Meet with city staff to review draft and accept comments.

Prepare and submit a final study for sanitary sewer options and recommendations.

Assumptions

Several assumptions are necessary to make the Hamby Road route comparable to the other option for sanitary sewer service to southeast Bend. These are:

1. The Hamby Road route will begin at the downstream end at or near the confluence of the proposed North Interceptor and the existing Plant Interceptor and will be routed to an upstream termination near the intersection of SE 27th Street and Reed Market Road. From this point upstream, the 27th Street route and Hamby Route are identical.
2. The Hamby Road interceptor will be sized to convey all sewage upstream of the SE 27th Street/Reed Market Road intersection along with sewage that is able to be collected by local gravity systems along either side of Hamby Road.
3. Where gravity service is possible and practical, the URA boundary will serve as the outer limit of service for the Hamby Road system.
4. Calculation of sewage quantities in the Hamby Road service area will be based on residential development at the EDU density, per capita flow, and household populations used in the CSMP.
5. The Hamby Road route will follow the recommendation initially proposed and is contained entirely within public rights-of-way. No alternate routes will be considered.

Study Conditions

Surrounding Land Designations

The suggested Hamby Road interceptor route lies entirely outside the current Bend city limits. On June 11, 2007 the City submitted its proposed Urban Growth Boundary map and supporting materials to the Oregon Department of Land Conservation and Development for review. With this proposed modification to the UGB, only the northerly 7,500 feet of the route lies within the proposed Urban Growth Boundary. The remaining 23,660 feet of the Hamby Road interceptor is located with the proposed Urban Reserve Area. On Ward Road

from Bear Creek Road to Stevens Road, the URA boundary is Ward Road. It is unknown if the proposed URA boundary includes or excludes the Ward Road right-of-way in this area.

Horizontal and Vertical Location

As initially proposed, this interceptor route extends within the public rights-of-way as defined from north to south by Hamhook Road, Hamby Road, Ward Road and Stevens Road. No specific location within these rights-of-way was selected or is recommended. This route has topographic relief extending from elevation 3413 at the Plant Interceptor to about 3696 at the Stevens Road/SE 27th Street intersection.

Vertical location and elevation constraints for the interceptor were determined by traversing the line using a vehicle-mounted global positioning system (GPS) data collector, providing the ground profile elevations within the paved areas, accurate to within a few tenths of a foot.

Figure 2 shows the plan and profile view of the Hamby Road interceptor as configured to convey sewage from the southeast service area including basins upstream of the SE 27th Street, Reed Market Road intersection.

Review of the ground profile along the Hamby Road route indicates three locations where sewer lift stations and forcemains could be sited to mitigate the need for deep cuts that would otherwise be needed to maintain a complete gravity system. These pump station locations are located at Station 34+00 near the NUID main canal, at Station 133+00 north of Neff Road and at Station 198+00 just north of Hwy 20. An analysis of pump station construction and O&M costs was performed and the analysis quickly showed that pump stations are not a cost-effective solution. Results of considering this option are discussed under the Intermittent Pumping Analysis, below.

Existing Utilities

In addition to performing the GPS survey to determine more precise ground elevations along the pipeline corridor, a review of existing utilities located in or crossing these public roads was completed. This research identified five utilities currently operating in the area. These are Avion Water Company, the Central Oregon Irrigation District (COID), the North Unit Irrigation District (NUID), Qwest, and Gas Transmission Northwest. Avion Water, Qwest and Gas Transmission Northwest have limited impact in the rights-of-way. These utilities would both cross and parallel any sewer line located in the Hamby Road right-of-way.

Avion Water systems are the most extensive of the utilities with lines both parallel to and crossing the proposed sewer alignment. Gas Transmission Northwest owns and operates two parallel high pressure transmission lines which cross Ward Road and Stevens Road. In the Highway 20 right-of-way crossing at Ward Road, Qwest owns and operates a major communication trunk system consisting of multiple conduits including fiber optics.

North of Stevens Road, the COID operates a network of irrigation canals which cross the proposed sewer alignment at several locations. These canals are generally high enough that crossing under them with a sanitary sewer is feasible.

At the northerly end of the Hamby Road system (Hamehook Road), the proposed interceptor sewer must cross the NUID Main Canal to reach the existing Plant Interceptor. Initial investigation of this location and determination of the elevations of the existing Plant Interceptor (top of pipe - 3412.46) and the invert of the Main Canal (3413) indicate that required vertical clearance between the two may preclude use of this route without construction of a large pump station to convey all sewage under or over the canal and into the Plant Interceptor. There may be mitigating measures that could be taken in coordination with NUID to resolve this apparent elevation conflict, but the design criteria established for the Southeast Interceptor project included 36-inches of clearance between the lowest portion of the canal profile at crossings.

Hydraulic modeling indicates that construction of a 10.4 mgd lift station will provide a means of avoiding this elevation conflict. A preliminary construction cost of a lift station at this location is estimated by the Optimatics Genetic Algorithm at \$1.44 million with a 50-year net present value of \$ 3.84 million. The need for this station and its associated long-term costs to avoid the conflict in elevations could cause the Hamby Road interceptor option to be removed from consideration.

Other engineering solutions to this situation are possible but they will require significant expenditures of funds and/or dictate design of a feature that may be unacceptable to city maintenance staff. For example, design and construction of an inverted siphon is a possibility as is design of a multiple-pipe structure which would allow the top of the interceptor to be lowered enough to pass under the canal. Either of these options would allow construction of a Hamby Road interceptor that would avoid conflict with the NUID main canal but will create a significant maintenance issue in the future.

It seems unlikely that the city could receive approval to modify the NUID main canal although this request has not been made at this time.

Impact on Existing Pump Stations

The conceptual layout of an interceptor along the Hamby Road route does not allow removal of any existing pump stations or new pump stations identified in the City's Collection System Master Plan. The conceptual layout may reduce the need for future pump station construction in the areas east of Hamby Road should this or another major interceptor be constructed in the area.

Impact on Existing System Deficiencies

Hydraulic analysis of the existing system deficiencies has been conducted with and without the Southeast Interceptor as located in SE 27th Street. This analysis was performed in support of the Satellite Treatment Analysis evaluation performed as part of the Southeast Interceptor Conceptual Design. These analyses indicate that reconstruction costs of these deficient, capacity-limited segments of the existing system will range from \$ _____ to \$ _____. No similar analysis was done with the Hamby Road Interceptor. It is reasonable to assume however that locating the Southeast Interceptor in Hamby Road, that more deficiencies will remain in the existing system when compared with selection of the SE 27th Street route. This is because a number of the capacity-limited sewers are located in SE 27th Street and these would be fixed through construction of the SE 27th Street Interceptor. They would remain deficiencies if the Southeast Interceptor were to be located in Hamby Road.

Comment [CH1]: Do not have information from Shad Roundy/MSA yet

Removal of sewage flows from existing drainage basins south of the Reed Market Road area will have the same impact regardless of whether the 27th or Hamby route is selected since the Southeast Interceptor route is common south of that point.

Interceptor Development

Preliminary Sizing

Consideration of the Hamby Road route was initiated by gathering detailed information about the route profile through use of a GPS data collector. This produced a very accurate ground profile of the entire route for use in establishing critical elevations. In addition, surrounding land topography and its potential to be served by gravity into a line on Hamby Road was identified. Finally, future development densities in the area were used, as determined for the CSMP, and have been confirmed by city and county staff. This data was entered into the City's InfoSWMM hydraulic model to determine the suitable pipe diameter and slopes needed to convey peak flows at developed build-out conditions.

The profile view shown on Figure 2 shows the pipe diameter and changes in diameter where necessary. Pipe sizes were determined by including all areas west of the URA boundary, both those that can be served by gravity connection and several subbasins near the URA boundary that would require sewage to be pumped to the Hamby Road Interceptor. Criteria for pipe sizing including assumptions of full-flow $d/D = 0.8$, minimum cover = 3 feet, Mannings n pipe roughness = 0.013, and minimum slopes as identified in the Southeast Interceptor Design Data Summary report to achieve 2 feet per second scouring velocity when the pipe is flowing under dry weather conditions.

This profile extends only to the intersection of SE 27th Street and Reed Market Road. The profile south of this point is identical to that of the SE 27th Street Interceptor route and provides no differential information when comparing the two routes.

As noted above, subbasins east of the areas that could be reasonably served by gravity and west of the URA boundary were included in the initial hydrology analysis in InfoSWMM. With the natural topography receding to the east, it is also reasonable to assume that these areas may be better served with a gravity sewer in the Dickey Road right-of-way, flowing north toward the Wastewater Reclamation Facility. A future interceptor in the Dickey Road area will also reduce or eliminate the need for new pump stations in this area.

Following initial determination of pipe diameter, and in order that this route could be equitably compared with the proposed SE 27th Street route, the three subbasins which require sewage to be pumped to the Hamby Road Interceptor were removed from the analysis and only those subbasins contributing sewage through gravity connections were modeled to gauge the impact this flow would have on the Hamby Road Interceptor size. Preliminary results of these calculations indicate that removal of these flows from the Hamby Road Interceptor will not significantly decrease the line diameter north of Neff Road. Figure 3 shows the service area included in this calculation.

Table 1 shows the flows tributary to the Hamby Road Interceptor and reflects the pipe diameters that would be required to only serve the gravity-only subbasins in the Hamby service area (not including the entire URA). Flows upstream (south) from Stevens Road and

SE 27th Street were not included in this analysis. The following table shows the influent flows at specific nodes, cumulative flows and required pipe diameter at each node:

TABLE 1
Tributary Flows and Required Pipe Diameters

Location	Reference	Peak Flow(gpm)	Cumulative Flow (gpm)	Required Diameter (inches)	Minimum Slope (ft/100 ft)
Node 10		341	341	8	0.4
Node 9	Bear Creek Road	447	788	12	0.25
Node 8		277	1065	15	0.22
Node 7		405	1470	15	0.33
Node 6	Neff Road	343	1813	18	0.17
Node 5		641	2454	21	0.15
Node 4		894	3348	24	0.12
Node 3		637	3985	27	0.085
Node 2	Butler Market Road	955	4940	30	0.045
Node 1	Repine Drive	575	5515	30	0.085

Notes:

1. Flows are computed using InfoSWMM for subbasins tributary at each node.
2. Downstream peak flows are arithmetically accumulated at each node.
3. Diameters are selected by maintaining 2 ft/sec at each node.

Hydraulic Modeling and Optimization Analysis

The hydraulic model developed for the CSMP SE 27th Street alignment was modified to convey flows from the basins upstream of the SE 27th / Reed Market Road intersection along a route following Stevens Road, Ward Road, Hamby Road and Hamhook Road to a connection with the existing Plant Interceptor. In addition to the upstream flows, this model included flows from subbasins extending to the limits of the Urban Reserve Area to the east. Some of this service area can only reach Hamby Road alignment by pumping. As discussed later in this memo, the gravity sewer size was also evaluated for a “gravity only” system and the required pipe sizes are similar.

Gravity Flow Analysis

Optimatics North America prepared preliminary analysis of the size and cost of a gravity interceptor for the Hamby Road service area. Page 10 of their Preliminary Optimization Technical Memorandum states the following:

“Hamby Road Alignment

The Hamby Road sewer alignment transfers flow east then north along Stevens Road and Hamby Road to the North Intertie with the existing gravity sewer. The optimized gravity sewer diameter ranges from 24” to 30”. The total length of 24” main is 27,692 feet and the total length of 30” main is 3,471 feet. The gravity sewer profile is shown in Figure 9 and Figure 10. The total capital cost for the Hamby Road alignment is (\$18.08M in October 2007 dollars.)

The Hamby Road alignment has a canal crossing immediately upstream of the North Intertie. To connect with the existing gravity sewer the Hamby route has (minimal) cover (less than the required 2.5 ft) from the top of pipe to the low point in the canal. At this same location the PDWF max depth over diameter is 0.9 (which is above the 0.8 max d/D criteria for PDWF). To eliminate these criteria violations the Hamby Route would require a lift station.”

Intermittent Pumping Analysis

Preliminary analysis of the cost-effectiveness of using intermittent pump stations to lift sewage over high points in the profile indicated that, even in the most likely location, it is less expensive in the long term to maintain gravity sewer service in lieu of pumping. As noted in the Optimatics report on Preliminary Optimization Technical Memorandum dated December 14, 2007, which says, in part, page 13:

“Example Comparison of Lift Station and Deep Gravity Sewer Alternatives; and affect of Anticipated Changes to Gravity Sewer Unit Costs

The discussion in this section is to demonstrate why lift station alternatives to constructing deep gravity sewers are not economically viable for this system. The discussion is also extended to consider the potential impact of revised gravity sewer costs that are anticipated based on recent discussion with CH2M HILL. To demonstrate why lift stations are not economically viable for the SE Interceptor an example is used from the Hamby Route which reflects the most advantageous scenario of using a lift station (i.e. where the inclusion of a lift station would allow for the greatest length of downstream gravity sewer to be raised to a shallow sewer rather than a deep sewer.)

The section of gravity sewer being compared with a lift station alternative is shown in Figure 11 (deep gravity sewer) and Figure 12 (lift station / shallow gravity sewer). The detailed cost comparison is presented in (the document). The results from the comparison demonstrate that using the costs provided for this analysis it is less expensive to construct a deep gravity sewer than it is to construct a shallow gravity sewer and lift station (without even considering the LS operating costs at all).

Findings

Findings of this investigation are:

1. The Hamby Road route is feasible for use as a sanitary sewer interceptor if resolution of the elevation conflict with the NUID main canal can be managed.
2. Improvements to the existing sanitary sewer system will be required on 27th Street to solve existing capacity limitations if the Hamby Road route is selected.
3. The Hamby Road service area north of Stevens Road which can be served by gravity is limited because the topography of the area descends to the east, requiring pump stations for the most easterly areas of the service area.
4. The Hamby Road alternative does not address deficiencies in the core area compared to the alternative of an interceptor in 27th Street.
5. Table 2 below shows the cost summary for Hamby Road as calculated through the Optimatics Genetic Algorithm process using 2007 unit costs.

TABLE 2
Hamby Road Sewer Cost Summary

Pipeline route	Gravity	Pump Station	O&M	Other Existing Deficiencies	Subtotal
Hamehook Road, Hamby Road, Ward Road, Stevens Road	\$17.17	\$3.84	\$ 0.91	> \$xx	> \$21.91

Costs shown are 50-year Net Present Value with assumptions from Optimatics Design Data Summary.

Comment [CH2]: Input the value for the deficiencies identified by Shad if a sewer is not built in 27th