UPPER SOUTHEAST SALT CREEK TRUNK SEWER

PRELIMINARY ROUTING CORRIDOR STUDY AND DESIGN

DRAFT

08/31/2004

Prepared for:

Lincoln Wastewater System
Department of Public Works & Utilities
Lincoln, Nebraska

Prepared by:

EA Engineering, Science, and Technology, Inc.
121 South 13th Street, Suite 204
Lincoln, Nebraska 68508

August 2004

EA Project No.: 13540.06

EXECUTIVE SUMMARY

1. Introduction.

The purpose of this Preliminary Routing/Corridor Study and Design of the Upper Southeast Salt Creek Trunk Sewer is to evaluate and select an alignment for the extension of the Salt Creek sewer system to serve future growth in south Lincoln. The study includes a review of previous route concepts performed by Olsson Associates in 1999, and a screening process to select one route corridor. Detailed investigation of this route included the analysis of upstream service area requirements, and options for pipe alignment through the Wilderness Park corridor. This report includes discussion on geotechnical investigations, historical and environmental assessments, physical design constraints, estimated project costs, and selection criteria for six alternative alignment options.

2. Public Involvement Process.

A major component of this study was the solicitation of active input from the general public and various stakeholder groups. The environmentally sensitive nature and unique ecological considerations of Wilderness Park offer a rare opportunity and challenge to develop a project that addresses and balances the City's need for additional infrastructure with the valuable assets of the park. At several stages during the development and evaluation of alternative routes for the proposed trunk sewer, the project team held public meetings to "spread the word" about the nature of this project. These public information meetings, and the public input process were directed by the Heartland Center for Leadership Development, to provide a structured and open process for public participation. Information regarding project timelines, alternative routes, habitat characteristics, potential park impacts and park restoration, and construction techniques were discussed in detail. Those present at the meetings were offered the opportunity to voice their concerns and comments, and provide additional input on specific details of the corridor study and evaluation of alternatives.

Continued public involvement in this project, as it moves forward from the Preliminary Study to final design and construction, will be an integral part of the success of the project.

3. Service Area Alternatives.

In order to meet the wastewater collection needs for future growth in south Lincoln, the study reviewed three possible service area scenarios. The Comprehensive Plan Tier I service area includes projected growth for a 25-year period, for a total of 4,137 acres. The Tier II service area includes projected growth for a 50-year period, for a total of 7,311 acres. The Total Ridgeline service area includes all land within the natural drainage basin boundaries of Urban Planning Zones S-2, S-3, and S-5 (including 868 acres within the Town of

Roca's planning jurisdiction), for a total of 8,179 acres. Due to the long-term planning nature of trunk sewer design, the Tier I option was eliminated. The existing 48-inch trunk sewer has the capacity to serve a total of 7,802 additional acres, assuming full-pipe conditions at design flow.

4. BNSF Railroad Crossing at Rokeby Road.

At the Rokeby Road location, the selected sewer alignment must cross from the west to the east side of the BNSF railroad. On the west side, Wilderness Park has an abrupt transition from reclaimed agricultural fields ("Old Fields") to mature woodlands. The Old Fields area (north of Rokeby Road) is currently dominated by non-native grasses and plants, while the woodland area (south of Rokeby Road) is an established area of large oak, hackberry, and hickory trees. On the east side of the railroad, Wilderness Ridge golf course property (currently a detention pond) is north of Rokeby Road, and private agricultural land is south of Rokeby Road.

At Rokeby Road, there is a large change in ground elevation on the east side of the railroad, and an exposed outcropping of sandstone is evident along the railroad, and in the golf course property. Three pipe alignment alternatives are presented to determine the best route in terms of constructibility, cost, and protection of the park.

5. Alignment Selection Criteria and Cost Estimates.

The three alignment alternatives at Rokeby Road were compared and ranked against each other based on a number of engineering and ecological factors. Based on the ranking criteria, the alignment north of Rokeby Road is slightly favored over the diagonal crossing or the south alignment. Further geotechnical investigation in the area is necessary to determine the limits of the sandstone formation, and its affect on each of the alignments.

Estimates of project cost were prepared for a total of six alternatives, including each of the two service area options and three alignment options. The cost estimates range from $ 3,547,000 to $ 4,458,000. The two lowest cost alternatives were Option 1A and Option 1C, which were for the 48-inch pipe, with either the north or south crossing at Rokeby Road. These two cost estimates were $3,576,000 and $3,547,000, considered to be equivalent at the preliminary design phase.

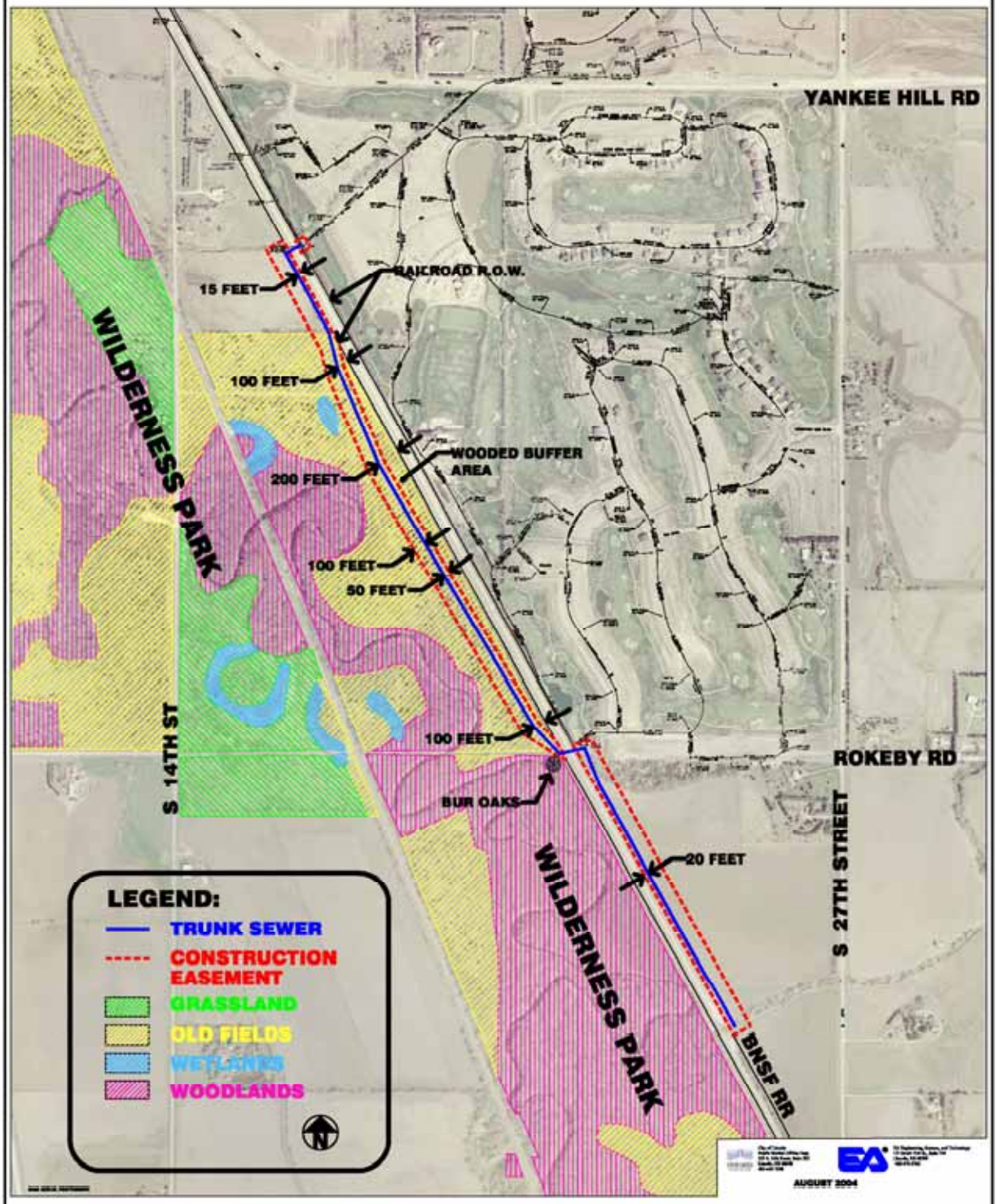
6. Conclusions and Recommended Alternative.

Alignment 1A, which serves the Tier II service area and crosses the BNSF railroad on the north side of Rokeby Road, is the one of the lowest cost options,

and provides for the least disruption of Wilderness Park, while including all of the required elements for long-term operation and maintenance by the Lincoln Wastewater System. The 48-inch pipe alternative is recommended over the 54-inch pipe, due to the cost savings and the 48-inch option can serve all of the Tier II area, and potentially serve the Total Ridgeline area with an acceptable amount of surcharge in the pipeline under peak flow conditions. The north crossing of Rokeby Road is the recommended alternative at this location, due to reduced impacts on the woodlands area of Wilderness Park, and the reduced cost versus a long diagonal bore under the BNSF railroad.

Alignment Option 1A should be pursued for final design of the Upper Southeast Salt Creek trunk sewer. Continuing the public participation process, as the details of final design are determined and construction activity is underway, is strongly recommended to insure that the concerns and expectations of the diverse group of stakeholders are addressed at each phase of the Upper Southeast Salt Creek trunk sewer project.

FIGURE 1 - RECOMMENDED ALTERNATIVE
UPPER SOUTHEAST SALT CREEK TRUNK SEWER
PRELIMINARY ROUTING STUDY
-LINCOLN WASTEWATER SYSTEM-



EA ENGINEERING, SCIENCE, AND TECHNOLOGY	UPPER SE SALT CREEK TRUNK SEWER PRELIMINARY ROUTING STUDY LINCOLN, NEBRASKA	RECOMENDED ALTERNATIVE

PROJECT MGR.	DESIGNED BY	DRAWN BY	CHECKED BY	DATE	SCALE	PROJECT NO.	FILE NAME	DRAWING NO.	FIGURE
DS	MAB	EG	LNG	8-24-04	NONE	13540.06	–	–	1

1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

The Preliminary Routing/Corridor Study and Design of the Upper Southeast Salt Creek Trunk Sewer was initiated to evaluate and select an alignment for the extension of the Salt Creek sewer system to serve future growth in south Lincoln. From the 2003 update of the Lincoln Wastewater Facilities Plan and the Lincoln/Lancaster County Comprehensive Plan, the area to be served by this trunk sewer extension is approximately bounded by Yankee Hill road on the north, and Wittstruck Road on the south, as well as Salt Creek on the west and 70th Street on the east. This area consists of the Urban Planning Zones/drainage basins known as S-2, S-3, and S-5. The existing Salt Creek trunk sewer terminates about ¼ mile south of Yankee Hill Road, along the Burlington Northern Santa Fe (BNSF) railroad tracks just east of South 14th Street. The anticipated route for this project will begin at this location and proceed south/southeast along the railroad corridor to a point approximately ½ mile south of Rokeby Road, where the main drainage channel for the S-2 and S-3 Urban Planning Zones flows into Salt Creek. This will provide an outfall for sewer service in the S-2 and S-3 basins, as well as further extensions upstream to serve the S-5 basin.

The Salt Valley trunk sewer system conveys wastewater flows from south, southeast, and southwest Lincoln to the Theresa Street WWTP near North 27th St. and Cornhusker Highway. The main trunk sewer generally parallels Salt Creek through the City of Lincoln. In addition to the upper Salt Creek basins, this trunk sewer system also picks up flow from several other drainage basins throughout the city, including: Beal Slough, Haines Branch, Middle Creek, and West O basins. The Salt Valley trunk sewer system is in the process of being upgraded with a parallel trunk sewer to increase system capacity. The final phase of this project (Phase V) will replace or parallel the existing 24-inch trunk sewer between Pioneers Boulevard and Old Cheney Road. This will provide the needed downstream capacity for the existing 48-inch trunk sewer that is the starting point of the Upper Southeast Salt Creek trunk sewer. Phase V is scheduled for construction in the proposed 2004-2010 CIP during the 2005-2006 and 2006-2007 fiscal years.

A major component of this study was the solicitation of active input from the general public and various stakeholder groups. The environmentally sensitive nature and unique ecological considerations of Wilderness Park offer a rare opportunity and challenge to develop a project that addresses and balances the City's need for additional infrastructure with the valuable assets of the park. During the development and evaluation of alternative routes for the proposed trunk sewer, the project team held public meetings to "spread the word" about the nature of this project. These public information meetings were conducted provide a structured and open process for public participation.

1.2 SITE DESCRIPTION

The project location will generally follow along the BNSF corridor, which is bordered on the east by the Wilderness Ridge golf course and residential development north of Rokeby Road, and agricultural land south of Rokeby Road. The BNSF corridor is bordered on the west by Wilderness Park, with the area north of Rokeby Road consisting of "Old Fields" of reclaimed agricultural land, and the area south of Rokeby Road consisting of mature woodlands.

The proposed alignment through Wilderness Park will begin with a bore under the BNSF railroad tracks at the termination point of the existing trunk sewer. The alignment will then turn south/southeast along the BNSF right-of-way, offset from the right-of-way line approximately 15 feet. Upon reaching the north border of Wilderness Park, the alignment will gradually deflect to 100 feet and then 200 feet west of the BNSF right-of-way, in order to avoid disturbing a buffer strip of trees along the right-of-way line. The alignment will then gradually shift back towards the BNSF right-of-way as the sewer approaches the location of Rokeby Road. The alignment will then bore under the BNSF railroad tracks to the east, and then proceed along the east side of the BNSF right-of-way, offset at approximately 20 feet. The alignment will cross under the existing drainage channel south of Rokeby Road, and terminate at a point on the south side of the drainage channel. The total length of the proposed alignment is approximately 7,330 feet depending on the location and direction of the south crossing of the BNSF tracks.

1.3 PREVIOUS INVESTIGATIONS

In 1999, Olsson Associates evaluated several conceptual alternative routes for the trunk sewer. EA reviewed these routes and updated the cost estimates to allow the City to determine if the funding in the Capital Improvements Plan is appropriate. Figure 2 illustrates the different alignments.

EA made some modifications and changed the costs to reflect these changes. Table 1.1 below summarizes the different alignments and associated costs. The depth of the force main was decreased by 10-feet on the upstream end of the Brown Alignment to decrease depth of cut through Dakota Sandstone. The siphon under the Union Pacific Railroad on the Green Alignment was taken out. This railroad has been taken out of service and cover could now be added over the pipe at that location instead of using a siphon.

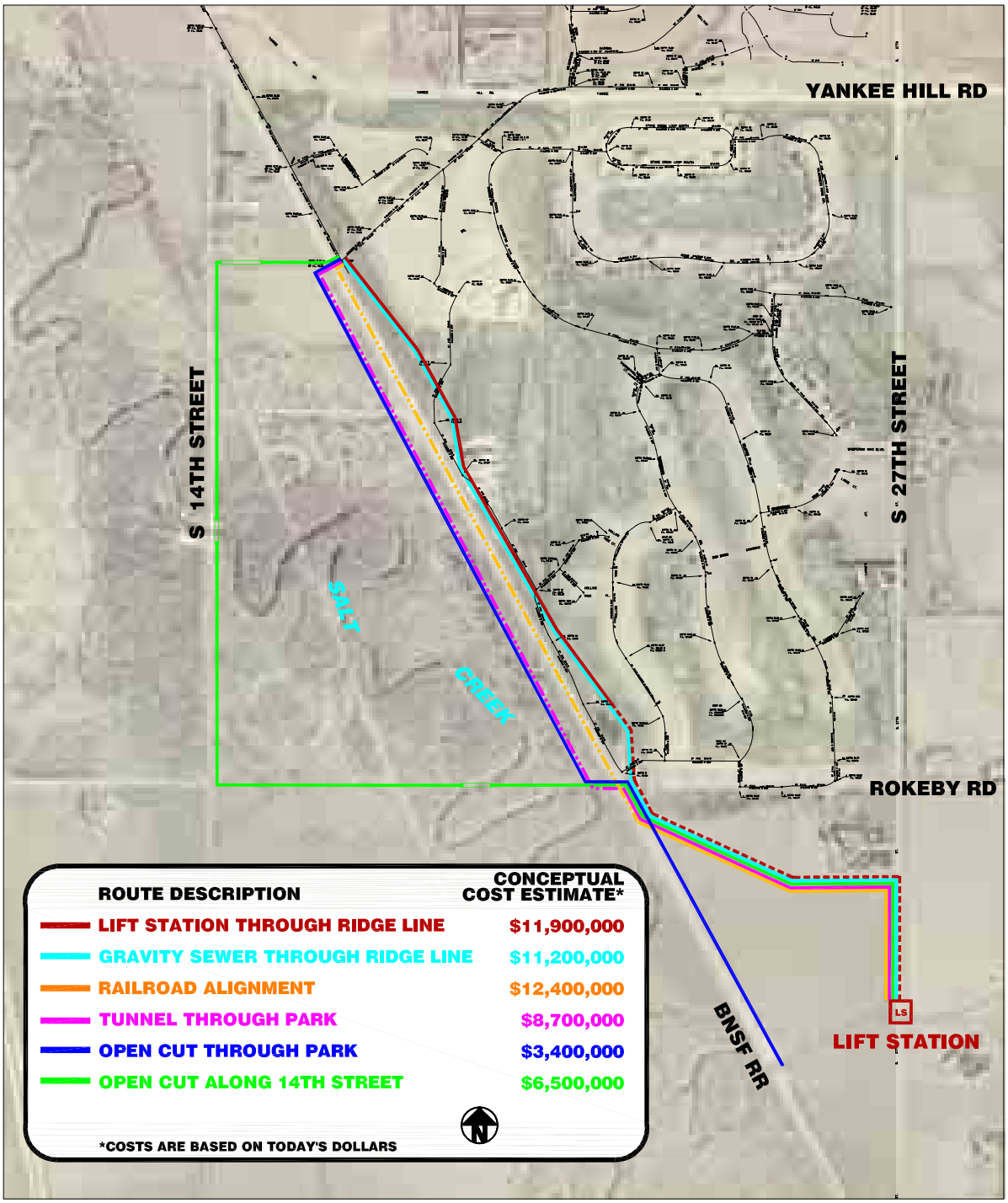
At the kick-off meeting for this project on 29 January 2004, it was decided that the Dark Blue Alignment was the best choice. At this time, it was also decided to move the upstream termination point from 27th Street and Rokeby Road to just south of the drainage ditch south of Rokeby Road, parallel to the Burlington Northern-Santa Fe Railroad. The following table reflects the above modifications.

Table 1.1 – Update of Olsson Associates' 1999 Conceptual Cost Estimates

Conceptual Alignment	Description	OA's 1999 Cost Estimate	OA's Cost Inflated to 2004 Prices	EA's 2004 Cost Estimate
Brown	**Golf Course/Lift Station** 30-inch Force Main - Open Cut 42-inch Gravity Sewer - Open Cut	$12,600,000	$14,300,000	$11,900,000
Light Blue	**Golf Course/Gravity Sewer** 48-inch Gravity Sewer - Open Cut	$11,950,000	$13,500,000	$11,200,000
Orange	**Railroad Alignment** 48-inch Gravity Sewer - Open Cut 48-inch Gravity Sewer - Tunnel in RR ROW	$10,850,000	$12,300,000	$12,400,000
Purple	**Tunnel Through Park** 48-inch Gravity Sewer - Open Cut 48-inch Gravity Sewer - Tunnel in Park	$7,600,000	$8,600,000	$8,700,000
Dark Blue	**Open Cut Through Park** 48-inch Gravity Sewer - Open Cut	$2,300,000	$2,600,000	$3,400,000
Green	**Open Cut along 14th Street** 66-inch Gravity Sewer - Open Cut	$7,300,000	$8,300,000	$6,500,000

As can be seen from the above table, the Dark Blue Alignment, open cut through Wilderness Park, is the most economical alignment. Tis route does not cut through Dakota Sandstone (except possibly at the Rokeby Road BNSF crossing), it has less depth of cut, and it does not incur the cost of closing down and restoring the golf course. Compared to the other Park alignments, tunneling in the railroad right-of-way or through the Park is more expensive than open cut construction in the Park, and the alignment along 14th Street requires much greater length and larger diameter pipe.

FIGURE 2 - CONCEPTUAL ROUTES
UPPER SOUTHEAST SALT CREEK TRUNK SEWER
PRELIMINARY ROUTING STUDY
-LINCOLN WASTEWATER SYSTEM-



EA ENGINEERING, SCIENCE, AND TECHNOLOGY

UPPER SE SALT CREEK TRUNK SEWER
PRELIMINARY ROUTING STUDY
LINCOLN, NEBRASKA

CONCEPTUAL ROUTES

PROJECT MGR.	DESIGNED BY	DRAWN BY	CHECKED BY	DATE	SCALE	PROJECT NO.	FILE NAME	DRAWING NO.	FIGURE
DS	MAB	EG	LNG	8-24-04	NONE	13540.06	–	–	2

2.0 DESIGN CRITERIA

2.1 GEOTECHNICAL INVESTIGATION

A preliminary geotechnical study was conducted by HWS for this project. This study consisted of Dutch friction-cone soundings, test borings, and soil sampling performed at the site on May 7, 2004. These tests were conducted in 3 general areas: the north end of the alignment on the west side of the BNSF tracks, the mid-point of the alignment near Rokeby Road (east and west of the railroad tracks), and the south end of the alignment on the east side of the railroad tracks.

In general, the types of soils encountered during the geotechnical study consisted of medium stiff to very stiff clays, which appear to be suitable for open-cut trench methods. Of special note, for the borings at Rokeby Road, on the east side of the railroad, the soil sampling equipment met refusal at approximately 7.5 feet below grade. This is assumed to be due to the underlying Dakota sandstone formation, which is apparent to the north of this location along a cut made for the railroad corridor. The elevations at which these events occurred are well above the proposed flow line elevation of the trunk sewer. More detailed investigations in this area are recommended to determine the extents and geological properties of the sandstone formation, in order to select the appropriate route and construction methods through this area.

From the geotechnical study, groundwater elevations were compared to the proposed flow line elevations of the trunk sewer along the alignment. At the north end, the groundwater elevation is approximately at the same elevation as the flow line of the pipe. A the mid-point of the alignment near Rokeby Road, the groundwater elevation was approximately 4 feet above the proposed flow line elevation. At the south end of the alignment, near the drainage channel, the groundwater elevation was approximately 6.5 feet above the proposed flow line elevation of the trunk sewer. These groundwater elevations may fluctuate based on antecedent moisture conditions and stream flow levels. From the data collected, it appears that de-watering of the trench may be required along the proposed alignment.

A complete copy of the Geotechnical Engineering Report is included in Appendix B.

2.2 HISTORICAL AND ENVIRONMENTAL ASSESSMENTS

An archeological site file search was conducted for the project area by the Nebraska State Historical Society (NSHS). According to the NSHS, there are no recorded archeological sites in their records within the limits of this project. Any potential archeological or historic sites discovered during final design or construction must be brought to the attention of the NSHS for further review, as part of the Section 106 Requirements of the National Historic Preservation Act.

A search of several environmental records was conducted to determine if there are any potential hazardous or contaminated sites, or existing wells that might conflict within the boundaries of this project. The environmental databases researched include the following:

1. Registered underground storage tanks (USTs), from the Office of the Nebraska Fire Marshall.
2. Leaking underground storage tanks (LUSTs), from the Nebraska Department of Environmental Quality.
3. EPA Envirofacts Warehouse, which contains information on the following EPA programs and environmental databases:
    a. Air Releases under the AIRS/AFS system.
    b. Toxic Release Inventory (TRI).
    c. Superfund (CERCLIS) sites.
    d. RCRAInfo for hazardous waste generators and TSDFs.
4. Registered groundwater wells, from the Nebraska Department of Natural Resources.

From a review of the reporting lists, it does not appear that there are any potential hazardous or contaminated sites within the boundaries of this project. There are several groundwater wells in the general area, but they appear to be irrigation wells that will not be adversely impacted by the trunk sewer.

2.3 SERVICE AREAS, DESIGN FLOWS, AND PIPE SIZES

Development projections for the Tier I (25-year), Tier II (50-Year), and Tier III (beyond 50-year) horizons were taken from the City of Lincoln-Lancaster County Comprehensive Plan. As decided at the 3 March 2004 meeting with personnel from the City of Lincoln's Wastewater Division, the trunk sewer associated with this project will receive flow from Urban Planning Zones S-2, S-3, and S-5, and will NOT serve the Upper Southwest Salt Creek basin.

The Tier I plan includes all of S-2 and S-3, and a part of S-5. The Tier II plan includes all of S-2, S-3 and S-5 (see Table 2 below). Since trunk sewer planning and service life lasts beyond the 25-year horizon, and with the intention of constructing through Wilderness Park only once, this report evaluates each of the Tier I, Tier II, and Tier III conditions. In addition, as shown in the Lincoln Wastewater Facility Plan, the boundary around S-5 circles around the Town of Roca's 1-mile zoning jurisdiction (see Figure 3). This does not represent the actual ridgeline for S-5 which would include an additional 868 acres to the south. When designing sewers, the ridgeline area is typically used because this would include all of the area that could drain to the sewer by gravity. Table 2.1 below summarizes the total acreages for the scenarios discussed above.

Table 2.1 – Urban Planning Zone Service Area Summary

Urban Planning Zone	Tier I Acres	Tier II Acres	Total Ridgeline Acres
S-2	2,128	2,128	2,128
S-3	1,929	1,929	1,929
S-5	586	3,760	3,760
S-5 (ridge-line)			868
Total	4,643	7,817	8,685
Green Space	-275	-275	-275
Revised Total	4,368	7,542	8,410

According to the City of Lincoln Design Standards, the entire acreage of the natural watershed is used to compute the design flow, minus any public or private park lands, golf courses, cemeteries, and other dedicated open-space that decreases the developed density in the watershed, if it is greater than 50 acres. Green space areas were calculated from the Lincoln/Lancaster County Land Use Plan given in the City of Lincoln's Comprehensive Plan (updated October 21, 2003). For the project area, 275 acres were determined to be green space, including the flood plain area. The flood prone area was not subtracted out for a more conservative approach. All 275 acres of green space are within the Tier I area.

The acreages given in Table 2.1, minus the green space area, are the areas (A) used in calculating the peak flow using the City's design flow equation:

$$Q\ (cfs) = 0.01726*(A)^{0.8} + 0.003(A) \qquad [A = \text{area (acres)}]$$

Table 2.2 summarizes the calculated flow, pipe diameter, slope and resulting velocity for the three planning scenarios discussed above and shown in Table 2.1. Existing Trunk Service Areas include basin S-1 (748 acres). The slope was calculated using the existing 48-inch downstream invert elevation and matching the top of pipe to the bottom elevation of the south drainage ditch at the project termination point. Channel stabilization will be required at this drainage ditch. Pipe capacities are calculated using a Manning's roughness coefficient (n) of 0.013.

Table 2.2 – Future Service Area Requirements Vs. Capacity
Calculated Pipe Diameter, Flow and Velocity

Planning Horizon	Cumulative Flow Area, acres	Design Flow, cfs	Required Pipe Diameter, inches	Available Pipe Slope, ft/ft	Pipe Capacity, Cfs	Full Flow Velocity, fps
Tier I	4,368	27.2	42	0.00099	31.7	3.3
Tier II	7,542	44.5	48	0.00093	43.8	3.5
Total Ridgeline Area	8,410	49.1	54	0.00086	57.7	3.6
Existing Trunk Capacity	8,550	49.8	48	0.00120	49.8	4.0
Existing Trunk Service Area **(Tier I)**	5,116	31.4				
Existing Trunk Service Area **(Tier II)**	8,290	48.4				
Existing Trunk Service Area **(Total Ridgeline)**	9,158	53.0				

----In each case listed to the left, the Existing Trunk Service Area includes Urban Planning Zone S-1 (748 acres)

As can be seen in the above table, depending on the area used, Tier I, Tier II or the Total Ridgeline area, the required pipe diameter changes. This project will connect to the existing 48-inch trunk sewer. This 48-inch line can serve 8,550 acres of developed land based on pipe slope in the City record drawings. It is currently serving Urban Planning Zone S-1 (748 acres). Subtracting out the area from basin S-1, this leaves 7,802 acres for future development. By comparing this to the areas given for each planning scenario, the Tier I and Tier II areas could be served by the existing trunk sewer, but the existing trunk sewer could not serve all of the Total Ridgeline area. Out of the additional 868 acres added by including all of the basin S-5 ridgeline area, 608 acres could theoretically not be served.

Hydraulic Grade Line (HGL) Analysis

An analysis of the various service areas, design flows, pipe sizes, and pipe slope options was performed to determine the HGL in the proposed trunk sewer extension, as well as the existing 48-inch trunk sewer immediately downstream. The 48-inch and 54-inch pipe

sizes were analyzed at various slopes and flows to determine the HGL and potential full-pipe surcharge under these conditions. The results are summarized below in Table 2.3.

Table 2.3 – Hydraulic Grade Line Calculations For Pipe Diameter, Slope, and Flow

Pipe Diameter (in)	Pipe Slope (ft/ft)	Service Area	Total Flow @ Existing MH #37	FL Elev @ Existing MH #37	HGL Elevation @ MH #37	Amount of Surcharge @ Existing Manhole #37 (*)
48	0.00093	Tier II	50.1	1171.34	1174.70	None
48	0.00093	Total Ridgeline	54.7	1171.34	1175.61	0.27 ft (increases to 3.0 ft upstream)
54	0.00086	Total Ridgeline	54.7	1171.34	1175.61	0.27 ft (decreases upstream)

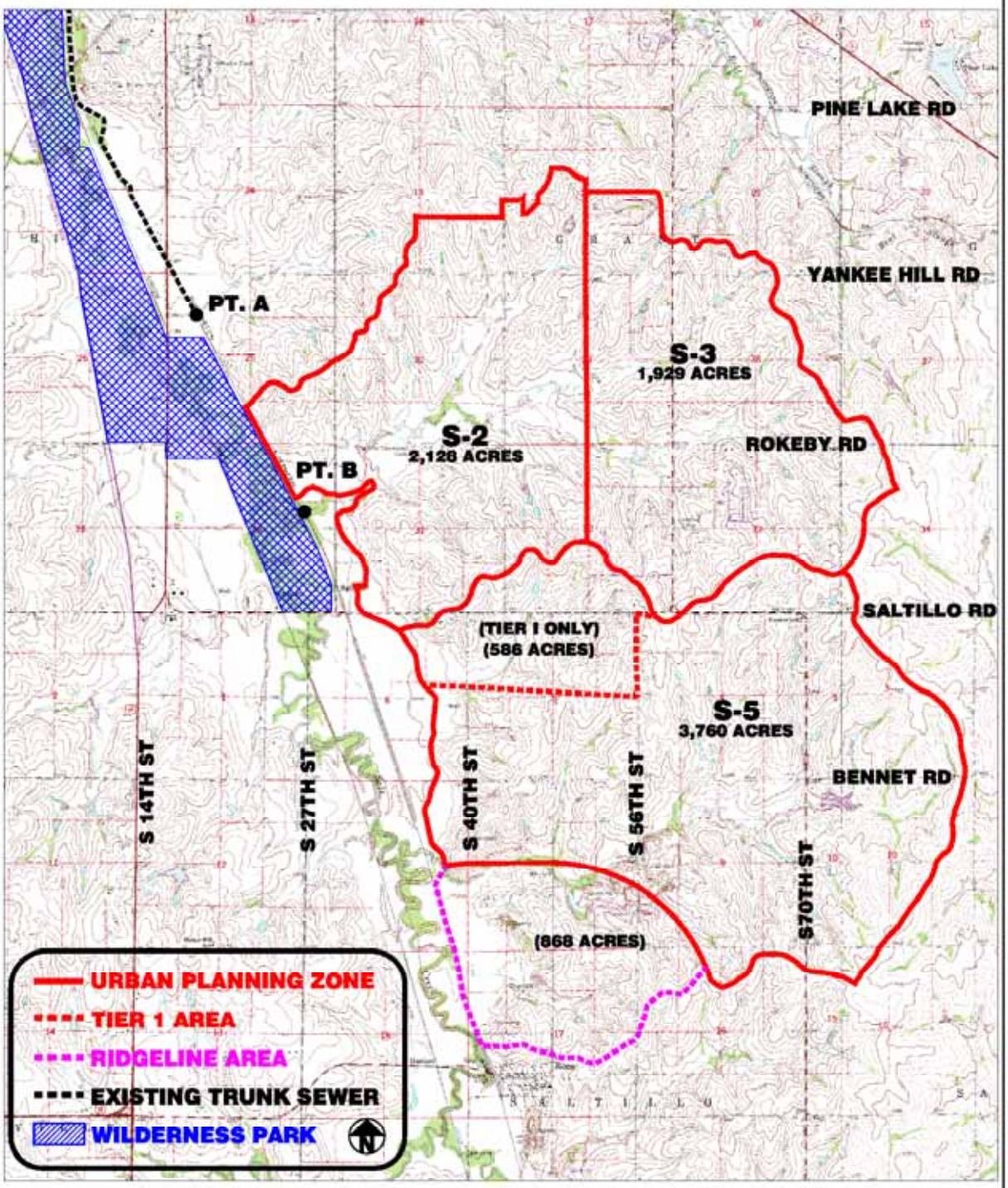
**** Manhole 37 is the is the last manhole on the existing trunk sewer.***

- In the Tier II service condition, the existing and proposed 48-inch trunk sewer do not experience a surcharge at design flow conditions.
- In the Total Ridgeline service condition, the maximum surcharge in the existing 48-inch trunk sewer is 0.27 feet, but the HGL continues to rise as the proposed 48-inch trunk sewer progresses upstream, to a level of 3.0 feet above the pipe at the last manhole. This level is approximately 3 feet below the proposed rim elevation of the manhole.
- In the Total Ridgeline service condition, the maximum surcharge in the existing 48-inch trunk sewer remains at 0.27 feet, but the HGL stays within the pipe profile in the proposed 54-inch trunk sewer.

The modeling was performed on the last 3 sections of the existing trunk sewer and the entire reach of the proposed trunk sewer. Flow input for Urban Planning Zone S-1 was included at Manhole 38 on the existing trunk sewer, and flow input for the proposed service areas were input at the upper end of the proposed trunk sewer. In the Total Ridgeline scenarios, there was minimal surcharge in the existing trunk sewer, because the greater slope of the existing trunk sewer (s=0.00120) provides capacity that is only slightly less than the model flow (49.8 cfs versus 54.7 cfs).

Results of the HGL analysis for each of these scenarios are included in Appendix C.

FIGURE 3 - SERVICE AREAS
UPPER SOUTHEAST SALT CREEK TRUNK SEWER
PRELIMINARY ROUTING STUDY
-LINCOLN WASTEWATER SYSTEM-



EA ENGINEERING, SCIENCE, AND TECHNOLOGY	UPPER SE SALT CREEK TRUNK SEWER PRELIMINARY ROUTING STUDY LINCOLN, NEBRASKA	SERVICE AREAS

PROJECT MGR.	DESIGNED BY	DRAWN BY	CHECKED BY	DATE	SCALE	PROJECT NO.	FILE NAME	DRAWING NO.	FIGURE
DS	MAB	EG	LNG	8-24-04	NONE	13540.06	–	–	3

2.4 PHYSICAL CONSTRAINTS AND DESIGN ISSUES

Several site-specific constraints and constructibility issues have been identified as a part of the Preliminary Routing/Corridor Study. Their effects on the preliminary design and pipe alignment are discussed in the following sections.

1. Pipe slope and available grade.
   The maximum slopes identified for each pipe size in Table 2.2 are based upon the flow line of the existing 48-inch trunk sewer at the terminal manhole. The pipe slope was set at a continuous grade such that the top of the pipe will match the flow line elevation of the drainage channel at the south end of the project. In each case, the full flow velocity of the pipe is adequate for scouring requirements to prevent solids deposition in the pipe. However, it is anticipated that there will be relatively small flows in the pipe when it is first placed in service, and may require periodic cleaning to prevent solids buildup.

   In the Tier I and Total Ridgeline scenarios in Table 2.2, the flow capacity for the 42-inch and 54-inch pipes are greater than the design flow for the service area, which would allow for a slightly flatter pipe slope and additional cover at the south drainage channel, while maintaining adequate pipe capacity. In the Tier II scenario, the flow capacity of the 48-inch pipe is nearly equal to the design flow for the service area, which requires that the pipe slope be maintained at the maximum allowable, which provides the minimum clearance at the upstream drainage channel. For final design the elevation of the channel must be confirmed with the Watershed Management Division, for compliance with the Southeast Upper Salt Creek Basin Stormwater Master Plan. If the proposed trunk sewer can project into the stream cross-section at a higher elevation, the slope could be increased, resulting in increased capacity and reduced depth and de-watering costs. Stream crossing protection and a grade check structure in the channel will be required, similar to the details in LSP-220.

2. Groundwater and de-watering alternatives.
   As noted in the Geotechnical Engineering Report, the profile of the proposed Upper Southeast Salt Creek Trunk Sewer intersects the groundwater profile at the beginning of the project. As the trunk sewer extends upstream, it's profile projects deeper into the groundwater table, proceeding to about 6.5 ft into groundwater at the upstream end of the project. Since the presence of groundwater and de-watering costs have the potential to significantly impact the project construction cost, extensive geotechnical exploratory investigations are required for final design. These investigations should include required data collection and preliminary design of the de-watering methods necessary for the work.

3. Pipe materials and bedding design.
   It is anticipated that the allowed pipe materials for this project will include reinforced concrete pipe (RCP), pre-stressed concrete cylinder pipe (PCCP), centrifugally cast

fiberglass reinforced polymer mortar pipe (CCFRPMP or Hobas Pipe), and polyvinyl chloride pipe (PVC). Concrete pipe will be required to have a corrosion resistant liner on the inside of the pipe (such as T-Lok). Advantages of the concrete pipe materials include the inherent strength of rigid pipe and reduced bedding requirements. Advantages of Hobas and PVC pipe include longer laying lengths, and inherent corrosion resistance.

Due to the elevation of groundwater along the alignment and the properties of the potentially dispersive clay soils present at the site, it is anticipated that the bedding design will require the use of geotextile fabric to encase the granular bedding material. Bedding requirements for rigid pipe are anticipated to be to the springline of the pipe, and bedding requirements for flexible pipe are expected to be a minimum of 12 inches above the top of the pipe. These requirements and the need for additional foundation material in the trench may be revised depending upon actual field conditions, and recommendations of the geotechnical engineer.

4. Manhole design, spacing, and rim elevations.
   Depending upon the pipe material chosen for the trunk sewer, the manholes may be constructed according to LSP-201, or as prefabricated tee manholes from the pipe manufacturer. It has been the Wastewater Division's policy in the past to not construct manhole steps in large diameter trunk sewers, because personnel entry is very infrequent and confined space regulations require the use of a personnel retrieval system, which can cause interference with permanent manhole steps. Based on comments received at the Design Memo review meeting on 31 March 2004, the maximum manhole spacing for this trunk sewer should be between 800 and 1,000 feet. Also discussed at the review meeting was the preferred method of flood-proofing the manholes that are within the 100-year flood plain. In the past, manhole rim elevations have been set at 1 foot above the 100-year flood elevation. This results in manhole risers that can be several feet above grade. This option may be intrusive to the natural habitat of the park. Other options include placing the manhole rims at grade with watertight lids, which may be bolted down or tack welded in place.

5. Connection to existing 48-inch trunk sewer.
   The last manhole on the existing 48-inch trunk sewer was stubbed out to the south with a 48-inch pipe, directly opposite to the downstream sewer, and parallel to the BNSF right-of-way. Due to the proximity (less than 10 feet) of a double box culvert under the railroad tracks, it appears that the best alignment would be to continue south for approximately 30 feet, and then cross to the west side of the railroad tracks at a perpendicular angle. This will allow additional separation between the boring/ receiving pits and the box culvert wing walls. This alignment will also allow the existing manhole to be used in-place, rather than be reconstructed to accommodate a revised stub location. In addition, the existing manhole receives flow from the 18-inch sewer to the east, and reconstruction under live flow would require plugging and by-pass pumping.

6. Future connection to upstream trunk sewers.
   The upper end of this project will terminate at the drainage channel south of Rokeby Road. The trunk sewer will cross under the channel, and terminate on the south side. This location is where flow from the S-2/S-3 basins and the S-5 basin will connect to the trunk sewer, and a manhole and sewer stubs to the east and south will be required at this location. Drainage area of the S-2 and S-3 basins is 4,057 acres, which yields a design flow of 25.5 cfs, based on the City's design equation. Extension of the trunk sewer upstream to the S-5 basin will serve an area of 3,760 acres (Tier II area) to 4,628 acres (Total Ridgeline area). Due to the flat topography at this location the sewer stubs to each of these upstream basins will require flat slopes and large diameter pipes. The minimum slopes and required pipe sizes are summarized in Table 2.4 below.

Table 2.4 – Upstream Basin Service Requirements
Calculated Pipe Diameter, Flow and Velocity

Urban Planning Zone	Flow Area, acres	Design Flow, cfs	Pipe Diameter, inches	Minimum Pipe Slope, ft/ft	Pipe Capacity, Cfs	Full Flow Velocity, fps
S-2	2,128					
S-3	1,929					
Combined S-2/S-3	4,057	25.5	36	0.00150	25.8	3.7
			42	0.00080	28.5	3.0
S-5 (Tier II)	3,760	23.8	36	0.00130	24.1	3.4
			42	0.00080	28.5	3.0
S-5 (Total Ridgeline)	4,628	28.7	36	0.00190	29.1	4.1
			42	0.00085	29.3	3.1

   In each case shown above, the minimum slope for the 42-inch pipe is limited by the requirement of maintaining the full-flow velocity in the pipe above 3.0 feet per second, in order to achieve scouring velocities and prevent solids deposition. The flat topography at this location may prevent the use of 36-inch pipes to serve these upstream basins.

7. Railroad crossings.
   The trunk sewer alignment will require crossings of the BNSF railroad tracks at the point of connection to the existing 48-inch trunk sewer, and again at approximately Rokeby Road. BNSF standards require steel casing pipe for all utility crossings under the railroad. The steel casing pipe must be a minimum of 5.5 feet beneath the base of the rail, and must have a minimum of 3 feet of cover below the ground surface throughout the railroad right-of-way. The use of plastic carrier pipe requires the use of steel casing pipe for the full width of the railroad right-of-way. The proposed alignment will locate the turn manholes at either end of the railroad crossing outside of the railroad right-of-way. The north crossing at the beginning of the project will be a perpendicular crossing. The south crossing at Rokeby Road may be a diagonal crossing, in order to accommodate conflicts with Dakota sandstone outcropping on

the east side of the railroad and the mature Bur Oak trees on the west side of the railroad, as well as the meander of Salt Creek.

The two railroad crossings will require Pipeline Crossing Permits from BNSF. Due to delays in the permitting process, the permit applications and 2 sets of drawings should be submitted to the railway's real estate agent as soon as possible, to avoid potential construction delays.

8. Trenchless methods and locations.
   The soil borings from the geotechnical investigation at the crossing locations indicated primarily medium stiff to very stiff lean to fat clays. These material are suitable for traditional directional boring applications. The soil borings at the drainage channel at Rokeby Road, on the east side of the BNSF railroad tracks, indicate that underlying Dakota sandstone is present at 7 to 7.5 feet below grade (elevations 1186 to 1190), which is also evident in the railroad cut bank north of this location, and at other locations along the stream bed. These elevations are above the flow line elevation of the trunk sewer, and therefore the alignment and boring/tunneling method through this area will require further delineation of the extents and elevations of the rock formation. Consideration of an alternate route that stays on the west side of the BNSF railroad for an additional distance south of Rokeby Road (200 to 300 feet) should be reviewed.

9. Other utilities.
   The proposed alignment is relatively clear of other existing utilities, due to the location within Wilderness Park and on undeveloped agricultural land. However, site inspection of the alignment has revealed several locations of interest where coordination with other public and private installations will be necessary. Other utilities identified along the alignment include:
   a. At the north end of the alignment, there is evidence of a waterline trench along the west boundary of the Wilderness Ridge golf course, presumably a section of the irrigation system. Further investigation of the golf course record drawings and maintenance records will be necessary to determine size and exact location of this system.
   b. Along the BNSF railway, inside the east right-of-way line, are markers for Qwest fiber optic cable. BNSF utility guidelines require that buried fiber optic lines paralleling the railroad be within 5 feet of the right-of-way line, and have a minimum of 4 feet of cover. It is anticipated that the boring operations for the railroad crossings will be significantly below these fiber optic lines, but on-site location by Qwest will be necessary to avoid any potential conflicts.
   c. At the southwest corner of the Wilderness Ridge golf course property, near Rokeby Road, there is a stormwater detention cell, with a drop inlet structure and a RCP outlet to the drainage ditch south of the golf course property. The outlet structure to the channel is approximately 25 feet east of the west property line of the golf course. There is also a line of overhead power poles at the southwest corner of the golf course property.

d. At the south end of the proposed alignment, near the main drainage channel for the S-2 and S-3 basins, there is a line of overhead power poles and an agricultural irrigation well, along the east right-of-way line of the BNSF railway.

10. Land ownership, required easements, and construction access.

Parcel ownership along the proposed route, from the north to the south are as follows:

e. Wilderness Ridge LLC (golf course)
f. Burlington Northern Santa Fe Railway
g. Ridge Development Company
h. Lancaster County (Wilderness Park)
i. Lola Sievers, et al

It is anticipated that there will be a 40-foot wide permanent easement for the Upper Southeast Salt Creek trunk sewer, centered over the pipe. Construction easements will generally be 150 feet wide, with some adjustments for staging areas and locations of the bores under the railroad.

Construction access on the west side of the railroad will likely be provided from 14th Street, on the access road at the north end of the Wilderness Park property. Construction access on the east side of the railroad will be from 27th Street, likely along the south drainage channel at the south end of the project, across the Sievers property. These access points will need to be confirmed and included in the agreements with the easement documents.

2.5 WILDERNESS PARK ISSUES

1. Existing park habitat characteristics and previous studies.
   Previous studies and park management recommendations that are referenced in this report include:
   a. "Ecosystem Report of Wilderness Park", January 1999, EA Engineering, Science and Technology
   b. "S1-S2 Subarea Plan", February 1999, Lincoln/Lancaster County Planning Department
   c. "Wilderness Park Subarea Plan", 1999, J. Kip Hulvershorn
   d. "Salt Creek at Wilderness Park Hydrologic Study", 1999, US Army Corps of Engineers (USACE)

   The area of the park that is within the alignment of the proposed trunk sewer is comprised mainly of the plant community characterized as "Old Fields", which are previously farmed agricultural fields that have been idle for 20-30 years. The "Old Fields" areas are dominated by non-native grasses and plant species, such as Smooth Brome and Goldenrod, and by Eastern Red Cedar, Green Ash, Dogwood, and Smooth Sumac. These species are indicative of rapid-spreading species that have established themselves due to the lack of habitat management practices in the old agricultural areas. The "Old Fields" area is generally north of Rokeby Road. On the property line between this area and the BNSF railroad, there is a stand of mature oak, hickory, and walnut trees, which act as a buffer between the park and the railroad. This area extends generally about 25 to 50 feet from the fence line onto the park property.

   The area south of Rokeby Road is a mature woodland area, consisting of Bur Oak, Hackberry, and Bitternut Hickory trees. Other tree species present include Black Walnut and Kentucky Coffeetree. Understory shrubs beneath the tree canopy include: Wolfberry, Gooseberry, and Wahoo. Other ground cover plants include: Wood Nettles, Wingstem, Black Sanicle, Honewort, Aniseroot, Meadow Rue, and Moonseed. This is a well-established woodland area of considerable age. However, it is undergoing a transition to more shade tolerant tree species, due to the closed canopy and the lack of habitat management practices.

   From the USACE Hydrologic Study, general recommendations regarding the habitat characteristics of Salt Creek and Wilderness Park included:
   a. Do not employ channel straightening or confinement projects within the park, as this will have an adverse effect on peak flood flows and flood storage within the park.
   b. Maintain the woodland and grassland vegetation areas of the park, in order to maintain flow "roughness values" across the park. Large scale removal or reduction of woodland and grassland habitat will have a negative effect on flood attenuation capacity in the park.

c. Any future development or fill within the floodplain will increase peak flows, and should be compensated for by on-site mitigation and compensatory storage techniques.

2. Sensitive areas and alignment considerations.
The "Old Fields" area north of Rokeby Road has been identified as in need of management and restoration activities, in order to control the existing invasive plant species and re-introduce native species. The mature trees along the fence line bordering the BNSF railroad have been identified as a valuable asset that should be maintained as a buffer between the park and the railroad. There is a seasonal wetland along the south side of the existing access road at the north end of the site, just to the west of the proposed trunk sewer alignment. Construction access to the site via this road will minimize impacts to the park in areas outside of the proposed construction easement.

The woodland area south of Rokeby Road is sensitive due to the nature and age of the tree and plant community, as well as its importance to the numerous bird species that are present in the area. Some habitat management recommendations have suggested that thinning and prescribed burns in this area will maintain the health of the dominant oak tress in the area. However, disturbance of this area for trunk sewer construction will be more difficult to restore to pre-construction conditions than the "Old Fields" area north of Rokeby Road. Removal and replacement of mature trees will require careful planning and monitoring during construction activities.

The presence of a Salt Creek meander south of Rokeby Road will have an impact on the chosen alignment through this area. At its closest point this oxbow in Salt Creek is approximately 120 to 130 feet from the property line of the BNSF railroad. If the alignment alternative selected proceeds to the south through this area, a satisfactory buffer distance from the bank and channel of the stream will need to be determined, and a shift in the construction easement may be required to minimize impacts on the creek and the woodland area. A study of aerial photos dating back to 1937 indicates that the channel and banks of the creek have not shifted appreciably over time, and the oxbow appears to be fairly stable. Lack of significant upstream development or increased flows at this reach of the stream have contributed to the stability of the channel.

3. Restoration
Post-construction rehabilitation of this area will require careful backfill and grading to ensure that natural drainage through the park area is maintained as close to existing conditions as possible. Segregation of topsoil from the remainder of the trench spoil material is recommended; in order to replace the top soil strata to match the existing areas outside of the trench limits. In-situ soil density testing of the park site should be conducted so that backfill compaction and areas disturbed by construction equipment can be restored as close as possible to native conditions.

General recommendations of previous park studies and public meetings for restoration of the "Old Fields" area of the park include the removal of non-native invasive species of grass, shrubs and trees, and re-introduction of native prairie grasses and wildflowers, and selected tree plantings of native species. Restoration should occur in a non-linear, "cluster" manner to soften the transition to park boundaries and areas disturbed by construction. Construction and restoration activities should be sensitive to breeding seasons of the bird species present, and in general disturbance of the area in the fall and winter periods is preferred.

In addition to park restoration within the limits of the sanitary sewer construction as a part of the project cost, there are other potential funding sources available. If there is a decision to pursue additional park land restoration within and beyond the limits of the sewer construction project, there are federal programs available for assistance with these restoration costs. The "Fish and Wildlife Management and Habitat Restoration Program", sponsored by the U.S. Fish and Wildlife Service of the Department of the Interior, provides funding for habitat restoration projects on the basis of a 50/50 match with the local entity or landowner. The types of projects eligible for these funds include:

- Planting native trees and shrubs in formerly forested wetlands and other habitats.
- Planting native grasslands and other vegetation.
- Prescribed burning as a method of removing exotic species and to restore natural disturbance regimes necessary for some species survival.
- Removal of exotic plants and animals that compete with native fish and wildlife and alter their natural habitats.

2.6 PROJECT PARTNERING AND PUBLIC MEETINGS

1. Project partnering approach.
   EA has enlisted the Heartland Center for Leadership Development (HCLD) to facilitate, summarize, and direct the project kickoff meeting and the subsequent open house/public meetings. Two public meetings have been held thus far, to discuss such issues as the alternative routes for the trunk sewer, habitat characteristics of Wilderness Park, construction phase activities, and park land restoration. The first two public meetings were held on March 4th and March 25th of 2004. Notices of the public input process have been sent to such local groups as the Friends of Wilderness Park, the Wilderness Park Committee, the Wilderness Ridge Homeowner's Association and other adjacent landowners, the Lower Platte South NRD, the Audubon Society, the Lancaster County Ecological Advisory Committee, and the Parks and Recreation Advisory Committee.

2. Public meetings/ issues raised.
   The primary topics of discussion at the March 4th and March 25th public meetings centered around the proposed alignment for the trunk sewer, especially at the area near Rokeby Road, where potential conflicts with the woodland area, the oxbow of Salt Creek, and the elevation difference and sandstone outcropping on the east side of the BNSF railroad will affect the final route selected. Also of major interest during the public meetings was the proposed plan for restoration and long-term management of the park, and the potential for public input and monitoring of the final design, construction and restoration processes.

3. Summary of meeting discussions.
   The materials presented for review at the March 4th and March 25th public meetings are included in Appendix D, along with the report and meeting synopsis from the Heartland Center for Leadership Development, which documented the comments and discussion topics that were raised by the public audience in attendance.

4. Continued Public Participation.
   Additional stakeholder meetings are planned for September, to present the findings of this report in draft form. The results of the corridor study and the alternatives analysis will be presented to the Mayor's Environmental Committee, the County Ecological Committee, and the Wilderness Park Committee, in order to provide additional opportunities for input and to allow these groups to pass on project information and concerns to their constituents and the project team. Continued public involvement in this project, as it moves forward from the Preliminary Study to final design and construction, will be an integral part of the success of the project.

3.0 DESIGN ALTERNATIVES

3.1 FUTURE SERVICE AREA.

There are three general alternatives for the design service area of the Upper Southeast Salt Creek trunk sewer. As discussed in Table 3, the options include the Comprehensive Plan - Tier I service area, the Comprehensive Plan - Tier II service area, and the Total Ridgeline service area. Due to the long-term planning horizon for major trunk sewers, the Tier I option is not recommended. The choice between the Tier II and Total Ridgeline service areas will depend upon the City's determination of growth potential for the southern end of the S-5 Urban Planning Zone, and whether it is appropriate to include the area that is currently within the planning jurisdiction of the Village of Roca, but not within the Tier II or Tier III planning area for the City of Lincoln.

Potential grade limitations at the crossing of the S-2/S-3 basin drainage channel will affect the vertical alignment and pipe size for this project. Depending upon the service area and corresponding design flow, the trunk sewer may need to change in size and slope to accommodate the chosen alternative. The Tier II option appears to be serviceable with a 48-inch diameter pipe, but the Total Ridgeline option may require a 54-inch diameter pipe because of the grade limitations. In addition the existing 48-inch trunk sewer does not have the necessary capacity to serve all of the Total Ridgeline area, though the difference between pipe capacity and the theoretical design flow is less than 5% (49.8 cfs versus 51.8 cfs).

3.2 ALTERNATIVE ALIGNMENTS AT ROKEBY ROAD.

There are also three alternatives for the alignment and crossing of the BNSF railroad at Rokeby Road. The first option is to begin the crossing north of Rokeby Road, and bore under the tracks on an approximate perpendicular alignment, then cross into the Wilderness Ridge golf course detention cell. This alignment will avoid any disruption of the woodland area and the oxbow of Salt Creek in Wilderness Park, but from preliminary geotechnical investigations, will likely encounter sandstone in the bore and on the golf course property. In addition the ground elevation in the golf course area is significantly higher (approximately 10 feet) than the area to the south. The sandstone and additional depth on this alignment will increase the cost of the project.

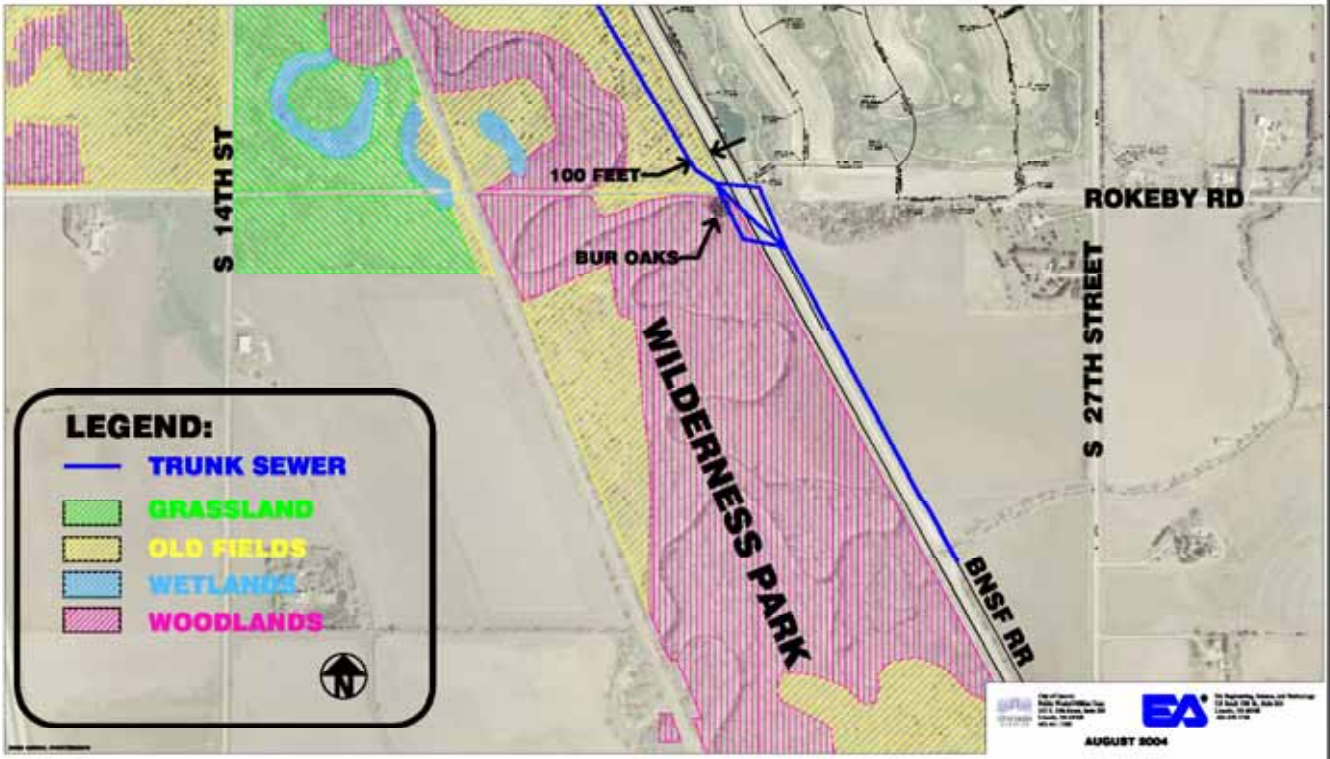
The second alignment option would begin at the same location in the park as the first option, but to bore under the BNSF tracks along a diagonal alignment to the southeast, in order to avoid the sandstone and additional depth on the golf course property. This will require a much longer bore under the railroad (potentially 300 feet or more). The BNSF Utility Accommodation policy requires crossings under the railroad to be perpendicular whenever possible, but will allow crossings at up to 45 deg. angles when conditions warrant. This alignment would require a crossing at 65 to 70 deg. from perpendicular, and may not be acceptable to BNSF Engineering.

The additional cost of increasing the bore length is significant, which makes this alignment option the most expensive for each service area alternative.

The third alignment option extends further south in Wilderness Park, south of Rokeby Road and into the woodland area of the park. This option would have the sewer route pass between the oxbow of Salt Creek and the BNSF property line. The alignment would extend approximately 250 to 300 feet south of Rokeby Road, and then bore under the BNSF tracks with an approximate perpendicular alignment. This option will be more invasive into the sensitive woodland area of the park, and may require significantly more restoration. However, the sandstone formation of the northern crossing location and the additional depth on the east side of the railroad would be avoided.

In order to determine the preferred option of these three alignments, it will be necessary to conduct further geotechnical investigations, to delineate the actual extent of the sandstone formation. Costs for each of the alternatives will be evaluated to compare economic considerations.

FIGURE 4 - ROKEBY ROAD ALTERNATIVES
UPPER SOUTHEAST SALT CREEK TRUNK SEWER
PRELIMINARY ROUTING STUDY
-LINCOLN WASTEWATER SYSTEM-



ROKEBY ROAD ALTERNATIVES

UPPER SE SALT CREEK TRUNK SEWER
PRELIMINARY ROUTING STUDY

EA ENGINEERING, SCIENCE, AND TECHNOLOGY

PROJECT NO.	13340.06
DATE	8-24-04
SCALE	NONE
CHECKED BY	LNG
DRAWN BY	EG
DESIGNED BY	MAB
PROJECT MGR.	DS
FIGURE	4

4.0 EVALUATION OF ALTERNATIVES

4.1 Alignment Selection Criteria.

The decision on Service Area alternatives is independent of the decision on Alignment Alternatives, and will not affect the alignment selection criteria. The service area alternative will be chosen on the basis of policy and cost implications, while the alignment alternative will be selected on the basis of several engineering, ecological, and cost considerations.

Table 4.1 summarizes the selection criteria used for ranking the alignment options, and provides a rating score for each alternative, in order to provide an overall comparison among the three alignments. A rating scale of 1 to 5 was used for each selection criterion, with "1" being the least favorable and "5" being the most favorable.

Table 4.1 – Alignment Selection Criteria and Ranking

Criteria	Alignment #1	Alignment #2	Alignment #3
Engineering Factors			
Length of total project	4	4	4
Length of bores	5	2	5
Impacts on the BNSF railroad	4	3	4
ROW and Permit requirements	4	2	3
Hydraulic Design	4	5	4
Impacts on existing utilities	3	3	3
Geotechnical considerations **	--	--	--
Construction techniques/constructibility	3	3	5
Ecological Factors			
Impacts on park flora	4	4	2
Impacts on park fauna	4	4	2
Impacts on Salt Creek	5	5	4
Impacts on sandstone formation	3	4	4
Area of construction disturbance	5	5	3
Extent of restoration required	5	5	3
Impacts on other adjacent properties	3	4	4
TOTALS	56	53	50

** The geotechnical considerations need to be detailed in additional studies.

The selection criteria and relative ranking scores indicate that Alignment #1 is the most favored option, followed by Alignment #2, and then Alignment #3. These rankings should be considered in conjunction with a comparison of total project costs for each of the three alternatives. The estimate of project costs for each alternative are summarized on the following pages.

4.2 Engineer's Estimate of Project Costs

The following estimates are divided into two groups of three options each. Options 1A, 1B and 1C are based on the Tier II Service Area, which can be accommodated with a 48-inch diameter pipe. The three alternatives under Option 1 are separated by the BNSF railroad crossing location at Rokeby Road, with Option 1A as the north crossing through the Wilderness Ridge detention cell on the west side, Option 1B as the diagonal crossing, and Option 1C as the south crossing through the woodland area of the park on the east side. Options 2A, 2B, and 2C are based on the Total Ridgeline Service Area, which requires a 54-inch diameter pipe. The three alternatives under Option 2 also differentiate the three railroad crossing options at Rokeby road.

From the individual cost estimates, the difference in project cost from a 48-inch diameter pipe to a 54-inch diameter pipe is in the range of $500,000 to $57,000, depending upon the method of crossing the railroad at Rokeby Road. The cost of Options A and C for each pipe size are nearly identical, with the cost of additional depth through the detention cell in Option A being offset by the cost of Additional park restoration in Option C. In each case for Option B, the long diagonal bore at Rokeby Road was the most expensive alternative. Table 4.2 below gives a summary of the Total Project Cost for each option.

Table 4.2 – Engineer's Estimated Total Project Cost Alternatives Matrix

Alternatives	North Crossing at Rokeby Road	Diagonal Crossing at Rokeby Road	South Crossing at Rokeby Road
Tier II (48-inch pipe)	1A - $3,576,000	1B - $3,891,000	1C - $3,547,000
Total Ridgeline (54-inch pipe)	2A - $4,080,000	2B - $4,458,000	2C - $4,055,000

In addition to the alternative cost estimates given above, there was some question as to the additional cost of skewing the alignment to the west of the BNSF property line in the "Old Fields" area of Wilderness Park, in order to preserve the stand of mature trees that acts as a buffer strip between this area of the park and the railroad. The additional construction requirements for this route adjustment include 45 feet of additional pipeline length, and 2 additional manholes for deflections in the pipe alignment. The construction cost for these route adjustments are as follows:

48-inch diameter pipe - $ 24,000
54-inch diameter pipe - $ 26,000

The cost of these adjustments is included in the cost estimates given above and detailed on the following pages.

Upper Southeast Salt Creek Trunk Sewer
Preliminary Cost Estimate

Option 1A - Tier II Service Area (48" pipeline) and
Rokeby Road crossing at north end

	ITEM	QUANTITY	UNITS	UNIT COST	TOTAL COST
	48" sanitary sewer (10'-15' deep)	4,530	LF	$150	$679,500
	48" sanitary sewer (15'-20' deep)	1,700	LF	$200	$340,000
	48" sanitary sewer (20'-25' deep)	1,100	LF	$275	$302,500
	72" diam. manhole (10' deep)	17	Each	$5,000	$85,000
	72" manhole add'l depth	170	VF	$250	$42,500
(North)	72" diam. casing, bored in place	140	LF	$1,100	$154,000
(South)	72" diam. casing, bored in place	140	LF	$1,200	$168,000
	42" diam. pipe stub & plug (10')	2	Each	$1,500	$3,000
	Pipe encasement/stream crossing	75	LF	$2,000	$150,000
	Dewatering (ave. depth = 8')	7,330	LF	$30	$219,900
	Park restoration	575,000	SF	$0.20	$115,000
	Tree replacement	200	Each	$300	$60,000
	SUBTOTAL				$2,319,400
	Contingencies (25%)				$579,850
	Permanent Easements	150,000	SF	$1.00	$150,000
	Temporary Easements	600,000	SF	$0.10	$60,000
	SUBTOTAL				$3,109,250
	Engineering, Legal, Admin. (15%)				$466,388
	TOTAL				**$3,575,638**

Upper Southeast Salt Creek Trunk Sewer
Preliminary Cost Estimate

Option 1B - Tier II Service Area (48" pipeline) and
Rokeby Road diagonal crossing

	ITEM	QUANTITY	UNITS	UNIT COST	TOTAL COST
	48" sanitary sewer (10'-15' deep)	4,530	LF	$150	$679,500
	48" sanitary sewer (15'-20' deep)	2,000	LF	$200	$400,000
	48" sanitary sewer (20'-25' deep)	800	LF	$275	$220,000
	72" diam. manhole (10' deep)	16	Each	$5,000	$80,000
	72" manhole add'l depth	150	VF	$250	$37,500
(North)	72" diam. casing, bored in place	140	LF	$1,100	$154,000
(South)	72" diam. casing, bored in place	350	LF	$1,200	$420,000
	42" diam. pipe stub & plug (10')	2	Each	$1,500	$3,000
	Pipe encasement/stream crossing	75	LF	$2,000	$150,000
	Dewatering (ave. depth = 8')	7,330	LF	$30	$219,900
	Park restoration	575,000	SF	$0.20	$115,000
	Tree replacement	200	Each	$300	$60,000
	SUBTOTAL				$2,538,900
	Contingencies (25%)				$634,725
	Permanent Easements	150,000	SF	$1.00	$150,000
	Temporary Easements	600,000	SF	$0.10	$60,000
	SUBTOTAL				$3,383,625
	Engineering, Legal, Admin. (15%)				$507,544
	TOTAL				**$3,891,169**

Upper Southeast Salt Creek Trunk Sewer
Preliminary Cost Estimate

Option 1C - Tier II Service Area (48" pipeline) and
Rokeby Road crossing at south end

	ITEM	QUANTITY	UNITS	UNIT COST	TOTAL COST
	48" sanitary sewer (10'-15' deep)	4,530	LF	$150	$679,500
	48" sanitary sewer (15'-20' deep)	2,300	LF	$200	$460,000
	48" sanitary sewer (20'-25' deep)	500	LF	$275	$137,500
	72" diam. manhole (10' deep)	17	Each	$5,000	$85,000
	72" manhole add'l depth	150	VF	$250	$37,500
(North)	72" diam. casing, bored in place	140	LF	$1,100	$154,000
(South)	72" diam. casing, bored in place	140	LF	$1,200	$168,000
	42" diam. pipe stub & plug (10')	2	Each	$1,500	$3,000
	Pipe encasement/stream crossing	75	LF	$2,000	$150,000
	Dewatering (ave. depth = 8')	7,330	LF	$30	$219,900
	Park restoration	575,000	SF	$0.20	$115,000
	Tree replacement	300	Each	$300	$90,000
	SUBTOTAL				$2,299,400
	Contingencies (25%)				$574,850
	Permanent Easements	150,000	SF	$1.00	$150,000
	Temporary Easements	600,000	SF	$0.10	$60,000
	SUBTOTAL				$3,084,250
	Engineering, Legal, Admin. (15%)				$462,638
	TOTAL				**$3,546,888**

Upper Southeast Salt Creek Trunk Sewer
Preliminary Cost Estimate

Option 2A - Total Ridgeline Service Area (54" pipeline) and
Rokeby Road crossing at north end

	ITEM	QUANTITY	UNITS	UNIT COST	TOTAL COST
	54" sanitary sewer (10'-15' deep)	4,530	LF	$190	$860,700
	54" sanitary sewer (15'-20' deep)	1,700	LF	$245	$416,500
	54" sanitary sewer (20'-25' deep)	1,100	LF	$315	$346,500
	72" diam. manhole (10' deep)	17	Each	$5,000	$85,000
	72" manhole add'l depth	170	VF	$250	$42,500
(North)	78" diam. casing, bored in place	140	LF	$1,250	$175,000
(South)	78" diam. casing, bored in place	140	LF	$1,400	$196,000
	42" diam. pipe stub & plug (10')	2	Each	$1,500	$3,000
	Pipe encasement/stream crossing	75	LF	$2,000	$150,000
	Dewatering (ave. depth = 8')	7,330	LF	$30	$219,900
	Park restoration	575,000	SF	$0.20	$115,000
	Tree replacement	200	Each	$300	$60,000
	SUBTOTAL				$2,670,100
	Contingencies (25%)				$667,525
	Permanent Easements	150,000	SF	$1.00	$150,000
	Temporary Easements	600,000	SF	$0.10	$60,000
	SUBTOTAL				$3,547,625
	Engineering, Legal, Admin. (15%)				$532,144
	TOTAL				**$4,079,769**

Upper Southeast Salt Creek Trunk Sewer
Preliminary Cost Estimate

Option 2B - Total Ridgeline Service Area (54" pipeline) and
Rokeby Road diagonal crossing

	ITEM	QUANTITY	UNITS	UNIT COST	TOTAL COST
	54" sanitary sewer (10'-15' deep)	4,530	LF	$190	$860,700
	54" sanitary sewer (15'-20' deep)	2,000	LF	$245	$490,000
	54" sanitary sewer (20'-25' deep)	800	LF	$315	$252,000
	72" diam. manhole (10' deep)	16	Each	$5,000	$80,000
	72" manhole add'l depth	150	VF	$250	$37,500
(North)	78" diam. casing, bored in place	140	LF	$1,250	$175,000
(South)	78" diam. casing, bored in place	350	LF	$1,400	$490,000
	42" diam. pipe stub & plug (10')	2	Each	$1,500	$3,000
	Pipe encasement/stream crossing	75	LF	$2,000	$150,000
	Dewatering (ave. depth = 8')	7,330	LF	$30	$219,900
	Park restoration	575,000	SF	$0.20	$115,000
	Tree replacement	200	Each	$300	$60,000
	SUBTOTAL				$2,933,100
	Contingencies (25%)				$733,275
	Permanent Easements	150,000	SF	$1.00	$150,000
	Temporary Easements	600,000	SF	$0.10	$60,000
	SUBTOTAL				$3,876,375
	Engineering, Legal, Admin. (15%)				$581,456
	TOTAL				**$4,457,831**

Upper Southeast Salt Creek Trunk Sewer
Preliminary Cost Estimate

Option 2C - Total Ridgeline Service Area (54" pipeline) and
Rokeby Road crossing at south end

	ITEM	QUANTITY	UNITS	UNIT COST	TOTAL COST
	54" sanitary sewer (10'-15' deep)	4,530	LF	$190	$860,700
	54" sanitary sewer (15'-20' deep)	2,300	LF	$245	$563,500
	54" sanitary sewer (20'-25' deep)	500	LF	$315	$157,500
	72" diam. manhole (10' deep)	17	Each	$5,000	$85,000
	72" manhole add'l depth	150	VF	$250	$37,500
(North)	78" diam. casing, bored in place	140	LF	$1,250	$175,000
(South)	78" diam. casing, bored in place	140	LF	$1,400	$196,000
	42" diam. pipe stub & plug (10')	2	Each	$1,500	$3,000
	Pipe encasement/stream crossing	75	LF	$2,000	$150,000
	Dewatering (ave. depth = 8')	7,330	LF	$30	$219,900
	Park restoration	575,000	SF	$0.20	$115,000
	Tree replacement	300	Each	$300	$90,000
	SUBTOTAL				$2,653,100
	Contingencies (25%)				$663,275
	Permanent Easements	150,000	SF	$1.00	$150,000
	Temporary Easements	600,000	SF	$0.10	$60,000
	SUBTOTAL				$3,526,375
	Engineering, Legal, Admin. (15%)				$528,956
	TOTAL				**$4,055,331**

5.0 CONCLUSIONS AND RECOMMENDED ALTERNATIVE

Service Area

The Tier II Service Area encompasses approximately 7,542 developable acres, while the Total Ridgeline Service Area includes a total of 8,410 developable acres (from Table 2.1). The full pipe capacity of the existing 48-inch trunk sewer is 49.8 cfs, which, based on the City's design equation, yields a service area of 8,550 acres. The existing trunk sewer is already serving the S-1 Urban Planning Zone, an area of 748 acres. The remaining service area capacity of the existing trunk sewer is then (8,550 acres – 748 acres) = 7,802 acres.

The Tier II Service Area is the recommended option. The additional area beyond Tier II in the Total Ridgeline boundary is not within the future service limit of the City of Lincoln, due to its proximity to the Village of Roca. Selection of the Tier II option is the lower cost alternative, due to the selection of a 48-inch pipe size, versus the 54-inch pipe required to serve the larger area. The Total Ridgeline service area is larger than the existing trunk sewer can accommodate, based on design peak flows.

Pipe Size

Due to available grade and potential elevation conflicts with the existing drainage channel for the S-2/S-3 drainage basin, and based on design flows for each service area, providing gravity sewer service to the Tier II area requires a 48-inch diameter sewer. The additional area of the Total Ridgeline option requires a 54-inch diameter sewer to provide enough flow capacity and still meet the grade limitations. However, the hydraulic grade line analysis decribed in Section 2.3 and Table 2.3 show that a 48-inch diameter pipe could serve the larger area, if a tolerable amount of surcharge is allowed in the pipeline.

Rokeby Road Alignment

Three options were proposed for the bored crossing of the BNSF railroad near Rokeby Road. The first option is a perpendicular bore north of the road, which avoids the woodland area of Wilderness Park, but is deeper on the east end and intersects the Dakota sandstone formation. The second option is a long diagonal bore under the railroad, to avoid the woodland area and the extra depth on the east side. The third option is a perpendicular bore south of the road, which encroaches in the woodland area, but avoids the extra depth on the east side.

Based on the selection criteria and ranking of the three alternatives in Table 4.1, the north crossing is slightly favored over the diagonal and south crossings. However, before the alignment is selected for final design, additional geotechnical investigations should be performed to determine de-watering methods and costs, as well as the actual extent of the rock formation in this area. This will directly affect cost and constructibility issues, and may alter the outcome of the ranking analysis.

Cost Estimates

The six cost estimates derived from the two service area/pipe size alternatives and the three alternative Rokeby road alignments show that the Tier II/48-inch pipe option is approximately $ 550,000 less expensive than the Total Ridgeline/54-inch pipe option. The additional cost is due to increased material cost for the pipe, an increase in excavation and bedding costs, and increase in the diameter of the casing pipes for the bores.

For each of the service area alternatives, the cost of the north and south crossings of the BNSF railroad at Rokeby Road are equivalent, with the cost for extra depth and rock excavation at the north offset by the additional clearing and restoration costs at the south. In each of the two service area alternatives, the long diagonal bore under the BNSF railroad was the most expensive option.

Each of these cost estimates contains a large contingency factor (25%) to reflect the uncertainties of the amount of rock excavation that will be required, and the specifics of park restoration requirements.

Recommended Alternative

Alternative 1A (Tier II service area / 48-inch pipe / north crossing at Rokeby Road) is the most cost effective option for the Lincoln Wastewater System, and represents the least construction impact and encroachment into Wilderness Park.

If a slight amount of hydraulic surcharge is deemed tolerable in the proposed trunk sewer (and in the existing trunk sewer) during peak flow events, the 48-inch pipe could potentially serve the Total Ridgeline area. This may be preferable to the additional cost of over $ 0.5 Million for a 54-inch pipe, in order to serve the additional 868 acres in the Total Ridgeline service area.

GENERAL RECOMMENDATIONS

In order to select the best option and ensure the success of the project, it is recommended that the Project Partnering Approach be continued through the final design and construction phases of this project. Making a sound fiscal decision, providing for the long-term operational and maintenance needs of the Lincoln Wastewater System, and providing protection and oversight of the unique habitat in Wilderness Park will require input from a wide range of stakeholders on this project. A committee of Project Partners, representing each of the various disciplines and stakeholder groups, should be created to assist the City and the Engineer with plan selection during final design.

APPENDIX A

Preliminary Plan and Profile Drawings

UPPER SOUTHEAST SALT CREEK TRUNK SEWER
– INDEX SHEET –

SITE LOCATION MAP
(1"=1000')

VICINITY MAP
(1"=4000')

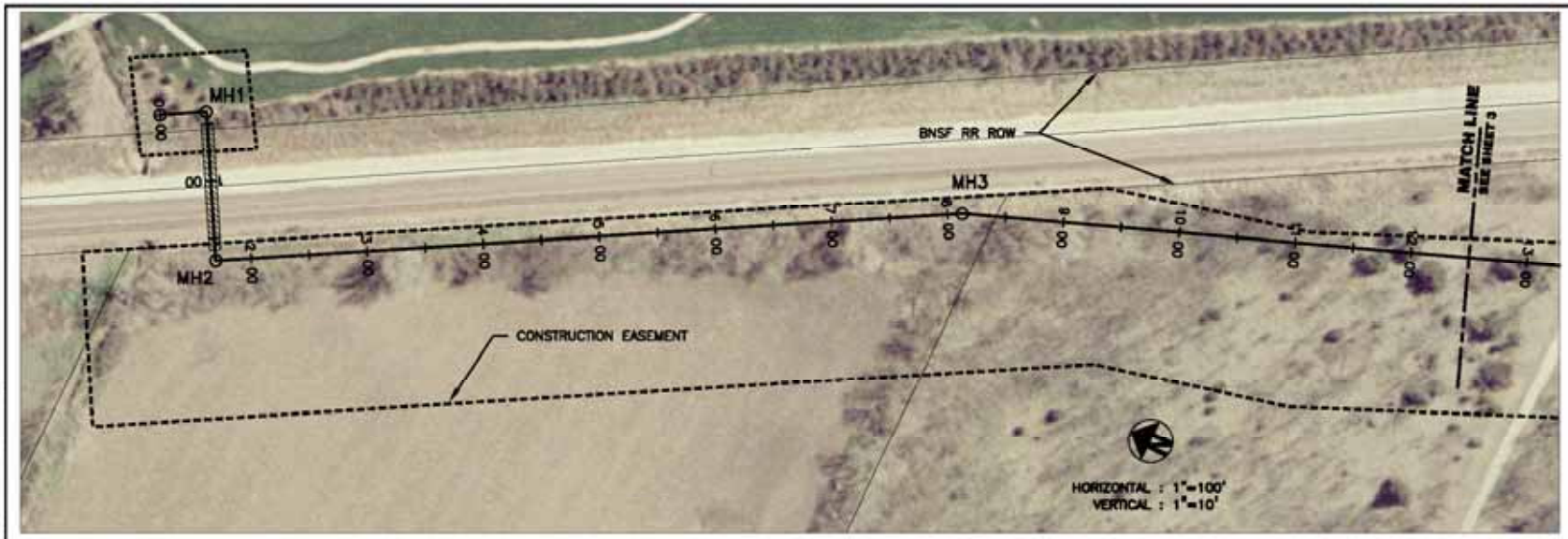
CAUTION !
BEFORE YOU DIG CALL
1–800–331–5666
FOR MARKING UNDERGROUND
UTILITY LINES
DIGGERS HOTLINE OF NEBRASKA

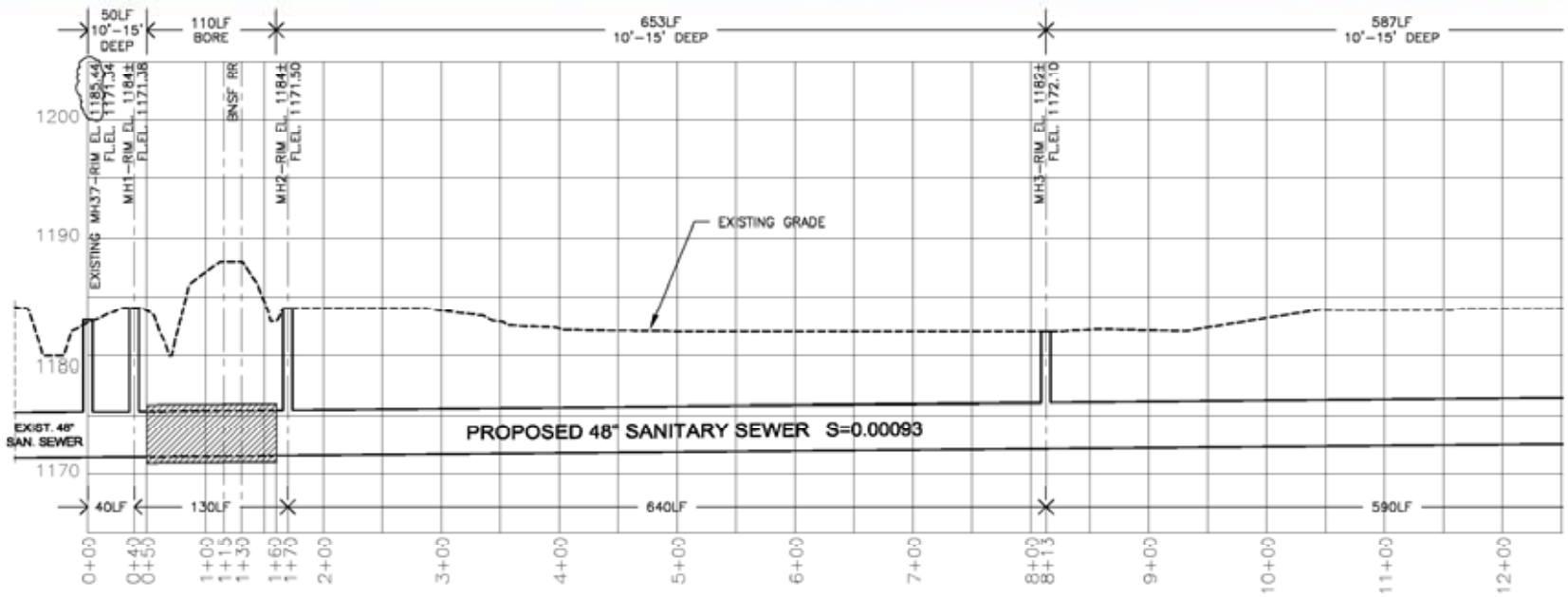
CITY OF LINCOLN, NEBRASKA
LINCOLN WASTEWATER SYSTEM

SANITARY SEWER PROJECT XXXXX
UPPER SOUTHEAST SALT CREEK TRUNK SEWER
LINCOLN, NEBRASKA

EA ENGINEERING, SCIENCE, AND TECHNOLOGY

PROJECT MGR.	DESIGNED BY	DRAWN BY	CHECKED BY	DATE	SCALE	PROJECT NO.	FILE NAME	DRAWING NO.	FIGURE
LNG	-	EG	LNG	AUGUST 2004	AS SHOWN	04630.80	-	-	1





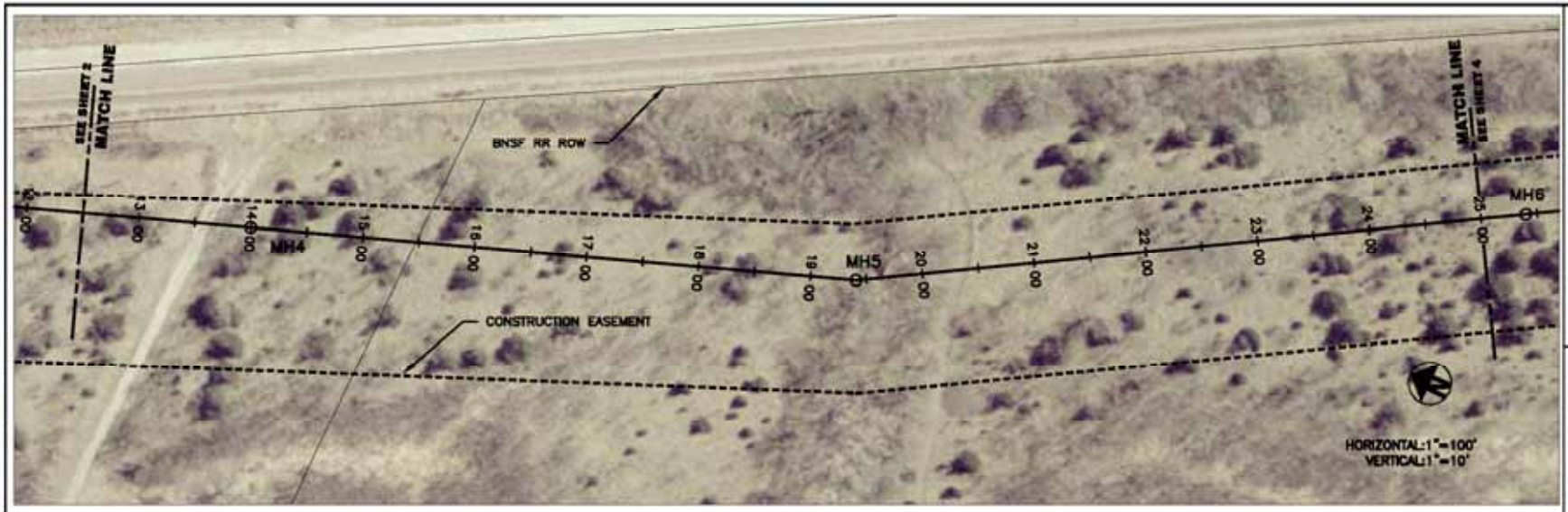
CITY OF LINCOLN, NEBRASKA
LINCOLN WASTEWATER SYSTEM

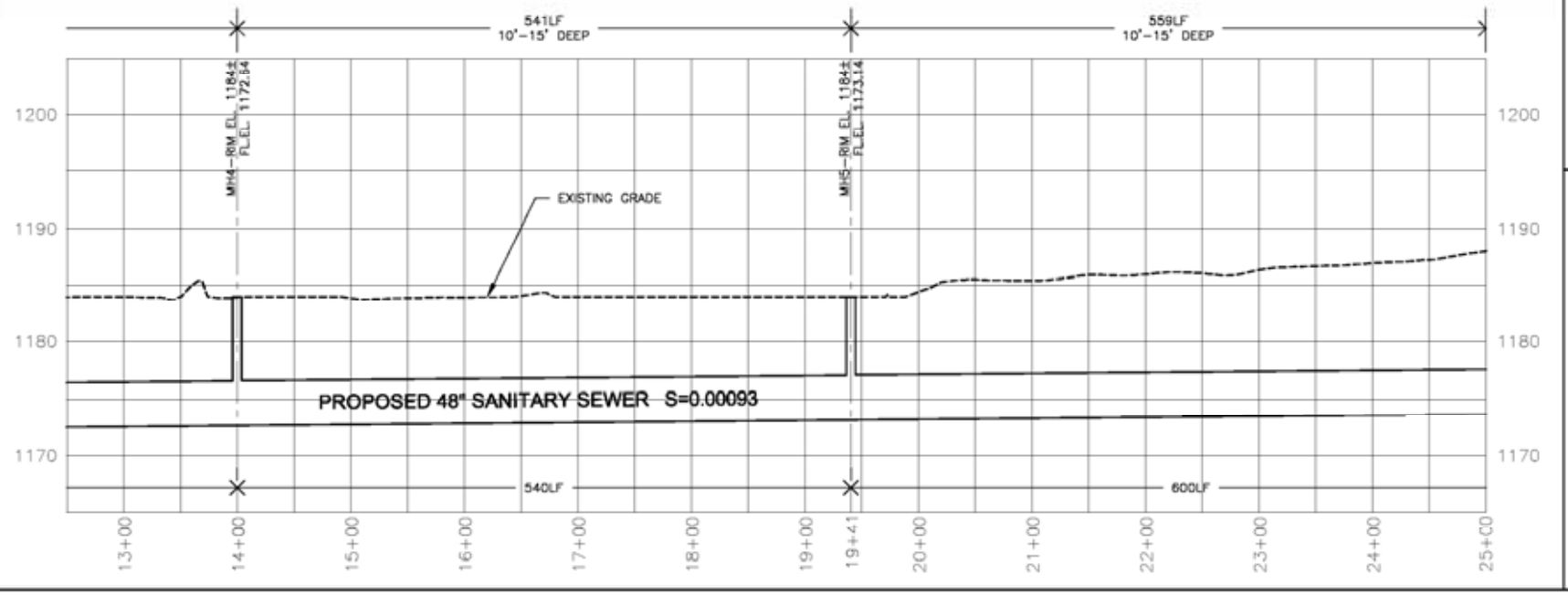
SANITARY SEWER PROJECT XXXXX
UPPER SOUTHEAST SALT CREEK TRUNK SEWER
LINCOLN, NEBRASKA

EA ENGINEERING, SCIENCE, AND TECHNOLOGY

PROJECT MGR.	DESIGNED BY	DRAWN BY	CHECKED BY	DATE	SCALE	PROJECT NO.	FILE NAME	DRAWING NO.	FIGURE
LNG	-	EG	LNG	AUGUST 2004	AS SHOWN	04630.80	-	-	2

DRAWING NAME: F:\State & Local\Municipal\City of Lincoln\PROJECTS\13540051\Figures_Jun04\Trunk_sewer\dwg\Plan-Profile_11x17.dwg
DATE: 08/31/2004 TIME: 16:16 DRAWN BY: eggeric





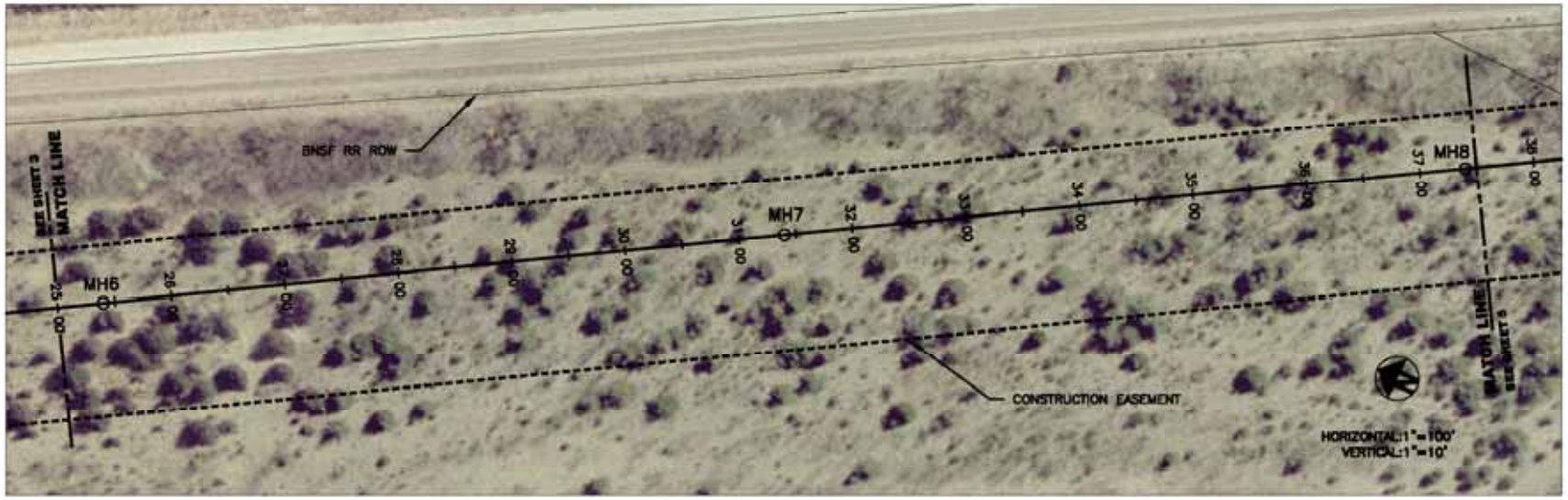
CITY OF LINCOLN, NEBRASKA
LINCOLN WASTEWATER SYSTEM

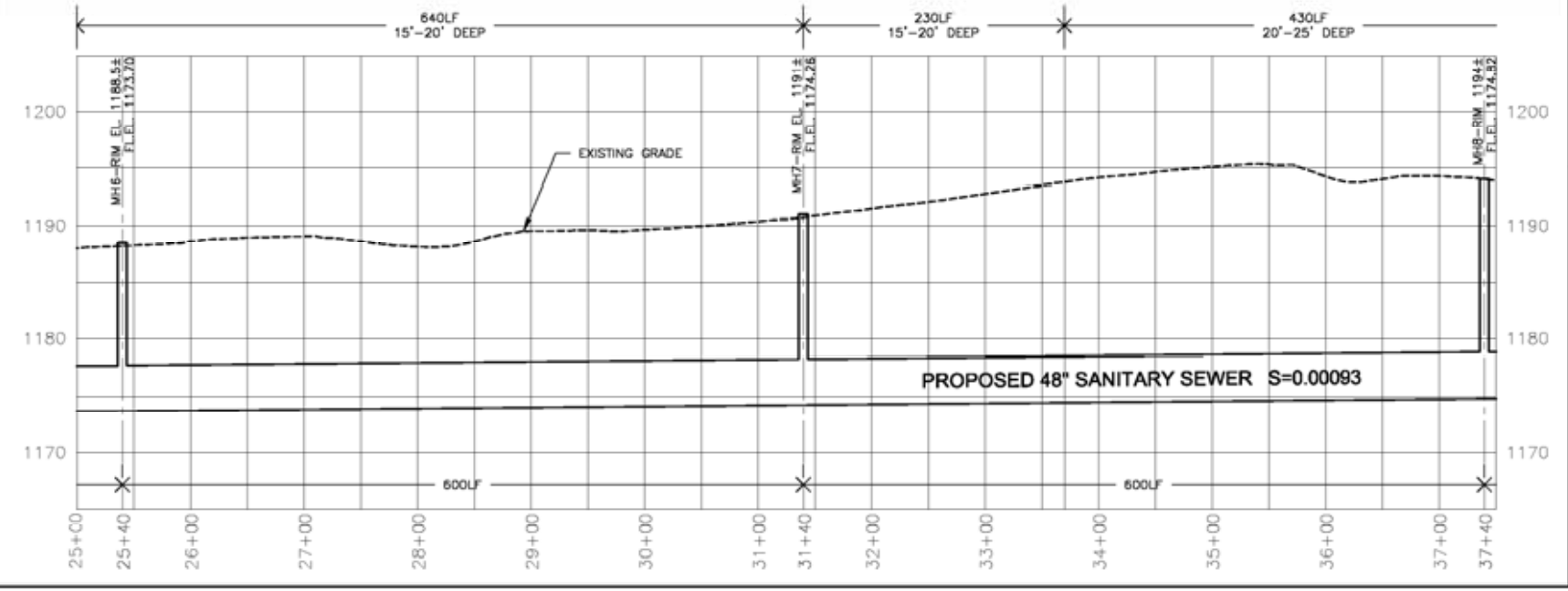
SANITARY SEWER PROJECT XXXXX
UPPER SOUTHEAST SALT CREEK TRUNK SEWER
LINCOLN, NEBRASKA

EA ENGINEERING, SCIENCE, AND TECHNOLOGY

PROJECT MGR.	DESIGNED BY	DRAWN BY	CHECKED BY	DATE	SCALE	PROJECT NO.	FILE NAME	DRAWING NO.	FIGURE
LWG	-	EG	LWG	AUGUST 2004	AS SHOWN	04630.80	-	-	3

DRAWING NAME: F:\State & Local\Municipal\City of Lincoln\PROJECTS\13540056\Figures_Jun04\Trunk_sewer\Dwg\Plan-Profile_11x17.dwg
DATE:08/31/2004 TIME:16:16 DRAWN BY: eggelic





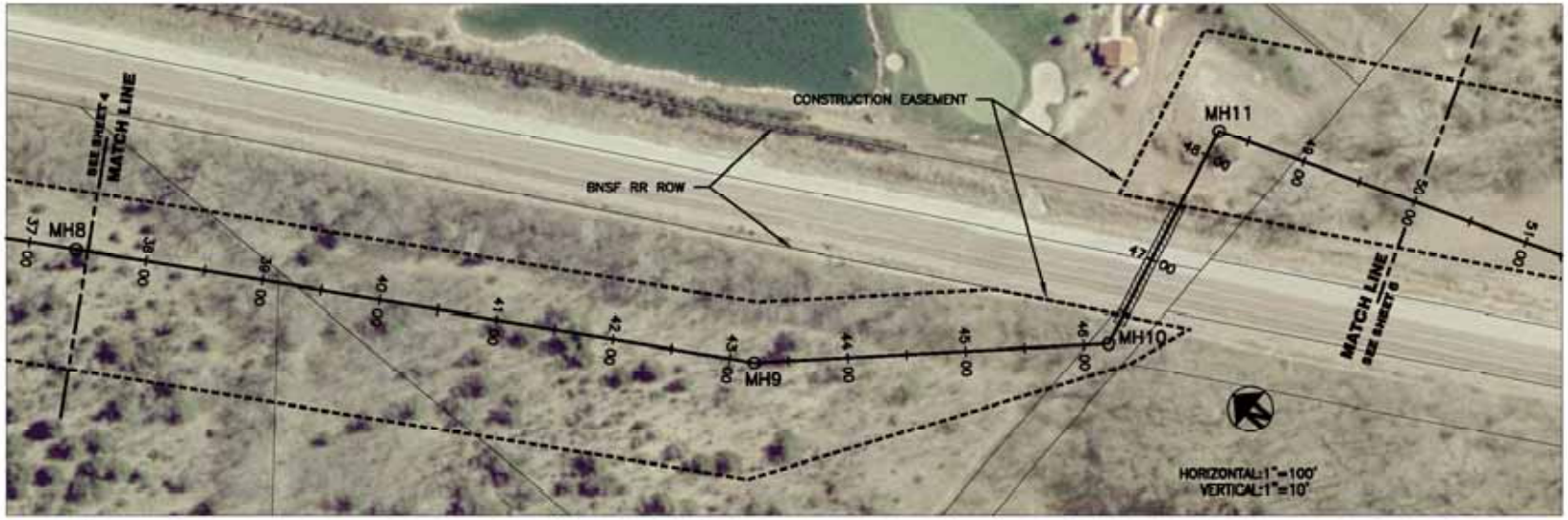
CITY OF LINCOLN, NEBRASKA
LINCOLN WASTEWATER SYSTEM

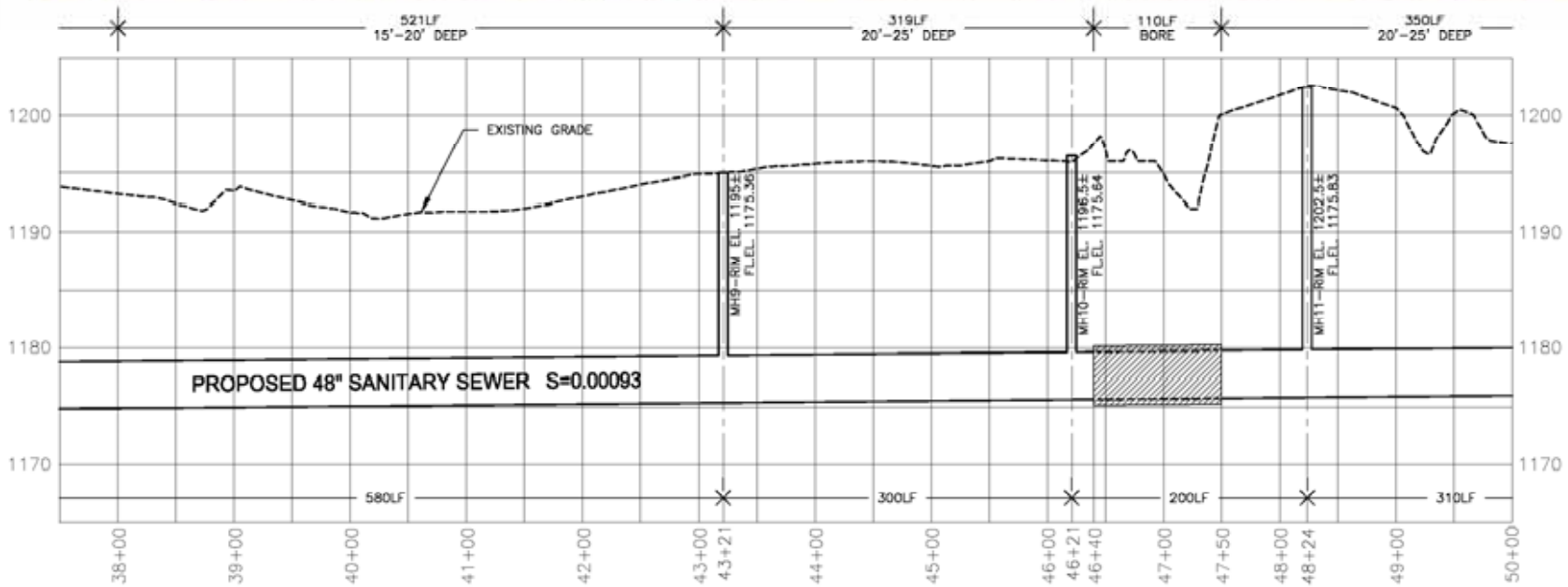
SANITARY SEWER PROJECT XXXXX
UPPER SOUTHEAST SALT CREEK TRUNK SEWER
LINCOLN, NEBRASKA

EA ENGINEERING, SCIENCE, AND TECHNOLOGY

PROJECT MGR.	DESIGNED BY	DRAWN BY	CHECKED BY	DATE	SCALE	PROJECT NO.	FILE NAME	DRAWING NO.	FIGURE
LNG	-	EG	LNG	AUGUST 2004	AS SHOWN	04630.80	-	-	4

DRAWING NAME: F:\State & Local\Municipal\City of Lincoln\PROJECTS\13540056\Figures_Jun04\Trunk_sewer\dwg\Plan-Profile_11x17.dwg
DATE:08/31/2004 TIME:16:16 DRAWN BY: eggeric





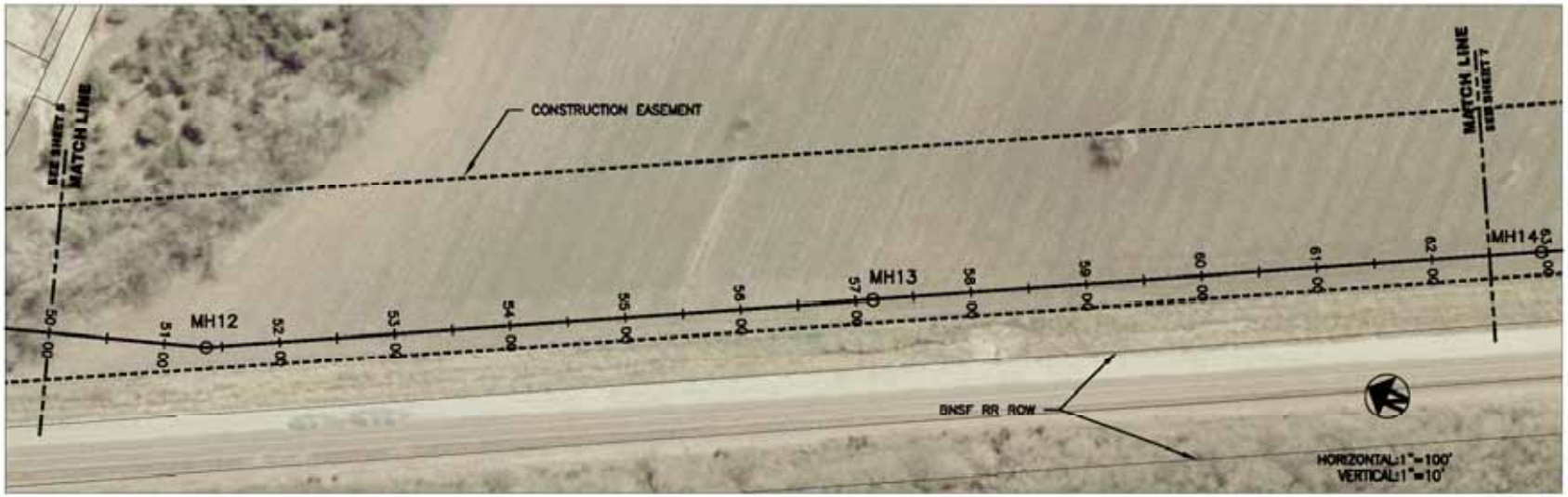
CITY OF LINCOLN, NEBRASKA
LINCOLN WASTEWATER SYSTEM

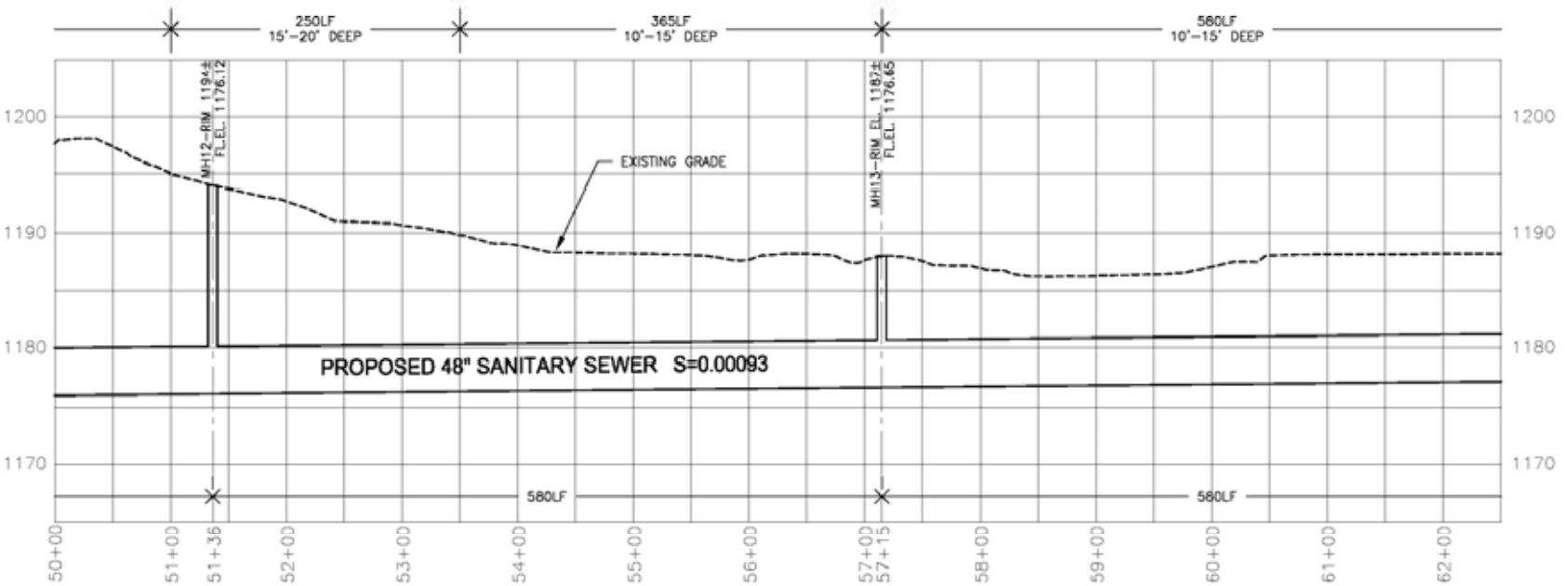
SANITARY SEWER PROJECT XXXXX
UPPER SOUTHEAST SALT CREEK TRUNK SEWER
LINCOLN, NEBRASKA

EA ENGINEERING, SCIENCE, AND TECHNOLOGY

PROJECT MGR.	DESIGNED BY	DRAWN BY	CHECKED BY	DATE	SCALE	PROJECT NO.	FILE NAME	DRAWING NO.	FIGURE
LNG	-	EG	LNG	AUGUST 2004	AS SHOWN	04630.80	-	-	5

DRAWING NAME: F:\State & Local\Municipal\City of Lincoln\PROJECTS\13540056\Figures_Jun04\Trunk_sewer\Dwg\Plan-Profile_11x17.dwg
DATE:08/31/2004 TIME:16:16 DRAWN BY: eggeric





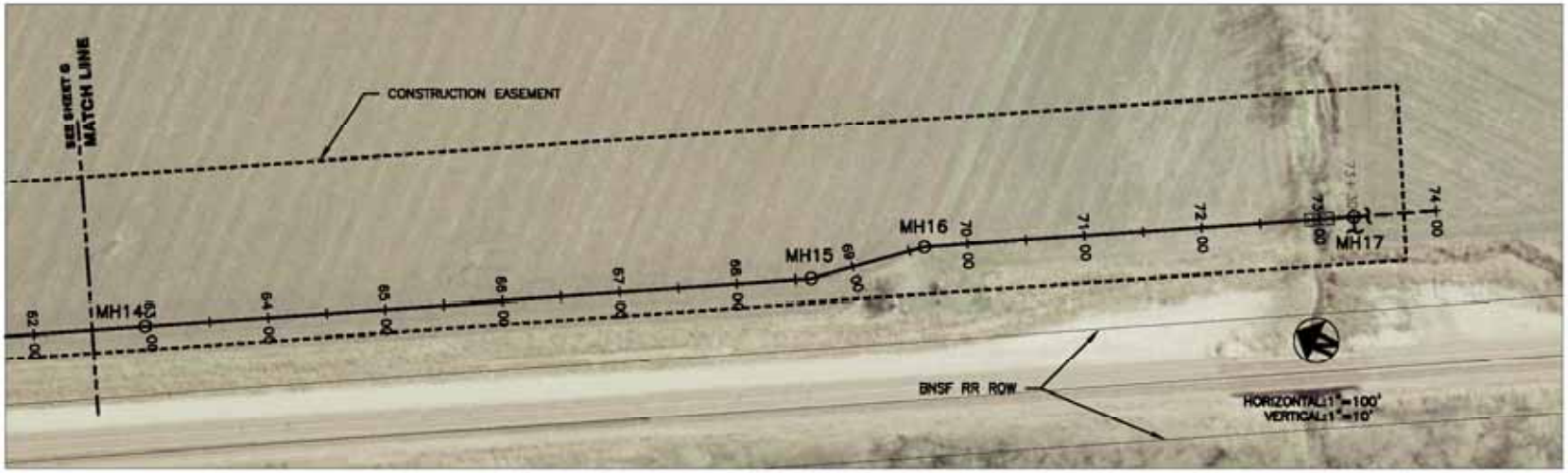
CITY OF LINCOLN, NEBRASKA
LINCOLN WASTEWATER SYSTEM

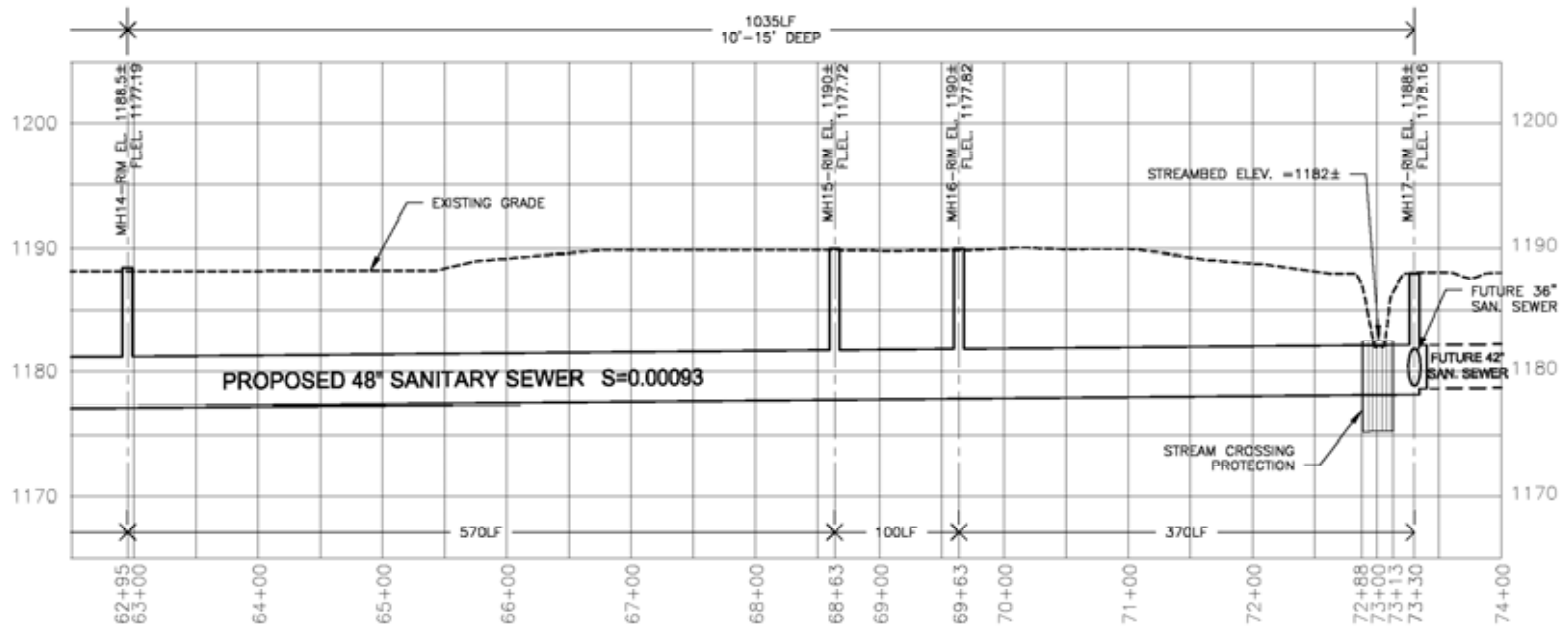
SANITARY SEWER PROJECT XXXXX
UPPER SOUTHEAST SALT CREEK TRUNK SEWER
LINCOLN, NEBRASKA

EA ENGINEERING, SCIENCE, AND TECHNOLOGY

PROJECT MGR.	DESIGNED BY	DRAWN BY	CHECKED BY	DATE	SCALE	PROJECT NO.	FILE NAME	DRAWING NO.	FIGURE
LNG	-	EG	LNG	AUGUST 2004	AS SHOWN	04630.80	-	-	6

DRAWING NAME: F:\State & Local\Municipal\City of Lincoln\PROJECTS\13540051\Figures_Jun04\Trunk_sewer\dwg\Plan-Profile_11x17.dwg
DATE:08/31/2004 TIME:16:16 DRAWN BY: eggelic





CITY OF LINCOLN, NEBRASKA
LINCOLN WASTEWATER SYSTEM

SANITARY SEWER PROJECT XXXXX
UPPER SOUTHEAST SALT CREEK TRUNK SEWER
LINCOLN, NEBRASKA

EA ENGINEERING, SCIENCE, AND TECHNOLOGY

PROJECT MGR.	DESIGNED BY	DRAWN BY	CHECKED BY	DATE	SCALE	PROJECT NO.	FILE NAME	DRAWING NO.	FIGURE
LNG	-	EG	LNG	AUGUST 2004	AS SHOWN	04630.80	-	-	7

DRAWING NAME: F:\State & Local\Municipal\City of Lincoln\PROJECTS\13540056\Figures_Jun04\Trunk_sewer\dwg\Plan-Profile_31+17.dwg
DATE:08/31/2004 TIME:16:16 DRAWN BY: eggeric

APPENDIX B

Geotechnical Engineering Report

GEOTECHNICAL ENGINEERING REPORT

Preliminary Geotechnical Study
Upper Southeast Salt Creek Sanitary Trunk Sewer
Lincoln Wastewater System
Lincoln, Nebraska

PREPARED FOR

EA Engineering, Science, and Technology
121 South 13th Street
Suite 701
Lincoln, NE 68508

May 28, 2004

PREPARED BY

HWS
Solutions Through Service

HWS Consulting Group
825 J Street, Box 80358
Lincoln, NE 68501-0358
402.479.2200 Fax: 402.479.2276
www.hws.com

May 28, 2004

Mr. Dale Schlautman
EA Engineering, Science, and Technology
12 1 South 13th Street
Suite 701
Lincoln, Nebraska 68508

REFERENCE: Preliminary Geotechnical Study
Upper Southeast Salt Creek Sanitary Trunk Sewer
Lincoln Wastewater System
Lincoln, Nebraska

Dear Mr. Schlautman:

The City of Lincoln, Nebraska plans to construct a trunk sewer line that is about 1.3 miles in length. This sewer will run approximately parallel to the BNSF Railroad tracks from approximately 1 mile NNW of the intersection of 27th Street and Rokeby Road to about ½ mile SSE of the intersection of 27th Street and Rokeby Road. The sewer will cross under the BNSF Railroad tracks at two locations, via trenchless construction, such as utility tunneling, pipe jacking, or microtunneling. The remaining portion of the sewer will be installed by means of open cut trenching.

As requested, HWS Consulting Group Inc. (HWS) has performed a subsurface exploration and a preliminary geotechnical study of the subsurface soils at the referenced site. The purpose of these services was to address geotechnical issues for the preliminary design of the proposed sanitary sewer. This report summarizes the findings of the subsurface exploration and the preliminary geotechnical study.

SUBSURFACE EXPLORATION

A program of Dutch friction-cone soundings, test borings, and soil sampling was performed at the project site on May 7, 2004. Three (3) Dutch friction-cone soundings were made at the site. Four (4) exploratory borings were taken to depths of between 7 and 30 feet below the existing grade to establish the general subsurface conditions of the area under consideration. Three of these borings were made immediately beside the three soundings.

The Dutch friction-cone soundings were performed with a mechanical penetrometer in accordance with ASTM D 3441-98, Standard Method for Deep, Quasi-Static, Cone, and Friction Cone Penetration Tests of Soil. The mechanical penetrometer operates incrementally, using a set of inner rods to operate a telescoping penetrometer tip and to transmit the components of penetration resistance (cone bearing and friction sleeve resistance) to the surface for

measurement. The plot of the test data identifies the relative positions and thicknesses of hard and soft layers.

The borings were made in accordance with ASTM D 1452-80 (Reapproved 2000), Standard Practice for Soil Investigation and Sampling by Auger Borings. A machine-driven, continuous flight auger having a diameter of 6 inches was used to advance borings 1,2, and 4 for sampling. Access with the drill rig was not possible at boring locations 3a and 3b, therefore, these two borings were advanced used a hand auger and a Backsaver soil probe. All bore holes were stable and casing was not required. Water level readings were made in the auger borings at times and under conditions stated on the boring logs.

Several small disturbed soil samples were obtained and were examined in the laboratory by a member of HWS' professional engineering staff to supplement the field identification.

The vicinity map and the boring location plan are presented in Appendix A. The penetration diagrams (see Appendix B) present the results of the Dutch friction-cone soundings. The boring logs (refer to Appendix C) present the data obtained in the subsurface exploration. The logs include the surface elevations, the approximate depths and elevations of major changes in the character of the subsurface materials, visual descriptions of the materials in accordance with the criteria presented in Appendix D, and groundwater data. The approximate locations of the soundings and borings are shown in Appendix A.

Elevations (approximate) at the sounding and boring locations were determined by survey with reference to points that HWS' Survey Department located and elevated prior to the subsurface exploration. These reference points are presented below. The elevations are with reference to USGS datum (NAVD88).

- **Boring 1.** Top of manhole cover, located east of the railroad tracks and on the south side of the ditch; elevation = 1 1 85.4 feet.
- **Boring 2.** Control point # 174; elevation = 1 194.5 feet.
- **Borings 3a and 3b.** Control point #182; elevation = 1203.6 feet.
- **Boring 4.** Top of railroad bridge deck; elevation = 1 194.8 feet.

GEOLOGY AND SITE CONDITIONS

The city of Lincoln lies in the Dissected Till Plains section of Nebraska, a part of the Central Lowland province of the Interior Plains physiographic division[1]. The project site is located in the southern portion of Lincoln, and is situated in both alluvial bottomlands and a loess mantled terrace adjacent to Salt Creek. Dakota sandstone is exposed in a railroad cut north of borings 3a and 3b. Refusal of hand sampling equipment-presumably on Dakota sandstone-occurred at boring locations 3a and 3b at depths of 7.3 and 7.6 feet, respectively, below existing grade. In the Lincoln area, the upper portion of the Dakota sandstone is known to have beds of both shale and ironstone.

[1] Physiographic Provinces of North America, Map by A. K. Lobeck, 1948; The Geographical Press; Columbia University, New York

The subsurface materials encountered at the boring locations are briefly described below in descending order of occurrence. Detailed descriptions are provided in the boring logs, which are presented in Appendix C.

Soil Zone	**Description**
Modern Alluvium	Silty sand, low plasticity, 50 to 60 % fine to coarse sand, wet, loose, extends from the ground surface to a maximum depth of 0.9 feet, encountered at boring 3b.
Topsoil	Lean clay, medium plasticity, 0 to 25% fine sand, wet, medium stiff to stiff, extends from the ground surface to a maximum depth of 3 feet, encountered at borings 2, 3a, and 4.
Alluvium	Fat clay, lean to fat clay, lean clay, silty sand, 0 to 70% fine sand, low to high plasticity, wet to saturated, stiff to very stiff and medium dense, extends from the ground surface, or underlies the topsoil, to a maximum depth of the depth explored, encountered at borings 1 and 4.
Subsoil	Fat clay, lean clay, high to medium plasticity, 0 to 15% fine sand, wet, stiff, underlies the topsoil and extends to a maximum depth of 4 feet, encountered at borings 2 and 3 a.
Lower-Subsoil	Lean clay, medium plasticity, wet, stiff to very stiff, underlies the subsoil and extends to a maximum depth of 5.5 feet, encountered at boring 2.
Peoria Alluvium	Fat clay, lean to fat clay, lean clay, sandy lean clay, clayey sand, silty sand, 0 to 80% fine to medium sand, low to high plasticity, medium stiff to very stiff, moist to saturated, underlies the Peoria and extends to a maximum depth of the depths explored, encountered at borings 2,3a, and 3b.
Dakota Sandstone (assumed)	Assumed to underlie the Peoria alluvium, Dakota sandstone is exposed in a railroad cut section northwest of borings 3a and 3b; borings 3a and 3b are assumed to have reached refusal on Dakota sandstone.

Groundwater was encountered at elevations ranging from 1 17 1.9 to 1 179.9 feet (5.2 to 2 1.8 feet below existing grade). The water table could be expected to fluctuate several feet depending on surface drainage, rainfall, vegetation, temperature, and other factors.

DISCUSSION

1. General soil Conditions. The soils encountered at borings B-1, B-2, and B-4 generally consisted of medium stiff to very stiff clay soils. Open cut trenching is expected to be a suitable construction method, except at the BNSF crossings where trenchless construction would be utilized. At borings B-3a and B-3b, refusal of the hand sampling equipment occurred at elevations 1 190.2 and 1 186.8 feet (7.3 and 7.6 feet below existing grade), respectively. The refusal was assumed to be on Dakota sandstone because sandstone is evident in the railroad cut located immediately northwest of borings B-3a and B-3b. Boring B-3a was made on the bank of a small creek and B-3b was made within the creek.

2. Groundwater. As previously discussed, groundwater was encountered at elevations ranging from 1 17 1.9 to 1 179.9 feet (5.2 to 2 1.8 feet below existing grade). Table 1 presents groundwater data at the five boring locations.

TABLE 1
Groundwater Data

Boring No.	Groundwater Elevation, ft.	Groundwater Depth*, ft.	Distance the Water Table is Above or Below the Proposed Flow Line, ft.
1	1171.9	5.2	0.5 below
2	1172.7	21.8	4.2 above
3a	**	**	**
3b	**	**	**
4	1179.9	8.4	6.6 above

*Below existing grade.
** Groundwater was not encountered to the depths of the borings (7.3 feet [elevation 1190.2 feet] at B-3a and 7.6 feet [elevation 1186.8 feet] at B-3b).

3. Trenchless Construction. Trenchless installation methods (for example, utility tunneling, pipe jacking, and microtunneling) will likely be used at the two railroad crossings. A brief summary of the soil and groundwater conditions at the trenchless locations is presented in Table 2. It should be noted that bedrock (Dakota sandstone) will likely be encountered during trenchless construction on the east side of the tracks in the vicinity of borings 3a and 3b.

TABLE 2
Brief Description of Soil and Groundwater Conditions At Trenchless Locations

Location	Boring No.	Groundwater*	General Soil Conditions
BNSF Tracks	1	0.5' above	Stiff to very stiff lean and fat clays.
West Side of BNSF Tracks	2	4' below	Medium stiff to very stiff lean and fat clays.
East Side of BNSF Tracks	3a, 3b	**	Soft to stiff lean clays overlying presumably Dakota sandstone.

*Approximate distance that the water table is above or below the proposed flow line of the sewer.
**Groundwater was not encountered to the depths of the borings (7.3 feet [elevation 1190.2 feet] at B-3a and 7.6 feet [elevation B 186.8 feet] at B-3b).

4. Bank Erosion. In the vicinity of boring 2, the currently proposed alignment of the sewer line is approximately 120 feet from the nearest bank of a meander of Salt Creek. Concern has been expressed that future bank erosion by Salt Creek might endanger the proposed sewer line. EA Engineering indicated that the flow line of the sewer would be approximately 26 feet below existing grade. The soils encountered at boring 2 consisted of medium stiff to very stiff lean and fat clays. Aerial photographs dated 1956 show that the stream channel is in approximately the same location as its current location. The flow line elevation of the channel could be compared to the sewer line flow elevation to help determine if bank erosion could become a future problem.

5. Applicability of Recommendations. The recommendations presented in this report are based in part upon HWS' analyses of the data from the Dutch friction-cone soundings and soil borings. The penetration diagrams, boring logs, and related information depict subsurface conditions only at the specific sounding and boring locations and at the time of the subsurface exploration. Soil conditions may differ between the soundings and exploratory borings and might change with the passage of time. The nature and extent of any variations between the sounding and boring locations or of any changes in soil conditions (e.g., drying of soil) might not become evident until excavation and construction of the trunk sewer project have begun.

HWS should be contacted if any questions arise concerning this report or if changes in the preliminary nature, design, or location of the sewer line are planned. This report shall not be reproduced, except in full, without the written approval of HWS Consulting Group Inc.

Submitted By

HWS CONSULTING GROUP INC.

Prepared by:

Joshua M. Letts
Engineering Geologist

Reviewed by:

Doyle B. Petersen, P.E.

REGISTERED PROFESSIONAL ENGINEER
DOYLE B. PETERSEN
E-5528
5-28-04
STATE OF NEBRASKA

JML/jml
Enclosures
#52-34-1702.0200 (#52-84-3099)
USESCTS2.doc
Orig. & 2 pc.: EA Engineering, Science, and Technology

APPENDIX A.

VICINITY MAP AND BORING LOCATION PLAN

VICINITY MAP

Preliminary Geotechnical Study
Upper Southeast Salt Creek Sanitary Truck Sewer
Lincoln Wastewater System
Lincoln, Nebraska

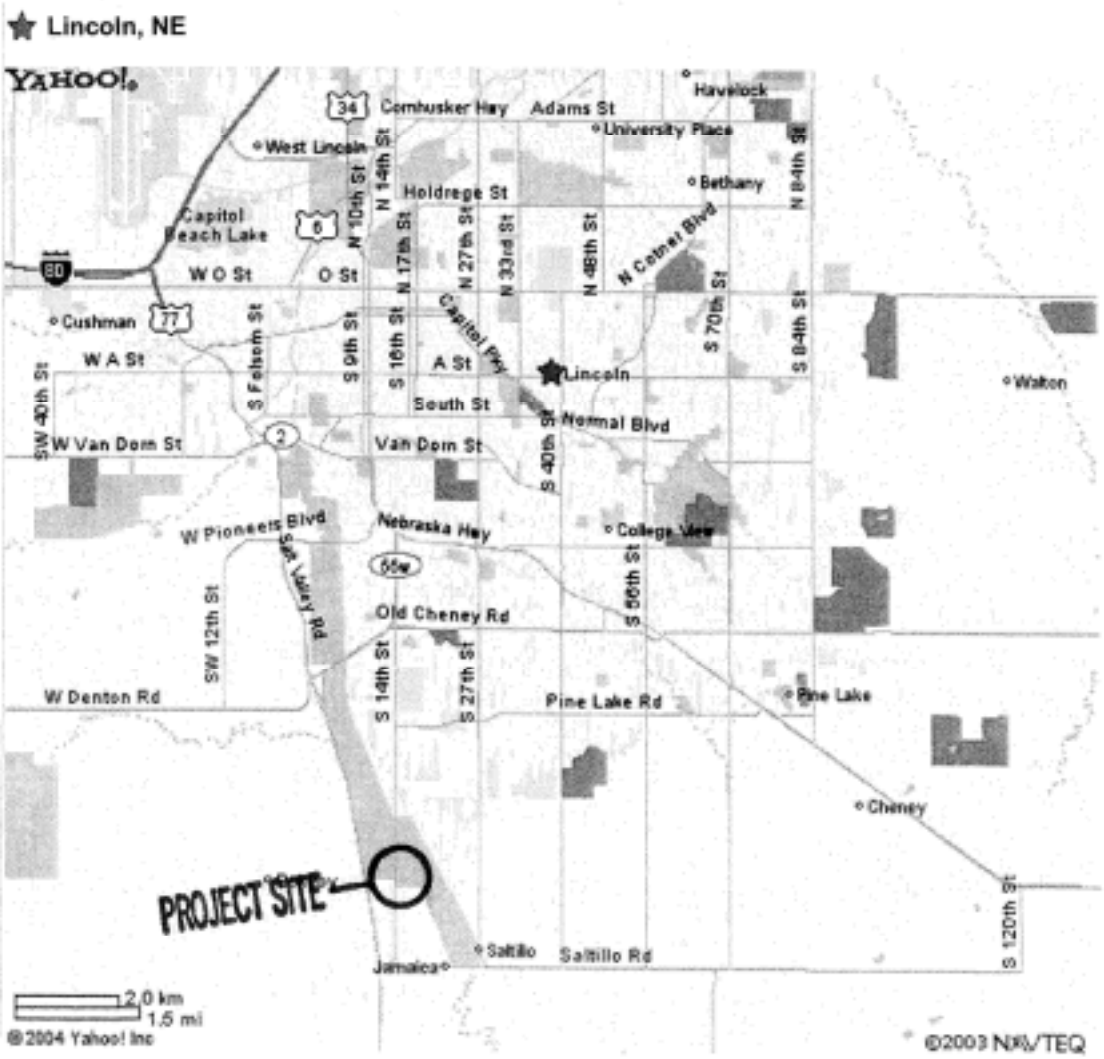
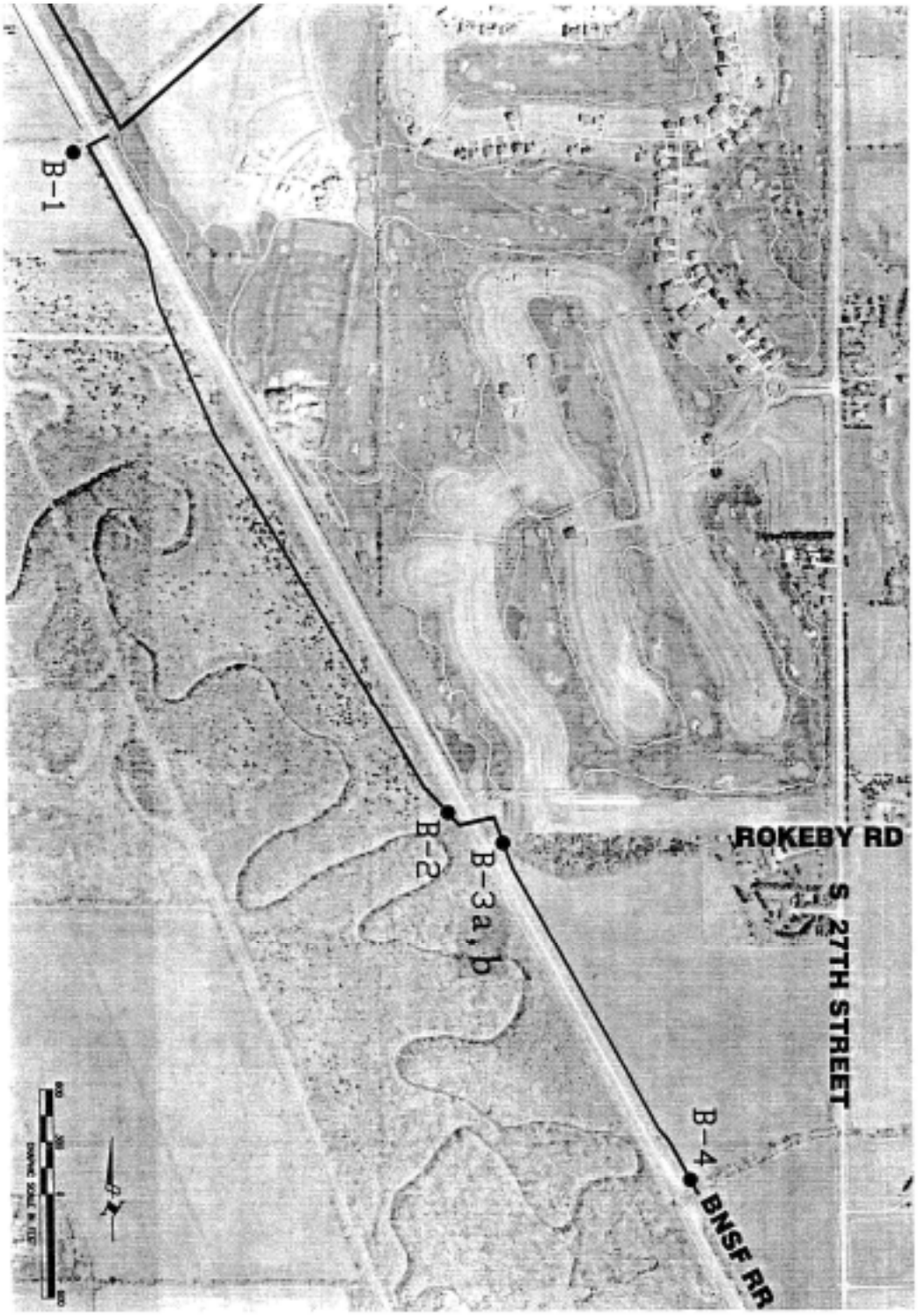


Figure A-1



EA ENGINEERING, SCIENCE, AND TECHNOLOGY	UPPER SOUTHEAST SALT CREEK TRUNK SEWER PRELIMINARY STUDY LINCOLN, NEBRASKA						SURVEY DATA POINTS AND GEOTECH DATA POINTS		
PROJECT MGR. DJS	DESIGNED BY -	DRAWN BY HSL	CHECKED BY DJS	DATE APRIL 2004	SCALE AS SHOWN	PROJECT NO. 13540.06	FILE NAME -	DRAWING NO. -	FIGURE -

APPENDIX B.

DUTCH FRICTION-CONE PENETRATION DIAGRAMS

HWS
Solutions Through Service

LINCOLN OFFICE
825 "J" Street, P.O. Box 80358
Lincoln, NE 68501
(402) 479-2200 FAX (402) 479-2276

PENETRATION DIAGRAM OF DUTCH FRICTION-CONE PENETROMETER

PROJECT: **Preliminary Geotechnical Study**
Upper Southeast Salt Creek Sanitary Trunk Sewer

SOUNDING NO.: **S-1**
LOCATION: **B-1**
SURFACE ELEVATION: **1177.1 feet**

DATE: **May 7, 2004**
TESTED BY: **SP**
RECORDED BY: **MS**

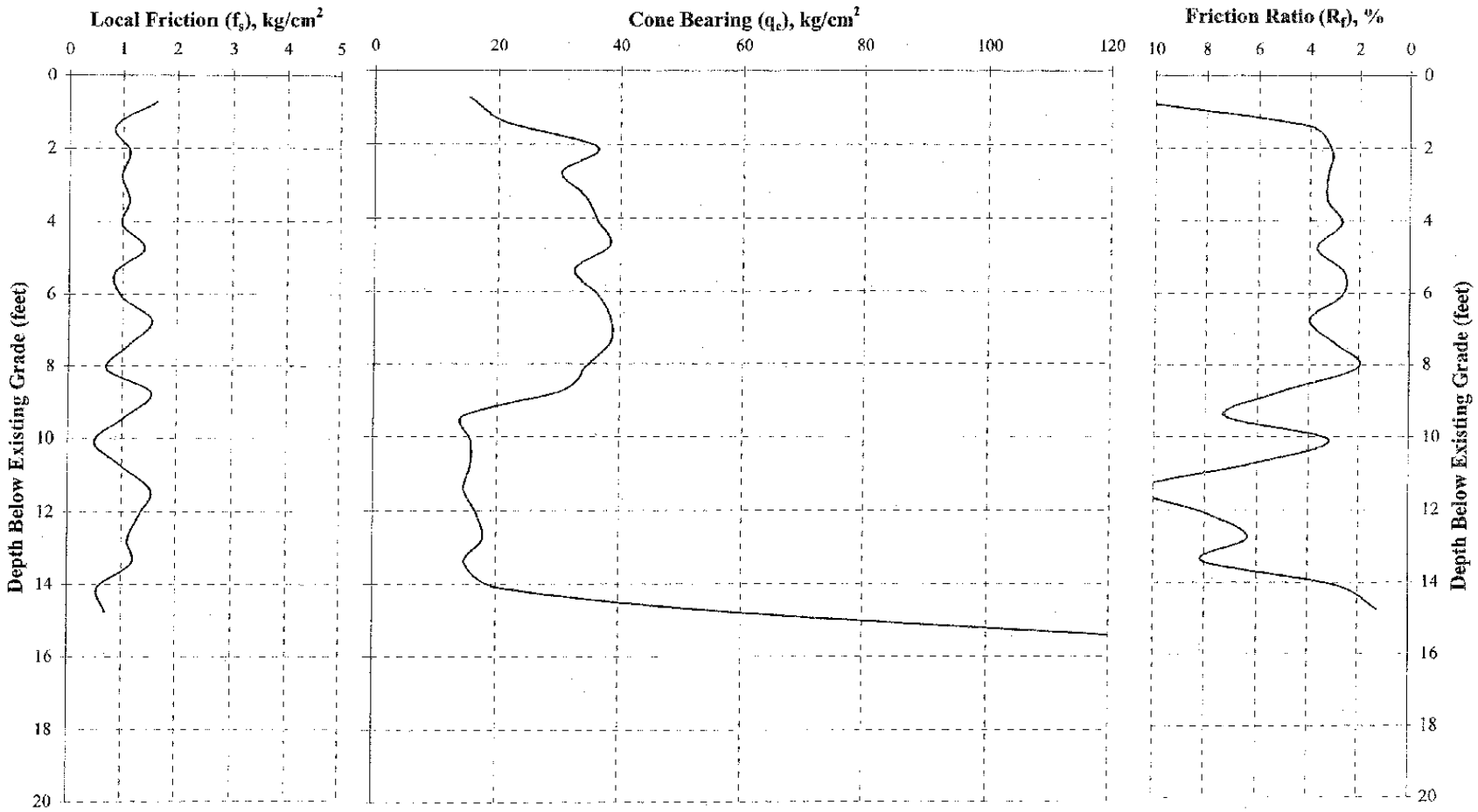


Figure B-1a

HWS
Solutions Through Service

LINCOLN OFFICE
825 "J" Street, P.O. Box 80358
Lincoln, NE 68501
(402) 479-2200 FAX (402) 479-2276

PENETRATION DIAGRAM OF DUTCH FRICTION-CONE PENETROMETER

PROJECT: **Preliminary Geotechnical Study**
Upper Southeast Salt Creek Sanitary Trunk Sewer

SOUNDING NO.: **S-2**
LOCATION: **B-2**
SURFACE ELEVATION: **1194.5 feet**

DATE: **May 7, 2004**
TESTED BY: **SP**
RECORDED BY: **MS**

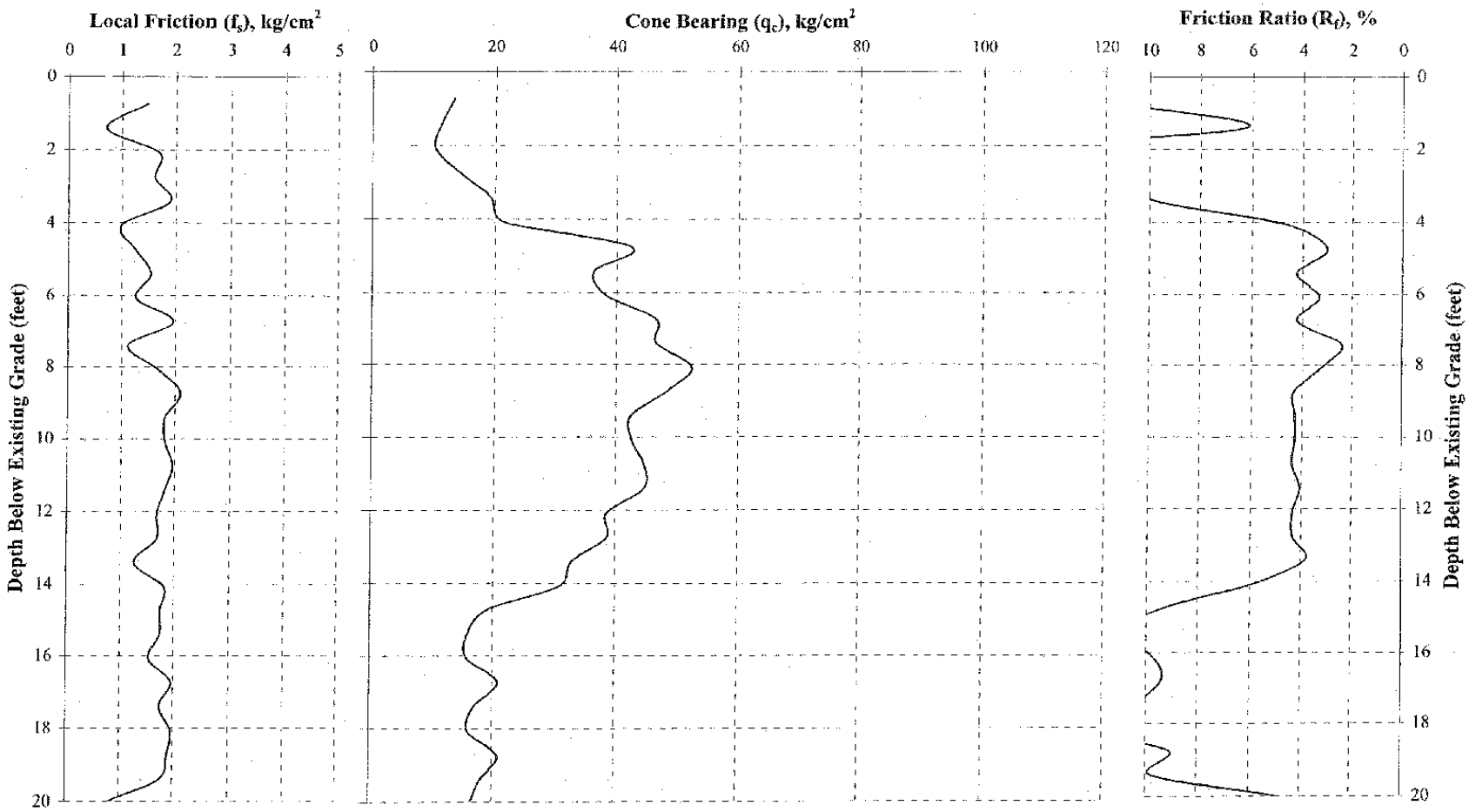


Figure B-2a

HWS
Solutions Through Service

LINCOLN OFFICE
825 "J" Street, P.O. Box 80358
Lincoln, NE 68501
(402) 479-2200 FAX (402) 479-2276

PENETRATION DIAGRAM OF DUTCH FRICTION-CONE PENETROMETER

PROJECT: **Preliminary Geotechnical Study**
Upper Southeast Salt Creek Sanitary Trunk Sewer

SOUNDING NO.: **S-2**
LOCATION: **B-2**
SURFACE ELEVATION: **1194.5 feet**

DATE: **May 7, 2004**
TESTED BY: **SP**
RECORDED BY: **MS**

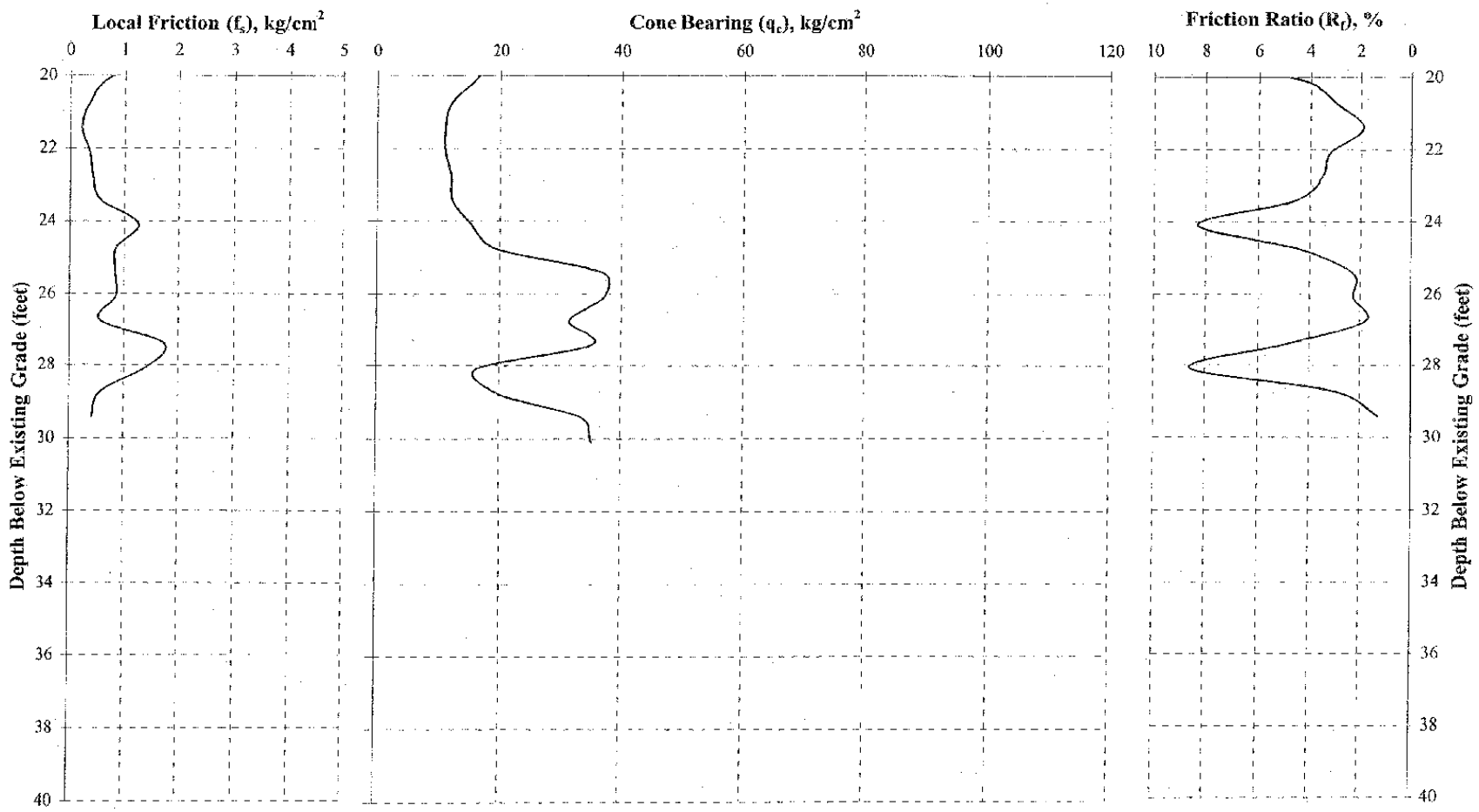


Figure B-2b

HWS
Solutions Through Service

LINCOLN OFFICE
825 "J" Street, P.O. Box 80358
Lincoln, NE 68501
(402) 479-2200 FAX (402) 479-2276

PENETRATION DIAGRAM OF DUTCH FRICTION-CONE PENETROMETER

PROJECT: **Preliminary Geotechnical Study**
Upper Southeast Salt Creek Sanitary Trunk Sewer

SOUNDING NO.: **S-4**
LOCATION: **B-4**
SURFACE ELEVATION: **1188.3** feet

DATE: **May 7, 2004**
TESTED BY: **SP**
RECORDED BY: **MS**

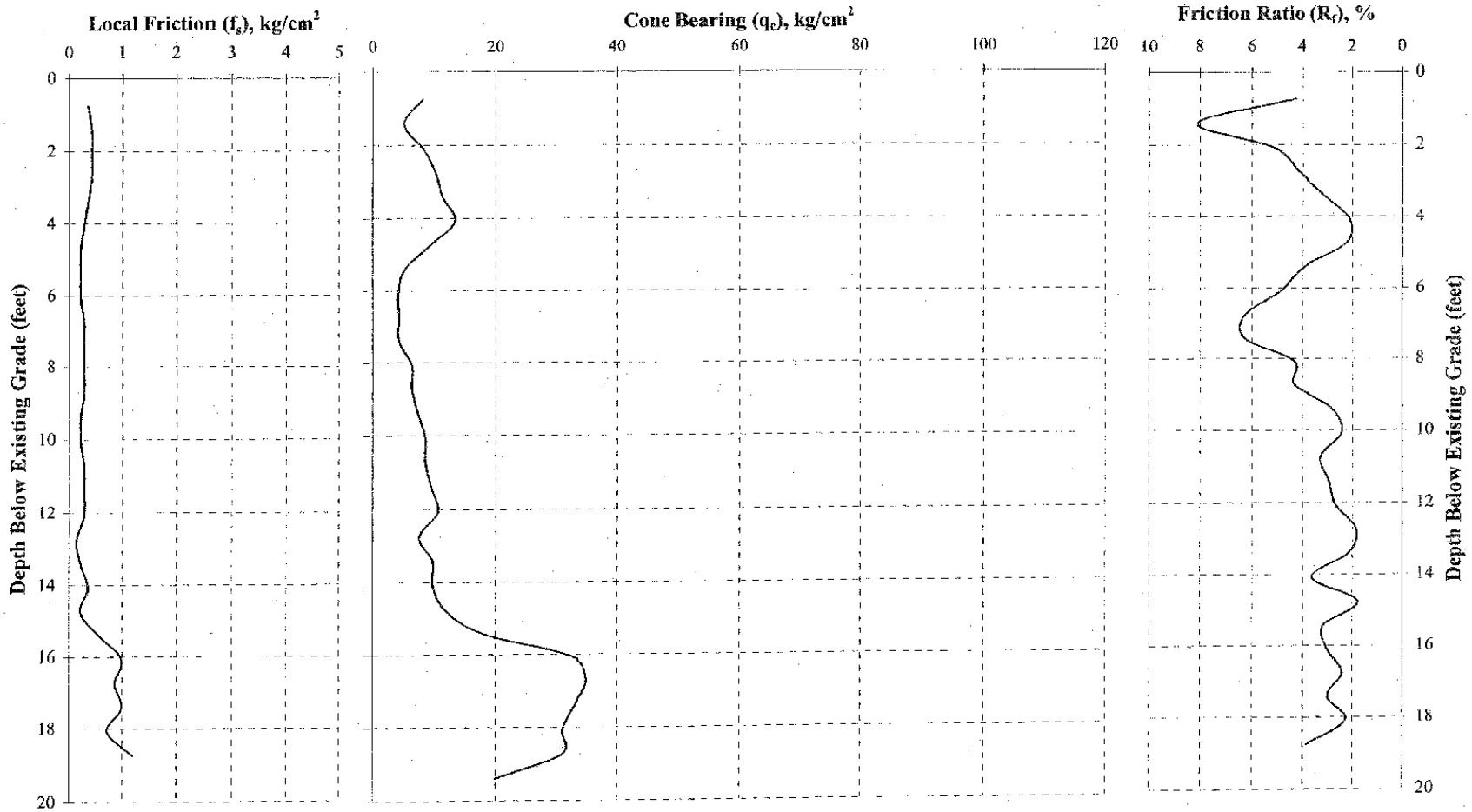


Figure B-4a

APPENDIX C.

BORING LOGS

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501

BORING LOG

PRELIMINARY GEOTECHNICAL STUDY
UPPER SOUTHEAST SALT CREEK SANITARY TRUNK SEWER
LINCOLN WASTEWATER SYSTEM
LINCOLN, NEBRASKA

Boring No. B-1
Sheet: 1 of 1
Date: 5-7-04

ELEV. ft.	DEPTH ft.	GROUP SYMBOL	SOIL DESCRIPTION	SPT	N	SAMPLE NO.	Dry Dens. pcf	MOIST %	DEPTH ft.
1177.1	0.0	CL	LEAN CLAY; medium plasticity; very dark gray; wet; stiff. (Alluvium)						0
1176.1	1.0	CH	FAT CLAY; high plasticity; very dark grayish brown mottled with very dark gray; wet; stiff. (Alluvium)						1
1175.6	1.5	CH	Same as above except very stiff. (Alluvium)						2
1174.6	2.5	CH	Same as above except dark grayish brown highly mottled with very dark gray and olive brown; with a trace of lime nodules. (Alluvium)						3
									4
			Groundwater was encountered at 5.2 feet at 5 hours after drilling..						5
1171.6	5.5	CH	FAT CLAY; high plasticity; very dark grayish brown slightly mottled with very dark gray; saturated; very stiff. (Alluvium)						6
									7
1169.1	8.0	CL	LEAN CLAY; medium plasticity; grayish brown slightly mottled with dark yellowish red and black; saturated; very stiff. (Alluvium)						8
1168.1	9.0	CL	Same as above except stiff. (Alluvium)						9
1167.1	10.0	CL	Same as above except dark grayish brown. (Alluvium)						10
									11
1165.6	11.5	CL/CH	LEAN TO FAT CLAY; medium to high plasticity; dark grayish brown heavily mottled with very dark grayish brown and dark yellowish red slightly mottled with black; saturated; stiff. (Alluvium)						12
1164.1	13.0	CL	LEAN CLAY; with silty sand seams; grayish brown heavily mottled with dark yellowish red; saturated; stiff. (Alluvium)						13
1163.6	13.5	CL	LEAN CLAY; 5-10% fine sand; grayish brown heavily mottled with dark yellowish red; saturated; stiff. (Alluvium)						14
1162.6	14.5	SM	SILTY SAND; 60-70% fine sand; 30-40% fines with low plasticity; light grayish brown heavily mottled with yellowish red; saturated; medium dense. (Alluvium)						15

Figure C-1

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501

BORING LOG

PRELIMINARY GEOTECHNICAL STUDY
UPPER SOUTHEAST SALT CREEK SANITARY TRUNK SEWER
LINCOLN WASTEWATER SYSTEM
LINCOLN, NEBRASKA

Boring No. B-2
Sheet: 1 of 2
Date: 5-7-04

ELEV. ft.	DEPTH ft.	GROUP SYMBOL	SOIL DESCRIPTION	SPT N	SAMPLE NO	Dry Dens. pcf	MOIST %	DEPTH ft.
1194.5	0.0	CL	LEAN CLAY; medium plasticity; black; wet; medium stiff. (Topsoil)					0
1193.2	1.3	CL	LEAN CLAY; medium plasticity; very dark grayish brown; wet; medium stiff. (Topsoil)					1
1192.3	2.2	CL	Same as above except stiff. (Topsoil)					2
1191.5	3.0	CH	FAT CLAY; high plasticity; very dark grayish brown slightly mottled with dark gray; wet; stiff. (Subsoil)					3
1190.5	4.0	CL	LEAN CLAY; medium plasticity; dark olive brown; wet; stiff. (Lower-Subsoil)					4
1189.5	5.0	CL	Same as above except very stiff. (Lower-Subsoil)					5
1189.0	5.5	CL	LEAN CLAY; trace of fine sand; medium plasticity; olive brown; wet; very stiff. (Peoria)					6
								7
								8
1185.5	9.0	CL	Same as above except grayish brown. (Peoria)					9
								10
								11
1182.5	12.0	CL	SANDY LEAN CLAY; 30-40% fine to medium sand; medium plasticity; grayish brown mottled with olive brown and yellowish red; wet; very stiff. (Peorian Alluvium)					12
1181.5	13.0	CL	LEAN CLAY; medium plasticity; olive brown mottled with dark grayish brown; wet; very stiff. (Peorian Alluvium)					13
1180.5	14.0	CL	Same as above except stiff. (Peorian Alluvium)					14
1179.5	15.0							15

Figure C-2a

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501

BORING LOG

PRELIMINARY GEOTECHNICAL STUDY
UPPER SOUTHEAST SALT CREEK SANITARY TRUNK SEWER
LINCOLN WASTEWATER SYSTEM
LINCOLN, NEBRASKA

Boring No. B-2
Sheet: 2 of 2
Date: 5-7-04

ELEV. ft.	DEPTH ft.	GROUP SYMBOL	SOIL DESCRIPTION	SPT	N	SAMPLE NO.	Dry Dens. pcf	MOIST %	DEPTH ft.
1179.5	15.0	CL	LEAN CLAY; trace of fine sand; medium plasticity; olive brown mottled with dark grayish brown; wet; stiff. (Peorian Alluvium)						15
									16
									17
1176.5	18.0	CL	LEAN CLAY; trace of fine sand; medium plasticity; dark grayish brown; wet; stiff. (Peorian Alluvium)						18
									19
1174.5	20.0	CL	Same as above except medium stiff. (Peorian Alluvium)						20
									21
1172.5	22.0	CL	Same as above except with silt seams. (Peorian Alluvium)						22
1172.0	22.5	CL/CH	LEAN TO FAT CLAY; medium to high plasticity; very dark grayish brown mottled with dark grayish brown; wet; medium stiff. (Peorian Alluvium)						23
1170.5	24.0	CH	FAT CLAY; high plasticity; dark grayish brown mottled with grayish brown and yellowish red and black; saturated; stiff. (Peorian Alluvium)						24
									25
1169.0	25.5	CH	FAT CLAY; high plasticity; grayish brown heavily mottled with yellowish red and black and light gray; saturated; very stiff. (Peorian Alluvium)						26
									27
1166.5	28.0	CL	LEAN CLAY; medium plasticity; grayish brown mottled with yellowish red and black and light gray; saturated; stiff. (Peorian Alluvium)						28
									29
1164.5	30.0								30

Groundwater was encountered at 21.8 feet at 3 hours after drilling.

Figure C-2b

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501

BORING LOG

PRELIMINARY GEOTECHNICAL STUDY
UPPER SOUTHEAST SALT CREEK SANITARY TRUNK SEWER
LINCOLN WASTEWATER SYSTEM
LINCOLN, NEBRASKA

Boring No. B-3a
Sheet: 1 of 1
Date: 5-7-04

ELEV. ft.	DEPTH ft.	GROUP SYMBOL	SOIL DESCRIPTION	SPT	N	SAMPLE NO.	Dry Dens. pcf	MOIST %	DEPTH ft.
1197.5	0.0	CL	LEAN CLAY WITH SAND; 20-25% fine sand; medium plasticity; very dark brown; wet; stiff. (Topsoil)						0
1196.5	1.0	CL	LEAN CLAY; 10-15% fine sand; medium plasticity; very dark grayish brown; wet; stiff. (Subsoil)						1
1195.8	1.7	CL	LEAN CLAY WITH SAND; 25-30% fine sand; medium plasticity; dark yellowish brown; wet; stiff. (Colluvium)						2
									3
1194.0	3.5	CL	LEAN CLAY; trace of fine sand; medium plasticity; yellowish brown; wet; stiff. (Peoria)						4
1193.4	4.1	CL	LEAN CLAY; medium plasticity; light olive brown; moist; hard. (Peoria)						5
1191.5	6.0	CL	SANDY LEAN CLAY; 40-50% fine to coarse sand with trace of gravel; medium plasticity; black; moist; stiff. (Peorian Alluvium)						6
1191.1	6.4	SM	SILTY SAND; 70-80% fine to medium sand; 20-30% fines with low plasticity; strong brown; moist; loose to medium dense. (Peorian Alluvium)						7
1190.2	7.3		Soil probe refusal on assumed Dakota Sandstone.						8
									9
									10
									11
									12
									13
									14
									15

Figure C-3a

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501

BORING LOG

PRELIMINARY GEOTECHNICAL STUDY
UPPER SOUTHEAST SALT CREEK SANITARY TRUNK SEWER
LINCOLN WASTEWATER SYSTEM
LINCOLN, NEBRASKA

Boring No. B-3b
Sheet: 1 of 1
Date: 5-7-04

ELEV. ft.	DEPTH ft.	GROUP SYMBOL	SOIL DESCRIPTION	SPT	N	SAMPLE NO.	Dry Dens. pcf	MOIST %	DEPTH ft.
1194.4	0.0	SM	SILTY SAND; 50-60% fine to coarse sand; 40-50% fines with low plasticity; dark yellowish brown; wet; loose. (Modern Alluvium)						0
1193.5	0.9	CL	LEAN CLAY; medium plasticity; grayish brown; wet; stiff. (Peoria)						1
									2
1191.4	3.0	CL	Same as above except soft. (Peoria)						3
									4
1189.8	4.6	CL	LEAN CLAY; medium plasticity; dark grayish brown; wet; stiff. (Peorian Alluvium)						5
1188.4	6.0	CL	Same as above except with 5-15% fine sand. (Peorian Alluvium)						6
1187.4	7.0	SC	CLAYEY SAND; 50-60% fine to medium sand; 40-50% fines with medium plasticity; dark yellowish brown; wet; medium dense. (Peorian Alluvium)						7
1186.8	7.6		Soil probe refusal on assumed Dakota Sandstone.						8
									9
									10
									11
									12
									13
									14
									15

Figure C-3b

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501

BORING LOG

PRELIMINARY GEOTECHNICAL STUDY
UPPER SOUTHEAST SALT CREEK SANITARY TRUNK SEWER
LINCOLN WASTEWATER SYSTEM
LINCOLN, NEBRASKA

Boring No. B-4
Sheet: 1 of 1
Date: 5-7-04

ELEV. ft.	DEPTH ft.	GROUP SYMBOL	SOIL DESCRIPTION	SPT N	SAMPLE NO.	Dry Dens. pcf	MOIST %	DEPTH ft.
1188.3	0.0	CL	LEAN CLAY; medium plasticity; black; wet; medium stiff. (Topsoil)					0
1187.1	1.2	CL	LEAN CLAY; medium plasticity; very dark grayish brown; wet; medium stiff. (Alluvium)					1
1186.0	2.3	CL	Same as above except with silt seams. (Alluvium)					2
								3
								4
								5
1182.3	6.0	CL	LEAN CLAY; 5-10% fine sand; medium plasticity; very dark gray; wet; medium stiff. (Alluvium)					6
								7
								8
1179.9	8.4	CL	Same as above except saturated. (Alluvium)	Groundwater was encountered at 8.4 feet after drilling.				
1179.3	9.0	CL	LEAN CLAY; 10-15% fine sand; medium plasticity; very dark gray; wet; medium stiff. (Alluvium)					9
								10
1177.3	11.0	CL	LEAN CLAY; with silt seams; medium plasticity; very dark gray; saturated; medium stiff. (Alluvium)					11
								12
								13
1174.3	14.0	CH	FAT CLAY; high plasticity; very dark gray slightly mottled with dark grayish brown; saturated; stiff. (Alluvium)					14
1173.3	15.0							15

Figure C-4

APPENDIX D.

CRITERIA USED FOR VISUAL SOIL CLASSIFICATION

TABLE D-1

Soil Classification Chart					
Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]			Group	Soil Classification: Group Symbol	Soil Classification: Group Name[B]
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]	GW	Well-graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3$[E]	GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]	SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 \geq Cc \geq 3$[E]	SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines classify as CL or CH	SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI>7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI<4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OL	Organic clay[K,L,M] Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OH	Organic clay[K,L,M,P] Organic silt[K,L,M,Q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor		PT	Peat	

[A] Based on the material passing the 3-in. (77-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded with silt
GP-GC poorly graded gravel with clay
[D] Sands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains $\geq$15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
[H] If fines are organic, add "with organic fines' to group name.
[I] If soil contains $\geq$ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.
[L] If soil contains $\geq$30% plus No. 200, predominantly sand, add "sandy" to group name.
[M] If soil contains $\geq$30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI $\geq$4 and plots on or above "A" line.
[O] PI <4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.

TABLE D-2

CRITERIA FOR DESCRIBING MOISTURE CONDITION OF CLAY SOIL	
Description	**Criteria**
Dry	Absence of moisture, dusty, dry to the touch.
Moist	Damp, slightly wet, moisture content below plastic limit.
Wet	Moisture content above the plastic limit.
Saturated	Very wet. Usually soil is below water table.

TABLE D-3

CRITERIA FOR DESCRIBING MOISTURE CONDITION OF GRANULAR SOIL	
Description	**Criteria**
Dry	Absence of moisture, dry to the touch.
Moist	Damp but no visible free water.
Wet	Visible free water.
Saturated	Usually soil is below water table.

TABLE D-4

CRITERIA FOR DESCRIBING CONSISTENCY OF CLAY SOIL	
Density	**Penetration Resistance, N Blows per 12 in.**
Very Soft	Less Than 2
Soft	2-4
Medium	4-8
Stiff	8-15
Very Stiff	15-30
Hard	Greater Than 30

TABLE D-5

CRITERIA FOR DESCRIBING DENSITY OF COARSE-GRAINED SOIL	
Density	**Penetration Resistance, N Blows per 12 in.**
Loose	Less Than 10
Medium	10-30
Dense	30-50
Very Dense	Greater Than 50

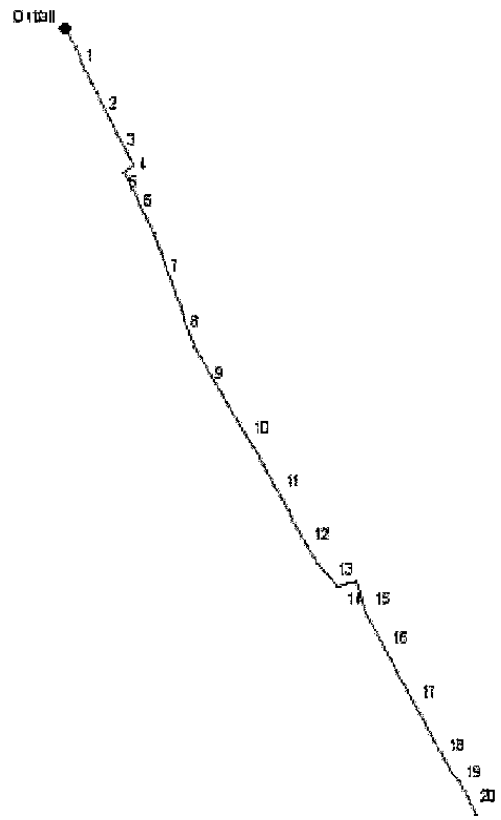
TABLE D-6

CRITERIA FOR DESCRIBING STRENGTH OF ROCK	
Description	**Criteria**
Very soft	Permits denting by moderate pressure of the fingers.
Soft	Resists denting by the fingers, but can be abraded and pierced to a shallow depth by a pencil point.
Moderately soft	Resists a pencil point, but can be scratched and cut with a knife blade.
Moderately hard	Resistant to abrasion or cutting by a knife blade, but can be easily dented or broken by light blows of a hammer.
Hard	Can be deformed or broken by repeated moderate hammer blows.
Very hard	Can be broken only by heavy, and in some rocks, repeated hammer blows.

APPENDIX C

Pipe Capacity and HGL Calculations

Hydraflow Plan View



Project file: 48 inch-Tier 2.stm	No. Lines: 20	08-30-2004

Sewer Summary Report

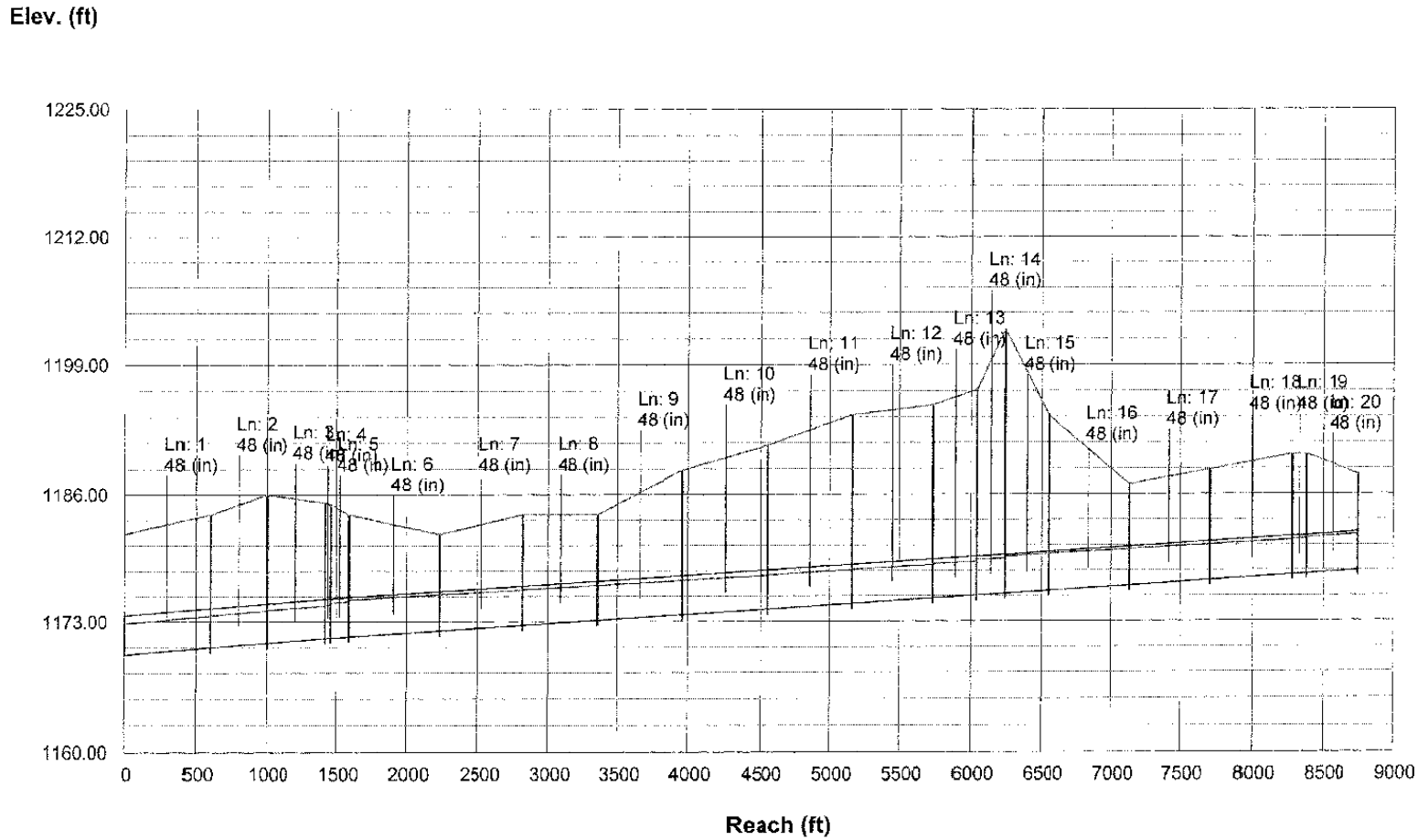
Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	Dns line No.
1	MH40-MH39	50.10	48 c	600.0	1169.64	1170.36	0.120	1172.83	1173.60	0.05	End
2	MH39-MH38	49.60	48 c	400.0	1170.36	1170.84	0.120	1173.65	1174.12	0.05	1
3	MH38-MH37	49.60	48 c	418.0	1170.84	1171.34	0.120	1174.17	1174.65	0.05	2
4	MH37-P1	43.20	48 c	40.0	1171.34	1171.38	0.100	1174.70	1174.73	0.23	3
5	P1-P2	43.20	48 c	130.0	1171.38	1171.50	0.092	1174.96	1175.06	0.21	4
6	P2-P3	43.20	48 c	640.0	1171.50	1172.10	0.094	1175.27	1175.76	0.03	5
7	P3-P4	43.20	48 c	590.0	1172.10	1172.65	0.093	1175.79	1176.25	0.03	6
8	P4-P5	43.20	48 c	540.0	1172.65	1173.15	0.093	1176.28	1176.71	0.03	7
9	P5-P6	43.20	48 c	600.0	1173.15	1173.71	0.093	1176.74	1177.22	0.03	8
10	P6-P7	43.20	48 c	600.0	1173.70	1174.26	0.093	1177.25	1177.73	0.03	9
11	P7-P8	43.20	48 c	600.0	1174.26	1174.82	0.093	1177.76	1178.26	0.03	10
12	P8-P9	43.20	48 c	580.0	1174.82	1175.36	0.093	1178.29	1178.77	0.10	11
13	P9-P10	43.20	48 c	300.0	1175.36	1175.64	0.093	1178.87	1179.11	0.18	12
14	P10-P11	43.20	48 c	200.0	1175.64	1175.83	0.095	1179.30	1179.45	0.20	13
15	P11-P12	43.20	48 c	310.0	1175.83	1176.12	0.094	1179.66	1179.90	0.03	14
16	P12-P13	43.20	48 c	580.0	1176.12	1176.66	0.093	1179.92	1180.37	0.03	15
17	P13-P14	43.20	48 c	580.0	1176.66	1177.20	0.093	1180.40	1180.85	0.03	16
18	P14-P15	43.20	48 c	570.0	1177.20	1177.73	0.093	1180.88	1181.32	0.09	17
19	P15-P16	43.20	48 c	100.0	1177.73	1177.82	0.090	1181.42	1181.49	0.09	18
20	P16-P17	43.20	48 c	370.0	1177.82	1178.16	0.092	1181.58	1181.87	0.20	19

Project File: 48 inch-Tier 2.stm | Number of lines: 20 | Run Date: 08-30-2004

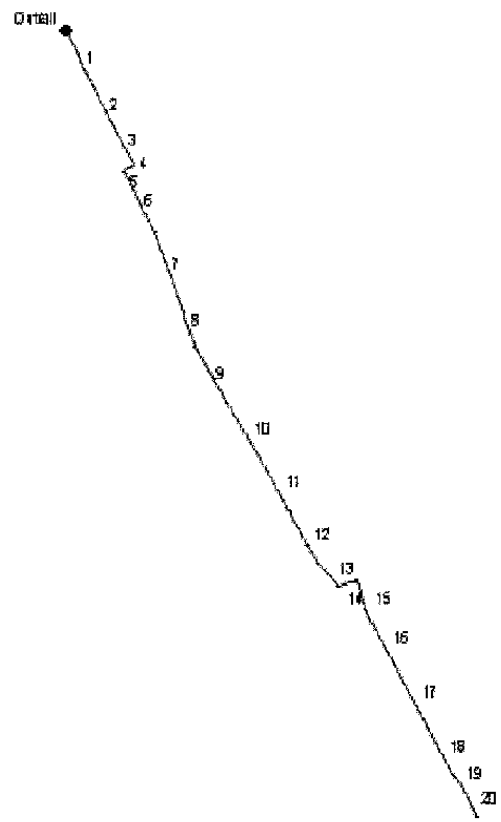
NOTES: c = circular; e = elliptical; b = box; Return period = 100 Yrs.; * Indicates surcharge condition.

Sewer Profile

Proj. file: 48 inch-Tier 2.stm



Hydraflow Plan View



Project file: 48 inch-Total Ridgeline.stm	No. Lines: 20	08-30-2004

Sewer Summary Report

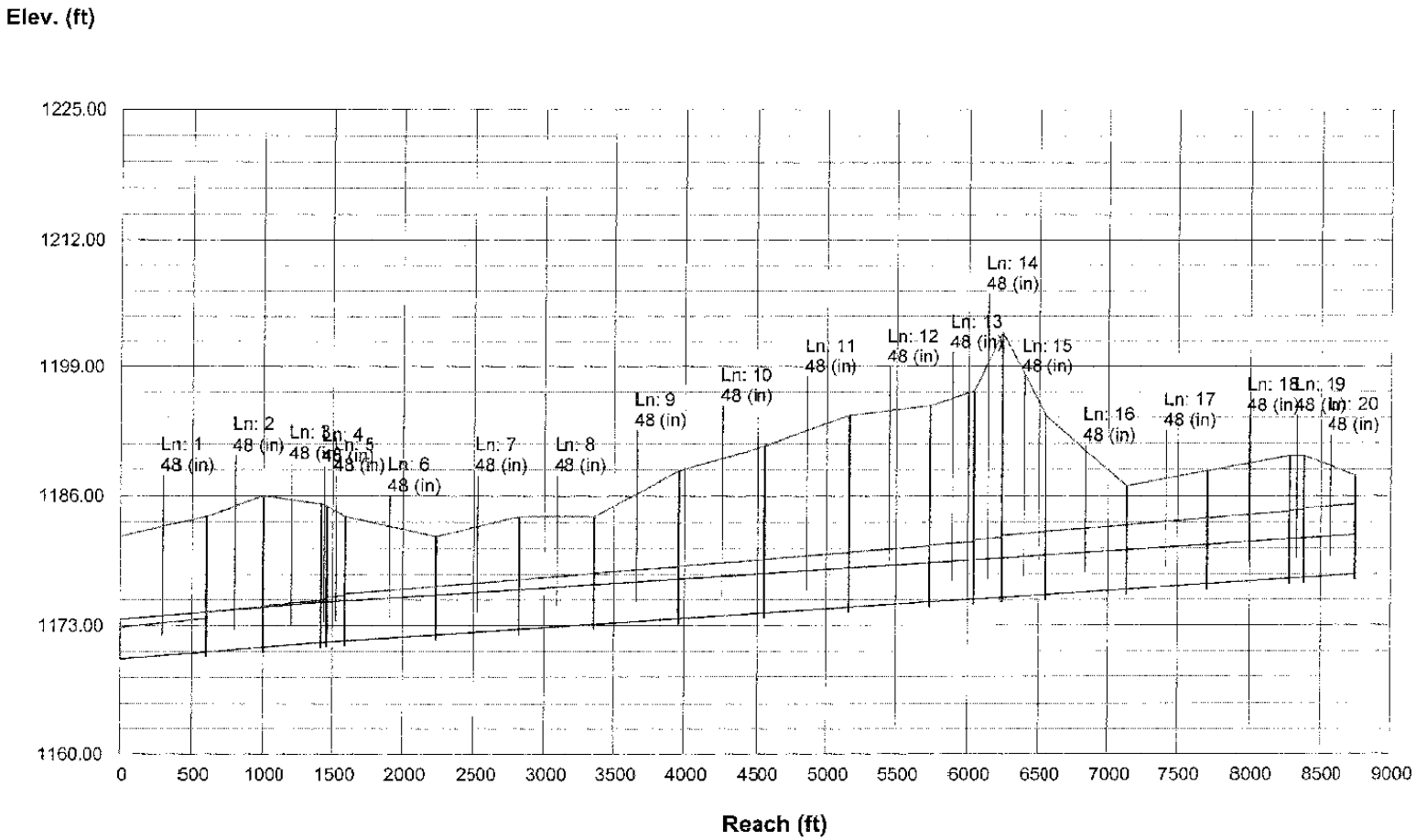
Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	Dns line No.
1	MH40-MH39	54.70	48 c	600.0	1169.64	1170.36	0.120	1172.83	1173.74	0.05	End
2	MH39-MH38	54.20	48 c	400.0	1170.36	1170.84	0.120	1174.36*	1174.93*	0.04	1
3	MH38-MH37	54.20	48 c	418.0	1170.84	1171.34	0.120	1174.97*	1175.57*	0.04	2
4	MH37-P1	47.80	48 c	40.0	1171.34	1171.38	0.100	1175.61*	1175.66*	0.22	3
5	P1-P2	47.80	48 c	130.0	1171.38	1171.50	0.092	1175.88*	1176.03*	0.22	4
6	P2-P3	47.80	48 c	640.0	1171.50	1172.10	0.094	1176.25*	1176.96*	0.03	5
7	P3-P4	47.80	48 c	590.0	1172.10	1172.65	0.093	1176.99*	1177.65*	0.03	6
8	P4-P5	47.80	48 c	540.0	1172.65	1173.15	0.093	1177.68*	1178.28*	0.03	7
9	P5-P6	47.80	48 c	600.0	1173.15	1173.71	0.093	1178.31*	1178.98*	0.03	8
10	P6-P7	47.80	48 c	600.0	1173.70	1174.26	0.093	1179.01*	1179.68*	0.03	9
11	P7-P8	47.80	48 c	600.0	1174.26	1174.82	0.093	1179.71*	1180.37*	0.03	10
12	P8-P9	47.80	48 c	580.0	1174.82	1175.36	0.093	1180.41*	1181.05*	0.10	11
13	P9-P10	47.80	48 c	300.0	1175.36	1175.64	0.093	1181.15*	1181.48*	0.19	12
14	P10-P11	47.80	48 c	200.0	1175.64	1175.83	0.095	1181.67*	1181.90*	0.22	13
15	P11-P12	47.80	48 c	310.0	1175.83	1176.12	0.094	1182.12*	1182.46*	0.03	14
16	P12-P13	47.80	48 c	580.0	1176.12	1176.66	0.093	1182.50*	1183.14*	0.03	15
17	P13-P14	47.80	48 c	580.0	1176.66	1177.20	0.093	1183.17*	1183.82*	0.03	16
18	P14-P15	47.80	48 c	570.0	1177.20	1177.73	0.093	1183.85*	1184.48*	0.10	17
19	P15-P16	47.80	48 c	100.0	1177.73	1177.82	0.090	1184.58*	1184.69*	0.10	18
20	P16-P17	47.80	48 c	370.0	1177.82	1178.16	0.092	1184.80*	1185.20*	0.22	19

Project File: 48 inch-Total Ridgeline.stm | Number of lines: 20 | Run Date: 08-30-2004

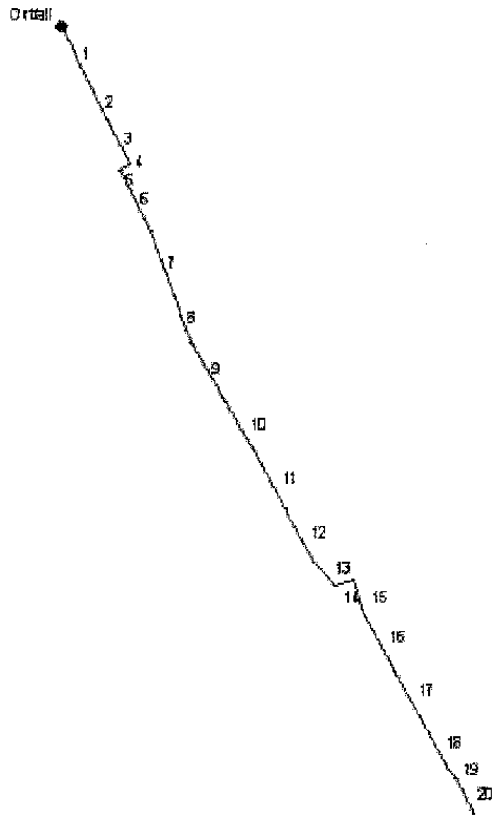
NOTES: c = circular; e = elliptical; b = box; Return period = 100 Yrs.; * Indicates surcharge condition.

Sewer Profile

Proj. file: 48 inch-Total Ridgeline.stm



Hydraflow Plan View



Project file: 54 inch-Total Ridgeline.stm | No. Lines: 20 | 08-30-2004

Sewer Summary Report

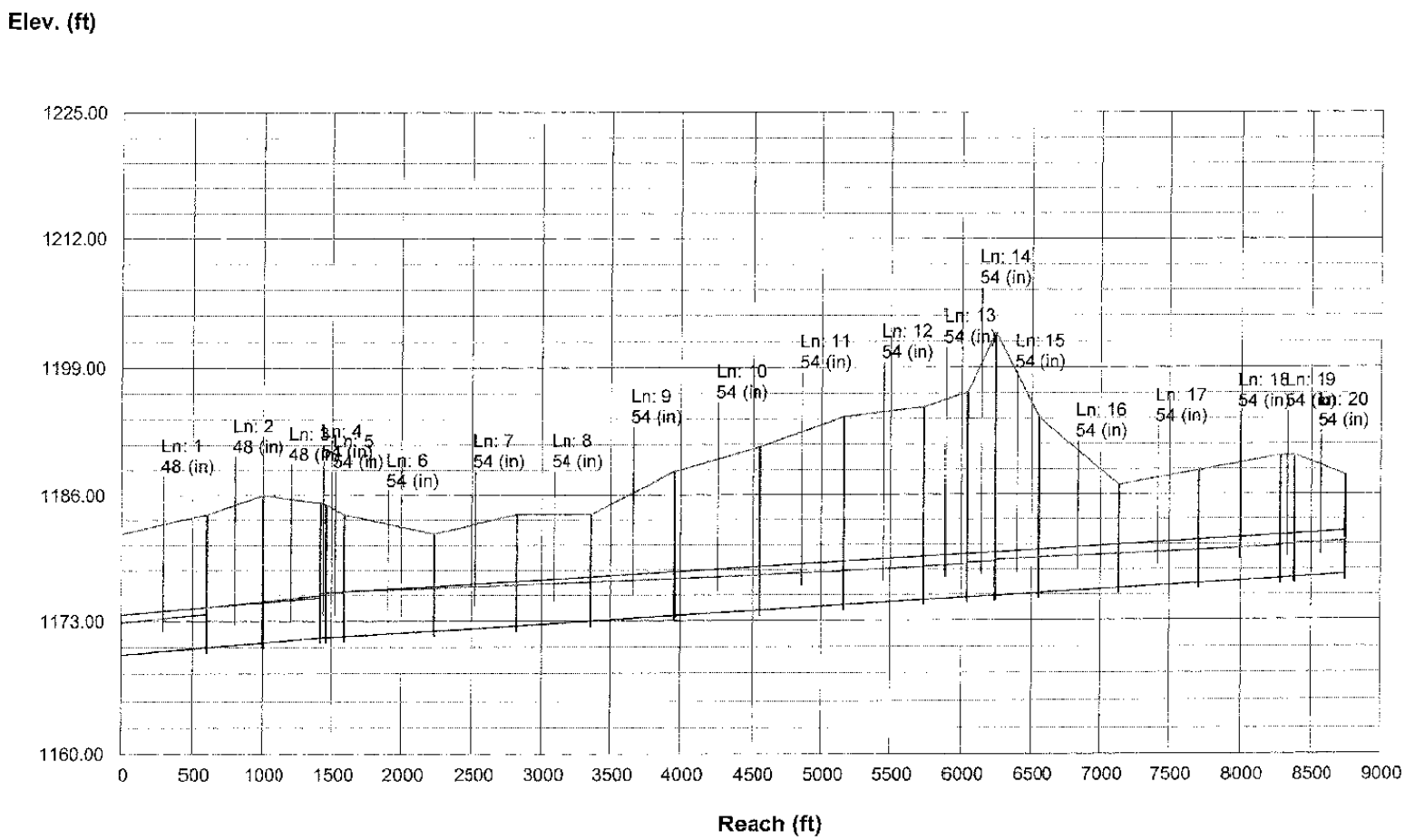
Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	Dns line No.
1	MH40-MH39	54.70	48 c	600.0	1169.64	1170.36	0.120	1172.83	1173.74	0.05	End
2	MH39-MH38	54.20	48 c	400.0	1170.36	1170.84	0.120	1174.36*	1174.93*	0.04	1
3	MH38-MH37	54.20	48 c	418.0	1170.84	1171.34	0.120	1174.97*	1175.57*	0.04	2
4	MH37-P1	47.80	54 c	40.0	1171.34	1171.37	0.075	1175.61	1175.63	0.15	3
5	P1-P2	47.80	54 c	130.0	1171.37	1171.48	0.085	1175.78	1175.84	0.14	4
6	P2-P3	47.80	54 c	640.0	1171.48	1172.03	0.086	1175.99	1176.34	0.02	5
7	P3-P4	47.80	54 c	590.0	1172.03	1172.54	0.086	1176.36	1176.65	0.02	6
8	P4-P5	47.80	54 c	540.0	1172.54	1173.00	0.085	1176.68	1176.95	0.02	7
9	P5-P6	47.80	54 c	600.0	1173.00	1173.52	0.087	1176.97	1177.29	0.03	8
10	P6-P7	47.80	54 c	600.0	1173.52	1174.04	0.087	1177.32	1177.65	0.03	9
11	P7-P8	47.80	54 c	600.0	1174.04	1174.56	0.087	1177.68	1178.05	0.03	10
12	P8-P9	47.80	54 c	580.0	1174.56	1175.06	0.086	1178.08	1178.45	0.10	11
13	P9-P10	47.80	54 c	300.0	1175.06	1175.32	0.087	1178.55	1178.74	0.18	12
14	P10-P11	47.80	54 c	200.0	1175.32	1175.49	0.085	1178.92	1179.04	0.20	13
15	P11-P12	47.80	54 c	310.0	1175.49	1175.76	0.087	1179.24	1179.41	0.03	14
16	P12-P13	47.80	54 c	580.0	1175.76	1176.26	0.086	1179.44	1179.78	0.03	15
17	P13-P14	47.80	54 c	580.0	1176.26	1176.76	0.086	1179.81	1180.18	0.03	16
18	P14-P15	47.80	54 c	570.0	1176.76	1177.25	0.086	1180.21	1180.60	0.10	17
19	P15-P16	47.80	54 c	100.0	1177.25	1177.34	0.090	1180.70	1180.77	0.09	18
20	P16-P17	47.80	54 c	370.0	1177.34	1177.66	0.087	1180.86	1181.10	0.21	19

Project File: 54 inch-Total Ridgeline.stm Number of lines: 20 Run Date: 08-30-2004

NOTES: c = circular; e = elliptical; b = box; Return period = 100 Yrs.; * Indicates surcharge condition.

Sewer Profile

Proj. file: 54 inch-Total Ridgeline.stm



APPENDIX D

Public Involvement Process

City of Lincoln
Public Works/Utilities Dept
555 S. 10th Street, Suite 203
Lincoln, NE 68508
402-441-7588

EA Engineering, Science, and Technology
121 South 13th St., Suite 204
Lincoln, NE 68508
402-476-3766

Upper Southeast Salt Creek Trunk Sewer Open House
March 4, 2004

AGENDA

7:00 Welcome/Introductions

Project Background/History – Steve Masters, Public Works/Utilities

Alternative Routes – Dale Schlautman, EA Engineering

Small Group Discussions –

- Habitat Characteristics
- Park Restoration
- Construction Phase

General Session, Summary

Adjourn

The City of Lincoln Public Works/Utilities Department and EA Engineering would like to thank you for coming tonight and participating in the open house. We hope the information you received tonight has been helpful in understanding the project.

Please fill out comment cards with suggestions or concerns that you have. You may also direct questions to Dale Schlautman or Holly Lionberger at EA Engineering (476-3766).

City of Lincoln
Public Works/Utilities Dept
555 S. 10th Street, Suite 203
Lincoln, NE 68508
402-441-7588

EA Engineering, Science, and Technology
121 South 13th St., Suite 204
Lincoln, NE 68508
402-476-3766

Upper Southeast Salt Creek Trunk Sewer

What:	**Informational Open House**
Where:	**Scott Middle School Multi-Purpose Room**
	2200 Pine Lake Road (parking and entrance on north side)
When:	**Thursday, March 4, 2004, 7:00-9:00 p.m.**

Trunk Sewer Project

The City of Lincoln recently initiated a Preliminary Routing/Corridor Study to assess potential trunk sewer alignments to serve citizens in Southwest Lincoln as the City continues to grow. EA Engineering, Science, & Technology is working with the City on this project. Various alternate routes have been evaluated and a preliminary route has been proposed. A portion of the proposed route passes through the eastern edge of Wilderness Park. (See map below).

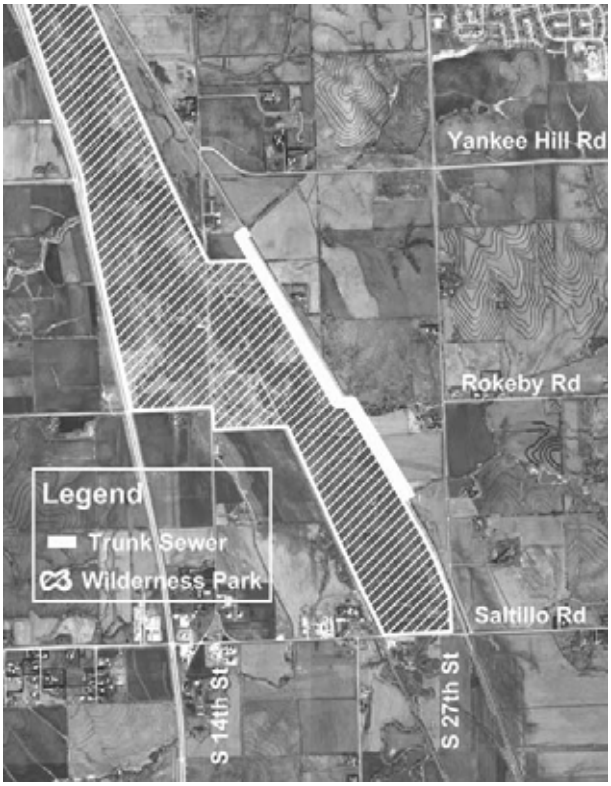
The Lincoln Public Works/Utilities Department is seeking input from interested parties regarding the proposed route. The open house will present an overview of the project and provide an opportunity for individuals to express their ideas and concerns. The input collected during this open house will be used to develop variations for improving the proposed route.

You can help develop the best design solution by:

- Attending the Open House
- Identifying key issues regarding the proposed route
- Sharing ideas for Park restoration

Please Call With Questions

If you have questions regarding this project, you may call Dale Schlautman or Holly Lionberger with EA Engineering at 476-3766. We look forward to working with you in the development of this community project.



Project Site Map
Southwest Lincoln

City of Lincoln
Public Works/Utilities Dept
555 S. 10th Street, Suite 203
Lincoln, NE 68508
402-441-7588

EA Engineering, Science, and Technology
121 South 13th St., Suite 204
Lincoln, NE 68508
402-476-3766

Preliminary Routing/Corridor Study and Design of Upper Southeast Salt Creek Trunk Sewer for the Lincoln Wastewater System

Introduction:

The City of Lincoln has initiated a Preliminary Routing/Corridor Study to assess potential trunk sewer alignments to serve citizens in Southwest Lincoln as the community continues to grow. EA Engineering, Science, & Technology (EA) is working with the City on this project. Various alternate routes have been evaluated and a preliminary route has been proposed as the best choice alternative. A portion of this proposed route passes through the eastern edge of Wilderness Park. (See Evaluated Alternate Routes figure below). The purpose of this open house is to present the reasons for selecting the best choice alternative and to gain input from the public on refinements to the route to the best possible advantage of Wilderness Park. Specific topics for discussion include the current habitat characteristics of the Park, the potential for Park restoration, and the construction phase of the project.

A second open house will be held on Thursday, March 25, 2004 from 7:00-9:00 p.m. at the Scott Middle School Multi-Purpose Room, 2200 Pine Lake Road to present the information gained from tonight's public meeting.

Dark Blue (Proposed Route) – gravity sewer line, open cut through Wilderness Park.

- The trunk sewer will pass through a section of Wilderness Park that was formerly agricultural fields, currently overgrown with brome grass and scrub trees.
- After construction, the affected area could be returned to natural prairie grass and wildflowers.
- A diagonal bore under the RR at the upstream end could be used to avoid old growth trees and a Salt Creek oxbow.
- There is potential for tunneling under portions of Wilderness Park where sensitive areas are identified.

Other Alternative Routes Evaluated:

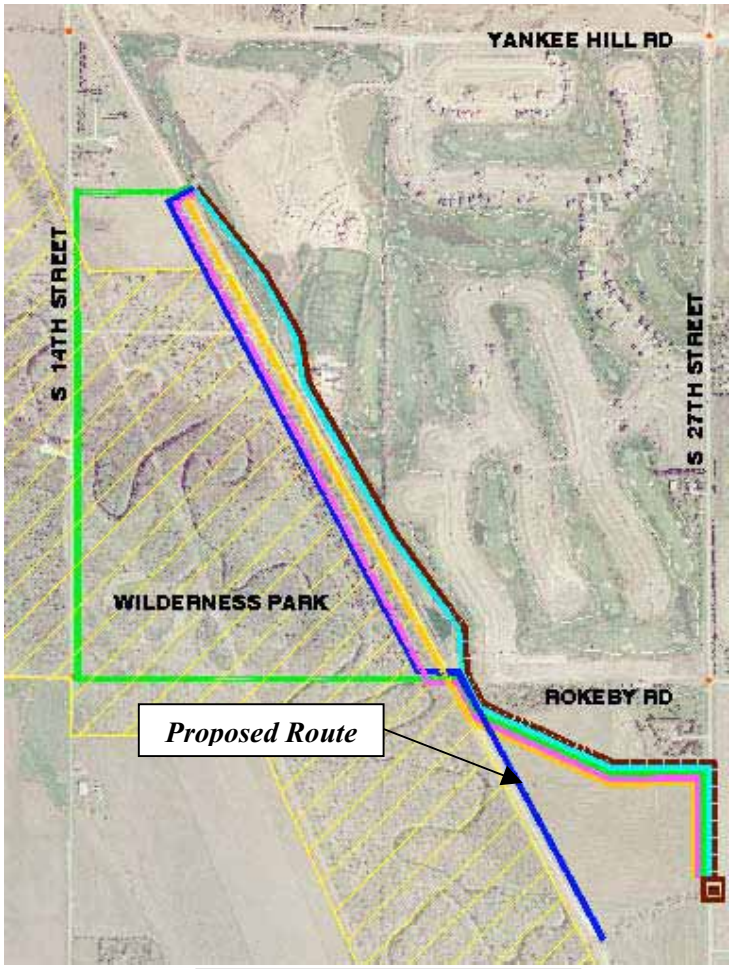
Brown – 20,000 gpm pumping station
- 30-inch force main, open cut
- 42-inch gravity sewer, open cut
- passes through Dakota Sandstone, and requires operation and maintenance on the pumping station

Light Blue – 48-inch gravity sewer, open cut
- requires deep cuts through Dakota Sandstone

Orange – 48-inch gravity sewer, open cut
-48-inch gravity sewer, tunnel in RR ROW
- construction in RR ROW

Purple – 48-inch gravity sewer, open cut
- 48-inch gravity sewer, tunnel in Wilderness Park

Green – 66-inch gravity sewer, 3 siphons, open cut
- passes through rare bird habitat



Evaluated Alternate Routes

Please Call With Questions

If you have questions regarding this project, please call Dale Schlautman or Holly Lionberger with EA Engineering at 476-3766. We look forward to working with you in the development of this community project.

Frequently Asked Questions

Engineering Related Questions:

Why do we need a sewer in this area?

New developments are continually being built in Lincoln to accommodate our increasing population. As these areas are constructed, utility services will need to be made available. For this project, the City of Lincoln anticipates that by the year 2025, the City will have expanded to cover the area east of Wilderness Park from Yankee Hill Road to Saltillo Road and from 27th Street to 70th Street. By year 2050, the City of Lincoln anticipates that this area will be expand to include the land, from Saltillo Road to Wittstruck Road and from 27th Street to 84th Street.

What is open-cut trenching?

Open-cut trenching is the most common method of underground utility construction. Open-cut trenching involves digging a ditch in the ground, called a trench. The dirt that is dug out is placed on one side of the trench, and the pipe is set on the other side. The contractor lowers the pipe into the open trench and covers it up with the soil that was dug out. In general, open-cut trenching is significantly less expensive than other methods of utility construction.

How are utilities installed by boring?

Boring is a method of installing underground utilities with minimal disturbance of the ground surface. Borings are commonly used to install utilities beneath existing railroads and roadways. A hole, or bore pit, is dug out at opposite ends of where the pipe is to be placed. Equipment is then used to horizontally drill a tunnel between the two pits, and pipe segments are either pushed or pulled into the tunnel. Boring is usually much more expensive than open cut.

What is the difference between a gravity sewer and a pressure sewer?

A gravity sewer takes advantage of the natural tendency of water to flow to the lowest point possible. All the pipes in a gravity sewer system are positioned, so that water will flow from the high end to the low end by the force of gravity.

The other common type of sewer is a pressurized system. In a pressure system, energy is used to pump against gravity, moving water from a low point to a high point. This method can be very expensive, due to construction, operation, and maintenance costs, and is generally avoided if a gravity sewer is possible.

Habitat Related Questions:

What are old fields?

The old field areas of Wilderness Park, are portions of the Park that were once used for farming activities. Some of these areas have been reseeded with grass (smooth brome) and are undergoing a natural sequence of habitat changes. Currently invasive tree species such as Siberian elm, Green ash, Honey locust and Red cedars are rapidly overgrowing some of these grass areas.

What is the potential for Park restoration post-construction?

Plans are not firm yet, but this is a great opportunity for the Park. Reestablishment of native grasses and forbs would be appropriate in many areas.

Please Call With Questions

If you have questions regarding this project, please call Dale Schlautman or Holly Lionberger with EA Engineering at 476-3766. We look forward to working with you in the development of this community project.

City of Lincoln
Public Works/Utilities Dept
555 S. 10th Street, Suite 203
Lincoln, NE 68508
402-441-7588

EA Engineering, Science, and Technology
121 South 13th St., Suite 204
Lincoln, NE 68508
402-476-3766

Upper Southeast Salt Creek Trunk Sewer Open House March 25, 2004

AGENDA

7:00 Welcome/Introductions

Overview of Previous Meeting – Holly Lionberger, EA

Preferred Route Refinements – Dale Schlautman, EA

Park Restoration – Deanna Pulse, EA

Summary – Steve Masters, Public Works/Utilities

9:00 Adjourn

The City of Lincoln Public Works/Utilities Department and EA Engineering would like to thank you for coming tonight and participating in the open house. We hope the information you received tonight has been helpful in understanding the project.

Please fill out comment cards with suggestions or concerns that you have. You may also direct questions to Dale Schlautman or Holly Lionberger at EA Engineering (476-3766).

City of Lincoln
Public Works/Utilities Dept
555 S. 10th Street, Suite 203
Lincoln, NE 68508
402-441-7588

402-476-3766

EA Engineering, Science, and Technology
121 South 13th St., Suite 204
Lincoln, NE 68508

Upper Southeast Salt Creek Trunk Sewer Open House
March 25, 2004

SUMMARY OF COMMENTS/DISCUSSIONS – PUBLIC MEETING MARCH 4, 2004

MOST COMMONLY ASKED QUESTIONS (Answered below and in presentation)

Can the railroad crossover be moved north to avoid the bur oaks and the Salt Creek oxbow?

Can the Salt Creek course be altered?

What are the maintenance requirements for the sewer line ?

What will be involved in the maintenance of the restoration areas?

What are the potential cumulative effects of this project and future projects to the park?

HABITAT MODULE

Q: Where is the rare bird habitat?
A: The rare bird habitat is located along Rokeby Road between 14th Street and the old Union Pacific Railroad tracks. What is unique about this area is that the Carolina Wren and the Bell's Vireo are using the habitat for nesting. The habitat is not rare, but the birds are listed on the Nebraska Natural Heritage Program rare animal list.

Q: What kind of routine maintenance/access will be necessary?
A: There will be manholes accessed for sewer cleaning. Trucks will use the park maintenance trails.

Q: What will the park be restored to? Is this the last utility that will encroach on the park and will there be more? The cumulative effect may have a big impact.
A: The disturbed areas will be restored back to native prairie. Sewers rely on gravity to drain and are therefore most impacted by topography. Other utilities such as power, water and gas, do not need to follow along a natural slope, and could be more easily routed around the Park. Since the sewer line will be underground, it may have less of an impact than a road or power line. Individual utilities need to be considered on a case by case basis.

Q: Why couldn't the sewer stay on the east side?
A: This would require boring through sandstone and having deep excavations. This would increase the cost of the project significantly. The sewer construction through the Park is an excellent opportunity to begin the restoration process.

OTHER COMMENTS:
- Friends of Wilderness Park completed a Park study with the Parks & Recreation Planning Department about a year ago.
- Addition of a trail was suggested.

CONSTRUCTION MODULE

Q: What is the time frame for the project? How much disturbance will the project create for the park?
A: It could take as long as three years before the project is completed. The project will involve planning, design and construction phases. A minimum 125 feet to a potential 150 –feet wide construction easement will be required. Typically no more than 100-feet of trench will be open at any one time for practical purposes.

Q: What type of material will be used for the pipes and how will they be sealed? How many manholes are necessary?
A: Several different types of pipe material are being considered. A common pipe material is reinforced concrete with a PVC lining, but the exact material for this project has not been selected at this time. Manholes will be placed about every 600 feet and at bends in the pipe. With around 4,000 feet of pipe and about four inflection points in the Park, this would mean approximately 10-12 manholes.

Q: Can there be a trail or easy access to the park? Is there funding?
A: There will be an access road for sewer maintenance. A trail and park access have been mentioned as part of the future plan for the Park, but may not be a part of this project.

Q: Will there be a need for a treatment plant in SW Lincoln?
A: As given in the Lincoln Wastewater Facilities Plan Update (2003), under the 50-year horizon, a southwest treatment plant should be considered depending on the future growth of the community.

Q: What are the options for crossing the railroad tracks at the south end?
A: Right now three options are being evaluated for crossing the railroad at the south end.

1. Boring under the RR north of the existing stand of bur oak trees into a stormwater detention cell on the golf course side. This would require a deep bore pit and might involve going through sandstone. It would also require crossing under the drainage ditch directly south of the golf course and avoiding the existing storm sewer outlet.
2. Boring under the RR north of the existing stand of bur oak trees, and end up south of the existing drainage ditch south of the golf course. The railroad typically requires that pipelines cross the tracks at a 90° angle. They may allow some deviation to that, but probably not much. If this is the case, this option would not be feasible.
3. With as minimal impact on the bur oaks as possible, bore under the RR farther south ending up in the field south of the golf course. This would allow the required railroad crossing angle to be met, would hopefully avoid the sandstone, and would not require crossing the drainage ditch and avoiding the existing storm sewer.

Q: Can the Salt Creek course be rerouted (cut off oxbow)? How deep is the water table?
A: Changing the Salt Creek oxbow would require a US Army Corps of Engineers 404 permit which could be very time consuming. Changing the creek course will be avoided. The route will place as much separation between the creek and the sewer as possible. From borings done previously along the proposed route, the water table is around 15 – 18 feet below the ground surface. If water is encountered in trenching, the pipeline trench would need to be dewatered.

RESTORATION MODULE (TOPICS OF DISCUSSION)

- Suggested creating a transition from the golf course to the wooded area – grassland, shrubs, trees.
- Suggested softening the boundary on the east side of the Park area – create a curved corridor rather than a straight line boundary.
- Suggested tree cluster plantings throughout the restoration area.
- Planting and restoration have to provide access for maintenance (burning or mowing).
- Mowing could be done every few years to invigorate the grass and eliminate new tree growth. Trees would not interfere with the sewer line if they are not planted directly over the line.

City of Lincoln
Public Works/Utilities Dept
555 S. 10th Street, Suite 203
Lincoln, NE 68508
402-441-7588

EA Engineering, Science, and Technology
121 South 13th St., Suite 204
Lincoln, NE 68508
402-476-3766

Upper Southeast Salt Creek Trunk Sewer

March 25, 2004

WILDERNESS PARK RESTORATION

1. PREVIOUSLY DISCUSSED OPTIONS
   - Grasslands, shrubs, trees succession
   - Soften the straight east boundary line
   - Tree cluster plantings
   - Wetlands restoration

2. WALK-THROUGH FINDINGS
   - Typical Site Conditions
   - Grasses, shrubs further to west of east fence line
   - Wetland areas
   - Hardwoods along east fence line
   - Bur Oak Community

3. PREPARATION ACTIVITIES
   - Clearing and grubbing, removal of brush, log piles
   - Mulch, wood chips

4. PRAIRIE GRASS MIXTURES
   - Short Grass Mixture
     - Short and mid-height grasses (1-3 ft), compatible in height for wildflower mixtures
     - Buffalograss, Blue Grama, Sideoats Grama and Little Bluestem
     - Seed rate – Broadcast - 1 lb/ 3,000 sq ft, Drilled - 8 lbs/acre
   - Tall and Mid-Height Grass Mixture
     - Tall and mid-height grasses (Big and Little Bluestem, Indiangrass, Switchgrass, Sideoats Grama, Western Wheatgrass and Virginia Wildrye)
     - Seed rate – Broadcast - 1 lb/2,000 sq, ft, Drilled - 10 lb/acre
     - Provides greater competition to wildflowers, habitat for wildlife, effective sound barrier
     - Red, gold and purple colors adds to aesthetic value
   - Floodplain Mixture
     - Variety of inundation tolerances, recommended for fluctuating shorelines and lowlands
     - Species include Virginia/Canada wildryes, Switchgrass, Western Wheatgrass, Red Top and Big Bluestem
     - Seed rate – 12-15 lb/acre in spring or in fall after frost

5. WILDFLOWER MIXTURES
   - Short Wildflower mixture
     - Perennial and annual mixture, height 1-2+ ft height
     - 17 species including black-eyed susan, blue flax, coreopsis, primrose, aster, yarrow, daisy, coneflower
     - Seed rate –Broadcast - 1 oz/300 sq ft, Drill – 1 lb/acre
   - Wildflower mixture
     - 25 varieties perennial and annuals, adapted to various conditions, 7 reseeding annual species to compete against weeds while perennials get established
     - Seed rate - Broadcast - 1 oz/400 sq ft, Drill – 1 lb/5,000 sq ft.
   - Habitat Mixture (Wildflower/legume mixture)
     - Attracts butterflies, nesting cover for birds, stabilizes soils, soil builder
     - Contains 17 species wildflowers, (50% by weight), also clovers, ground covers
     - Seeding rate – Broadcast 1 lb/3,500 sq ft, Drill – 10 lb/acre

Heartland Center for Leadership Development

March 26, 2004

Dale Schlautmm
EA Engineering Services and Technology
121 South 13th Street, Suite 204
Lincoln, Ne 68508

Dear Dale:

Enclosed is a report that summarizes the public participation and two public meetings related to the Upper Southeast Salt Creek Trunk Sewer project. It's been a pleasure working with you and your team. Please do keep us in mind if we can assist in any future efforts.

Yours Truly,

Vicki B. Luther, PhD.

941 O Street • Suite 920 • Lincoln, NE 68508
Telephone: (402) 474-7667
Fax: (402) 474-7672

Report
Upper Southeast Salt Creek Trunk Sewer Project
Open House
March 25, 2004

7:00 – 9:00 p.m.
Scott Middle School

EA Presenters:
Holly Lionberger
Dale Schlautman
Deanna Pulse

Commentary:
Lee Gustafson (EA)
Steve Masters

Heartland Center Facilitators:
Mary Emery
Reggi Carlson

Participants:
Moni Usasz
Harlan Layton
Phyllis Hergenrader
Gary Hergenrader
Terry
Mary Roseberry-Brown
Terry Genrich

Meeting Notes/Discussion

Mary Emery opened the meeting, welcomed participants, reviewed the agenda and asked people to introduce themselves. Participants were given three handouts that served as support materials for evening's main topics:

1. Summary of Comments/Discussions from the public meeting on March 4,2004
2. Preferred Route Refinements
3. Park Restoration Options

Summary of Comments/Discussions
Holly Lionberger began the Power Point presentation and group discussion by explaining that the engineering team had taken a "walk in the park" to get a closer look at preferred route, which runs through the eastern edge of Wilderness Park. She provided a summary of the most commonly asked questions and is s raised from the previous meeting. **(See handout attached.)**

One participant asked what will be involved in future maintenance for the sewer line. Steve Masters explained that the public does not prefer raised manholes, and that one option would include burying every other manhole through the park.

There was discussion about maintenance of restored areas. One participant said that warm season grasses cannot survive with just annual mowing, and that invasive trees and shrubs would not be stopped by a single annual mowing. Terry Genich explained that

controlled burning could be employed, and that would help the situation. This is an accepted practice.

There was additional concern expressed and explanation regarding the potential cumulative effects of future projects in the area. Holly explained the importance of the gravity factor to installing a sewer line. Other utilities do not depend on gravity, and may not need to follow the same route a proposed sewer route.

Route Refinements
Dale Schlautman explained that construction easements required greater footage than permanent easements. He used a map of the area to orient participants and describe features along the route, such as manholes, railroad tracks and right-of-way, and storm water detention cells. **(See handout).**

In describing the northern edge of Wilderness Park he explained the need to provide a buffer between the park and the railroad tracks for a sight and sound barrier, and noted that the first 50 feet into the park included better trees and a potential maintenance trail.

He pointed out that the route was designed with an influx, which resulted in a 50 to 100 foot buffer. This influx would save stands of walnut and hickory trees, would involve a little less coverage because of a natural slope, however, there would be some additional costs because the influx lengthened the route somewhat.

Dale then introduced three options for the sewer line to cut across the railroad tracks.

Option 1 is to cut across just north of a burr oak stand of trees and about 150 feet away the Salt Creek oxbow.

Option 2 is to have a much less severe (less than 90 degree) angle and begin the cross over farther north. However, it is not typical for the railroad to accept this design, and they are not legally bound to do so.

Option 3 would cut across the edge of the burr oak trees.

Steve Masters asked about the elevation of the storm cell to the pipe. The answer is about 20 feet. Participants said that they were more worried about the creek than the storm cell. Dale said that the challenge of moving the crossover farther north is getting through the outcropping of sandstone, however, it is still feasible.

Participants requested further information about why a more northern crossing was difficult. The reason given was that moving north increases the depth of drilling to at least 25 feet instead of 10 feet, plus the boring would need to go through limestone.

Option 1 provided at least 150 feet from the nearest manhole to the creek's oxbow.

Participants asked if there would be a need to stabilize the creek so that it didn't move closer to the sewer. The prediction that it would move that way because of future development to the south and increase the flow.

They noted that stabilization takes away from the natural values of the creek.

Holly noted that future development will likely employ practices that minimize runoff.

One participant said that, even so, we need to try to get the railroad to agree to a longer crossover, and move it to the north.

Dale said what it all comes down to is determining how far is a safe distance, and that the engineers felt good about the 150 feet they found when they did their walk through.

Lee Gustafson said that if we study historic photos we can see that we are in good shape with the 150 feet distance. We will have to monitor progress and make changes only if necessary. But perhaps starting the crossover another 25 feet further north is possible. It is a trade off. We may be able to go to the north end of the detention cell without having to go deeper. We have some testing to do yet, such as boring to take samples.

One participant said if going north would help protect the creek and it cost a little more, so be it. It is money well spent.

Another said that angling the cross over less than 90 degrees would be better for sewage flow.

Discussion followed about the railroad's policies, and the difficulty in persuading officials to accept longer tunneling under their tracks.

One participant noted that trees add to the stability of the creek. She said we are using public dollars to stabilize creeks after utilities went in. It disrupts the habitat. We need to keep the sewer line as far away from the oxbow as possible. There was general agreement that more investigation was needed to determine if the crossover could be moved north.

Dale reminded people that boring required a huge hole just to get the boring equipment in. One participant said that rehabbing a golf course greens and fairways would be easier than stabilizing a creek.
It was mentioned that 10 to 12 manholes would be needed within the park.

The question was asked, When will operation begin? The answer is about three to four years out.

Another question, What precautions will be in place to prevent sediment pollution?
The answer was that construction would need a control plan; also protecting the wetlands would be a consideration. The lay of the land, however, is fairly flat, which should help with erosion problems.

Wilderness Park Restoration
After a short break with refreshments, Deanna Pulse presented information and answered questions regarding current conditions and opportunities for restoring the park to a more natural condition following construction.

The engineer's walk through findings included congested small trees competing with grasses and larger trees. As we move west, it clears, but there are areas of invasive thickets. There are a couple of wetland areas, but because of drought there is little vegetation and trees are competing for moisture with the grasses. There are hardwood stands where smaller trees are invading.

Deanna then briefed the group on preparation activities, optional short, tall and floodplain mixture grasses and wildflower mixtures. **(See hand out for details of optional recommendations.)**

There seems to be a very low ratio of forbs to grass.

Terry said that the parks committee would provide guidance as to what gets planted where.

How would we determine placement of plants? Deanna said that the principle was to create a meandering border/buffer that was more natural than an abrupt barrier, and would encourage the development of a balanced habitat. Grasses are the original habitat before the ground was farmed.

The woodland areas follow the creek bed. The committee should decide what to remove before it is removed.

Since we are dealing with an old farm field we can actually create whatever we want.

There was caution against planting short grass because it does not do well here, but another participant noted that in the right places, buffalo grass thrives just fine when taller grasses do not shade it out.

There were questions about where the construction access road would be. The answer is that an existing roadway that used to go to a farm, near the wetland seemed to be a good choice. Other shorter access points would also be required. We may want to add some protection against erosion in these areas.

What will happen to the dug up soil? It could be incorporated into the site. We will have to look at the borings, because we do not want to spoil the topsoil with waste. There may be a need to ship out some waste, but not much is predicted. If you trench 10 to 15 feet, back into the trench.

Summary
Steve Masters gave a summary of key points discussed at the meeting. He began by saying that the overall goal is to have a good project, that we will be able to look back and hold this project up as an example of the way projects should be carried out.

Having these meetings is really a good component to a good project. It is important to partner with parks and interested people. Once we have a contractor we will put together goals, progress meetings, etc. Some things will be better than expected, and others will be disappointing.

Some thing we will want EA to report on:

Warm season grass selection and management. Terry's committee needs to make sure what is done is right. We are fortunate to have this opportunity. It is a win-win situation for everyone.

The crossing at Rokeby Road, and how it is configured. Optimizing is the goal

Approaching the railroad to allow us more leeway in the angle of the crossover.

Manhole placement and grade.

Soil and sediment, as well as spoils. We do not want to repeat the mistakes that we had with the old landfill.

We will probably need a geomorphology study regarding the oxbow issue.

Participant Question? How will we find out about how issues are resolved?
We will have one more meeting to report on our recommendations. I've pledged to work closely with parks and also the NRD on this. We will be doing another meeting and inviting people back.

The report is tentatively scheduled for August of 2004. We will do some additional data collection and then that will conclude the preliminary design. Then partners will begin the final design process.

Evaluations

Two persons returned evaluation sheets, rating the evening presentation as a 4.5 on a scale of 1-poor to 5-excellent. Comments revealed that participants liked the open process, and that all projects should be done in this way.