Appendix B
Constraints of Habitat and Channel Stability on the Development of Drainage Improvement Alternatives for the S-1, S-2, and S-3 Urban Planning Zones and the N-1, N-2, N-3, N-4, and N-5 Urban Planning Zones

The studies commission for the Southeast Upper Salt Creek and the Lower Little Salt Creek Watersheds were published in a single report to reduce costs.

CONSTRAINTS OF HABITAT AND CHANNEL STABILITY ON THE DEVELOPMENT OF DRAINAGE IMPROVEMENT ALTERNATIVES FOR THE S-1 TO S-3 AND N-1 TO N-5 URBAN PLANNING ZONES

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961-102.040

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APPENDIX

1.0 FINDINGS/RECOMMENDATIONS

This report is an evaluation of the constraints of habitat and channel stability on the development of drainage improvement alternatives for the two study areas (the N- and S- watersheds) denoted in Figure 1. A summary of findings and recommendations is provided below. The findings and recommendations are based upon two site visits to the subject watersheds, the results of macro-invertebrate sampling in the N- watershed and discussions with staff from the City of Lincoln and the Lower Platte South Natural Resources District (LPSNRD). Each item listed below is discussed in more detail in the body of this report.

1. The findings of an initial site visit (including lack of water in the S- catchments and many of the N-catchment streams) and results of macro-invertebrate sampling of the subject watersheds changed the focus of this study to channel stability from its original focus on bio-assessment.

2. The type and extent of development of the subject watersheds and development schedule are currently not defined. This report is written in a general manner that would be applicable to any type of development ranging from the current agricultural development to relatively high-density commercial development.

3. There was no water in the S- channels during the September 2000 site visit. This precluded biological sampling of the stream. The channels at the upper end of the S-watershed then showed little degradation. The channels showed mild to moderate incision downstream of 40th Street.

4. Biological sampling was carried out in three locations of Little Salt Creek during the September 2000 site visit. The results of the sampling are reported in Appendix A. The channels in the N- watershed showed head cutting and bank instability, indicating that these channels are subject to significant degradation when the watershed develops.

5. The major effect of urbanization of the watersheds will come from changes in hydrology. In the absence of suitable mitigation measures, the increased flow rates and volumes,

increased frequency of high flows, and increased base flows will cause channel instability including erosion of the channel bed and banks. This type of degradation is evident in the Beal Slough channel and other channels in the City of Lincoln.

6. Detention should be provided for all new development in the subject watersheds, either through regional or on-site storage facilities for the water quality and 2-, 10- and 100-year storm events as per City of Lincoln's criteria (section 6.4.2).

7. Channel bed stabilization is essential for the channels in both watersheds. This can be achieved through proper design of a constructed grass or wetland channel. It can also be accomplished by installing bed stabilization structures (such as concrete cut-off walls) in natural channels. Culverts can also act as bed stabilization structures if they are properly designed.

8. Wide riparian buffers around channels are valuable for preserving channel stability. The buffers should (at a minimum) conform to the City of Lincoln's criteria (section 1.5.6).

9. A stream channel assessment and monitoring program should be instituted to track streambed erosion. This will enable bed stabilization measures to be installed when needed.

2.0 PURPOSE/SCOPE

The purpose of this report is to present the results of a bio-assessment of the creeks in certain watersheds located close to the City of Lincoln, Nebraska. (See Figure 1.) This study is to be used as part of the master drainage planning effort for the subject watersheds. When used jointly with the results of hydrologic, hydraulic, engineering and cost studies of the watersheds, the results of this study can be used to develop, analyze and rank alternative channel improvement plans developed for each watershed.

The original scope of this study (developed jointly by Wright Water Engineers [WWE] and Olsson Environmental Sciences [OES]) was to collect biological samples from the watersheds, analyze those samples and develop recommendations for the master drainage planning based upon the results of the sampling. The scope of the study was modified after an initial field visit to the subject watersheds on September 16 and 17, 2000 because (a) there was little or no water in most of the subject stream channels and (b) observations from the initial site visit indicated that channel stability would be a vital component of habitat in the channels. The revised scope of work, therefore, included an analysis of channel stability instead of additional biological sampling of the watersheds.

Work tasks completed as part of this study included:

1. Ryan Unterreiner of WWE and Dr. Edwin Herricks performed a site visit to the subject watersheds on September 16 and 17, 2000. The site visit included biological sampling at three sites on Little Salt Creek in the N- planning zones. It also included a meeting with John Cambridge of OES in order to scope the project.

2. Macro-invertebrates collected during the sampling were counted and identified. Standard metrics were calculated for the samples. The results of the analysis are presented in Appendix A.

3. Peter Waugh of WWE and Edwin Herricks carried out a site visit on October 27 and 28, 2000. During this site visit, a meeting was held to present preliminary results of the study to the City of Lincoln and the LPSNRD. Also, extensive field observations of the north and south watersheds were carried out to assess the condition of the stream channels in the subject watersheds. The field observations focused on the channels near road crossings because these areas were easiest to access.

3.0 CURRENT CATCHMENT/STREAM CONDITIONS

The S-watershed has a mixture of low-density residential, golf course and farming development. Catchment S-1 consists of woodlands, agricultural areas and areas currently undergoing development.

Catchment S-2 consists mostly of agricultural development except for the golf course on the northern edge of the catchment. The riparian area around the channels has been preserved in some areas. This includes native trees and shrubs within a buffer zone around the drainageway. Photograph 1 shows the area immediately downstream of 40th Avenue. In other areas, grading for agricultural development has taken place up to the edge of the low-flow channel of the drainageway. There is no riparian vegetation in these areas. Photograph 2 shows the area immediately upstream of 40th Avenue.

Photograph 1. Stream channel immediately downstream of 40th Street in the S-2 catchment. A riparian buffer has been preserved.

Catchment S-3 consists mainly of large lot (each about three acres) residential development. Much of the development has gravel roadways with grassed roadside swales. The overall percentage imperviousness for this type of development is on the order of 10 to 15 percent. This is low compared to a 40 to 45 percent imperviousness expected in a "typical" residential development. In general, it appears that the natural drainageways in the development have been respected. Photograph 3 shows a drainageway in catchment S-3. Development of the area has not caused significant stormwater impacts on the downstream channel reaches.

Photograph 2. Stream channel immediately upstream of 40th Street in the S-2 catchment. Riparian vegetation has been removed for agricultural development.

The channels in the S-3 watershed show little degradation in the reaches upstream of 40th Street. There is increased degradation, as shown by vertical channel incision in the lower portions of the

Constraints of
Habitat and Channel Stability on the Development of
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S-2 watershed. There was no flowing water in any of the channels at the time of the September or October 2000 site visits. There was a small area with standing water.

Photograph 3. Drainageway in Catchment S-3 adjacent to Rokeby Road.

The majority of the N-watershed has agricultural development or is undeveloped. The far western fringe of the N-4 catchment is currently undergoing development. A portion of the N-1 catchment (adjacent to the Interstate 80–U.S. Highway 77 interchange) has commercial development.

Many of the stream channels in the N-watershed show moderate to severe degradation. The degradation is manifested as vertical incision of the channels and accompanying sloughing of the channel banks. In many cases, the degradation appears to be due to historic stream channelization or placement of culverts.

There are few defined channels in the N-1 catchment. The channel that crosses Interstate 80 just west of U.S. Highway 77 has been heavily modified by commercial development adjacent to the interchange. The remainder of the channels in the area are small and do not show significant degradation.

The N-2, N-3 and N-5 catchments have agricultural development. The channels in these catchments show head cutting and vertical incision. (See photographs 4 and 5.) Catchment N-4 does not show channel incision but has deposition in some areas.

Photograph 4. Channel with head cutting or scour hole downstream of channel.

Constraints of
Habitat and Channel Stability on the Development of
Drainage Improvement Alternatives for the S-1 to S-3 and N-1 to N-5 Urban Planning Zones

Photograph 5. Channel with vertical incision.

4.0 POTENTIAL CHANGES DUE TO FUTURE DEVELOPMENT

Urbanization of any catchment will affect and potentially degrade the channels in that catchment. These changes stem from the changes in hydrology caused by urbanization. The extent of the changes in hydrology is dependent on the percentage imperviousness of the area developed, type of development, structural mitigation measures used (such as stormwater detention), and nonstructural measures used (such as buffer zone protection and wetlands protection). Hydrologic changes that often occur with development of a catchment are listed below.

1. The base flow in a catchment is often increased by urbanization.

2. Small storm events (less than the 2-year event) that infiltrate into the soil in the undeveloped condition can yield runoff after development. The frequency of runoff events is, therefore, increased. The volume of runoff from these events is also markedly increased after urbanization.

3. Channel forming flows (generally the 2-year event) will increase after urbanization.

4. Major event storm flows (10-year and larger events) will increase due to urbanization.

The increase in channel-forming flows and the increase in frequency and volume of smaller runoff events are the storm events that will have the greatest effect on stream channel stability. Increase in base flow will have significant effects (positive and negative) on stream habitat and aquatic life. The increase in major event storm flows will affect the flooding potential of the streams.

Natural stream channels attain a stable longitudinal slope depending on the type of bed material and magnitude of flows in the channel. The higher the flows or the smaller the bed material, the flatter the longitudinal slope of the channel must be to maintain stability. During urbanization of any of the subject catchments, storm flows in the streams will increase as described above. The increase in flow will reduce the stable longitudinal slope of the streams in the catchment. The streams will reach a new stable longitudinal slope that is flatter that the one that was dependant upon historic condition storm flows. This will result in streambed erosion (incision) that often starts at the downstream end of the stream at a control point that has a stable (or relatively stable) bottom elevation (such as the Salt Creek or a culvert with a headwall). The erosion proceeds upstream forming a "head cut" (discontinuity) at the upstream end of the erosion. The head cut gradually migrates upstream until another control point is reached. The upstream control point can be a layer of rock or competent soil or a constructed facility such as a grade control structure.

Streambed incision causes a gradual channel widening. The incision results in the channel side slopes becoming steeper. If the channel banks become too steep to be stable, they will gradually slough in order to achieve a flatter slope. This sloughing will result in a gradual widening of the

channel until a stable channel cross section is reached. Resulting sediment can become a problem downstream as deposition.

The longitudinal bed slope and bank slope of a channel can be influenced by constructed facilities in the channel. For example, a culvert can start a head cut if it is placed too low. This has happened in small tributaries in the N-3 catchment. A culvert can also stop a head cut from below from progressing farther upstream. A constructed channel can set a new control point elevation for tributary streams.

Changes in streambed longitudinal slope or channel widening will result in changes in riparian vegetation and stream habitat. Riparian vegetation will be lost to erosion until a new stable channel configuration is reached.

5.0 ALTERNATIVE DRAINAGE IMPROVEMENTS

This section provides a framework for the development, review and analysis of alternative drainage improvement scenarios with respect to channel stability and stream habitat. The key goals for preparation of alternatives are:

1. Reduce post-development flow rates through the use of detention.

2. Develop stable channel longitudinal slopes.

3. Provide wide riparian buffer strips adjacent to channels.

4. Monitor stream channel bed slope and cross section changes over time.

5. Use new channel construction and/or rehabilitation as an opportunity to improve habitat.

As development occurs in any area of either of the watersheds, detention should be provided for the water quality storm (0.5-inch storm), 2-yr, 10-yr and 100-yr storms as per section 6.4.2 of the

City of Lincoln's *Drainage Criteria Manual*. Regional detention facilities that control runoff from entire developments or large portions of catchments (tributary areas of approximately 100 acres or larger) are generally more effective than on-site facilities that control runoff from only one site (tributary areas as small as a few acres). Regional detention facilities are often designed and constructed with greater care and have better long-term maintenance. If properly designed and constructed, storage facilities reduce to historic levels the peak flow rates from a new development at the location immediately downstream of the outlet structure of the storage facility. The hydrology of the catchment downstream of the facility is nevertheless changed because the volume of runoff is increased. Without a regional watershed plan, this increase in volume from each sub-catchment will likely increase the overall peak flow rate in the stream further downstream in the watershed (as the flows from several catchments combine). The effect of detention should be included in the hydrologic modeling of the watershed so that channel improvements can be properly designed.

Channel improvements must focus upon establishing a stable longitudinal bed slope for the stream channels in the study area. This can be done a variety of ways. If a constructed channel is proposed for a given reach of stream, the slope of the channel must be stable for the bed material used. Drop structures should be used to reduce the slope of the constructed channel from the original channel slope. Wetland bottom channels and grassed channels are preferred over hard-lined channels. Channel stability and habitat can be enhanced by providing for a wide buffer zone around the channel and providing a sinuous, meandering invert for the low-flow channel. Channel improvements can provide for improved habitat by including pools and bed material preferred by micro-invertebrates and by planting species of vegetation that provide good habitat.

If no constructed channel is provided in a reach of stream, bed stabilization should be provided. Construction of this modified natural channel can be accomplished in a number of ways. Placing buried concrete cut-off walls that will act as channel check structures would stabilize the channel bed. It may be possible to use road crossings as the primary means of maintaining a stable bed slope. This would require that each road crossing be designed as a channel check structure

(through use of a headwall with a footing well below the ground surface) and placed at the correct elevation for the future channel slope. A wide vegetated buffer zone should be provided around natural channels.

The timing and funding of channel improvements may be an issue during development of the watershed. While a developer may fund improvements to the reach of channel included within his development, the development will likely also affect downstream reaches of the stream channel. The downstream channel may be in an area that has not been developed and hence has not received any improvements. The channel could then be degraded by upstream development even though the upstream development provided detention per City of Lincoln's criteria and has stabilized the channel within its boundaries.

A system to monitor changes in the channel bed elevation and channel cross section shape would be useful in order to determine if specific reaches of the channel are influenced by upstream development.

A summary of recommended improvements for each catchment is provided below.

1. ***Catchment S-1.*** This catchment is directly tributary to Salt Creek. The majority of this catchment is currently undergoing development. Changes in hydrology from this development will only affect the channels within the catchment itself. They will not have a significant effect on downstream areas. The master planning effort should focus on ensuring that the planned drainage improvements maintain a stable channel within the catchment and the development or redevelopment meets applicable criteria.

2. ***Catchment S-2.*** This catchment lies downstream of catchment S-3 but will not be significantly affected by that catchment, unless widespread land use changes occur in the future, because S-3 is mostly built out with low-density residential development. The stream channel between 27th and 40th Streets currently shows mild degradation in some areas. The degradation of the channel will increase with development of the S-2 catchment. The channel should be monitored to determine whether it is degrading due to

development in the watershed. The channel should be stabilized with bed stabilization measures when the monitoring shows that problems are developing. A buffer area adjacent to the channel should be maintained, enlarged or provided, depending on the current condition of the riparian area.

3. ***Catchment S-3.*** This catchment is largely developed. Detention should be provided in areas that will undergo future development. Consideration should be given to retrofitting storage in the existing developments. Hydrologic analyses should be carried out to determine whether retrofitting storage facilities will produce downstream benefits. The channels in this catchment appear to be largely in good condition and may not need stabilization measures.

4. ***Catchment N-1.*** This catchment consists of a number of sub-catchments that are directly tributary to Salt Creek. The channel that flows near the Interstate 80/U.S. 77 highway intersection has been modified by area development and should be reestablished. The sub-catchments lying east of U.S. 77 appear to be in reasonably good condition south of Interstate 80. The Salt Creek floodplain dominates the southern portion of the catchment. Channel stability in this area will likely not be a significant issue, because the channel slopes are relatively flat.

5. ***Catchments N-2, N-3 and N-5.*** These catchments are all dominated by agricultural development. The creek channels in these catchments show moderate to serious degradation. Little Salt Creek through this area has degraded because of historic channelization of the channel in the reach upstream of Interstate 80 and down cutting to match Salt Creek's channel. This section of channel is straight and deep with steep, unstable banks. North of Bluff Street, the channel is more natural and less degraded. The tributaries in these catchments show incision that is progressing upstream from Little Salt Creek or, in some instances, is progressing upstream from culverts placed at too low elevations. Channel bed stabilization is essential for these catchments. Little Salt Creek may be at or near a stable slope and, consequently, not need stabilization. The resulting

drop in groundwater levels affects the saline groundwater inflow to the adjacent saline wetlands.

6. ***Catchment N-4.*** The channels in the N-4 catchment show less degradation than the channels in the other N- catchments. Some areas show deposition of materials rather than the erosion shown in the other N- catchments. The channels in this catchment should be monitored, and bed stabilization should be provided if the channels start degrading as development occurs.

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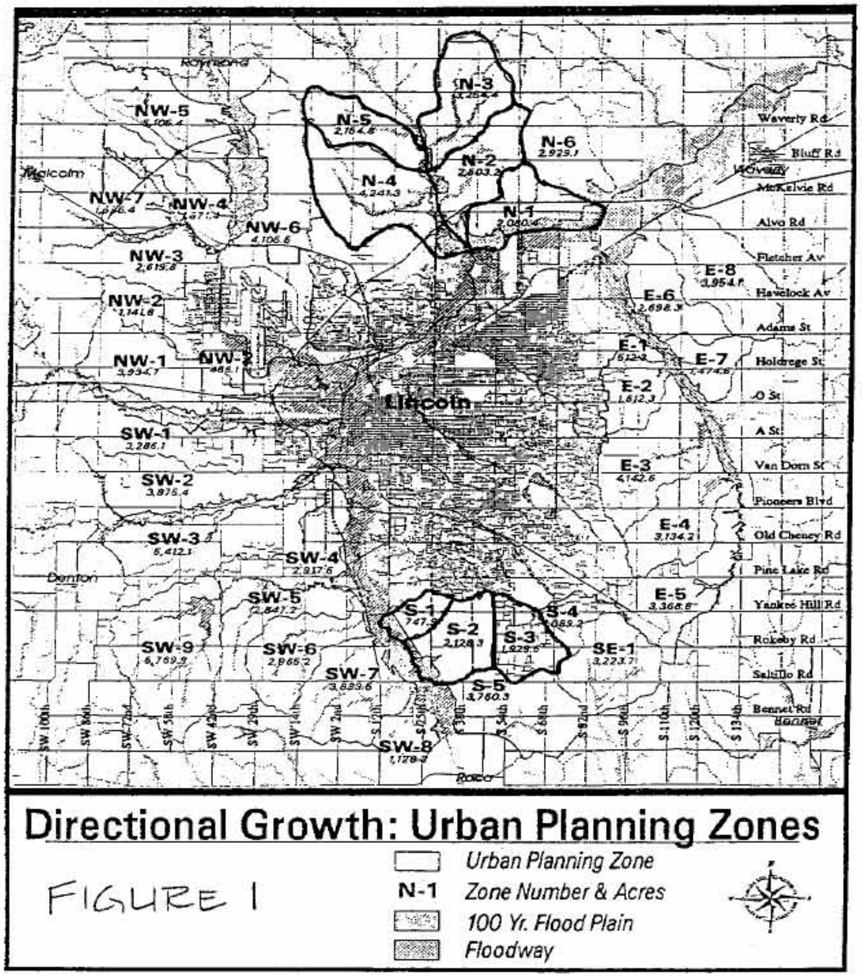

Directional Growth: Urban Planning Zones

FIGURE 1

APPENDIX A

Sampling Results

WWE
MEMORANDUM

To: Project File #961-102.040

From: Wright Water Engineers, Inc.
Ryan Unterreiner

Date: October 6, 2000

Re: Little Salt Creek Bioassessment

Wright Water Engineers, Inc. (WWE) met with Dr. Edwin Herricks on September 15 and 16 in Lincoln, Nebraska with two intentions: 1) to complete a reconnaissance survey of subbasins N1-N5 (north) and S1-S3 (south) and 2) to collect benthic macroinvertebrates at various reaches in the north and south watersheds. The purpose was to provide the City of Lincoln and Olsson Environmental with an indication of the quality of these drainages with regard to aquatic life, watershed development and stormwater management and the possible extent to which they may be improved and/or protected by future development plans.

NORTH AND SOUTH BASINS

WWE, with Dr. Herricks, completed a reconnaissance survey of the north and south watersheds within a limited timeframe. Eight subbasins in the north and south watersheds were observed and photo-documented. This information will be provided by Dr. Herricks and will afford insight into the current condition of the watersheds and creeks with respect to watershed development and stormwater management.

BENTHIC MACROINVERTEBRATE SAMPLING

Benthic macroinvertebrate samples were collected at three locations from Little Salt Creek in the north watershed. Habitat Assessment Field Data Sheets, provided by the Environmental Protection Agency (EPA) Rapid Bioassessment Protocol (RBP), and general sketches of the stream were also completed at each location. The purpose was to determine the instream habitat and conditions of the macroinvertebrate community prior to development as well as to establish the existing conditions of Little Salt Creek as it meanders through the north watershed.

The south watershed was dry at the time of our visit. The three subbasins contained in this watershed (S1-S3) had defined bed and banks in drainages but are likely intermittent streams. Benthic macroinvertebrate sampling in the south watershed was not possible due to a lack of water.

Dr. Herricks used a dipnet for sampling a variety of habitats, including silt, sand and gravel substrate, vegetation along the banks and in the channel. An average of twenty jabs was used per station.

Site 01R1

This site was located on Northwest 12th Road, North of Waverly Road, downstream the bridge spanning Little Salt Creek. The purpose for sampling at this location was to establish a "reference site" and determine baseline conditions upgradient in the watershed. This location will remain relatively unchanged by future development.

Banks were relatively steep at approximately 2:1 and consisted mainly of grasses, with occasional emergent grasses at the channel edge. Duckweed was present in this reach of the stream. There was a high silt content in the substrate with occasional sand and gravel. Woody debris provides good habitat for turtles, fish and macroinvertebrates. There is relatively good channel variability in this reach of the stream with pools, a narrow channel and an upland bar.

Site 01

This site was located downstream of the Waverly Road Bridge across Little Salt Creek. There was a relatively steep grade at this location causing an increased flow and channel regime. Artificial substrate (riprap) existed from the bridge construction but substrate mainly consisted of silt with occasional sand and gravel. Periphyton on the channel bottom silt implied some length of stability of the stream. There was a visible difference in the extent of channilization as compared to the reference site. Vegetation along the banks consisted mainly of grasses. The stream had also become slightly more eroded as evidenced by the exposed salt hardpan located approximately 200 yards downstream at a steep eroded bank.

Site 05

This site was located downstream of the Arbor Road Bridge and 27th Street at the lower end of the watershed. There was extreme channelization at this location and an abundance of sediment in the substrate. Filamentous algae lined the channel and provided a substrate for sampling. There was very little in the way of vegetative cover for fish or macroinvertebrates.

Successive sampling at these locations during and following development of the watershed could provide a good indication as to the impact development may have had, or is having on the biological community.

PROCEDURE

WWE separated the samples from detritus and debris using the sugar flotation technique. The samples were then analyzed and separated into their respective taxonomic groups to the Family level. Several "metrics," as described in EPA's RBP, were calculated to assess the character of the macroinvertebrate community at each location. The results of this analysis are provided as attachments.

ANALYSIS

Table 1 provides the metrics that describes the general health of the macroinvertebrate community, and also the habitat score rating. Each metric measures a different component of community structure and has a different range of sensitivity to pollution stress.

TABLE 1

Metric Calculations for Little Salt Creek Sampling Sites

METRIC	Sample Location		
	O1R1	O1	O5
Taxa Richness	16	11	6
Scraper - Filtering Collector Ratio	0.009	0	0
EPT - Chironomidae Ratio	0.6	0.9	0.5
Percent Contribution of Dominant Taxon	24%	33%	40%
EPT Index	3	1	0
Modified FBI	5.5	5.1	5.9
Habitat Score	127	109	75

A brief description and explanation of metric results from the three sample stations are discussed below.

Taxa Richness

This metric reflects the health of the community in terms of the variety of taxa present. The decreasing number of taxa present in the samples downstream indicates reduced diversity due to water quality, habitat diversity or habitat suitability of the stream. Generally speaking, habitat conditions in Little Salt Creek diminished downstream through the watershed as a result of increased channelization and erosion and reduced available substrate.

Scraper—Filtering Collector Ratio

This metric reflects the riffle/run community food base. The predominant feeding strategy in the three samples was Filtering Collectors. Filamentous algae (observed in the field) provide good attachment sites for Filtering Collectors. The dominance of Filtering Collectors indicates an overabundance of filamentous algae and the presence of few diatoms in the Little Salt.

EPT—Chironomidae Ratio

This metric measures community balance. Species in the Orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) are relatively sensitive, while chironomids are generally insensitive to stress. Mayflies and caddisflies were found in small numbers in samples O1R1 and 05. Sample 01 contained a comparatively high number of caddisflies (Hydropsychidae). This may be explained by the slight increase in gradient at this location, allowing for a riffle and run habitat to exist thereby enhancing habitat variability and suitability. The artificial substrate (riprap) at the bridge also increased available substrate.

Percent Contribution of Dominant Taxon

This metric is another indicator of community balance. Values for this metric increase in a downstream direction, which suggests diminished conditions in the creek. This was consistent with conditions noted in the field.

EPT Index

These Orders were poorly represented in all three samples. These Orders represent sensitive taxonomic groups and the lack of representation indicates poor biotic conditions overall.

Modified FBI

The Modified Family Biotic Index (FBI) tolerance values range from 0 to 10, with a higher value assigned to more tolerant organisms. The FBI was relatively constant at all sites, and lowest at site 01.

Habitat Assessment

Habitat, as affected by instream and surrounding topographical features, is a major determinant of aquatic community potential. Both the quality and quantity of available habitat affect the structure and composition of resident biological communities. Habitat parameters are evaluated and given a score. Scores increase as habitat quality increases. Reference site 01R1 was given the highest score with habitat quality diminishing for the two downstream sites.

Memorandum to Project File #961-102.040
October 6, 2000
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CONCLUSION

Little Salt Creek consistently lacks rooted, woody vegetation on its banks, and the lack of woody vegetation may be a result of saline soils. Eroded materials comprise most of the instream substrate, and are poor habitat for macroinvertebrates. High natural saline conditions and agricultural runoff have likely contributed to diminished water quality and more tolerant species. In addition, an overabundance of filamentous algae has created an imbalance in feeding groups. It was apparent the riparian and in-stream conditions diminished as the Little Salt Creek flowed through the watershed, which is likely a result of increased channelization and erosion of bank materials.

The results of the macroinvertebrate sampling showed that a healthier community exists at the upstream site 01R1, but that the community is relatively limited at all sites. Comparison to data collected from other, similar streams could help to define "optimal" conditions for Little Salt Creek, and the amount of impairment currently present.

The Little Salt Creek is a stream subject to its natural environment. While bank stabilization techniques are recommended to minimize erosion, high salinity and poor water quality may limit the integrity of the biological community.

Attachments

cc: Dr. Ed Herricks, University of Illinois (Champaign-Urbana)
John Cambridge, Olsson Environmental

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LITTLE SALT CREEK BIOASSESSMENT

ORGANISM DATA SHEET - UPSREAM REFERANCE STATION - SAMPLE O1R1

Project Name and Number: City of Lincoln
Station Number/Sample I.D.: Upstream Reference 01R1
Sample Date: September, 2000

Identifying Scientist: R. Unterreiner
Identification Date: September, 2000

PHYLUM	CLASS	ORDER	SUBORDER	FAMILY	QUANTITY	COMMENTS
Arthropoda	Insecta	Coleoptera		Elmidae	1	
Arthropoda	Insecta	Odonata	Anisoptera	Gomphidae	1	
Arthropoda	Insecta	Odonata	Zygoptera	Coenagrionidae	7	
Arthropoda	Insecta	Collembola		Sminthuridae	32	
Arthropoda	Insecta	Ephemeroptera	Neophemera	Oligoneuridae	6	
Arthropoda	Insecta	Ephemeroptera		Caenidae	3	
Arthropoda	Insecta	Diptera		Ptychopteridae	28	
Arthropoda	Insecta	Diptera		Chironomidae	28	
Arthropoda	Insecta	Megaloptera		Sialidae	4	
Arthropoda	Insecta	Trichoptera		Hydropsychidae	7	
Arthropoda	Insecta	Hemiptera		Corixidae	8	
Arthropoda	Insecta	Lepidoptera		Pyralidae	3	
Annelida		Hirudinea		Piscicolidae	1	
Annelida		Hirudinea		Glossiphoniidae	1	
Annelida	Oligochaeta	Haplotaxida		Naididae	1	
Gastropoda		Limnophila		Lymnaeidae	2	
Pelecypoda					1	
				TOTAL	134	

DRAFT REVISION—January 21, 1998

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

STREAM NAME Little Salt Creek	LOCATION NW 12th Rd, N. of ~~[illegible]~~ Raymond Rd. (downstream of bridge)
STATION # 001-R1 RIVERMILE	STREAM CLASS
LAT 40°58.076' LONG 96°44.309'	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS Ryan Unterreiner, Ed Harricks	
FORM COMPLETED BY RU	DATE 9/17/00 TIME 8:30 AM PM — REASON FOR SURVEY Base Condition

Parameters to be evaluated in sampling reach

Habitat Parameter	Optimal	Suboptimal	Marginal	Poor
	Condition Category			
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 (8) 7 6	5 4 3 2 1 0
2. Pool Substrate Characterization ("See Substrate")	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 (8) 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% <20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 (9) 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 (18) 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

- Rock substrate ≈ 1.5m from bar. Silt substrated measured @ 1.5m - no bottom.
- When washed in net, sand left behind - fair amount
- Filamentous algae found on bank.
- Sandy material on bed after probing through silt
- Saline soils and incised channel limiting riparian zone, including woody cover

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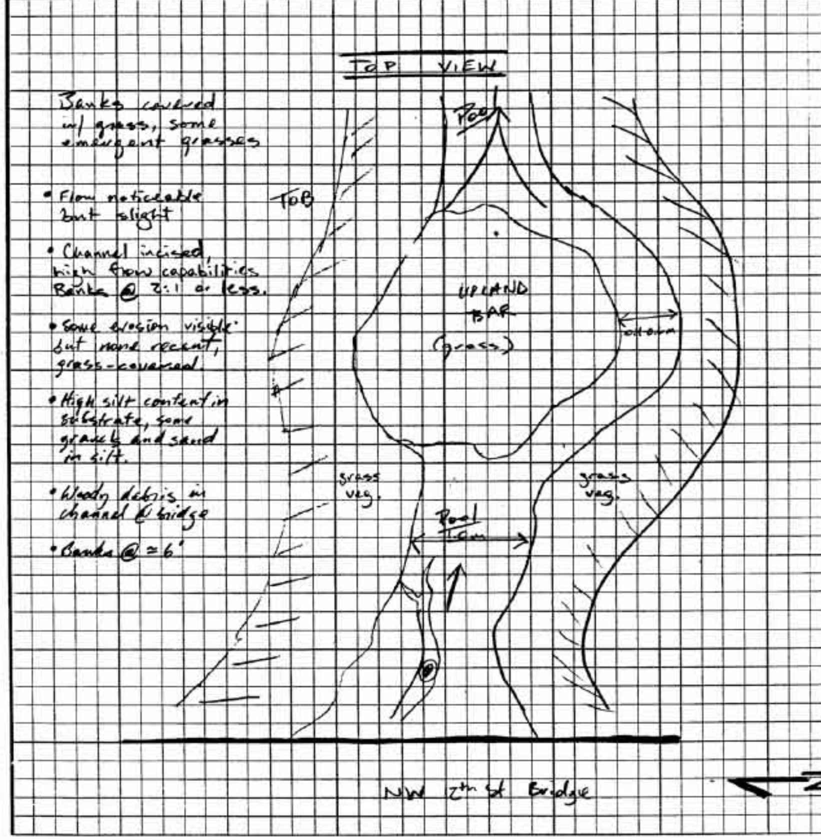
Date 9/17/00 Sheet ____ of ____
Proj. No. 961-102.040
Proj. Name City of Lincoln
Des. By RU Ckd. By ____
Subject Channel Sketch, NW 12th St Bridge, Sample Sta 001-R1



LITTLE SALT CREEK BIOASSESSMENT
ORGANISM DATA SHEET - TOP OF WATERSHED STATION - SAMPLE 01

Project Name and Number: City of Lincoln
Station Number/Sample I.D.: Sample 01
Sample Date: September, 2000

Identifying Scientist: R. Unterreiner
Identification Date: September, 2000

PHYLUM	CLASS	ORDER	SUBORDER	FAMILY	QUANTITY	COMMENTS
Arthropoda	Insecta	Coleoptera		Hydrophilidae	3	
Arthropoda	Insecta	Odonata	Zygoptera	Coenagrionidae	1	
Arthropoda	Insecta	Collembola		Sminthuridae	1	
Arthropoda	Insecta	Diptera	Nematocera	Simuliidae	3	
Arthropoda	Insecta	Diptera		Psychopteridae	5	
Arthropoda	Insecta	Diptera		Chironomidae	94	
Arthropoda	Insecta	Trichoptera		Hydropsychidae	87	
Arthropoda	Insecta	Hemiptera		Corixidae	107	
Arthropoda	Insecta	Lepidoptera		Pyralidae	16	
Annelida	Oligochaeta	Haplotaxida		Naididae	2	
Gastropoda		Limnophila		Lymnaeidae	3	
				TOTAL	322	

City of Lincoln
cpud/d:/061-102/040/eju/bugs.xls

Wright Water Engineers, Inc.
10/4/00

Des by: RU
Ckd by: DM

DRAFT REVISION—January 21, 1998

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

STREAM NAME Little Salt Creek	LOCATION Waverly Bridge
STATION # 01 RIVERMILE	STREAM CLASS
LAT 40°55.981' LONG 96°41.579'	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS Ryan Unterreiner, Ed Harricks	
FORM COMPLETED BY RU	DATE 9/13/00 TIME 9:45 AM PM — REASON FOR SURVEY Head of Basin

Parameters to be evaluated in sampling reach

Habitat Parameter	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 (11)	10 9 8 7 6	5 4 3 2 1 0
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 (8) 7 6	5 4 3 2 1 0
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE	20 19 18 17 16	15 14 13 12 (11)	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% <20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 (13) 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 (14) 13 12 11	10 9 8 7 6	5 4 3 2 1 0

- Substrate firm material overlaind by silt
- Substrate natural foreign
- Simulids, Trichoptera
- Periphytic growth on bottom silt, implies some length of stability

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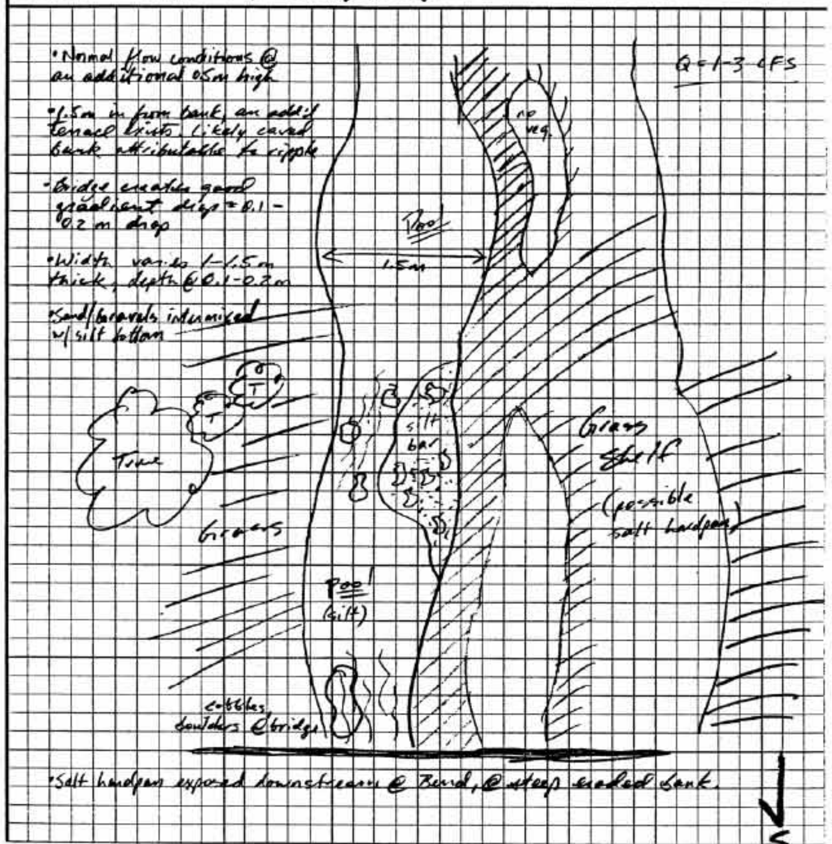
Date 9/17/00 Sheet ____ of ____
Proj. No. 961-102.040
Proj. Name City of Lincoln
Des. By RU Ckd. By ____
Subject Sample 4, Waverly Bridge



LITTLE SALT CREEK BIOASSESSMENT
ORGANISM DATA SHEET - DOWNSTREAM STATION - SAMPLE O5

Project Name and Number: City of Lincoln
Station Number/Sample I.D.: Sample 05
Sample Date: September, 2000

Identifying Scientist: R. Unterreiner
Identification Date: September, 2000

PHYLUM	ORDER	SUBORDER	FAMILY	QUANTITY	COMMENTS
Insecta	Odonata	Zygoptera	Coenagrionidae	15	
	Diptera		Ptychopteridae	3	
	Diptera		Chironomidae	47	
	Hemiptera		Corixidae	10	
	Lepidoptera		Pyralidae	52	
Annelida	Oligochaeta	Haplotaxida	Naididae	2	
			TOTAL	129	

DRAFT REVISION—January 21, 1998

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

STREAM NAME Little Salt Creek	LOCATION 27th & Arbor Rd Bridge - Downstream
STATION # #5 RIVERMILE	STREAM CLASS
LAT 40°53.597' LONG 96°40.912'	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS Ryan Unterreiner, Ed Herricks	
FORM COMPLETED BY RU	DATE 9/17/00 TIME 10:36 AM PM — REASON FOR SURVEY End of all Watersheds

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 (8) 7 6	5 4 3 2 1 0
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 (8) 7 6	5 4 3 2 1 0
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 (6)	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% <20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	(5) 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel, or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 (9) 8 7 6	5 4 3 2 1 0

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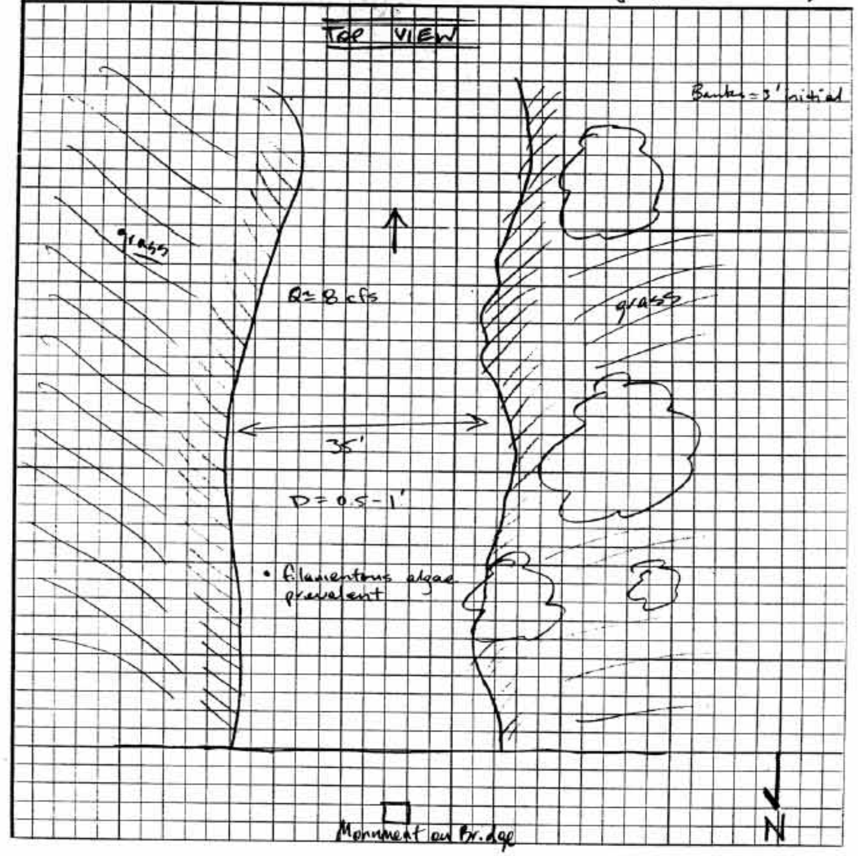
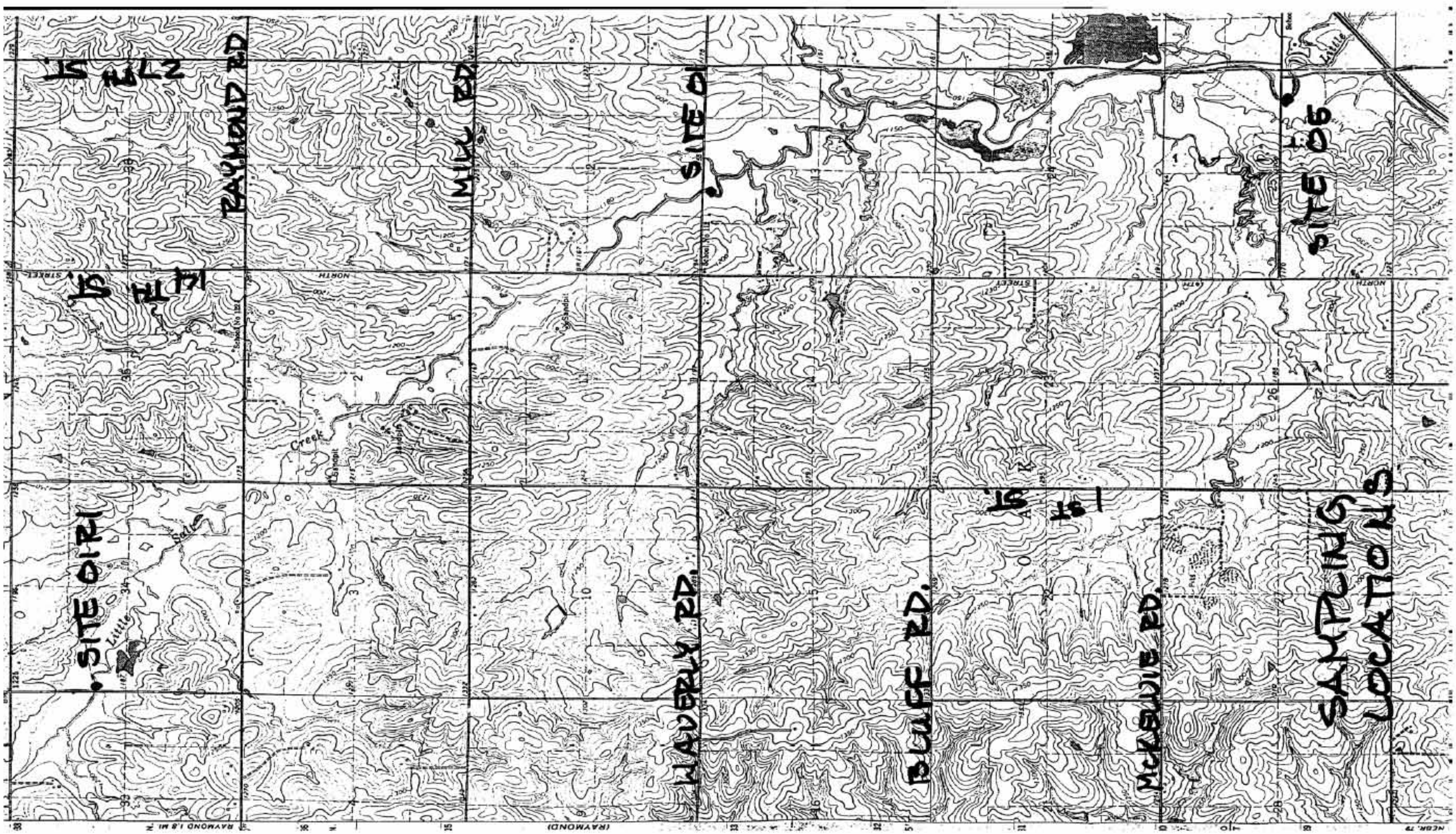
Date 9/17/00 Sheet ____ of ____
Proj. No. 961-102.040
Proj. Name City of Lincoln
Des. By RU Ckd. By ____
Subject Sample Station 05, 27th & Arbor Rd Bridge (Downstream)




RAYMOND RD
MILL RD
SITE 01
SITE 06
WAVERLY RD.
BLUFF RD.
McKELVIE RD.
SAMPLING LOCATIONS