MASTER PLAN FORMULATION

In Section I of this report the results of hydrologic, hydraulic, and stream habitat studies for existing and projected future land use conditions were presented and discussed for the watershed containing Urban Planning Zones S-1, S-2, S-3 and a portion of UPZ S-5. All of the master plan watershed area is identified as Tier I growth area in the Lincoln-Lancaster County Comprehensive Plan (LLCCP).

Proposed components of the stormwater master plan, presented here, are based on what was learned from hydrologic and hydraulic studies and public input from four open houses. The Southeast Upper Salt Creek Stormwater Master Plan will provide a sound basis for discussions regarding making improvements within the watershed, for effective management of stormwater, and protection of urbanized/developed areas from flooding.

Problems/Opportunities

Problems and opportunities have been identified through public involvement and hydraulic analysis of the watershed. They are listed below in no particular order.

- Flow rates for projected urban conditions will reduce stream bed and bank stability between Wilderness Park and South 48th Street extended.
- The lack of a delineated FEMA floodplain and floodway on this drainageway will enable urbanization to encroach to the minimum flood corridor allowed by the Drainage Criteria Manual (DCM), likely increasing flood depths for floods larger than the annual event, and changing stream geomorphology.
- Pollutants associated with projected urbanization will likely degrade the quality of water in the stream and entering Wilderness Park.
- 16 culverts or bridges on public roads in the watershed do not meet minimum hydraulic capacity requirements (see Figure I-13 on page 79).
- 10 houses are in or near the 100-year flood limits for existing conditions.
- Hydraulic and hydrologic evaluation of post development impacts of subdivisions, required by the design standard, does not extend beyond the subdivision property lines.
- The linear nature of a floodplain provides opportunity to develop recreational features in conjunction with urbanization of the watershed that can connect to the existing trail system and provide new multi-purpose use potential between Wilderness Park and the rest of the watershed.
- Urbanization of the watershed is projected to occur within the next 25 years, providing opportunity to proactively address stormwater issues.
- Years of agricultural use, increased flows, and significant sediment from adjacent land limits macroinvertebrate habitat; reducing the biological integrity of the streams in the watershed.
- Riparian corridors have been compromised, the natural channel course and sinuosity have been altered, and increased flows from land use changes have incised the channel and caused unstable banks in some areas.
- Public involvement provides opportunities for public/private partnerships to build master plan components.
- Public involvement makes water quality improvement components eligible and more attractive for NDEQ § 319 funding.
- Master planning provides for orderly implementation of comprehensive plan components.
- Stormwater master planning provides opportunities for preservation and protection of natural environment in urban settings, likely enhancing value of adjacent properties.
- Opportunities are provided for education and outreach programs for water quality BMPs, erosion and sediment control BMPs, and flood control.
- Opportunities are provided for wildlife corridors along stream channels.

These problems and opportunities were used to identify goals and select alternative concept components.

Goals and Objectives

The following goals have been identified through the public involvement process.

- Preserve stream bed and banks that are stable, and improve stability of those at risk
- Reduce flood hazard to existing and future buildings and to infrastructure
- Coordinate components to provide multi-purpose use potential
- Improve water quality and preserve or restore instream and riparian habitat
- Identify funding opportunities

The proposed concept master plan components discussed in this report have been selected to attain those goals. They have been analyzed to determine the degree to which they attain the goals and solve the problems, or take advantage of the opportunities presented in the Southeast Upper Salt Creek (SEUSC) Watershed.

Table MP-1 lists the goals, objectives, and potential alternatives to be considered for inclusion in the stormwater master plan for the SEUSC Watershed.

Table MP-1
Stormwater Master Plan Decision Matrix

Goals - Preserve stream bed and banks that are stable, and improve stability of those at risk - Reduce flood hazard to existing and future buildings and infrastructure - Coordinate components to provide multi-purpose use potential - Improve water quality and preserve or restore instream and riparian habitat - Identify funding opportunities		
Problem/Opportunity Identification	***Objective***	***Alternative***
Stream Stability		
The lack of a FEMA-mapped floodplain and floodway on this drainageway will enable urbanization to encroach to the minimum flood corridor allowed by the Drainage Criteria Manual, likely increasing flood depths for floods larger than the annual event and changing stream geomorphology.	Maintain existing flood profiles	Preserve existing floodplain from development
		Provide compensatory flood storage elsewhere in the watershed
	Preserve stream geomorphology	Preserve existing floodplain from development
Flow rates for projected urban conditions will reduce stream bed and bank stability between Wilderness Park and South 48th Street extended.	Increase stream bed and bank stability	Limit “stream forming” flows to current values by restricting runoff from new development to pre-development rates using a holistic watershed approach
		Stabilize bed and bank with bioengineered solutions designed for projected flows
		Repair stream bed and bank scour as it occurs
		Restore natural channel course and sinuosity
Flood Hazard Reduction		
10 houses are in or near the 100-year flood limits for existing conditions.	Determine flood hazard exposure	Determine low opening and lowest floor elevation for subject buildings
	Reduce hazard to future development	For new construction, require the lowest floor elevation of buildings adjacent to the floodplain be elevated 1-ft above the 100-year water surface profile
		Reduce flood depths to remove buildings from floodplain by constructing upstream storage facilities
	Reduce public responsibility for flood damage repair	Require flood insurance policies on affected buildings and contents
		Delineate FEMA FIS floodplain
		Enforce current FEMA floodplain regulations on new development in anticipated floodplain

Goals - Preserve stream bed and banks that are stable, and improve stability of those at risk
- Reduce flood hazard to existing and future buildings and infrastructure
- Coordinate components to provide multi-purpose use potential
- Improve water quality and preserve or restore instream and riparian habitat
- Identify funding opportunities

Problem/Opportunity Identification	***Objective***	***Action***
Flood Hazard Reduction (continued)		
16 culverts or bridges on public roads in the watershed do not meet minimum hydraulic capacity requirements.	Improve bridge or culvert capacity	Raise roadway to temporarily store excess flows and obtain flood storage easements
		Increase structure capacity by adding supplemental barrels or replacing with a larger structure
		Reduce flow rates to capacity values of existing structures
Hydraulic and hydrologic evaluation of post development impacts of subdivisions does not extend beyond the subdivision property lines.	Determine incremental impact of subdivisions	Use watershed hydrologic and hydraulic model to perform holistic watershed evaluation of proposed subdivisions
Multi-Purpose Use Potential		
The linear nature of a floodplain provides opportunity to develop recreational features in conjunction with urbanization of the watershed that can connect to the existing trail system and provide new multi-purpose use potential between Wilderness Park and the rest of the watershed.		Incorporate hiking/biking paths along stream channel in the watershed
Urbanization of the watershed is projected to occur within the next 25 years, providing opportunity to proactively address stormwater issues.		Preserve existing floodplain from development
Master planning provides for orderly implementation of comprehensive plan components.		
Opportunities are provided for water quality BMPs, erosion and sediment control BMPs, and flood control education and outreach programs.		
Water Quality Improvement		
Pollutants associated with projected urbanization will likely degrade the quality of water in the stream and entering Wilderness Park.	Reduce urban pollutants from stormwater runoff	Implement source control BMPs for pesticide, herbicide, phosphorus, nitrogen and bacteria pollutants through education efforts
		Capture urban pollutants in created wetlands
		Require installation of permanent water quality BMPs in urban subdivisions
		Improve erosion and sediment controls during construction

Goals - Preserve stream bed and banks that are stable, and improve stability of those at risk
- Reduce flood hazard to existing and future buildings and infrastructure
- Coordinate components to provide multi-purpose use potential
- Improve water quality and preserve or restore instream and riparian habitat
- Identify funding opportunities

Problem/Opportunity Identification	***Objective***	***Action***
Water Quality Improvement (continued)		
Riparian corridors have been compromised, the natural channel course and sinuosity have been altered, and increased flows from land use changes have incised the channel and caused unstable banks in some areas.	Restore stream to pre-agricultural alignment	Preserve and enhance riparian corridors in proposed developments
Years of agricultural activity, increased flows, and significant sediment from adjacent land limits macroinvertebrate habitat, reducing the biological integrity of the streams in the watershed.	Restore stream to pre-agricultural alignment	Obtain enough stream corridor width to recreate or restore historic meanders and allow for dynamic equilibrium
	Improve instream habitat	Create riffle and pool complexes in the streams
		Install riprap grade check structures
Loss of riparian habitat due to development in the floodplain	Re-establish riparian habitat	Preserve a riparian buffer zone
Provides opportunities to maintain existing or re-establish historic wildlife corridors along stream channels.		
Funding		
Public involvement process provides opportunities for public/private partnerships to build master plan components.	Enhance eligibility for state and federal cost share	Encourage public/private partnerships in mutually beneficial master plan components
Public involvement process makes water quality improvement components eligible for, and more attractive for NDEQ § 319 funding.		Apply for NDEQ § 319 funding for constructed water quality wetlands
Stormwater master planning provides opportunities for preservation and protection of natural environment in urban settings, likely enhancing value of adjacent properties.		

STREAM STABILITY

Changing stream flow characteristics can change the interaction with subbasin flows or discharges entering the channel and upset stream equilibrium. "Streams and stream corridors evolve in concert with and in response to surrounding ecosystems. Changes within a surrounding ecosystem (e.g., watershed) will impact the physical, chemical and biological processes occurring within a stream corridor. Stream systems normally function within natural ranges of flow, sediment movement, temperature, and other variables, in what is termed "dynamic equilibrium." When changes in these variables go beyond their natural ranges, dynamic equilibrium may be lost, often resulting in adjustments in the ecosystem that might conflict with societal needs. In some circumstances, a new dynamic equilibrium may eventually develop, but the time frames in which this happens can be lengthy, and the changes necessary to achieve this new balance significant." (Stream Corridor Restoration, 1998)

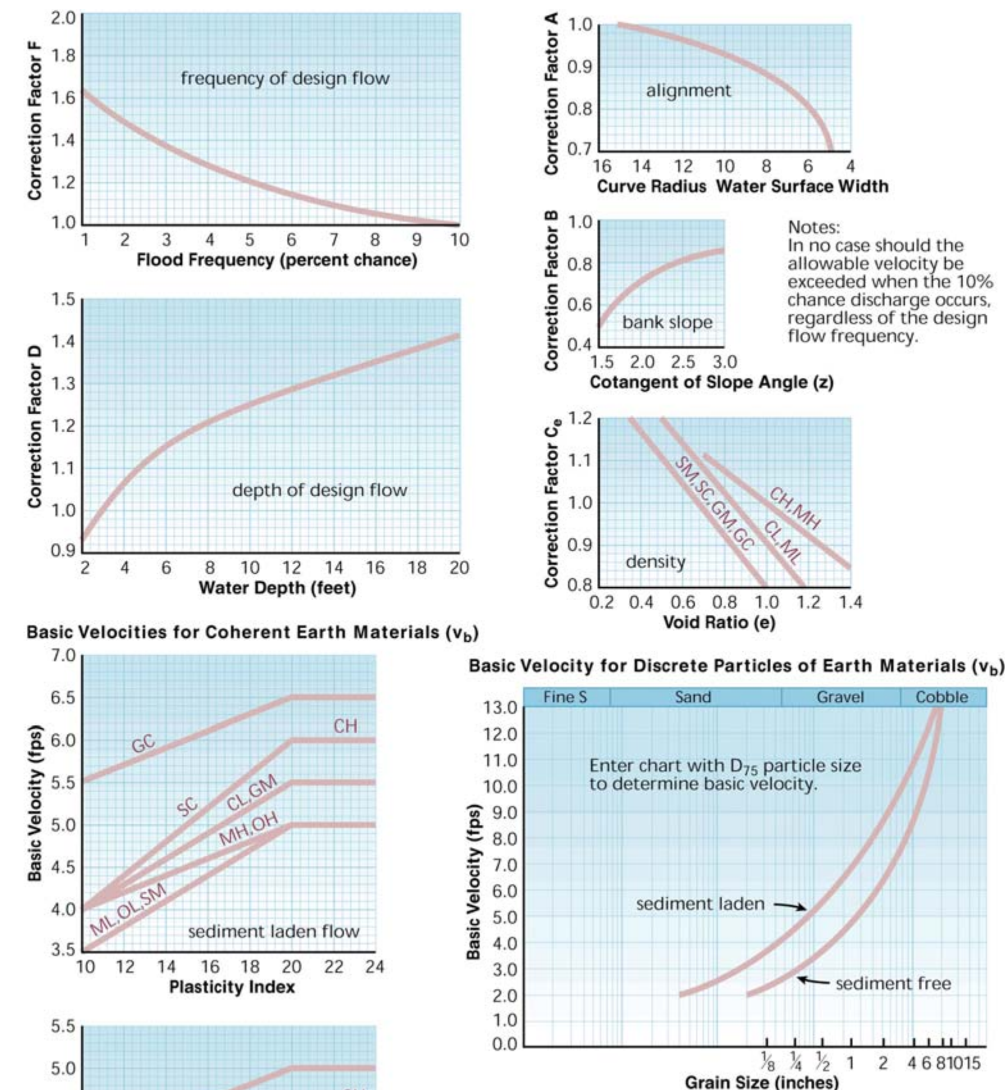
Projected urbanization of the SEUSC Watershed will place heavy demands on the stream and stream corridor, likely upsetting the "dynamic equilibrium" of the stream system.

The existing stream system shows a few signs of instability. The channel between the Burlington Northern and Santa Fe (BNSF) Railroad Bridge, as well as just downstream of South 40th Street, currently experiences erosive velocities, and the allowable velocities for unprotected channels are exceeded in these locations.

Bank stability is affected by two groups of forces; those due to the action of water on the stream bank surface, and those due to subsurface geotechnical characteristics.

One tool used to forecast erosion due to the action of water is presented in "Stream Corridor Restoration". It is based on "published tables regarding the maximum nonscouring velocity for given channel boundary materials. Different versions of these tables have appeared in numerous, subsequent documents; notably Simons and Senturk (1977) and USACE (1991). The applicability of those tables is limited to relatively straight silt and sand-bed channels with depths of flow less than 3 ft and very low bed material loads. Adjustments to velocities have been suggested for situations departing from those specified, see below.

Figure MP-1 [Figure 8.31 of "Stream Corridor Restoration"] depicts a series of graphs that summarize the tables and aid in selecting correction factors for flow depth, sediment concentration, flow frequency, channel curvature, bank slope, and channel boundary soil properties. Use of the allowable velocity approach is not recommended for channels transporting a significant load of material larger than 1 mm." The alluvial soils found in the SEUSC floodplain consist of particles that pass the No. 40 sieve, (0.425 mm openings), based in Lancaster County Soil Survey Data. Figure MP-1 was used to determine allowable velocities for SEUSC Watershed channels in addition to soil information from the Lancaster County Soil Survey.



Allowable Velocities for Unprotected Earth Channels	
Channel Boundary Materials	**Allowable Velocity**
Discrete Particles	
Sediment Laden Flow	
$D_{75} > 0.4$mm	basic velocity chart value x D x A x B
$D_{75} < 0.4$mm	2.0 fps
Sediment Free Flow	
$D_{75} > 0.2$mm	basic velocity chart value x D x A x B
$D_{75} < 0.2$mm	2.0 fps
Coherent Earth Materials	
PI > 10	basic velocity chart value x D x A x F x C_e
PI < 10	2.0 fps

Source: USDA Soil Conservation Service, 1977.

Fig. 8.31 -- Allowable velocities for unprotected earth channels. Curves reflect practical experience in design of stable earth channels.
In Stream Corridor Restoration: Principles, Processes, and Practices, 10/98.
Interagency Stream Restoration Working Group (FISRWG)(15 Federal agencies of the US).

Figure MP- 1
Allowable Velocities

A tool used to predict approximate erosion of channel banks due to subsurface geotechnical characteristics is determination of critical bank height.

Critical bank height is a function of the soil density, friction angle, and degree of saturation. When the combination of bank height and channel bank slope is less than critical bank height for corresponding slope for saturated conditions, the bank is considered stable. If the combination of bank height or slope is less than critical bank height for dry conditions, but above for saturated values, the bank is considered to be “at-risk”. The bank is considered unstable when the combination of bank height and slope is greater than critical bank height for dry conditions (see Figure MP-2).

The channel depth in the reaches upstream and downstream of South 27th Street are “at-risk” bank heights for the alluvial soils typical of the watershed’s floodplain. The rest of the channels in the watershed are in the stable zone of Figure MP-2. The scour threat is due to erosive forces in excess of the characteristics of the bed and bank soils.

Stream flow data for existing and projected conditions were used to identify stream reaches where channel velocities exceed allowable velocities for bed and bank soils. Figure MP-3 shows the channel scour threat locations for existing conditions and projected conditions with the floodplain preserved. Approximately 10,000 linear feet of channel is currently at-risk, and approximately an additional 3,200 linear feet of channel will likely be at-risk for projected conditions with preserved floodplain. Figure MP-4 shows the channel scour threat locations for existing conditions and projected conditions with the minimum corridor preserved. An additional 8,800 linear feet of channel will likely be at-risk for projected conditions. If a 400-ft corridor is preserved, the channel conditions for the channel forming flows are nearly the same as if the 100-year existing floodplain were preserved.

Stream geomorphological data is presented in Table MP-2. Stream type characterization is useful for predicting a river’s behavior. David L. Rosgen developed a stream classification system based on discrete combinations of stream feature data. Data includes entrenchment, width and depth ratio, sinuosity, and channel material type. The streams in SEUSC are Rosgen’s Type E-6 streams. Type E-6 streams are slightly entrenched, have a low width/depth ratio, variable sinuosity, flat slope, and silty/clay channel material. They generally have:

- Very high sensitivity to disturbance (i.e., flow magnitude)
- Good recovery potential once the cause of instability is corrected
- Low sediment supply
- Moderate stream bank erosion potential
- Very high sensitivity to the influence of stream bank vegetation

(From Table 3 “Management Interpretation of Various Stream Types” Applied Fluvial Geomorphology, Rosgen, 1994)

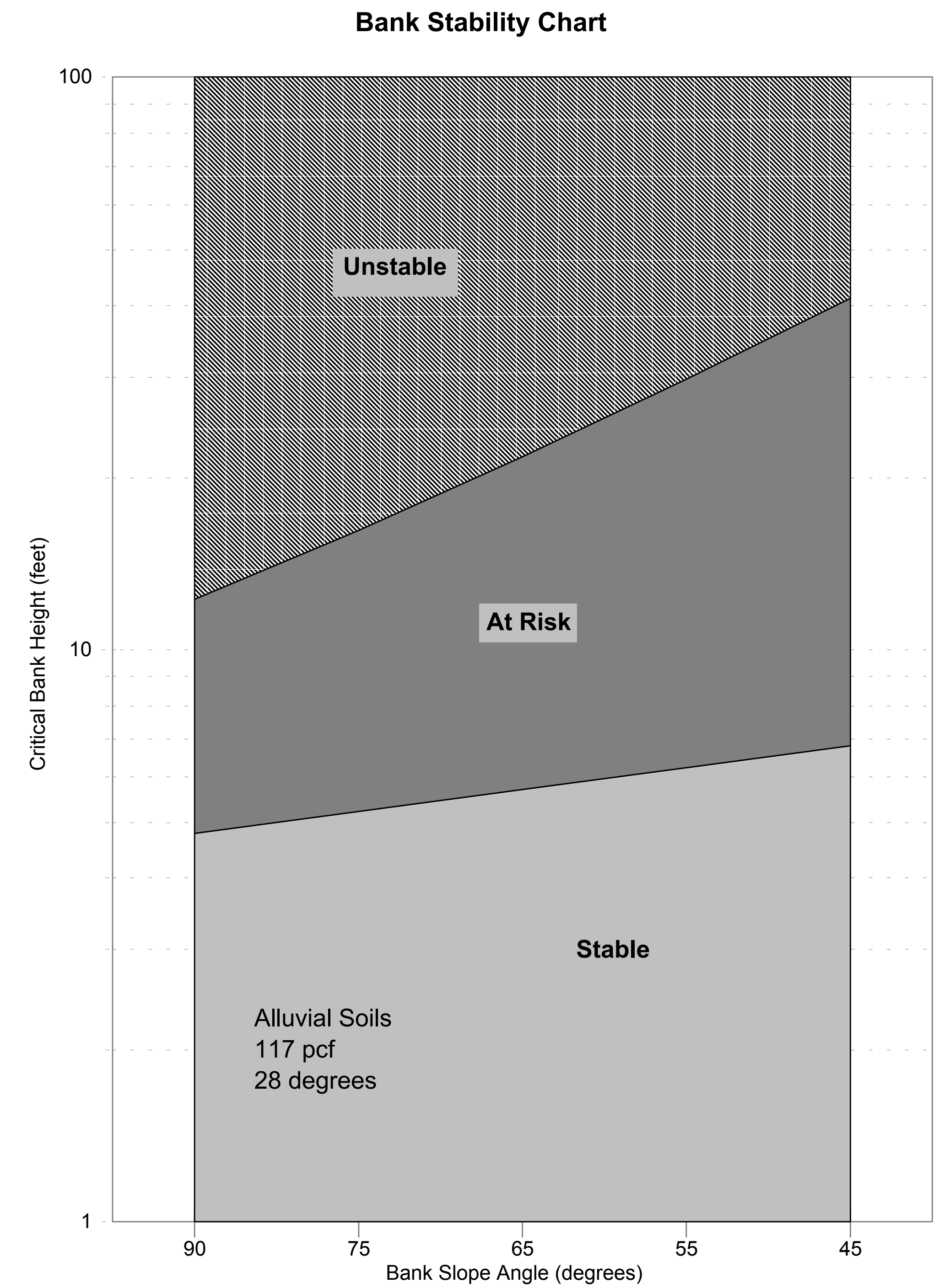


Figure MP-2
Bank Stability Chart

Insert
Figure MP-3
Channel Scour Threat - Floodplain Preserved

Insert
Figure MP-4
Channel Scour Threat - Minimum Corridor Preserved

Table MP-2
Stream Geomorphological Data

Stream Segment	Stream Subsegment Description (if required)	W_{FP}	W_{BF}	D_{BF}	L_{ST}	L_V	Entrenchment (W_{FP}/W_{BF})	W_{BF}/D_{BF} Ratio	Sinuosity (L_{ST}/L_V)	Slope	Channel Material	Rosgen's Stream Type*
Mainstem												
1		80	20	5	2,200	2,200	4	4.0	1.0	0.004	Silt/Clay	E6
2		100	50	10	2,600	2,600	2	5.0	1.0	0.007	Silt/Clay	E6
3a	Salt Creek Floodplain	N/A	20	10	1,010	1,010	N/A	2.0	1.0	0.001	Silt/Clay	E6
3b	US 27th Street	900	15	10	2,790	2,300	60	1.5	1.2	0.004	Silt/Clay	E6
4a	DS tributary	450	25	9	2,310	2,310	18	2.8	1.0	0.005	Silt/Clay	E6
4b	US tributary	500	10	5	3,950	2,050	50	2.0	1.9	0.003	Silt/Clay	E6
5		200	10	4	3,290	2,950	20	2.5	1.1	0.007	Silt/Clay	E6
6a	DS Cromwell Drive	200	20	6	1,490	1,250	10	3.3	1.2	0.003	Silt/Clay	E6
6b	US Cromwell Drive	300	20	6	2,600	1,550	15	3.3	1.7	0.006	Silt/Clay	E6
7a	DS 63rd Extended	200	10	2	2,790	2,750	20	5.0	1.0	0.010	Silt/Clay	E6
7b	US 63rd Extended	50	8	4	1,620	1,300	6	2.0	1.2	0.002	Silt/Clay	E6
7c	US 66th Street	80	20	3	500	500	4	6.7	1.0	0.008	Silt/Clay	E6
Tributaries												
8		200	9	3	3,800	3,280	22	3.0	1.2	0.007	Silt/Clay	E6
9		80	12	4	1,800	1,550	7	3.0	1.2	0.007	Silt/Clay	E6
10		90	8	2	4,000	1,750	11	4.0	2.3	0.004	Silt/Clay	E6
11		40	10	2	4,790	3,650	4	5.0	1.3	0.004	Silt/Clay	E6
12	Salt Creek Floodplain	N/A	30	2	4,800	4,800	N/A	15.0	1.0	0.000	Silt/Clay	E6
13		1,600	40	4	2,580	2,580	40	10.0	1.0	0.010	Silt/Clay	E6
14		200	15	2	4,260	3,650	13	7.5	1.2	0.012	Silt/Clay	E6
15a	Salt Creek Floodplain	N/A	15	2	2,300	2,300	N/A	7.5	1.0	0.000	Silt/Clay	E6
15b	US Salt Creek FP	100	40	2	200	200	3	20.0	1.0	0.014	Silt/Clay	E6

*Based on method developed by David L. Rosgen, "Applied Stream Morphology", 1994 and republished in "Stream Corridor Restoration", 1998.

W = Width, ft
D = Depth, ft
L = Length, ft

FP = Flood-prone (approximately 0.02 to 0.10 annual probability)
BF = Bankfull
ST = Stream
V = Valley

Stream Management Alternatives

Selection of stream management alternatives can be guided by the use of Rosgen's stream classification methods. "The ability to predict a river's behavior from its appearance and to extrapolate information from similar stream types"[1] can be used to evaluate the effects of management measures on streams.

Bank sloping and planting involves excavation of the existing channel bank to a stable slope (3:1 was used to determine approximate quantities, geotechnical analysis during preliminary design must be performed to determine site specific values) and planting vegetation appropriate for the region and for the site-specific habitat. In acknowledgment of the prairie habitat, and to account for the Corps of Engineers 404 Permit tree removal mitigation requirements, a biological approach with a planting mix containing 60% trees and shrubs and 40% grasses, by area, and vertical banks excavated to 3:1 side slopes were used for purposes of preparing opinions of probable cost for these concept components.

Stone-toe protection involves installation of rock riprap at the toe of the channel bank to resist erosive stream forces. A 3-ft thick layer of 12" riprap with a width proportionate to the bank height was used to prepare opinions of probable cost for these concept components.

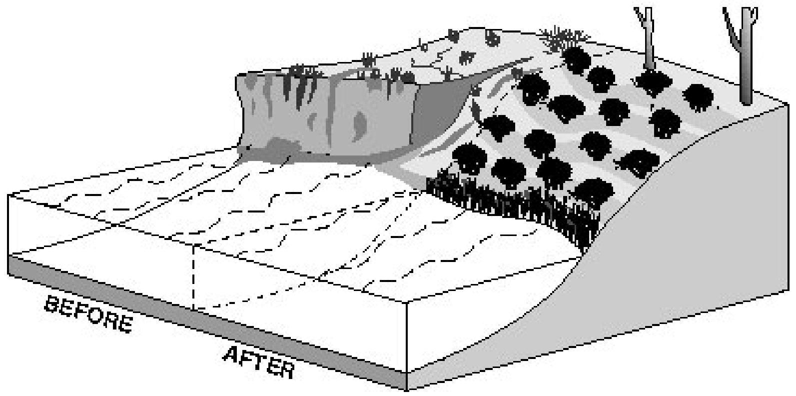
Extensive planting involves a higher performing plant schedule to accommodate increased erosive forces, and it would increase the cost of the plantings described above. Double the planting cost was used to prepare opinions of probable cost for this component.

Vegetated gabions involve rock-filled wire baskets with live branch cuttings installed between rows of gabions that can provide both bank stability and erosion resistance functions. They can be used at transitions with "hard" structures such as bridges and culverts, and in reaches where the softer approaches provide insufficient erosion protection or require too much width. A single tier of 3-ft x 3-ft gabions was used for channel with bank heights of 2 to 4 ft. For bank heights of 5 to 8 ft, a double base row of gabions would support a second tier of gabions. A third row of gabions was added to that configuration for bank heights of 9 to 10 ft.

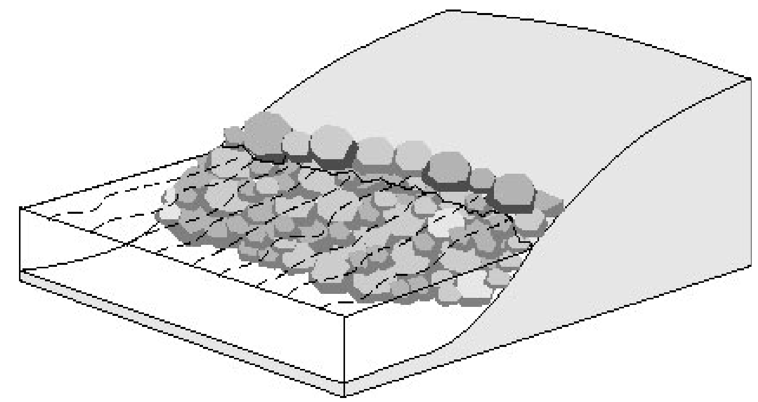
Master plan components are evaluated at concept-level detail. Design of bioengineering solutions for stream stability improvement and stream restoration must consider site-specific conditions, and requires an understanding of complex stream corridor ecosystems that are most appropriately handled during preliminary and final design efforts. If a bioengineered solution is justified by the goals and objectives for the stream reach, then the physical, chemical, and biological processes of the subject reach must be evaluated and understood during the design process in order for the restoration to be successful.

Typical bioengineered bank stability practices include; toe protection, bank sloping, and use of vegetative protection of the bank (brush mattresses, appropriate plantings, live fascines, etc.) for channels where moderate erosion and channel migration is expected. Use of vegetated gabions, vegetated geogrid, or joint planting in riprap for channels where some form of structural protection is needed. Figure MP-5 illustrates six potential approaches to a bioengineering solution.

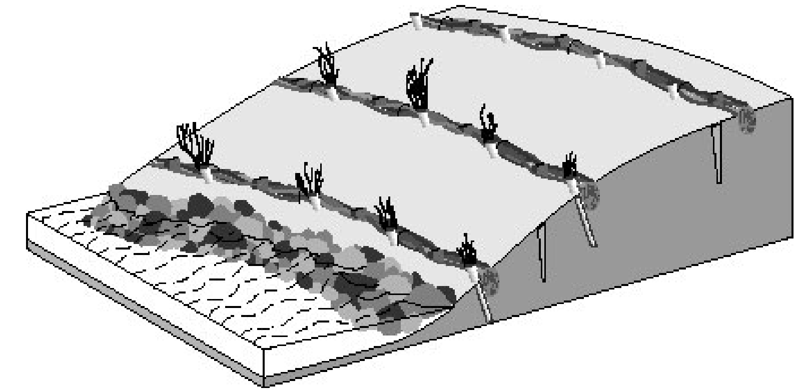
[1] D.L. Rosgen, "Applied Fluvial Geomorphology", 1994



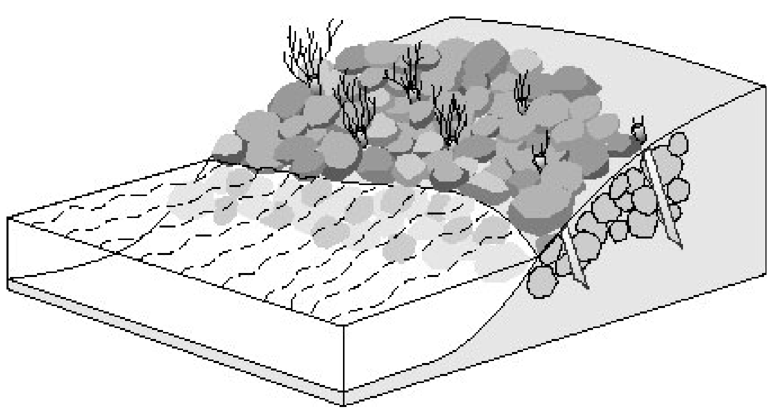
Bank Shaping



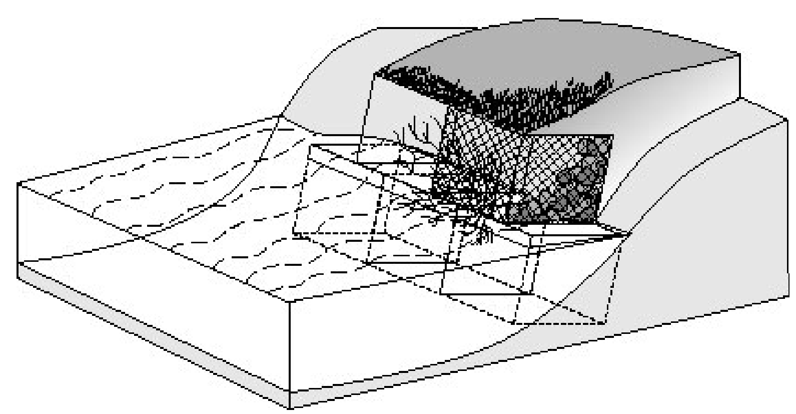
Stone-Toe Protection



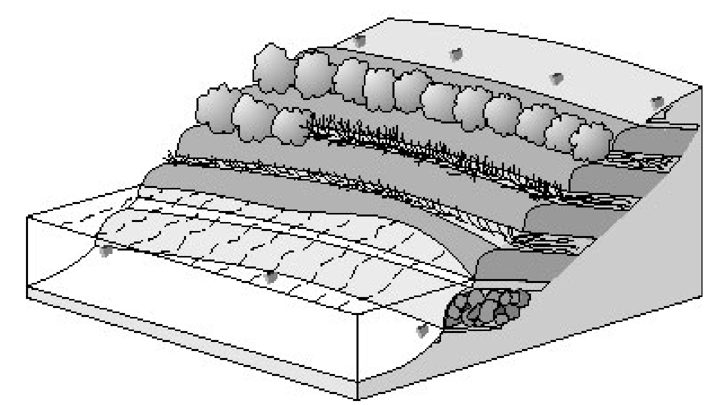
Live Fascines



Joint Planting



Vegetated Gabion



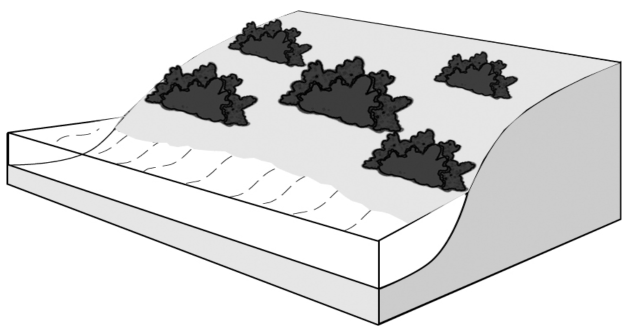
Vegetated Geogrid

Figure MP-5 - Example Bioengineering Approaches

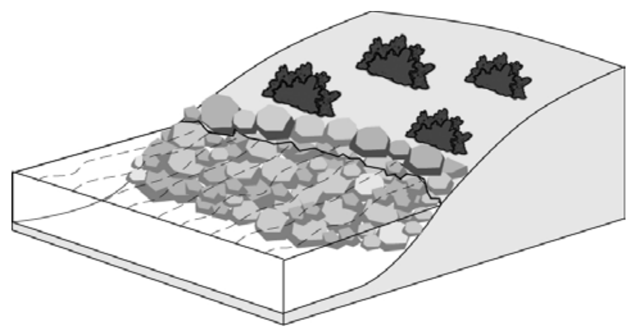
Source: “<u>Stream Corridor Restoration</u>”

Bioengineering Concept Alternatives

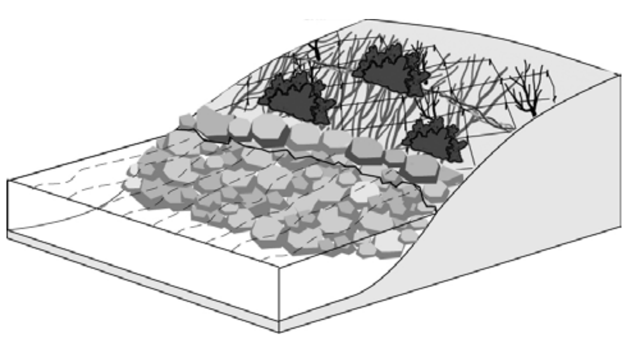
Alternatives are presented (Figure MP-6) for concept components in the master plan for four threat conditions: 1) low erosion potential; has low stream velocity, below bare soil erosion threshold, low shear stress forces, and stable stream bed, 2) moderate erosion potential; has moderate stream velocities of or slightly above bare soil erosion threshold, shear stress at or near soil resistance values, and some potentials for existing stream bed instability, 3) high erosion potential; has moderate stream velocities below a vegetated slope threshold, shear stress below well vegetative soil resistance values, and some potential for or existing stream bed instability, and 4) transitions to bridges, culverts and other "hard" practices; areas of high velocity and shear stress that require non-vegetative erosion protection. They use one or more of the components presented above. Other components may be determined to be appropriate during preliminary and final design.



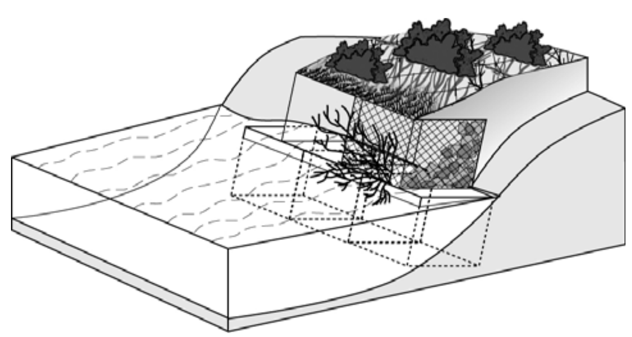
Bioengineering Concept 1
Bank Shaping and Planting



Bioengineering Concept 2
Bank Shaping, Planting & Stone-Toe Protection



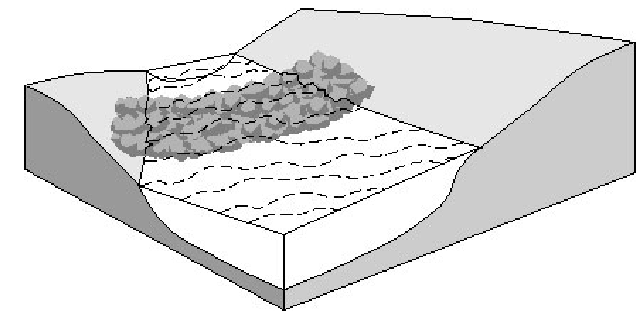
Bioengineering Concept 3
Bank Shaping, Stone-Toe Protection,
and Extensive Planting



Bioengineering Concept 4
Vegetated Gabions and Planting

Figure MP-6
Adapted from "Stream Corridor Restoration"

Stream stability can be improved by several methods, dependent on the cause of instability and desired objectives. In reaches where bank heights exceed critical bank heights, banks can be "laid back" to stable slopes, and the effective height can be restored to previously stable values using grade checks, see Figure MP-7.



Riprap Grade Check Structure
Figure MP-7
Source: "Stream Corridor Restoration"

Traditional "hard" engineered solutions could also be used, such as concrete-lined trapezoidal channels; however, the environmental benefits afforded by softer approaches are gaining wider recognition and bioengineered solutions are being used where appropriate.

Stream stability could also be enhanced by reducing the stream forming flows to non-erosive values by limiting discharges into the mainstem from subbasins with projected land use changes. Stormwater storage, for up to the 1-year or 2-year event, could be incorporated into proposed constructed water quality wetlands with bypass facilities to divert severe storms around the wetland.

Bioengineered approaches should be built before, or as the adjoining property urbanizes, rather than waiting until instability problems develop. Repairing stream and bed scour as it occurs would lead to a patch work of practices, and likely result in transferring problems elsewhere in the channel.

A matrix of bioengineering conceptual applications is presented in Table MP-3. The table presents conceptual unit costs for applications based on the threat level and channel depth. For example, a nine-ft deep channel with a moderate erosion potential would be in depth Zone C and would be treated with Concept 2. The components of Concept 2 are bank shaping, planting and stone-toe protection, and would have a conceptual unit cost at $400 per foot of channel.

Buried utilities and support structures of overhead utilities should be installed below anticipated scour depths and outside anticipated meander limits.

Table MP-3
Bioengineering Component Matrix

<table>
<tr><th rowspan="2">Channel Bank Height (ft)</th><th rowspan="2">Depth Zone</th><th colspan="5">Approximate Unit Prices for Bioengineering Component Construction*</th></tr>
<tr><th>Bank Shape</th><th>Planting</th><th>Stone-Toe Protection</th><th>Extensive Planting</th><th>Vegetated Gabion</th></tr>
<tr><td>2 to 4</td><td>A</td><td>$10</td><td>$6</td><td>$40</td><td>$12</td><td>$70</td></tr>
<tr><td>5 to 8</td><td>B</td><td>$100</td><td>$90</td><td>$60</td><td>$180</td><td>$200</td></tr>
<tr><td>9 to 10</td><td>C</td><td>$200</td><td>$120</td><td>$80</td><td>$240</td><td>$270</td></tr>
<tr><th colspan="2">Threat Level</th><th colspan="5">Application</th></tr>
<tr><td colspan="2">Low Erosion Potential</td><td colspan="2">Concept 1</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Moderate Erosion Potential</td><td colspan="3">Concept 2</td><td></td><td></td></tr>
<tr><td colspan="2">High Erosion Potential</td><td>Concept 3</td><td></td><td colspan="2">Concept 3</td><td></td></tr>
<tr><td colspan="2">Transitions</td><td></td><td>Concept 4</td><td></td><td></td><td>Concept 4</td></tr>
</table>

*Values are per foot of channel treating both banks

The following unit prices were used to help prepare the opinions of probable costs in the previous table.

Item	Unit Price
Earthwork	$5/CY
Planting	$14,500/Acre
Stone-Toe Protection	$40/CY
Extensive Planting	$29,000/Acre
Vegetated Gabions	$100/CY
Grade Check Structure	$50,000/EA

Table MP-4
Opinion of Probable Cost for Bioengineering Concept Alternatives

Stream Segments	Depth Zone	Preserved Floodplain				Preserved Minimum Corridor			
		Affected Length	Threat Level	Proposed Concept	Cost	Affected Length	Threat Level	Proposed Concept	Cost
1	B	1,800	Low	1 & Grade Check	$510,000	1,800	Low	1 & Grade Check	$510,000
2	C	0	Moderate	-	$0	0	Moderate	-	$0
3	C	2,100	Moderate	1 & 2 Grade Checks	$1,004,000	3,700	Moderate	3 & 2 Grade Checks	$2,631,000
4a	C	700	Moderate	1	$291,000	2,400	Moderate	3	$1,622,000
4b	B	2,100	Moderate	1 & 2 Grade Checks	$649,000	2,100	Moderate	1 & 2 Grade Checks	$649,000
5	B	0		-	$0	0		-	$0
6	B	0		-	$0	0		-	$0
7	A	0		-	$0	0		-	$0
8	A	1,200	Moderate	1	$25,000	2,700	Moderate	2	$197,000
9	A	700	Moderate	1	$15,000	700	Moderate	2	$51,000
10	A	0		-	$0	0		-	$0
11	A	2,000	Low	1	$42,000	2,000	Low	1	$42,000
12	A	0		-	$0	0		-	$0
13	A	500	Moderate	1	$10,000	500	Moderate	2	$36,000
14	A	3,700	Moderate	1	$77,000	3,700	Moderate	2	$269,000
15	A	500	Moderate	1	$10,000	500	Moderate	2	$36,000
Total		15,300			$2,633,000	20,100			$6,043,000

Engineering design, biologic evaluation, and construction observation is 30% of the opinion of probable cost of construction. Bioengineered concepts would be contained within the minimum corridor so no land rights costs are included in the opinion of probable costs.

FLOOD HAZARD REDUCTION

FLOODPLAIN PRESERVATION

As watersheds urbanize, pressures to develop in flood prone areas increase. This watershed is in the Tier I growth area, which is expected to develop within the next 25 years. There is no FEMA-mapped floodplain delineated in this watershed.

Preserving the Minimum Flood Corridor

The City of Lincoln Stormwater regulations require that in all watersheds where an FEMA-mapped floodplain has not been delineated, development shall preserve stream corridors with a minimum width equal to the channel bottom width, plus 60 ft, plus six times the channel depth. The corridor width will be centered on the channel and be delineated along all channels with a drainage area exceeding 150 acres. Flood corridors delineated during development, whether they be the minimum corridor or the entire floodplain, must be legally described and recorded.

The minimum corridor is intended to provide developers with a method to preserve some flood conveyance without the expense of undertaking a watershed study. Existing maximum channel depths in each reach were used to calculate the minimum corridor widths used in this master plan.

If development occurs in flood prone areas of the SEUSC Watershed prior to delineation of a FEMA floodplain, a minimum corridor will be required. If only the minimum corridor is preserved and the balance of the floodplain storage is eliminated, flow rates will increase 40 to 45% for the 2-year, 15 to 20% for the 10-year and 10-20% for the 100-year events, unless the lost floodplain storage is mitigated with storage elsewhere in the watershed. See Tables MP-5, MP-6 and MP-7. Channel velocities and depth of flow will also increase, aggravating existing or instigating new channel stability problems in affected reaches. New development adjacent to minimum corridors is required to be at or above the 100-year water surface profile determined for projected land use conditions upstream. This will reduce the flood hazard for adjacent new development, but would require higher bridges and roadways to prevent overtopping, increasing bridge replacement costs, potentially increase the flood hazard to existing upstream or downstream properties, and alter stream hydraulics and adversely affect channel geomorphology. The developer is also required to evaluate channel velocities and demonstrate that the natural condition, or proposed alternative cross-section, will provide stable stream bed and bank conditions.

Preserving the Floodplain

If the entire floodplain is preserved to the limits of the existing 100-year flood, flow rates and velocities will increase as development occurs. However, the amount of increase will be substantially less than would occur if only the minimum corridor is preserved. Existing overbank storage areas can attenuate increases in flood flow rates and velocities due to projected development. If development occurs in the SEUSC Watershed and the floodplain is preserved, flow rates will increase 10 to 15% for the 2-year due to increased impervious areas, but decrease 5 to 10% for the 10-year and the 100-year storms, see Tables MP-5, MP-6 and MP-7.

New development adjacent to the preserved floodplain would be required to be at or above the 100-year water surface profile determined with projected land use conditions upstream. This would reduce the flood hazard for new development, and roadway embankments will need to be raised less than if the minimum corridor is preserved.

Preserving a 400-ft Flood Corridor

During the public involvement process, it was suggested that stormwater storage facilities and a flood corridor could be combined to result in a 100-year flood profile below South 40th Street that would approximate the 100-year flood profile if the existing floodplain were preserved. Through an iterative modeling process, a 400-ft corridor was determined to best match the desired profile. The 400-ft corridor in conjunction with stormwater storage facilities provides enough floodplain storage to mitigate the effects of the loss of the entire floodplain capacity. This also provides the same stream scour conditions as preserving the existing floodplain.

Table MP-5
2-Year Peak Flow Rate Values at Selected Locations

Location	Model Element		Existing	Projected w/ Minimum Corridor		Projected w/ 100-yr Existing Floodplain		Projected w/ 400-ft Flood Corridor	
	HEC-1	HEC-RAS	Q-cfs	Q-cfs	% Change	Q-cfs	% Change	Q-cfs	% Change
Mainstem									
Rokeby Road	202	25,159	177	157	-11%	157	-11%	49	-72%
South 66th Street	66TH	24,449	169	150	-11%	150	-11%	41	-76%
South 56th Street	56THB	20,036	545	489	-10%	489	-10%	352	-35%
Cromwell Road	NODE62	17,440	734	687	-6%	687	-6%	554	-25%
South 40th Street	40THB	12,655	908	934	3%	899	-1%	813	-10%
Tributary Confluence	NODE25	8,707	1,249	1,748	40%	1,423	14%	1,035	-17%
Rokeby Road	ROKEBY	6,395	1,383	1,984	43%	1,606	16%	1,222	-12%
South 27th Street	27THB	3,607	1,430	2,080	45%	1,607	12%	1,313	-8%
BNSF Railroad	BNSF	2,600	1,427	2,073	45%	1,587	11%	1,684	18%
Salt Creek	R6A	2,491	1,427	2,057	44%	1,451	2%	1,662	16%
Northeast Tributary									
Rebel Drive	REBEL	9,430	257	257	0%	257	0%	257	0%
South 56th Street	56THA	8,265	179	179	0%	179	0%	179	0%
South 53rd Street	S53RD	7,195	178	178	0%	178	0%	178	0%
Private Drive	R22	6,120	275	275	0%	275	0%	275	0%
Private Drive	R22	5,670	275	275	0%	275	0%	275	0%
Southwest Tributary									
South 40th Street	S2T	500	233	419	80%	419	80%	419	80%
Southcentral Tributary									
New Castle Road	CLV310	310	164	164	0%	164	0%	164	0%
Southeast Tributary									
Rokeby Road	201	464	243	206	-15%	206	-15%	134	-45%
Northwest Tributary									
Yankee Hill Road	YANKB	5,700	167	167	0%	167	0%	167	0%
South 40th Street	40THA	3,875	253	332	31%	332	31%	332	31%
Saltillo Road	SALTIL	1,466	637	1,062	67%	1,075	69%	1,020	60%
So. 38th St. (north)	S38TH	7,280	322	428	33%	408	27%	255	-21%
So. 38th St. (south)	S5E	3,706	120	203	69%	203	69%	161	34%

Table MP-6
10-Year Peak Flow Rate Values at Selected Locations

Location	Model Element		Existing	Projected w/ Minimum Corridor		Projected w/ 100-yr Existing Floodplain		Projected w/ 400-ft Flood Corridor	
	HEC-1	HEC-RAS	Q-cfs	Q-cfs	% Change	Q-cfs	% Change	Q-cfs	% Change
Mainstem									
Rokeby Road	202	25,159	341	319	-6%	319	-6%	47	-86%
South 66th Street	66TH	24,449	344	325	-6%	325	-6%	47	-86%
South 56th Street	56THB	20,036	1,200	1,164	-3%	1,164	-3%	821	-32%
Cromwell Road	NODE62	17,440	1,557	1,525	-2%	1,525	-2%	1,209	-22%
South 40th Street	40THB	12,655	2,216	2,286	3%	2,171	-2%	2,017	-9%
Tributary Confluence	NODE25	8,707	3,193	3,634	14%	2,954	-7%	2,353	-26%
Rokeby Road	ROKEBY	6,395	3,387	4,039	19%	3,240	-4%	2,628	-22%
South 27th Street	27THB	3,607	3,519	4,309	22%	3,419	-3%	2,854	-19%
BNSF Railroad	BNSF	2,600	3,500	4,311	23%	3,408	-3%	3,632	4%
Salt Creek	R6A	2,491	3,500	4,325	24%	3,043	-13%	3,485	0%
Northeast Tributary									
Rebel Drive	REBEL	9,430	612	612	0%	612	0%	612	0%
South 56th Street	56THA	8,265	609	609	0%	609	0%	609	0%
South 53rd Street	S53RD	7,195	533	533	0%	533	0%	533	0%
Private Drive	R22	6,120	700	700	0%	700	0%	700	0%
Private Drive	R22	5,670	700	700	0%	700	0%	700	0%
Southwest Tributary									
South 40th Street	S2T	500	471	766	63%	766	63%	766	63%
Southcentral Tributary									
New Castle Road	CLV310	310	328	328	0%	328	0%	272	-17%
Southeast Tributary									
Rokeby Road	201	464	506	461	-9%	461	-9%	251	-50%
Northwest Tributary									
Yankee Hill Road	YANKB	5,700	371	371	0%	371	0%	371	0%
South 40th Street	40THA	3,875	507	612	21%	612	21%	612	21%
Saltillo Road	SALTIL	1,466	1,445	2,151	49%	2,109	46%	2,022	40%
So. 38th St. (north)	S38TH	7,280	660	855	30%	786	19%	487	-26%
So. 38th St. (south)	S5E	3,706	257	390	52%	390	52%	300	17%

Table MP-7
100-Year Peak Flow Rate Values at Selected Locations

Location	Model Element		Existing	Projected w/ Minimum Corridor		Projected w/ 100-yr Existing Floodplain		Projected w/ 400-ft Flood Corridor	
	HEC-1	HEC-RAS	Q-cfs	Q-cfs	% Change	Q-cfs	% Change	Q-cfs	% Change
Mainstem									
Rokeby Road	202	25,159	537	517	-4%	517	-4%	51	-91%
South 66th Street	66TH	24,449	535	516	-4%	516	-4%	51	-90%
South 56th Street	56THB	20,036	2,004	1,992	-1%	1,992	-1%	1,411	-30%
Cromwell Road	NODE62	17,440	2,668	2,639	-1%	2,639	-1%	2,050	-23%
South 40th Street	40THB	12,655	3,933	4,031	2%	3,836	-2%	3,510	-11%
Tributary Confluence	NODE25	8,707	5,734	6,217	8%	5,207	-9%	4,085	-29%
Rokeby Road	ROKEBY	6,395	6,141	6,934	13%	5,637	-8%	4,605	-25%
South 27th Street	27THB	3,607	6,468	7,564	17%	5,935	-8%	5,063	-22%
BNSF Railroad	BNSF	2,600	6,441	7,495	16%	5,934	-8%	6,049	-6%
Salt Creek	R6A	2,491	6,441	7,574	18%	4,318	-33%	5,995	-7%
Northeast Tributary									
Rebel Drive	REBEL	9,430	1,075	1,075	0%	1,075	0%	1,075	0%
South 56th Street	56THA	8,265	1,042	1,042	0%	1,042	0%	1,042	0%
South 53rd Street	S53RD	7,195	830	830	0%	830	0%	830	0%
Private Drive	R22	6,120	1,136	1,136	0%	1,136	0%	1,136	0%
Private Drive	R22	5,670	1,136	1,136	0%	1,136	0%	1,136	0%
Southwest Tributary									
South 40th Street	S2T	500	762	1,175	54%	1,175	54%	1,175	54%
Southcentral Tributary									
New Castle Road	CLV310	310	488	488	0%	488	0%	488	0%
Southeast Tributary									
Rokeby Road	201	464	827	796	-4%	796	-4%	404	-51%
Northwest Tributary									
Yankee Hill Road	YANKB	5,700	639	639	0%	639	0%	639	0%
South 40th Street	40THA	3,875	814	929	14%	929	14%	929	14%
Saltillo Road	SALTIL	1,466	2,454	3,485	42%	3,339	36%	3,253	33%
So. 38th St. (north)	S38TH	7,280	1,140	1,481	30%	1,250	10%	765	-33%
So. 38th St. (south)	S5E	3,706	428	613	43%	612	43%	393	-8%

Insert
Figure MP-8
Potential Preserved Existing 100-year Floodplain

Insert
Figure MP-9
Potential 400-ft Flood Corridor

The following table provides information on the approximate land requirements for the two potential floodplain preservation components. It was assumed the floodplain would be protected through the purchase of a conservation easement in lieu of a fee-simple purchase. An easement value of 50% of the approximate land cost, $30,000 per acre, was used to prepare the opinion of probable cost for this component. Purchase of an easement was assumed because a large area could be protected for the same cost, and the density could still be utilized from that area in a larger development as part of a Community Unit Plan (CUP). Although the easement would include the minimum corridor area, the minimum corridor was subtracted from the floodplain component area because the minimum corridor would be required if no master plan were to be adopted. Easement values may be reduced by the use of density from the floodplain on other areas of a CUP.

Table MP-8
Land Requirements for Floodplain Preservation Components

Stream Segment	Minimum Corridor Area, acres	Preserve Existing Floodplain		Preserve 400-ft Flood Corridor		
		Area [1] acres	Opinion of Probable Costs	Total Width, ft	Area [1] acres	Opinion of Probable Costs
1	5	0[2]	$0	90[2]	0[2]	$0
2	5	0[2]	$0	90[2]	0[2]	$0
3	11	90	$1,350,000	400	18	$270,000
4	20	42	$630,000	400	25	$375,000
5	12	14	$210,000	Varies[3]	14[3]	$210,000
6	17	0[4]	$0	Varies[3]	0[4]	$0
7	10	0[4]	$0	Varies[3]	0[4]	$0
8	10	10	$150,000	Varies[3]	1[5]	$15,000
9	4	2	$30,000	Varies[3]	2[3]	$30,000
10	10	2	$30,000	Varies[3]	2[3]	$30,000
11	22	0	$0	Varies[3]	0	$0
12	N/A[6]	0[6]	$0	N/A[6]	0[6]	$0
13	3	43	$645,000	150[7]	0	$120,000
14	11	15	$225,000	90[7]	0[8]	$150,000
15	2	10	$150,000	90[7]	0	$90,000
Total	142	228	$3,420,000		62	$1,290,000

[1] Value is the area outside the minimum flood corridor
[2] Area surrounding stream segment is already developed. Therefore, only existing minimum flood corridor (90 ft) is preserved in this segment.
[3] Since 400 ft corridor is less than or equal to the floodplain corridor, the entire floodplain corridor will be preserved in this segment. Corridor width varies with the floodplain width.
[4] Area is already developed in acreages. Redevelopment is unlikely; therefore, floodplain land acquisition is not required.
[5] Does not include footprint area of proposed Site A stormwater storage facility.
[6] Reach is located within Salt Creek floodplain. ROW purchase is not required.
[7] Structural controls in the vicinity of this stream segment limit the width of the required preservation corridor to less than 400 ft.
[8] Does not include footprint area of proposed Site S-5B stormwater storage facility.

OTHER RECOMMENDED FLOOD HAZARD REDUCTION MEASURES

Floodproofing (Prior to Delineating FEMA Floodplain)

For new construction, enforce City of Lincoln FEMA floodplain regulations on new development in the flood prone areas identified in the master plan, including the requirement that the lowest floor elevation be elevated to 1-ft above the 100-year water surface profile.

Flood Insurance

Encourage federal flood insurance policies for building and contents of homes in the existing 100-year floodplain in the SEUSC Watershed. Federal Emergency Management Agency (FEMA) flood insurance is available to every property owner in Lincoln and Lancaster County, Nebraska. Table MP-9 shows the flood insurance rates and the discount the citizens of Lincoln and Lancaster County receive through the Community Rating Service program for specific flood damage reduction activities adopted by the community. Special flood hazard areas are shown on the Lancaster County and Incorporated Areas Flood Insurance Rate Map (FIRM) for the following categories (source: the FIRM legend):

Zone A — The flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the FEMA Flood Insurance Study (FIS) by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations (BFEs) or depths are shown within this zone. Mandatory flood insurance purchase requirements apply.

Zone AE — The flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the FIS by detailed methods. In most instances, BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.

Zone X — The flood insurance rate zone that corresponds to areas outside the 100-year floodplains, areas of 100-year sheet flow flooding where average depths are less than 1 ft, areas of 100-year stream flooding where the contributing drainage area is less than 1 square mile, or areas protected from the 100-year flood by levees. No BFEs or depths are shown within this zone.

The following facts can be found on the FEMA website. "Buildings in special flood hazard areas shown on FIRMs may be damaged when flooding occurs. Some buildings flood frequently, while others get damaged by only the more severe events. If your home is in the 1% annual chance floodplain, it has a 26% chance of getting flooded over a 30-year period. This means it is about five times more likely to get damaged by flood than by a severe fire!"

Table MP-9
Annual Flood Insurance Rates (2002)

Special Flood Hazard Areas Inundated by the 100-year Flood	Standard Rate	Lincoln Discount	Lincoln/Lancaster County Rate
A	$460	$46	$414
AE	$320	$32	$288
X	$320	$32	$288

Reduce Flood Depths

Reduce flood depths of the existing floodplain, east of South 48th Street extended, by constructing upstream storage facilities. Determine the low opening elevation for the nine existing structures in or near the 100-year floodplain in order to gauge the necessary reduction in water surface profile required. Exact flow value reductions needed to protect the existing buildings, if any, will not be known until confirmation surveys of the low openings are completed. However, for the purpose of discussion, if a house near Cromwell Drive is determined to be at risk from the 100-year flood, reducing the flow rate of 2,700 cfs to about 2,000 cfs may lower the 100-year water surface profile to below the low opening. Potential sites for storage facilities upstream of Cromwell Road are very limited, since the watershed is entirely developed, except for an area near South 70th and Rokeby Road. If combined discharge from subbasins S-2AD and S-2AF is limited to 50 cfs, the 100-year flow near Cromwell Road would be about 2,000 cfs. See the discussion on Stormwater Storage Facilities later in this report for more information.

Reduce Future Flood Hazards

A FEMA floodplain should be delineated for this watershed since the drainage area exceeds one square- mile. The community should aggressively pursue enforcement of floodplain regulations for development, subsequent to adoption of the stormwater master plan, and prior to delineating of an FEMA floodplain, using the best available floodplain information.

Monitor Changes

Incremental stormwater impact of subdivisions should be monitored by the Public Works and Utilities Department’s Watershed Management Program using the hydrologic and hydraulic models of the watershed, developed for this Stormwater Master Plan, to monitor changes and evaluate proposed developments if different from projected land use.

WATER QUALITY IMPROVEMENT

Constructed Wetlands

Pollutants typically found in urban runoff include sediment (total suspended solids), nutrients such as nitrogen and phosphorus, heavy metals, and bacteria. The EPA has gathered data on pollution from urban land uses (NURP, 1994). The City of Lincoln has also collected data as part of their NPDES Phase I sampling program. Residential loading is shown in Table MP-10.

Table MP-10
Selected Urban Pollutant Loading

Pollutant	NURP	Lincoln
Total Suspended Solids (TSS) mg/l	150 (range 2 to 2890)	488
Total Phosphorus (TP) mg/l	0.383	1.1
Zinc mg/l	0.135	0.035
Lead mg/l	0.144	0.006

Properly located and constructed stormwater wetlands can be highly effective at removing urban pollutants.[1] They can trap suspended and dissolved materials. "The design of wetland management measures is a very complex being, generally being a function of nearly everything. But, the three most important components of wetland creation and function are water, soil, and vegetation."[2] Pollutants are carried to constructed wetlands by stormwater. The residence time (average time the water stays in the wetland) is the most determining factor for pollutant removal.

Soils found in natural wetlands are saturated and develop anaerobic conditions. These "hydric" soils support and encourage growth of wetland vegetation. Constructed wetlands in urban settings are typically on mineral soils that support hydric conditions. Anaerobic conditions develop over time.

Wetland plants have adapted to frequent flooding that may last up to five days. Plant species may be adapted to specific depth zones such as 36" to 6" deep, 6" to 0" deep, and 0" to 6" above water. Aquatic plants can be used in the permanent pools of wetlands. Plant selection is critical to the pollutant removal efficiency of constructed wetlands and should be based on pollutant removal objectives.

Table MP-11
Average Annual Pollutant Removal Capability of Wetlands
(After Colorado Stormwater Task Force, 1990)

Pollutant	% Removal for Standard Wetland (USGS, 1986)
Total Suspended Solids (TSS) mg/l	40 to 94
Total Phosphorus (TP) mg/l	(-4) to 90
Zinc mg/l	(-29) to 82
Lead mg/l	27 to 94

Pollution removal takes place through biological uptake (microbial, algal, vascular plant), sedimentation, volatilization, adsorption, precipitation, and filtration. Rooted vegetation removes nutrients through the soil while non-rooted vegetation removes it directly through the water (Debo and Reese, 1995).

Pollutant removal efficiency depends physically on aquatic treatment volume, surface area to volume ratio and surface area to watershed ratio. Pollutant removal can be enhanced by maximizing any of these variables, and can be further enhanced by increasing the flow path, providing pre-treatment with forebays and using redundant pollutant removal pathways (Schueler, 1992).

Locating constructed wetlands "off-line" can help reduce the chances of being overwhelmed by large, infrequent storms that can resuspend sediment or other accumulated pollutants, reducing efficiency of the wetland. Off-line systems would intercept low flows, but would bypass infrequent storms that could overwhelm the wetlands and resuspend collected pollutants and vegetative material.

Wetlands are a transition between upland and aquatic systems and share attributes with both. They are sensitive to watershed hydrology. Some authorities recommend wetland surface areas of 1.5% to 3% of the watershed area. Others recommend a runoff capture volume of 0.5 inches of runoff from the impervious surfaces in the watershed. A well designed wetland can provide both and have a balanced mixture of deep, shallow, and exposed areas to provide a range of habitats.

Water quality wetlands should provide a residence time of at least 20 hours. About 40% to 70% of the wetland should be 12" deep or less, of which 1/3 to 1/2 should be about 6" deep, see Figure MP-10. The remainder of the wetland should be between 18" and 36" deep. A sediment trap equal in size to 10% of the treatment volume and 4 to 6 ft deep should precede the wetland to reduce maintenance efforts.

[1] Debo, Thomas N. and Reese, Andrew J., "Municipal Storm Water Management"
[2] ibid, p. 584

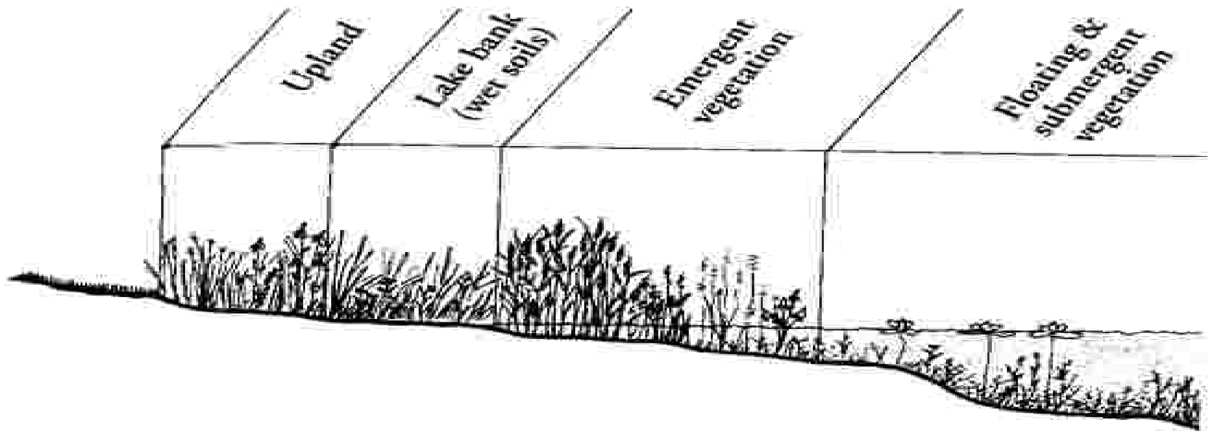


Figure MP-10
Typical Constructed Wetland Cross-Section

Source: Minnesota Department of Natural Resources

The location of suitable wetland sites should be determined by the availability of appropriate hydrology and soils. If the limits of the floodplain are preserved, then the best sites can be selected from numerous potential locations and enhanced pollutant removal efficiencies can be used. The wetlands would be located near the subbasin outlet, and can be designed to capture runoff from the whole drainage area. The valley shape near basin outlets typically will facilitate bypassing severe floods.

If the minimum corridor or the 400-ft flood corridor are preserved, as opposed to the existing floodplain, the number of potential sites would be reduced and pollutant removal efficiencies would be reduced by competing site constraints such as balancing wetland area with the developable area. Since the wetlands would likely be located further up the watershed, the captured drainage ("treated") area would be smaller. Two examples of constructed wetlands were evaluated here to allow comparative analysis of site location. The first site is with the floodplain preserved and the second is with a minimum corridor preserved. The City of Lincoln "Stormwater Quality Pollutant Loading Evaluation" Model (SQPLE Model) was used to evaluate the pollutant removal rates.

Example 1 Given: A suitable site in the existing floodplain at the bottom of a 150-acre drainage area with residential land use. The site is large enough to provide a surface area to watershed ratio of 3%.

((150)(3%) = 4.5 wetland acres)) and store 0.5 inches of runoff from the impervious area sensitivity:

$$\frac{[(150\text{ acres})(40\%\text{ imp})(0.5\text{ in})]}{(12\text{ in/ft})} = 2.5\text{ acre-feet}$$

Long, redundant pathways can be easily accommodated along with a sediment forebay. Therefore, it is reasonable to use removed efficiencies in the upper range of values. Removal efficiencies are provided in Table MP-12a.

Table MP-12a
Approximate Pollutant Removal Performance of Constructed Wetland with 100-Year Existing Floodplain

Pollutant	Amount Delivered (lbs) To Wetland[1]	Removal Efficiency %	Amount Released (lbs)
TSS	685	90	69
TP	2.598	85	0.39
Zinc	0.916	80	0.183
Lead	0.977	90	0.098

[1]Pollutant Loadings are from NURP Data generated by SQPLE Model.

Example 2 Given: A site in the same watershed, but available half-way up the watershed, and the site constraints are such that two acres are available for the wetland site. After grading the side slopes, just over one acre is available for the wetland surface. The site also can also store 0.5 inches of runoff from the impervious area.

$$\frac{[(75\text{ acres})(40\%\text{ imp})(0.5\text{ in})]}{(12\text{ in/ft})} = 1.25\text{ acre-feet}$$

A single pathway can be provided, but it will require more complex construction techniques and design efforts to be effective. It also has a sediment forebay. Because this example site would be in close proximity to developed areas, an increased level of maintenance efforts will be provided. It is reasonable to use removal efficiencies from the upper range of values. Removal efficiencies are provided in Table MP-12b.

Table MP-12b
Approximate Pollutant Removal Performance of Constructed Wetland with 400-ft Flood Corridor

Pollutant	Amount Delivered (lbs) To Wetland	Removal Efficiency %	Amount Released (lbs)
TSS	343	90	34
TP	1.30	85	0.195
Zinc	0.458	80	0.092
Lead	0.508	90	0.051

This site releases half of the amount of pollutants as the site in Example 1, but would be more difficult to construct and maintain, and only treats half of the watershed. The other half would deliver all of the pollutants to the watershed outlet, see Table MP-13.

Table MP-13
Comparison of Pollutant Removal Efficiency of Examples 1 and 2

	Released from 150-Acre Drainage Area	
Pollutant	Example 1	Example 2
TSS	69	377
TP	0.39	1.50
Zinc	0.183	0.550
Lead	0.098	0.559

Pollutant discharge from the example watershed is significantly greater when the constructed wetland is located halfway up the watershed. Furthermore, an even lower performing wetland located at the basin outlet would remove more pollutants than a high performing wetland in the middle of the watershed, since runoff from the whole watershed would be treated.

The following representative values were used to determine the opinion of probable costs to build constructed wetlands in the SEUSC Watershed. Higher construction costs are anticipated for wetlands outside the existing 100-year floodplain due to site constraints and the larger footprint required per surface acre in steeper terrain.

Inside floodplain - $10,000/acre (no additional land costs, since in preserved 100-year existing floodplain)
Outside floodplain - $20,000/acre (plus $15,000/ac for easement, see easement discussion on page 99)

Engineering design, biologic evaluation, and construction observation is 30% of the opinion of probable cost of construction. Wetlands would be contained within the floodplain easement, so no land rights costs are included in the opinion of probable costs in Table MP-14a. The subbasins listed in Tables MP-14a and MP-14b are in the Tier I growth area, and outlet into the existing floodplain of either the mainstem or tributary channels. Wetland locations will be determined within the preserved 100-year floodplain during the final design process. Tables MP-14a and MP-14b present the opinion of probable cost of constructed wetlands for preserved existing 100-year floodplain and preserved 400-ft flood corridors, respectively. Not only would the cost be lower for constructed wetlands in the existing 100-year floodplain, but they would likely be more effective as well since available wetland sites outside the floodplain would be further up the watershed and would treat a smaller percentage of the watershed area. Land right costs for wetland sites S-2J and S-2L, in Table MP-14b, are included in the flood pool area of Dam Site A. No other proposed detention facilities have enough flood pool area to accommodate the respective wetland sites, so land rights costs would apply.

Other Water Quality Improvement Measures

Expand public awareness and education efforts to reduce the amount of pesticides, herbicide, phosphorus, nitrogen, bacteria and other pollutants exposed to stormwater, such as promoting fertilizers without the phosphorus unnecessary for the soils.

Improve performance of erosion and sediment control measures by increasing public awareness of existing rules and regulations, and continue to sponsor annual erosion and sediment control plan development training sessions for contractors, engineers and developers.

Table MP-14a Opinion of Probable Costs for Constructed Water Quality Wetland FP

Location	Drainage Area (sm)	Approximate Wetland Area (ac)	Opinion of Probable Cost
S-2B1	0.14	3	$39,000
S-2E	0.25	6	$78,000
S-2F2	0.18	4	$52,000
S-2H2	0.20	5	$65,000
S-2J	0.23	5	$65,000
S-2L	0.17	4	$52,000
S-2O	0.27	6	$78,000
S-2T	0.36	8	$104,000
S-5B	0.37	9	$117,000
S-5C	0.23	5	$65,000
S-5E	0.18	4	$52,000
Totals	2.58	59	$767,000

Table MP-14b Opinion of Probable Costs for Constructed Water Quality Wetland 400'

Location	Drainage Area (sm)	Approximate Wetland Area (ac)	Opinion of Probable Cost
S-2B1	0.14	3	$137,000
S-2E	0.25	6	$273,000
S-2F2	0.18	4	$182,000
S-2H2	0.20	5	$228,000
S-2J	0.23	5	$228,000
S-2L	0.17	4	$182,000
S-2O	0.27	6	$273,000
S-2T	0.36	8	$364,000
S-5B	0.37	9	$410,000
S-5C	0.23	5	$228,000
S-5E	0.18	4	$182,000
Totals	2.58	59	$2,687,000

Insert
Figure MP-11
Potential Constructed Water Quality Wetland Locations

BRIDGE AND CULVERT IMPROVEMENTS

There are 26 bridges and culverts modeled in the SEUSC Watershed. See Tables I-13a, I-13b, and I-13c for capacities and approximate overtopping frequencies for existing and projected conditions in UPZ S-2/S-3 and a portion of S-5. The five stream crossings in UPZ S-1 all meet or exceed minimum DCM requirements for overtopping. Excluding the BNSF Railroad structure below 27th Street, there are 20 remaining stream crossings in UPZ S-2/S-3 and UPZ S-5 (partial). Four of these 20 crossings meet or exceed minimum DCM requirements for overtopping.

Nine potential bridge and culvert improvement locations are shown in Figure MP-12 (Page 106). As shown in Figure 1-13 (Page 107), there are 16 road structures in S-2/3 and S-5 that do not meet design standards. One of these, Saltillo Road, is not shown in Figure MP-12 because it is in the Salt Creek floodplain. Four structures (66th Street above Rokeby Road, 38th Street above Bennet Road, and the two on Rokeby Road between 56th and 70th) are not shown because they meet design standards once detention components of the Master Plan are built. The remaining two crossings are not shown because they are private driveways.

The hydraulic criteria used for sizing the proposed bridge and culvert concepts is summarized below:

Stream Crossing	Design Storm	Allowable Design Headwater	100-year Allowable Headwater Depth
Culvert	50-year	1-ft below road sag point	No greater than existing, and no deeper than 6-in over roadway
Bridge	100-year	1-ft below low chord	No greater than 1-ft above existing water surface

Hydraulic parameters for existing and projected conditions, and anticipated roadway geometrics at the mainstem stream crossings of South 27th Street, Rokeby Road, and South 40th Street, are of sufficient magnitude to need bridges. These roadways will become urban arterial streets when the adjoining properties become developed and are annexed into the Lincoln corporate limits. Typical urban arterial roadways in Lincoln have two lanes in each direction, a left turn lane, raised median, and sidewalks resulting in a roadway width of about 105 ft. Typical urban residential roadways are one-lane in each direction and have a sidewalk on each side resulting in a roadway width of 60 ft. Stream crossing structure widths equal to roadway widths are used to prepare opinions of probable cost. The structures are three-span, continuous concrete slab bridges or cast-in-place (CIP) reinforced concrete culverts.

The following unit prices are used for the purpose of preparing the opinions of probable costs. The embankment prices reflect borrow from a nearby off-site location. Demolition is 20% of the construction cost. For proposed culverts, engineering and construction observation fees were assumed to be 20% of the estimated opinion of probable cost. For proposed bridges; engineering, geotechnical investigation, and construction observation fees were assumed to be 35% of the estimated opinion of probable cost.

Item	Unit Price	Item	Unit Price
Bridge	$10,000/LF	84" CMP	$160/LF
CIP Culvert	$400/CY	72" CMP	$140/LF
Embankment	$5/CY	60" CMP	$80/LF

Deficient stream crossing structures, adjacent to property projected for development, will need to be replaced or supplemented as the adjoining properties develop. Other stream crossings should be prioritized and added to the capital improvement plan and replaced as warranted.

The proposed bridge improvement component shown for South 38th Street (north site) is near the proposed South Beltway alignment shown on Exhibit SM4-2 of the Lincoln South and East Beltways Environmental Impact Statement, May 23, 2002. Exhibit SM4-2 shows that South 38th Street, on the north side of the proposed Beltway alignment, would be terminated in a cul-de-sac. The functionality of the culvert proposed in this Stormwater Master Plan would remain unchanged whether, it served under the cul-de-sac or under the proposed Beltway.

Capital project components identified in the master plan are generally included in order to meet City of Lincoln design standards and/or to accommodate future urban growth projected for the basins in the SEUSC Watershed. In some cases, the magnitude of the project also reflects the results of more detailed hydrologic and hydraulic modeling completed with HEC-1 and HEC-RAS. It is recognized that prior to areas within the watershed being annexed into the city, the county may have a need to construct improvements in these locations, and that these improvements may not reflect the standards identified in the master plan. In these cases, it is anticipated that such components would be upgraded in the future by the City of Lincoln.

Insert
Figure MP-12
Potential Public Bridge and Culvert Improvement Locations

Insert Figure MP-13
Typical Structure Cross-Sections

Table MP-15
Opinion of Probable Costs for Proposed Bridge and Culvert Improvements (Mainstem) S-2/S-3

Location	County ID	Size and Type	100-yr Water Surface Elevation	Deck Elevation	Low Chord	Road Sag	Low Chord Freeboard	Road Sag Freeboard	Bridge/Culvert		Embankment		Opinion of Probable Cost
									Size	Est Cost	Fill	Est Cost	
Rokeby Road	P 202	CBC 4' x 4' x 52'	1,326.4	1,325.0	1,323.3	1,320.0	-3.1	-6.4					
Projected (w/o storage site S-202)		Dbl 6' x 5' CBC	1,324.2	1,326.0	1,323.0	1,326.0	-1.2	1.8	140	$69,000	5,400	$27,000	$130,000
South 66th Street	City	CMP 72" x 53'	1,319.0	1,318.0	1,314.0	1,318.0	-5.0	-1.0					
Projected (w/o storage site S-202)		Supl 72" CMP	1,315.7	1,318.0	1,314.0	1,318.0	-1.7	2.3	53	$5,000	0	$0	$7,000
South 56th Street	P 92	CSB 36' x 30'	1,272.1	1,272.0	1,270.6	1,272.0	-1.5	-0.1					
Cromwell Drive	City	Trpl CBC 8' x 6' x 40'	1,255.7	1,256.0	1,254.0	1,254.0	-1.7	-1.7	20				
Projected		Supl Dbl 8' x 8' Raise Rd 1,158.0	1,257.4	1,258.0	1,256.0	1,257.5	-1.4	0.1	60	$52,000	43,600	$218,000	$365,000
Preserved Floodplain and 400' Corridor		Supl 10' x 6' Raise Rd 1,158.0	1,257.9	1,258.0	1,254.0	1,257.5	-3.9	-0.4	60	$33,000	43,600	$218,000	$339,000
South 40th Street	P 84	Trpl CBC 10' x 5' x 48'	1,229.3	1,227.6	1,224.7	1,227.0	-4.6	-2.3					
Minimum Corridor		75' Bridge Raise Rd 1,234.0	1,230.3	1,234.0	1,231.5	1,234.0	1.2	3.7	75	$750,000	34,000	$170,000	$1,242,000
Preserved Floodplain and 400' Corridor		75' Bridge Raise Rd 1,233.0	1,229.5	1,233.0	1,230.5	1,233.0	1.0	3.5	75	$750,000	28,000	$140,000	$1,202,000
Rokeby Road	P 196	CBC 10' x 10' x 54'	1,207.8	1,206.0	1,204.2	1,206.0	-3.6	-1.8					
Minimum Corridor		95' Bridge Raise Rd 1,212.5	1,209.1	1,212.5	1,210.0	1,212.5	0.9	3.4	95	$950,000	45,000	$225,000	$1,586,000
Preserved Floodplain		95' Bridge Raise Rd 1,211.5	1,207.7	1,211.5	1,209.0	1,211.5	1.3	3.8	95	$950,000	35,000	$175,000	$1,519,000
400-ft Flood Corridor		95' Bridge Raise Rd 1,210.5	1,206.8	1,210.5	1,208.0	1,210.5	1.2	3.7	95	$950,000	30,000	$150,000	$1,485,000
South 27th Street	P 27	IBB 23' x 30'	1,195.5	1,194.0	1,191.8	1,192.0	-3.7	-3.5					
Minimum Corridor		110' Bridge Raise Rd 1,203.0	1,199.1	1,203.0	1,200.5	1,203.0	1.4	3.9	110	$1,100,000	230,000	$1,150,000	$3,038,000
Preserved Floodplain		110' Bridge Raise Rd 1,201.0	1,197.2	1,201.0	1,198.5	1,201.0	1.3	3.8	110	$1,100,000	196,000	$980,000	$2,808,000
400-ft Flood Corridor		110' Bridge Raise Rd 1,200.0	1,196.5	1,200.0	1,197.5	1,200.0	1.0	3.5	110	$1,100,000	148,000	$740,000	$2,484,000
BNSF Railroad	Private	Timber Bridge 100' x 30'	1,194.4	1,194.0	1,189.5	1,194.0	-4.9	-0.4					

Note: The bridges or culverts in UPZ S-1 meet current hydraulic design criteria.

Table MP-15 (continued)
Opinion of Probable Costs for Proposed Bridge and Culvert Improvements (Tributary) S-2/S-3 & Portion of S-5

Location		County ID	Size and Type	100-yr Water Surface Elevation	Deck Elevation	Low Chord	Road Sag	Low Chord Freeboard	Road Sag Freeboard	Bridge/Culvert		Embankment		Opinion of Probable Costs
										Size	Est Cost	Fill	Est Cost	
Yankee Hill Rd	S-2/S-3	P 191	CBC 10' x 6' x 98'	1,256.2	1,260.0	1,253.2	1,260.0	-3.0	3.8					
South 40th Street	S-2/S-3	P 83	Dbl CBC 6' x 5' x 36'	1,242.3	1,242.0	1,239.3	1,242.0	-3.0	-0.3					
Projected			Supl 6' x 5'	1,242.1	1,242.0	1,239.3	1,242.0	-2.8	-0.1	140	$63,000	4,500	$23,000	$116,000
South 40th Street	S-2/S-3	P 85	CBC 6' x 6' x 54'	1,232.1	1,232.1	1,228.3	1,228.0	-3.8	-4.1					
Projected			Dbl 8' x 6'	1,232.2	1,232.0	1,228.3	1,232.0	-3.9	-0.2	152	$122,000	4,500	$23,000	$196,000
Rebel Drive	S-2/S-3	City	Dbl CMP 48" x 48'	1,293.5	1,292.0	1,289.5	1,292.0	-4.0	-1.5					
Projected			Dbl 84" CMP Raise Rd 1,294	1,294.7	1,294.0	1,292.5	1,294.0	-2.2	-0.7	95	$19,000	5,400	$27,000	$62,000
South 56th Street	S-2/S-3	P 93	CBC 9' x 8' x 101'	1,283.9	1,284.0	1,277.8	1,284.0	-6.1	0.1					
South 53rd Street	S-2/S-3	City	CMP Arch 14' x 6' x 50'	1,271.7	1,272.0	1,268.0	1,272.0	-3.7	0.3					
Private Drive	S-2/S-3	Private	CMP 36" x 24'	1,259.4	1,258.0	1,257.0	1,258.0	-2.4	-1.4					n/a
Private Drive	S-2/S-3	Private	CMP 36" x 32'	1,256.6	1,255.0	1,254.0	1,254.0	-2.6	-2.6					n/a
New Castle Road	S-2/S-3	City	Dbl CMP 60" x 48'	1,266.3	1,266.0	1,264.3	1,266.0	-2.0	-0.3					
Projected			Supl 60" CMP	1,265.9	1,266.0	1,264.3	1,266.0	-1.6	0.1	110	$11,000	0	$0	$15,000
Rokeby Road	S-2/S-3	P 201	CBC 6' x 4' x 25'	1,295.1	1,294.0	1,290.7	1,294.0	-4.4	-1.1					
Projected (w/o storage sites S-201 or S-2AF)			Tpl 6' x 6'	1,293.4	1,294.0	1,292.7	1,294.0	-0.7	0.6	140	$63,000	5,000	$25,000	$119,000
So. 38th St. (north)	S-5	S 54	8' x 8' RCBox	1,220.0	1,218.6	1,217.7	1,218.0	-2.3	-2.0					
Projected (w/o storage site S-5B)			Dbl 10' x 8' RCBox	1,219.1	1,219.0	1,217.7	1,219.0	-1.4	-0.1	171	$143,000	10,000	$50,000	$261,000
Preserved Floodplain (w/o storage site S-5B)			Dbl 10' x 8' RCBox	1,218.6	1,219.0	1,217.7	1,219.0	-0.9	0.4	171	$143,000	10,000	$50,000	$261,000
Preserved Corridor (w/ storage site S-5B)			Supl 6' x 8' RCBox	1,217.0	1,218.0	1,217.7	1,218.0	0.7	1.0	171	$75,000	6,500	$33,000	$146,000
Saltillo Road	S-5	P 29	Dbl CBC 6' x 6' x 42	1,200.0	1,200.0	1,196.3	1,198.0	-3.7	-2.0					n/a
So. 38th St. (south)	S-5	S 55	5' x 4' RCBox	1,222.6	1,221.5	1,220.5	1,221.5	-2.1	-1.1					
Projected (w/o storage site S-5E)			Dbl 8' x 5' RCBox	1,221.7	1,222.0	1,221.5	1,222.0	-0.2	0.3	213	$96,000	12,000	$60,000	$211,000

REGIONAL STORMWATER STORAGE FACILITIES

Flood hazard in the watershed can be reduced by construction of stormwater storage facilities. Local detention ponds are typically designed to serve a single subdivision and likely do not decrease the flood hazard downstream. City stormwater criteria does not require developers to evaluate flow rates beyond the downstream limits of a subdivision. Regional facilities are typically larger in size and provide flood hazard reduction for a larger area than local detention ponds or are designed to meet the flood hazard reduction needs of multiple subdivisions. A regional storage facility would be designed to meet the Natural Resources Conservation Service (NRCS) Technical Release No. 60 (TR-60) criteria. TR-60 describes design procedures and provides minimum requirements for planning and designing earth dams and reservoirs. Any structure with 15 acre-feet or more of permanent pool, with 50 acre-feet or more cumulative permanent pool and temporary storage, is 25 ft or more high, or exceeds the "low hazard" definition is required by the Nebraska Department of Natural Resources (NDNR) to obtain a storage permit and comply with TR-60 criteria. The plans and specifications must be reviewed and approved by the NDNR before construction of the proposed site. Most of the proposed potential stormwater storage facilities would require a NDNR permit. Other federal or local permits may also be required, such as COE 404, City of Lincoln Floodplain Development, and NPDES Construction Activities permits.

Potential stormwater facility sites were evaluated at seven locations, see Figure MP-14.

Site selection criteria for potential storage facilities included valley geometry, contributing drainage area, and the embankment and storage pool areas that would be on property projected for future development.

A typical cross-section template for a Class "C", high hazard dam in Lincoln, Nebraska is a 14-ft top width, 4:1 side slopes, and a wave berm with a width. Wave berm width is determined by wave fetch. If the embankment top is used as a arterial roadway, the cross-section template would have a 105-ft top width, 6:1 side slopes and a wave berm (see Figure MP-19). A local roadway would have the same cross-section template except with a 60-ft top width. These templates and the unit prices listed below were used to prepare opinions of probable cost for regional storage facilities. For proposed regional detention facilities; engineering, geotechnical investigation, and construction observation fees were assumed to be 35% of the estimated opinion of probable cost. For proposed storage facilities not regulated; engineering and construction observation fees were assumed to be 25% of the estimated opinion of probable cost.

Item	Unit Price	Item	Unit Price
Embankment	$2/CY		
48" Pressure Pipe	$400/LF	24" Pressure Pipe	$90/LF
30" Pressure Pipe	$125/LF	18" Pressure Pipe	$70/LF

Regional storage facilities could be used to offset the storage lost from the floodplain if encroachment is allowed. Potential regional sites are; Site A on the tributary between Rokeby Road and Yankee Hill Road, Site B on South 40th Street across the mainstem, and Site S-5E south of Saltillo Road and east of South 38th Street.

Three other slightly smaller potential storage facilities would likely meet the exclusion criteria for low hazard dams and would not likely require a storage permit from the NDNR. They are; Site S-201 on Rokeby Road near South 70th Street, Site S-2AF near Rokeby Road and South 70th Street, and Site S-5E on South 38th Street near Bennet Road.

All proposed facilities were assumed to include sediment traps to facilitate maintenance and prolong storage capacity.

Site A would reduce downstream peak flow rates in the watershed (see Table MP-14) by about half for the 2-year storm and by about a third for the 10-year and 100-year storms. This structure would provide flood hazard reduction, and is recommended for consideration as a component of a master plan concept that includes preserving the minimum corridor to partially mitigate the effects of the lost floodplain storage.

Site B is proposed as a road dam, and it would be built on the mainstem on South 40th Street. In order to minimize flood storage encroachment onto existing upstream development, there would be no permanent pool and a large principal spillway would be used. The structure would reduce the 100-year peak flow rate by15 to 20%, but would not reduce the 2-year or 10-year peak flow rates. This structure is deemed to be infeasible based on lack of peak flow reduction during storms more frequent than the 100-year event, the high cost compared to other storage facilities and to other bridge options, and upstream constraints. Because this is a road dam under an arterial roadway, the auxiliary spillway must not operate at less than the 500-year event.

Site S-201 was also dropped from further consideration because the land that would be inundated by the storage pool has already been developed into an acreage lot.

Site S-202 and Site S-5E are proposed as undersized culverts. Site S-202 is on Rokeby Road near 70th Street, and Site 38th Street south is on South 38th Street near Bennet Road. These sites, as proposed, would have no permanent pool, store less than 50 acre-feet at the road sag, and would likely be excluded for permitting as low hazard structures. A flood storage easement would preserve the storage volume upstream of the culverts.

Site S-2AFand Site S-5B are proposed as stormwater storage facilities. They would each likely have permanent pools, would store more than 50 acre-feet each, and would be 12 ft and 14 ft high, respectively, with the 14-ft wide template.

Data on key elevations, pool area, height, and embankment volume for the sites are provided in Table MP-16. Peak flow rates for the 2-, 10-, and 100-year events, with the facilities in place on their own and in combination, are provided in Tables MP-17, MP-18 and MP-19.

Insert
Figure MP-14
Potential Regional Stormwater Storage Facility Locations

Table MP-16
Potential Stormwater Storage Facility Data

Site	Top of Dam	Permanent Pool			Flood Pool			Auxiliary Spillway		Height ft	Footprint Area [1] Ac	Embankment Volume CY	Principal Spillway	Opinion of Probable Land Cost	Opinion of Probable Construction Cost
		Elevation	Area ac	Volume ac-ft	Elevation	Area ac	Volume ac-ft	Crest Elevation	Width ft						
A	1,238	1,225	26	78	1,231.0	64	260	1,232.5	100	24	71	78,000	120 LF 48" CPP [2]	$2,700,000	$2,975,000
B	1,246	1,220	0	0	1241.5 [3]	70	470	1,241.5	400	26	91	328,600	Tw 10' x 8' RCBox	$3,780,000	$5,083,000
S-201	1,317	1,300	4	25	1,313.0	14	120	1,313.0	120	27	18	65,800	450 LF 18" RCP	$690,000	$886,000
S-202 [4]	1,341	1,319	0	0	1,340.5	7	50	1,340.5	80	22	13	96,100	420 LF 18" RCP	$495,000	$751,000
S-5B	1,249	1,232	5	17	1,243.0	15	110	1,343.0	150	14	22	18,700	195 LF 30" CPP	$810,000	$893,000
S-5E [4]	1,228	1,216	0	0	1,227.0	4	12	1,227.0	200	12	5	18,200	200 LF 72" RCP	$210,000	$291,000
S-2AF	1,335	1,320	1	6	1,330.0	7	44	1,330.0	80	25	13	24,500	240 LF 18" CPP	$480,000	$562,000

[1]Includes embankment, auxiliary spillway, and flood pool area   [2]Concrete Pressure Pipe   [3]500-year storm   [4]Undersized culvert with roadway embankment storage

Table MP-17
2-Year Peak Flow Rate Values at Selected Locations

Location	Model Element		Existing	Projected	With Site A		With Site B		Site S-2AF		Site S-202		Sites S-2AF & S-202		Sites A, S-2AF, & S-202		Site S-5B		Sites S-5B & S-5E	
	HEC-1	HEC-RAS	Q	Q	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%
Mainstem																				
Rokeby Road	202	25,159	177	157	157	0%	157	0%	157	0%	42	-73%	42	-73%	42	-73%	157	0%	157	0%
South 66th Street	66TH	24,449	169	150	150	0%	150	0%	150	0%	41	-73%	41	-73%	41	-73%	150	0%	150	0%
South 56th Street	56THB	20,036	545	489	489	0%	489	0%	425	-13%	404	-17%	352	-28%	352	-28%	489	0%	489	0%
Cromwell Road	NODE62	17,440	734	687	687	0%	687	0%	631	-8%	603	-12%	554	-19%	554	-19%	687	0%	687	0%
South 40th Street	40THB	12,655	908	934	850	-9%	934	0%	885	-5%	859	-8%	813	-13%	813	-13%	934	0%	934	0%
Tributary Confluence	NODE25	8,707	1,249	1,748	934	-47%	1,760	1%	1,745	0%	1,741	0%	1,739	-1%	1,039	-41%	1,748	0%	1,748	0%
Rokeby Road	ROKEBY	6,395	1,383	1,984	995	-50%	2,006	1%	1,981	0%	1,977	0%	1,974	-1%	1,276	-36%	1,984	0%	1,984	0%
South 27th Street	27THB	3,607	1,430	2,080	1,052	-49%	2,121	2%	2,070	0%	2,065	-1%	2,062	-1%	1,378	-34%	2,080	0%	2,080	0%
BNSF Railroad	BNSF	2,600	1,595	2,073	1,495	-28%	2,108	2%	2,317	12%	2,324	12%	2,322	12%	1,693	-18%	1,490	-28%	1,490	-28%
Salt Creek	R6A	2,491	1,593	2,057	1,491	-28%	2,072	1%	2,314	12%	2,309	12%	2,306	12%	1,689	-18%	1,488	-28%	1,488	-28%
So. 38th St. (north)	S38th	7,280	322	428	428	0%	428	0%	428	0%	428	0%	428	0%	428	0%	255	-40%	255	-40%
So. 38th St. (south)	S5E	3,706	120	203	203	0%	203	0%	203	0%	203	0%	203	0%	203	0%	203	0%	181	-11%

Table MP-18
10-Year Peak Flow Rate Values at Selected Locations

Location	Model Element		Existing	Projected	With Site A		With Site B		Site S-2AF		Site S-202		Sites S-2AF & S-202		Sites A, S-2AF, S-202		Site S-5B		Sites S-5B & S-5E	
	HEC-1	HEC-RAS	Q	Q	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%
Mainstem																				
Rokeby Road	202	25,159	341	319	319	0%	319	0%	319	0%	47	-85%	47	-85%	47	-85%	319	0%	319	0%
South 66th Street	66TH	24,449	344	325	325	0%	325	0%	325	0%	47	-86%	47	-86%	47	-86%	325	0%	325	0%
South 56th Street	56THB	20,036	1,200	1,164	1,164	0%	1,164	0%	992	-15%	990	-15%	821	-29%	821	-29%	1,164	0%	1,164	0%
Cromwell Road	NODE62	17,440	1,557	1,525	1,525	0%	1,525	0%	1,366	-10%	1,362	-11%	1,209	-21%	1,209	-21%	1,525	0%	1,525	0%
South 40th Street	40THB	12,655	2,216	2,286	2,286	0%	2,452	7%	2,154	-6%	2,143	-6%	2,017	-12%	2,017	-12%	2,286	0%	2,286	0%
Tributary Confluence	NODE25	8,707	3,193	3,634	2,267	-38%	3,319	-9%	3,597	-1%	3,576	-2%	3,544	-2%	2,377	-35%	3,634	0%	3,634	0%
Rokeby Road	ROKEBY	6,395	3,387	4,039	2,396	-41%	3,822	-5%	4,016	-1%	3,999	-1%	3,979	-1%	2,747	-32%	4,039	0%	4,039	0%
South 27th Street	27THB	3,607	3,519	4,311	2,527	-41%	4,139	-4%	4,284	-1%	4,268	-1%	4,244	-2%	3,027	-30%	4,309	0%	4,309	0%
BNSF Railroad	BNSF	2,600	3,576	5,273	3,022	-43%	4,149	-21%	4,866	-8%	4,851	-8%	4,835	-8%	3,793	-28%	5,273	0%	5,273	0%
Salt Creek	R6A	2,491	3,566	5,213	2,972	-43%	4,023	-23%	4,772	-8%	4,755	-9%	4,732	-9%	3,730	-28%	5,213	0%	5,213	0%
So. 38th St. (north)	S38th	7,280	660	837	837	0%	837	0%	837	0%	837	0%	837	0%	837	0%	487	-42%	487	-42%
So. 38th St. (south)	S5E	3,706	257	390	390	0%	390	0%	390	0%	390	0%	390	0%	390	0%	390	0%	300	-23%

Table MP-19
100-Year Peak Flow Rate Values at Selected Locations

Location	Model Element		Existing	Projected	With Site A		With Site B		Site S-2AF		Site S-202		Sites S-2AF & S-202		Sites A, S-2AF, S-202		Site S-5B		Sites S-5B & S-5E	
	HEC-1	HEC-RAS	Q	Q	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%
Mainstem																				
Rokeby Road	202	25,159	537	517	517	0%	517	0%	517	0%	51	-90%	51	-90%	51	-90%	517	0%	517	0%
South 66th Street	66TH	24,449	535	516	516	0%	516	0%	516	0%	51	-90%	51	-90%	51	-90%	516	0%	516	0%
South 56th Street	56THB	20,036	2,004	1,992	1,992	0%	1,992	0%	1,682	-16%	1,718	-14%	1,411	-29%	1,411	-29%	1,992	0%	1,992	0%
Cromwell Road	NODE62	17,440	2,668	2,639	2,639	0%	2,639	0%	2,338	-11%	2,377	-10%	2,050	-22%	2,050	-22%	2,639	0%	2,639	0%
South 40th Street	40THB	12,655	3,933	4,031	4,031	0%	4,356	8%	3,760	-7%	3,779	-6%	3,510	-13%	3,510	-13%	4,031	0%	4,031	0%
Tributary Confluence	NODE25	8,707	5,734	6,217	4,018	-35%	4,924	-21%	6,092	-2%	6,086	-2%	6,013	-3%	4,107	-34%	6,217	0%	6,217	0%
Rokeby Road	ROKEBY	6,395	6,141	6,934	4,240	-39%	5,813	-16%	6,857	-1%	6,844	-1%	6,771	-2%	4,835	-30%	6,934	0%	6,934	0%
South 27th Street	27THB	3,607	6,468	7,564	4,407	-42%	6,577	-13%	7,432	-2%	7,417	-2%	7,373	-3%	5,519	-27%	7,564	0%	7,564	0%
BNSF Railroad	BNSF	2,600	5,212	9,268	4,945	-47%	6,675	-28%	8,484	-8%	8,469	-9%	8,436	-9%	6,710	-28%	9,268	0%	9,268	0%
Salt Creek	R6A	2,491	5,196	9,268	4,739	-49%	6,469	-30%	8,474	-9%	8,460	-9%	8,411	-9%	6,699	-28%	9,268	0%	9,268	0%
So. 38th St. (north)	S38th	7,280	1,140	1,430	1,430	0%	1,430	0%	1,430	0%	1,430	0%	1,430	0%	1,430	0%	765	-47%	765	-47%
So. 38th St. (south)	S5E	3,706	428	613	613	0%	613	0%	613	0%	613	0%	613	0%	613	0%	613	0%	393	-36%

Insert
Figure MP-15
Potential Site ‘A’ Regional Detention Plan View

Insert
Figure MP-16
Potential Site ‘B’ Regional Detention Plan View

Insert
Figure MP-17
Potential Stormwater Storage Facilities Sites S-201, S-202, & S-2AF

Insert
Figure MP-18
Potential Stormwater Storage Facilities Sites S-5B & S-5E

Insert
Figure MP-19
Potential Stormwater Storage Facility Typical Cross-Section

MULTI-PURPOSE USE POTENTIAL

Preservation of the 400-ft corridor or the existing 100-year floodplain would provide opportunities for inclusion of linear features such as hiking/biking paths, open space areas, and riparian vegetative and animal habitat. Preserving the 100-year floodplain would enhance site selection options for constructed water quality wetlands. Water quality wetlands could be incorporated into the stormwater storage facilities, as could passive recreational features such as open space.

Active recreation would require additional land area and would preclude use of easement values for the flood pool area.

The floodplain between BNSF Railroad and South 27th Street could provide a buffer between Wilderness Park and development. An active use, recreation, destination park could be considered with a pedestrian underpass to access Wilderness Park across the BNSF Railroad tracks, and would likely require additional expenditures for fee title land rights.

FUNDING

Funding of such stormwater management facilities in Lincoln has historically been done in one, or in combination of the following ways:

- Bond issue financing of city storm drain projects
- General revenue appropriation
- Cooperative cost sharing by the city and NRD for projects of joint interest and responsibility
- NRD funding of channel improvements
- City use of Federal Highway Administration and Nebraska Department of Roads assistance for bridges and culvert improvements
- Private funding of stormwater facilities required for land subdivision and development process

Innovative methods of financing may need to be evaluated and developed. Water quality wetland construction and preservation of the existing 100-year floodplain enhance project eligibility for Nebraska Environmental Trust Fund and Nebraska Department of Environmental Quality § 319 Fund programs. The Nebraska Legislature is also considering enabling legislation during the 2003 Legislative Session to allow local governments to form stormwater utilities.

CONCEPT MASTER PLAN ALTERNATIVES

Two concept master plans evolved from the public involvement and input process. Concept Plan A can be categorized as preserving the existing 100-year floodplain, and Concept Plan B can be categorized as preserving a 400-ft flood corridor with stormwater storage facilities. Both concept master plans meet Master Plan goals and include components that improve stream stability, reduce flood hazard, improve water quality, and provide multi-purpose use potential. The plans are discussed below.

Concept Plan A - Preserve Existing Floodplain - $8,424,000

The components of Concept Plan A include preservation of the existing 100-year floodplain from below South 70th Street to the Salt Creek floodplain delineated limits, construction of three detention facilities, construction of water quality wetlands in the preserved floodplain at subbasin outlets, use of bioengineering approaches to improve stream stability, and replacement of undersized bridges and culverts (see Figure MP-20, "Concept Plan A Potential Component Locations"). Refer to Figures MP-22A through MP-22o for site details, and to Table MP-23 for opinions of probable cost for Concept Master Plan A. This concept plan would meet the stormwater management goals established for this watershed, and would require 405 acres of land rights acquisition.

Concept Plan B - Preserve a Flood Corridor with Regional Storage Facilities - $12,082,000

The components of Concept Plan B include preservation of a flood corridor from below South 70th Street to the Salt Creek Floodplain delineated limits, a 400-ft flood corridor below South 40th Street, preserving the existing flood corridor along streams upstream of South 40th Street and on the tributaries, construction of a regional storage facility west of South 40th Street on a tributary, construction of four other detention facilities, construction of water quality wetlands outside the preserved floodplain at subbasin outlets, use of bioengineering approaches to improve stream stability, and replacement of undersized bridges and culverts (see Figure MP-21 "Concept Plan B Potential Component Locations"). Refer to Figures MP-22A through MP-22o for site details, and to Table MP-23 for opinions of probable cost for Concept Master Plan B. The combination of stormwater storage, 400-ft flood corridor, and proposed bridges would provide a 100-year water surface profile similar to the water surface profile for preservation of the existing 100-year floodplain. This concept plan would require land rights acquisition of 396 acres of Tier 1 area. The loss of 100-year floodplain areas outside the minimum flood corridor with this concept would require an additional $3.7 million to meet the water quality goals established for this watershed. Thus, Concept B would only be acceptable if private development were to complete the water quality improvements needed to offset the impacts to water quality caused by development.

Those areas identified as Low Density Residential in the Future Land Use Plan are already developed, and are expected to remain low density residential even beyond the 25-year planning period. While there may be individual 3-acre parcels in this area which are subdivided in the future, no significant redevelopment of this area into urban land use is anticipated. The Master Plan assumes that the 100-year floodplain within Low Density Residential areas is at low risk of being impacted by future land subdivisions, which would be anticipated to be generally compatible with continued preservation of the floodplain. Thus, costs for acquisition of 100-year floodplain within Low Density Residential areas is not included within the costs identified for implementation of the Master Plan. Tables MP-20, MP-21, and MP-22 compare the 2-, 10-, and 100-year peak flow rates for existing conditions to Concept Master Plan A and to Concept Master Plan B.

The following definitions were used to evaluate the relative performance of components selected for consideration in the concept master plan alternatives.

- High - component fully meets the established objective of addressing the problem/ opportunity identified in the watershed.
- Medium - component fully meets the established objective of addressing the problem/ opportunity identified in the watershed, but may limit or be limited by the performance level of one or more of the other components.
- Low - component adequately meets the established objective of addressing the problem/ opportunity identified in the watershed, and limits or is limited by the performance level of one or more of the other components.

RECOMMENDATION

Both proposed Concept Master Plans would meet the goals to preserve stream bed and banks that are stable and improve stability of those at risk, reduce flood hazard to existing and future buildings and infrastructure, provide opportunities for multi-purpose use potential, and preserve or restore instream and riparian habitat. However, Concept Master Plan B would be more expensive, based on the opinions of probable cost provided in Table MP-23 SEUSC Master Plan Performance Matrix, and does not provide the high level of water quality improvement as does Concept Master Plan A. The flood hazard reduction and water quality improvement components account for the differential.

Maintaining the status quo is not, and should not be acceptable because it meets none of the stormwater management goals, and would add approximately $800,000 and $3,400,000 to the probable costs for bridge replacement and stream stability measures, respectively.

Based on the above discussion, Concept Master Plan A was recommended to be selected for adoption of the stormwater master plan for the SEUSC Watershed. While Concept Master Plan B accommodates 45 more developable acres, it is at a significantly higher total cost. Concept Plan B costs $3.7 million more than Concept Plan A to provide the same relative water quantity and quality benefits. Concept Plan A allows for protection of the 100-year floodplain and the construction of water quality wetlands in the lower portion of the subbasins. In doing so, Concept Plan A meets all of the stormwater management goals established for this watershed at significantly lower cost than the alterative plan.

Implementation of Concept Plan B would only be recommended if private development in the watershed were to offset its own water quality and quantity impacts in such a way as to provide the same relative water quantity and quality benefits as Concept Plan A.

Capital project components identified in the master plan are generally included in order to meet City of Lincoln design standards and/or to accommodate future urban growth projected for the basins in the SEUSC Watershed. In some cases, the magnitude of the project also reflects the results of more detailed hydrologic and hydraulic modeling completed with HEC-1 and HEC-RAS. It is recognized that prior to areas within the watershed being annexed into the city, the county may have a need to construct improvements in these locations, and that these improvements may not reflect the standards identified in the master plan. In these cases, it is anticipated that such components would be upgraded in the future by the City of Lincoln.

Insert
Figure MP-20
Concept Master Plan A Potential Component Locations

Insert
Figure MP-21
Concept Master Plan B Potential Component Locations

Table MP-20
2-Year Peak Flow Rate Values at Selected Locations

Location	Model Element		Existing	Concept Master Plan A		Concept Master Plan B	
	HEC-1	HEC-RAS	Q-cfs	Q-cfs	% Change	Q-cfs	% Change
Mainstem							
Rokeby Road	202	25,159	177	42	-76%	42	-76%
South 66th Street	66TH	24,449	169	41	-76%	41	-76%
South 56th Street	56THB	20,036	545	352	-35%	352	-35%
Cromwell Road	NODE62	17,440	734	554	-25%	554	-25%
South 40th Street	40THB	12,655	908	739	-19%	813	-10%
Tributary Confluence	NODE25	8,707	1,249	1,491	19%	1,035	-17%
Rokeby Road	ROKEBY	6,395	1,383	1,674	21%	1,222	-12%
South 27th Street	27THB	3,607	1,430	1,648	15%	1,313	-8%
BNSF Railroad	BNSF	2,600	1,427	1,827	28%	1,684	18%
Salt Creek	R6A	2,491	1,427	1,822	28%	1,662	16%
Northeast Tributary							
Rebel Drive	REBEL	9,430	257	257	0%	257	0%
South 56th Street	56THA	8,265	179	179	0%	179	0%
South 53rd Street	S53RD	7,195	178	178	0%	178	0%
Private Drive	R22	6,120	275	275	0%	275	0%
Private Drive	R22	5,670	275	275	0%	275	0%
Southwest Tributary							
South 40th Street	S2T	500	233	419	80%	419	80%
Southcentral Trib.							
New Castle Road	CLV310	310	164	164	0%	164	0%
Southeast Tributary							
Rokeby Road	201	464	243	206	-15%	134	-45%
Northwest Tributary							
Yankee Hill Road	YANKB	5,700	167	167	0%	167	0%
South 40th Street	40THA	3,875	253	332	31%	332	31%
Saltillo Road	SALTIL	1,466	637	1,037	63%	1,018	60%
So. 38th St. (north)	S38TH	7,280	322	408	27%	255	-21%
So. 38th St. (south)	S5E	3,706	120	59	69%	59	-51%

Table MP-21
10-Year Peak Flow Rate Values at Selected Locations

Location	Model Element		Existing	Concept Master Plan A		Concept Master Plan B	
	HEC-1	HEC-RAS	Q-cfs	Q-cfs	% Change	Q-cfs	% Change
Mainstem							
Rokeby Road	202	25,159	341	47	-86%	47	-86%
South 66th Street	66TH	24,449	344	47	-86%	47	-86%
South 56th Street	56THB	20,036	1,200	821	-32%	821	-32%
Cromwell Road	NODE62	17,440	1,557	1,209	-22%	1,209	-22%
South 40th Street	40THB	12,655	2,216	1,880	-15%	2,017	-9%
Tributary Confluence	NODE25	8,707	3,193	2,989	-6%	2,353	-26%
Rokeby Road	ROKEBY	6,395	3,387	3,299	-3%	2,628	-22%
South 27th Street	27THB	3,607	3,519	3,430	-3%	2,854	-19%
BNSF Railroad	BNSF	2,600	3,500	3,658	5%	3,632	4%
Salt Creek	R6A	2,491	3,500	3,648	4%	3,485	0%
Northeast Tributary							
Rebel Drive	REBEL	9,430	612	612	0%	612	0%
South 56th Street	56THA	8,265	609	609	0%	609	0%
South 53rd Street	S53RD	7,195	533	533	0%	533	0%
Private Drive	R22	6,120	700	700	0%	700	0%
Private Drive	R22	5,670	700	700	0%	700	0%
Southwest Tributary							
South 40th Street	S2T	500	471	766	63%	766	63%
Southcentral Trib.							
New Castle Road	CLV310	310	328	328	0%	272	-17%
Southeast Tributary							
Rokeby Road	201	464	506	461	-9%	251	-50%
Northwest Tributary							
Yankee Hill Road	YANKB	5,700	371	371	0%	371	0%
South 40th Street	40THA	3,875	507	612	21%	612	21%
Saltillo Road	SALTIL	1,466	1,445	2,043	41%	2,022	40%
So. 38th St. (north)	S38TH	7,280	660	786	19%	487	-26%
So. 38th St. (south)	S5E	3,706	257	168	-35%	300	17%

Table MP-22
100-Year Peak Flow Rate Values at Selected Locations

Location	Model Element		Existing	Concept Master Plan A		Concept Master Plan B	
	HEC-1	HEC-RAS	Q-cfs	Q-cfs	% Change	Q-cfs	% Change
Mainstem							
Rokeby Road	202	25,159	537	51	-91%	51	-91%
South 66th Street	66TH	24,449	535	51	-90%	51	-90%
South 56th Street	56THB	20,036	2,004	1,411	-30%	1,411	-30%
Cromwell Road	NODE62	17,440	2,668	2,050	-23%	2,050	-23%
South 40th Street	40THB	12,655	3,933	3,212	-18%	3,510	-11%
Tributary Confluence	NODE25	8,707	5,734	5,138	-10%	4,085	-29%
Rokeby Road	ROKEB	6,395	6,141	5,667	-8%	4,605	-25%
South 27th Street	27THB	3,607	6,468	5,927	-8%	5,063	-22%
BNSF Railroad	BNSF	2,600	6,441	5,328	-17%	6,049	-6%
Salt Creek	R6A	2,491	6,441	5,307	-18%	5,995	-7%
Northeast Tributary							
Rebel Drive	REBEL	9,430	1,075	1,075	0%	1,075	0%
South 56th Street	56THA	8,265	1,042	1,042	0%	1,042	0%
South 53rd Street	S53RD	7,195	830	830	0%	830	0%
Private Drive	R22	6,120	1,136	1,136	0%	1,136	0%
Private Drive	R22	5,670	1,136	1,136	0%	1,136	0%
Southwest Tributary							
South 40th Street	S2T	500	762	1,175	54%	1,175	54%
Southcentral Trib.							
New Castle Road	CLV310	310	488	488	0%	488	0%
Southeast Tributary							
Rokeby Road	201	464	827	796	-4%	404	-51%
Northwest Tributary							
Yankee Hill Road	YANKB	5,700	639	639	0%	639	0%
South 40th Street	40THA	3,875	814	929	14%	929	14%
Saltillo Road	SALTIL	1,466	2,454	3,281	34%	3,253	33%
So. 38th St. (north)	S38TH	7,280	1,140	1,253	10%	765	-33%
So. 38th St. (south)	S5E	3,706	428	462	8%	393	-8%

Table MP-23
SEUSC Master Plan Performance Matrix

Goals - Preserve stream bed and banks that are stable, and improve stability of those at risk
- Reduce flood hazard to existing and future buildings and infrastructure
- Coordinate components to provide multi-purpose use potential
- Improve water quality and preserve or restore instream and riparian habitat
- Identify funding opportunities

Objective	*Master Plan Component*	*Concept Plan A*				*Concept Plan B*			
		Performance			Cost	Performance			Cost
		High	Med	Low		High	Med	Low	
Stream Stability									
Maintain existing flood profiles	Preserve floodplain to limits of existing 100-year flood	X			n/a				n/a
Preserve stream geomorphology	Preserve 400-ft corridor from BNSF Railroad to South 40th Street, and minimum corridor below proposed stormwater storage facilities							X	
Increase stream bed and bank stability	Apply bioengineering approach for stream bed and bank stability measures	X			$2,633,000	X			$2,633,000
Subtotal					$2,633,000				$2,633,000
Flood Hazard Reduction									
Determine flood hazard and reduce hazard for existing development	Build Sites S-202, S-2AF and S-5E	X			$1,604,000	X			$1,604,000
	Build Site S-5B				$0	X			$893,000
	Build on-site detention								
Reduce hazard to future development	Preserve floodplain to limits of existing 100-year flood	X			$3,420,000			X	$1,290,000
	Build Site A and preserve 400-ft corridor from BNSF Railroad to South 40th Street					X			$2,975,000
Reduce public responsibility for flood damage repair	Encourage flood hazard insurance for homes and buildings in the 100-year flood prone area		X				X		
Determine incremental impact of subdivisions	Require submittal of hydrologic and hydraulic analysis in a consistent format for use by PW&U	X			$0	X			$0
Subtotal					$5,024,000				$6,762,000
Multi-Purpose Use Potential									
Provide components that facilitate multiple use	Preserve a corridor wide enough to accommodate hiking/biking paths and provide opportunity for riparian wildlife habitat	X					X		
Subtotal					$0				$0
Water Quality Improvement									
Remove urban pollutants	Construct water quality wetlands	X			$767,000	X			$2,687,000
Restore stream to pre-agricultural alignment	Provides adequate room if desired for restoration	X						X	
Improve instream habitat		X						X	
Loss of riparian habitat due to development in the floodplain	Preserve a corridor wide enough to provide opportunity for riparian wildlife habitat	X						X	
Subtotal					$767,000				$2,687,000
Funding									
Provide components that enhance likelihood of funding	Water quality wetlands and preserving existing 100-year floodplain enhance NET Fund and NDEQ §319 Fund eligibility	X						X	
Total Concept Master Plan Opinions of Probable Cost					**$8,424,000**				**$12,082,000**

Estimated costs for potential bridge and culvert improvements are not included within the total costs estimated to implement the SEUSC Watershed Master Plan. Drainage improvements associated with arterial streets are anticipated to be completed with road projects as urban standards are met when these streets are improved from a rural to an urban cross-section in the future. Likewise, improvements associated with local streets within existing acreage developments are expected to occur when street improvements are made to these areas in the future. For information purposes, estimated costs for bridge and culvert improvements are included in Table MP-15 on pages 108-109, but these costs are not included within total costs listed in the SEUSC Master Plan Performance Matrix on page ES-5 and page 125.

Insert Figures 22A..o
Proposed Concept Master Plan Components - Stream Segments 1 through 15

Insert Figures 23A..o
Proposed 100-year Water Surface Profiles - Stream Segments 1 through 15

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