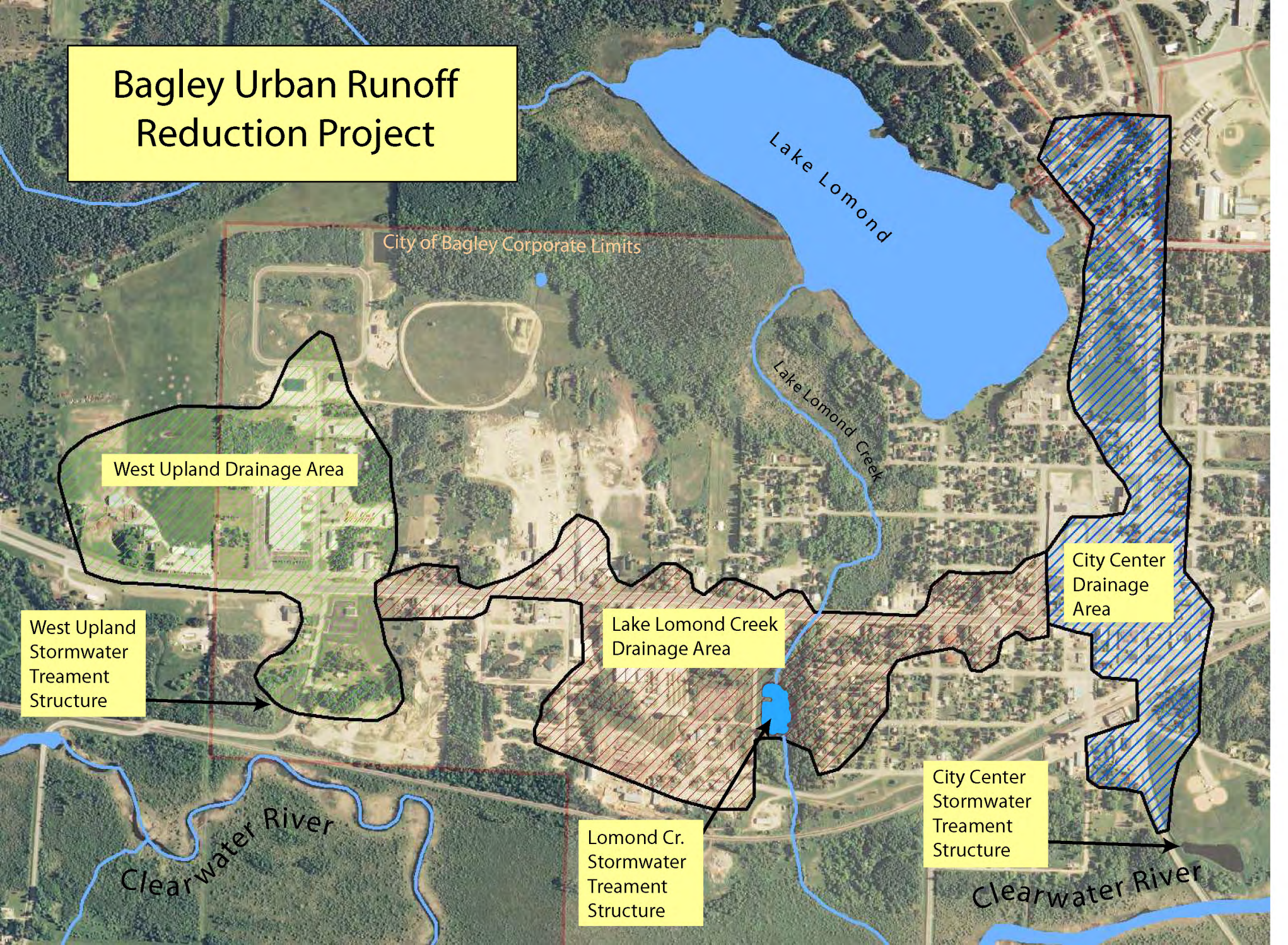
Red Lake Watershed District

Bagley Urban Runoff Reduction Project

Project No. 151


Bagley Urban Runoff Reduction Project
Lake Lomond
City of Bagley Corporate Limits
Lake Lomond Creek
West Upland Drainage Area
West Upland Stormwater Treament Structure
Lake Lomond Creek Drainage Area
City Center Drainage Area
Lomond Cr. Stormwater Treament Structure
City Center Stormwater Treament Structure
Clearwater River
Clearwater River

FINAL ENGINEER'S REPORT

BAGLEY URBAN RUNOFF REDUCTION PROJECT

City Center Drainage

GENERAL: This is a north-south oriented 79 acre drainage area that consists primarily of the MN Hwy 92 corridor through Bagley. It is located in Section 29, T147N, R37W. The upstream area consists of low-density residential development and a well used city park. It then changes to a business district. This continues as the drainage crosses US Hwy 2. This area has approximately 38% impervious surface and includes three fuel storage or service areas. The majority of the runoff from this area is collected in a storm sewer system with curb and gutter inlets. The storm sewer outlets into the Hwy 92 ditch. Runoff then flows along the east side of the highway about 800 feet to the Clearwater River.

The proposed detention basin area is bordered by the Clearwater River to the south and softball diamonds to the north. The highway 92 embankment defines the west boundary. The area is fairly level and 2 to 3 acres in size. Current ownership is by the City of Bagley. The land is currently unused.

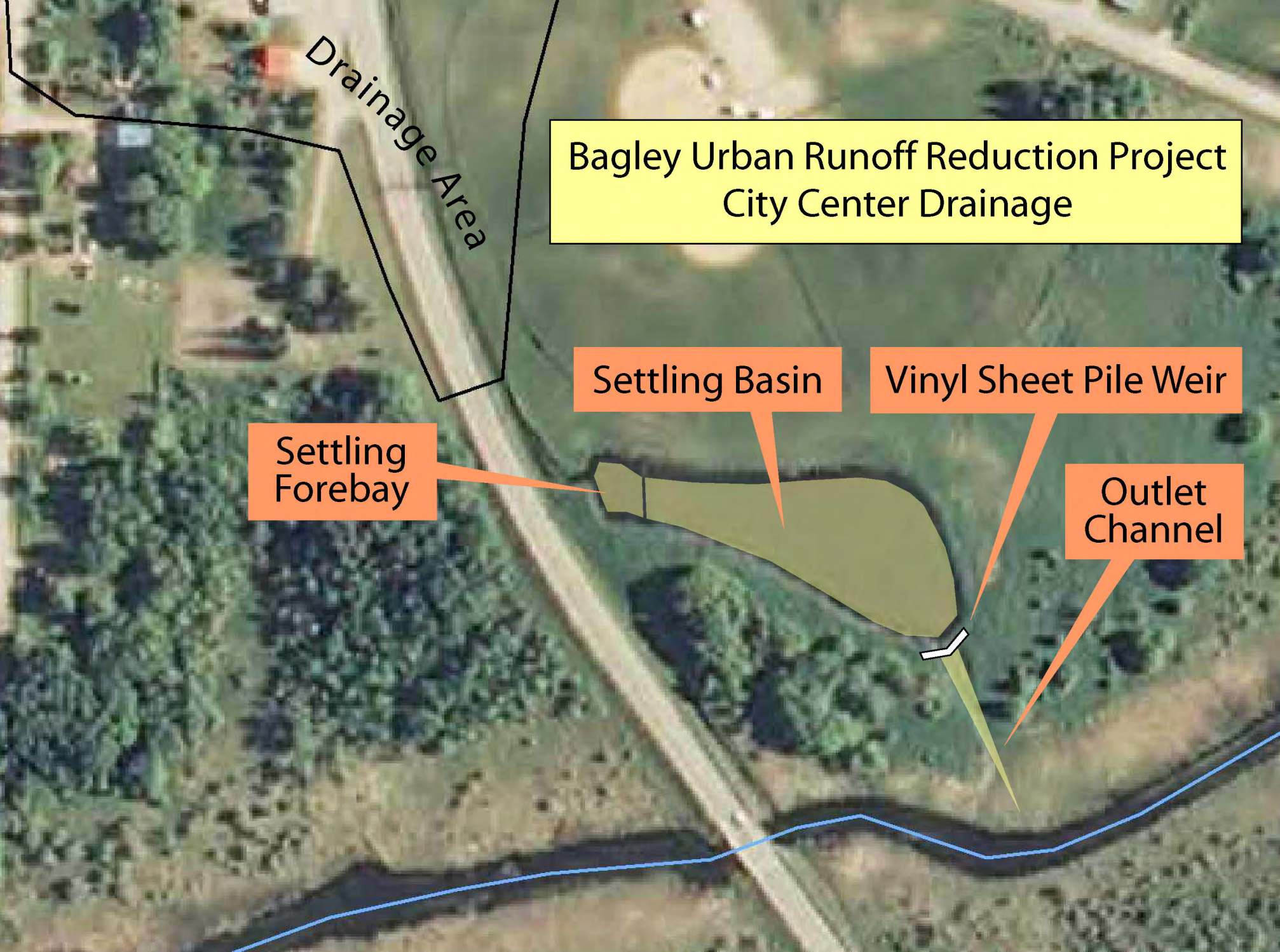
SOILS: The soil type at the site is mapped as Markey muck. This soil is very poorly drained. It has a seasonal high water table from 1 foot above to 1 foot below the surface. The landform setting at this site is an outwash plain. The most common textures are peat and sand. Site specific soils conditions have been verified by test holes. They were found to match the Markey muck description closely. There is approximately 2 to 3 feet of highly organic soil with coarse sand below it. The sand is saturated and the test holes filled with water fairly rapidly. The test holes were taken to a depth of 6 feet. The saturated sand continued to the 6 foot depth and likely beyond.

Shallow soils at this site also consist of decomposing wood chips and sawdust from a former lumber processing operation at this location.

DESIGN CONSIDERATIONS: Design guidelines were mainly taken from two references. One is a stormwater management pond design example for extended detention wet pond by Richard A. Claytor, Jr., P.E. of the Center for Watershed Protection in Ellicott City, MD. The other is the Wet Detention Basin Conservation Practice Standard Number 1001 issued by the Wisconsin Department of Natural Resources.

Basin sizing is based on design guidelines and site limitations. The configuration includes a sediment forebay to trap large particles such as road sand and a larger but shallower main basin. The length to width ratio pond exceeds 2:1 to ensure an adequate length of flow for treatment. The outlet consists of a vinyl sheet pile weir structure with riprap protection upstream and downstream of the weir. A short section of outlet channel delivers the outflow to the Clearwater River.

The planned basin is relatively shallow with side slopes of 4 horizontal to 1 vertical or flatter. This is mainly due to the soil conditions at the site. Both the organic soil and the


Drainage Area
Bagley Urban Runoff Reduction Project
City Center Drainage
Settling Basin
Vinyl Sheet Pile Weir
Settling Forebay
Outlet Channel

saturated sand will slough and cave as an excavation is made. Shallow excavations with flatter slopes are most suitable in these conditions.

As mentioned earlier, this site is fairly level. The result is that the ponds will be created almost entirely by excavation.

The layout of the treatment system is such that the runoff from the road ditch is diverted to the east into the forebay just downstream from the existing City of Bagley sign. It then continues through the main basin and over the weir structure. A new outlet channel is to be constructed downstream from the weir structure and the water will enter the river approximately 300 feet downstream from where it currently enters. The main basin location is directly south of the softball fields.

HYDROLOGY/HYDRAULICS: As mentioned earlier, the majority of the runoff in this watershed is collected in a storm sewer system. The Minnesota Department of Transportation has estimated the capacity of this system to be approximately 10 cfs.

Technical Release 55 "Urban Hydrology for Small Watersheds" developed by the USDA Soil Conservation Service was used to calculate runoff volumes and peak discharges for this site (attachments 1&2).

The estimated watershed peak discharge during the 1 yr. 24-hr rainfall event (1.95 in.) is 12 cfs, so the capacity of the storm sewer system is fairly frequently exceeded. During the larger runoff events, some of the water flowing to this area does so overland. The capacity of the outlet weir is 50 cfs, which is slightly less than the estimated 25 yr. 24-hr. peak discharge for the watershed of 55 cfs. At discharges higher than this, flow will begin in the overflow spillway located in the SW corner of the main basin. It is anticipated that this will only occur during extremely large runoff events.

POND SIZING: Wet Detention Basin Conservation Practice Standard Number 1001 issued by the Wisconsin Department of Natural Resources was used to size the pond. Table 1 (see attachment 3) was used to determine the permanent pool surface area based on watershed land uses. The results are as listed:

Land Use	Area (Acres)	Pond Surface Area (% of Drainage Area)	Req'd Surface Area (Acres)
Parks/Open Space	19.43	0.6	0.117
Streets (Curb & Gutter)	9.60	2.8	0.269
Streets (Open Ditch)	6.84	1.4	0.096
Commercial	26.78	2.1	0.562
Industrial	1.61	1.8	0.029
Residential (1/2 acre)	13.80	0.7	0.097
			1.170 Acres Total

The combined surface area of the proposed sediment forebay and main basin is 1.39 acres at the crest elevation of the outlet structure. The surface area is slightly larger

FINAL ENGINEER'S REPORT

BAGLEY URBAN RUNOFF REDUCTION PROJECT

Lake Lomond Creek

GENERAL: This drainage area consists of nearly a mile of Hwy 2, mixed residential developments, and some small commercial businesses. It is located in Sections 29 & 30 T147N R37W. Runoff from this area is collected in the Hwy 2 storm sewer system and outlets into Lake Lomond Creek immediately downstream from where Hwy 2 crosses the creek.

The potential detention basin area is flat wetland meadow type area approximately 500 ft. downstream from where Hwy 2 crosses Lake Lomond Creek. Some willow and alder is present. Drainage from two large industrial sites where wood products are processed comes to this area. This drainage area also contains two other commercial sites and a few residences. Runoff from this area passes under Sunset Ave. SW in an 18" metal culvert. It then flows through a short channel into Lake Lomond Creek.

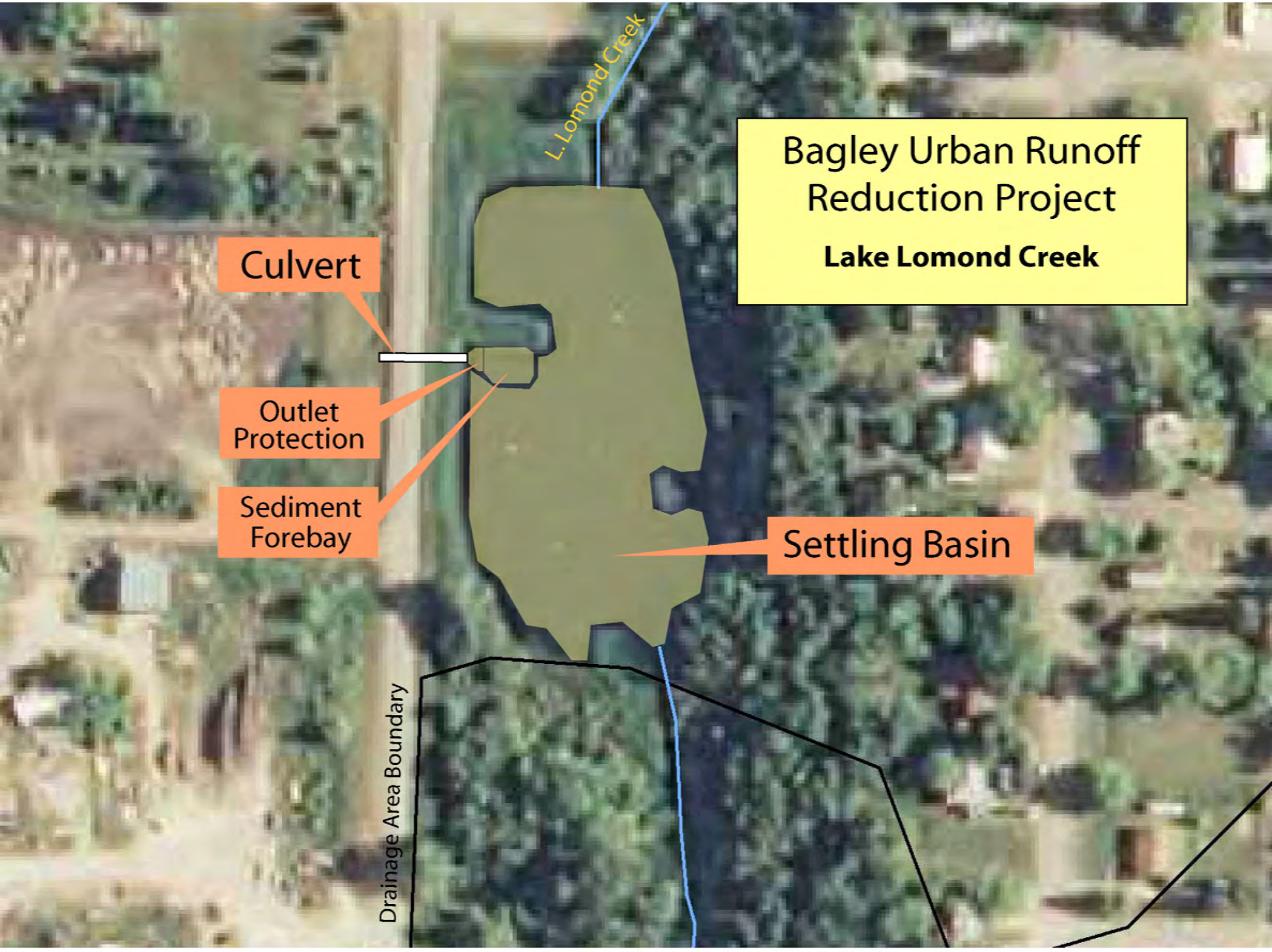
The proposed basin area is currently under the ownership of the Lucille Thompson Estate. The Red Lake Watershed District is currently in the process of purchasing the needed land. Once the project is completed, the land is to be turned over to the City of Bagley for ownership.

SOILS: The soil type at the site is mapped as Mooselake mucky peat. This soil very poorly drained. It has a seasonal high water table from 1 foot above to 1 foot below the surface. The dominant parent material is organic materials. The most common texture is peat. Site specific soil conditions have been verified by test holes. Four bucket auger borings were taken in the proposed basin area. The black peat extended to depths ranging from 2' to 5.5'. Three of the test holes showed a soft silt and clay soil below the peat. Test holes ranged from 3.5' to 6' in depth.

DESIGN CONSIDERATIONS: Design guidelines were mainly taken from two references. One is a stormwater management pond design example for extended detention wet pond by Richard A. Claytor, Jr., P.E. of the Center for Watershed Protection in Ellicott City, MD. The other is the Wet Detention Basin Conservation Practice Standard Number 1001 issued by the Wisconsin Department of Natural Resources. The Minnesota Pollution Control Agencies Protecting Water Quality in Urban Areas Manual was also used.

This site is a fairly level riparian wetland. Detention basin storage will need to be created by excavation. Soils in this area may necessitate the use of specialized equipment or methods to accomplish the excavation. Excavation under frozen conditions may be the preferred situation.

Two Hwy 2 storm sewers outlet into Lake Lomond Creek immediately downstream from where the highway crosses the creek. The proposed design involves collecting the entire flow of these two storm sewers and the stream flow into a settling pond. The flow would be returned to the existing channel downstream from the excavated treatment


Bagley Urban Runoff Reduction Project
Lake Lomond Creek
L. Lomond Creek
Culvert
Outlet Protection
Sediment Forebay
Settling Basin
Drainage Area Boundary

pond. This pond would also receive the water from the west draining under Sunset Ave. SW.

Sand and sediment appear to have agraded the stream channel somewhat in this area. The storm sewer outlets and centerline culvert outlet are partially filled with sand and sediment. This maintenance issue is likely to continue with this option.

The proposal includes a clean out of the sand and sediment at the outlets of the pipes and in the portion of the stream channel between the pipe outlets and the planned settling pond.

Lake Lomond Creek is considered a protected water by the MN DNR. Therefore, alterations to the flow and to the channel itself will need to be permitted by this agency and possibly others as well.

This design concept was briefly discussed with Kirk English, MN DNR Area Hydrologist. An initial review of the rules regarding stream alterations did not reveal anything that would automatically disqualify this proposal.

The planned pond configuration includes an island, some shoreline irregularity and a shallow water shelf area. The intention of these features is to improve the aesthetics, safety, treatment effectiveness and wildlife habitat of the pond area.

HYDROLOGY/HYDRAULICS: Three separate watersheds contribute runoff to this treatment pond site. Two of the drainage areas have storm sewer systems that deliver the runoff. One drains the Hwy 2 corridor to the west of Lake Lomond Creek and the other drains the Hwy 2 area to the east of the creek. The third contributing area comes from the west and drains through and 18" cmp culvert under Sunset Ave. SW. Characteristics of these three watersheds are as follows:

Name	Area (Acres)	Runoff Curve Number	1 yr.-24 hr. Storm Runoff (Ac.-Ft)
LLC East	25.7	80	1.13
LLC West	21	86	1.40
Sunset Ave. SW	43.50	83	2.39

Technical Release 55 "Urban Hydrology for Small Watersheds" developed by the USDA Soil Conservation Service was used to calculate runoff volumes for this site.

The Minnesota Department of Transportation (MNDOT) lists the capacity of the west storm sewer at 33.3 cfs and the east system at 60.7 cfs. MNDOT estimates the 50 yr.-24hr. peak discharge for Lake Lomond Creek at 105 cfs for a total combined flow during the 50 yr. event of 199 cfs entering the settling pond from these sources. The capacity of the 18" cmp under Sunset Ave. SW is 12 cfs. Lake Lomond Creek has a small base-flow channel through the project area so out-of-bank flow occurs often during runoff events.

The Lake Lomond Creek channel currently runs through the planned settling pond area. Due to the base flow of the creek it is anticipated that the pond will remain continuously filled with water. The stream will serve as the main inlet and the sole outlet of the

than required by Practice Standard 1001 in order to provide additional extended detention storage volume.

The available storage of the proposed basin and forebay is as follows:

Elevation	Area (Acres)	Accumulated Storage (Ac.-Ft.)
90.0	0.05	0.0
91.0	0.07	0.06
92.0	1.03	0.61
93.0	1.15	1.70
94.0	1.26	2.91
95.0	1.39	4.24
96.0	1.45	5.66

Practice Standard 1001 recommends providing an extended detention storage volume equal to the runoff from the 1 yr., 24-hr. rainfall event. The watershed has a composite runoff curve number of 80. The runoff volume from the 1 yr. 24 hr. storm event (1.95 in.) is approximately 3.4 ac. ft. The proposed basin provides a total storage volume of 4.24 acre-ft. at elev. 95.0 (weir crest). Estimating a draw-down of the water level between runoff events to elev. 93.0 due to infiltration and evaporation provides 2.54 acre-ft. of extended detention storage. The treatment effects of the under-sizing for extended detention are likely to be offset by the positive treatment impacts of the wetland vegetation in the main basin given the shallow depth and flat slopes.

WATER POLLUTION CONTROL: This treatment system as proposed is expected to remove a minimum of 80% of the total suspended solids load from the runoff volume generated by the drainage area on an average annual basis.

settling pond. No alterations are planned for the creek at the settling pond inlet or outlet. The pond water level will be based on the depth of flow in the creek channel at the outlet end.

POND SIZING: This site is somewhat unique in that the pond will remain continuously full due to the base flow of Lake Lomond Creek. Treatment is anticipated through settling of suspended particles and nutrient uptake by aquatic vegetation. Wet Detention Basin Conservation Practice Standard Number 1001 issued by the Wisconsin Department of Natural Resources was used to size the pond. Table 1 (see attachment 3, page 6) was used to determine pond surface area based on watershed land uses. The results are as listed:

Sunset Ave. SW

Land Use	Area (Acres)	Pond Surface Area (% of Drainage Area)	Req'd Surface Area (Acres)
Streets (Open Ditch)	0.93	1.4	0.013
Commercial	6.54	2.4	0.157
Industrial	29.6	1.8	0.533
Residential (1/3 acre)	6.42	0.8	0.050
			0.753 Acres Total

LLC West

Land Use	Area (Acres)	Pond Surface Area (% of Drainage Area)	Req'd Surface Area (Acres)
Open Space	0.8	0.6	0.005
Streets (Curb & Gutter)	5.3	2.8	0.148
Commercial	7.9	2.1	0.166
Residential (1/4 acre)	3.1	0.8	0.025
Residential (1/2 acre)	3.9	0.7	0.027
			0.371 Acres Total

LLC East

Land Use	Area (Acres)	Pond Surface Area (% of Drainage Area)	Req'd Surface Area (Acres)
Open Space	1.1	0.6	0.007
Streets (Curb & Gutter)	2.6	2.8	0.073
Streets (Open Ditch)	3.0	1.4	0.042
Commercial	2.2	2.1	0.046
Residential (1/4 acre)	16.8	0.8	0.134
			0.302 Acres Total

The combined surface area required from the three watersheds is 1.426 acres. The surface area of the planned pond is 1.62 acres.

The targeted storage volume for the settling pond is the volume of the 1 yr.-24 hr storm (1.95 in.) runoff volume from the three drainage areas. The combined total volume from the three areas is 4.92 ac.-ft. The storage provided in the settling pond is as shown below:

Elevation	Area (Acres)	Accumulated Storage (Ac.-Ft.)
86.0	0.29	0.0
87.0	0.52	0.40
88.0	1.07	1.20
89.0	1.19	2.33
90.0	1.47	3.66
91.0	1.62	5.20

Elevation 91.0 is the expected normal pool level of the proposed pond.

WATER POLLUTION CONTROL: This settling pond as proposed is expected to remove approximately 80% of the total suspended solids load from the runoff volume generated by the drainage areas on an average annual basis.

FINAL ENGINEER'S REPORT

BAGLEY URBAN RUNOFF REDUCTION PROJECT

West Upland Drainage

GENERAL: This 88-acre drainage area on the west-end of the city consists of the Bagley Industrial Park. Other developed areas include a school building and bus lot, three vehicle sales and service areas, two county buildings, and a segment of Hwy 2. Development of this area has recently increased and that trend is likely to continue. Future development for industrial or service businesses as well as residences is anticipated.

Runoff is collected in open road ditches and a storm sewer system with catch basins and curb and gutter inlets. Highway 2 east of County Road 25 (Tower Ave. SW) has a recently installed storm sewer system that outlets into the ditch on the west side of County Road 25. Runoff from north and west of County Road 25 also drains to this area. It flows down this ditch and through a drainage swale before it passes under County Road 25 as it curves to the west. It then passes under a railroad grade a short distance downstream from the road and goes directly into the Clearwater River.

The proposed detention basin area is in the drainage swale just upstream from where the runoff passes under County Road 25. This area is heavily wooded with a diverse mix of trees and brush. Pine, spruce, aspen, alder, and willow are some of the species present. Current land ownership is by Vernon McFarland of Grand Forks, ND. He owns a 4.28-acre parcel in that area with an estimated market value of $3,400.00. The Red Lake Watershed District is pursuing ownership of the needed land.

SOILS: The soil type at the site is mapped as Sugarbush loamy sand. This soil is well drained. It has a seasonal high water table greater than 6.0 feet deep. The dominant parent material is glacial outwash. The most common textures are silt and sand. Site specific soil conditions have been verified by test holes. A soil boring was taken in the proposed pool area near the bottom of the drainageway. The top 1.0 ft. consisted of a black clay based topsoil. The next 2.5 ft. was a sandy lean clay. Below that was a plastic silt. The end of the hole was at 5.0 ft. Borings were also attempted on the hillsides of the drainageway. The material consisted of coarse sand near the surface. Several bucket auger holes were attempted. Each was terminated at shallow depths due to contact with rock. Several large rocks are visible at this site and soil boring attempts indicate more are present below the surface.

DESIGN CONSIDERATIONS: Design guidelines were mainly taken from two references. One is a stormwater management pond design example for extended detention wet pond by Richard A. Claytor, Jr., P.E. of the Center for Watershed Protection in Ellicott City, MD. The other is the Wet Detention Basin Conservation Practice Standard Number 1001 issued by the Wisconsin Department of Natural Resources. The Minnesota Pollution Control Agency's Protecting Water Quality in Urban Areas Best Management Practices Manual was also referenced.


Bagley Urban Runoff
Reduction Project
West Upland Drainage
Sediment Forebay
Culvert
Pool
Area
Riprap
Chutes
Pipe and
Riser Assembly
8' Earthen Berm
Stilling
Basin
Spillway
Drainage Area Boundary
Outlet
Culvert

The embankment and spillways were designed in accordance with Practice Standard 378 of the USDA Natural Resources Conservation Service (NRCS) Technical Guide Section IV. The Water Resource Site Analysis Computer Program developed by NRCS and Kansas State University was used to flood route the structure and size the spillways.

This site appears to have the potential for the construction of a detention basin. Soils in the pool area appear suitable for the construction of an embankment across the drainageway. The combination of the embankment and excavation of the pool area would maximize the storage capacity of this site. The pool area is approximately 0.6 ac. including the forebay area.

The principle spillway for this structure will consist of a corrugated metal pipe tube and riser configuration. A pond drain pipe and valve that enters the bottom of the riser will allow the pond to be drawn down for maintenance. A high stage inlet in the riser will determine the permanent pool elevation and the area between the permanent pool and the riser crest will account for the extended detention storage volume. A sand drain diaphragm will be installed around the principle spillway outlet pipe to ensure seepage water along the outside of the pipe is collected and conveyed downstream of the embankment. There will be a pipe support and rock riprap stilling basin at the outlet of the principle spillway. A vegetated channel will be constructed from the stilling basin to the culvert under County Road 25. Runoff events in excess of the capacity of the principle spillway will flow around one end of the embankment in a vegetated spillway.

The proposed sediment forebay is located adjacent to County Road 25. This will be advantageous for maintenance.

HYDROLOGY/HYDRAULICS: Runoff entering the proposed pond area flows from the north through a 27" cmp approach culvert with a capacity of approximately 31 cfs. Water also enters from the east through a 15 dia. cmp under County Road 25. The capacity of this pipe is approximately 10 cfs.

Technical Release 55 "Urban Hydrology for Small Watersheds" developed by the USDA Soil Conservation Service was used to calculate runoff volumes and peak discharges for this site (attachments 12,13 & 14).

The watershed has a composite runoff curve number of 72. The runoff volume from the 1 yr. 24 hr. storm event (1.95 in.) is approximately 1.98 ac. ft. The total storage of the proposed pond is 3.61 ac. ft. with extended detention storage of 1.25 ac. ft.

The pipe structure is sized based on the 10 yr. 24 hr. storm peak discharge of 44 cfs. The vegetated spillway is sized based on the 25 yr. 24 hr. storm peak discharge of 60.3 cfs. The rating table is as follows:

Elevation	Discharge (cfs) Pipe Spillway	Discharge (cfs) Vegetated Spillway	Total (cfs)
93.0	0.00	0.00	0.00
93.26	5.11	0.00	5.11
93.52	14.46	0.00	14.46
93.77	26.57	0.00	26.57
94.03	40.91	0.00	40.91
94.18	41.35	0.34	41.69
94.27	41.62	0.68	42.30
94.45	42.09	1.29	43.38
94.66	42.66	2.03	44.69
95.04	43.67	12.28	55.96
95.52	44.91	40.57	85.48
96.0	46.11	80.40	126.52

A printout of the Site Analysis Computer Program output is attached. The design of the spillways is slightly conservative due to the fact that the discharge through the 10" dia. cmp high stage drawdown pipe is not taken into account.

POND SIZING: Wet Detention Basin Conservation Practice Standard Number 1001 issued by the Wisconsin Department of Natural Resources was used to size the pond. Table 1 (see attachment 3, page 6) was used to determine pond surface area based on watershed land uses. The results are as listed:

Land Use	Area (Acres)	Pond Surface Area (% of Drainage Area)	Req'd Surface Area (Acres)
Open Space	21.50	0.6	0.129
Streets (Open Ditch)	3.60	1.4	0.050
Streets (Curb & Gutter)	4.30	2.1	0.090
Commercial	17.50	2.1	0.368
Industrial	0.74	1.8	0.013
Small Grain Crops	18.80	0.6	0.113
Woods	14.20	0.6	0.085
Residential (1/2 acre)	7.61	0.7	0.053
			0.901 Acres Total

The targeted extended detention storage volume is the runoff volume from the 1 yr. 24 hr. rainfall event, which is 1.98 ac. ft. The storage provided in the proposed pond is as listed below:

Elevation	Area (Acres)	Accumulated Storage (Ac.-Ft.)	Detention Storage (Ac.-Ft.)
84.0	0.03	0.0	
85.0	0.08	0.055	
86.0	0.19	0.19	
87.0	0.23	0.40	
88.0	0.26	0.645	
89.0	0.30	0.925	
90.0 (Drawdown Crest)	0.34	1.245	0.0
91.0	0.38	1.605	0.36
92.0	0.45	2.02	0.775
93.0 (Riser Crest)	0.50	2.495	1.25
94.0 (Veg. Splwy Crest)	0.56	3.025	1.78
95.0	0.61	3.61	2.365
96.0 (Top of Dam)	0.66	4.245	3.00

The extended detention storage provided between the high stage drawdown crest (elev. 90.0) and the riser crest (elev. 93.) is 1.25 ac. ft. The pool surface area is 0.56 acres at the vegetated spillway crest. These values are both less than the targeted storage volume of 1.98 ac. ft. and surface area of 0.9 acres. This is due to site conditions and restrictions. Efforts have been made in planning and design to maximize the storage volume and pool area of this pond.

WATER POLLUTION CONTROL: This site lacks the required area and storage volume necessary for optimal pollutant removal efficiency. However, the P8 Urban Catchment Model was run based on the available pond area to evaluate what kind of removal efficiencies can be expected. The following table lists those results:

Rainfall Amount (in.)	Rainfall Duration (hr.)	Suspended Solids Removal (%)	Total Phosphorus Removal (%)
1.25	24	57	28
1.0	24	68	45
0.75	24	77	59

Even though site limitations do not allow design water quality volumes to be realized, a detention pond at this site has significant water quality improvement potential. The vast majority of the annual pollutant loading is delivered during the smaller runoff events. As shown by the modeling, this pond can substantially reduce pollutant delivery to the Clearwater River from these common rainfall events.

As urban development increases in this watershed, on-site storage and treatment of runoff is strongly recommended since the effectiveness of this planned treatment pond is limited.