Technical Memo

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Project Name: Section 7 - Cascade

Client: City of Rochester

To: Douglas Nelson, Dept. Public Works, City of Rochester

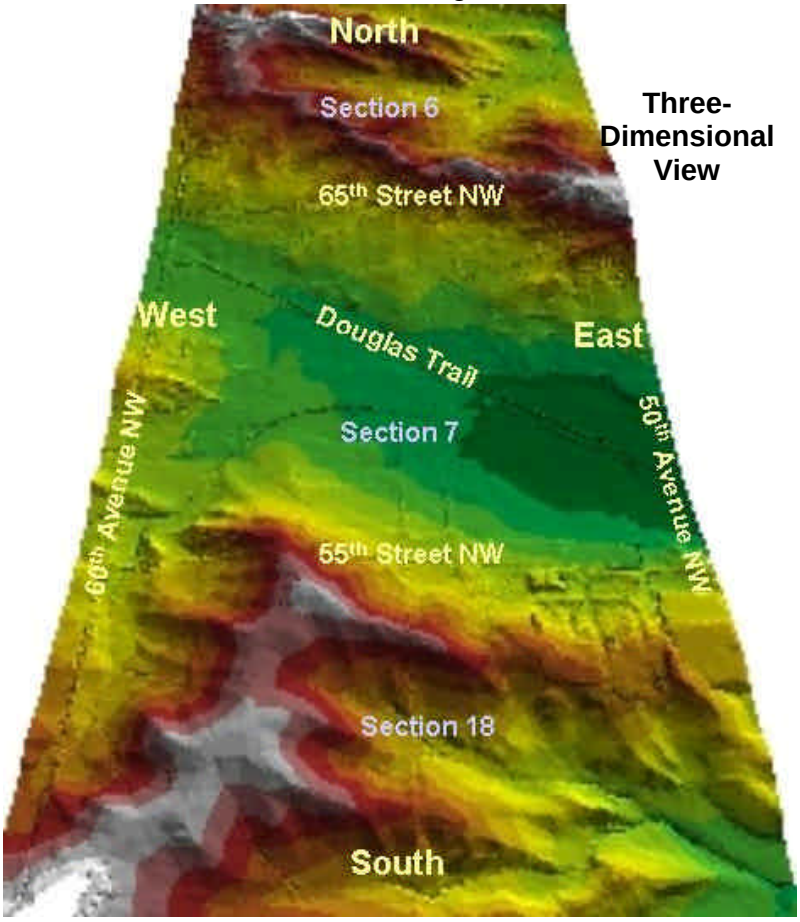
File No: 363-01-000

Date: November 6, 2002

From: Ismael Martínez/Ivo López, Bonestroo Rosene Anderlik & Associates

Re: Storm Water Management Alternatives for Section 7

This study considers the Upper Kings Run watershed located in the northwest region of the City of Rochester. The purpose of the study is to estimate the existing floodplain in Section 7 and identify cost-effective storm water management alternatives to reduce flooding and accommodate future development.



Three-Dimensional View

The study concentrates in Section 7 and selected adjacent areas:

- Section 7 is located in Cascade Township, partially within the Rochester City limits, and is bound by 50th Avenue NW on the east; 60th Avenue NW on the west; 65th Street NW on the north; and 55th Street NW on the south (see Figure 1 for the watershed area and sub districts, and Figure 2 for a close-up photo-image of the area).
- The adjacent areas draining to Section 7 and lying between 50th and 60th Avenue NW, include the following:
  - areas draining from the north: about 132 acres in Section 6
  - areas draining from the south: about 168 acres in Section 18

Areas within this watershed located west of 60th Avenue NW, in Kalmar Township, were also included to determine total flows draining into Section 7.

For the purpose of this report "floodplain" are areas likely to meet floodplain standards of the Federal Emergency Management Agency (FEMA), although no detailed analysis has been conducted.

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1. Background

The City of Rochester is experiencing rapid growth, creating a hightened development pressure, particularly in the northwest portion of the City. The City's Storm Water Management Plan was completed in 1997. At that time the areas west of 50th Avenue NW were outside the 25-year urban development area. Section 7 was just inside the 50-year study area limit in 1997. This status remained when the Plan was revised in December of 1999. Today, however, Section 7 is already under development (Weatherstone, Ripley) and grading plans have been submitted to the Department of Public Works for other new subdivisions (e.g., Harvestview/Seeger).

The northern part of Section 18 of Cascade Township (about 168 acres) drains northward into Section 7 and is also developing rapidly. At present, Holy Spirit Church and parts of Wedgewood Hills and Kingsbury Hills are developed. More land is under development, including additions to Kingsbury Hills. The southwestern part of Section 6 (about 132 acres) drains southward into Section 7. It currently has agricultural land use with only a few scattered houses, it is also likely to begin developing in the near future.

The City of Rochester is pro-actively planning to serve the needs of Section 7. Efforts include planning the expansion of utility services and the reconstruction of 50th Avenue NW. This analysis uses an integrated approach to consider potential urban development in the watershed draining to the 50th Avenue NW, to plan storm water facilities accordingly. Special attention was placed on the analysis for storm water facilities required to achieve the desired flood protection as Section 7 watershed develops.

The City of Rochester is interested in identifying alternatives for storm water management, including floodplain reduction/mitigation. The objective is to maximize development, while minimizing the flooding risk to all associated developments and infrastructure located downstream.

Supporting documents used for this analysis include:

1. Storm Water Management Plan: Rochester, Minnesota (October 1997; Revised December 1999)
2. Technical Memo to Rochester Public Works on Hydrologic/Hydraulic Analyses for Upper Kings Run Watershed (March 16, 1999) prepared for the design of 55th Street crossing in 1996 and expanded to accommodate White Oaks development in 1998.[1]
3. Memo to Rochester Public Works on Sizes for 50th Avenue NW Culvert Crossings at Douglas Trail (April 26, 2001)
4. Soil Survey for Olmsted County (SSOC; USDA-SCS, March 1980)

[1] The hydrologic analysis dated March 16, 1999 assumed all areas within the watershed and west of 50th Avenue NW (i.e., Section 7) would remain agricultural for the next 30 years.

2. Existing Conditions

2.1. General Characteristics of the Watershed and Section 7

2.1.1. Watershed Area and Geomorphology

An intermittent stream drains the gently rolling area to the Kings Run Creek (see Figure 1). The approximate total drainage area to some locations of interest is:

- 3400 acres to 55th Street NW (near the intersection with Douglas Trail).
- 3300 acres to the White Oaks ponds and by-pass channel.
- 3100 acres to 50th Avenue NW (east side of Section 7).
- 2160 acres to 60th Avenue NW (west side of Section 7).

The ground elevation in the watershed ranges from 1280 ft in the southwest portion (Section 14, Kalmar Township) to 1030 ft at the crossing under 55th Street NW near the Douglas Trail—a total drop of about 250 ft. Natural land slopes generally range from 1 to 12%, with mild slopes between 1 and 2% mainly along the valley, by the Douglas Trail. The steeper slopes, greater than 6% and up to an occasional 35%, characterize the upper areas of the watershed and hence have lower water storage capacity than the mild sloped valley. See Figure 1 (USGS topographic map) for land and drainage characteristics of the area. For more details about the watershed, refer to the Technical Memo to Rochester Public Works on Hydrologic/Hydraulic Analyses for Upper Kings Run Watershed (March 16, 1999).

The milder slopes in the watershed are within the valleys in Section 7. About a third of Section 7 (more than 200 acres) has flat to mild slopes (up to about 2%). These mild slopes represent floodplains and are very important hydrologically for peak-flow flood control. (See following comments on soils, or the Soil Survey for Olmsted County [SSOC, 1980] for more details).

2.1.2. Drainage

The drainage in the Upper Kings Run watershed follows a dendritic (tree-like) pattern. The area west of Section 7 generally drains in the northeast direction. The flatter valley, near the Douglas Trail, drains in the southeast direction to White Oaks pond and the Lower Kings Run at the 55th Street NW crossing, eventually discharging to the South Fork of the Zumbro River.

Within Section 7, the construction of the railroad along the valley modified the natural stream pattern and created the waterways on both sides of the Douglas Trail: mainly manmade drainage swales on the south, and a more “natural” creek on the north. This latter creek has an average cross-section depth of 4 to 5 ft and a bankfull width of 10 to 20 ft. Drainage swales or vegetated waterways have been built within Section 7 both for erosion control and to improve drainage for crop production in mild-sloped areas in conjunction with tile drains.

2.1.3. Depressional Storage

The gently rolling hills create areas for depressional water storage, generally found in medium to mild slopes. These depressions can create wetland environments when they are not affected by farming operations or artificial drainage (e.g., drainage swale from 55th Street NW toward the Douglas Trail). Examples of these wetlands are/were found in Weatherstone and Ripley developments, having different degrees of agricultural and/or urban impact.

2.1.4. Soils

Soils in the watershed are generally loam, with about 75% represented by these soil types: 30 B Kenyon Loam; 401 B&C Mt. Carroll Silt Loam; 176 Garwin Silty Clay Loam; 477 B Littleton Silt Loam; and 16 Arenzville Silt Loam (based on the SSOC, March 1980). These soils are in hydrologic group B, with moderately slow permeability (0.6 to 2 in/hr). The seasonal high water table can be 3 to 6 ft below the surface in the lowland, Arenzville soils (SSOC, pg. 11).

The Arenzville soils are found in the valley along the Douglas Trail and occupy a significant area of Section 7. This soil is generally found in floodplains 100 to 500 ft wide (SSOC, pg. 11), but is up to 850 ft wide in Section 7. Arenzville soils are characterized as having a buried soil layer (that is, soil previously at the surface that was covered by soil eroded upstream) 20 to 40 inches below surface. This buried organic soil layer is typical of a depositional floodplain.

North of the Douglas Trail, the "Kato silty clay loam depressional" is also found within Section 7 with a width of about 650 ft and a seasonal high water table less than 1 foot deep (SSOC, pg. 67). The Soil Survey states that both Arenzville and Kato soils have "poor potential for building site development and sanitary facilities" (SSOC, pgs. 11 and 67, respectively). Similar comments and flooding potential also apply to other soils found in Section 7 (e.g., Garwin, Richwood, Floyd, Littleton, Maxfield). Several of these soils have seasonal high water tables from 1 to 6 ft below surface.

Figure 3 presents a floodplain estimates at 155 acres. This designation is based on the soil flooding frequency from the SSOC and the road elevation of 50th Avenue NW. Only soils classified as frequently and occasionally flooded were mapped (i.e., soils flooding rarely were not included). Using data from the Soil Survey (SSOC, Table 16: Soil and Water Features) and the digital soils map from MNDNR, about 65% of soils do not flood in Section 7 and 35% (approx. 218 acres) flood with varying frequencies: 20% flood frequently (125 acres, Arenzville and Otter silt loam soils); 4% occasionally (23 acres, Kato silty clay loam depressional); and 11% rarely (70 acres, Littleton and Richwood silt loam soils, 0 to 1% and 0 to 2% slopes, respectively). The presence of 50th Avenue NW causes upstream soils to flood more frequently (i.e., compared to previous existing natural conditions that influenced soil deposition and formation). Therefore, the floodplain area shown in Figure 3 was increased to reflect the impact of this road, which was not included in the natural setting described in the Soil Survey.

2.1.5. Land Use

Land use in Rochester has been changing from natural, to agricultural, to urban. Each change in land use tends to increase peak runoff flows in ditches, swales, and streams. This is no different in Section 7, where agricultural land use is changing to urban development. Most of the land west of 50th Avenue NW is presently used for agriculture, with best management practices that include contour cropping and crop rotation. Some areas south of 65th Street NW and east of 60th Avenue NW (in Sections 7 and 18) are currently under development. Some of the existing

agricultural areas have drainage systems that include swales, to reduce erosion in steeper slopes and allow crop production in flatter or depression areas, such as south of the Douglas Trail between 50th and 60th Avenues NW.

The study area had about half a dozen scattered farmstead dwellings and has recently begun changing to urban development land. Examples of recent urbanization in this watershed are Holy Spirit Church and the developments of Wedgewood Hills, Kingsbury Hills, Weatherstone, and Ripley. Development is now planned for Harvest View/Seeger. Figure 2 indicates the location of these developments. The 1999 aerial photographs of Sections 7 and 18 show only Holy Spirit Church and Wedgewood Hills. By the end of 2001, Weatherstone, Wedgewood Hills and Kingsbury Hills neared full development.

2.1.6. Transportation Network and Waterway Crossings

The current transportation network is hydrologically important. Road crossings at stream/creek locations can reduce the peak flows. These partly compensate for the increased runoff peaks from agricultural land use, as compared to the natural land cover once present. Therefore, downstream waterways remain relatively stable. However, this stability may be affected where road culverts are increased in size and the culvert capacity exceeds the creek conveyance capacity downstream. At 60th Avenue NW on the south side of Douglas Trail a 10-ft by 4-ft box culvert and a 48-inch circular culvert were replaced by two 12-ft by 4-ft box culverts in 1996. The downstream waterway is now receiving higher peak flows that affect its morphological stability.

Upstream of these two 12-ft by 4-ft box culverts and less than 4000 ft west of 60th Avenue NW is County Rd. 3. This road has two main culvert crossings: (1) two 7-ft wide by 5-ft high box culverts; and (2) an 8-ft wide by 6-ft high culvert. These structures and the topographic characteristics just upstream of the road are important in determining the peak flows reaching Section 7.

Water enters Section 7 at 60th Avenue NW on the south side of the Douglas Trail (previously railroad). The trail splits Section 7 along the floodplain valley (see Figures 1 and 2). The waterway crosses the Douglas Trail (south to north) at a bridge located about 360 ft east of 60th Avenue. Current creek and Douglas Trail bridge capacities create back-water effects on the two 12-ft by 4-ft culverts under 60th Avenue. As a result, water backs up upstream (west) of 60th Avenue onto the agriculturally-modified floodplain that includes a drainage swale. Modeling existing conditions upstream of this point results in an estimated capacity of 850 cfs at these two culverts for the 100-yr event, which will overtop the road by approximately nine inches.

The transportation network within Section 7 basically consists of its perimeter roads (50th and 60th Avenue NW and 55th and 65th Street NW); the Douglas Trail; a few road entrances to farm dwellings; and streets that are part of the developments.

2.2. Downstream Capacity: 50th Avenue NW Culvert Crossing

Section 7 storm water flows are served by five existing culverts under 50th Avenue NW at the Douglas Trail location (invert elevations are indicated in parenthesis):

- A 54-inch RCP (1037.2 ft);
- A 48-inch CMP (1037.2 ft);
- A 30-inch CMP (1039.58 ft); and
- Two 48-inch CMP (1039.2 ft)

These culverts have a combined estimated capacity of 588 cfs, before overtopping occurs with the top-of-road at 1045 ft elevation (April 26, 2001 Memo to Rochester Public Works). The flow rate across 50th Avenue NW must be limited to this 588 cfs to avoid flooding existing infrastructure downstream.

Currently, the reconstruction of 50th Avenue NW is in the final design stages. These five existing culverts will be replaced with three culverts that will maintain a similar total capacity. The replacement culvert design calls for two 54-inch circular RCPs with inverts at 1035.5 and 1038.0 ft on the north side of the Douglas Trail, and a 65-inch span by 40-inch rise arch RCP with invert at 1039.2 ft on the south side. (For more details see April 26 memo and follow-up email of May 27 to Douglas Nelson.)

The Technical Memo to Rochester Public Works on Hydrologic/Hydraulic Analyses for Upper Kings Run Watershed (March 16, 1999) included estimated flows for this 50th Avenue NW crossing based on development conditions at that time:

Storm frequency (years)	1	2	5	10	25	50	100
24-hr Precipitation (inches)	2.5	3.0	3.8	4.4	4.8	5.5	6.2
Flow (cfs)	93.2	186	359	476	545	650	835

Therefore, 50th Avenue NW culverts are estimated to have almost a 50-year level of flood protection prior to overtopping the roadway (see section 2.4 for impact of floodplain losses on this protection level).

2.3. Value of Existing Floodplains and Depression Storage

All the valleys—small (uplands), medium, and large (around Douglas Trail)—have important hydrologic roles as floodplains and areas with depression storage. They reduce peak runoff flows, hence determining the current capacity characteristics of waterways. Although these floodplains are not currently delineated by the Federal Emergency Management Agency (FEMA) and flooding may occur just for short periods of time, they are important in controlling the maximum flows that reach streams and other waterways.

Based on the topographic features of the watershed draining to the 50th Avenue NW and Douglas Trail area, Section 7 has proportionally the largest floodplain area of the entire watershed. This is confirmed by existing soils and geologic maps that identify depositional/flooding areas. Figure 4 illustrates this fact by displaying a portion of the Sand and Gravel Resources Map (County Atlas Series, Atlas C-3, Plate 9, Geologic Resources by

University of Minnesota-Minnesota Geological Survey). According to this map, about five-sixths of the area with primary resource of sand and gravel upstream of 50th Avenue NW is in Section 7, and only about a sixth is upstream of 60th Avenue NW.

The estimated floodplain covers 20 to 35% of Section 7, from 125 to 218 acres. This is estimated using floodplain soils identified in the Soil Survey (for more details see section 2.1.4. on Soils or the Soil Survey). Using frequently to occasionally flooded soils and adjusting for backwater impact from 50th Avenue NW, the estimated floodplain area in Section 7 is approximately 155 acres (see Figure 3). Delineation of the flood boundary requires more field data and detailed modeling beyond the scope of this study.

Estimated floodplain storage volumes in Section 7 are between 160 and 260 acre-ft. Of these volumes, about 84 acre-ft are impounded by 50th Avenue top-of-road elevation.

Floodplain and depression storage were not estimated for areas outside of Section 7, but were observed to be significant. Local depressions are characteristic of the landscape. These depressions increase infiltration of water into the soil and reduce overland runoff (peak flows).

2.4. Floodplain Loss and Mitigation

Floodplains in the study area have been encroached by urban development. When development occurs in flood plains, mitigating measures must be implemented to prevent flooding from occurring more frequently; that is, for lower precipitation events. White Oaks development's 22.5 acre-feet multi-cell pond is an example of floodplain loss mitigation (see Memo of March 16, 1999).

The estimated floodplain volume prior to development in the Weatherstone area is about 47 acre-ft. The 12 acre-ft pond designed for the development only addresses the increase in runoff attributed to the change of land use (agricultural to urban) within the development area. This volume does not mitigate for floodplain loss. About 18 acre-ft of floodplain volume remain in post-development conditions, which results in a net 29 acre-ft loss of floodplain volume as a result of Weatherstone development. This loss-volume will increase to 50 acre-ft by 50th Avenue NW when the development south of the Douglas Trail occurs (Harvestview/Seeger development and immediate upstream area).

These estimates do not include the Ripley development or other development that could encroach on the floodplain in the future. This loss of floodwater storage is among the reasons this report was prepared. See the estimated floodplain area within Section 7 in Figure 3.

The implication of encroaching on the floodplain can be illustrated in terms of protection from overtopping a road. For example, floodplain losses associated with the Weatherstone development cause overtopping of 50th Avenue NW to occur during the 25-yr rainfall event (4.8 inches), instead of the 50-year event (5.5 inches) before floodplain encroachment. The 50-year level of protection was estimated in the Technical Memo to Rochester Public Works on Hydrologic/Hydraulic Analyses for Upper Kings Run Watershed (March 16, 1999).

In other words, failing to mitigate floodplain volume losses increases the flooding frequency of infrastructure downstream. Therefore, for the purpose of this study, impacts to floodplains and natural depression storage were analyzed in relation to the existing capacity of waterways and storm water facilities.

2.5. Kings Run Environmental Corridor

The Storm Water Management Plan for the City of Rochester (1997, revised 1999) identifies the Kings Run Corridor as running from 50th Avenue NW to Essex Park (located at the junction of the Kings Run and the South Fork Zumbro River). This corridor provides a natural environmental connection between the Douglas Recreational Trail System on the west and Essex Park on the east. Topographically, it is located along the drainage ways, where soils are characterized as hydric with frequent flooding.

The Kings Run Environmental Corridor has been developing as a natural ecosystem within the urban setting. Today it includes the White Oaks ponds east of 50th Avenue NW; a recreational area with two dry ponds north of 55th Street NW; and a meandering man-made stream that ties into the natural stream near County Road 22 and 55th Street NW. This system is improving water quality, reducing peak flows and stabilizing the stream, as well as fostering growth of native vegetation and wildlife habitat, including wetland environments and hardwood forest.

The storm water facilities included in the present study could be part of a natural extension of the Kings Run Environmental Corridor, and harbor natural resources within the urban development area. Hence, enhancements to this corridor from 50th Avenue NW to the upstream side of 60th Avenue NW can be part of the City's efforts to promote an environmentally friendly community. See Figure 5 for an illustration of the Kings Run Environmental Corridor.

3. Alternatives

Several storm water management alternatives were evaluated to maximize developable land in Section 7. Expanding the capacity of storm water facilities downstream of 50th Avenue NW was considered as one alternative. Building additional channels or expanding existing ones (more than a mile in length) and up-sizing current crossings was estimated as too expensive and nonviable.

The most significant alternatives considered are included in this document:

3.1. Design post-development flows to meet existing flows
3.2. Distribute flow capacity at 50th Avenue equally among contributing area
3.3. Build regional facilities with efficient ponding and floodplain compensation west of Section 7
3.4. Build regional facilities with efficient ponding and 50 acre-feet floodplain compensation within Section 7

These alternatives will be analyzed individually. For these analyses, areas west of 60th Avenue NW were modeled as agricultural, while areas east of this avenue were modeled as urban development.

3.1. Design Post-Development Flows to Meet Existing Flows

The alternative of designing post-development flows to meet existing flows means that ponds would be built only to compensate for change in land use, to "maintain" predevelopment flow conditions (particularly peak runoff flows). This alternative would produce higher surface runoff volumes than the historical, pre-development conditions. As a consequence, more water storage would be required than the volume available in the "existing" floodplain (see Figure 3 and sections 2.3. and 2.4. on floodplains), requiring an increase in floodplain areas or mitigation with additional pond volumes.

In addition, floodplain losses that have already occurred due to encroachment by developments (Weatherstone and Harvest View) must be compensated for. This alternative would require significantly more land area for floodplain to mitigate for the 50 acre-ft floodplain losses by 50th Avenue NW. Therefore, this alternative provides no benefit in reducing floodplain areas to allow development. The overall goals of the study would not be addressed by this alternative; hence, no further analysis was conducted.

3.2. Distribute Flow Capacity At 50th Avenue Equally Among Contributing Area

The culvert crossing capacity at 50th Avenue NW and the Douglas Trail is estimated at 588 cfs without road overtopping (April 26, 2001 Memo to Rochester Public Works). Distributing this flow evenly for the 3100 acres upstream yields a contribution of 0.19 cfs per acre. If this maximum allowable flow rate per area were applied, 50th Avenue NW would be protected (not overtopped) for 100-yr events. However, this alternative would be impractical to achieve in areas with steeper slopes and where natural storage capacities are minimal. Grading costs could be prohibitive.

One of the disadvantages of this alternative is that each land development would have to build ponding facilities to meet the allowable rate, which results in inefficient ponding and requires more total land to be dedicated to ponding. Therefore, the goal of maximizing the land area available for development in Section 7 would not be achieved.

Alternative 3.2 would result in about 68 acres of floodplain reduction within Section 7. The cost of excavation and land for these ponds is estimated at $1,820,874; for more details see Table 5 and section 5, Estimated Cost. This cost includes only ponds in Section 7 and the two ponds adjacent, west of 60th Avenue NW. Therefore, the cost is higher when other upstream ponds are included to mitigate for floodplain losses using the 0.19 cfs per acre criterion.

3.3. Build Regional Facilities With Efficient Ponding and floodplain compensation west of Section 7

Upstream areas with steep slopes make ponding difficult and are not able to meet the 0.19 cfs per acre criteria proposed in Alternative 3.2. Efficient regional storm water facilities could be built where it is cost-effective in order to preserve floodplain volumes and compensate for the lack of storage in the steep upstream areas. This alternative would secure storage volume capacities while increasing the area of developable land in Section 7 by including significant facilities west of Section 7.

In this alternative, most ponds are considered to be regional in nature and would be built cost-effectively. They would be designed to address storm water management related to:

(a) Changes in land use;
(b) Existing culvert crossing capacities; and
(c) Floodplain and local depression storage loss.

The estimated pond layout for Section 7 is displayed in Figure 6 (the largest, light-blue numbers are the pond identification numbers). These ponds are envisioned as an extension of the Kings Run Environmental Corridor and are located generally within the current floodplain.

The hydrologic/hydraulic modeling results and pond parameters are listed in Table 1. These assumptions were made for modeling:

- Areas east of 60th Avenue NW were modeled as fully developed.
- Areas west of 60th Avenue NW were modeled using existing conditions (agricultural land use).
- Any future change from agricultural land use in areas west of 60th Avenue NW will require regional facilities for storm water management designed with the "efficient-ponding" criterion to achieve the 100-yr level of flood protection.
- Areas draining to Section 7 that are east of 60th Avenue NW (a) north of 65th Street NW (Cascade Section 6); and (b) south of 55th Street NW (Cascade Section 18) were considered to be included in the sizing of ponds in Section 7.

Alternative 3.3 would result in about 72 acres of floodplain reduction within Section 7. The cost of excavation and land for these ponds is estimated at $1,745,567; for more details see Table 5 and section 5, Estimated Cost.

Table 1. Modeling Results and Estimated Pond Parameters for Alternative 3.3 -
Regional Facilities With Efficient Ponding:

Pond Number	Pond Name	ID	Storage Volume for 100-yr event (acre-ft)	Estimated Area at NWL (acres)	Estimated Area at HWL for 100-yr event (acres)	Approx. Drainage Area Served (acres)	Comments
Section 7 Ponding Required for Change in Land Use (i.e., no floodplain loss mitigation):							
1300	Harvest View	kr-p1.4.11	2.2	0.3	0.6	15.5	Serves: Harvest View development (Also known as Seagar). Use maximum available area of about 1.5 acres to mitigate for about 6 AF of floodplain loss
304	Wedgewood North	kr-p1.4.12	16.4	2.9	3.6	107.0	Serves: Wedgewood Hills development; part of Holy Spirit; & areas north
305	Kingsbury North	kr-p1.4.13	16.5	3.0	3.7	80.0	Serves: Kingsbury Hills development; part of Wedgewood Hills; & areas north
14	Douglas South	kr-p1.4.14	44.0	8.2	9.4	280.0	Serves: remaining areas south of Douglas Trail & east of 60th Ave. NW, including areas south of 55th St. NW
3000	Weatherstone	kr-p1.4.21	30.0	1.4	5.2	103.0	Serves: All phases of Weatherstone development. Data based on Grading Plan (MBI, 10/16/2000). Includes about 18 AF of floodplain volume remaining considering channel & up to 1045 ft elevation.
8601	Ripley East	kr-p1.4.22	9.5	1.6	2.2	76.5	Serves: part of Ripley development. Detention volume for allocated pond area in grading plan. Drainage area estimated as half of development (153 acres total: approx. 135 acres in Ripley & 18 acres north of 65th St. NW).
8602	Ripley West	kr-p1.4.23	5.5	0.9	1.3	76.5	Serves: part of Ripley development. Detention volume for allocated pond area in grading plan. Drainage area estimated as half of development (153 acres total: approx. 135 acres in Ripley & 18 acres north of 65th St. NW).
8002	Douglas North	kr-p1.4.24	33.0	6.1	7.1	189.0	Serves: remaining areas north of Douglas Trail & east of 60th Ave. NW, including approx. 114 acres north of 65th St. NW
870	Weatherstone Wetland	kr-p1.4.41	11.0	2.5	3.0		Serves: part of Weatherstone development
8600	Ripley South Wetland	kr-p1.4.42	14.0	3.2	3.8		Serves: part of Ripley development
8610	Ripley North Wetland	kr-p1.4.43	6.0	1.6	2.4		Serves: part of Ripley development
1120	Holy Spirit Wetland	kr-p1.4.31	1.2	0.3	0.5		Serves: most of Holy Spirit
Upstream ponds of interest (not in Section 7):							
40	60th Ave by Douglas Tr.	kr-p1.1	165.0	26.3	28.7	1447	Serves: areas west of 60th Ave. NW draining to the south side of Douglas Trail and 60th Ave. NW
3	60th Ave by 55th St	kr-p1.2	64.8	12.3	13.7	367	Serves: areas west of 60th Ave. NW draining to the stream crossing 60th Ave. NW just north of 55th St. NW

Within Section 7:

Total for Ponds	157	24	33	928
Total for Ponds including Listed Wetlands	189	32	43	

For Section 7 and Upstream Ponds of Interest:

Total for Ponds	387	63	75
Total for Ponds including Listed Wetlands	419	71	85

3.4. Build Regional Facilities With Efficient Ponding And 50 Acre-Feet Floodplain Compensation Within Section 7

Alternative 3.3 assumes that potential losses in existing floodplain in Section 7 are mostly mitigated upstream/west of Section 7. Alternative 3.4 is considered here in order to proportionally allocate the necessary storage volume for flood control, estimated at a total of 150 acre-feet. This results in an allocation of 50 acre-feet within Section 7 and 100 acre-feet in ponds west of 60th Avenue NW, to compensate for floodplain losses and steep-slope areas with limited ponding opportunities. Hence, pond 14 is increased by 50 acre-feet in comparison to Alternative 3.3. Alternative 3.4 is illustrated in Figure 7 and the pond characteristics are presented in Table 2.

Floodplain within Section 7 was estimated to be between 160 and 260 acre-feet, but values of storage higher than 150 acre-feet are not necessary since the proposed and future ponds (ultimate developed conditions for the watershed) will also compensate for the floodplain volumes present before encroachment.

The estimated 50 acre-feet floodplain compensation volume within Section 7 is an area-proportional allocation of the 150 acre-feet. It is based on physical watershed characteristics, efficient ponding and modeling results. Upper areas of the watershed with steeper slopes located within sections 1, 11, 12, 13, and 14 of Kalmar Township (such as subdistrict areas 1 and 2 in Figure 1) have limited natural storage volume capacity and make pond construction more expensive. Soils, geomorphology, and geologic conditions indicate that 2/3 to 5/6 of the floodplain area upstream of 50th Avenue NW is within Section 7 (see comments in 2.3 and Figure 4).

The assumptions made for hydrologic/hydraulic modeling are the same for Alternative 3.4 as were previously stated for Alternative 3.3:

- Areas east of 60th Avenue NW were modeled as fully developed.
- Areas west of 60th Avenue NW were modeled using existing conditions (agricultural land use).
- Any future change from agricultural land use in areas west of 60th Avenue NW will require regional facilities for storm water management designed with the “efficient-ponding” criterion to achieve the 100-yr level of flood protection.
- Areas draining to Section 7 that are east of 60th Avenue NW (a) north of 65th Street NW (Cascade Section 6); and (b) south of 55th Street NW (Cascade Section 18) were considered to be included in the sizing of ponds in Section 7

Alternative 3.4 would result in about 62 acres of floodplain reduction within Section 7. The cost of excavation and land for these ponds is estimated at $1,854,145. For more discussion and details see Table 5 and section 5, Estimated Cost.

Consider these important points when comparing Alternative 3.3 to 3.4 (Table 1 versus Table 2):

- Pond 14 is increased by 50 acre-feet, while pond 40 (kr-p1.1) is reduced by 39.5 acre-feet to achieve 100-yr event flood protection.
- If only pond excavation/grading is considered (without land cost), Alternative 3.4 would require less excavation and hence cost less than Alternative 3.3 due to the flatter slopes in Section 7.
- If land costs are included, Alternative 3.3 would costs less because of the difference in assumed land price: $14,000 per acre in Section 7 and $5,000 per acre outside of Section 7 (west of 60th Avenue NW).
- Until ponds 40 and 3 are built, Alternative 3.4 provides better flood protection (40-yr event) than Alternative 3.3 (10-yr event)
- If only pond 3 is not built, Alternative 3.4 provides better flood protection (85-yr event) than Alternative 3.3 (70-yr event)

Construction timing of the ponds is important in selecting the preferred alternative.

Table 2. Modeling Results and Estimated Pond Parameters for Alternative 3.4 -
Regional Facilities With Efficient Ponding and 50 Acre-Feet Floodplain Compensation Within Section 7:
(Ponds that differ between Alternatives 3.3 and 3.4 are highlighted)

Pond Number	Pond Name	ID	Storage Volume for 100-yr event (acre-ft)	Estimated Area at NWL (acres)	Estimated Area at HWL for 100-yr event (acres)	Approx. Drainage Area Served (acres)	Comments
Section 7 Increasing Pond 14 By 50 acre-ft To Mitigate For Floodplain Loss:							
1300	Harvest View	kr-p1.4.11	2.2	0.3	0.6	15.5	Serves: Harvest View development (Also known as Seagar). Use maximum available area of about 1.5 acres to mitigate for about 6 AF of floodplain loss
304	Wedgewood North	kr-p1.4.12	16.4	2.9	3.6	107.0	Serves: Wedgewood Hills development; part of Holy Spirit; & areas north
305	Kingsbury North	kr-p1.4.13	16.5	3.0	3.7	80.0	Serves: Kingsbury Hills development; part of Wedgewood Hills; & areas north
14	Douglas South	kr-p1.4.14	94.0	18.0	19.6	280.0	Serves: remaining areas south of Douglas Trail & east of 60th Ave. NW, including areas south of 55th St. NW. MITIGATES for 50 acre-ft of floodplain loss
3000	Weatherstone	kr-p1.4.21	30.0	1.4	5.2	103.0	Serves: All phases of Weatherstone development. Data based on Grading Plan (MBI, 10/16/2000). Includes about 18 AF of floodplain volume remaining considering channel & up to 1045 ft elevation.
8601	Ripley East	kr-p1.4.22	9.5	1.6	2.2	76.5	Serves: part of Ripley development. Detention volume for allocated pond area in grading plan. Drainage area estimated as half of development (153 acres total: approx. 135 acres in Ripley & 18 acres north of 65th St. NW).
8602	Ripley West	kr-p1.4.23	5.5	0.9	1.3	76.5	Serves: part of Ripley development. Detention volume for allocated pond area in grading plan. Drainage area estimated as half of development (153 acres total: approx. 135 acres in Ripley & 18 acres north of 65th St. NW).
8002	Douglas North	kr-p1.4.24	33.0	6.1	7.1	189.0	Serves: remaining areas north of Douglas Trail & east of 60th Ave. NW, including approx. 114 acres north of 65th St. NW
870	Weatherstone Wetland	kr-p1.4.41	11.0	2.5	3.0		Serves: part of Weatherstone development
8600	Ripley South Wetland	kr-p1.4.42	14.0	3.2	3.8		Serves: part of Ripley development
8610	Ripley North Wetland	kr-p1.4.43	6.0	1.6	2.4		Serves: part of Ripley development
1120	Holy Spirit Wetland	kr-p1.4.31	1.2	0.3	0.5		Serves: most of Holy Spirit
Upstream ponds of interest (not in Section 7):							
40	60th Ave by Douglas Tr.	kr-p1.1	125.5	19.9	22.0	1447	Serves: areas west of 60th Ave. NW draining to the south side of Douglas Trail and 60th Ave. NW. Case with 50 acre-ft FLOODPLAIN LOSS MITIGATION allocated to Pond 14
3	60th Ave by 55th St	kr-p1.2	64.8	12.3	13.7	367	Serves: areas west of 60th Ave. NW draining to the stream crossing 60th Ave. NW just north of 55th St. NW

Within Section 7:

Total for Ponds	207	34	43	928
Total for Ponds including Listed Wetlands	239	42	53	

For Section 7 and Upstream Ponds of Interest:

Total for Ponds	397	66	79
Total for Ponds including Listed Wetlands	430	74	89

4. Summary of Pond Sizes and Level of Protection

Table 3 presents a Summary of Required Pond Sizes by Alternative (3.2, 3.3 and 3.4). To help analyze which is the best alternative, floodplain reduction areas were estimated as an indicator of benefit. Alternative 3.1 is not included in the comparison because it is considered not feasible, since existing flows are not achievable with the floodplain reduction that has started to occur within Section 7.

Table 3. Section 7 Summary of Required Pond Sizes by Alternative
City of Rochester (363-01-000)
Bonestroo, Rosene, Anderlik & Associates/ILL

Alternatives [1]	Storage Volume for 100-yr event (acre-ft)	Estimated Area at NWL (acres)	Estimated Area at HWL for 100-yr event (acres)	Area of Douglas Tr. Property in Sec.7 (acres)	Un-account-ed Water-way areas (acres)	Estimated Frequent-ly Flooded Area (acres) [2]	Estimated Floodplain Reduction (acres) [3]	Estimated Floodplain Reduction (%)	Comments
Within Section 7:									
3.2. Distribute flow capacity at 50th Avenue equally among contributing area (0.19 cfs/acre)	170	31	37	14	6	125	68	54	
3.3. Build regional facilities with efficient ponding (minimum in Section 7)	157	24	33	14	6	125	72	57	Maximizes developable land in Section 7
3.4. Build regional facilities with efficient ponding and 50 acre-feet floodplain compensation within Section 7	207	34	43	14	6	125	62	49	
Only for Upstream Ponds of Interest (Ponds 40 & 3):									
3.2. Distribute flow capacity at 50th Avenue equally among contributing area (0.19 cfs/acre)	227	38	42			42	0	0	
3.3. Build regional facilities with efficient ponding (minimum in Section 7)	230	39	42			42	-1	-2	Floodplain is increased by 2%
3.4. Build regional facilities with efficient ponding and 50 acre-feet floodplain compensation within Section 7	190	32	36			42	6	15	
For Section 7 and Upstream Ponds of Interest (Ponds 40 & 3):									
3.2. Distribute flow capacity at 50th Avenue equally among contributing area (0.19 cfs/acre)	397	69	79	14	6	167	68	41	
3.3. Build regional facilities with efficient ponding (minimum in Section 7)	387	63	75	14	6	167	71	43	
3.4. Build regional facilities with efficient ponding and 50 acre-feet floodplain compensation within Section 7	397	66	79	14	6	167	68	41	

Notes:
[1] Alternative 1 is not considered for comparisons because "existing" flows cannot be sustained with current impacts to floodplains
[2] Frequently flooded area west of 60th Ave. NW (upstream of Section 7) was estimated as 1/3 of the flooded area in Section 7 (based on topographic characteristics)
[3] Estimated Floodplain Reduction is calculated subtracting to frequently flooded areas the sum of areas at High Water Level (HWL), Douglas Tr. Property, and waterways

Alternative 3.3 yields the most developable land within Section 7.

Alternative 3.2 includes only ponds in Section 7 and the two ponds adjacent, west of 60th Avenue NW. Therefore, the total required storage volume to be provided is greater than the estimate in Table 3, because other upstream ponds are still needed to achieve the 0.19 cfs per acre criterion. Due to topographic characteristics, the required excavation per unit storage volume increases as we move upstream in the watershed.

Pond construction depends on the funding and sequencing of development. Each stage of development will provide a different level of flood protection at 50th Avenue NW. Prior to development of any subdivision west of 50th Avenue NW, the protection for this avenue was estimated at the 50-yr event. Table 4 presents the estimated levels of protection associated with the construction of the ponds considered feasible. A 100-yr event protection will be achieved when either Alternative 3.3 or 3.4 is fully implemented.

Table 4. Level of Protection
City of Rochester (363-01-000)
Bonestroo, Rosene, Anderlik & Associates/ILL

				Ponds Included in Each Condition										
							Douglas South (14)		60th Ave. NW by Douglas Trail (40)					
No.	Condition	Approximate Level of Protection at 50th Avenue NW (year event) [1]	Estimated Floodplain Reduction in Section 7 (acres)	Harvest View (1300)	Wedgewood North (304)	Kingsbury North (305)	without floodplain mitigation	with-50 acre-ft floodplain mitigation	without floodplain mitigation in Pond 14	with-50 acre-ft floodplain mitigation in Pond 14	60th Ave. by 55th St. NW (3)	Weatherstone (3000)	Ripley (8601 & 8602)	Douglas North (8002)
1	Pre-development of any subdivision west of 50th Avenue NW	50	None											
2	Pre-Weatherstone, Post-Wedgewood/Kingsbury Hills	40	None											
	Post-development east of 60th Avenue NW:													
3	Alternative 3.3 w/o Pond 3	70	72	X	X	X	X		X			X	X	X
4	Alternative 3.3 w/o Pond 40	15	72	X	X	X	X				X	X	X	X
5	Alternative 3.3 w/o Ponds 3 & 40	10	72	X	X	X	X					X	X	X
6	Alternative 3.4 w/o Pond 3	85	62	X	X	X		X		X		X	X	X
7	Alternative 3.4 w/o Pond 40	50	62	X	X	X		X			X	X	X	X
8	Alternative 3.4 w/o Ponds 3 & 40	40	62	X	X	X		X				X	X	X
9	Alternative 3.3	100	72	X	X	X	X		X		X	X	X	X
10	Alternative 3.4	100	62	X	X	X		X		X	X	X	X	X

Notes:

[1] Approximate levels of protection are estimated to prevent 50th Avenue NW from overtopping with road elevation at 1045 ft; any changes in agricultural land use or culvert crossings west of 60th Avenue NW would affect the estimated values.

X Means pond is included; if not included it is left blank.

Without construction of ponds west of 60th Avenue NW (Ponds 40 and 3), Alternatives 3.3 and 3.4 would not provide acceptable level of protection. Overtopping 50th Avenue NW is estimated at 1.2 ft and 0.6 ft for Alternatives 3.3 and 3.4, respectively. Overtopping the White Oaks ponds is also estimated at about 1.2 ft and 0.6 ft, respectively (reaching about 1040.3 ft and 1039.6 ft elevation). From the perspective of frequency of overtopping, the White Oaks pond is estimated to overtop at the 15-yr and 50-yr events, respectively (4.7 versus 5.5-inch-24-hr storm); and 50th Avenue NW at the 10-yr and 40-yr events. Hence, Alternative 3.4 without building the ponds west of 60th Avenue NW would allow a level of protection similar to existing conditions prior to Weatherstone construction, but for ultimate developed conditions east of this avenue.

5. Estimated Costs

Table 5 presents a Cost Comparison by Alternative (3.2, 3.3 and 3.4) using the estimated cost for excavation and land: $1,820,874; $1,745,567; and $1,854,145, respectively. Due to topographic characteristics the required excavation per unit of storage volume will be greater west than east of 60th Avenue NW: 60% versus 40% of storage volume. The results show the impact of assumed land costs (west of 60th Avenue NW at $5,000 per acre and east at $14,000 per acre), making Alternative 3.3 less costly than Alternative 3.4 by $108,578 considering the costs for ponds within Section 7 and ponds 40 and 3 (kr-p.1.1 and kr-p1.2, respectively). However, this difference is small compared to the total cost and if unit costs or site conditions are different than assumed, the actual cost of Alternative 3.4 may be less than 3.3. In conclusion, these two alternatives are too close to select one based solely on cost.

Table 5. Section 7 Cost Comparison by Alternative
City of Rochester (363-01-000)
Bonestroo, Rosene, Anderlik & Associates/ILL

Alternatives [1]	Storage Volume for 100-yr event (acre-ft)	Estimated Area at NWL (acres)	Estimated Area at HWL for 100-yr event (acres)	Estimated Property Required (area @HWL + 15%) (acres)	Assumed Land Price ($/acre)	Estimated Land Cost ($)	Estimated Excava-tion (cub.yds) [2]	Estimated Excavation Cost (placed on site @ 3$/cub.yd) ($)	Estimated Land and Excavation Cost ($)	Comments
Within Section 7:										
3.2. Distribute flow capacity at 50th Avenue equally among contributing area (0.19 cfs/acre)	170	31	37	42	14,000	593,361	109,922	329,767	923,127	
3.3. Build regional facilities with efficient ponding (minimum in Section 7)	157	24	33	38	14,000	530,653	101,369	304,107	834,760	Lowest cost within Section 7!
3.4. Build regional facilities with efficient ponding and 50 acre-feet floodplain compensation within Section 7	207	34	43	50	14,000	695,880	133,636	400,907	1,096,787	
Only for Upstream Ponds of Interest (Ponds 40 & 3):										
3.2. Distribute flow capacity at 50th Avenue equally among contributing area (0.19 cfs/acre)	227	38	42	48	5,000	239,904	219,281	657,843	897,747	
3.3. Build regional facilities with efficient ponding (minimum in Section 7)	230	39	42	49	5,000	243,526	222,427	667,281	910,807	
3.4. Build regional facilities with efficient ponding and 50 acre-feet floodplain compensation within Section 7	190	32	36	41	5,000	204,785	184,191	552,573	757,358	Lowest cost for west of 60th Ave. NW!
For Section 7 and Upstream Ponds of Interest (Ponds 40 & 3):										
3.2. Distribute flow capacity at 50th Avenue equally among contributing area (0.19 cfs/acre)	397	69	79	90		833,265	329,203	987,610	1,820,874	
3.3. Build regional facilities with efficient ponding (minimum in Section 7)	387	63	75	87		774,179	323,796	971,388	1,745,567	Lowest overall cost!
3.4. Build regional facilities with efficient ponding and 50 acre-feet floodplain compensation within Section 7	397	66	79	91		900,665	317,827	953,480	1,854,145	Lowest excavation cost!

Notes:
[1] Alternative 1 is not considered for comparisons because "existing" flows cannot be sustained with current impacts to floodplains
[2] Estimated Excavation assumes 40% of storage volume within Section 7.
Due to topographic considerations the Estimated Excavation assumes west of 60th Ave. NW is asummed at 60% of storage volume.

Alternative 3.2 includes only ponds in Section 7 and the two ponds adjacent, west of 60th Avenue NW. Therefore, the total cost of implementing this alternative would be greater than the estimated cost in Table 5. This is because additional storage volume needs to be provided upstream, where excavation per unit storage volume increases (estimated larger than 60% of storage volume). This would result in a higher cost than the other two alternatives.

Table 6 presents estimates of the total cost including all ponds for Alternatives 3.3 and 3.4. These costs represent the expected maximum totals—item costs will be estimated more accurately in the design phase. If land costs are not considered, Alternative 3.3 is estimated to cost about $8,234 more than Alternative 3.4. However, including land costs Alternative 3.3 is about $118,252 less costly and maximizes the land available for development in Section 7. In summary, the expected total cost associated with the construction of the ponds considered in these alternatives would be less than 2.9 million dollars.

The total for Alternative 3.4 without ponds west of 60th Avenue NW would be about $1,638,900, depending on the engineering and contingencies costs. Associated with the Weatherstone and Ripley ponds the cost is between $53,000 and $69,000.

Table 6. Total Estimated Cost

City of Rochester (363-01-000)

Bonestroo, Rosene, Anderlik & Associates/ILL

Item	Units	Unit Price ($)	Quantity	Cost ($)
For Alternative 3.3:				
Excavation for Water Quantity [1]	cub.yd.	3	323,796	971,388
Excavation for Water Quality [2]	cub.yd.	3	124,827	374,480
Hydraulic Outlet Structures [3]	structure	15,000	10	150,000
Grading & Planting [4]	acre	2,000	15	30,125
SUBTOTAL				1,525,993
Costs for Engineering & Contingencies (30%)				457,798
Land [5]	acre	8,939	87	774,179
TOTAL without land	**acre-ft pond**	**5,128**	**387**	**1,983,791**
TOTAL with land	**acre-ft pond**	**7,129**	**387**	**2,757,970**
For Alternative 3.4:				
Excavation for Water Quantity [1]	cub.yd.	3	317,827	953,480
Excavation for Water Quality [2]	cub.yd.	3	128,215	384,644
Hydraulic Outlet Structures [3]	structure	15,000	10	150,000
Grading & Planting [4]	acre	2,000	16	31,535
SUBTOTAL				1,519,659
Costs for Engineering & Contingencies (30%)				455,898
Land [5]	acre	9,934	91	900,665
TOTAL without land	**acre-ft pond**	**4,972**	**397**	**1,975,557**
TOTAL with land	**acre-ft pond**	**7,238**	**397**	**2,876,222**

Differences: Alternative 3.3 minus Alternative 3.4	
TOTAL without land	**8,234**
TOTAL with land	**-118,252**

Notes:

[1] Excavation cost assumes material is placed on-site

[2] Estimated Excavation required for Water Quality is estimated at 1/5 the storage volume for water quantity control; excavation cost assumes material is placed on-site

[3] The 7 structures do not include Weatherstone and Ripley ponds, including these would make them 10

[4] Area for grading and planting is estimated at 20% of the High Water Level area for 100-yr event

[5] Land costs are assumed at $14 000 in Section 7 and $5 000 west of 60th Avenue NW
Required land is estimated as 15% additional to the area required at High Water Level for 100-yr protection

6. Conclusions and Recommendations

6.1. The no-action alternative—building no ponds in Section 7—is not viable, since the standard 100-year flood protection will not be able to be met to protect infrastructure downstream of 50th Avenue NW.

6.2. The ponds to be built in Section 7, and just west of 60th Avenue NW, are part of the **Kings Run Environmental Corridor** (see Figure 5), which includes the Kings Run meandering stream and the White Oaks ponds. This is a continuation of efforts by the City of Rochester to enhance this corridor, thus promoting an environmentally friendly community.

6.3. Alternatives 3.1 and 3.2 were considered not feasible.

6.4. Alternative 3.3 (Figure 6) allows the greatest amount of developable land within Section 7, enabling the use of an estimated 72 acres of now frequently flooded area.

6.5. Alternative 3.4 (Figure 7) proportionally allocates storage volumes for flood control, given the topographic characteristics of the watershed, and is compatible with current use of lowlands. This is important since areas west of 60th Avenue NW will also have to consider storm water from any land use change from agricultural if it develops in the future. Alternative 3.4 allows 62 acres of floodplain reduction in Section 7; that is, 10 acres less of developable land than Alternative 3.3.

6.6. Prior to any urban development west of 50th Avenue NW, the level of protection at this avenue did not meet the 100-yr event. For a 50-yr event 50th Avenue NW would not overtop; overtopping would have been about 0.5 ft for a 100-yr event. Considering current change in land use in Wedgewood Hills and Kingsbury Hills developments, this overtopping is less than a tenth of a foot higher because of the high floodplain storage available upstream of 50th Avenue NW before the Weatherstone development occurred (approximately 103 acre-feet). White Oaks houses and pond are still protected for the 100-yr event under these conditions. However, floodplain reduction is critical and needs to be compensated for before additional development occurs in this area.

6.7. To achieve 100-yr event protection for 50th Avenue NW and White Oaks infrastructure, Alternatives 3.3 or 3.4 should be implemented. This includes the specified ponds west of 60th Avenue NW and maintaining existing undeveloped conditions (rural agricultural land use) west of 60th Avenue NW.

6.8. If the ponds in Alternative 3.3 were built with the exception of Pond 40 (west of 60th Avenue NW, south of the Douglas Trail), 50th Avenue NW would be protected from overtopping only up to the level of a 15-year storm. The 100-yr event overtopping depth on the avenue would be about 1.2 ft.

6.9. If the ponds in Alternative 3.4 were built with the exception of Pond 40 (west of 60th Avenue NW, south of the Douglas Trail), the additional 50 acre-feet in Pond 14 would make it possible to achieve a 50-yr storm protection from overtopping 50th Avenue NW. A 100-yr storm would overtop it by about 0.5 ft. If both Pond 40 and Pond 3 (west of 60th Avenue NW, north of 55th Street NW) were not built in Alternative 3.4, Pond 14 would still offer some protection (close to a 40-year event overtopping protection), but the 100-year event would overtop 50th Avenue NW by about 0.6 ft. Downstream, this would mean that water for the 100-year flood would reach the top-of-berm level at White Oak Ponds.

6.10. Table 4 presents a summary of levels of protection with the estimated floodplain reduction in Section 7. Different conditions are presented, to visualize existing conditions (pre-development of any subdivisions west of 50th Avenue NW) compared with other scenarios based on Alternatives 3.3 and 3.4. Mainly, the conditions of building or not building ponds west of 60th Avenue NW (Ponds 40 and 3, by Douglas Trail and 55th Street NW, respectively) are presented.

6.11. This analysis assumed that areas west of 60th Avenue NW would remain agricultural. However, if these lands were to develop, their storm water management analysis must consider the impacts to floodplain and depression storage volumes, as well as the change in land use for urban development. The objective is to efficiently size storm water management facilities (such as ponds) without sacrificing degree of protection (100-yr event) to downstream areas that could result from underestimating the hydrologic importance of floodplains/depressions.

6.12. Since road culvert crossings are also very important in controlling water flows, the replacement of existing culverts with larger ones, in particular, should be carefully analyzed for the impact on flood protection to infrastructure downstream.

6.13. No lands should develop in Section 7 prior to the construction of the proper storm water facilities.

6.14. Considering potential funding sources, Alternative 3.3 is recommended, provided Pond 40 is given a high construction priority. However, Alternative 3.4 could also be implemented if conditions change that affect the assumptions made in this study.

6.15. Priorities for Pond Construction:

Pond Name	Priority or Status
Weatherstone Pond (No. 3000)	Under construction
Ripley Ponds (No. 8601, 8602, 8600 & 8610)	Development dependent
Wedgewood North Pond (No. 304)	High priority (areas south of 55th Street NW are already developed)
Kingsbury North Pond (No. 305)	High priority (areas south of 55th Street NW are mostly developed)
Harvest View Pond (No. 1300)	High priority
60th Ave by Douglas Tr. (No. 40)	High priority
Douglas South Pond (No. 14)	High priority
60th Ave by 55th St. NW (No. 3)	Development dependent [1]
Douglas North Pond (No. 8002)	Development dependent

[1] Pond 3 construction priority depends on when areas being served by Pond 14 develop.

6.16. We recommend Ponds 1300, 304 and 305 be built first, as Phase 1.

6.17. Ponds 14, 305, and 304 could be built on-line, which would reduce storage volume insignificantly, but could help further reduce peak flows. The design phase should consider this issue and alternatives for stair-casing the ponds, to reduce grading costs.

6.18. Pond 14 can be designed for two-phase construction, with part being dry-pond having recreational use. This secondary use will be more likely if the pond size for Alternative 3.4 is implemented. Phase one of Pond 14 should be built with high priority, because of existing development and the need to have storage capacity to partially compensate for floodplain loss. Phase two should be built by when the drainage area to Pond 14 develops.

6.19. Pond 40 can also be built combining areas for water quality treatment—including wetland environments—with dry-pond areas for recreational secondary use. Figure 8 illustrates an alternative for this pond with a layout to enhance a naturalized ecosystem.

6.20. Since the Douglas Trail approaching 50th Avenue NW serves to balance high water levels between the north and the south sides, this issue will need to be addressed if the future pedestrian bridge plans to affect the distribution of water on the upstream side of this avenue.

6.21. Waterways (such as creeks, swales and ditches) may need to be relocated, enlarged and/or protected from erosion as Section 7 develops. These alterations will be required to allow changes in land use, but depend on the development plans for their implementation. Therefore, the impact to storm water conveyance systems will need to be addressed throughout the development of Section 7.

7. Summary of Alternative Chosen for Implementation

The City of Rochester chose to implement Alternative 3.3, to pro-actively address storm water management in order to enhance the environment and protect downstream infrastructure. Alternative 3.3 provides the following benefits:

- Maximizes developable area within Section 7;
- Adapts to development patterns in the area;
- Minimizes construction costs;
- Allows obtaining additional funding sources from the flood control program.

Table 7 lists the ponds included in Alternative 3.3 (for more details see Table 1), illustrated in Figure 6. The construction of these ponds will provide a 100-year flood protection at 50th Avenue NW. These ponds are sized to manage runoff from areas draining directly to each pond based on a Single Family Residential (SFR) Land Use. If other land use is expected, then adjustments will need to be made.

Table 7. Summary of Ponds Included in Alternative 3.3 (details in Table 1)

Regional Facilities With Efficient Ponding:

Pond Number	Pond Name	Storage Volume for 100-yr event (acre-ft)	Estimated Area at HWL for 100-yr event (acres)	Approx. Drainage Area Served (acres)	Priority
Section 7 Ponding Required for Change in Land Use (i.e., no floodplain loss mitigation):					
1300	Harvest View	2.2	0.6	15.5	High
304	Wedgewood North	16.4	3.6	107.0	High
305	Kingsbury North	16.5	3.7	80.0	High
14	Douglas South	44.0	9.4	280.0	High
3000	Weatherstone	30.0	5.2	103.0	Under construction
8601	Ripley East	9.5	2.2	76.5	Development dependent
8602	Ripley West	5.5	1.3	76.5	Development dependent
8002	Douglas North	33.0	7.1	189.0	Development dependent
870	Weatherstone Wetland	11.0	3.0		Development dependent
8600	Ripley South Wetland	14.0	3.8		Development dependent
8610	Ripley North Wetland	6.0	2.4		Development dependent
1120	Holy Spirit Wetland	1.2	0.5		Constructed
Upstream ponds of interest (not in Section 7):					
40	60th Ave by Douglas Tr.	165.0	28.7	1447	High
3	60th Ave by 55th St	64.8	13.7	367	Development dependent [1]

For Section 7 and Upstream Ponds of Interest:		
Total for Ponds including Listed Wetlands	419	85

[1] Pond 3 construction priority depends on when areas being served by Pond 14 develop.

The total estimated cost to implement the ponds in Alternative 3.3 is approximately $2.8 million, assuming land costs of $14,000 within Section 7 and $5,000 west of 60th Avenue NW. The construction cost is approximately $2 million, not including land acquisition. For more details, see section 5 in this report.

The required ponds to meet the 100-year flood protection include Ponds 40 and 3, located in Section 12 of Cascade on the upstream side of 60th Avenue NW. Both of these ponds are sized for existing agricultural land use upstream of this avenue.

The vision is to construct ponds in a phased approach depending on development. The ponds with high construction priority include Ponds 1300, 304, 305, 14 and 40. These ponds compensate for floodplain losses and current development. The first three should be built as Phase 1. Implementing more of these planned ponds will result in higher levels of flood protection, to provide the 100-year protection goal when all ponds get built.

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