URS

MEMORANDUM

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Subject: City of Roseville
Charlie Pond Stormwater Modeling Project
Project Summary and Results

The purpose of this memorandum is to document the data and results produced for an existing condition drainage study performed for the entire drainage area and storm sewer system associated with Charlie Pond in the City of Roseville. In addition to the existing condition model, the City of Roseville requested additional modeling of possible modifications to the Storm Sewer System. Summarized below are the background and scope of services provided by URS for this modeling project, the existing condition drainage study results, and the modeling results for the possible adjustments to the storm sewer system.

BACKGROUND & SCOPE OF SERVICES

For many years, concern has been raised about periodic flooding in the watershed of Charlie Pond during high intensity rain events. The City of Roseville has performed a number of improvements to address flooding in areas such as Avon Street, Millwood Avenue, and Victoria Street. Also, the City of Roseville, in cooperation with the City of Shoreview, constructed two ponding facilities immediately north of Charlie Pond, which provide extra stormwater storage and increased water treatment prior to discharge to Lake Owasso.

The City of Roseville has analyzed the Charlie Pond watershed in a variety of different formats over the past 20 years. As indicated above, numerous modifications and additions have been made to the storm sewer system within the watershed. This has resulted in the necessity to re-evaluate the system as a whole. The City of Roseville hired URS Corporation to prepare a detailed hydrologic model to help clarify how stormwater is conveyed through the watershed.

Due to the complexity of the Charlie Pond watershed, the City of Roseville determined that the XPSWMM software was best suited for the analysis of the Charlie Pond watershed. XPSWMM is a comprehensive software package used for the analysis and design of stormwater, sanitary, or river systems. It simulates natural rainfall-runoff processes and the performance of engineered systems that control water resources. XPSWMM is a dynamic unsteady flow model rather than a steady state or standard step model, which means the program is capable of delivering results far more accurately and realistically than a steady state model would be able to accomplish. Dynamic models yield true representations of the water levels at any point in space and time by allowing for the effects of storage, backwater, and the timing of the hydrographs in conduits and floodplains.

The following three tasks were identified by the City of Roseville as the original scope of services for URS to complete for the Charlie Pond Stormwater Modeling Project.

Task #1 consisted of collecting data required to accurately model the Charlie Pond watershed. The physical characteristics of the existing storm sewer system were defined by the following sources of information:

1. Roseville storm sewer as-builts for watershed
2. Shoreview storm sewer as-builts for northern drainage area
3. Roseville GIS (contours, roadways, storm pipes, building footprints)
4. Shoreview GIS (contours only)
5. Previous Roseville HydroCAD models
6. Previous Roseville drainage study reports and memos
7. Neighborhood historical data for rain events and depth of flooding
8. Inlet casting inventory for all streets. (Inlet castings tell us how much water can enter the storm sewer system during a rain event)

Task #2 involved setting up the XPSWMM model for the existing conditions. Individual sub-tasks included:

1. Data entry of physical characteristics of the stormwater system including pipe, drainage areas, available storage, and outlet/ inlet structures, etc.
2. Establishing and entering hydrologic data including time of concentration, rainfall intensity, curve numbers, etc.
3. Reviewing developed model with previously completed models
4. Running model to verify continuity with historical data collected

Task# 3 involved running the existing conditions XPSWMM model and analyzing results. Individual sub-tasks included:

1. Run the model for 2, 10, and 100 year storm events
2. Analyze data and identify high water elevations and locations of flooding, if present
3. Summarize data in a memo

EXISTING CONDITION DRAINAGE STUDY SUMMARY

URS worked closely with the City of Roseville through multiple meetings and site visits to the neighborhood in order to collect the data summarized above for Task #1. Task #2 began with the establishment of the hydrologic data specific to the area. In order to run an XPSWMM model, hydrologic information is needed in addition to the physical data provided on as-builts and other historical documents. A list of the hydrologic information collected is summarized below:

Hydrologic Data

1. This watershed was modeled using the SCS unit hydrograph method.
2. A type II, 24 hour distribution curve was applied to define the rain intensity in relation to time.
3. The rainfall intensity was defined by the MNDOT drainage manual in Appendix B(1), B(3), and B(6), with a value of 2 year storm = 2.7", 10 year storm = 4.2", and 100 year storm = 6.0". (By definition, a 100 year storm has a 1% probability of occurring in any given year.)
4. Curve numbers (value used to classify the land use and soil type) for this model were chosen utilizing HydroCAD and verified with the MNDOT Drainage manual (table 3.11 SCS Curve Numbers for Urban Land Uses) under soil type B. (Type B soils have moderate infiltration rates when thoroughly wetted and typically consist of sandy clay to clayey sand type materials)
5. Time of concentration for storm runoff was calculated for each sub drainage area, with the minimum

time of concentration being 7 minutes.

6. For Shoreview drainage areas related to this watershed, the time of concentration was taken from previous models.

URS continued with Task #2, the model set-up, by entering all the physical data gathered into an XPSWMM model, recreating the entire watershed system, including the drainage areas, pond volumes, storm sewer pipe, manholes, inlets, outlets, etc. See Exhibit 1 for a map of the Charlie Pond Watershed area showing structure and ponding labels. The hydrologic information identified above is then entered and the model was then run for the three rainfall intensities specified above, the 2-year, the 10-year, and the 100-year, and the data was analyzed and summarized.

The type of information that an XPSWMM model provides includes the volume and elevation of water flowing through the system at any point in time during specific rainfall intensitys. XPSWMM gives us the ability to analyze a representative storage area above a manhole or catchbasin ground elevation which indicates flooding. Inlets, manholes, ponds, and wetlands all have a "spill crest" or ground elevation, as well as a representative storage area entered as a physical parameter. The model indicates if and how high the water will rise so if there is a time during a certain rainfall event where the system cannot handle the amount of runoff, the model will produce data showing when, where, and how much.

Historically, there have been specific areas of concern within the Charlie Pond watershed: the low point on Millwood Avenue south of Brenner Avenue, the intersection of Millwood Avenue and Brenner Avenue, the low point on Avon Street, and the backyards on the west side of Millwood Avenue (specifically the lot just west of 800 Millwood Avenue, which is identified as AD 1 in the model). There has also been some concern with the function of Charlie Pond in relation to the entire watershed and also with the addition of the two ponds to the north. While the model includes data for every structure and pipe in the system, these areas described above are the only spots that show flooding in the model; this corresponds with historical data gathered. Data from the XPSWMM model for these particular areas is summarized below:

Existing Conditions Results

For the areas of concern within roadways, we looked at the depth of flooding present from the top of the storm sewer castings during a particular rain event. These ponding depths represent a weighted average depth for all the inlets associated with the storm drain system in the drainage area. Flooding depths for the three residential areas identified above during the 2, 10, and 100 year rainfall events are as follows:

LOCATION	2-YR-DEPTH	10-YR-DEPTH	100-YR-DEPTH
1. Millwood South - Low Point	0.01 ft	0.52 ft	1.98 ft
2. Millwood - Brenner Intersection	0.00 ft	0.14 ft	0.85 ft
3. Avon - Low point	0.05 ft	0.89 ft	1.95 ft

The existing conditions model set up to run the 2-year rainfall event showed negligible flooding or storage problems at any of the locations indicated above. The results for the 10-year rainfall event showed minimal flooding in the Millwood – Brenner intersection. The other two locations show a flooding depth that is under a foot, which, in most instances, can be considered a manageable depth of flooding depending on the time span. The model indicates that the time to drain the Millwood South low point is between a half hour and an hour, while the time to drain the Avon low point is between an hour and an hour and a half, assuming the inlets are not clogged with debris. The 100-year rainfall event produces flooding close to two feet in depth for the Millwood South area and the Avon low point and drain times of two to four hours, again assuming the inlets are not clogged. The Millwood – Brenner intersection shows less than a foot of flooding and a one to two hour drain time, which can be considered manageable. Depth of flooding is clearly a problem with the 100-year rain event and can be verified by reviewing historical data for these particular locations. These depths provide evidence that show the model is representing the Charlie Pond watershed accurately.

The following table shows pond elevation data, accompanied with the storm water elevations produced from the XPSWMM models for Charlie Pond (C Pond), the pond north and east of Charlie Pond (NE Pond), the pond north and west of Charlie Pond (W Pond), and AD 1 during the 2, 10, and 100 year rainfall events. Elevations for these areas were reviewed in order to determine whether the volume of the pond is adequate for the drainage areas flowing to them.

LOCATION	NWL	SPILL CREST	2-YR-WL	10-YR-WL	100-YR-WL
1. C Pond	894.00	909.00	894.67	896.44	897.80
2. NE Pond	906.54	908.79	907.46	908.82	909.06
3. W Pond	901.68	905.02	903.25	905.10	905.15
4. AD 1	902.00	904.00	904.53	907.27	910.45

The analysis of the W, NE, and C ponds are considered together because the W and the NE pond drain to Charlie pond during more intense rain events. Focusing on Charlie Pond, even in the 100-year event, Charlie pond does not rise to an elevation that would go over the spill crest. This tells us that Charlie Pond has adequate volume to handle all the drainage areas flowing to it, including the two newer ponds. Area AD 1 needs to be analyzed separately. Model results indicate that water ponds in this area during all rain events. The 100-year rain event also showed an elevation that is very close to some of the historical data provided, which continues to indicate that the model is producing results that accurately represent the Charlie Pond watershed and the AD 1 sub-drainage area. Appendices A-1, A-2, and A-3 provide a further summary of key physical and hydrologic data for the 2, 10, and 100 year rain events produced by the XPSWMM existing conditions model for the Charlie Pond Watershed.

SUMMARY AND ANALYSIS OF POSSIBLE SYSTEM IMPROVEMENTS

During the process of setting up the XPSWMM existing conditions model, the City of Roseville requested some additional modeling to review possible improvements that could be made to the storm sewer system. After the existing model was complete, these additional scenarios were set up, run, and analyzed. The description and results of these models for the 100-year rainfall event are summarized below.

The alternative scenario models were all run with the 100-year rainfall event only and include three main storm sewer system adjustments; eliminating the storage associated with the AD 1 drain and creating a swale that sends the water directly to Brenner, adding an inlet to MH105 (currently a closed manhole at the corner of Millwood and Brenner), and providing an overflow connection between MHCBN to MH103 (at the Millwood South low point). Also modeled was the possible combination of these improvements in conjunction with one another. The fourth scenario, modeled as a separate case, was to change out any inlet castings that allow only 1.4 cfs maximum to castings that allow 1.5 cfs maximum. The fifth scenario, also modeled as a separate case, disconnects CB 1, CB 2, and CB 3 in the Millwood South low area and sends water directly to Lake Owasso instead of to Charlie Pond and then back to Lake Owasso. Flooding depths (based on weighted average by drainage area) for the three residential areas identified above during the 100 year rainfall events are as follows:

1. **Eliminate storage at AD 1**

LOCATION	100-YR-DEPTH	Existing
1. Millwood South - Low Point	1.98 ft	1.98 ft
2. Millwood - Brenner Intersection	1.04 ft	0.85 ft
3. Avon - Low point	1.95 ft	1.95 ft
(Charlie pond elevation = 898.50)		

2. **The addition of an inlet at MH105**

LOCATION	100-YR-DEPTH	Existing
1. Millwood South - Low Point	1.93 ft	1.98 ft
2. Millwood - Brenner Intersection	0.84 ft	0.85 ft

3. Avon - Low point	1.95 ft	1.95 ft
(Charlie pond elevation = 897.82)		

3. **The connection of storm drain MHCBN to MH103 by an overflow pipe**

LOCATION	100-YR-DEPTH	Existing
1. Millwood South - Low Point	1.69 ft	1.98 ft
2. Millwood - Brenner Intersection	0.86 ft	0.85 ft
3. Avon - Low point	1.95 ft	1.95 ft
(Charlie pond elevation = 897.79)		

4. **Action (1) and the addition of an inlet at MH105**

LOCATION	100-YR-DEPTH	Existing
1. Millwood South - Low Point	2.01 ft	1.98 ft
2. Millwood - Brenner Intersection	1.02 ft	0.85 ft
3. Avon - Low point	1.95 ft	1.95 ft
(Charlie pond elevation = 898.37)		

5. **Action (1) and the connection storm drain MHCBN to MH103 by an overflow pipe**

LOCATION	100-YR-DEPTH	Existing
1. Millwood South - Low Point	1.71 ft	1.98 ft
2. Millwood - Brenner Intersection	0.90 ft	0.85 ft
3. Avon - Low point	1.95 ft	1.95 ft
(Charlie pond elevation = 897.83)		

6. **Action (1), MHCBN to MH103 connection, and additional inlet at MH105**

LOCATION	100-YR-DEPTH	Existing
1. Millwood South - Low Point	1.71 ft	1.98 ft
2. Millwood - Brenner Intersection	0.89 ft	0.85 ft
3. Avon - Low point	1.95 ft	1.95 ft
(Charlie pond elevation = 897.81)		

7. **Addition of inlet at MH105 and connection MHCBN to MH103**

LOCATION	100-YR-DEPTH	Existing
1. Millwood South - Low Point	1.88 ft	1.98 ft
2. Millwood - Brenner Intersection	1.05 ft	0.85 ft
3. Avon - Low point	1.95 ft	1.95 ft
(Charlie pond elevation = 898.64)		

8. **Change inlet capacity from 1.4 to 1.5 cfs by switching out castings**

LOCATION	100-YR-DEPTH	Existing
1. Millwood South - Low Point	1.87 ft	1.98 ft
2. Millwood - Brenner Intersection	0.81 ft	0.85 ft
3. Avon - Low point	1.90 ft	1.95 ft
(Charlie pond elevation = 897.84)		

9. **Direct CB 1, CB 2, and CB 3 directly into Lake Owasso through Charlie Pond Outlet sewer**

LOCATION	100-YR-DEPTH	Existing
1. Millwood South - Low Point	1.69 ft	1.98 ft
2. Millwood - Brenner Intersection	0.85ft	0.85 ft
3. Avon - Low point	1.95ft	1.95 ft
(Charlie pond elevation = 897.83)		

None of these possible scenarios result in significant changes to the drainage system. Some adjustments make localized changes in the 100-year storm events ponding depth but there is no ideal solution to relieve the entire area. Charlie Pond elevations fluctuate very little, but still stay under the spillway elevation, which shows that Charlie Pond has adequate storage to handle all of these possible storm system adjustments. Appendix A-4 through A-12 provides a further summary of key physical and hydrological data for the 100 year rain events produced by the XPSWMM model for each scenario detailed above.