MEMO
External Correspondence

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To: Doug Thomas
District Administrator, RCWD

From: Lan Tornes and Chris Otterness, P.E.
Through: Mark Deutschman, Ph.D. P.E.

Subject: Hugo Victor Gardens Development
Subsurface Water-Level Evaluation

Introduction

Victor Gardens is a new housing development on the western edge of Hugo, MN. Construction of the homes started in May, 2002 with development continuing in 2008. Its location provides convenient access to the Twin Cities Metropolitan Area and other destinations via a nearby Interstate highway. Many homeowners in the Victor Gardens development have been experiencing problems with wet basements. The City of Hugo and the Rice Creek Watershed District (RCWD) have expended considerable effort to assist these residents and understand this problem.

Figure 1 is an aerial photograph that shows the layout of the Victor Gardens development including the houses and surface-water features. Although it is not evident when the photograph was taken, it shows vacant lots where homes are known to exist. The development is relatively flat with the highest point having an elevation of about 922 feet above mean sea level (MSL) along Arbre Lane near the center of the development down to 900 MSL near Clearwater Creek which is north of the development.

The surficial geology in this development describes most of the material as being glacial till. This material is quite dense and typically is resistant to the flow of water because of a small pore size in the predominantly clay-like material. In the northwest part of the development, generally near Poets Green and where Arbre Lane runs west into Garden Way (**Figure 1**), surficial deposits are described as outwash or outwash over till. Where highly conductive outwash intersects with less conductive till, ground water flow patterns can become erratic depending on the nature of the contact areas.

The geotechnical evaluation report for RCWD permit 99-164 dated Dec. 07, 2001 states: "Due to the rather impermeable nature of the glacial soils, this site contains perched ground water conditions. This situation is reflected by the borehole water level readings…As such, ground water can be expected at various elevations across the site dependent upon subsurface soil types, surface drainage patterns and seasonal precipitation." The report goes on to explain that "where ground water is encountered during excavation work, we anticipate that seepage rates will be rather slow and excavation dewatering, if necessary, can likely he handled with sumps and pumps". These water problems may have persisted into the current wet-basement problems, but a direct link to those reported elevations was not pursued in detail. As material is moved about during construction, the original surficial geology can be greatly modified leading to considerable uncertainty as to the applicability of the original finding of the geotechnical reports.

A document from Westwood Professional Services, Inc. dated January 31, 2003 specified the Minimum Basement Foundation Elevations (MBFE) and the Lowest Opening Elevations (LOE) for changed 100-year flood elevation for Clearwater Creek. It was not verified whether these specified elevations were followed, but the water problems that have been experienced in the development would likely have no relation to flood elevation of Clearwater Creek.

As is common for newer construction, all these homes probably have foundation drainage systems that are designed to intercept water from around the foundation and convey it away from the house via a drain or into a sump basket. From the sump basket, the water may be pumped away from the house. The material used beneath the foundation of the homes should be coarse to prevent capillary action from drawing moisture from the ground-water surface up to the basement floor and walls. Also, moisture from roofs and other impervious surfaces should be conveyed away from the foundation to prevent seepage into the basement foundation. A cursory search of the available records did not indicate what drainage precautions were advised and whether they were incorporated into the construction.

Foundation drainage systems are designed to convey incident water, originating as precipitation and runoff, away from the foundation. They are not designed to lower the water table surrounding the foundation. The water removed by the foundation drainage often is conveyed only a short distance down-slope from the structure and is intended not to cycle back to the foundation. However, water could cycle back to the foundation if it percolated back to a shallow ground-water system.

Houston Engineering, Inc. (HEI), as the engineering consultant for the RCWD, was asked to evaluate the available information and determine what type of ground-water study was needed to determine the source of the basement water problems. This information would be used by the City of Hugo and the RCWD (the local stakeholders) to mitigate the water problems. HEI had been asked to determine the cost to install a network of ground-water observation wells and to operate that network to assess the problem. HEI determined, however, that the data already available from the local stakeholders should be adequate to estimate ground water surface elevations without the need to install a ground water monitoring network.

Purpose and Scope

The purpose of this study is to determine the water level elevations beneath the Victor Gardens development in Hugo, MN based on data provided by the local stakeholders. The local stakeholders would use this information to determine the most appropriate means to reduce the potential for basement flooding; this might involve some technique to lower the ground-water level near affected structures. The area considered for this study included the Victor Gardens development and nearby water-control structures including constructed ponding areas, established wetlands, and nearby drainage ditches including Clearwater Creek.

Methods

During September, 2007, a local resident conducted a qualitative door-to-door and email survey of homeowners in the Victor Gardens development to identify homes having problems with wet foundations and to determine the extent of the wet-basement problem. The questions asked included:

Does your sump pump run:

All the time, during rain, or never?

Does your sump pump run during the winter? Yes or No.
How often does your sump pump run?
Has your basement ever flooded?
If yes, did the flooding occur because of a problem with your sump pump?

The results of these questions, a series of maps showing the layout of the development, the street address of the affected homes, the approved and the constructed elevation of the lowest part of the basement floors, and related information were provided by the local stakeholders to HEI. Selected results of that survey, listed by feature name or street address, and related data are shown in **Table 1**. These data were used to construct a map showing the ground water surface elevation beneath the development.

The approved and constructed basement elevations often differed, but the constructed elevation was used for this determination of the ground-water surface elevation. The constructed elevation of foundations in Victor Gardens averaged 0.16 feet below the approved elevation, and did not appear to be strongly weighted toward the homes reporting sump pumps that ran continuously compared to those that did not; 0.25-feet lower compared to 0.06-feet lower, respectively.

When the survey results indicated that the homeowner observed that the sump pump ran continuously and/or the sump pump ran at times other than when it would be expected to run (such as following rainfall or snowmelt), the constructed elevation of the basement was assumed to represent the surface of the water table. Although the constructed basement elevation did not provide information specific-enough to determine exactly where the water table was in relation to the water-table elevation, 10 of the 54 households that responded to the survey reported that a problem with the sump pump resulted in flooding of their basement. This suggests a water-table elevation higher than the basement-floor elevation. Acting like a well, the foundation-drainage system probably was effective in lowering the water-table elevation near most homes. When the homeowner reported that the pump ran only after a rain event or never ran, the basement elevation was assumed to be higher than the surface of the water table. The frequently-running-pump basement elevations were used to map the water table; except where noted otherwise.

Most of the ponding areas around the development had designed outlet elevations, and those elevations were assumed to be the normal water level. These were used as peripheral ("boundary") estimates of the ground-water table elevation. Other surface- water feature elevations were based on 2-foot contour intervals that were developed by Washington County in 2000. The elevations of Clearwater Creek which runs from east to west along the east and north of the development had a bank-full elevation of 902 feet above mean sea level (MSL) east of the development and 900 MSL north of the development. Although the bank-full elevation was used as the water-table elevation, the normal water-surface elevation of Clearwater Creek likely would be lower than bank-full. Additional elevation points along the creek were added by interpolating between the established points.

The latitude-longitude coordinates of the elevation points (homes and surface-water features) were estimated from aerial photographs of the housing development similar to what is shown in **Figure 1**. The latitude-longitude coordinates were used to position the elevation points for determination of the ground water surface elevation. The elevation points were interpolated and contours drawn using the Delaunay Triangulation method in the AutoCad 2009 software system.

Homeowner-survey results that appeared contradictory may have been removed from the data that were used to estimate ground water surface elevations and are noted in the discussion. Data that could not justifiably be discarded were retained and their effect on the results is discussed.

The elevations used in this report were provided to HEI by the local stakeholders. The values are consistent with those provided on documents prepared by Westwood Professional Services, Inc. who was a consultant to the developers of Victor Gardens. It appears that the provided elevations all are referenced to the North American Vertical Datum of 1988 (NAVD-88).

Results

This assessment is based on the qualitative observations of homeowners that have lived on these properties for as much as five years, so it is difficult to determine whether they are reporting a recent or long-term problem. Also, a problem that may have plagued them a few years ago may have gone away, but the memories are still fresh. Variations in climate also may have an effect. However, the annual average precipitation near Hugo during 2003-2007 was 30.47 inches which compares favorably with the 1971-2000 31.76 inches annual average precipitation recorded at Forest Lake (Minnesota Climatology Working Group data, http://climate.umn.edu/doc/historical.htm, Sept. 2008).

Figure 2 shows the results of interpolating elevation between points labeled green that intersect with and define the ground-water table. For this map, all homes reporting that their sump pump ‘runs all the time’ were included, as well as those whose sump pumps ran during the winter-months when runoff from impervious surfaces should not occur. Also included and labeled green were homes where the homeowner described that their sump pump ‘occasionally’ ran, or ran very little in the winter suggesting that their unqualified answer would have been ‘Yes’. The dark blue points along the periphery of the development are the surface-water features described previously. The points labeled light blue show the location of homes that did not have water problems at a magnitude that met criteria for defining the water-table elevation.

In most cases the elevation of the basement of the ‘dry-basement’ homes labeled light blue are considerably higher than the indicated water-table surface elevations. One exception is house number 4519 along Cosette Lane (point 25), but the computer-generated water-table contour lines may not represent the actual water table in this undefined part of the water-table contour map.

Only one elevation point (light-blue point 63 in the northwest part of the development) where a homeowner reported that their sump pump ran in the winter was eliminated from the computation of the ground-water level. Including it would have resulted in an anomalous water-level gradient in the northwest part of the development that appeared inconsistent with the other nearby water-surface elevation points including surface-water bodies and homes where sump pumps ‘never run’ or run only when it rains, but not in the winter. If the reported operation of the sump pump was not in error, it could indicate a localized hydrologic anomaly, such as a preferential flow path of water from a higher elevation to this foundation. Even with that point removed, the ground-water surface gradient from homes reporting water problems to nearby surface water features is very steep; as much as 9 feet decline over 150 feet distance.

The ground-water surface elevation contours in **Figure 2** were overlaid on the aerial photo of Victor Gardens shown in F**igure 1** to produce the illustration in **Figure 3**, but not showing the eastern extension of the ground water table beyond the development. The ground-water surface elevation in **Figure 3** was highest at the eastern side of the development at data points 26, 27, 35, and 36 which is near where Garden Way and Cosette Lane intersect. That greater-than 917-foot water level declined about 1 foot per 300 feet toward water-affected homes in the northwest, then rapidly declined toward the elevation of surface water features beyond: ponds and Clearwater Creek. The decline in water-table elevations to the northeast also was rapid, but data points to provide better definition of that decline were lacking giving the water-table decline a uniform appearance.

Less than 500-feet west and southwest of the 916-foot water table elevation, homes having a foundation only about 2.5 feet lower were intersecting the water table. From this region on, the water-table elevation appears to generally flatten out, presumably being influenced by subsurface materials that restrict the ground-water flow. Assuming that the pond elevations chosen for this model of ground-water elevations are reliable, data points 9 and 8, named Southwest Pond and Southeast Pond, respectively, have a strong local effect on the ground-water table as indicated by the steep elevation gradient drawing water from near homes that are affected by ground water.

The pond to the southwest of the development (point 9, near where the abandoned part of Elmcrest Ave. used to turn north) was assigned an elevation of 910 MSL for this study, but no designated outlet elevation was noted on the map showing planned elevations[1]. With no designed outlet, a 3-foot rise in the elevation of water in this pond above 910 MSL could affect the basements of nearby homes.

Point 8, which is named 'Southeast Pond', is designated 'Pond 4' on the map showing planned elevations with an outlet at 910 MSL. The high water level for this pond is 910.85 MSL. The pond at point 5 designated 'East Pond' is not labeled on the planned-elevations map, but is part of a wetland area designated with a normal water level elevation of 912 MSL and a high water elevation of 912.4 MSL.

Homes in the southwest part of the development had the greatest likelihood of having wet-basement problems because they intersect the modeled ground-water table. Whereas the Southeast Pond (point 8) appears to create a sufficient gradient to drain water away from homes in its vicinity, the influence of the Southwest Pond is inadequate to reliably protect those homes. Nearly all the homes adjacent to the abandoned Elmcrest Ave. alignment north to the Northwest Pond (point 7) have wet-basement problems with foundation elevations between 913 and 915 MSL, with no apparent place for the water to drain. It is possible that the Elmcrest Ave. road grade, which was observed to be at least 6-feet higher than the adjacent driveways and yards, or other features create a dam that retards the flow of water away from the foundations.

[1] The large-format map showing planned elevations is available from the Rice Creek Watershed District but is not included in this report.

The water-table contour map shows a strong vertical gradient in the northwest part of the development. The 914.3 MSL water level producing a wet basement at house 14304 Garden Way (point 46) drops about 9 feet within 150 feet to the Northwest Pond behind the house. A notable decline also is apparent where the water table at 4429 Cosette Lane (point 20) tapers north toward Clearwater Creek. The northern-most house in the development, at point 63, reporting sump-pump operation suggesting a wet basement at elevation 914 MSL was not used in this estimation of the ground-water table elevation. It is located nearly between two surface-water features, points 1 and 6, at elevations of 900 MSL and 905 MSL, respectively. The northwest part of the development had complicated surficial geology where till and outwash intersected suggesting a complex hydrology that might result in these irregular reports of sump-pump activity. The geotechnical evaluation report suggested perched water tables in the development, and those could be upwelling in this area. However, the nearest soil boring was at the North Pond (point 6) north of these homes so it does not indicate what conditions were like at the affected homes.

Because the Victor Gardens development is surrounded on three sides by lower elevation drainage ditches, excess water should naturally be carried away. The ground-water level to the west of the development (across the abandoned Elmcrest Ave.) is unknown, but regional ground-water flow in this vicinity generally follows the land surface moving from east to west, away from the development. With the till-based soils that slow conduction of water and a shallow water table, precipitation may tend to mound near the surface and is not conveyed naturally to drainage systems as adequately as expected. The excavation of foundations penetrating the land surface form depressions that may draw water from the surrounding soils. In many modern housing developments, normal precipitation is artificially augmented with lawn and garden watering systems. That added water also has to be conveyed away via runoff or through the sluggish subsurface system.

Conclusions and Recommendations

The data used for this study were of undetermined quality relying on the observations and opinions of a variety of homeowners. However, taken as a whole, a few mistaken observations should even out making the data set generally reliable. Although the data were collected during a limited time frame (September 2007), the information collected took into account long-term observations of the residents.

The data provided a useful delineation of the surficial ground-water table beneath the Victor Gardens development with some qualifications. The boundary conditions based on the planned elevations at surface water features around the development are somewhat less certain because they suggest steep gradients along the periphery of the development. Verification of the outlet elevations of ponds around the development and how they interact with the nearby ground-water elevations would help define the steep gradients indicated, however this likely will not provide information that would affect management decisions except near the homes in the southwest part of the development.

There are gaps in the data used to estimate ground-water levels that may need additional definition. These gaps are in common-space areas where homes were not established but that may be crucial to understanding how the shallow groundwater interacts with the foundations of affected homes. There is a notable gap where Victor Hugo Blvd. ends at a park east of the center of **Figures 1** and **3**, and where the highest ground-water elevations are indicated. A similar gap occurs in the park encompassed by Garden Way and Arbre Lane, and to the south where a traffic circle interrupts Jardin Ave. This is an area where many homes are affected by water problems. A better definition of the water table using driven piezometers or small excavations could aid the understanding of groundwater flow patterns where these gaps exist.

It is expected that most homes in this development have sprinkler systems that are used to water lawns and gardens. Sprinkler systems were observed operating in common areas of the development with green lawns prevalent into October. It is possible that excessive artificial watering is creating a local mound of shallow ground water in the vicinity of many of these homes that can not adequately be conveyed away by natural subsurface drainage. Reduced, more prudent lawn watering could allow the water table to approach more natural conditions which might be lower than many basement elevations. However, because lawn watering only occurs during the growing season, this augmented water level should decline through the winter.

In certain parts of the development, particularly where water problems are most prevalent, the homes are very closely spaced with considerable paved surfaces nearby. This creates a relatively high concentration of impervious surfaces that may be drained very near the home foundations. Depending on the design of the basement foundation and backfill, any drainage from impervious surfaces could preferentially drain into the bowl created by the basement foundation within the denser till-based soils.

Two options seem plausible for correcting the water problems. One option is to use drain tile to intercept the groundwater upgradient of the problem basements and to gravity flow the water to the existing stormwater ponds. This requires a thorough understanding of the elevation of the groundwater surface. Because of the type of soils present, obtaining sufficient understanding of the groundwater flow is challenging; even with the installation of monitoring wells. The additional monitoring cost is likely better used to install a more aggressive drainage system.

The second and more reliable method to alleviate the Victor Gardens wet basement problems is direct drainage away from the existing drainage system at each affected house foundation via buried pipe. This water should be drained to the nearest pond having a high-water elevation lower than the basement elevation. Because most of the soils are naturally resistant to the flow of water, any less aggressive system could potentially fail.

Figure 4 shows a proposed drainage system to convey water away from affected homes. Two sizes of pipe are employed: 4 inch pipes shown in yellow drain from individual homes or pairs or homes, while 12-inch pipes shown red accumulate water from the 4-inch pipes and convey it to downstream basins. A 12-inch pipe could be buried along the base of Elmcrest Ave. beneath an existing alley extending north to the northwest pond (point 7) with a final elevation consistent with the 100-year pond elevation (less than 910 feet). The foundations of homes adjacent to the alley west of Garden Way would be connected to that pipe.

Multiple homes along Arbre Lane have water problems that are not adequately drained into the low area behind the homes. That low area appears to have an elevation of 916 feet which is higher than the affected-basement elevations; this elevation anomaly was verified by RCWD staff. Because that low area appears inadequate, it should be further excavated, but **Figure 4** shows installation of a buried pipe that runs to the north pond (point 6). Water-affected homes along Arbre Lane the western loop of Cossette Lane should be drained to that conveyance.

Each home having water problems along the northern loop of Cossette Lane could have a gravity drain installed from their foundation drainage system to the lowest nearby water body: the north pond (point 6). The homes having water problems in the eastern part of the development where Cossette Lane meets Garden Way could drain from their foundation drainage system to the wetland area to their south. Each home having water problems in the southern part of the development along Jardin Ave. could have a gravity drain installed from their foundation drainage system to the wetland area to the east or the pond to the southwest (point 9; assuming that pond drainage is assured as described earlier in this memo).

The information provided in **Figure 4** was used to estimate the cost of installing this proposed drainage system. The total cost is estimated to be about $191,000 as detailed in **Table 2** and would serve 30 homes at $6,400 per home. This cost does not include additional engineering and site inspections that will be needed to ensure the success of this proposed project. Existing foundation drain systems should remain in place for backup purposes. If any of the foundation drainage systems are installed inside rather than outside the foundation, the foundation may have to be penetrated to access the existing foundation drainage.

There may be homes that have been built and are having wet-basement problems that were not included as part of this study. These should be considered for inclusion in any attempt to remedy the situation.

Homes constructed in the future should be closely monitored for potential groundwater problems during excavation of the basements and foundation to minimize the likelihood of intercepting groundwater. The presence of water is an obvious sign of problems. Backfilling with good engineered fill and raising the basement elevation should prevent the need for remediation.

Lastly, it should be noted that the RCWD review process did include an analysis of groundwater elevations.

Table 1. Victor Gardens Homeowner Survey: Selected Results and Water-level Data

Map Identification Number	Identifier or House Number	Feature Description or Street Name	Constructed Elevation in Feet	Does your sump pump run during dry weather or only when it rains?	Does your sump pump run during the winter?	How often does your sump pump run?	Has your basement ever flooded?	From problem with pump?	Estimated Latitude in Decimal Degrees	Estimated Longitude in Decimal Degrees
1	1	Bankfull Creek	900.00	N/A					45.1590	-93.0193
2	2	Bankfull Creek	903.90	N/A					45.1579	-93.0113
3	3	Bankfull Creek	901.00	N/A					45.1593	-93.0173
4	4	Bankfull Creek	902.00	N/A					45.1597	-93.0140
5	5	East Pond	912.00	N/A					45.1555	-93.0170
6	6	North Pond	905.00	N/A					45.1586	-93.0183
7	7	Northwest Pond	905.00	N/A					45.1576	-93.0201
8	8	Southeast Pond	910.00	N/A					45.1550	-93.0185
9	9	Southwest Pond	910.00	N/A					45.1542	-93.0201
10	4344	Arbre Lane N	913.50	All the time	Yes	Every 2 mins.	Yes	Yes	45.1569	-93.0188
11	4362	Arbre Lane N	913.80	All the time	?	All the time	Yes	Yes	45.1570	-93.0190
12	4376	Arbre Lane N	912.30	All the time	Yes	Every 5-10 mins	No	N/A	45.1570	-93.0193
13	14181	Arbre Lane N	913.20	All the time	Yes	Every 10-15 mins	No	N/A	45.1557	-93.0182
14	14203	Arbre Lane N	912.80	During rain	No-unless	Frequently	No	N/A	45.1558	-93.0182
15	14217	Arbre Lane N	912.70	All the time	Yes	Every 15-20 mins	Yes	Yes	45.1561	-93.0182
16	14233	Arbre Lane N	914.50	All the time	Yes	Every 5-10 mins	No	N/A	45.1564	-93.0181
17	14241	Arbre Lane N	914.50	All the time	Yes	Every 10 mins	No	N	45.1566	-93.0182
18	14251	Arbre Lane N	915.50	During rain	No	Regularly	No	N/A	45.1568	-93.0184
19	4407	Cosette Lane N	913.70	During rain	No	Hourly	No	N/A	45.1585	-93.0179
20	4429	Cosette Lane N	913.80	All the time	Yes	Fairly often	No	N/A	45.1586	-93.0176
21	4455	Cosette Lane N	914.50	Never	No	Never	No	N/A	45.1586	-93.0169
22	4477	Cosette Lane N	912.00	During rain	Very Little	?	No	N/A	45.1584	-93.0163
23	4489	Cosette Lane N	912.85	All the time	Yes	Every 15 mins	Yes	Yes	45.1583	-93.0161
24	4513	Cosette Lane N	917.00	During rain	No	?	No	N/A	45.1564	-93.0155
25	4519	Cosette Lane N	913.00	During rain	No	Often	Yes	Yes	45.1578	-93.0158
26	14256	Cosette Lane N	916.90	All the time	Yes	Almost Constantly	No	N/A	45.1567	-93.0150
27	14264	Cosette Lane N	916.00	Continuously	?	Every 10-15 mins	Yes	Yes	45.1570	-93.0151
28	14292	Cosette Lane N	916.00	During rain	No	?	No	N/A	45.1575	-93.0155
29	14326	Cosette Lane N	914.00	Never	No	N/A	No	N/A	45.1576	-93.0180
30	14338	Cosette Lane N	913.35	?	Yes	?	No	N/A	45.1576	-93.0183
31	14356	Cosette Lane N	913.44	During rain	No	1-2 times per day	No	N/A	45.1581	-93.0182
32	4377	Garden Way N	913.50	During rain	No	2 x per day	No	N/A	45.1553	-93.0186
33	4391	Garden Way N	913.40	During rain	Unsure	?	No	N/A	45.1553	-93.0183
34	4415	Garden Way N	914.58	During rain	No	?	No	N/A	45.1553	-93.0181
35	4505	Garden Way N	917.10	All the time	?	Every 5 mins	No	N/A	45.1564	-93.0157
36	4545	Garden Way N	916.00	During rain	Occasionally	?	No	N/A	45.1563	-93.0149
37	14105	Garden Way N	913.00	During rain	Occasionally	Every other day	No	N/A	45.1545	-93.0190
38	14160	Garden Way N	913.70	All the time	?	3 times / hour	?	N/A	45.1555	-93.0193
39	14176	Garden Way N	913.40	All the time	Yes	Every 8-10 mins	Yes	Yes	45.1556	-93.0197
40	14198	Garden Way N	914.65	All the time	Yes	Daily	No	N/A	45.1558	-93.0198
41	14206	Garden Way N	914.30	All the time	Yes	Every 5 mins	No	N/A	45.1559	-93.0199
42	14222	Garden Way N	913.80	All the time	Yes	Every 10-15 mins	No	N/A	45.1562	-93.0200
43	14234	Garden Way N	913.60	All the time	Yes	Every 5-10 mins	No	N/A	45.1564	-93.0200
44	14246	Garden Way N	913.50	All the time	?	Daily	No	N/A	45.1565	-93.0199
45	14303	Garden Way N	913.80	Never	No	Never	No	N/A	45.1574	-93.0190
46	14304	Garden Way N	914.30	During rain	Sometimes	?	No	N/A	45.1575	-93.0195
47	14322	Garden Way N	913.93	During rain	No	?	No	N/A	45.1577	-93.0195
48	14344	Garden Way N	914.00	During rain	Occasionally	?	No	N/A	45.1579	-93.0182
49	14351	Garden Way N	914.40	Never	No	Never	No	N/A	45.1581	-93.0188
50	14074	Jardin Ave N	913.50	All the time	Yes	Continuously	Yes	Yes	45.1542	-93.0195
51	14096	Jardin Ave N	913.10	All the time	Yes	Unkown	No	N/A	45.1543	-93.0196
52	14108	Jardin Ave N	913.30	All the time	Yes	Every 30 mins	No	N/A	45.1545	-93.0196
53	14118	Jardin Ave N	913.83	All the time	No	Every 15-30 mins	No	N/A	45.1547	-93.0199
54	14123	Jardin Ave N	914.15	During rain	No	Rarely	No	N/A	45.1547	-93.0189
55	14131	Jardin Ave N	914.00	During rain	No	?	No	Yes	45.1549	-93.0189
56	14136	Jardin Ave N	914.20	During rain	No	?	No	N/A	45.1548	-93.0199
57	14142	Jardin Ave N	914.00	All the time	Yes	Regularly	No	N/A	45.1550	-93.0198
58	14143	Jardin Ave N	913.45	All the time	Yes	Daily	No	N/A	45.1550	-93.0189
59	14152	Jardin Ave N	913.70	All the time	Yes	Every 30 Sec	Yes	Yes	45.1553	-93.0194
60	14184	Jardin Ave N	914.25	All the time	Yes	3 times / hour	No	N/A	45.1552	-93.0197
61	14336	Poets Green	912.77	Never	No	Never	No	N/A	45.1578	-93.0199
62	14348	Poets Green	913.00	Never	No	Never	Yes	No	45.1580	-93.0200
63	4354	Victor Hugo Blvd	914.00	During rain	Yes	?	No	N/A	45.1587	-93.0191

Table 2 -- Preliminary Probable Opinion of Construction Cost for a Drainage System in Victor Gardens

10/29/2008			EST'D	Engineers Estimate	
	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	EXTENSION
	Mobilization	Lump Sum	1.00	$2,000.00	$2,000.00
REMOVALS	Remove & Disposal of Concrete Curb	Lin Ft	370.00	$3.00	$1,110.00
	Remove & Disposal of Bituminous	Sq Yd	511.00	$3.00	$1,533.00
	Sawing Bituminous & Concrete	Lin Ft	90.00	$3.00	$270.00
	Clearing & Grubbing	Acre	0.10	$5,000.00	$500.00
REPAIRS	Aggregate Base, Class 5	Ton	209.00	$15.00	$3,135.00
	Bituminous Pavement	Ton	112.00	$70.00	$7,840.00
	Concrete Curb & Gutter	Lin Ft	370.00	$12.00	$4,440.00
	Salvage & Reinstall Storm Sewer	Lin Ft	330.00	$25.00	$8,250.00
	Concrete Manhole, 48", w/Casting	Each	2.00	$2,500.00	$5,000.00
DRAIN SYSTEM	4" HDPE Draintile	Lin Ft	2382.00	$15.00	$35,730.00
	12" HDPE Tile	Lin Ft	3274.00	$20.00	$65,480.00
	Riprap, Cl III	Cu Yd	10.00	$70.00	$700.00
	Geotextile Filter Fabric Type III	Sq Yd	10.00	$1.25	$12.50
EROSION CONTROL	Silt Fence	Lin Ft	500.00	$2.00	$1,000.00
	Seeding	Acre	3.0	$1,000.00	$3,000.00
	Sod	Sq Yd	5293.0	$3.50	$18,525.50
	Rock for Construction Entrance	Cu Yd	19.0	$53.00	$1,007.00
				SUBTOTAL	**$159,533.00**
			20% CONTINGENCY		**$31,906.60**
				TOTAL	**$191,439.60**

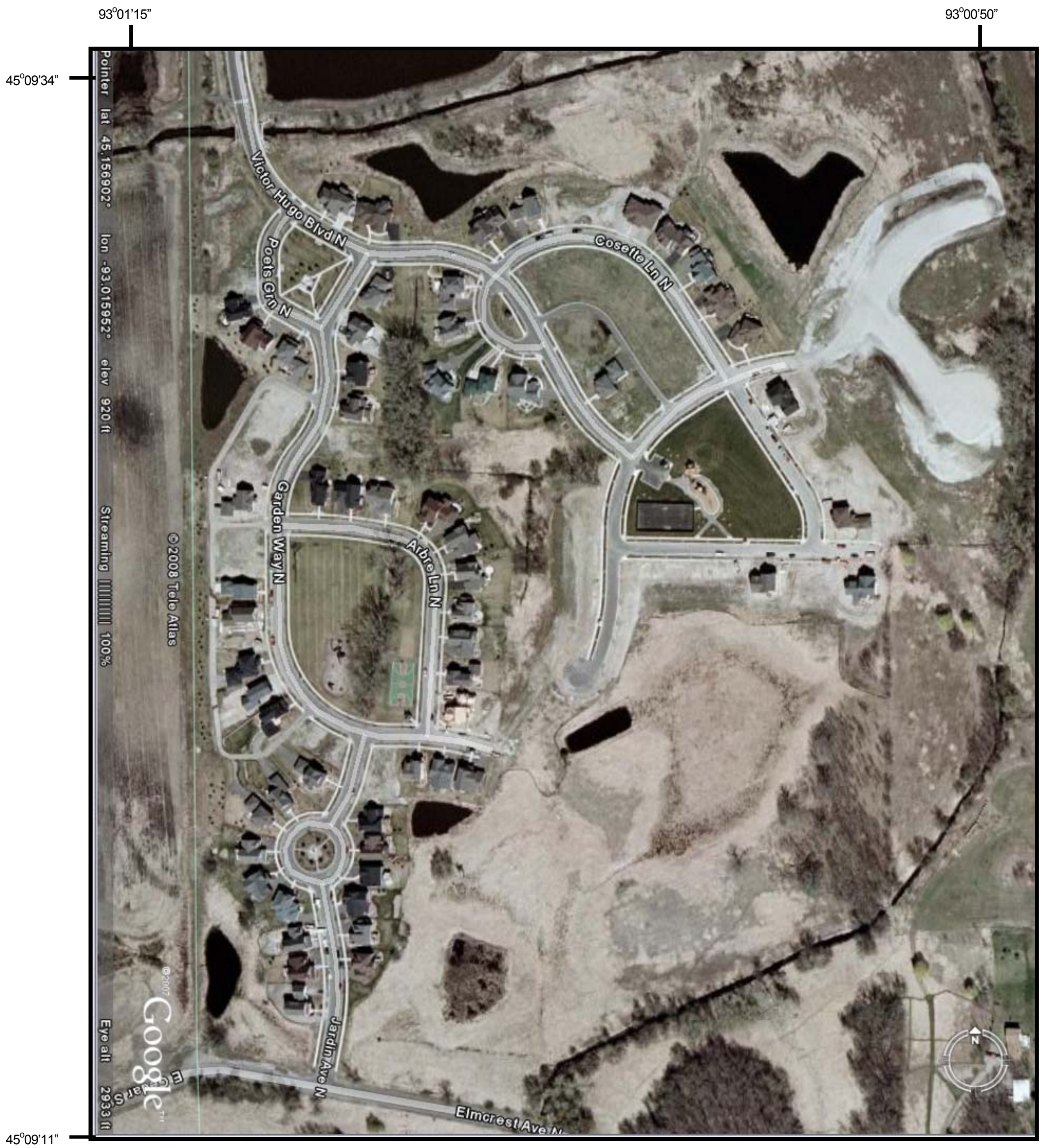

Figure 1 – Victor Gardens Development in Hugo, MN Showing Location of Houses and other features used as Measurement Points

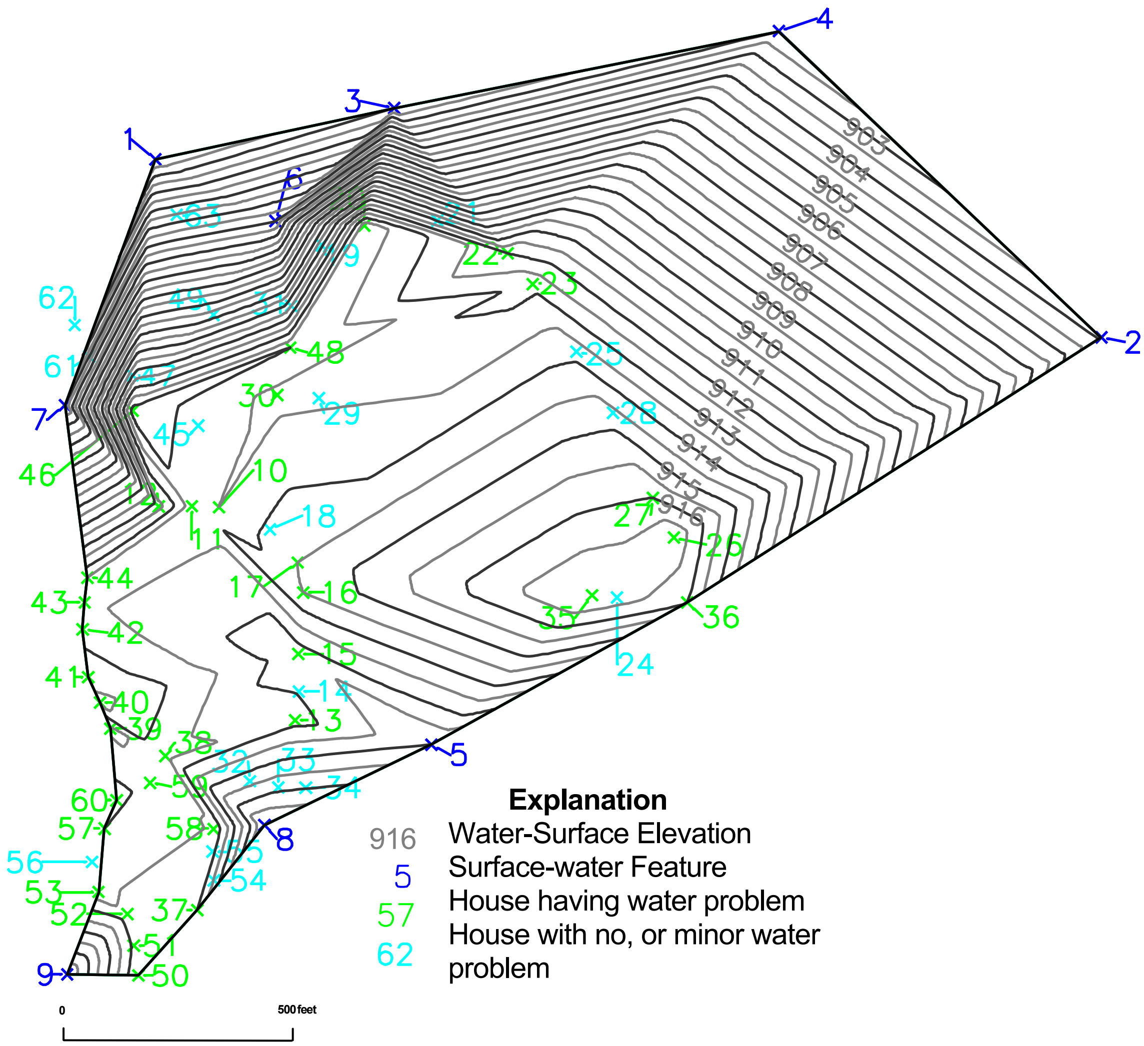

Figure 2 – Computed ground-water surface elevation and control points for Victor Gardens Development, Hugo, MN [number is site identifier in Table 1]

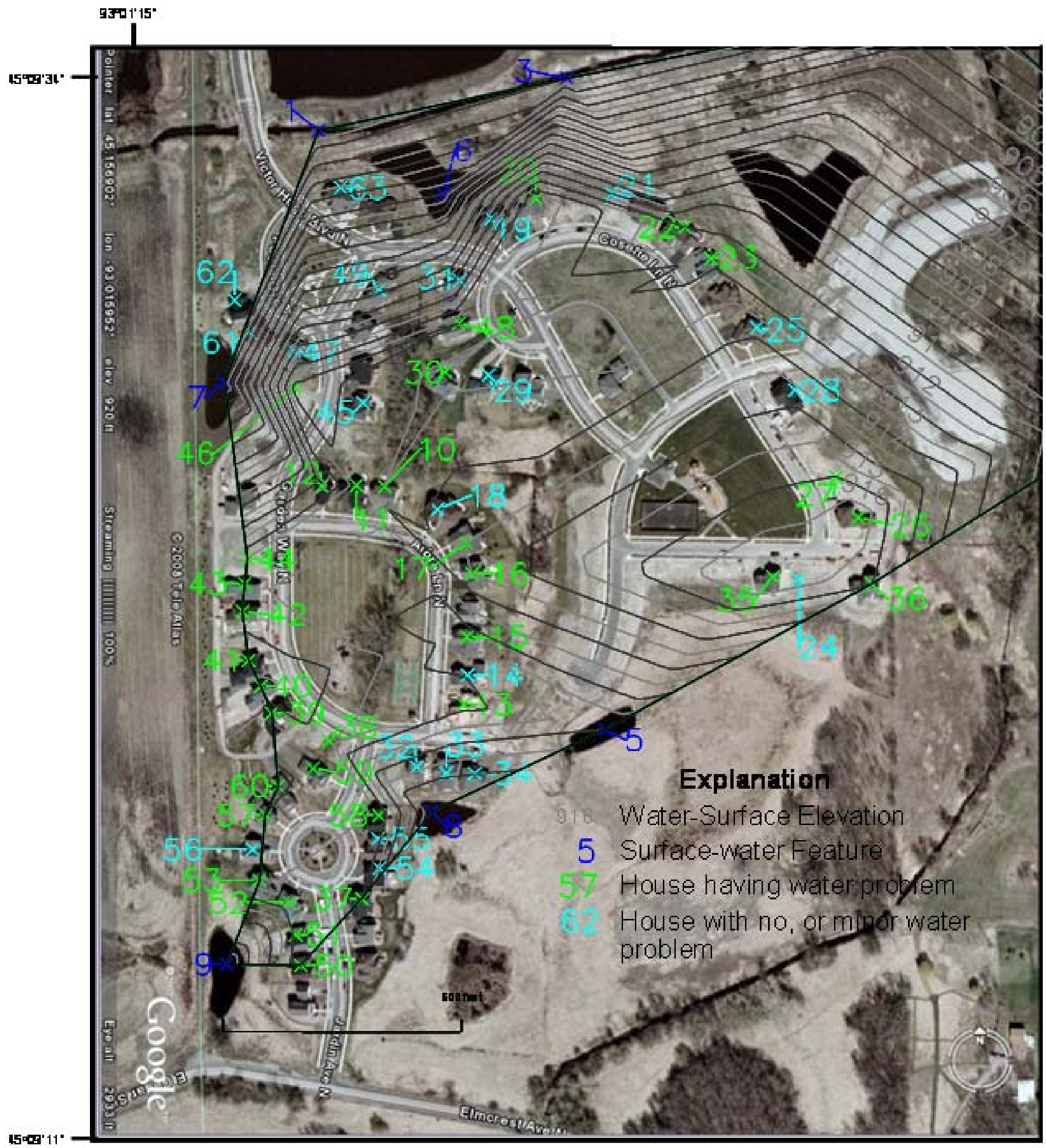

Figure 3 – Ground-water surface elevation projected on map of Victor Gardens Development, Hugo, MN [number is site identifier in Table 1]

Figure 4 – Diagram of foundation-drainage system proposed for the Victor Gardens Development, Hugo, MN