SECTION 1.0
INTRODUCTION

1.1 OVERVIEW AND REPORT PURPOSE

The March 2007 flood caused substantial damages to the City of Browns Valley, Minnesota (the "City") placing severe social and economic hardship on the residents and the community. Unfortunately, the spring 2007 flood is one of several documented floods dating back to the early 1940's that have affected Browns Valley. Although several studies evaluating flood mitigation solutions were completed by a variety of agencies, earlier efforts to implement a permanent flood mitigation project proved unsuccessful.

The City working cooperatively with Traverse County, Minnesota (i.e., the County) intends to plan, design and construct a permanent flood mitigation solution. The City and the County requested technical assistance to evaluate the various permanent flood mitigation solutions from the Upper Minnesota River Watershed District (UMRWD) in August 2007 (see **Appendix A**). The UMRWD agreed to evaluate the various flood mitigation solutions and to assume responsibility for leading the planning, design and construction effort on behalf of the City and the County. The UMRWD retained Houston Engineering, Inc. to provide technical assistance for the completion of the Browns Valley Flood Mitigation Project in August 2007.

The UMRWD initiated a watershed district project in accordance with Minnesota Statute (MS) 103D by majority resolution of the Board of Managers on August 14, 2007. The process described by MS 103D requires the preparation of an "Engineer's Report" (see MS 103D.711). Based upon MS 103D.711 the Engineer's Report must include findings and recommendations about the proposed project, including a determination of whether the Engineer finds the project feasible and a plan for the proposed project. The minimum plan content must include:

- a map of the project area drawn to scale, showing the location of the proposed improvements, if any. The map must include (as applicable):
    - the location and adequacy of the outlet, if the project is related to drainage;

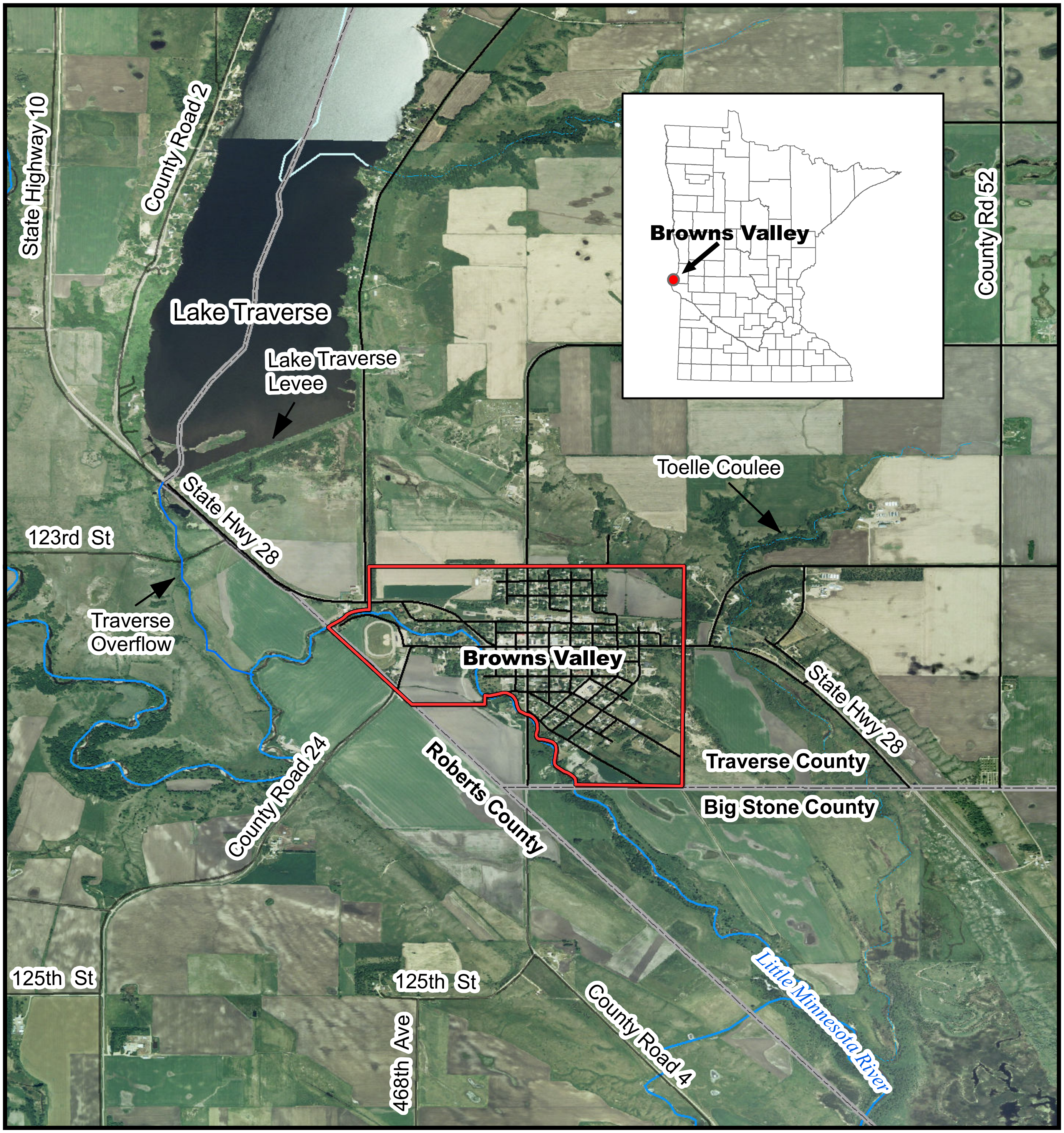
- the watershed of the project area;
- the location of existing highways, bridges, and culverts;
- the property, highways, and utilities affected by the project with the names of the known property owners;
- the location of public land and water affected by the project; and
- other physical characteristics of the watershed necessary to understand the area

- the estimated total cost of completing the project including construction, operation, implementation, supervision, and administrative costs;
- the acreage required as right-of-way listed by each lot and 40-acre tract or fraction of the lot or tract under separate ownership, if required to implement the project; and
- other details and information to inform the Managers of the practicability and necessity of the proposed project with the Engineer's recommendations on these matters.

The Engineer's Report can include additional details at the discretion of the Engineer as needed for the determination of feasibility. This report presents information relevant to the Browns Valley Flood Mitigation Project and serves as the Engineer's Report in accordance with MS 103D.711. Expectations are that following selection of the preferred flood mitigation solution by the Board of Managers, additional more detailed information specific to design, construction and environmental issues will be prepared.

1.2 GENERAL DESCRIPTION OF THE PROBLEM

The City is located within a unique geologic setting, which leads to a heightened susceptibility to flooding. The City is located essentially on a glacial outwash plain, at the continental divide between the Red River of the North and the Minnesota River. The Red River flows north to Lake Winnipeg, whereas the Minnesota River flows to the Mississippi River (which flows south to the Gulf of Mexico). Two water bodies contribute to flooding within the City; i.e., the Little Minnesota River and an unnamed coulee (coined "Toelle Coulee") located just northeast of the City (see **Figure 1-1**).



Legend

Roberts Co. Roads

Traverse County Roads

City Boundary

County Boundary

N
W E
S

0.5 0.25 0 0.5 Miles

Figure 1-1

General Location Map
Browns Valley Flood Mitigation Project

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The origin of both of these water bodies is relatively steep terrain associated with the glacial till plain. The terrain tends to lead to "flashy" streams, with high peak flows that overflow the river channel near Browns Valley. Ice during early spring also contributes to the flood problem by raising the water level sufficient to leave the banks of the Little Minnesota River. Man has also changed the landscape by constructing roads, reservoirs, and changing land uses.

1.3 HISTORY OF FLOODING AND PREVIOUS EFFORTS TO ADDRESS FLOODING

Browns Valley has a long history of flooding. The causes and effects of flooding in the city are many and have changed through time as the watershed has evolved. Many documents exist; addressing flooding issues as they are related to the regional geology, hydrology, topography, and infrastructure (see **Appendix B**). This section provides a general description of historical and physical flooding issues in Browns Valley, as well as previous efforts to address flooding.

1.3.1 General Description of Historic Flooding

The Little Minnesota River discharges into Big Stone Lake which is controlled by Big Stone Dam. Big Stone Lake is the headwaters of the Minnesota River. The Little Minnesota River also passes within approximately 800 yards of Lake Traverse, which outlets to the Bois de Sioux River, which along with the Ottertail River forms the headwaters for the Red River of the North[1]. Following the last ice age, Glacial Lake Agassiz drained south for a period through the Glacial River Warren. This river formed the valley of the Minnesota River and the beds of Lake Traverse and Big Stone Lake. The valley of the River Warren is about 1 mile wide and 130 feet deep near Browns Valley. The Little Minnesota River flows from the coteau in South Dakota to Big Stone Lake, and the river flows through the valley of the River Warren from near Browns Valley to Big Stone Lake. Where the Little Minnesota River enters the valley of the River Warren the channel slope decreases from about 8 feet per mile (near the Peaver Gage) to about 2

[1] Report: Browns Valley Dike, History and Potential for Interbasin Flow. Kenton Spading, U.S. Army Corps of Engineers, July 1999, Revised January 2000.

feet per mile near Browns Valley. Over time an alluvial fan has developed where the Little Minnesota River enters the valley of the River Warren.

Floodwaters from the Little Minnesota River have historically overflowed on the alluvial fan[2] area at the Valley entrance west of Browns Valley. This alluvial fan has developed over thousands of years where the Little Minnesota River enters the glacial outwash channel (Glacial River Warren). Some overflows go south and others north across the continental divide and into Lake Traverse. High water in Lake Traverse can also cause water to discharge the opposite way into the Little Minnesota River in rare instances.

Floods on the Little Minnesota River have historically resulted from excessive spring snowmelt runoff—often occurring along with ice jams on the river, and from runoff stemming from intense summer rainfalls. **Table 1-1** lists recorded historic floods in Browns Valley and corresponding peak discharges at the USGS gage near Peever, South Dakota.

Another potential source of flooding is Toelle Coulee, located northeast of Browns Valley. The city experienced serious flooding in June 1965, which resulted from a critical combination of meteorological conditions. During the evening of June 1, 1965, the Lake Traverse area received 4 to 10 inches of rainfall in about one hour. Within the Toelle Coulee watershed, ½ inch of rain fell at about 5 P.M. (saturating the soil). A very intense rainstorm occurred later in the evening from 8:00 to 8:45 P.M. Total rainfall depths within the Toelle Coulee watershed were 3.75 to 5.0 inches. The resulting runoff flowed across saturated ground into the coulee and was impounded to a depth of about 25 feet upstream from the County Highway 2 crossing, at which point it overflowed into the west ditch of the highway and discharged down into the eastern portion of the village.[3]

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[2] Alluvial fans are fan-shaped deposits of water-transported material (alluvium).

[3] Section 205, Flood Control Reconnaissance Report. Unnamed Coulee at Browns Valley, Minnesota. U.S. Army Corps of Engineers, St. Paul District, January, 1966.

Table 1-1

Historic Floods in Browns Valley

Year	Peak Flow (cfs)[4]	Month	Flood influenced by icejams
1943	4,320	March	No
1952	4,730	April	No
1962	3,140	May	No
1965	2,920	June	No
1969	3,270	April	No
1989	N/A	Spring	Yes
1993	N/A	Spring	Yes
1993	8,900	July	No
1995	2,700	March	Yes
1997	3,590	March	Yes
2001	3,180[5]	April	No
2007	4,467[6]	March	Yes

1.3.2 Previous Efforts to Address Flooding

The following paragraphs describe some of the major efforts to address flooding by modifying the natural drainage pattern of the Little Minnesota River. Some of these efforts were very beneficial to their targeted areas, but some also came along with side effects which caused increased flooding risk elsewhere.

1.3.2.1 Browns Valley Dike

One of the most significant infrastructure improvements in the region was the construction of the Browns Valley Dike in 1941. The dike is located on the southern end of Lake Traverse. The dike was part of the Lake Traverse Flood Control Project, a flood control

[4] Browns Valley Dike, History and Potential for Interbasin Flow. Kenton Spading, U.S. Army Corps of Engineers, July 1999, Revised January 2000.
[5] USGS National Water Information System: http://waterdata.usgs.gov/nwis.
[6] Estimated from a single measured high water mark and the existing USGS rating curve.

and water conservation project which also included the construction of Reservation Dam and White Rock Dam. The purpose of the dike was to prevent water from the reservoir from spilling into the Little Minnesota River during an extremely high pool level.[7]

Prior to the construction of the Brown's Valley Dike, floodwaters from the Little Minnesota River could overflow the continental divide and spill northwest into Lake Traverse. However, soon after the construction of the dike in late March and early April of 1943, a large flood occurred on the Little Minnesota River. This flood resulted from the rapid melting of snow and ice jams formed just upstream of Browns Valley. Water overflowing the left bank of the Little Minnesota River discharged toward the north, and unable to follow the natural historical discharge path to Lake Traverse, overtopped Minnesota State Highway No. 28 (TH 28). After crossing this highway, the water was prevented from discharging in to Lake Traverse by the Browns Valley Dike, which caused ponding in the areas south of the dike until the water level overtopped Minnesota State Highway No. 27 (TH 27) to the east. From here the water followed low areas in the north and east part of Browns Valley where it was ponded behind the Great Northern Railway and TH 28, flooding many homes. Not long after this flood, three concrete box culverts were placed through the dike to restore the natural flow path.[8]

1.3.2.2 Raising of Roberts County Road No. 24 (Roberts CR 24)

Another infrastructure project affecting the flood mechanism in the region included the raising of the Roberts County Road No. 24 (Roberts CR 24) (Dakota Street) about 18 inches by the County Highway Department (occurring at unknown *time* prior to 1972). A levee was also constructed beside the Little Minnesota River at the point just upstream of Browns Valley where the river emerges onto the outwash plain. This levee was intended to prevent overbank discharge from damaging the improved road. Before the raising of this road, a significant portion of the flood discharge on the Little Minnesota River could overtop the roadway and discharge southeast to rejoin the river channel downstream of Browns Valley, via the natural overland drainage

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[7] Browns Valley Dike, History and Potential for Interbasin Flow. Kenton Spading, U.S. Army Corps of Engineers, July 1999, Revised January 2000.
[8] Review of Report. Minnesota River, Minnesota for Diversion of Floodwaters of Little Minnesota River into Lake Traverse. War Department, United States Engineer Office, St. Paul, Minnesota. 17 September 1945.

system, effectively bypassing the village. Raising the road reduced the frequency of flood discharges which follow this natural bypass, and as a result, increased the extent of flooding to agricultural lands both north and west of the raised road and within the village.[9]

1.3.2.3 Agricultural Levees

Between 1943 and 2007, most of the flooding impacted the southwest side of the City. In both 2007 and 1943, the flood primarily impacted the north side of the city. However, in the 2007 flood caused by an ice jam on the river near the state line west of Browns Valley, significantly more water broke out to the north and exceeded the capacity of the 3 - 9' x 6' culverts leading into Lake Traverse. As in 1943, without the culverts the excess water overtopped both TH 28 and TH 27, and then proceeded to flood the north side of the city, overtopping Traverse County Highway No. 4 (Traverse CSAH 4) and TH 28 again on the east side of town. Some believe that more discharge broke out to the north rather than the south because of the influence of agricultural levees, which flank both sides of the Little Minnesota River in South Dakota. Higher levees on the south side may have caused more water to flow north.[10]

1.3.2.4 Traverse County Highway No. 4 (Traverse CSAH 4) Improvements

Traverse CSAH 4 was modified in the year of 2000. Construction included the replacement of an overland flood discharge opening and a grade re-alignment. The road was modified to create a lower sag curve to convey flood discharges at a lower elevation.

1.3.2.5 Toelle Coulee Improvements

A 1995 document indicates that the conditions along Toelle Coulee have changed since the 1965 flood, and that at the time the document was written, the coulee had not experienced

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[9] Memo for Record. Flood Emergency in Browns Valley, Minnesota. Thomas Raster, Planning Branch, Engineering Division. U.S. Army Corps of Engineers. 20 March, 1972.
[10] Report: Spring Flood 2007, Browns Valley, Minnesota. JOR Engineering, Inc. May 15, 2007.

flooding since 1965. Traverse County Highway No. 2 (Traverse CSAH 2) had been raised and realigned.[11]

[11] Post Ice Jam Flood Field Trip Report, Little Minnesota River at Browns Valley, MN, Richard Pomerleau, P.E., U.S. Army Corps of Engineers, St. Paul District, March 28, 1995.