Attachment 2 – Cemetery Mitigation Study

FMM Draft Cemetery Mitigation Plan

June 2015

Main Report
Appendix A – USACE Mitigation Study dated June 2014
Appendix B – Cemetery Parcel Maps
Appendix C – Historic Inundation Maps
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FLOOD DIVERSION AUTHORITY

05/19/2015

Cemetery Mitigation Study

Fargo-Moorhead Metro Area Flood Risk Management Project

Report

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Background

The Fargo-Moorhead Metropolitan Area Flood Risk Management Project (Project) consists of a 30 mile long diversion channel and a 6 mile long connecting channel. The Project will reduce the flood risk from the Red, Wild Rice, Sheyenne, Maple, Rush, and Lower Rush Rivers for the cities of Fargo and Moorhead, as well as surrounding communities. The Project will also utilize a staging area upstream of the diversion channel that is designed to temporarily store flood waters during various flood events. The Project and staging area will only operate for floods that exceed the 10-percent chance flood event.

1. Cemetery Mitigation Study

1.1 Purpose

The purpose of this report is to provide mitigation alternatives for eleven cemeteries that are upstream of the Project and are impacted by Project operations through increased peak water surface elevation, increased flooding duration, or both. The evaluation of these cemetery properties includes feasibility level layout of alternatives and preliminary cost estimates for each alternative at each cemetery site. This report will document the assessment process and detail the potential mitigation alternatives for each of the eleven cemetery sites.

2. Mitigation Alternatives

This analysis establishes a baseline, identifies problems, and assesses mitigation alternatives for each cemetery. The parameters used to formulate the mitigation alternatives include the existing site conditions, the impacts of staged water to the site, and overall feasibility of the plan. The impacts of staged water due to the Project at each site were evaluated in order to produce an understanding of each unique site. The impacts include the increase in water surface elevation, increase in the duration of flooding, impacts caused by debris, and unstable bank slopes. Access into the cemetery site as well as access to the cemetery site from adjacent township, county, state and/or federal highways was also evaluated. The impacts were evaluated for existing and with Project conditions.

Extensive hydrologic and hydraulic modeling has been conducted for the Project. The resulting water surface elevations at each of the eleven cemetery sites have been determined. Appendix B shows the existing and with-project water surface elevations at each of the eleven cemetery sites for several statistical flood events. These maps also provide the duration of flooding for each event. Where alternatives include berms, berms are designed to provide one foot of freeboard above the project's 1 or 0.2-percent chance flood event water elevation, whichever is higher.

Appendix C provides flood imagery for each of the cemetery sites from either the 1997 or 2009 spring flood events. These maps help to demonstrate the existing flood threat at each cemetery.

Cemetery representatives have identified their level of service expectations during site visits with the USACE, Local Sponsors, and the project's consultants. The considerations identified as most important by the cemetery representatives include obtaining flood protection and the desire to prevent any disruption of the cemetery services during flood events. These two guidelines were used to set criteria, screen options, and determine feasible alternatives.

3. Cemetery Sites

The cemeteries included in this assessment are located upstream of the Project, in and upstream of its staging area. The staging area encompasses property where the 1-percent chance flood event water surface elevation will be increased by 1 foot or greater by the Project. This is located south of Fargo and Moorhead along the Wild Rice River, the Red River and Wolverton Creek. Of the eleven cemeteries included in this assessment, seven are located within the staging area and four are upstream of the staging area. See Figures 1 and 2 in Appendix E.

The eleven cemeteries analyzed for the report have been grouped based on their local watershed. Three cemeteries are located on or near the Wild Rice River, six are located on or near the Red River, and the remaining two are located on or near Wolverton Creek.

A site survey will be necessary to evaluate and identify unmarked grave sites that lie in the proposed alternative alignment or footprint of any improvements prior to any implementation. Ground penetrating radar will likely be used to assist in locating unmarked grave sites. Also considered will be any environmental mitigation costs that the proposed improvements will incur. By measuring the area impacted and setting mitigation cost as a function of area, a replacement ratio of 2:1 was used. All alternatives have been screened to minimize these impacts. Some of the unavoidable impacts have been identified and a cost consideration has been included in Appendix F.

3.1 Wild Rice River

3.1.1 Site 1 - North Pleasant Cemetery

The North Pleasant Cemetery is a 2.83 acre parcel (pin no. 57000010375020) located in the S half of the SE quarter of the SW quarter of Section 27, Township 137 North, Range 49 West, Pleasant Township, Cass County, North Dakota. Based on the legal description from the Cass County Government 2013 Parcel Information web site, the North Pleasant Cemetery parcel measures 196 feet north-south by 627 feet east-west. It is bounded by a cultivated field on the west, north and east, and by a gravel road, 53rd Street SE, on the south. An overhead power line parallels the road along the cemetery side of road's north ditch. According to the NRCS's Web Soil Survey, soil at and near the cemetery consists of Fargo silty clay, 0 to 1 percent slopes.

Vegetation in the cemetery consists of mown lawn grass with a multi-row windbreak of deciduous trees on the north and east sides and a single row of conifers on the west side of the cemetery. A large deciduous tree stands in the middle of the western quarter of the cemetery. There are upright, beveled, flat and unmarked monuments. A wrought iron arch bearing the cemetery's name ("NORTH PLEASANT") faces the gravel road. There is no vehicle access point into the cemetery from the road. This active cemetery contains approximately 360 graves. The church formerly at this location was moved to Hickson, North Dakota in the early 1940s. An unmarked grave of a suicide victim outside the formal cemetery was reported but not confirmed.

Ground surface elevation in the cemetery is approximately 921.0 feet throughout, with areas of 920.0 feet to the west and northwest. For modeled existing conditions, there is no flooding for the 10 percent event; for the 2 percent event there will be a peak water surface elevation of 920.1 feet; for the 1 percent event there will be a peak water elevation of 920.7 feet; and for the 0.2 percent event there will be a peak water surface elevation of 921.6 feet. Based on existing conditions modeling, there will be no flooding at the cemetery for the 10 percent, 2 percent and 1 percent events. Flooding does not occur until somewhere between the 1 percent and 0.2 percent events, when the peak water surface elevation reaches 921.0 feet and the entire cemetery will be flooded. For the 0.2 percent event there would be water above the 921.0 feet elevation for 3.5 days.

Based on aerial photography taken during the 1997 flood event, there was no flooding in the North Pleasant Cemetery. Aerial photography taken during the March 2009 flood event shows floodwater near the cemetery's north side in a low area in the agricultural field, but none in the cemetery. Because the cemetery has not previously flooded, no post-flood clean-up has been necessary. Two burials have been removed from this cemetery due to uncertainty of future flooding connected with the Project.

For the Project in place, the 10 percent event modeled the peak water surface elevation to be less than 921.0 feet and there would be no flooding same as existing conditions. For the 2 percent event, the water surface elevation would be above 921.0 feet for a duration of 3 days with a peak elevation of 921.6 feet; an increase in duration of 3 days and an increase in peak elevation of 1.5 feet over the existing conditions. For the 1 percent event, the peak water surface elevation would be above 921.0 feet for a duration of 5 days with a peak elevation of 922.4 feet; an increase in duration of 5 days and an increase in peak elevation of 1.7 feet over the existing conditions. For the 0.2 percent event, the peak water surface elevation would be above 921.0 for a duration of 6 days with a peak elevation at 922.6 feet; an increase in duration of 2.5 days and an increase in peak elevation of 1.0 feet over the existing conditions.

As under existing conditions, the cemetery would not flood during the 10 percent event. For the 2 percent and 1 percent events, however, there would be 0.6 to 1.4 feet of flooding for 3 to 5 days with the Project in place where there is none under existing conditions. Maximum increase in water surface elevation with the Project in place would be 1.7 feet depth and maximum additional duration would be 5 days more than that experienced under existing conditions.

Table 1. North Pleasant Cemetery Synthetic Flooding Data

Return Frequency	Existing Conditions		With Project	
	Peak Water Elevation	Duration (Days) of WSEL Above Natural Ground	Peak Water Elevation	Duration (Days) of WSEL Above 921.0'
10 percent	No flooding		No flooding	
2 percent	920.1	0	921.6	3
1 percent	920.7	0	922.4	5
0.2 percent	921.6	3.5	922.6	6
Note: 921.0 is the approximate lowest site elevation				
All Hydraulic Data Taken from Phase 7 HEC-RAS Models March 2013				

THE FIRST ALTERNATIVE evaluated was a ring berm surrounding the cemetery to minimize impacts from staged water. A feasibility level berm layout is included in Appendix D, Site Plan #1 drawing. A typical berm section drawing is included at the end of Appendix D. The configuration of this berm has an average height of 3 feet, a maximum height of 3.5 feet, a crest width of 4 feet and 3H:1V side slopes. The design further address the concerns highlighted herein and subsequent challenges resulting from site specific constraints.

EXTERIOR FLOOD CONTROL

The township road on the south will be raised as part of the ring berm to enclose the site. The ring berm will be generally 4 foot in height and has a 28 foot base footprint. The road will be elevated to the protected level and transition at a 2 percent grade back to the existing road elevation. The berm will be located a minimum of 20 feet from trees surrounding the cemetery and drainage will be redirected around the north side of the berm

from east to west. Access to the cemetery will require minimal re-grading because the township road at the existing access point will be subject to a minimal raise.

INTERIOR FLOOD CONTROL

The components of the interior flood control include a ditch parallel to and inside the berm, gated outlet appurtenances, and pump system. The drainage from inside the ring berm will be collected by shallow ditches parallel to the ring berm. These interior ditches will convey the interior drainage to a culvert located near the northwest corner of the cemetery. The drainage outlet will include provisions to close the culvert during flood events as well as a pump station to allow pumping of runoff during flood events when the outlet would be prevented from draining by gravity.

Two options for pump stations have been included in the analysis; one with a wet well in which a portable pump would be installed and operated during flood events, and a second with a permanent automated pump station. For the purpose of this report, the wet well and portable pump option has been considered the base option and the automated pump station has been considered the alternate option.

OPTIONAL ACCESS TO SITE

The current roads accessing the site will be inundated during some flood events. An option to provide access to the site during flood events would require raising approximately 2 miles of gravel township roads that connect to Interstate 29. There will be a range of 0 to 2.5 feet rise in grade for the optional access path. Appendix E shows this route. It is anticipated there will be utility coordination and relocation, temporary construction easements and permanent right of way acquisitions, water crossing extensions, and reconstruction and road raising. An estimate of the costs was produced for the optional access assuming a roadway centerline elevation of one foot above the Project 1-percent chance flood event water surface elevation. The cost estimate for the road raises necessary to maintain access to the site during a flood is included in Appendix F.

It should be noted that raising roads within the staging area may impact hydraulics during some flood events. The access improvements do not include provisions for allowing additional conveyance under raised roadways. In the case of the North Pleasant Cemetery, an analysis of the Phase 7 HEC-RAS model results show that raising roads to access the cemetery during floods may impact water surface elevations in the area.

THE SECOND ALTERNATIVE does not prevent floodwaters from inundating the cemetery but instead allows the event to occur. Two structural measures are utilized for this alternative. The first will be to incorporate a fence that is structurally capable of preventing potential damaging floodwater debris from impacting the headstones or entering the site. The second measure is to anchor the upright monuments (headstones), which would provide increased resiliency from potential debris flowing within the floodwaters.

There are upright, beveled, flat and unmarked monuments. Aerial imagery was used to categorize the total grave sites into upright or beveled and flat. Since the upright or beveled monuments both cast a shadow an accurate differentiation could not be determined.

The protection of the upright monuments is the focus for this alternative. It should be noted that this alternative may not be warranted if the floodwaters are not deep enough to transport the potential damaging debris. Regardless, there were two options considered for the fence alternative. Option 1 looked at providing one foot of protection above the upright monuments up to five feet in height. Option 2 looked at providing one foot of protection above the estimated high water surface elevation for the 0.2 percent chance flood event.

Option 1 will provide equal protection from any flood event, whereas option 2 will only provide protection up to the estimated high water elevation.

Both options will consider standard fence heights of 4, 7 and 8 feet. Minor earthwork grading will be necessary along the fence alignment in order to maintain the protection elevation, and maintain positive drainage at the cemetery. An iron fence was used for this alternative and assumed to be cast iron.

For the fence alternative option 1, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at a uniform elevation with a minimum vertical clearance of one foot above all upright monuments. The fence will be the barrier that prevents any potential damaging debris from entering the cemetery until the water level is one foot above the tallest upright monument where the debris would safely float by with no impact to the monuments.

For the fence alternative option 2, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at or above a determined elevation for the site, which is one foot above the estimated high water surface elevation for the 0.2 percent chance flood event. The fence will be the barrier that prevents any potential damaging debris from entering the site.

Anchoring the upright monuments should consist of evaluating the existing stability of the upright monuments and determine any needed measures to maintain stability during a flood event. The upright monuments likely consist of a soil or concrete foundation; a base usually is made of granite, bronze or concrete; and the upright section, which is commonly referred as a die. It is common practice that the die will be pinned and or glued to the base as the type of anchoring system in place in order for the monument to be upright. The approach for this alternative will assume that there is no existing anchoring system in place, while the new anchoring system will consist of incorporating four 30-inch long dowel bars and concrete. This anchoring system of the die is similar to current practices.

3.1.2 Site 2 - South Pleasant Cemetery

The South Pleasant Cemetery (also known as the Lium Cemetery) is an approximately 1.25 acre parcel (pin no. 2000000399000) located in the NE quarter of the NE quarter of the NE quarter of the NW quarter of Section 22, Township 136 North, Range 49 West, Walcott Township, Richland County, North Dakota. The cemetery parcel is approximately 180 feet north-south by 210 feet east-west. It is bounded by an agricultural field on the west, south and east, and by a gravel road, 57th Street SE, on the north. There is a shallow ditch between the road and the cemetery. According to the NRCS's Web Soil Survey, soils in the cemetery and the adjacent field are Fargo silty clay, 0 to 1 percent slopes.

Vegetation in the cemetery consists of mown lawn grass with a line of conifer trees along its south edge, and scattered conifers along the east, north and west edges, plus several in the cemetery's interior. The entrance to the cemetery is marked by an arched metal pipe entranceway labeled "SO. PLEASANT & CHRISTINE", with a pedestrian gate on either side, all of which is connected to the chain link fence which surrounds the cemetery. The entrance arch is flanked by two mature conifer trees. This cemetery contains at least 80 graves. This site has upright, beveled, flat and unmarked monuments. There are no buildings at the cemetery.

Ground surface elevations in the cemetery range from a low of 923.0 feet in the northwest corner to a high of 925.0 feet along the east and south sides. Most of the cemetery is in the 923-924 foot range. For modeled existing conditions, the 10 percent event peak water elevation is 921.5 feet; the 2 percent event peak water elevation is 925.6 feet; the 1 percent event peak water elevation is 927.0 feet; and the 0.2 percent event peak

water elevation is 928.0 feet. Based on existing conditions modeling, there is no flooding for the 10 percent event. Much of the cemetery is flooded to a 2.6 foot depth during the 2 percent event. All of the cemetery is flooded during the 1 percent and 0.2 percent events, to depths of up to 4.0 feet and 5.0 feet, respectively. The duration of flooding ranges from 5.5 days for the 2 percent event, to 7.5 days for the 1 percent event, to 10 days for the 0.2 percent event.

Based on aerial photography taken during the 1997 flood event, water from the nearby drainage to the west backed up the road ditch and flooded the northwest corner of the cemetery. The road itself was underwater west of the cemetery. Aerial photography taken during the March 2009 flood event shows less backup of water into the cemetery from the road ditch.

For the Project in place, the 10 percent event modeled the peak water surface elevation to be less than 923.0 feet and there will be no flooding same as existing conditions. For the 2 percent event, the water surface elevation would be above 923.0 feet for a duration of 6.5 days with a peak water surface elevation at 925.7 feet; an increase in duration of 1 day and an increase in peak elevation of 0.1 feet compared to the existing conditions. For the 1 percent event, the water surface elevation would be above 923.0 feet for a duration of 8 days with a peak water surface elevation at 927.0 feet; an increase in duration of 0.5 days and no change in peak elevation compared to the existing conditions. For the 0.2 percent event, water surface elevation would be above 923.0 feet for a duration of 10 days with a peak water surface elevation at 928.0 feet; an increase in duration of 0.5 days and no change in peak elevation compared to the existing conditions.

Except for a negligible water depth increase of 0.1 foot for the 1 percent event, there would be no difference between existing conditions and with the Project in place. Duration of flooding is the same both with and without the Project in place.

Table 2. South Pleasant Cemetery Synthetic Flooding Data

Return Frequency	Existing Conditions		With Project	
	Peak Water Elevation	Duration (Days) of WSEL Above Natural Ground	Peak Water Elevation	Duration (Days) of WSEL Above 923.0’
10 percent	921.5	0	921.5	0
2 percent	925.6	5.5	925.7	6.5
1 percent	927.0	7.5	927.0	8
0.2 percent	928.0	10	928.0	10.5
Note: 923.0 is the approximate lowest site elevation				
All Hydraulic Data Taken from Phase 7 HEC-RAS Models March 2013				

THE FIRST ALTERNATIVE evaluated was a ring berm surrounding the cemetery to minimize impacts from staged water. A feasibility level berm layout is included in Appendix D, Site Plan #2 drawing. A typical berm section drawing is included at the end of Appendix D. The configuration of this berm has an average height of 5 feet, a maximum height of 7 feet, a crest width of 6 feet and 3H:1V side slopes. The design addressed the concerns highlighted herein and subsequent challenges resulting from site specific constraints.

EXTERIOR FLOOD CONTROL

The township road on the north boundary of the cemetery will be raised as part of the berm to enclose the site. The road will be elevated to the protected level and transition at a 2 percent grade back to the existing road elevation. All construction is located a minimum of 20 feet from trees surrounding the cemetery and drainage will be redirected around the south side of the berm from east to west. Access to the cemetery will require some re-grading because the township road at the existing access point will be subject to a significant raise.

INTERIOR FLOOD CONTROL

The components of the interior flood control include a ditch parallel to and inside the berm, gated outlet appurtenances, and pump system. The drainage from inside the ring berm will be collected by shallow ditches parallel to the ring berm. These interior ditches will convey the interior drainage to a culvert located near the southwest corner of the cemetery. The drainage outlet will include provisions to close the culvert during flood events as well as a pump station to allow pumping of runoff during flood events when the outlet would be prevented from draining by gravity.

Two options for pump stations have been included in the analysis, one with a wet well in which a portable pump would be installed and operated during flood events and a second with a permanent automated pump station. For the purpose of this report, the wet well and portable pump option has been considered the base option and the automated pump station has been considered the alternate option.

OPTIONAL ACCESS TO SITE

Access to the site during flood events could be maintained by improving approximately 2.5 miles of gravel township roads between the site and Interstate 29. There will be a range of 0 to 3.0 feet rise in grade for the optional access path (Appendix E). It is anticipated there would be utility coordination and relocation, temporary construction easements and permanent right of way acquisitions, water crossing extension or reconstruction and road raising. An estimate of the costs was produced for the optional access assuming a roadway centerline elevation of one foot above the Project 1-percent chance flood event water surface elevation. The cost estimate for the road raises necessary to maintain access to the site during a flood is included in Appendix F

It should be noted that raising roads may impact hydraulics during some flood events. The access improvements do not include provisions for allowing additional conveyance under raised roadways. In the case of the South Pleasant Cemetery, an analysis of the Phase 7 HEC-RAS model results show that raising roads to access the cemetery during floods may impact water surface elevations in the area.

THE SECOND ALTERNATIVE does not prevent floodwaters from inundating the cemetery but instead allows the event to occur. Two structural measures are utilized for this alternative. The first will be to incorporate a fence that is structurally capable of preventing potential damaging floodwater debris from impacting the headstones or entering the site. The second measure is to anchor the upright monuments (headstones), which would provide increased resiliency from potential debris flowing within the floodwaters.

There are upright, beveled, flat and unmarked monuments. Aerial imagery was used to categorize the total grave sites into upright or beveled and flat. Since the upright or beveled monuments both cast a shadow an accurate differentiation could not be determined.

The protection of the upright monuments is the focus for this alternative. It should be noted that this alternative may not be warranted if the floodwaters are not deep enough to transport the potential damaging

debris. Regardless, there were two options considered for the fence alternative. Option 1 looked at providing one foot of protection above the upright monuments up to five feet in height. Option 2 looked at providing one foot of protection above the estimated high water surface elevation for the 0.2 percent chance flood event. Option 1 will provide equal protection from any flood event, whereas option 2 will only provide protection up to the estimated high water elevation.

Both options will consider standard fence heights of 4, 5, 6, 7, 8, and 10 feet. Minor earthwork grading will be necessary along the fence alignment in order to maintain the protection elevation, and maintain positive drainage at the cemetery. An iron fence was used for this alternative and assumed to be cast iron.

For the fence alternative option 1, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at a uniform elevation with a minimum vertical clearance of one foot above all upright monuments. The fence will be the barrier that prevents any potential damaging debris from entering the cemetery until the water level is one foot above the tallest upright monument where the debris would safely float by with no impact to the monuments.

For the fence alternative option 2, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at or above a determined elevation for the site, which is one foot above the estimated high water surface elevation for the 0.2 percent chance flood event. The fence will be the barrier that prevents any potential damaging debris from entering the site.

Anchoring the upright monuments should consist of evaluating the existing stability of the upright monuments and determine any needed measures to maintain stability during a flood event. The upright monuments likely consist of a soil or concrete foundation; a base usually is made of granite, bronze or concrete; and the upright section, which is commonly referred as a die. It is common practice that the die will be pinned and or glued to the base as the type of anchoring system in place in order for the monument to be upright. The approach for this alternative will assume that there is no existing anchoring system in place, while the new anchoring system will consist of incorporating four 30-inch long dowel bars and concrete. This anchoring system of the die is similar to current practices.

3.1.3 Site 3 - South Pleasant Church Cemetery

The South Pleasant Church Cemetery is an approximately 1.4 acre parcel (pin no. 2000000391100) located in the SW quarter of the SW quarter of the SE quarter of Section 21, Township 136 North, Range 49 West, Walcott Township, Richland County, North Dakota. The cemetery parcel is approximately 221 feet north-south by 268 feet east-west. It is bounded on the west by the churchyard, on the north by an agricultural field, on the east by a tributary drainage to the Wild Rice River, and on the south by a gravel road, 58th Street SE. According to the NRCS's Web Soil Survey, soils in the cemetery and churchyard are both Fargo silty clay, 0 to 1 percent slopes. Soils in the drainage to the east are Cashel-Fluvaquents, channeled complex, and wooded, 0 to 35 percent slopes, frequently flooded.

Vegetation in the cemetery consists of mown lawn grass with a line of deciduous trees on its north side continuing westward to the line of trees on the west side of the churchyard. The drainage to the east contains both brush and trees. A black chain link fence surrounds the cemetery and churchyard, with the entryway to both through a squared arch labeled "SOUTH PLEASANT" leading to a concrete walkway to the church steps. This active cemetery contains 50 to 100 graves. Headstones include both vertical monuments and horizontal slabs. Services are no longer held at the church.

Ground surface elevations in the cemetery ranges from approximately 927.0 feet at its eastern edge to approximately 930.5 feet in the southwest quarter. For modeled existing conditions, the 10 percent event peak water elevation will be 922.4 feet; the 2 percent event peak water elevation will be 926.9 feet; the 1 percent event peak water elevation will be 928.2 feet; and the 0.2 percent event peak water elevation is 929.3 feet. The cemetery is not flooded during the 10 percent event. The eastern edge of the cemetery is flooded with 0.9 feet of water for less than 4 days during the 2 percent event. The eastern third of the cemetery is flooded with 2.2 feet of water for 4 days during the 1 percent event. The east half and much of the northwest quarter of the cemetery is flooded with 3.3 feet of water for 7 days during the 0.2 percent event.

Based on aerial photography taken during the 1997 flood event, most of the eastern third of the cemetery was inundated with water from the adjacent drainage. The access road to the cemetery was also inundated where it crossed that drainage and another drainage west of the cemetery. Aerial photography taken during the March 2009 flood event shows flooding only in the cemetery's southeast corner, estimated at 927.0 to 928.0 feet elevation. Past impacts on the cemetery due to flooding include damage to the grass, tipping of headstones, and loss of access. Post-flood restoration has included having the monument company come out and reset monuments on their concrete footings.

For the Project in place, the 10 percent event modeled the peak water surface elevation to be less than 927.0 feet and there would be no flooding same as existing conditions. For the 2 percent event the peak water elevation is at 926.9 feet with no flooding same as existing conditions. For the 1 percent event the water surface elevation will be above 927.0 feet for duration of 4 days, with a peak water surface elevation at 928.3 feet; no change in duration and an increase in peak elevation of 0.1 feet compared to the existing conditions. For the 0.2 percent event the water surface elevation will be above 927.0 feet for a duration of 7.5 days with a peak water surface elevation at 929.3 feet; an increase in duration of 0.5 days and no change in peak elevation compared to existing conditions.

Except for a negligible increase of 0.1 foot depth for the 1 percent event, there would be no difference between existing conditions and with the Project in place. Duration of flooding is the same both with and without the Project in place except for an additional half day of flooding for the 0.2 percent event with the Project in place.

Table 3. South Pleasant Church Cemetery Synthetic Flooding Data

Return Frequency	Existing Conditions		With Project	
	Peak Water Elevation	Duration (Days) of WSEL Above Natural Ground	Peak Water Elevation	Duration (Days) of WSEL Above 927.0'
10 percent	922.4	0	922.4	0
2 percent	926.9	0	926.9	0
1 percent	928.2	4	928.3	4
0.2 percent	929.3	7	929.3	7.5
Note: 927.0 is the approximate lowest site elevation.				
All Hydraulic Data Taken from Phase 7 HEC-RAS Models March 2013				

THE FIRST ALTERNATIVE evaluated was a ring berm surrounding the cemetery to minimize impacts from staged water. A feasibility level berm layout is included in Appendix D, Site Plan #3 drawing. A typical berm section drawing is included at the end of Appendix D. The configuration of this berm has an average height of 4 feet, a

maximum height of 6 feet, a crest width of 4 feet and 3H:1V side slopes. The design addressed the concerns highlighted herein and subsequent challenges resulting from site specific constraints.

EXTERIOR FLOOD CONTROL

The township road on the south boundary of the cemetery will be raised as part of the berm to enclose the site. The road will be elevated to the protected level and transition at a 2 percent grade back to the existing road elevation. All construction is located a minimum of 20 feet from trees surrounding the cemetery. Access to the cemetery will require little re-grading because the township road at the existing access point will be subject to only a slight raise. The resulting berm construction may result in impacts to wetlands that may require mitigation.

INTERIOR FLOOD CONTROL

The components of the interior flood control include a ditch parallel to and inside the berm, gated outlet appurtenances, and pump system. The drainage from inside the ring berm will be collected by shallow ditches parallel to the berm. These interior ditches will convey the interior drainage to a culvert located near the northeast corner of the cemetery. The drainage outlet will include provisions to close the culvert during flood events as well as a pump station to allow pumping of runoff during flood events when the outlet would be prevented from draining by gravity.

Two options for pump stations have been included in the analysis, one with a wet well in which a portable pump would be installed and operated during flood events and a second with a permanent automated pump station. For the purpose of this report, the wet well and portable pump option has been considered the base option and the automated pump station has been considered the alternate option.

OPTIONAL ACCESS TO SITE

The site accessibility during flood events can be maintained by traveling 0.5 miles to the west, thence 2.0 miles south, and thence 1.8 miles east to Interstate 29. This route is not impacted by the flooding and does not require any road raising. Because there are no impacts to access, no estimate was necessary. The more direct route 1.5 miles to the east would require the improvement of a 130 foot long bridge which for this study was not a viable route because of other feasible options.

THE SECOND ALTERNATIVE does not prevent floodwaters from inundating the cemetery but instead allows the event to occur. Two structural measures are utilized for this alternative. The first will be to incorporate a fence that is structurally capable of preventing potential damaging floodwater debris from impacting the headstones or entering the site. The second measure is to anchor the upright monuments (headstones), which would provide increased resiliency from potential debris flowing within the floodwaters.

There are upright, beveled, flat and unmarked monuments. Aerial imagery was used to categorize the total grave sites into upright or beveled and flat. Since the upright or beveled monuments both cast a shadow an accurate differentiation could not be determined.

The protection of the upright monuments is the focus for this alternative. It should be noted that this alternative may not be warranted if the floodwaters are not deep enough to transport the potential damaging debris. Regardless, there were two options considered for the fence alternative. Option 1 looked at providing one foot of protection above the upright monuments up to five feet in height. Option 2 looked at providing one foot of protection above the estimated high water surface elevation for the 0.2 percent chance flood event.

Option 1 will provide equal protection from any flood event, whereas option 2 will only provide protection up to the estimated high water elevation.

Both options will consider standard fence heights of 4, 7, 8, and 10 feet. Minor earthwork grading will be necessary along the fence alignment in order to maintain the protection elevation, and maintain positive drainage at the cemetery. An iron fence was used for this alternative and assumed to be cast iron.

For the fence alternative option 1, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at a uniform elevation with a minimum vertical clearance of one foot above all upright monuments. The fence will be the barrier that prevents any potential damaging debris from entering the cemetery until the water level is one foot above the tallest upright monument where the debris would safely float by with no impact to the monuments.

For the fence alternative option 2, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at or above a determined elevation for the site, which is one foot above the estimated high water surface elevation for the 0.2 percent chance flood event. The fence will be the barrier that prevents any potential damaging debris from entering the site.

Anchoring the upright monuments should consist of evaluating the existing stability of the upright monuments and determine any needed measures to maintain stability during a flood event. The upright monuments likely consist of a soil or concrete foundation; a base usually is made of granite, bronze or concrete; and the upright section, which is commonly referred as a die. It is common practice that the die will be pinned and or glued to the base as the type of anchoring system in place in order for the monument to be upright. The approach for this alternative will assume that there is no existing anchoring system in place, while the new anchoring system will consist of incorporating four 30-inch long dowel bars and concrete. This anchoring system of the die is similar to current practices.

THE THIRD ALTERNATIVE considers raising the existing ground at the cemetery site one foot above the 0.2 percent flood event. The actual buried graves will not be disturbed with this alternative. This alternative would include a survey of the graves sites and markers, removing the grave markers, placing material to raise the site, and resetting the removed markers. The costs associated with any possible requirements by the State Historical Preservation Office have not been estimated for this study.

3.2 Red River of the North

3.2.1 Site 4 - Lower Wild Rice and Red River Cemetery

The Lower Wild Rice and Red River Cemetery (LWRRR) is in a 3.5-acre parcel (pin no. 57000010201126) located in the SW quarter of the SW quarter of the NW quarter of Section 6, Township 137 North, Range 48 West, Pleasant Township, Cass County, North Dakota. Based on the legal description from the Cass County Government 2013 Parcel Information web site, the LWRRR Cemetery parcel measures 730.50 feet north-south by 208.73 feet east-west. It is bounded by an intermittent drainage and a slough pond on the north, a cultivated field on the east, a gravel road/driveway on the south, and County Road 81 on the west. There is an overhead power line and a wide ditch between the cemetery and County Road 81. According to the NRCS's Web Soil Survey, soil at the cemetery is Fargo silty clay, 0 to 1 percent slopes, except for north of the east-west row of conifers at the north end of the cemetery where the soil is Fargo silty clay, depressional, 0 to 1 percent slopes.

Vegetation in the cemetery consists of mown lawn grass and three north-south rows of trees, one row of alternating mature deciduous and young conifers on the west side of the cemetery, a second row of mature deciduous and coniferous trees up the middle of the cemetery, and a third row of alternating mature and young deciduous trees along the east border of the cemetery. An east-west row of conifers marks where the north side of the cemetery drops off into the drainage. The entrance to the cemetery is off County Road 81. This active cemetery contains 384 burial plots dating from 1872 to present. Markers within the cemetery consist of several types, including headstones, die-in-socket, die-on-base, pedestal, footstones, lawn-markers, plaques, family plot markers, and 26 government-issued veteran's markers. Some of the older headstones have inscriptions in Norwegian. There are at least two unmarked graves at the cemetery, indicated by grave boxes but containing no headstone. A church was built here in 1880. It was struck by lightning and burned down in July 1940 and all cemetery records were lost. There is a commemorative marker where the church was located and another marker and a flagpole at the entrance to the cemetery. A church-shaped shed is located in the north half of the cemetery.

Ground surface elevations in the cemetery range from a low of about 907.0 feet on the north and east sides to a high of about 909.9 feet in the southwest corner. For modeled existing conditions, the 10 percent event peak water elevation will be 908.1 feet; the 2 percent event peak water elevation will be 913.3 feet; the 1 percent event peak water elevation will be 913.9 feet; and the 0.2 percent event peak water elevation will be 915.0 feet. Under existing conditions, those parts of the cemetery at and below 908 feet elevation are flooded during a 10 percent event for 0.5 day. The entire cemetery will be flooded during a 2 percent event to a depth of 5.3 feet, during a 1 percent event to a depth of 5.9 feet, and during a 0.2 percent event to a depth of 7.0 feet. Duration of flooding ranges from half a day for the 10 percent event to 9 days for the 2 percent event, 10 days for the 1 percent event, and 14.5 days for the 0.2 percent event.

Based on aerial photography taken during the 1997 flood event, the LWRRR Cemetery was completely inundated. Aerial photography taken during the March 2009 flood event shows the southeast corner of the cemetery and the roads to the west and south of the cemetery as inundated. Water will be backing into the cemetery entryway from County Road 81 and into its northeast corner from the drainage/slough to the north-northeast. Past flood impacts on the cemetery include crop debris washed into the cemetery from the adjacent field, headstones shifted or toppled, vegetation die off, some erosion in the road ditch, and loss of access. In 1997, there was ice, but no flow; water and ice rose and fell in place. Post-flood restoration has included cleaning up washed-in crop debris, resetting headstones, and replanting grass. This clean-up work was done by the cemetery association. General clean-up took about one weekend.

For the Project in place, the 10 percent event modeled the peak water surface elevation to be above 908.0 feet for a duration of 1 day with a peak water surface elevation of 908.3 feet over the existing conditions; an increase in duration of 0.5 days and an increase in peak elevation of 0.2 feet over the existing conditions. For the 2 percent event, the water surface elevation will be above 908.0 feet for a duration of 11 days with a peak water surface elevation at 921.5 feet; an increase in duration of 2 days and an increase in peak elevation of 8.2 feet over the existing conditions. For the 1 percent event, the water surface elevation will be above 908.0 feet for a duration of 12 days, with a peak water surface elevation at 922.2 feet; an increase in duration of 2 days and an increase in peak elevation of 9.3 feet over the existing conditions. For the 0.2 percent event, the water surface elevation will be above 908.0 feet for a duration of 14 days, with a peak water surface elevation at 922.2 feet; an increase in duration of 0.5 days and an increase in peak elevation of 7.2 feet over the existing conditions.

As under existing conditions, the parts of the cemetery at and under 908 feet elevation would flood at the 10 percent event. Similarly, the entire cemetery would be inundated during the 2 percent or larger events. Maximum increase in water surface elevation with the Project in place would be 8.3 feet depth and maximum additional duration would be 2 days more than that experienced under existing conditions.

Table 4. LWRRR Cemetery Synthetic Flooding Data

Return Frequency	Existing Conditions		With Project	
	Peak Water Elevation	Duration (Days) of WSEL Above Natural Ground	Peak Water Elevation	Duration (Days) of WSEL Above 908.0'
10 percent	908.1	0.5	908.3	1
2 percent	913.3	9	921.5	11
1 percent	913.9	10	922.2	12
0.2 percent	915.0	14.5	922.2	14
Note: 908.0 is the approximate lowest site elevation				
All Hydraulic Data Taken from Phase 7 HEC-RAS Models March 2013				

THE FIRST ALTERNATIVE evaluated was a combination ring berm and floodwall surrounding the cemetery to minimize impacts from staged water. A feasibility level berm layout is included in Appendix D, Site Plan #4 drawing. A typical berm section drawing is included at the end of Appendix D. The configuration of this berm has an average height of 15 feet, a maximum height of 16 feet, a crest width of 22 feet and 3H:1V side slopes. Due to the change in access to the cemetery, the crest width here functions as an access road requiring the wider path to accommodate the dual purpose. The design further address the concerns highlighted herein and subsequent challenges resulting from site specific constraints.

EXTERIOR FLOOD CONTROL

The ring berm will include raising Cass Highway 81 on the west boundary of the site and the township road on the south side of the site, a flood wall on the north and berm on the east. The roads will be elevated to the protected level and transition at a 2 percent grade back to existing road bed elevation. All construction, except the floodwall along the north boundary of the site, will be located a minimum of 20 feet from trees surrounding the cemetery. Unlike other cemeteries included in this report, the conceptual floodwall at this site will be located within the boundary of the cemetery. The proximity of the cemetery's north boundary to the existing wetland makes a structural option outside of the cemetery boundary infeasible. Access to the cemetery from the existing entrance will require significant re-grading due to the significant difference in elevation between the top of levee and the existing ground at the site entrance. A new access road coming from the south coming into the east side of the cemetery was developed.

INTERIOR FLOOD CONTROL

The components of the interior flood control include a ditch parallel to and inside the berm, gated outlet appurtenances, and pump system. The drainage from inside the ring berm will be collected by shallow ditches parallel to the ring berm. These interior ditches will convey the interior drainage to a culvert located near the northeast corner of the cemetery. The drainage outlet will include provisions to close the culvert during flood events as well as a pump station to allow pumping of runoff during flood events when the outlet would be prevented from draining by gravity.

Two options for pump stations have been included in the analysis, one with a wet well in which a portable pump would be installed and operated during flood events and a second with a permanent automated pump station. For the purpose of this report, the wet well and portable pump option has been considered the base option and the automated pump station has been considered the alternate option.

Possible considerations for addressing the church shaped shed on the north side of the cemetery include two options for this alternative. One option is that the alignment of the floodwall and drainage ditch would be designed such that the shed remain in its current location. The geotechnical requirements of the floodwall foundation would dictate the floodwall proximity, and the drainage ditch alignment may need to be routed around the shed, or possibly under the shed with storm sewer pipe. Another option would be to move the shed to the south enough to accommodate the proposed improvements of this alternative.

OPTIONAL ACCESS TO SITE

Cass Highway 81, while not being raised through the staging area, will be raised to go up and over the southern embankment. Because of the proximity of the Lower Wild Rice and Red River Cemetery to the southern embankment, the portion of Cass Highway 81 that would be raised as part of the ring berm would tie into the road raise over the southern embankment. The result is that access to the site during flood events would be possible while raising no additional roads.

THE SECOND ALTERNATIVE does not prevent floodwaters from inundating the cemetery but instead allows the event to occur. Two structural measures are utilized for this alternative. The first will be to incorporate a fence that is structurally capable of preventing potential damaging floodwater debris from impacting the headstones or entering the site. The second measure is to anchor the upright monuments (headstones), which would provide increased resiliency from potential debris flowing within the floodwaters. As for the commemorative marker, more information will be needed in order to adequately assess the protection level this alternative provides or to determine a suitable alternative comparable to this alternative.

There are upright, beveled, flat, unmarked monuments and one commemorative church shaped marker. Aerial imagery was used to categorize the total grave sites into upright or beveled and flat. Since the upright or beveled monuments both cast a shadow an accurate differentiation could not be determined.

The protection of the upright monuments is the focus for this alternative. There were two options considered for the fence alternative. Option 1 looked at providing one foot of protection above the upright monuments up to five feet in height. Option 2 looked at providing one foot of protection above the estimated high water surface elevation for the 0.2 percent chance flood event. Option 1 will provide equal protection from any flood event, whereas option 2 will only provide protection up to the estimated high water elevation.

Option 1 will consider standard fence heights of 5, 6, 7 and 8 feet. While option 2 will have to consider a special sized fence of 15 feet. Minor earthwork grading will be necessary along the fence alignment in order to maintain the protection elevation, and maintain positive drainage at the cemetery. An iron fence was used for this alternative and assumed to be cast iron.

For the fence alternative option 1, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at a uniform elevation with a minimum vertical clearance of one foot above all upright monuments. The fence will be the barrier that prevents any potential damaging debris from entering the cemetery until the water level is one foot above the tallest upright monument where the debris would safely float by with no impact to the monuments.

For the fence alternative option 2, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at or above a determined elevation for the site, which is one foot above the estimated high water surface elevation for the 0.2 percent chance flood event. The fence will be the barrier that prevents any potential damaging debris from entering the site.

Anchoring the upright monuments should consist of evaluating the existing stability of the upright monuments and determine any needed measures to maintain stability during a flood event. The upright monuments likely consist of a soil or concrete foundation; a base usually is made of granite, bronze or concrete; and the upright section, which is commonly referred as a die. It is common practice that the die will be pinned and or glued to the base as the type of anchoring system in place in order for the monument to be upright. The approach for this alternative will assume that there is no existing anchoring system in place, while the new anchoring system will consist of incorporating four 30-inch long dowel bars and concrete. This anchoring system of the die is similar to current practices.

3.2.2 Site 5 - Clara Cemetery

The Clara Cemetery is an approximately 2.3 acre parcel (pin no. 150173000) located in the SW quarter of the SW quarter of the SW quarter of the SW quarter of Section 17, Township 137 North, Range 17 West, Holy Cross Township, Clay County, Minnesota. The cemetery area is approximately 330 feet north-south by 300 feet east-west. It is bounded by an agricultural field on the north and east, by a gravel road, 150th Avenue South, on the south, and by another gravel road, 3rd Street South, on the west. According to the NRCS's Web Soil Survey, soils in the cemetery are Fargo silty clay, 0 to 1 percent slopes.

Vegetation in the cemetery consists of mown lawn grass with two rows of mature spruce trees along its north and east edges and one row of spruce trees along its west and south edges, plus a few lone spruce in the interior of the cemetery. There is a U-shaped grassy two-track road through the cemetery with access from the road on the south. This active cemetery contains 220 marked and 3 unmarked graves dating from 1894 to the present. Headstones include both vertical monuments and horizontal slabs. This cemetery originally was a Swedish cemetery as reflected by the Swedish inscriptions on the earlier headstones. Members of the locally prominent Hicks family are buried here. There is a brick monument with a metal plaque with the cemetery's name ("CLARA LUTHERAN CEMETERY") and a wooden sign board at the cemetery. There are no buildings at the cemetery.

Ground surface elevations in the cemetery range from a low of 915.0 feet on the north and east sides of the cemetery to a high of 917.0 feet on the south side. For modeled existing conditions, the 10 percent event peak water elevation will be 913.5 feet; the 2 percent event peak water elevation will be 914.6 feet; the 1 percent event peak water elevation will be 915.4 feet; and the 0.2 percent event peak water elevation will be 916.8 feet. Under existing conditions, there will be no flooding of the cemetery during the 10 percent and 2 percent events. During the 1 percent event, the west, north and east sides of the cemetery would be flooded by 0.4 foot (4.8 inches) of water for 2 days. During the 0.2 percent event, most of the cemetery would be flooded by up to 1.8 feet of water for 6.5 days.

Based on aerial photography taken during the 1997 flood event, there was floodwater just outside the west, north and east sides of the Clara Cemetery, but none in the cemetery itself. The roads to the west and south of the cemetery were also inundated where they crossed branches of the drainage northeast of the cemetery. Aerial photography taken during the March 2009 flood event also shows no flooding in the cemetery, but water

and ice to its north and east. Because the cemetery has never flooded, no post-flood clean-up has been necessary. There may have been problems with road access however.

For the Project in place, the 10 percent event modeled the peak water surface elevation to be less than 915.0 feet and no flooding on the site, the same as the existing conditions. For the 2 percent event, the water surface elevation will be above 915.0 feet for a duration of 8 days with a peak water surface elevation at 921.6 feet; an increase in duration of 8 days and an increase in peak elevation of 7 feet over the existing conditions. For the 1 percent event, the water surface elevation will be above 915.0 feet for a duration of 9.5 days with a peak water surface elevation at 922.3 feet; an increase in duration of 7.5 days and an increase in peak elevation of 6.9 feet over the existing conditions. For the 0.2 percent event, the water surface elevation will be above 915.0 feet for a duration of 9.5 days with a peak water surface elevation at 922.3 feet; an increase in duration of 3.0 days and an increase in peak elevation of 5.5 feet over the existing conditions.

As under existing conditions, there would be no flooding with the Project in place during the 10 percent event. The major change with the Project in place would be that the cemetery would flood during the 2 percent event, when there is no flooding under existing conditions. Maximum increase in water surface elevation with the Project in place for the 2 percent, 1 percent and 0.2 percent events would be 6.6 feet depth and maximum additional duration would be 8 days more than that experienced under existing conditions.

Table 5. Clara Cemetery Synthetic Flooding Data

Return Frequency	Existing Conditions		With Project	
	Peak Water Elevation	Duration (Days) of WSEL Above Natural Ground	Peak Water Elevation	Duration (Days) of WSEL Above 915.0’
10 percent	913.5	0	913.5	0
2 percent	914.6	0	921.6	8
1 percent	915.4	2	922.3	9.5
0.2 percent	916.8	6.5	922.3	9.5
Note: 915.0 is the approximate lowest site elevation				
All Hydraulic Data Taken from Phase 7 HEC-RAS Models March 2013				

THE FIRST ALTERNATIVE evaluated was a ring berm surrounding the cemetery to minimize impacts from staged water. A feasibility level berm layout will be included in Appendix D, Site Plan #5 drawing. A typical berm section drawing will be included at the end of Appendix D. The configuration of this berm has an average height of 9 feet, a maximum height of 11 feet, a crest width of 8 feet and 3H:1V side slopes. The design further address the concerns highlighted herein and subsequent challenges resulting from site specific constraints.

EXTERIOR FLOOD CONTROL

The roads on the west and south boundaries of the cemetery would be raised as part of the berm to enclose the site. The roads will be elevated to the protected level and transition at a 2 percent grade back to existing road bed elevation. All construction would be located a minimum of 20 feet from trees surrounding the cemetery. Access to the cemetery will require significant re-grading because of the significant difference in elevation between the top of levee and the existing ground at the site.

INTERIOR FLOOD CONTROL

The components of the interior flood control include a ditch parallel to and inside the berm, gated outlet appurtenances, and pump system. The drainage from inside the ring berm will be collected by shallow ditches parallel to the berm. These interior ditches will convey the interior drainage to a culvert located near the northeast corner of the cemetery. The drainage outlet will include provisions to close the culvert during flood events as well as a pump station to allow pumping of runoff during flood events when the outlet would be prevented from draining by gravity.

Two options for pump stations have been included in the analysis, one with a wet well in which a portable pump would be installed and operated during flood events and a second with a permanent automated pump station. For the purpose of this report, the wet well and portable pump option has been considered the base option and the automated pump station has been considered the alternate option.

OPTIONAL ACCESS TO SITE

Access to the site during the flood event could be maintained by improving approximately 1 mile of gravel township roads to connect to US Highway 75, which will be raised as part of the Project. There will be a range of 2 to 7 feet rise in grade for the optional access path (Appendix E). It is anticipated there will be utility coordination and relocation, temporary construction easements and permanent right of way acquisitions, water crossing extension or reconstruction and road raising. An estimate of the costs was produced for the optional access assuming a roadway centerline elevation of one foot above the Project 1-percent chance flood event water surface elevation. The cost estimate for the road raises necessary to maintain access to the site during a flood is included in Appendix F

It should be noted that raising roads within the staging area may impact hydraulics during some flood events. The access improvements do not include provisions for allowing additional conveyance under raised roadways. In the case of the Clara Cemetery, an analysis of the Phase 7 HEC-RAS model results show that raising roads to access the cemetery during floods may impact water surface elevations in the area.

THE SECOND ALTERNATIVE does not prevent floodwaters from inundating the cemetery but instead allows the event to occur. Two structural measures are utilized for this alternative. The first will be to incorporate a fence that will be structurally capable of preventing potential damaging floodwater debris from impacting the headstones or entering the site. The second measure will be to anchor the upright monuments (headstones), which would provide increased resiliency from potential debris flowing within the floodwaters.

There are upright, beveled, flat and unmarked monuments. Aerial imagery was used to categorize the total grave sites into upright or beveled and flat. Since the upright or beveled monuments both cast a shadow an accurate differentiation could not be determined.

The protection of the upright monuments will be the focus for this alternative. It should be noted that this alternative may not be warranted if the floodwaters are not deep enough to transport the potential damaging debris. Regardless, there were two options considered for the fence alternative. Option 1 looked at providing one foot of protection above the upright monuments up to five feet in height. Option 2 looked at providing one foot of protection above the estimated high water surface elevation for the 1 or 0.2 percent chance flood event. Option 1 will provide equal protection from any flood event, whereas option 2 will only provide protection up to the estimated high water elevation.

Both options will consider standard fence heights of 5, 6, 7, 8, and 10 feet; and option 2 will consider one special size of 11 feet. Minor earthwork grading will be necessary along the fence alignment in order to maintain the protection elevation, and maintain positive drainage at the cemetery. An iron fence was used for this alternative and assumed to be cast iron.

For the fence alternative option 1, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at a uniform elevation with a minimum vertical clearance of one foot above all upright monuments. The fence will be the barrier that prevents any potential damaging debris from entering the cemetery until the water level will be one foot above the tallest upright monument where the debris would safely float by with no impact to the monuments.

For the fence alternative option 2, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at or above a determined elevation for the site, which will be one foot above the estimated high water surface elevation for the 1 or 0.2 percent chance flood event. The fence will be the barrier that prevents any potential damaging debris from entering the site.

Anchoring the upright monuments should consist of evaluating the existing stability of the upright monuments and determine any needed measures to maintain stability during a flood event. The upright monuments likely consist of a soil or concrete foundation; a base usually is made of granite, bronze or concrete; and the upright section, which is commonly referred as a die. It is common practice that the die will be pinned and or glued to the base as the type of anchoring system in place in order for the monument to be upright. The approach for this alternative will assume that there is no existing anchoring system in place, while the new anchoring system will consist of incorporating four 30-inch long dowel bars and concrete. This anchoring system of the die is similar to current practices.

3.2.3 Site 6 - Roen Family Cemetery

The Roen Family Cemetery is an unregistered cemetery located at the Roen family farmstead along with various potentially historic buildings. The approximately 600-square-foot cemetery (pin no. 150193400) is located in the SW quarter of the NE quarter of the SW quarter of the SW quarter of Section 19, Township 137 North, Range 48 West, Holy Cross Township, Clay County, Minnesota. The cemetery is approximately 20 feet northwest-southeast by 30 feet northeast-southwest. It is located within two feet of the top of the bank of the Red River of the North with the farmyard to the northeast, east and south. According to the NRCS's Web Soil Survey, soils in the cemetery and farmyard are Wahpeton silty clay, 0 to 2 percent slopes, occasionally flooded. Soils on the river bank slope northwest and west of the cemetery are Fluvaquents, frequently flooded—Hapludolls complex, 0 to 30 percent slopes.

Vegetation in the cemetery consists of mown lawn grass, which is also present in the remainder of the farmyard. The slope down to the Red River is covered with deciduous trees and bushes. Access to the cemetery is northward through the farmyard from paved County Road 2 (160th Avenue South). This family cemetery contains three graves for a brother and sister (Ingvald Roen, age 5, buried 1884 and Ida Roen, age 18, buried 1901) and for a cousin (Myrtle Roen, age 3, buried 1905). The slant-face vertical headstones were placed in the 1970s and may not accurately mark the actual grave locations. The cemetery is surrounded by a fence made of metal chain-link fence posts and horizontal metal rails, but no actual chain link fencing.

The original homesteader of the parcel containing the cemetery was Narve Roen, a Civil War veteran who received a grant of land (259.3 acres in Sections 19 and 30) from the Federal government under the Homestead

Act. The log cabin and barn of that original homestead were built in 1871 in Section 30 and are no longer standing. In 1881, Narve built the first frame house in the community as well as a barn in Section 30, both of which are still standing, as are a blacksmith shop and a granary. Narve was also the first banker in the area. His son Stennom Roen built a four-story frame house, still standing, along with other farm buildings in 1905-1906 in Section 19; this is the farmstead where the cemetery is located. A brother, Gilbert Roen, lived at the farm in Section 19 north of Stennom's. Other early buildings have been moved onto these farmsteads.

Ground surface elevation at the cemetery is approximately 917.0 feet, rising to 918.0 feet in the farmyard, but dropping rapidly down the adjacent steep riverbank section to 892.0 feet at the Red River. For the modeled existing conditions, the 10 percent event peak water elevation is 910.7 feet; the 2 percent event peak water elevation is 916.5 feet; the 1 percent event peak water elevation is 917.5 feet; and the 0.2 percent event peak water elevation is 919.7 feet. There is no flooding for the 10 percent and 2 percent events, 0.5 feet for 1.5 days for the 1 percent event, and 2.7 feet for 7.0 days for the 0.2 percent event under existing conditions.

Based on aerial photography taken during the 1997 flood event, water in the Red River inundated its floodplain and reached near the top of the riverbank adjacent to the Roen Family Cemetery and farmyard, neither of which were flooded. Aerial photography taken during the March 2009 flood event shows the cemetery and farmyard with no flooding, but with the Red River floodplain inundated to near the top of the riverbank. The landowner, Rhoda (Roen) Ueland has stated that there has been no past flooding of the cemetery and thus no clean-up has been necessary. Maintenance, i.e., grass mowing, at the cemetery is done as part of farmyard mowing.

For the Project in place, the 10 percent event modeled the peak water surface elevation to be less than 917.0 feet and no flooding on the site, the same as the existing conditions. The 2 percent event will be above 917.0 feet for a duration of 7 days with a peak elevation at 921.7 feet; an increase in duration of 7 days and an increase in peak elevation of 5.2 feet over the existing conditions. The 1 percent event will be above 917.0 feet for a duration of 8.5 days with a peak elevation at 922.3 feet; an increase in duration of 7 days and an increase in peak elevation of 4.8 feet over the existing conditions. The 0.2 percent event will be above 917.0 feet for a duration of 9 days with a peak elevation of 922.6 feet; an increase in duration of 2 days and an increase in peak elevation of 2.9 feet over the existing conditions.

The main change with the Project in place would be flooding of the cemetery at the 2 percent event where there is no flooding under existing conditions. Maximum increase in water surface elevation with the Project in place for the 2 percent, 1 percent and 0.2 percent events would be 4.7 feet depth and maximum additional duration would be 7 days more than that experienced under existing conditions.

Table 6. Roen Family Cemetery Synthetic Flooding Data

Return Frequency	Existing Conditions		With Project	
	Peak Water Elevation	Duration (Days) of WSEL Above Natural Ground	Peak Water Elevation	Duration (Days) of WSEL Above 917.0'
10 percent	910.7	0	910.7	0
2 percent	916.5	0	921.7	7
1 percent	917.5	1.5	922.3	8.5
0.2 percent	919.7	7	922.6	9
Note: 917.0 is the approximate lowest site elevation				
All Hydraulic Data Taken from Phase 7 HEC-RAS Models March 2013				

THE FIRST ALTERNATIVE, unlike many of the cemetery sites, does not include a ring berm. Because the site sits at the edge of the riverbank, even a floodwall is not a feasible option for enclosing the site. Because of the infeasibility of a berm/floodwall, this alternative does not prevent floodwaters from inundating the cemetery but instead allows the event to occur. Two structural measures are utilized for this alternative. The first is incorporating a fence that is structurally capable of preventing potential damaging floodwater debris from impacting the headstones or entering the site. The second measure is to anchor the upright monuments (headstones), which would provide increased resiliency to any potential debris within the floodwaters. A feasibility level fencing layout is included in Appendix D, Site Plan #6 drawing.

This site does not have an identifiable cemetery boundary so an estimated 250 linear foot was selected for the length of fence. The protection of the upright monuments is the focus for this alternative. It should be noted that this alternative may not be warranted if the floodwaters are not deep enough to transport the potential damaging debris Regardless, there were two options considered for the fence alternative. Option 1 looked at providing one foot of protection above the upright monuments up to five feet in height. Option 2 looked at providing one foot of protection above the estimated high water surface elevation for the 0.2 percent chance flood event. Option 1 will provide equal protection from any flood event, whereas option 2 will only provide protection up to the estimated high water elevation.

Both options will consider a standard fence height of 6 feet. Minor earthwork grading will be necessary along the fence alignment in order to maintain the protection elevation, and maintain positive drainage at the cemetery. An iron fence was used for this alternative and assumed to be cast iron.

For the fence alternative option 1, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at a uniform elevation with a minimum vertical clearance of one foot above all upright monuments. The fence will be the barrier that prevents any potential damaging debris from entering the cemetery until the water level is one foot above the tallest upright monument where the debris would safely float by with no impact to the monuments.

For the fence alternative option 2, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at or above a determined elevation for the site, which is one foot above the estimated high water surface elevation for the 0.2 percent chance flood event. The fence will be the barrier that prevents any potential damaging debris from entering the site.

Both fence alternative options result in a six foot tall fence. The cost estimates for both options are included in Appendix F

Anchoring the upright monuments should consist of evaluating the existing stability of the upright monuments and determining any needed measures to maintain stability during a flood event. The upright monuments likely consist of a soil or concrete foundation; a base usually is made of granite, bronze or concrete; and the upright section, which is commonly referred as a die. It is common practice that the die will be pinned and or glued to the base as the type of anchoring system in place in order for the monument to be upright. The approach for this alternative will assume that there is no existing anchoring system in place, while the new anchoring system will consist of incorporating four 30-inch long dowel bars and concrete. This anchoring system of the die is similar to current practices.

OPTIONAL ACCESS TO SITE

No consideration of access to the site is included in this analysis because no feasible alternative to prevent site inundation is included.

3.2.4 Site 7 - Hemnes Cemetery

The Hemnes Cemetery is an approximately 1.2 acre parcel (pin no. 1000000066000) located in the NE quarter of the NW quarter of the NW quarter of the SE quarter of Section 1, Township 136 North, Range 49 West, Eagle Township, Richland County, North Dakota. The parcel is bounded on its north, west and south sides by an agricultural field. The parcel is approximately 245 feet along its north border, 175 feet along its west border, and 350 feet along its south border. The east border follows an outside curve of the Red River for approximately 202 feet at the river's edge and 237 feet at the top of the riverbank. The actual cemetery area is approximately 175 feet north-south by 140 feet east-west., with riverbank sliding having claimed a third of the cemetery parking area and part of its access road and now eating into the northeast corner of the actual cemetery area. According to the NRCS's Web Soil Survey, soils in the cemetery parcel above the slumping riverbank are Fargo-Hegne silty clays, 0 to 1 percent slopes and soils on the riverbank slope are Wahpeton-Cashel silty clays, wooded, 1 to 15 percent slopes, occasionally flooded.

Vegetation in the cemetery consists of mown lawn grass with a row of mature conifers on the north, west and south sides and one deciduous tree in the southeast corner. The riverbank area is brushy, with a deciduous tree still upright in one of the most recent slump blocks. Current access to the cemetery is from the north along a two-track road at the eastern edge of the agricultural field. A white-painted chain and post fence marks the upper edge of the slumping riverbank where the access road enters the cemetery parking area.

This is the oldest Norwegian Lutheran Church Cemetery in North Dakota. It contains 58 marked graves plus 18 unmarked graves, most in the southeast quarter of the cemetery. The first burial in the cemetery dates to 1872, but its location is unknown. In 1875, a soldier from Fort Abercrombie was buried here. The cemetery also contains the graves of local pioneers and veterans of World War I and World War II. The most recent burial dates to 1993. Two burials have been relocated here from the North Pleasant Cemetery because their families wished to avoid any flooding. The cemetery is still active. Headstones at the Hemnes Cemetery include both vertical monuments (die-in-socket, die-on-base, pulpit, pedestal, and a pediment obelisk) and horizontal slabs (in-ground headstones and lawn-type markers). Footstones and family plot markers are also present. There is a wooden sign with the cemetery's name and a nearby wooden information board containing the history of the church and cemetery. A flagpole is also present. In 1889, the church for this cemetery was located one-quarter mile away in

the NW corner of this section. After the congregation had dissolved, the church building was moved to Strathcona, Minnesota, in 1935, where it is still in use.

Ground surface elevation at the cemetery is 922.0 feet, with much of the adjacent agricultural field at 921.0 feet. The slumping riverbank drops down to 893 feet at the edge of the Red River. For modeled existing conditions, the 10 percent event peak water elevation is 912.2 feet; the 2 percent event peak water elevation is 918.3 feet; the 1 percent event peak water elevation is 919.6 feet; and the 0.2 percent event peak water elevation is 923.1 feet. There is no flooding during the 10 percent, 2 percent and 1 percent events under existing conditions. Flooding would not occur until somewhere between the 1 percent and 0.2 percent events, when the peak water surface elevation reaches 922.1 feet. For the 0.2 percent event there would be 1.1 feet of water on the cemetery for 3 days.

Based on aerial photography taken during the 1997 flood event, high water in the Red River reached nearly to the top of the riverbank adjacent to the Hemnes Cemetery. There was no flooding inside the actual cemetery, however. Aerial photography taken during the March 2009 flood event shows the Red River not as high as in 1997. Because the cemetery has not previously flooded, no post-flood clean-up has been necessary. Pioneer Township has recently taken over maintenance at the cemetery, work which was formerly done by volunteers.

Hemnes Cemetery has a serious riverbank erosion problem to deal with. Since the 1997 flood, the adjacent bank of the Red River has been actively sliding and has claimed a third of the parking area and part of the access road nearest the cemetery. Bank erosion is currently only 20 feet from graves in the northeast corner of the cemetery. It's been reported that ongoing erosion concerns have prevented some burials.

For the Project in place, the 10 percent event modeled the peak water surface elevation to be less than 922.0 feet and no flooding, the same as the existing conditions. The 2 percent event will be above 922.0 feet for a duration of 0.5 days with a peak water elevation at 922.1 feet; an increase of 0.5 days and an increase in peak water surface elevation of 3.8 feet over the existing conditions. The 1 percent event will be above 922.0 feet for a duration of 3.5 days with a peak water elevation at 922.7 feet; an increase in duration of 0.5 days and an increase in peak water surface elevation of 3.1 feet over the existing conditions. The 0.2 percent event will be above 922.0 feet for a duration of 6 days with a peak water elevation at 923.7 feet; an increase of 3 days and an increase in peak water surface elevation of 0.6 feet over the existing conditions.

While there would be no flooding with or without the Project in place for the 10 percent event, flooding at the cemetery would occur with the Project in place starting with the 2 percent event; whereas under existing conditions, flooding does not start until somewhere between the 1 percent and 0.2 percent events. The maximum increase in water surface elevation with the Project in place would be 1.7 feet depth and the maximum additional duration would be 3.5 days more than that modeled under existing conditions.

Table 7. Hemnes Cemetery Synthetic Flooding Data

Return Frequency	Existing Conditions		With Project	
	Peak Water Elevation	Duration (Days) of WSEL Above Natural Ground	Peak Water Elevation	Duration (Days) of WSEL Above 922.0'
10 percent	912.2	0	912.2	0
2 percent	918.3	0	922.1	0.5
1 percent	919.6	0	922.7	3.5
0.2 percent	923.1	3	923.7	6
Note: 922.0 is the approximate lowest site elevation				
All Hydraulic Data Taken from Phase 7 HEC-RAS Models March 2013				

An active slope failure is occurring at the site currently. Because of this geotechnical challenge, all improvements considered show alignments through the northeast corner of the cemetery. Considerable geotechnical and cultural investigation would likely be necessary at this location prior to implementation of any alternative. One possibility would be to rebuild the slumped river bank and reclaim cemetery lands, then install slope protection in order to avoid additional slumping of the river bank on the northeast and eastern edge of the cemetery. Once a proposed impact area is determined, the identification of unmarked grave sites and mitigation plans would need to be drawn in order to complete this reclamation. Once reclamation process and stability of the river bank are established, a floodwall option may no longer be warranted. A re-evaluation of stability of the new slope will determine a suitable alignment for a berm. Due to the undetermined alignment, all drawings show an alignment avoiding the slumping river bank; however, the costs to reclaim the bank and apply slope protection has been represented in the cost estimate (Appendix F).

THE FIRST ALTERNATIVE evaluated was a combination ring berm and floodwall surrounding the cemetery to minimize impacts from staged water. A feasibility level berm and floodwall layout is included in Appendix D, Site Plan #7 drawing. A typical berm section drawing is included at the end of Appendix D. The configuration of this berm has an average height of 4 feet, a maximum height of 4 feet, a crest width of 4 feet and 3H:1V side slopes. The design further address the concerns highlighted herein and subsequent challenges resulting from site specific constraints.

EXTERIOR FLOOD CONTROL

This alternative would include a combination of a berm and floodwall to enclose the site. All construction, with the exception of a portion of the floodwall near the northeast corner of the cemetery, would be located a minimum of 20 feet from trees surrounding the cemetery. The floodwall included in this conceptual design is located parallel to the Red River.

INTERIOR FLOOD CONTROL

The components of the interior flood control include a ditch parallel to and inside the berm, gated outlet appurtenances, and pump system. The drainage from inside the ring berm will be collected by shallow ditches parallel to the ring berm. These interior ditches will convey the interior drainage to a culvert located near the northeast corner of the cemetery. The drainage outlet will include provisions to close the culvert during flood events as well as a pump station to allow pumping of runoff during flood events when the outlet would be prevented from draining by gravity.

Two options for pump stations have been included in the analysis, one with a wet well in which a portable pump would be installed and operated during flood events and a second with a permanent automated pump station. For the purpose of this report, the wet well and portable pump option has been considered the base option and the automated pump station has been considered the alternate option.

ON-SITE ACCESS

Because the existing access route is near the riverbank and a portion has fallen down the slope with recent failures, a new access road is included in the cost estimate. The new driveway consists of a 24 foot wide approach approximately 400 feet long. The horizontal alignment is approximately 150 feet from the failing banks of the Red River. The access driveway will enter the site from the north and routed up and over the berm and over the ditch providing access directly to the cemetery grounds. A 50 by 80 foot area is just prior to the reaching the berm providing a turn-around and/or parking for the cemetery.

OPTIONAL ACCESS TO SITE

Access to the site during the flood events could be maintained by improving approximately 1.5 miles of gravel township roads connected to Cass Highway 81, which is high enough that it would not be inundated on events up to a 0.2 percent event. There will be a range of 0 to 6 feet rise in grade for the optional access path (Appendix E). It is anticipated there will be utility coordination and relocation, temporary construction easements and permanent right of way acquisitions, water crossing extension or reconstruction and road raising. An estimate of the costs was produced for the optional access assuming a roadway centerline elevation of one foot above the Project 1-percent chance flood event water surface elevation. The cost estimate for the road raises necessary to maintain access to the site during a flood is included in Appendix F

It should be noted that raising roads within the staging area may impact hydraulics during some flood events. The access improvements do not include provisions for allowing additional conveyance under raised roadways. In the case of the Hemnes Cemetery, an analysis of the Phase 7 HEC-RAS model results show that raising roads to access the cemetery during floods may impact water surface elevations in the area.

THE SECOND ALTERNATIVE does not prevent floodwaters from inundating the cemetery but instead allows the event to occur. Two structural measures are utilized for this alternative. The first will be to incorporate a fence that is structurally capable of preventing potential damaging floodwater debris from impacting the headstones or entering the site. The second measure is to anchor the upright monuments (headstones), which would provide increased resiliency from potential debris flowing within the floodwaters.

There are upright, beveled, flat and unmarked monuments. Aerial imagery was used to categorize the total grave sites into upright or beveled and flat. Since the upright or beveled monuments both cast a shadow an accurate differentiation could not be determined.

The protection of the upright monuments is the focus for this alternative. It should be noted that this alternative may not be warranted if the floodwaters are not deep enough to transport the potential damaging debris. Regardless, there were two options considered for the fence alternative. Option 1 looked at providing one foot of protection above the upright monuments up to five feet in height. Option 2 looked at providing one foot of protection above the estimated high water surface elevation for the 0.2 percent chance flood event. Option 1 will provide equal protection from any flood event, whereas option 2 will only provide protection up to the estimated high water elevation.

Both options will consider standard fence heights of 4, 6 and 7 feet. Minor earthwork grading will be necessary along the fence alignment in order to maintain the protection elevation, and maintain positive drainage at the cemetery. An iron fence was used for this alternative and assumed to be cast iron.

For the fence alternative option 1, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at a uniform elevation with a minimum vertical clearance of one foot above all upright monuments. The fence will be the barrier that prevents any potential damaging debris from entering the cemetery until the water level is one foot above the tallest upright monument where the debris would safely float by with no impact to the monuments.

For the fence alternative option 2, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at or above a determined elevation for the site, which is one foot above the estimated high water surface elevation for the 0.2 percent chance flood event. The fence will be the barrier that prevents any potential damaging debris from entering the site.

Anchoring the upright monuments should consist of evaluating the existing stability of the upright monuments and determine any needed measures to maintain stability during a flood event. The upright monuments likely consist of a soil or concrete foundation; a base usually is made of granite, bronze or concrete; and the upright section, which is commonly referred as a die. It is common practice that the die will be pinned and or glued to the base as the type of anchoring system in place in order for the monument to be upright. The approach for this alternative will assume that there is no existing anchoring system in place, while the new anchoring system will consist of incorporating four 30-inch long dowel bars and concrete. This anchoring system of the die is similar to current practices.

3.2.5 Site 8 - Eagle Valley Evangelical Cemetery

The Eagle Valley Evangelical Cemetery is located in two parcels totaling approximately 2 acres (pin nos. 1000000030200 and 1000000029000) in the SW quarter of the NW quarter of the SW quarter and the NW quarter of the SW quarter of the SW quarter of Section 20, Township 136 North, Range 48 West, Eagle Township, Richland County, North Dakota. The cemetery consists of two adjoining irregularly-shaped parcels, with the north parcel having maximum dimensions of approximately 216 feet north-south by 253 feet east-west (not counting the 100-foot-long entry road) and the south parcel having maximum dimensions of approximately 174 feet north-south by 316 feet east-west. The cemetery is bounded on the west and north by a drainage tributary to the Red River, on the east by a wooded slope down to the river bottomlands which are used as an agricultural field, and on the south by an agricultural field. According to the NRCS's Web Soil Survey, soils in the majority of the cemetery consist of Nutley-Fargo silty clays, 3 to 6 percent slopes. Soils in the drainage to the northwest and north and on the slope to the east consist of Wahpeton-Cashel silty clays, wooded, 1 to 15 percent slopes, occasionally flooded. Soils in the field to the south consist of Overly silty clay loam, 0 to 2 percent slopes.

Vegetation in the cemetery consists of mown lawn grass with a scattering of mature deciduous trees in the north cemetery parcel and on the west side of the south parcel and with discontinuous lines of conifers on the south and east borders of the south cemetery parcel and the east border of the north parcel. Entrance to the cemetery is from the north-south gravel road, 175th Avenue SE, located west of the drainage. This active cemetery contains approximately 200 graves, dating from 1880 to the present. Headstones include both vertical monuments and horizontal slabs. The original Eagle Cemetery is the north parcel. It did not have a church building associated with it. The cemetery was expanded in the 1980s and is now associated with the Eagle Valley Evangelical Christian Church located one-quarter mile to the south. There are no buildings at the cemetery.

Ground surface elevations in the cemetery range from a low of 923.0 feet on the west to a high of 928.0 feet where the two parcels abut. Much of the cemetery ranges from 926-928 feet in elevation. There are steep slopes to the drainage to the west and north and especially to the Red River bottomlands to the east. For modeled existing conditions, the 10 percent event peak water elevation is 917.0 feet; the 2 percent event peak water elevation is 923.9 feet; the 1 percent event peak water elevation is 925.7 feet; and the 0.2 percent event peak water elevation is 928.3 feet. Under existing conditions, there is no flooding at the cemetery for the 10 percent and 2 percent events. During the 1 percent event, there is 1.7 feet of water in the southwest corner of the south parcel and in the north and west sides of the north parcel for 2.5 days. During the 0.2 percent event, the entire cemetery would be flooded with up to 4.3 feet of water for 7 days.

Based on aerial photography taken during the 1997 flood event, only the extreme southwest corner of the south parcel of the cemetery was flooded. The floodplain to the east and the drainage to the north and west were full of water. Aerial photography taken during the March 2009 flood event shows no flooding in the cemetery, but water filling the floodplain to the east and the drainage north and west of the cemetery's north parcel. Past impacts on the cemetery due to flooding include possible tipping over of headstones (cemetery POC not sure of this). In 2009, there was water on one headstone in the low southwest corner area, the water coming from water backing up the drainage from the Red River. The adjacent road (175th Avenue SE) needed repairs after the 2009 flood from damage caused by overland flooding. Post-flood restoration has included repairs to the adjacent gravel road and possibly resetting of headstones.

For the Project in place, the 10 percent event modeled the peak water surface elevation to be less than 924.0 feet and no flooding on the site, the same as the existing conditions. The 2 percent event will be above 924.0 feet for 4 days with a peak water surface elevation at 924.9 feet; an increase of duration of 4 days and an increase in peak water surface elevation of 1.0 foot over the existing conditions. The 1 percent event will be above 924.0 feet for a duration of 5 days with a peak water elevation at 926.2 feet; an increase in duration of 2.5 days and an increase in peak elevation of 0.5 feet over the existing conditions. The 0.2 percent event will be above 924.0 feet for a duration of 8 days and at a peak water surface elevation of 928.3 feet; an increase in duration of 1 day with no change in peak water surface elevation compared to the existing conditions.

The maximum increase in water surface elevation with the Project in place would be 0.9 foot depth and the maximum additional duration would be 4 days more than that experienced under existing conditions.

Table 8. Eagle Valley Evangelical Cemetery Synthetic Flooding Data

Return Frequency	Existing Conditions		With Project	
	Peak Water Elevation	Duration (Days) of WSEL Above Natural Ground	Peak Water Elevation	Duration (Days) of WSEL Above 924.0
10 percent	917.0	0	916.9	0
2 percent	923.9	0	924.9	4
1 percent	925.7	2.5	926.2	5
0.2 percent	928.3	7	928.3	8
Note: 924.0 feet is the approximate lowest site elevation				
All Hydraulic Data Taken from Phase 7 HEC-RAS Models March 2013				

THE FIRST ALTERNATIVE evaluated was a ring berm surrounding the cemetery to minimize impacts from staged water. A feasibility level berm layout is included in Appendix D, Site Plan #8 drawing. A typical berm

section drawing is included at the end of Appendix D. The configuration of this berm has an average height of 6 feet, a maximum height of 7 feet, a crest width of 10 feet and 3H:1V side slopes. The height was measured from the cemetery grade. The elevation of the existing ground, on the staging side of the berm, has an elevation that is approximately 20 foot lower than the elevation of the interior side of the berm. The design further address the concerns highlighted herein and subsequent challenges resulting from site specific constraints.

EXTERIOR FLOOD CONTROL

The ring berm will include the one road on the west as part of the berm to enclose the site. The road will be elevated to the protected level and transition at a 2 percent grade back to existing road bed elevation. The berm is located a minimum of 20 feet from trees surrounding the cemetery and drainage will be redirected around the south side of the berm from west to east. The ditch currently draining on the west and north side of the site will be rerouted to a swale to the south of the site flowing from, 175th Avenue SE, west to east directly to the Red River. An erosion control drop structure would have to be implemented in order to protect the slopes of the Red River from erosion.

The resulting berm construction may result in impacts to wetlands that may require mitigation. Because of the proximity of the cemetery boundary to an existing steep slope, this alternative includes a significant amount of fill. Although the base of the constructed slope would be a considerable distance from the Red River a more detailed geotechnical analysis would be necessary prior to implementation of this alternative. Access to the cemetery would require some re-grading because the township road at the existing access point would be raised. The modifications to the existing access road would not impact the cemetery itself because the cemetery is set back from the road by over 100 feet.

INTERIOR FLOOD CONTROL

The components of the interior flood control include a ditch parallel to and inside the berm, gated outlet appurtenances, and pump system. The drainage from inside the ring berm will be collected by shallow ditches parallel to the ring berm. These interior ditches will convey the interior drainage to a culvert located near the northwest corner of the cemetery. The drainage outlet will include provisions to close the culvert during flood events as well as a pump station to allow pumping of runoff during flood events when the outlet would be prevented from draining by gravity.

Two options for pump stations have been included in the analysis, one with a wet well in which a portable pump would be installed and operated during flood events and a second with a permanent automated pump station. For the purpose of this report, the wet well and portable pump option has been considered the base option and the automated pump station has been considered the alternate option.

OPTIONAL ACCESS TO SITE

Access to the site during the flood event could be maintained by improving approximately ½ mile of gravel township road, which connects to the existing county road south of the site. There will be a range of 0 to 4 feet rise in grade for the optional access path (Appendix E). It is anticipated there will be utility coordination and relocation, temporary construction easements and permanent right of way acquisitions, water crossing extension or reconstruction and road raising. The cost estimate for the road raise necessary to maintain access to the site during a flood is included in Appendix F

It should be noted that raising roads within the staging area may impact hydraulics during some flood events. The access improvements do not include provisions for allowing additional conveyance under raised roadways.

In the case of the Eagle Valley Evangelical Cemetery, an analysis of the Phase 7 HEC-RAS model results show that raising roads to access the cemetery during floods may impact water surface elevations in the area.

THE SECOND ALTERNATIVE does not prevent floodwaters from inundating the cemetery but instead allows the event to occur. Two structural measures are utilized for this alternative. The first will be to incorporate a fence that is structurally capable of preventing potential damaging floodwater debris from impacting the headstones or entering the site. The second measure is to anchor the upright monuments (headstones), which would provide increased resiliency from potential debris flowing within the floodwaters.

There are upright, beveled, flat and unmarked monuments. Aerial imagery was used to categorize the total grave sites into upright or beveled and flat. Since the upright or beveled monuments both cast a shadow an accurate differentiation could not be determined.

The protection of the upright monuments is the focus for this alternative. It should be noted that this alternative may not be warranted if the floodwaters are not deep enough to transport the potential damaging debris. Regardless, there were two options considered for the fence alternative. Option 1 looked at providing one foot of protection above the upright monuments up to five feet in height. Option 2 looked at providing one foot of protection above the estimated high water surface elevation for the 0.2 percent chance flood event. Option 1 will provide equal protection from any flood event, whereas option 2 will only provide protection up to the estimated high water elevation.

Both options will consider standard fence heights of 4, 6, 7, 8 and 10 feet; and a special case fence height of 12 feet. Minor earthwork grading will be necessary along the fence alignment in order to maintain the protection elevation, and maintain positive drainage at the cemetery. An iron fence was used for this alternative and assumed to be cast iron.

For the fence alternative option 1, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at a uniform elevation with a minimum vertical clearance of one foot above all upright monuments. The fence will be the barrier that prevents any potential damaging debris from entering the cemetery until the water level is one foot above the tallest upright monument where the debris would safely float by with no impact to the monuments.

For the fence alternative option 2, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at or above a determined elevation for the site, which is one foot above the estimated high water surface elevation for the 0.2 percent chance flood event. The fence will be the barrier that prevents any potential damaging debris from entering the site.

Anchoring the upright monuments should consist of evaluating the existing stability of the upright monuments and determine any needed measures to maintain stability during a flood event. The upright monuments likely consist of a soil or concrete foundation; a base usually is made of granite, bronze or concrete; and the upright section, which is commonly referred as a die. It is common practice that the die will be pinned and or glued to the base as the type of anchoring system in place in order for the monument to be upright. The approach for this alternative will assume that there is no existing anchoring system in place, while the new anchoring system will consist of incorporating four 30-inch long dowel bars and concrete. This anchoring system of the die is similar to current practices.

THE THIRD ALTERNATIVE considers raising the existing ground at the cemetery site one foot above the 0.2 percent flood event. The actual buried grave will not be disturbed with this alternative. This alternative would include a survey of the graves sites and markers, removing the grave markers, installing embankment material to raise the site, and resetting the removed markers. The costs associated with any possible requirements by the State Historical Preservation Office have not been estimated for this study.

3.2.6 Site 9 - Wolverton Cemetery

The Wolverton Cemetery (also known as the Salem Lutheran Cemetery) is composed of two adjacent parcels totally approximately 2.1 acres (pin nos. 31-028-0050 and 31-28-0040) located in the SW quarter of the SW quarter of the SW quarter of the NW quarter of Section 28, Township 136 North, Range 48 West, Wolverton Township, Wilkin County, Minnesota. This cemetery is approximately 215 feet north-south by 395 feet east-west. It is located within the city limits of Wolverton and is bounded on the south by Park Avenue, on the north and east by an agricultural field, and on the west by an unnamed tributary to the Red River of the North. A narrow, approximately two-foot-deep road ditch is located between the cemetery and the gravel road. The city of Wolverton is one-quarter mile to the east. According to the NRCS's Web Soil Survey, soils at the cemetery consist of Fargo silty clay, 0 to 2 percent slopes. Soils in the drainage adjacent to the west are Lamoure silty clay loam, 0 to 1 percent slopes, occasionally flooded.

Vegetation in the cemetery consists of mown lawn grass with a row of deciduous trees on the west, north and east sides, an interior north-south line of deciduous trees one-third of the distance from the east edge, and scattered conifers in the interior of the western two-thirds of the cemetery. The main entrance to the cemetery is off the road to the south into the west parcel. It is marked by a two-door wrought-iron gate between two square brick pillars. The metal plaque on the right-hand pillar gives the name of the cemetery as "SALEM CEMETERY". A second entrance leads from the gravel road into the east parcel of the cemetery. This active cemetery contains 220 marked graves and 2 unmarked graves dating from 1908 to the present. Headstones include both vertical monuments and horizontal slabs. The church associated with this cemetery is now gone, but was presumably located in the eastern parcel. There is a small storage shed for lawnmowers and other maintenance tools at the cemetery.

Ground surface elevations in the cemetery range from a low of about 921.0 feet in the extreme southwest corner to a high of 930.0 feet along the center of the north side and the east half of the south side. The eastern two-thirds of the cemetery is at or above 929.0 feet. For modeled existing conditions, the 10 percent event peak water elevation is 917.7 feet; the 2 percent event peak water elevation is 925.0 feet; the 1 percent event peak water elevation is 926.8 feet; and the 0.2 percent event peak water elevation is 930.0 feet. There is no flooding for the 10 percent event. During the 2 percent event, the southwest corner of the cemetery is flooded up to 2 feet depth for 3.5 days. During the 1 percent event, the western third of the cemetery is flooded up to 3.8 feet depth for 4 days. Almost the entire cemetery is inundated during a 0.2 percent event, with the floodwater depth ranging from 1 foot over the eastern two-thirds of the cemetery to 7 feet in its southwest corner, with a duration of 8.5 days.

Based on aerial photography taken during the 1997 flood event, the southwest corner and western edge of the cemetery were inundated by water from the adjacent tributary to the Red River. Aerial photography taken during the March 2009 flood event shows flooding of the cemetery's southwest corner to a lesser extent than in 1997. Past impacts on the cemetery due to flooding include damage to grass in the southwest corner of the cemetery.

There are no graves in this low corner of the cemetery. Park Avenue was washed out west of the cemetery during flooding and will be raised.

For the Project in place, the 10 percent event modeled the peak water surface elevation to be lower than 923.0 feet with no flooding the same as existing conditions. The 2 percent event will be above 923.0 feet for a duration of 5.5 days with a peak water elevation at 925.7 feet; an increase in duration of 2 days and an increase in peak elevation of 0.7 feet over the existing conditions. The 1 percent event will be above 923.0 feet for a duration of 7 days with a peak water elevation at 927.2 feet; an increase in duration of 3 days and an increase in peak water surface elevation of 0.4 feet over the existing conditions. The 0.2 percent event will be above 923.0 feet for a duration of 9.5 days with a peak water elevation at 930.0 feet; an increase in duration of 1 day and no change in the peak elevation compared to the existing conditions.

The maximum increase in water surface elevation with the Project in place would be 0.7 feet and maximum additional duration would be 3 days more than that modeled under existing conditions. The portion of the cemetery impacted with the Project in place would be the same as under existing conditions, that is, only the southwestern corner would be flooded until greater than the 1 percent event.

Table 9. Wolverton Cemetery Synthetic Flooding Data

Return Frequency	Existing Conditions		With Project	
	Peak Water Elevation	Duration (Days) of WSEL Above Natural Ground	Peak Water Elevation	Duration (Days) of WSEL Above 923.0
10 percent	917.7	0	917.7	0
2 percent	925.0	3.5	925.7	5.5
1 percent	926.8	4	927.2	7
0.2 percent	930.0	8.5	930.0	9.5
Note: 923.0 is the approximate lowest site elevation				
All Hydraulic Data Taken from Phase 7 HEC-RAS Models March 2013				

THE FIRST ALTERNATIVE evaluated was a ring berm surrounding the cemetery to minimize impacts from staged water. A feasibility level berm layout is included in Appendix D, Site Plan #9 drawing. A typical berm section drawing is included at the end of Appendix D. The configuration of this berm has an average height of 5 feet, a maximum height of 10 feet, a crest width of 8 feet and 3H:1V side slopes. The design further address the concerns highlighted herein and subsequent challenges resulting from site specific constraints.

EXTERIOR FLOOD CONTROL

The ring berm will include raising a portion of the road on the south boundary of the cemetery. The road will be elevated to the protected level and transition at a 2 percent grade back to existing road bed elevation. The berm and interior ditch is located a minimum of 20 feet from trees surrounding the cemetery and drainage will be redirected around the north side of the berm from east to west. Because of the proximity of the cemetery boundary to a drainage pathway, this alternative includes a significant amount of fill along the west boundary of the site. The resulting berm construction may result in impacts to wetlands that may require mitigation. Access to the cemetery would require little re-grading because the elevation of the road at the existing access point would change very little.

INTERIOR FLOOD CONTROL

The components of the interior flood control include a ditch parallel to and inside the berm, gated outlet appurtenances, and pump system. The drainage from inside the ring berm will be collected by shallow ditches parallel to the ring berm. These interior ditches will convey the interior drainage to a culvert located near the northwest corner of the cemetery. The drainage outlet will include provisions to close the culvert during flood events as well as a pump station to allow pumping of runoff during flood events when the outlet would be prevented from draining by gravity.

Two options for pump stations have been included in the analysis, one with a wet well in which a portable pump would be installed and operated during flood events and a second with a permanent automated pump station. For the purpose of this report, the wet well and portable pump option has been considered the base option and the automated pump station has been considered the alternate option.

OPTIONAL ACCESS TO SITE

No additional roadway improvements would be necessary to provide access to the Wolverton Cemetery because the existing access route is elevated above the 0.2 percent water surface elevation.

THE SECOND ALTERNATIVE does not prevent floodwaters from inundating the cemetery but instead allows the event to occur. Two structural measures are utilized for this alternative. The first will be to incorporate a fence that is structurally capable of preventing potential damaging floodwater debris from impacting the headstones or entering the site. The second measure is to anchor the upright monuments (headstones), which would provide increased resiliency from potential debris flowing within the floodwaters.

There are upright, beveled, flat and unmarked monuments. Aerial imagery was used to categorize the total grave sites into upright or beveled and flat. Since the upright or beveled monuments both cast a shadow an accurate differentiation could not be determined.

The protection of the upright monuments is the focus for this alternative. It should be noted that this alternative may not be warranted if the floodwaters are not deep enough to transport the potential damaging debris. Regardless, there were two options considered for the fence alternative. Option 1 looked at providing one foot of protection above the upright monuments up to five feet in height. Option 2 looked at providing one foot of protection above the estimated high water surface elevation for the 0.2 percent chance flood event. Option 1 will provide equal protection from any flood event, whereas option 2 will only provide protection up to the estimated high water elevation.

Both options will consider standard fence heights of 4, 5, 6, 7, 8, and 10 feet; and a special case fence height of 12 feet. Minor earthwork grading will be necessary along the fence alignment in order to maintain the protection elevation, and maintain positive drainage at the cemetery. An iron fence was used for this alternative and assumed to be cast iron.

For the fence alternative option 1, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at a uniform elevation with a minimum vertical clearance of one foot above all upright monuments. The fence will be the barrier that prevents any potential damaging debris from entering the cemetery until the water level is one foot above the tallest upright monument where the debris would safely float by with no impact to the monuments.

For the fence alternative option 2, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at or above a determined elevation for the site, which is one foot above the estimated high water surface elevation for the 0.2 percent chance flood event. The fence will be the barrier that prevents any potential damaging debris from entering the site.

Anchoring the upright monuments should consist of evaluating the existing stability of the upright monuments and determine any needed measures to maintain stability during a flood event. The upright monuments likely consist of a soil or concrete foundation; a base usually is made of granite, bronze or concrete; and the upright section, which is commonly referred as a die. It is common practice that the die will be pinned and or glued to the base as the type of anchoring system in place in order for the monument to be upright. The approach for this alternative will assume that there is no existing anchoring system in place, while the new anchoring system will consist of incorporating four 30-inch long dowel bars and concrete. This anchoring system of the die is similar to current practices.

THE THIRD ALTERNATIVE considers raising the existing ground at the cemetery site one foot above the 0.2 percent flood event. The actual buried graves will not be disturbed with this alternative. This alternative would include a survey of the graves sites and markers, removing the grave markers, installing embankment material to raise the site, and resetting the removed markers. The costs associated with any possible requirements by the State Historical Preservation Office have not been estimated for this study.

3.3 Wolverton Creek

3.3.1 Site 10 - Hoff Cemetery

The Hoff Cemetery is an approximately 1.6 acre parcel (pin no. 150093301) located in the SW quarter of the SW quarter of the SW quarter of the SW quarter of Section 9, Township 137 North, Range 48 West, Holy Cross Township, Clay County, Minnesota. The cemetery parcel is approximately 210 feet north-south by 340 feet east-west. It is bounded on the north and east by brushy slopes down to Wolverton Creek, on the south by a gravel road, 140th Avenue South, and on the west by U.S. Highway 75. There is a wide ditch between the cemetery and Highway 75. The lines of an overhead power line cross the western half of the cemetery with poles outside the cemetery to the north and south. According to the NRCS's Web Soil Survey, soils in the cemetery consist of Wahpeton silty clay, 2 to 6 percent slopes, occasionally flooded.

Vegetation in the cemetery consists of mown lawn grass with a line of conifers inside a line of deciduous trees along the east side and scattered deciduous trees along the west and north sides of the cemetery. Access to the cemetery is from 140th Avenue South. This active cemetery contains 115 graves dating from 1904 to the present. Any burials before 1960 could likely be in wood caskets. Headstones consist of both vertical monuments and horizontal slabs. There is a brick monument with a metal plaque with the cemetery's name on it. No church building was ever present at this cemetery. There are no buildings at the cemetery.

Ground surface elevations in the cemetery range from a low of approximately 908.0 feet in the northeast corner to a high of 916.0 feet along the south side of the cemetery. For modeled existing conditions, the 10 percent event peak water elevation is 909.5 feet; the 2 percent event peak water elevation is 913.5 feet; the 1 percent event peak water elevation is 914.2 feet; and the 0.2 percent event peak water elevation is 915.1 feet. Under existing conditions, during the 10 percent event the northeastern part of the cemetery is flooded by up to 1.5 feet of water for 3 days. During the 2 percent event, about two-thirds of the cemetery is flooded by up to 5.5 feet of water for 9 days. During the 1 percent event, three-quarters of the cemetery is flooded by up to 6.2 feet of water

for 10 days. During the 0.2 percent event, almost the entire cemetery is flooded by 7.1 feet of water for 14.5 days.

Based on aerial photography taken during the 1997 flood event, the northern two-thirds of the cemetery was inundated by an overflowing Wolverton Creek. Aerial photography taken during the March 2009 flood event shows a similar level and source of flooding (and possibly ice) in the cemetery. Past impacts on the cemetery due to flooding include vegetation loss, headstones tipped over, and debris washed in. The existing trees snag and hold logs. Post-flood restoration involved cemetery trustees doing the clean-up and the monument companies that had originally put out the headstones, setting them back in place. Labor was a mix of volunteers and contracted additional lawn care. The cemetery association currently has a permit to build a levee to 917.0 feet. They will start building the ring levee after completion of the Project's mitigation plan for the Hoff Cemetery.

For the Project in place, the 10 percent event modeled the peak water surface elevation to be above 908.0 feet for a duration of 3 days with a peak water surface elevation at 909.6 feet; no increase in duration, but an increase in peak water surface of 0.1 feet in comparison to the existing conditions. The 2 percent event will be above 908.0 feet for a duration of 11.5 days with the peak water elevation at 921.5 feet; an increase in duration of 2.5 days and an increase of peak water surface of 8 feet over the existing conditions. The 1 percent event will be above 908.0 feet for a duration of 12 days with the peak water elevation at 922.2 feet; an increase in duration of 2.0 days and an increase of peak water surface of 8.0 feet over the existing conditions. The 0.2 percent event will be above 908.0 feet for a duration of 14 days with the peak water elevation at 922.2 feet; an increase in duration of 0.5 days and an increase of peak water surface of 7.1 feet over the existing conditions.

A majority of the cemetery would be inundated during the 2 percent or larger events with the Project in place. The maximum increase in water surface elevation with the Project in place would be 8.0 feet and maximum additional duration would be 2.5 additional days versus that modeled under existing conditions.

Table 10. Hoff Cemetery Synthetic Flooding Data

Return Frequency	Existing Conditions		With Project	
	Peak Water Elevation	Duration (Days) of WSEL Above Natural Ground	Peak Water Elevation	Duration (Days) of WSEL Above 908.0
10 percent	909.5	3	909.6	3
2 percent	913.5	9	921.5	11.5
1 percent	914.2	10	922.2	12
0.2 percent	915.1	14.5	922.2	14
Note: 908.0 is the approximate lowest site elevation				
All Hydraulic Data Taken from Phase 7 HEC-RAS Models March 2013				

THE FIRST ALTERNATIVE evaluated was a ring berm surrounding the cemetery to minimize impacts from staged water. A feasibility level berm layout is included in Appendix D, Site Plan #10 drawing. A typical berm section drawing is included at the end of Appendix D. The configuration of this berm has an average height of 10 feet, a maximum height of 16 feet, a crest width of 10 feet and 3H:1V side slopes. The design further address the concerns highlighted herein and subsequent challenges resulting from site specific constraints.

EXTERIOR FLOOD CONTROL

The berm and interior ditch would be located a minimum of 20 feet from trees surrounding the cemetery. The ring berm will include raising the township road located immediately south of the property and will tie into US Highway 75, which will be raised as part of the Project. The roads will be elevated to the protected level and transition at a 2 percent grade back to existing road bed elevation. This improvement will require the two reinforced concrete box culverts (2x12'x15') located just east of the cemetery to be relocated 100 feet further east. The close proximity of the cemetery to Wolverton Creek will require a significant amount of fill for the berm along the north and east boundary of the cemetery site, which will require realigning a portion of Wolverton Creek to the north and east of its current alignment. The resulting berm construction would result in impacts to wetlands (Wolverton Creek) that would require mitigation. A floodwall alternative along the north and east boundaries of the cemetery was evaluated, which eliminates the impact to Wolverton Creek and will not require relocation of the reinforced concrete box culverts. Access to the cemetery would still require significant re-grading because the elevation difference between the top of berm and the existing ground. Costs have been estimated and captured in the cost estimate (Appendix F).

INTERIOR FLOOD CONTROL

The components of the interior flood control include a ditch parallel to and inside the berm, gated outlet appurtenances, and pump system. The drainage from inside the ring berm will be collected by shallow ditches parallel to the ring berm. These interior ditches will convey the interior drainage to a culvert located near the northeast corner of the cemetery. The drainage outlet will include provisions to close the culvert during flood events as well as a pump station to allow pumping of runoff during flood events when the outlet would be prevented from draining by gravity.

Two options for pump stations have been included in the analysis, one with a wet well in which a portable pump would be installed and operated during flood events and a second with a permanent automated pump station. For the purpose of this report, the wet well and portable pump option has been considered the base option and the automated pump station has been considered the alternate option.

OPTIONAL ACCESS TO SITE

Access to the site will be maintained during flood events because the Project includes raising US Highway 75 which, as noted, would act as a portion of the ring berm for Hoff Cemetery.

THE SECOND ALTERNATIVE does not prevent floodwaters from inundating the cemetery but instead allows the event to occur. Two structural measures are utilized for this alternative. The first will be to incorporate a fence that is structurally capable of preventing potential damaging floodwater debris from impacting the headstones or entering the site. The second measure is to anchor the upright monuments (headstones), which would provide increased resiliency from potential debris flowing within the floodwaters.

There are upright, beveled, flat and unmarked monuments. Aerial imagery was used to categorize the total grave sites into upright or beveled and flat. Since the upright or beveled monuments both cast a shadow an accurate differentiation could not be determined.

The protection of the upright monuments is the focus for this alternative. There were two options considered for the fence alternative. Option 1 looked at providing one foot of protection above the upright monuments up to five feet in height. Option 2 looked at providing one foot of protection above the estimated high water surface elevation for the 1 or 0.2 percent chance flood event. Option 1 will provide equal protection from any flood event, whereas option 2 will only provide protection up to the estimated high water elevation.

Option 1 will consider standard fence heights of 6, 7, and 10 feet; and option 2 will consider a special case fence height of 15 feet. Minor earthwork grading will be necessary along the fence alignment in order to maintain the protection elevation, and maintain positive drainage at the cemetery. An iron fence was used for this alternative and assumed to be cast iron.

For the fence alternative option 1, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at a uniform elevation with a minimum vertical clearance of one foot above all upright monuments. The fence will be the barrier that prevents any potential damaging debris from entering the cemetery until the water level is one foot above the tallest upright monument where the debris would safely float by with no impact to the monuments.

For the fence alternative option 2, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at or above a determined elevation for the site, which is one foot above the estimated high water surface elevation for the 1 or 0.2 percent chance flood event. The fence will be the barrier that prevents any potential damaging debris from entering the site.

Anchoring the upright monuments should consist of evaluating the existing stability of the upright monuments and determine any needed measures to maintain stability during a flood event. The upright monuments likely consist of a soil or concrete foundation; a base usually is made of granite, bronze or concrete; and the upright section, which is commonly referred as a die. It is common practice that the die will be pinned and or glued to the base as the type of anchoring system in place in order for the monument to be upright. The approach for this alternative will assume that there is no existing anchoring system in place, while the new anchoring system will consist of incorporating four 30-inch long dowel bars and concrete. This anchoring system of the die is similar to current practices.

3.3.2 Site 11 - Comstock Cemetery

The Comstock Cemetery is a 2.6 acre parcel (pin no. 150281000) located in the NE quarter of the NE quarter of the NE quarter of the NE quarter of Section 28, Township 137 North, Range 48 West, Holy Cross Township, Clay County, Minnesota. The cemetery parcel is approximately 315 feet north-south by 270 feet east-west. It is bounded by paved County Road 2 (160th Avenue South) on the north, by a gravel road, 23th Street South, on the east, and by an agricultural field on the south and west. The city of Comstock is located one-half mile to the west. According to the NRCS's Web Soil Survey, soils in the western three-quarters of the cemetery are Bearden-Fargo complex, 0 to 2 percent slopes, and soils in the eastern quarter of the cemetery are Hegne-Fargo silty clays, 0 to 2 percent slopes.

Vegetation in the cemetery consists of mown lawn grass with a single row of widely-spaced conifers and deciduous trees around the edge of the cemetery plus a couple of trees in the interior. An L-shaped gravel road passes through the cemetery from County Road 2 to the gravel road on the east. A brick monument with a metal plaque containing the name of the cemetery and a wooden sign ("COMSTOCK LUTHERAN CEMETERY") with cemetery information are located near the north entrance. This active cemetery contains 338 marked graves and one unmarked grave dating from 1901 to the present. Headstones include both vertical monuments and horizontal slabs. This cemetery was the original Lutheran cemetery for the city of Comstock. There are no buildings at the cemetery.

Ground surface elevation in the cemetery is approximately 922.0 feet, with road ditches to the north and east at 921.0 feet. There is no flooding at the cemetery for the modeled existing conditions 10 percent, 2 percent, 1 percent, and 0.2 percent events. The peak water elevation for these events is less than 922.0 feet.

Based on aerial photography taken during the 1997 flood event, there was water in the County Road 2 ditches but none in the Comstock Cemetery itself. Aerial photography taken during the March 2009 flood event shows a similar water level in the road ditches, but no flooding in the cemetery. Because the cemetery has never flooded, no post-flood clean-up has been necessary. However, they have had to repair vandalism to the cemetery. County Road 2 is above 922.5 feet elevation and has not been flooded so access has not been a problem.

For the Project in place, the 10 percent event modeled the peak water surface elevation to be less than 922.0 feet and will not flood, the same as the existing conditions. The 2 percent event will be less than 922.0 feet and will not flood, the same as the existing conditions. The 1 percent and 0.2 percent events will be above 922.0 feet both for a duration of 2 days and both with a peak water elevation at 922.3 feet; an increase in duration of 2 days and an increase in peak water surface elevation of 0.3 feet over the existing conditions.

There would be no flooding at the cemetery during the 10 percent and 2 percent events. With the Project in place there would be 0.3 feet (3.6 inches) of water over the entire cemetery for 2 days during the 1 percent and 0.2 percent events versus no flooding under existing conditions.

Table 11. Comstock Cemetery Synthetic Flooding Data

Return Frequency	Existing Conditions		With Project	
	Peak Water Elevation	Duration (Days) of WSEL Above Natural Ground	Peak Water Elevation	Duration (Days) of WSEL Above 922.0'
10 percent	No Flooding		No Flooding	
2 percent	No Flooding		921.5	0
1 percent	No Flooding		922.3	2
0.2 percent	No Flooding		922.3	2
Note: 922.0 is the approximate lowest site elevation				
All Hydraulic Data Taken from Phase 7 HEC-RAS Models March 2013				

THE FIRST ALTERNATIVE evaluated was a ring berm surrounding the cemetery to minimize impacts from staged water. A feasibility level berm layout is included in Appendix D, Site Plan #11 drawing. A typical berm section drawing is included at the end of Appendix D. The configuration of this berm has an average height of 1 foot and a maximum height of 1.3 feet, with a crest width of 4 feet and 3H:1V side slopes. The design further address the concerns highlighted herein and subsequent challenges resulting from site specific constraints.

EXTERIOR FLOOD CONTROL

The ring berm would tie into the existing roads on the north and east boundaries of the cemetery and would generally be approximately two feet tall. The berm and interior ditch would be located a minimum of 20 feet from trees surrounding the cemetery. Access to the cemetery would remain unchanged because the existing roads would not be inundated.

INTERIOR FLOOD CONTROL

The components of the interior flood control include a ditch parallel to and inside the berm, gated outlet appurtenances, and pump system. The drainage from inside the ring berm will be collected by shallow ditches

parallel to the ring berm. These interior ditches will convey the interior drainage to a culvert located near the southeast corner of the cemetery. The drainage outlet will include provisions to close the culvert during flood events as well as a pump station to allow pumping of runoff during flood events when the outlet would be prevented from draining by gravity.

Two options for pump stations have been included in the analysis, one with a wet well in which a portable pump would be installed and operated during flood events and a second with a permanent automated pump station. For the purpose of this report, the wet well and portable pump option has been considered the base option and the automated pump station has been considered the alternate option.

OPTIONAL ACCESS TO SITE

Access to the site will be maintained during flood events because the existing roadway is at an elevation that will remain dry and which, as noted, would act as a portion of the ring berm for Comstock Cemetery.

THE SECOND ALTERNATIVE does not prevent floodwaters from inundating the cemetery but instead allows the event to occur. Two structural measures are utilized for this alternative. The first will be to incorporate a fence that is structurally capable of preventing potential damaging floodwater debris from impacting the headstones or entering the site. The second measure is to anchor the upright monuments (headstones), which would provide increased resiliency from potential debris flowing within the floodwaters.

There are upright, beveled, flat and unmarked monuments. Aerial imagery was used to categorize the total grave sites into upright or beveled and flat. Since the upright or beveled monuments both cast a shadow an accurate differentiation could not be determined.

The protection of the upright monuments is the focus for this alternative. It should be noted that this alternative may not be warranted if the floodwaters are not deep enough to transport the potential damaging debris. Regardless, there were two options considered for the fence alternative. Option 1 looked at providing one foot of protection above the upright monuments up to five feet in height. Option 2 looked at providing one foot of protection above the estimated high water surface elevation for the 1 or 0.2 percent chance flood event. Option 1 will provide equal protection from any flood event, whereas option 2 will only provide protection up to the estimated high water elevation.

Both options will consider standard fence heights of 4, 5 and 6 feet. Minor earthwork grading will be necessary along the fence alignment in order to maintain the protection elevation, and maintain positive drainage at the cemetery. An iron fence was used for this alternative and assumed to be cast iron.

For the fence alternative option 1, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at a uniform elevation with a minimum vertical clearance of one foot above all upright monuments. The fence will be the barrier that prevents any potential damaging debris from entering the cemetery until the water level is one foot above the tallest upright monument where the debris would safely float by with no impact to the monuments.

For the fence alternative option 2, the fence will surround the perimeter of the cemetery. The top of the fence will be installed at or above a determined elevation for the site, which is one foot above the estimated high water surface elevation for the 1 or 0.2 percent chance flood event. The fence will be the barrier that prevents any potential damaging debris from entering the site.

Anchoring the upright monuments should consist of evaluating the existing stability of the upright monuments and determine any needed measures to maintain stability during a flood event. The upright monuments likely consist of a soil or concrete foundation; a base usually is made of granite, bronze or concrete; and the upright section, which is commonly referred as a die. It is common practice that the die will be pinned and or glued to the base as the type of anchoring system in place in order for the monument to be upright. The approach for this alternative will assume that there is no existing anchoring system in place, while the new anchoring system will consist of incorporating four 30-inch long dowel bars and concrete. This anchoring system of the die is similar to current practices

THE THIRD ALTERNATIVE considers raising the existing ground at the cemetery site one foot above the 1 and 0.2 percent flood events. The actual buried graves will not be disturbed with this alternative. This alternative would include a survey of the graves sites and markers, removing the grave markers, installing embankment material to raise the site, and resetting the removed markers. The costs associated with any possible requirements by the State Historical Preservation Office have not been estimated for this study.

3.4 Summary

The mitigation alternatives costs are summarized in the below Table 12. Additional detail on the cost estimates is provided in Appendix F – Cost Estimates.

Table 12. Cost Summary of Mitigation Alternatives

No.	Item	ESTIMATED COSTS PER SITE ($1,000)											
	MITIGATION ALTERNATIVES	North Pleasant 1	South Pleasant 2	South Pleasant Church 3	Lower Wild Rice and Red River 4	Clara 5	Roen 6	Hemnes* 7	Eagle 8	Wolverton 9	Hoff** 10	Comstock 11	
1A	BERM	291	408	367	4,147	974	0	432	510	1,025	2,682	84	10,920
1B	OFFSITE ACCESS	744	290	0	0	1,093	0	640	364	0	0	0	3,131
1. A+B	BERM WITH OFFSITE ACCESS	1,035	698	367	4,147	2,067	0	1,072	874	1,025	2,682	84	14,051
2 Op 1	DEBRIS FENCE & ANCHORING	679	413	574	587	552	74	555	700	592	528	383	5,637
2 Op 2	DEBRIS FENCE & ANCHORING	490	261	356	1,422	620	74	508	438	411	548	346	5,474
3.	LOW AREA RAISE	0	0	187	0	0	0	0	424	399	0	386	1,396

* Hemnes costs assume reclaimed and stabilization of Red River bank are successful. Cost of berm/floodwall option with stabilization was estimated to be $2,848,000.

**Berm alternative for Hoff 140th Ave S crossingincludes the crossing improvement across Woverton Creek. Cost of floodwall option is estimated to be $6,280,000.

4. References

[1] "USGS Flood Tracking 05054000 RED RIVER OF THE NORTH AT FARGO, ND," 16 July 2012. [Online]. Available: http://nd.water.usgs.gov/floodtracking/charts/05054000.html.

[2] U.S. Army Corps of Engineers, "Appendix C: Economics," in *Fargo-Moorhead Metropolitan Area Flood Risk Management, Final Feasibility Report and Environmental Impact Statement*, July 2011.

[3] "State and County QuickFacts," U.S. Census Bureau, 6 June 2012. [Online]. Available: http://quickfacts.census.gov/qfd/index.html. [Accessed 16 July 2012].

[4] U.S. Army Corps of Engineers, "Engineering Manual (EM) 1110-2-1913 - Design and Construction of Levees," Washington DC, April 30, 2000.

[5] U.S. Army Corps of Engineers, "Engineering Manual (EM) 1110-2-571 - Guidelines for Landscape Plantings and Vegetation Management at Levees, Floodwalls, Embankment dams, and Appurtenant Structures," Washington D.C., April 10, 2009.

5. Appendices

Appendix A	**USACE Cemetery Study**
Appendix B	**Cemetery Parcel Maps**
Appendix C	**Historic Inundation Maps**
Appendix D	**Cemetery Mitigation Study Site Plans**
Appendix E	**Off Site Access Map**
Appendix F	**Cost Estimates**