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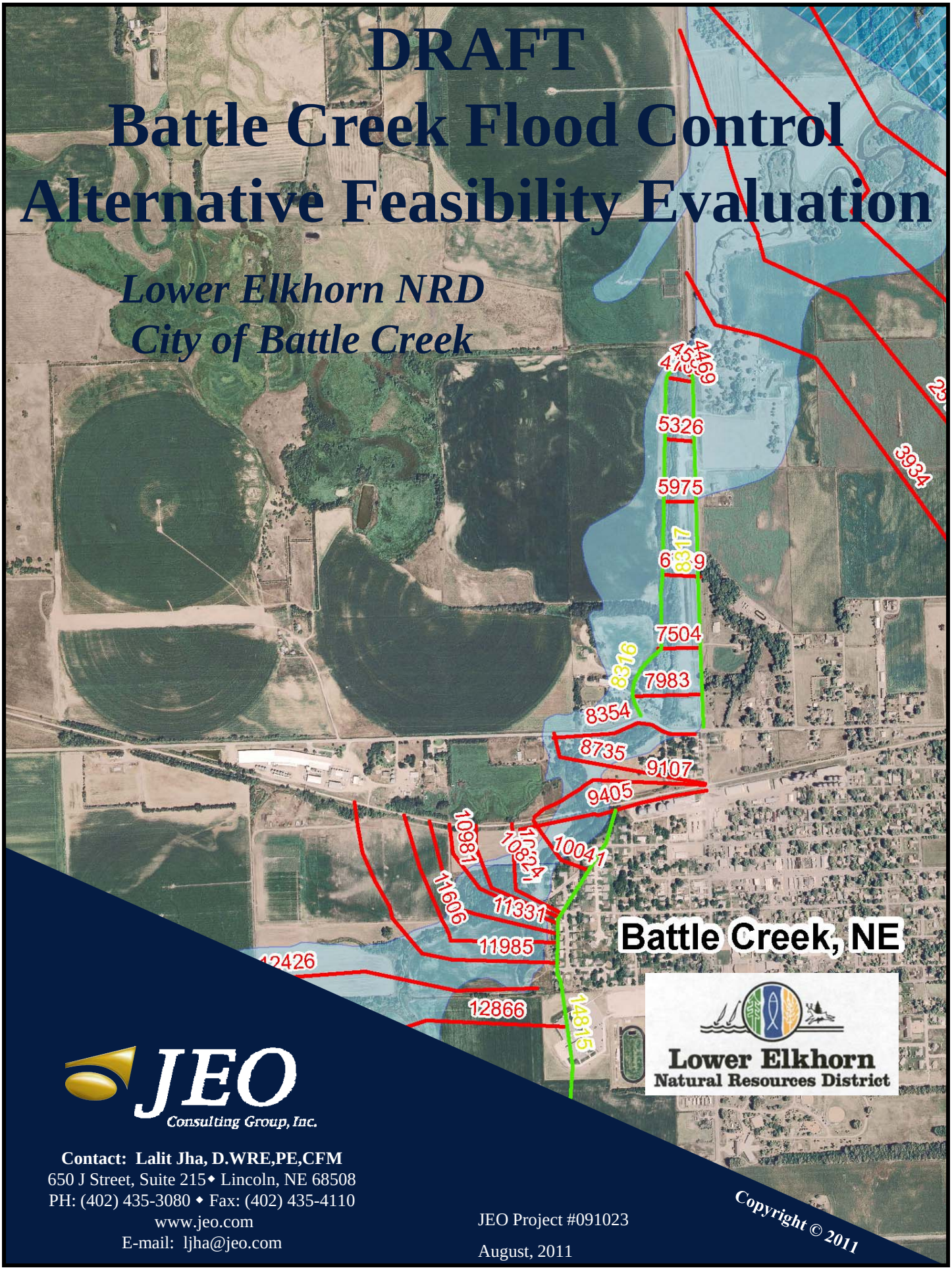
Battle Creek Flood Control Alternative Feasibility Evaluation

Lower Elkhorn NRD

City of Battle Creek



Lower Elkhorn Natural Resources District

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August, 2011

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LOWER ELKHORN NRD AND CITY OF BATTLE CREEK

AUGUST, 2011

1.0 - INTRODUCTION

The City of Battle Creek (City) is a growing second-class city of approximately 1,200 residents in Madison County, Nebraska. The City is located on the right descending bank of Battle Creek (Creek), approximately two miles upstream from the confluence with the Elkhorn River. The City lies on low, flat terrain in the Elkhorn River valley that is prone to flooding during rainfall events.

The majority of the Battle Creek Watershed is located in Madison County with small upstream portions located in Boone County. The City is situated in the lower portion of the Battle Creek watershed; nearly the entire watershed contributes flows to the stream channel adjacent to the City. The watershed of the Creek upstream of the City is approximately 91 square miles and consists of mostly agricultural land uses.

Due to recent flooding events at Battle Creek in 2007 and 2008, the Lower Elkhorn NRD in cooperation with the City of Battle Creek has been completing ongoing evaluations of flooding reduction alternatives for the watershed above the City. These efforts have included a reconnaissance level study completed in February, 2009 as well as a more detailed evaluation of selected alternatives completed in November, 2009. As a follow up to these efforts, JEO has completed this report which serves to further evaluate specific components of the primary flood reduction alternatives being investigated, which include a potential overflow diversion channel or a potential flood control dam. This evaluation includes information on more detailed investigations completed for environmental issues, geotechnical review, diversion channel hydraulic analysis, and a hypothetical NRDF funding evaluation. Each of these items is summarized below in sections 2.0 to 5.0 with more detailed evaluation information being supplied for each in Appendix A – D.

Additional detail regarding past flooding history and planning efforts can be found in the following sections 1.1 and 1.2; the historical evaluation reports from February, 2009 and November, 2009 are also supplied for reference on the enclosed CD in Appendix F.

1.1 - FLOODING HISTORY

Research was conducted on historical occurrences of flood events in order to document detailed flood damages, including dates, number of structures, and costs. During the research period there were no available reports from the Federal Emergency Management Agency (FEMA), Nebraska Emergency Management Agency (NEMA), or Nebraska Department of Natural Resources (NDNR). Due to the lack of detailed information, FEMA's HAZUS-MH was used to model and approximate probable damages which might occur during a 1% annual chance storm. LIDAR used to run HAZUS is accurate up to 6 inch contours of elevation.

- **1940s** – The earliest recorded flood occurrence was from the 1940s, where one Battle Creek resident reported at the June 2007 City Council meeting that the City received nine inches of rain and there was water waist deep in the Methodist Church area. Another record provided by the NDNR dates back to June 21, 1960, when five inches of rain caused evacuation of 12 families in Battle Creek and a 1967 flood on record with NDNR shows damages occurred between May 26 and June 16, 1967 due to heavy rain. Frequent damages from flooding spurred the United States Army Corps of Engineers (USACE) to complete a study in 1964 that suggested to construct a ring levee for Battle Creek, this project ultimately was not constructed.

- **May 31, 2007** – A reported five to six inches of rain fell rapidly around the City of Battle Creek and even higher rainfall amounts (up to seven to eight inches) were reported in the upstream reaches of the Battle Creek watershed to the southwest of the City. Following this storm event, the Creek rose very quickly, overtopped its banks and flowed into the City at several locations.

Many of the local roads were quickly inundated with floodwaters, and for a period of time all major roads leading into and out of the City were closed, including State Highway 121.

- Due to the high water levels in the Creek and the nearby Elkhorn River, many of the interior drainage systems in the City (i.e. storm drains and ditches) also did not adequately function, further compounding to the flooding problem in the City. There were also several reports that the City's sanitary sewer system backed up into homes.

- Ultimately, many structures were damaged due to the flooding. According to the NEMA there was approximately $2 million in damages done by this single event in which approximately 85 percent of the City received some flood damage. FEMA declared Presidential disaster #1714 on July 24, 2007, which covered a total of 15 counties.

- **June 8, 2008** – Heavy rain caused flash flooding which closed Highway 121 and many county roads around Battle Creek as well as a few streets in Battle Creek. Unofficial reports of three to four inches of rain fell from this storm in Battle Creek once again causing significant flooding despite sandbags placed around many homes in the area, quite a few residents on the east side of the City had their basements flooded. The continuous flooding spurred the City Council to look further at potential actions to limit damages.

1.2 – PREVIOUS PLANNING EFFORTS

- **1964** – The United States Army Corps of Engineers (USACE) completed a study of a ring levee for Battle Creek that was endorsed by the then City of Battle Creek board, but was not constructed, likely due to inability to acquire funding.

- **1975** – The Madison County Comprehensive Plan included a proposed flood control reservoir approximately four miles upstream of Battle Creek. The proposal was not constructed, primarily due to a lack of funding and public support.

- **2007** – The City of Battle Creek completed the Stormwater Master Plan for the purpose of evaluating existing site conditions, identifying problem areas, developing conceptual improvements, and prioritizing these improvements. The ultimate goal of this Plan was to develop a stormwater action plan that would allow the City to direct future stormwater improvements and guide future growth of the City of Battle Creek. Potential drainage improvement recommendations identified in this Plan included cleaning/re-grading the Battle Creek Channel, revised/updated floodplain mapping, a flood control ring levee around Battle Creek, or a Battle Creek Reservoir or multiple smaller dams.

- **February 2009** – The City completed the "Battle Creek Flooding Evaluation Reconnaissance Level Study" as an assessment of the flooding potential and technical alternatives analysis for projects designed to alleviate that flooding. The study included evaluation of multiple small upstream dams, channel widening, channel cleanout, a flood control levee and floodwall, flood control reservoir, and flood diversion channel. The three alternatives deemed most technically feasible in this study were the levee and floodwall, reservoir, and diversion channel.

- **November 2009** – The City completed a more detailed evaluation to provide technical information on two of the alternatives – the flood control reservoir and flood diversion channel. The City of Battle Creek continues to work towards a feasible solution to alleviate damages from flooding in the Battle Creek Watershed in the future.

1.3 – PROJECT PURPOSE AND NEED

The purpose of the potential Battle Creek Flood Control project is to reduce flooding in the Battle Creek Watershed which includes the City of Battle Creek. The proposed flood control project is needed to reduce property damages resulting from frequent overtopping and flooding of the Battle Creek thus causing damages in the City of Battle Creek. Failure to provide flood control would allow for continued repetitive damages of existing properties in the City of Battle Creek and reduce the likelihood of future growth in the City of Battle Creek.

2.0 – PRELIMINARY ENVIRONMENTAL ASSESSMENT SUMMARY

This section provides a synopsis of the environmental assessment effort; more detail on these efforts can be found in Appendix A and associated attachments as well as on the enclosed CD. This effort included definition of the purpose and need for the project, alternatives analysis, and preliminary investigations into historical properties and archeological information review. As part of this process, a number of coordination meetings with interested agencies, in particular the Nebraska Game and Parks Commission and U.S. Army Corps of Engineers were held.

2.1 – ALTERNATIVES ANALYSIS SUMMARY

The United States Army Corps of Engineers (USACE) requires that a list of reasonable alternatives be evaluated according to criteria of overall project purpose and practicability. Criteria recommended by USACE include: cost, logistics, and existing technology. All practicable alternatives for the Battle Creek Flood Control project have been evaluated against each of the above listed criteria to the extent possible based on currently available information. Those practicable alternatives carried forward were then further evaluated to identify the impacts to aquatic resources. The intent of the analysis is to provide information to the Corps to determine the least environmentally damaging practicable alternative.

Numerous structural flood control strategies, along with the no-action alternative and one regulatory non-structural alternative, were considered to determine if they met the project purpose and need. Structural and non-structural alternatives considered are summarized below:

- No-action
- Channel enlargement/improving conveyance
- Stream restoration with additional wetland storage
- Bridge and culvert clearing and enlargement
- Detention/retention upstream of Battle Creek
- Flood control reservoir at the Nebraska Game and Parks Commission (NGPC) Site
- Flood control reservoir above the NGPC site
- Flood diversion channel
- Multiple smaller sized upstream dams
- Multiple dry dams
- Low-level berms set back from the channel banks to provide floodways
- Levee along the western edge of the City and Battle Creek
- Conservation measures upstream in watershed
- Flood proofing existing structures in the City
- Property acquisitions and property elevation
- Floodplain regulations and zoning controls

Alternatives are carried forward that fulfill the purpose and are practicable. The following section provides information regarding alternatives considered over time and determination of practicability.

2.2 - ALTERNATIVES CONSIDERED FEASIBLE

Three structural alternatives, each of which have been studied in more detail in regards to engineering, environmental analysis, historical impact, hydrologic and hydraulic impacts, cost, and other implications were carried forward, along with the no-action alternative. A project description of each of these alternatives is found below:

- **No-Action Alternative –** With the no-action alternative, the City of Battle Creek would take no direct action to reduce the flood hazard as it exists today from the Battle Creek. Property owners and businesses would continue to suffer frequent damages, continue to face hardships, and the community would have limited capability for future economic growth in the community. According to a preliminary assessment using HAZUS, FEMA's flood loss GIS model (run by JEO in 2010), the no-action alternative could result in up to $5,490,000 in property damages (20% damage) during a 1% annual chance flood. HAZUS estimates Battle Creek to have 647 structures, 301 in the floodplain (created by HAZUS), two agricultural, 12 commercial, one educational, one governmental, two industrial, one religious, and 282 residential structures.

- **Flood Control Reservoir (NGPC Site) –** A large flood control reservoir, located approximately four miles upstream of the City of Battle Creek, would provide protection from the 1% annual chance storm (100-year). In February 2009, JEO prepared an evaluation for the Battle Creek Flood Control Dam that included a structure with a permanent pool of 160 acres. Topographic features of this site, located at Oak Valley Wildlife Management Area which is owned and operated by the NGPC, are favorable for construction of a dam. As proposed, this alternative would meet the project purpose and need.

- **Flood Control Reservoir (Above NGPC Site) –** A second potential site location for the Battle Creek Reservoir, located one mile upstream from the NGPC site, would provide protection from the 1% annual chance storm, be of similar size, and would meet the project purpose and need.

- **Flood Diversion Channel –** The flood diversion channel would divert high flows from the main channel to an auxiliary channel, thereby increasing combined channel capacity to equal that of the 1% annual chance storm. The diversion structure would be located along the west bank of the Battle Creek, approximately 1800 feet northwest of the High School, continuing northeasterly before connecting back with the main channel north of the City near Highway 121. The channel would have a natural lining, 125 foot bottom width, 200 foot top width, and ten foot depth. This alternative would meet the project purpose and need.

2.3 – ALTERNATIVE INVESTIGATION CORRESPONDENCE

Over the course of the development of the preliminary environmental assessment, several meetings and a site visit at Oak Valley Wildlife Management Area (WMA) were held with relevant agencies to discuss the potential coordination requirements and input of those agencies. In particular, the involved agencies included the U.S. Army Corps of Engineers (USACE), Nebraska Game and Parks Commission (NGPC), and the Lower Elkhorn NRD (LENRD). Records of the correspondence and meetings can be found in Attachment B and Attachment C of Appendix A, respectively.

It should be noted that through this correspondence, NGPC indicated that they are not supportive of a dam potentially being placed on the Oak Valley Wildlife Management Area. For more information on this decision, see the letter dated August 4th, 2010 in Attachment B of Appendix A.

2.4 – HISTORICAL AND CULTURAL RESOURCES

As part of the preliminary environmental assessment JEO utilized the information from a cultural resources investigation to help determine the type of flood control project and its location to minimize the effect on any potential historic properties. The area documented within this report is roughly a ten mile by three mile area which encompasses Battle Creek and a tributary of the Elkhorn River (see below area of potential effect map for survey area). This area is bounded on the east by Highway 121 and contains primarily rolling hills and agricultural land. The village of Battle Creek is also located within the project study area, but was not evaluated for historic properties because the efforts for flood control will be south and north of town along the Creek. JEO Consulting Group, Inc. has contracted with Historic Resources Group to provide the findings in this section of the report. The following summarizes the information compiled by Historic Resources Group; the full report can be found in Attachment A of Appendix A.

AREA OF POTENTIAL EFFECT

The area of potential effect (APE) for Section 106 purposes is defined at Sec. 800.16(d) in the regulations as the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The area of potential effect is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking. The APE for any undertaking is determined in consultation with the Federal Agency that is the nexus of the action, as well as consultation with the Nebraska State Historic Preservation Office. The APE for this potential flood control project is very broad so as to incorporate all possible locations of any appropriate flood control measures. An area in Madison County south, east and slightly north of the village of Battle Creek was reviewed. The area was bounded roughly by Highway 121 on the east, county road 832 on the south, county road 543 on the west and roughly the Elkhorn River to the north. This area incorporates a broad corridor that may house the flood control measures. The field investigation identified and documented all standing structures within the APE that were historic (approximately 50 years old or older), listed in or eligible for listing in the National Register of Historic Places (NRHP), or previously surveyed by the NeSHPO. The report further identified archeological resources that have been previously recorded in the Nebraska State Historical Society's Archeology Division GIS database.

Battle Creek survey area, map taken from Google.

Figure 1: Battle Creek Survey Area Map

RECOMMENDATIONS AND ARCHEOLOGICAL FILE SEARCH

This historical properties review was undertaken to complete a records search, identify existing resources, and make recommendations regarding further effort needed for Section 106 evaluation based on narrowing a scope for a Battle Creek flood control project. Field work and records search were conducted in August 2010. Two farmsteads are recommended National Register eligible, MD00-027 and MD00-058. One property is identified as potentially eligible with the recommendation that more research will assist in documenting a recommendation, and one property was not accessible during field survey and requires owner permission to access the property. No determination is recommended for this property because it was not clearly visible.

Future survey efforts for standing structures will be determined when an undertaking regarding the flood control project is identified and a new area of potential effect can be established based on the scope of the undertaking. At that time additional survey may be needed to further evaluate sites FN1 and FN4 as well as MD00-056. FN1 and FN4 will require owner permission to access their property while site MD00-056 will benefit from additional research to establish a potential pattern book design. These properties will only need further evaluation if they are located within a new APE based on the identified undertaking.

The two farmsteads recommended National Register eligible should be considered in the planning process at all stages. Further documentation efforts for these two properties may include a boundary definition if they are included within the APE of any future undertakings.

Stacy Stupka-Burda reviewed archeological site records and records of previous archeological surveys in the APE using the Geographic Information System (GIS) available at the Archeology Division of the Nebraska State Historical Society (NSHS) in August 2010.

This file search indicated that limited archeological investigations have been conducted near the APE. These archeological investigations include survey related to federal undertakings associated with bridge

replacements and borrow pits. None of these previous projects are located within the APE and no archeological sites were recorded.

One previously recorded site, 25MD502, is located just outside the APE on the north side of the community of Battle Creek. This site is the location of the former Battle Creek Roller Mills. In operation since 1875, the mill was demolished in 1981. The site form indicates that no remains of the building exist, but dam remnants are present. This site has not been formally evaluated with regard to National Register eligibility.

The most comprehensive survey of the Elkhorn River Valley was conducted by Steve Holen (Holen et. al. 1992) in 1991-1992. These investigations concentrated on the Elkhorn River drainage in the counties of Antelope, Stanton, and Madison counties. This project recorded 40 previously unrecorded archeological sites. Again, the surveyed area detailed in this report does not correspond or overlap with this APE. These investigations do, however, help to reinforce the idea that the Elkhorn River Valley is recognized as an area that has a high potential for archeological sites. These sites could likely document a rich human presence in this area, dating back to the Paleoindian period up through the settlement of the area by Euroamericans. The name "Battle Creek" serves to remind us of that rich history. Taken from a battle between the Nebraska Territorial Militia and the Pawnee in 1859, the community and the stream were named after a battle that historians now recognize was not really a battle, but was rather an event that ended with the surrender of the Pawnee to the Militia.

For any project moving forward within this APE with regard to archeological resources, the Nebraska State Historic Preservation Office (NeSHPO) will require a level of effort that includes 100% survey of the project area (personal communication, August 11, 2010). If ground surface visibility is less than 10%, more intensive survey methods may be necessary (NeSHPO, 2006).

Regarding archeological resources, recommendations include continued consultation and coordination of project activities with a professional archeologist. Identification of archeological sites and evaluation of those sites will need to be completed well in advance of any earth moving activities. In addition, project sponsors should expect to complete consultation with the appropriate modern Native American tribal governments. Finally, archeologists recognize a long history of private collecting in the area. Project sponsors should consider public outreach that invites area landowners and collectors to share their experience and information regarding archeological resources in the APE.

2.5 – CONCLUSIONS

Overall, the preliminary environmental assessment and historical property review to date support general feasibility for the potential flood control alternatives. However, it should be noted that the environmental assessment as a whole is preliminary and cannot be fully concluded until a specific project is determined and planned to move forward.

3.0 – GEOTECHNICAL EVALUATION SUMMARY

A preliminary geotechnical review of the potential overflow diversion channel and dam sites which was completed by Mid-State Engineering and Testing, Inc. in August, 2010. This effort included preliminary field investigation of both potential sites in order to evaluate construction feasibility.

Findings indicated potential concerns regarding groundwater levels, soil structure/erodibility, and consistency for dam embankment construction. However, the overall conclusion was that if these items are addressed by design efforts either project should be constructable based on the preliminary information obtained.

For full details of the geotechnical investigation, please refer to Appendix B.

4.0 – OVERFLOW DIVERSION CHANNEL SUMMARY

4.1 – INTRODUCTION AND PURPOSE

The City of Battle Creek, NE is subject to flooding during large discharge events on the Battle Creek due to flow leaving the main channel and entering the City. The Lower Elkhorn Natural Resources District (LENRD) in coordination with the City of Battle Creek are currently investigating feasible flood control alternatives to reduce flood damages at the City. One alternative under investigation is a proposed open channel that would provide additional flood flow conveyance and reduction of flood elevations during large Battle Creek discharges. The full report in Appendix C outlines the procedures and findings of the hydraulic analysis regarding a potential Battle Creek overflow diversion channel. The purpose of this study was to determine the effects a diversion channel would have on the flood hazards and flood elevations along the Battle Creek.

This analysis is a supplement to previous studies and analyses conducted in support of potential flood damage reduction alternatives for the City. In 2007 the City completed a Stormwater Master Plan including a discussion of watershed and channel conveyance improvements in support of flood reduction at the City. In 2009 the City completed the Battle Creek Flooding Evaluation Reconnaissance Level Study which evaluated the effects proposed improvements may have on reducing flooding at the City; a more detailed evaluation of a flood control reservoir and diversion channel was completed later in 2009. The data developed for the 2009 analysis was utilized for this analysis including peak flow and topographic data. More detail of the previous analysis and supporting information can be found in previous summary reports, which are provided as Appendix F to the Battle Creek Flood Control Alternative Feasibility Evaluation.

4.2 – FINDINGS

This analysis was conducted to determine the potential overflows leaving the main Battle Creek channel and to determine resultant effects of rerouting these overflows to downstream areas. Three hydraulic scenarios were created in HEC-RAS to determine the existing and proposed conditions. Previously developed hydrologic and topographic data were utilized for the hydraulic modeling; a previously developed hydraulic model was modified to reflect additional topographic LiDAR data.

The previous studies reported that the channel capacity prior to overtopping is approximately 7800 cfs at McAllister St.; this was based on the NDNR survey data and reported based on the point where flows leave the defined main channel, not necessarily where structural flooding occurs. The current existing condition model included overflows modeled as lateral weirs in HEC-RAS based on the LiDAR data. The current model results verify the previously reported approximate channel capacity at the McAllister St. location. The current model also indicated that the delineated lateral weir along the western edge of the City would begin to be overtopped and floodwaters would encroach upon the City during a discharge of approximately 8000 cfs. Accordingly, higher discharges would increase discharges to the City and the extent of flooding. Therefore the lateral weir along the western edge of the City is identified as the

critical location for calculating the desired design discharges for any improvement projects. Refer to the following table for overflow discharges to the City under existing conditions. It is important to note that due to the lack of a defined lateral weir such as a roadway embankment the analyzed alignment was based on professional judgment, alternate interpretations may result in different overflow locations and discharge amounts.

Table 1: Lateral Weir Overflows Along the Western Edge of the City

HEC-RAS River Station	Annual Chance Exceedance Probability	Discharge Over Lateral Weir (cfs)
14815	0.1	102
	0.02	3410
	0.01	4969

The current proposed conditions model indicated that the specified proposed diversion channel dimensions would convey approximately 7,500 cfs during the 1% ACE discharge; refer to the following table for the proposed diversion channel discharges. The proposed conditions model also indicated that even with the proposed diversion channel, minor overflows (less than 1000 cfs) into the City may still occur upstream of the proposed diversion channel, south of the high school. The diversion analysis was non-exhaustive and a refined model is expected be completed during a future design phase to ensure the flood reduction goal at the City is met. The proposed diversion structure was placed at a point along the channel that was preliminarily identified as being amenable for flow conveyance without modifying the overall system; the design phase may include additional improvements along the City such as flow directional berms or channel modifications for additional conveyance upstream of the diversion.

Table 2: Proposed Diversion Channel Discharges

HEC-RAS River Station	Annual Chance Exceedance Probability	Diversion Channel Discharge (cfs)
12100	0.1	2580
	0.02	6329
	0.01	7592

4.3 – CONCLUSIONS

The existing regulatory floodplain for the Battle Creek is delineated as an approximate Zone A. This flood hazard area is based on existing topographic hydrologic data such as DEMs and regression equations, respectively. This approximate modeling method did not account for overflows along the channel. The current modeling effort indicates that the flood hazards of the area are significantly larger than currently identified, especially at the City. This information should be reviewed during future flood mapping initiatives as well as for use in benefit/cost analyses prior to flood map revisions.

As indicated by the modeling results the flood elevations are within the 1-foot rise limitation downstream of Highway 121 for both proposed conditions; generally the increase in flood elevations between Highway 121 and the City would not comply with the 1-foot limit without improving the downstream channel and highway bridge conveyance areas. Depending on what is done for the Highway 121 area; land or easement purchase may be necessary in order to account for the additional flows from the

diversion channel. Overall the diversion channel appears to be feasible but may require purchase of land rights or easements at select locations due to the level of rise from the additional flows.

For more detailed information regarding analysis approach, procedures, and results please refer to the full hydraulic analysis report in Appendix C.

5.0 – PRELIMINARY NRDF FUNDING FEASIBILITY EVALUATION SUMMARY

5.1 – APPROACH TO ANALYSIS OF BENEFITS AND COSTS

A preliminary benefit/cost and rate of return analysis was performed as per the guidelines in section three, Appendix B (Economic Feasibility) of the Nebraska Natural Resources Development Fund (NRDF) guidelines. For detailed information regarding the analysis approach and results, refer to the detailed summary report in Appendix D.

The potential overflow channel or dam are both flood control projects and flood control benefits were analyzed as per the NRDF guidelines. In order to complete this review, potential project cost information was obtained from preliminary opinions of cost developed by JEO as part of previous studies. In order to develop average annual damage information and damages avoided/annual benefits, an assessment of both historical damages due to recent flood events as well as a review of predicted potential flooding damages based on flood elevations determined via hydraulic modeling were completed.

For the purposes of assessing modeled flooding risk to properties for this evaluation, the majority of flood elevations utilized are based on predicted sheet flow depths as described in the shallow flooding analysis summary. Through the hydraulic analysis of Battle Creek as provided in Appendix C of the Battle Creek Flood Control Alternative Feasibility Evaluation, it was determined that for certain return period events, overflows will exit the channel and enter the City of Battle Creek via overflow of a natural weir. These flows subsequently sheet flow across the City at a certain depth vs. the grade elevations. As described in the following Section 5.2, these sheet flow depths are 1 foot for the 2% annual chance exceedance flood and 2 feet for the 1% annual chance exceedance flood. There are a few selected properties nearer to the creek channel that fall outside (west) of the weir and the sheet flow area. For these properties, the flood elevations are based on the revised hydraulic model as provided in Appendix C of the Battle Creek Flood Control Alternative Feasibility Evaluation were used.

The preliminary review of potential flooding damages for this evaluation was based on a sample set of selected properties that were chosen based on establishing a cross section of properties both inside and outside of the areas impacted by sheet flows as well as a range of values and building use types (i.e., residential, commercial, etc.). Only properties with structures present on them were targeted for a physical field evaluation. Ultimately 53 structures were selected for field survey and this information was used to evaluate potential flooding damages to those structures. This information was then used to approximate the potential impacts to the approximately 522 structures within the City as a whole.

5.2 – SHALLOW FLOODING ANALYSIS SUMMARY

The shallow flooding analysis generally followed the procedures outlined in the National Flood Insurance Program Guidelines and Specifications for Flood Hazard Mapping Partners. The analysis was specifically developed for a cost benefit analysis regarding potential flood reduction strategies in the Battle Creek watershed; it was not developed in support of any flood hazard mapping activity and the information produced should be used with engineering judgment.

The analysis included a sensitivity analysis for varying roughness coefficients and cross section widths. It was determined that the lower portion of the roughness coefficients range was more applicable to the ground characteristics within the City. The calculations were not as sensitive to the effective conveyance width variable as the roughness coefficient. The range of calculated depths with varying inputs was used to determine a general flood depth for each discharge frequency which was then rounded. Refer to the following table for the determined flood depths.

Table 3: Shallow Flooding Analysis Flood Depths

Discharge Frequency Return Period	Sheet Flow Depth (ft)
10-Year	N/A
50-Year	1
100-Year	2

These results were subsequently utilized for determining flooding depths and potential damages as part of the cost benefit review for potential flood mitigation alternatives for Battle Creek (overflow channel or dam). Details of this review and how the sheet flow depths were utilized for this purpose are presented in detail in Appendix D.

5.3 – RESULTS AND CONCLUSIONS

Both the potential overflow channel and dam appear feasible based on rate of return, which is 6.60% for the overflow diversion channel and 5.81% for the dam. Due to having a lower cost, the overflow channel has a higher rate of return; however, if recreation or other benefits were to be taken into account for the possible dam this result may vary.

6.0 – OVERALL FINDINGS SUMMARY

Overall, the investigations completed appear to indicate that either the overflow channel or dam are feasible. However, each project has unique challenges and potential impacts that will need to be managed or mitigated as part of the project design process. The ultimate design direction and completion of the environmental assessment will rely upon the preferred alternative; this will need to be identified before further detailed investigations can be undertaken.

APPENDIX A

PRELIMINARY ENVIRONMENTAL ASSESSMENT AND CORRESPONDENCE

- *ATTACHMENT A – CULTURAL RESOURCES IDENTIFICATION REPORT*
- *ATTACHMENT B – AGENCY CORRESPONDENCE (ON CD)*
- *ATTACHMENT C – AGENCY COORDINATION MEETINGS (ON CD)*

PRELIMINARY ENVIRONMENTAL ASSESSMENT

FLOOD CONTROL ALTERNATIVE FEASIBLITY EVALUATION

LOWER ELKHORN NRD AND CITY OF BATTLE CREEK

AUGUST, 2011

1.0 - INTRODUCTION

The City of Battle Creek (City) is a growing second-class city of approximately 1,200 residents in Madison County, Nebraska. The City is located on the right descending bank of Battle Creek (Creek), approximately two miles upstream from the confluence with the Elkhorn River. The City lies on low, flat terrain in the Elkhorn River valley that is prone to flooding during rainfall events.

The majority of the Battle Creek Watershed is located in Madison County with small upstream portions located in Boone County. The City is situated in the lower portion of the Battle Creek watershed; nearly the entire watershed contributes flows to the stream channel adjacent to the City. The watershed of the Creek upstream of the City is approximately 91 square miles and consists of mostly agricultural land uses.

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    - Due to the high water levels in the Creek and the nearby Elkhorn River, many of the interior drainage systems in the City (i.e. storm drains and ditches) also did not adequately function, further compounding to the flooding problem in the City. There were also several reports that the City's sanitary sewer system backed up into homes.

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3.0 - PLANNING EFFORTS

- **1964** – The United States Army Corps of Engineers (USACE) completed a study of a ring levee for Battle Creek that was endorsed by the then City of Battle Creek board, but was not constructed, likely due to inability to acquire funding.

- **1975** – The Madison County Comprehensive Plan included a proposed flood control reservoir approximately four miles upstream of Battle Creek. The proposal was not constructed, primarily due to a lack of funding and public support.

- **2007** – The City of Battle Creek completed the Stormwater Master Plan for the purpose of evaluating existing site conditions, identifying problem areas, developing conceptual improvements, and prioritizing these improvements. The ultimate goal of this Plan was to develop a stormwater action plan that would allow the City to direct future stormwater improvements and guide future growth of the City of Battle Creek. Potential drainage improvement recommendations identified in this Plan included cleaning/ re-grading the Battle Creek Channel, revised/ updated floodplain mapping, a flood control ring levee around Battle Creek, or a Battle Creek Reservoir or multiple smaller dams.

- **February 2009** – The City completed the "Battle Creek Flooding Evaluation Reconnaissance Level Study" as an assessment of the flooding potential and technical alternatives analysis for projects designed to alleviate that flooding. The study included evaluation of multiple small upstream dams, channel widening, channel cleanout, a flood control levee and floodwall, flood control reservoir, and flood diversion channel. The three alternatives deemed most technically feasible in this study were the levee and floodwall, reservoir, and diversion channel.

- **November 2009** – The City completed a more detailed evaluation to provide technical information on two of the alternatives – the flood control reservoir and flood diversion channel. The City of Battle Creek continues to work towards a feasible solution to alleviate damages from flooding in the Battle Creek Watershed in the future.

- **September 2010** – In response to a request from the U.S. Army Corps of Engineers in their letter dated August 16th, 2010, a review to preliminarily approximate and summarize potential flood damages using FEMA's HAZUS-MH, risk assessment software that utilizes Geographic Information System (GIS) modeling software was completed. The study was based upon six-inch elevation contours using available LIDAR and 2000 Census information. HAZUS provides estimated physical damages due to flooding at varying levels. Based upon HAZUS, the City of Battle Creek could experience up to 301 damaged structures (out of 647 total estimated by HAZUS) with up to $5,490,000 in property damages (20% damage) during the 1% annual chance storm (100-year).

4.0 - PURPOSE AND NEED

The purpose of the proposed Battle Creek Flood Control project is to reduce flooding in the Battle Creek Watershed which includes the City of Battle Creek. The proposed flood control project is needed to reduce property damages resulting from frequent overtopping and flooding of the Battle Creek thus causing damages in the City of Battle Creek. Failure to provide flood control would allow for continued repetitive damages of existing properties in the City of Battle Creek and reduce the likelihood of future growth in the City of Battle Creek.

5.0 - ALTERNATIVES ANALYSIS SUMMARY

The United States Army Corps of Engineers (USACE) requires that a list of reasonable alternatives be evaluated according to criteria of overall project purpose and practicability. Criteria recommended by USACE include: cost, logistics, and existing technology. All practicable alternatives for the Battle Creek Flood Control project are listed in Table 1 and have been evaluated against each of the above listed criteria to the extent possible based on currently available information. Those practicable alternatives carried forward are then further evaluated in Table 2 below to identify the impacts to aquatic resources. The intent of the analysis is to provide information to the Corps to determine the least environmentally damaging practicable alternative.

Numerous structural flood control strategies, along with the no-action alternative and one regulatory non-structural alternative, were considered to determine if they met the project purpose and need. Structural and non-structural alternatives considered are summarized below:

- No-action
- Channel enlargement/improving conveyance
- Stream restoration with additional wetland storage
- Bridge and culvert clearing and enlargement
- Detention/retention upstream of Battle Creek
- Flood control reservoir at the Nebraska Game and Parks Commission (NGPC) Site
- Flood control reservoir above the NGPC site
- Flood diversion channel
- Multiple smaller sized upstream dams
- Multiple dry dams
- Low-level berms set back from the channel banks to provide floodways
- Levee along the western edge of the City and Battle Creek
- Conservation measures upstream in watershed
- Flood proofing existing structures in the City
- Property acquisitions and property elevation
- Floodplain regulations and zoning controls

Alternatives are carried forward that fulfill the purpose and are practicable. The following sections provide information regarding alternatives considered over time and determination of practicability.

5.1 – PREVIOUS PRELIMINARY ALTERNATIVES ANALYSIS

During February, 2009 the City completed the "Battle Creek Flooding Evaluation Reconnaissance Level Study" as an assessment of the flooding potential and technical alternatives analysis for projects designed to alleviate that flooding. The study included evaluation of several initially identified primary alternatives, including multiple small upstream dams, channel widening, channel cleanout, a flood control levee and floodwall, flood control reservoir, and flood diversion channel. The three alternatives deemed most technically feasible in this study were the levee and floodwall, reservoir, and diversion channel. A summary of the reviewed alternatives is provided below.

FLOOD CONTROL RING LEVEE AND FLOODWALL

A levee is an artificially constructed, usually earthen embankment to contain or control the flow of water to provide protection from temporary flooding. This initial alternative review was for the construction of a combination of levee and floodwall to provide protection from the 100-year storm event. The levee and flood wall would be constructed between the western edge of the City and Battle Creek. A levee would be constructed in areas where space allows for the width of the levee design and a floodwall built for those areas where there is limited space between the banks of the Creek and existing structures.

BATTLE CREEK RESERVOIR

As reservoir(s) with the primary focus on flood control, these structures would be designed and constructed to collect and impound stormwater flowing in the Creek. This stormwater would then be stored and released at a controlled rate after the passage of the storm. The construction of structures of this type would dramatically reduce the peak flows and the variability of the water levels in the Creek downstream of the dam(s).

A reservoir in the Battle Creek watershed would provide significant flood reduction benefits. The Battle Creek Reservoir would be located in the northeast ¼ of Section 23, Township 23, Range 3 W, approximately four miles upstream of the City of Battle Creek on the Nebraska Game and Parks Commission as the Oak Valley Wildlife Management Area. Several versions of the flood control structure were evaluated for the initial alternative analysis. These range from a dry dam with no permanent storage, to a large dam providing 1280 ac (two mi2) of permanent pool storage. Two alternatives have been included based upon potential benefits and feasibility. The general location and construction of both versions of the alternative are similar with changes to the proposed outlet structure and elevation of the dam structure.

A small flood control dam would potentially be constructed on Battle Creek providing some recreational benefits as well as agricultural benefits. The reservoir would have a permanent pool area of 160 acres. The primary spillway would consist of a twin 4-ft x 7-ft box culvert to attenuate peak flows, protecting downstream areas from flooding.

A large flood control dam and reservoir on Battle Creek was also evaluated at the same location as the small dam. The reservoir would have a permanent pool area of 1280 acres. The primary spillway would consist of a twin 4-ft x 7-ft box culvert to attenuate peak flows, protecting downstream areas from flooding. Again, this reservoir will provide many secondary benefits, such as recreation, versus a smaller dam.

FLOOD DIVERSION CHANNEL

A flow diversion is an artificially constructed structure to divert high flows from the main channel to an auxiliary channel, thereby increasing combined channel capacity. This initial alternative review was for the construction of a diversion channel will increase channel capacity to equal that of the 100-year storm event. The diversion structure would be located along the west bank of the Battle Creek, approximately 1800 ft northwest of the High School. The diversion channel would continue in a northwesterly direction, including a trail crossing and county road crossing, before connecting back with the main channel north of the City near Highway 121. The channel would have a natural lining, with approximate dimensions of: bottom 125 ft; top 200 ft; depth 10 ft.

MULTIPLE SMALL UPSTREAM DAMS

As reservoir(s) with the primary focus on flood control, it is anticipated that these structures would be designed and constructed to collect and impound stormwater flowing in the Creek. This stormwater would then be stored and released at a controlled rate after the passage of the storm. The construction of structures of this type would dramatically reduce the peak flows and the variability of the water levels in the Creek downstream of the dam(s).

As with the large flood control dam, attenuation of the peak flow in a stream can be accomplished using temporary storage behind multiple flood control dams. This initial alternative review comprised of a series of small or medium sized dams creating numerous ponds. These ponds would have a relatively small amount of permanent storage and would each be capable of temporarily storing some additional flood flow. The watershed area is comprised primarily of wide flat valleys which are not conducive to

constructing cost effective flood control structures. Seven locations were identified as potential sites for the flood control structures. Based on a preliminary analysis of the potential hydrograph attenuation by the seven locations and the anticipated cost of materials for their construction, it was determined that there is little potential for meaningful flood control using multiple small to medium sized dams.

CHANNEL WIDENING

Widening of the main channel of Battle Creek near the City was reviewed for feasibility. As seen from the size of the diversion channel alternative, substantial modifications would be required to increase channel size to meet conveyance needs for the 100-year storm event. Space limitations restrict possible channel widening or other improvements as do the existing bridge structures. For these reasons, this alternative was not deemed feasible of cost-effective.

CLEANOUT/RE-GRADING BATTLE CREEK CHANNEL

Due to years of neglect the channel of Battle Creek has become overgrown with trees and underbrush. These present a significant obstruction to efficient flow in the Creek. The Creek is also showing some signs of bank erosion at some locations. Additional grading and erosion control measures are recommended to prevent additional erosion and to increase the efficiency of the flow through the Creek.

Cleanout of the channel banks immediately adjacent to the City was evaluated as there is significant debris and vegetation accumulated. Dense debris along the banks can impede stream flow as it represents a high roughness value, decreasing capacity and thus increasing flood elevations. However, the relative benefit of cleaning these debris-laden reaches is not such that it would provide significant flood benefits. It appears that these improvements may increase the conveyance of the Creek during low or normal flow conditions, it is doubtful that these improvements can have a significant impact for the large flooding conditions.

5.2 - ALTERNATIVES NOT CONSIDERED FEASIBLE

Many of the alternatives originally considered did not meet the project objective of reducing flooding in the City of Battle Creek and therefore were not carried forward. Reasons for these alternatives not being considered are as follows:

- **Channel Enlargement/ Improving Conveyance** – Widening and cleanout of the main channel through the City of Battle Creek were reviewed for feasibility. Channel cleanout would have no relative benefit and provide minimum flood protection benefits while channel widening would require substantial modifications to meet conveyance needs for the 1% annual chance storm event. Space limitations restrict possible channel widening. For these reasons this alternative was not carried forward.

- **Stream Restoration with Wetland Storage** – This alternative was eliminated due to the immense quantity of land necessary for creation of wetlands to adequately store floodwaters.

- **Bridge and Culvert Clearing and Enlargement** – Enlarging bridges and cleaning culverts would have minimal flood control benefits.

- **Detention/ Retention Cells** – Off stream storage using detention or retention cells was considered but not evaluated due to the limited effectiveness of such structures reducing peak flows.

- **Multiple Upstream Dams** – Attenuation of the peak flow in a stream can be accomplished using temporary storage behind multiple flood control dams. The watershed area is comprised primarily of wide flat valleys which are not conducive to constructing cost effective flood control

structures. Based on a preliminary analysis of the potential hydrograph attenuation by the seven locations previously studied in the reconnaissance level study there is little potential for meaningful flood control using multiple small to medium sized dams.

- **Dry Dams** – Similar to the 'multiple upstream dam' alternative, multiple dry dams have little potential for meaningful flood control.

- **Low-Level Berms (set back from the channel banks)** – This alternative was eliminated due to the inability of low-level berms to provide adequate flood protection to the City of Battle Creek and spatial constraints.

- **Levee in Battle Creek** – Construction of a levee system in Battle Creek would not provide flood protection for the west side of the community in addition to causing an increase of flood elevations in some areas of the community.

- **Conservation Measures Upstream in Watershed** – This alternative was eliminated due to the inability of conservation measures to eliminate or reduce the peak flow in the Battle Creek.

- **Flood Proofing** – Flood proofing would not effectively protect wooden frame structures that remain inundated after floods.

- **Property Acquisitions/ Elevation** – This alternative was eliminated due to the large number of structures historically flooded, cost of acquiring and moving property, and social impact to the community.

- **Floodplain Regulations/ Zoning** – Non-structural solutions will not meet the project purpose.

5.3 - ALTERNATIVES CONSIDERED FEASIBLE

Three other structural alternatives, each of which have been studied in more detail in regards to engineering, environmental analysis, historical impact, hydrologic and hydraulic impacts, cost, and other implications were carried forward, along with the no-action alternative. A project description of each of these alternatives is found below:

- **No-Action Alternative –** With the no-action alternative, the City of Battle Creek would take no direct action to reduce the flood hazard as it exists today from the Battle Creek. Property owners and businesses would continue to suffer frequent damages, continue to face hardships, and the community would have limited capability for future economic growth in the community. According to a preliminary assessment using HAZUS, FEMA's flood loss GIS model (run by JEO in 2010), the no-action alternative could result in up to $5,490,000 in property damages (20% damage) during a 1% annual chance flood. HAZUS estimates Battle Creek to have 647 structures, 301 in the floodplain (created by HAZUS), two agricultural, 12 commercial, one educational, one governmental, two industrial, one religious, and 282 residential structures.

- **Flood Control Reservoir (NGPC Site) –** A large flood control reservoir, located approximately four miles upstream of the City of Battle Creek, would provide protection from the 1% annual chance storm (100-year). In February 2009, JEO prepared an evaluation for the Battle Creek Flood Control Dam that included a structure with a permanent pool of 160 acres. Topographic features of this site, located at Oak Valley Wildlife Management Area which is owned and operated by the NGPC, are favorable for construction of a dam. As proposed, this alternative would meet the project purpose and need.

- **Flood Control Reservoir (Above NGPC Site) –** A second potential site location for the Battle Creek Reservoir, located one mile upstream from the NGPC site, would provide protection from the 1% annual chance storm, be of similar size, and would meet the project purpose and need.

- **Flood Diversion Channel –** The flood diversion channel would divert high flows from the main channel to an auxiliary channel, thereby increasing combined channel capacity to equal that of the 1% annual chance storm. The diversion structure would be located along the west bank of the Battle Creek, approximately 1800 feet northwest of the High School, continuing northeasterly before connecting back with the main channel north of the City near Highway 121. The channel would have a natural lining, 125 foot bottom width, 200 foot top width, and ten foot depth. This alternative would meet the project purpose and need.

For a summary of alternatives considered, see the following Table 1. Please note that certain aspects of the alternatives have yet to be fully evaluated; this is expected to be completed as part of the project next steps if the Lower Elkhorn NRD selects an alternative and determines to move forward.

Table 1: Practicable Alternative Analysis – Summary of Alternatives Considered

ALTERNATIVES	COST	LOGISTICS	TECHNOLOGY	CARRY FORWARD
1. No action		Does not meet project objective		YES
2. Channel enlargement/improving conveyance		Space limitations/existing bridges restrict possible channel widening		NO
3. Stream restoration with wetland storage	Substantial cost/relocations/land purchase	Substantial amount of storage necessary		NO
4. Bridge and culvert clearing and enlargement		Would not provide significant benefits		NO
5. Detention/retention cells		Minimum potential for flood control		NO
6. Flood control reservoir (NGPC site)		Would contain 1% chance of flood		YES
7. Flood control reservoir (above-NGPC site)		Would contain 1% chance of flood		YES
8. Flood diversion channel		Would contain 1% chance of flood with adverse affects		YES
9. Multiple upstream dams		Minimum potential for flood control		NO
10. Dry dams		Minimum potential for flood control		NO
11. Low-level berms set back from the channel banks to provide floodways		Minimum potential for flood control		NO
12. Levee in Battle Creek		No flood protection for west side of community		NO
13. Conservation measures upstream in watershed		Insufficient in reducing peak flow		NO
14. Flood proofing structures	High cost	Does not meet project objective		NO
15. Property acquisitions/elevation	High cost	Does not meet project objective		NO
16. Floodplain regulations/zoning		Does not meet project objective		NO

6.0 - IMPACT TO AQUATIC RESOURCES

A preliminary evaluation of the impact to aquatic resources was completed by JEO using information gathered with Geographic Information Systems (GIS) and other available data collected through past engineering evaluations and site visits. A wetland delineation was not performed at each project site at the time this report was completed.

Estimates for waters of the United States fill and excavation are estimated based upon the following:

- None
- Low (less than one acres)
- Medium (one to two acres)
- High (greater than two acres)

Numbers for waters of the Unites States inundation were calculated based upon the flood control reservoir preliminary analysis and total length of the Battle Creek to be inundated by a 160-acre permanent pool for each reservoir project alternative.

The following table is used to identify the least environmentally damaging alternative for all alternatives that fulfill the project purpose and are practicable.

Table 2: Summary of Potential Impact to Aquatic Resources

ALTERNATIVE	Flood Control Reservoir (NGPC Site)	Flood Control Reservoir (Above NGPC Site)	Flood Diversion Channel	No-Action
Waters of US Fill	Low	Low	None	None
Wetland Fill	Low	Low	None	None
Waters of US Excavation	Low	Low	Medium	None
Wetland Excavation	Low	Low	None	None
Waters of US Inundation	5.34 miles	5.04 miles	None	None
Wetland Inundation	Medium	Medium	None	None
Waters of US Drained	None	None	None	None
Wetlands Drained	None	None	None	None

The City of Battle Creek will continue evaluation of each project alternative and will consider input from public agencies and public input as part of any permitting process.

7.0 – CORRESPONDENCE AND MEETINGS

Over the course of the development of this preliminary environmental assessment, several meetings and a site visit at Oak Valley Wildlife Management Area (WMA) were held with relevant agencies to discuss the potential coordination requirements and input of those agencies. In particular, the involved agencies included the U.S. Army Corps of Engineers (USACE), Nebraska Game and Parks Commission (NGPC), and the Lower Elkhorn NRD (LENRD). Records of the correspondence and meetings can be found in Attachment B and Attachment C, respectively.

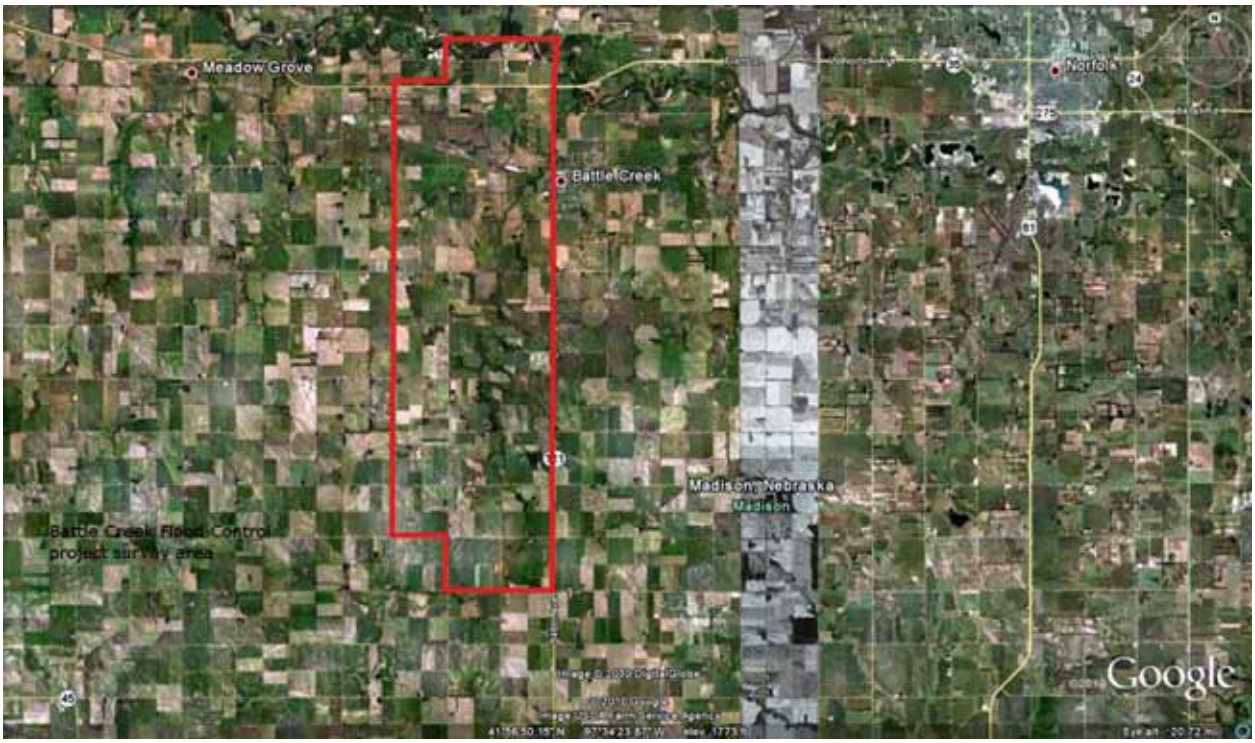
It should be noted that through this correspondence, NGPC indicated that they are not supportive of a dam potentially being placed on the Oak Valley Wildlife Management Area. For more information on this decision, see the letter dated August 4th, 2010 in Attachment B.

8.0 - IMPACT TO CULTURAL RESOURCES

As part of this project JEO utilized the information from the cultural resources investigation to help determine the type of flood control project and its location to minimize the effect on any potential historic properties. The area documented within this report is roughly a ten mile by three mile area which encompasses Battle Creek and a tributary of the Elkhorn River (see below area of potential effect map for survey area). This area is bounded on the east by Highway 121 and contains primarily rolling hills and agricultural land. The village of Battle Creek is also located within the project study area, but was not evaluated for historic properties because the efforts for flood control will be south and north of town along the Creek. JEO Consulting Group, Inc. has contracted with Historic Resources Group to provide the findings in this section of the report. The following summarizes the information compiled by Historic Resources Group; the full report can be found in Attachment A.

8.1 - AREA OF POTENTIAL EFFECT

The area of potential effect (APE) for Section 106 purposes is defined at Sec. 800.16(d) in the regulations as the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The area of potential effect is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking. The APE for any undertaking is determined in consultation with the Federal Agency that is the nexus of the action, as well as consultation with the Nebraska State Historic Preservation Office. The APE for this potential flood control project is very broad so as to incorporate all possible locations of any appropriate flood control measures. An area in Madison County south, east and slightly north of the village of Battle Creek was reviewed. The area was bounded roughly by Highway 121 on the east, county road 832 on the south, county road 543 on the west and roughly the Elkhorn River to the north. This area incorporates a broad corridor that may house the flood control measures. The field investigation identified and documented all standing structures within the APE that were historic (approximately 50 years old or older), listed in or eligible for listing in the National Register of Historic Places (NRHP), or previously surveyed by the NeSHPO. The report further identified archeological resources that have been previously recorded in the Nebraska State Historical Society's Archeology Division GIS database.



Battle Creek survey area, map taken from Google.

8.2 - METHODOLOGY

Historic properties were identified in this report through field survey and archival research. Information obtained regarding properties identified within the APE is included in this report and gathered in the following manner.

NATIONAL REGISTER CRITERIA FOR EVALUATION

When evaluating historic properties, the National Register of Historic Places is the primary device by which they are identified for protection under Section 106 of the National Historic Preservation Act of 1966. Criteria for determinations of eligibility are set forth in 36 CFR Part 60.4 (70) and are described in National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation. In order for a property to be determined eligible it must retain a high degree of historic integrity and possess significance. Location, design, setting, materials, workmanship, feeling and association are the seven aspects of integrity defined by the NRHP. In general most of the seven integrity aspects must be present for a property to convey historic significance. Historic significance may then be present in one of four categories: important historic events; significant people in history; significant architecture, design, or property type; and potential to yield important historic information. These integrity issues are bolstered by the following field survey and archival research descriptions.

FIELD SURVEY

The project area was initially examined to determine the type of resources present and the approximate area to be included in the survey. An on-site analysis of each property was conducted on August 12, 2010 to assess the existing condition, integrity, and significance of properties within the area of potential effect. Information gathered included identifying a style, property type, approximate construction date, as well as alterations, additions, and integrity issues. As approved by the NeSHPO, any properties surveyed were digitally photographed and mapped.

ARCHIVAL RESEARCH

Most archival information was taken from the files of the State Historic Preservation Office a division of the Nebraska State Historical Society. These include files on previously surveyed properties within the study area, along with historic contextual information, and National Register nominations where appropriate. Web sites were also consulted to assist in documenting the basic history of Madison County as well as the city of Battle Creek. Primarily referenced was the Madison County, Nebraska Historic Building Survey final report prepared by Mead and Hunt, Inc. in August 2001.

GENERAL HISTORY

Early Nebraska Territory is rich with Native American settlement, traders, and trail pioneers who blazed a new cross-country route through the state. Early permanent settlement in the state began in the 1840s with traders and military forts establishing the early communities to protect the yet organized state. Not until 1853 was the Nebraska Territory formally organized when President Franklin Pierce signed the Kansas-Nebraska Act in 1854. This act established the boundaries of the Territory of Nebraska and formalized the establishment of governments and city and county organizations.

Madison County was established in 1856 by the Nebraska Territorial Legislature and was named for President James Madison. Early settlers in the area were primarily Germans from Wisconsin. They made notable marks on the landscape with their long lot system. To provide farms with access to much needed waterways early lots would be drawn longer than they were wide. The narrow part of the lots generally faced the water ways and then stretched back from that point in a rectangular fashion. This defied the established grid system that was in common use at the time. Although the Germans were early settlers in the area, it was also well populated by the Nebraska militia, traders, and Native American tribes, namely the Pawnee.

In 1859 the Nebraska militia entered into a skirmish with a local Pawnee Village essentially driving the Pawnee out of the area. Although no battle actually occurred the local residents named the watershed Battle Creek. When the nearby village was settled in 1867 it adopted the name Battle Creek after the well-known skirmish that also named the waterway. The town was incorporated in 1873 and began its growth much like many other communities in Nebraska, with successful agriculture and cattle industries and the railroad.

The Fremont, Elkhorn and Missouri valley Railroad came through Norfolk, Battle Creek and Tilden in 1879. The area experienced rapid growth throughout the 1880s with good weather encouraging a strong family driven agriculture and cattle industry. This surge resulted in more than 2200 school age children attending 53 school houses across the county, surging service businesses such as lumber yards, opera houses, and downtown commercial areas. By 1890 the population in the county reached 13, 669 and grew to 19,101 in 1910.

Today Battle Creek is considered part of the Norfolk metropolitan area with a population of approximately 1168 people. The county itself occupies 576 square miles in north east Nebraska. The landscape in the area consists of well drained uplands, terraces and flood prone valleys. The Elkhorn River dominates much of the area including its tributaries the North Fork, Battle, Union, Taylor, Shell, Buffalo, Deer, Dry and Meridian Creeks. The presence of these waterways and the flood prone area near the town of Battle Creek provide for fertile agriculture, but also the need for some management. Identifying potential historic properties in this area will aid in that planning process.

8.3 - SURVEY RESULTS SUMMARY

The desktop survey for this project area was undertaking on August 10, 2010. At that time all properties that were previously surveyed by the Nebraska State Historic Building Survey completed by Mead and Hunt in 2001 were identified. That search identified approximately 15 previously surveyed standing structures within or near the project study area. All properties within the survey area are rural residential farmsteads, with some individual houses, one church complex, and one cemetery. However, most of these properties were not recommended eligible during the original survey and many of them have lost historic integrity since their initial evaluation. Three properties are recommended National Register eligible, and at least two properties were not accessible during the field survey and would need further documentation when the undertaking is identified. The following is a description of the recommended eligible properties.

MD00-058 FARMSTEAD

This farmstead was surveyed by Mead and Hunt during their 2001 county wide effort. The collection of buildings retains a high degree of historic integrity and includes a 1920s era craftsman style bungalow residence, a large gambrel roof barn, and two to three other historic outbuildings. The residence has a low sloping side gabled roof with a projecting through gabled dormer punctuated by paired fenestration in the dormer. Typical to the style a full width recessed front porch with battered columns extends the width of the main façade. The residence has a three part bay window just off the porch on the west façade. The residence and the major outbuildings are divided by a simple gravel drive. Across the drive is the main barn a gambrel roof building with attached projecting shed to the west side. A single metal ventilator is centrally located on the ridgeline with a hay hood projecting over the loft doors. A silhouette of a horse is painted on the loft doors. Smaller sheds and outbuildings are also located on the site and all date to within the historic period.

The residence is surrounded by large deciduous trees providing shade to the residence with the remainder of the site remaining cleared with a groomed lawn. This setting allows easy views to all buildings and a well-manicured accessible farmyard. This farm is located in a rural setting just outside the project study area identified in consultation with JEO Consulting Group. However, because it was previously surveyed and is just on the edge of the study area it was included in this study. The map below identifies the location of this property. This property is recommended National Register eligible under criterion C for its architectural merit typifying an early 20th century farmyard with a Craftsman style house and full collection of period outbuildings. The property can further contribute under criterion A for its contribution to the agricultural development of Madison County.

Main Residence at MD00-058

Main barn at MD00-058

View of farmyard at MD00-058

Map of MD00-058

MD00-027 ELIGIBLE FARMSTEAD

This farmstead is located in the northwest area of the area of potential effect as shown on the map below. The farmyard consists primarily of the two story residence with some smaller outbuildings all of the period of the house. The residence is a formally styled two story with a crossed jerkinhead or clipped gable roofline. The definitive feature of the main façade is the two story partial width front porch. This feature has four simple round columns with a railing and balusters on the second story porch. The landscaping consists of a grassy front yard with two large coniferous trees flanking the main façade. Two central doors are located in the center of the plan one atop the other on the first and second floor porches. The frame building is painted white with an asphalt roof. A root cellar is located on the north façade of the house and smaller sheds are also on the property.

The property is recommended National Register eligible under criterion C for its architectural merit and its high degree of historic integrity. This type of formal style residence is not typical in most rural settings. Further research could be done to document the degree of farming that took place on the site

given the fact that there are no major farm buildings associated with this property and its layout does not indicate if one or more may have been present at some point in its history.

MD00-027

SITE MD00-056 CONSIDERED POTENTIALLY ELIGIBLE AND NEEDING MORE INFORMATION

One property within the survey area is recommended as potentially eligible. Site MD00-056 was previously surveyed during the Mead and Hunt effort in 2001. The potential exists for this property to be part of a pattern book. During the field survey two other residences (both of which have lost integrity) that are virtually identical to this residence were identified. One feature that stands out and is unique to these properties includes the square battered front porch columns. These columns have recessed inset panels also seen on other properties within the study area. Because this is not typical to this style and it is represented on other buildings there may be a chance that these properties come from the same plan. Although this information does not qualify a property as automatically National Register eligible it can contribute to a better understanding of its historic context.

Site MD00-056 considered potentially eligible and needing more information

SITE FN4 CONSIDERED POTENTIALLY ELIGIBLE AND NEEDING MORE INFORMATION

A residential property identified as FN4 is located across the street from MD00-056. This property though clearly visible from the road was not picked-up in the Mead and Hunt Madison County Survey effort. Possible conclusions for that may be because the residence has siding that is not original to the house, but may date to the historic period. Further, few of the associated outbuildings were visible from the road. Prior to recommending an eligibility determination for this property a more thorough view of the land and evaluation of the residence would be required. Owner permission to enter the land is

required to pursue this additional information and at the time of the field survey, owner permission was not obtained.

Site FN4 requiring more field information for a recommendation of eligibility

SITE FN1 REQUIRING MORE FIELD INFORMATION FOR A RECOMMENDATION OF ELIGIBILITY

One other property located just west of Highway 121 approximately 5 miles south of Battle Creek was not evaluated because of access issues. This property was numbered FN1, and has a significant setback from the road and owner permission was not obtained prior to the field survey. The visual inspection identified a residence that appears to meet the 50 year age standard recommended by the National Register as well as a complex roofline with dormers that warranted additional evaluation. In order for this property to be evaluated owner permission to access the land would be required.

8.4 - RECOMMENDATIONS

This report was drafted to complete a records search, identify existing resources, and make recommendations regarding further effort needed for Section 106 evaluation based on narrowing a scope for a Battle Creek flood control project. Field work and records search were conducted in August 2010. Two farmsteads are recommended National Register eligible, MD00-027 and MD00-058. One property is identified as potentially eligible with the recommendation that more research will assist in documenting a recommendation, and one property was not accessible during field survey and requires owner permission to access the property. No determination is recommended for this property because it was not clearly visible.

Future survey efforts for standing structures will be determined when an undertaking regarding the flood control project is identified and a new area of potential effect can be established based on the scope of the undertaking. At that time additional survey may be needed to further evaluate sites FN1 and FN4 as well as MD00-056. FN1 and FN4 will require owner permission to access their property while site MD00-056 will benefit from additional research to establish a potential pattern book design. These properties will only need further evaluation if they are located within a new APE based on the identified undertaking.

The two farmsteads recommended National Register eligible should be considered in the planning process at all stages. Further documentation efforts for these two properties may include a boundary definition if they are included within the APE of any future undertakings.

ARCHEOLOGICAL FILE SEARCH

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The most comprehensive survey of the Elkhorn River Valley was conducted by Steve Holen (Holen et. al. 1992) in 1991-1992. These investigations concentrated on the Elkhorn River drainage in the counties of Antelope, Stanton, and Madison counties. This project recorded 40 previously unrecorded archeological sites. Again, the surveyed area detailed in this report does not correspond or overlap with this APE. These investigations do, however, help to reinforce the idea that the Elkhorn River Valley is recognized as an area that has a high potential for archeological sites. These sites could likely document a rich human presence in this area, dating back to the Paleoindian period up through the settlement of the area by Euroamericans. The name "Battle Creek" serves to remind us of that rich history. Taken from a battle between the Nebraska Territorial Militia and the Pawnee in 1859, the community and the stream were named after a battle that historians now recognize was not really a battle, but was rather an event that ended with the surrender of the Pawnee to the Militia.

For any project moving forward within this APE with regard to archeological resources, the Nebraska State Historic Preservation Office (NeSHPO) will require a level of effort that includes 100% survey of the project area (personal communication, August 11, 2010). If ground surface visibility is less than 10%, more intensive survey methods may be necessary (NeSHPO, 2006).

Regarding archeological resources, recommendations include continued consultation and coordination of project activities with a professional archeologist. Identification of archeological sites and evaluation of those sites will need to be completed well in advance of any earth moving activities. In addition, project sponsors should expect to complete consultation with the appropriate modern Native American tribal governments. Finally, archeologists recognize a long history of private collecting in the area. Project sponsors should consider public outreach that invites area landowners and collectors to share their experience and information regarding archeological resources in the APE.

9.0 - CONCLUSIONS

Overall, the preliminary environmental assessment and historical property review to date support general feasibility for the potential flood control alternatives. However, it should be noted that the environmental assessment as a whole is preliminary and cannot be fully concluded until a specific project is determined and planned to move forward.

Cultural Resources Identification and Evaluation
Battle Creek Flood Control
Madison County, Nebraska

August 2010

A Historic Property Section 106 Compliance report
Prepared by:
HISTORIC RESOURCES GROUP

Melissa Dirr Gengler
Cultural Resource Specialist
Archeological Resource Review by Stacy Stupka-Burda
442 South 28th Street
Lincoln, Ne 68510

For:
JEO Consulting Group, Inc.
Omaha, NE

Introduction:

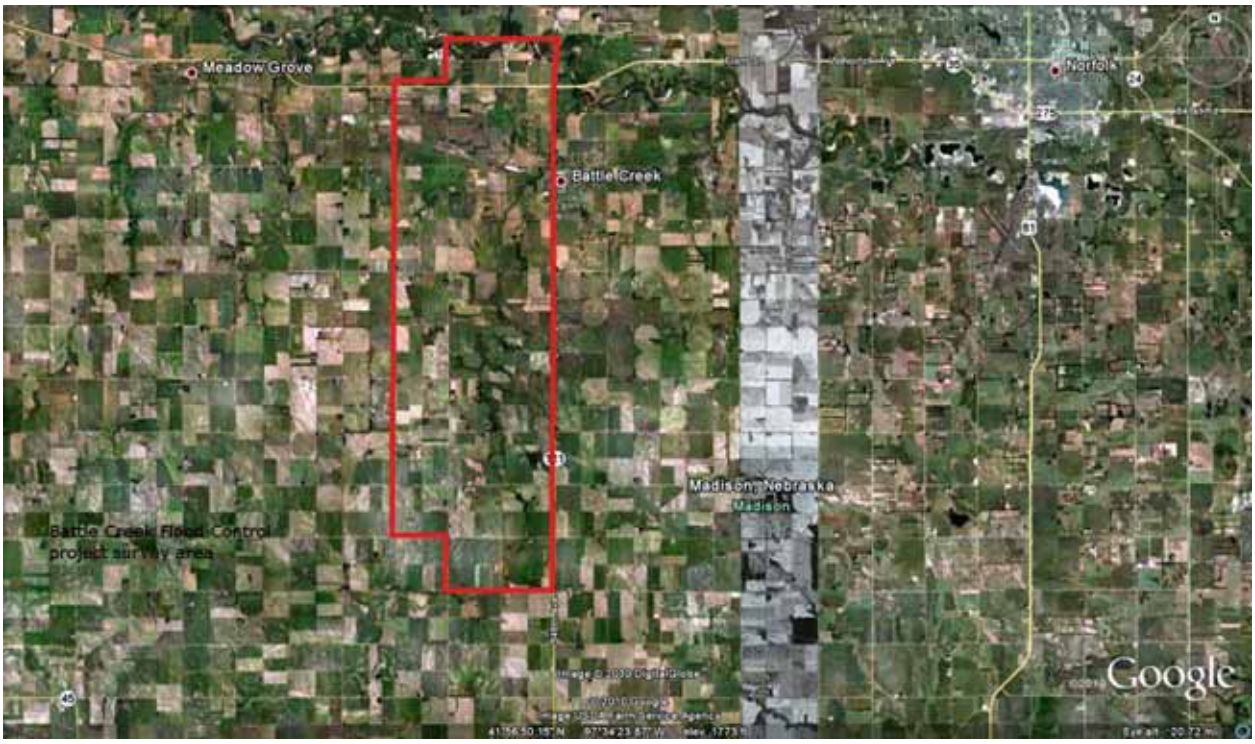
This report is submitted to begin the process of historic property identification for planning purposes and to meet the requirements of historic property identification under Section 106 of the National Historic Preservation Act of 1966 as amended and implementing regulations at 36 CFR Part 800. Particularly this report will identify existing historic standing structures within a broad project study area as well as known or potential archeological sites within the study area. Further this report will make recommendations for level of effort based on any potential undertaking within the area. These recommendations will identify any additional need for historic property identification as well as methodology for determining project effects.

JEO Consulting Group, Inc. in Omaha, Nebraska has been tasked by a Nebraska Natural Resource District to identify a broad area near Battle Creek in Madison County, Nebraska for future flood control planning purposes. As part of this project JEO will utilize the information to help determine the type of flood control project and its location to minimize the effect on any potential historic properties. The area documented within this report is roughly a ten mile by three mile area which encompasses Battle Creek, a tributary of the Elkhorn River (see attached project map for survey area). This area is bounded on the east by Highway 121 and retains primarily rolling hills and agricultural land. The village of Battle Creek is also located within the project study area, but was not evaluated for historic properties because the efforts for flood control will be south and north of town along the Creek. JEO Consulting Group, Inc. has contracted with Historic Resources Group to provide the findings in this report.

AREA OF POTENTIAL EFFECT

The area of potential effect (APE) for Section 106 purposes is defined at Sec. 800.16(d) in the regulations as the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The area of potential effect is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking. The APE for any undertaking is determined in consultation with the Federal Agency that is the nexus of the action, as well as consultation with the Nebraska State Historic Preservation Office. The APE for this potential flood control project is very broad so as to incorporate all possible locations of any appropriate flood control measures. An area in Madison County south, east and slightly north of the village of Battle Creek was reviewed. The area was bounded roughly by Highway 121 on the east, county road 832 on the south, county road 543 on the west and roughly the Elkhorn River to the north. This area incorporates a broad corridor that may house the flood control measures. The field investigation identified and documented all standing structures within the APE that were historic (approximately 50 years old or older), listed in or eligible for listing in the National Register of Historic Places (NRHP), or previously surveyed by the NeSHPO. The report further identified

archeological resources that have been previously recorded in the Nebraska State Historical Society's Archeology Division GIS database.



Battle Creek survey area, map taken from Google.

METHODOLOGY

Historic properties were identified in this report through field survey and archival research. Information obtained regarding properties identified within the APE is included in this report and gathered in the following manner.

National Register Criteria for Evaluation

When evaluating historic properties, the National Register of Historic Places is the primary device by which they are identified for protection under Section 106 of the National Historic Preservation Act of 1966. Criteria for determinations of eligibility are set forth in 36 CFR Part 60.4 (70) and are described in *National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation*. In order for a property to be determined eligible it must retain a high degree of historic integrity and possess significance. Location, design, setting, materials, workmanship, feeling and association are the seven aspects of integrity defined by the NRHP. In general most of the seven integrity aspects must be present for a property to convey historic significance. Historic significance may then be present in one of four categories: important historic events; significant people in history; significant architecture, design, or property type; and potential to yield important historic information. These integrity issues are bolstered by the following field survey and archival research descriptions.

Field Survey

The project area was initially examined to determine the type of resources present and the approximate area to be included in the survey. An on-site analysis of each property was conducted on August 12, 2010 to assess the existing condition, integrity, and significance of properties within the area of potential effect. Information gathered included identifying a style, property type, approximate construction date, as well as alterations, additions, and integrity issues. As approved by the NeSHPO, any properties surveyed were digitally photographed and mapped.

Archival Research

Most archival information was taken from the files of the State Historic Preservation Office a division of the Nebraska State Historical Society. These include files on previously surveyed properties within the study area, along with historic contextual information, and National Register nominations where appropriate. Web sites were also consulted to assist in documenting the basic history of Madison County as well as the city of Battle Creek. Primarily referenced was the *Madison County, Nebraska Historic Building Survey* final report prepared by Mead and Hunt, Inc. in August 2001.

GENERAL HISTORY

Early Nebraska Territory is rich with Native American settlement, traders, and trail pioneers who blazed a new cross-country route through the state. Early permanent settlement in the state began in the 1840s with traders and military forts establishing the early communities to protect the yet organized state. Not until 1853 was the Nebraska Territory formally organized when President Franklin Pierce signed the Kansas-Nebraska Act in 1854. This act established the boundaries of the Territory of Nebraska and formalized the establishment of governments and city and county organizations.

Madison County was established in 1856 by the Nebraska Territorial Legislature and was named for President James Madison. Early settlers in the area were primarily Germans from Wisconsin. They made notable marks on the landscape with their long lot system. To provide farms with access to much needed waterways early lots would be drawn longer than they were wide. The narrow part of the lots generally faced the water ways and then stretched back from that point in a rectangular fashion. This defied the established grid system that was in common use at the time. Although the Germans were early settlers in the area, it was also well populated by the Nebraska militia, traders, and Native American tribes, namely the Pawnee.

In 1859 the Nebraska militia entered into a skirmish with a local Pawnee Village essentially driving the Pawnee out of the area. Although no battle actually occurred the local residents named the watershed Battle Creek. When the nearby village was settled in 1867 it adopted the name Battle Creek after the well-known skirmish that also named the waterway. The town was incorporated in 1873 and began its growth much like many other communities in Nebraska, with successful agriculture and cattle industries and the railroad.

The Fremont, Elkhorn and Missouri valley Railroad came through Norfolk, Battle Creek and Tilden in 1879. The area experienced rapid growth throughout the 1880s with good weather encouraging a strong family driven agriculture and cattle industry. This surge resulted in more than 2200 school age children attending 53 school houses across the county, surging service businesses such as lumber yards, opera houses, and downtown commercial areas. By 1890 the population in the county reached 13, 669 and grew to 19,101 in 1910.

Today Battle Creek is considered part of the Norfolk metropolitan area with a population of approximately 1168 people. The county itself occupies 576 square miles in north east Nebraska. The landscape in the area consists of well drained uplands, terraces and flood prone valleys. The Elkhorn River dominates much of the area including its tributaries the North Fork, Battle, Union, Taylor, Shell, Buffalo, Deer, Dry and Meridian Creeks. The presence of these waterways and the flood prone area near the town of Battle Creek provide for fertile agriculture, but also the need for some management. Identifying potential historic properties in this area will aid in that planning process.

SURVEY RESULTS SUMMARY

The desktop survey for this project area was undertaking on August 10, 2010. At that time all properties that were previously surveyed by the Nebraska State Historic Building Survey completed by Mead and Hunt in 2001 were identified. That search identified approximately 15 previously surveyed standing structures within or near the project study area. All properties within the survey area are rural residential farmsteads, with some individual houses, one church complex, and one cemetery. However, most of these properties were not recommended eligible during the original survey and many of them have lost historic integrity since their initial evaluation. Three properties are recommended National Register eligible, and at least two properties were not accessible during the field survey and would need further documentation when the undertaking is identified. The following is a description of the recommended eligible properties.

MD00-058 Farmstead

This farmstead was surveyed by Mead and Hunt during their 2001 county wide effort. The collection of buildings retains a high degree of historic integrity and includes a 1920s era craftsman style bungalow residence, a large gambrel roof barn, and two to three other historic outbuildings. The residence has a low sloping side gabled roof with a projecting through gabled dormer punctuated by paired fenestration in the dormer. Typical to the style a full width recessed front porch with battered columns extends the width of the main façade. The residence has a three part bay window just off the porch on the west façade. The residence and the major outbuildings are divided by a simple gravel drive. Across the drive is the main barn a gambrel roof building with attached projecting shed to the west side. A single metal ventilator is centrally located on the ridgeline with a hay hood projecting over the loft doors. A silhouette of a horse is painted on the loft doors. Smaller sheds and outbuildings are also located on the site and all date to within the historic period.

The residence is surrounded by large deciduous trees providing shade to the residence with the remainder of the site remaining cleared with a groomed lawn. This setting allows easy views to all buildings and a well-manicured accessible farmyard. This farm is located in a rural setting just outside the project study area identified in consultation with JEO Consulting Group. However, because it was previously surveyed and is just on the edge of the study area it was included in this study. The map below identifies the location of this property. This property is recommended National Register eligible under criterion C for its architectural merit typifying an early 20th century farmyard with a Craftsman style house and full collection of period outbuildings. The property can further contribute under criterion A for its contribution to the agricultural development of Madison County.

Main Residence at MD00-058

Main barn at MD00-058

View of farmyard at MD00-058

Map of MD00-058

MD00-027 Eligible Farmstead

This farmstead is located in the northwest area of the area of potential effect as shown on the map below. The farmyard consists primarily of the two story residence with some smaller outbuildings all of the period of the house. The residence is a formally styled two story with a crossed jerkinhead or clipped gable roofline. The definitive feature of the main façade is the two story partial width front porch. This feature has four simple round columns with a railing and balusters on the second story porch. The landscaping consists of a grassy front yard with two large coniferous trees flanking the main façade. Two central doors are located in the center of the plan one atop the other on the first and second floor porches. The frame building is painted white with an asphalt roof. A root cellar is located on the north façade of the house and smaller sheds are also on the property.

The property is recommended National Register eligible under criterion C for its architectural merit and its high degree of historic integrity. This type of formal style residence is not typical in most rural settings. Further research could be done to document the degree of farming that took place on the site given the fact that there are no major farm buildings associated with this property and its layout does not indicate if one or more may have been present at some point in its history.

Properties requiring more information

MD00-056

One property within the survey area is recommended as potentially eligible. Site MD00-056 was previously surveyed during the Mead and Hunt effort in 2001. The potential exists for this property to be part of a pattern book. During the field survey two other residences (both of which have lost integrity) that are virtually identical to this residence were identified. One feature that stands out and is unique to these properties includes the square battered front porch columns. These columns have recessed inset panels also seen on other properties within the study area. Because this is not typical to this style and it is represented on other buildings there may be a chance that these properties come from the same plan. Although this information does not qualify a property as automatically National Register eligible it can contribute to a better understanding of its historic context.

Site MD00-056 considered potentially eligible and needing more information

A residential property identified as FN4 is located across the street from MD00-056. This property though clearly visible from the road was not picked-up in the Mead and Hunt Madison County Survey effort. Possible conclusions for that may be because the residence has siding that is not original to the house, but may date to the historic period. Further, few of the associated outbuildings were visible from the road. Prior to recommending an eligibility determination for this property a more thorough view of the land and evaluation of the residence would be required. Owner permission to enter the land is required to pursue this additional information and at the time of the field survey, owner permission was not obtained.

Site FN4 requiring more field information for a recommendation of eligibility

One other property located just west of Highway 121 approximately 5 miles south of Battle Creek was not evaluated because of access issues. This property was numbered FN1, and has a significant setback from the road and owner permission was not obtained prior to the field survey. The visual inspection identified a residence that appears to meet the 50 year age standard recommended by the National Register as well as a complex roofline with dormers that warranted additional evaluation. In order for this property to be evaluated owner permission to access the land would be required.

Recommendations

This report was drafted to complete a records search, identify existing resources, and make recommendations regarding further effort needed for Section 106 evaluation based on narrowing a scope for a Battle Creek flood control project. Field work and records search were conducted in August 2010. Two farmsteads are recommended National Register eligible, MD00-027 and MD00-058. One property is identified as potentially eligible with the recommendation that more research will assist in documenting a recommendation, and one property was not accessible during field survey and requires owner permission to access the property. No determination is recommended for this property because it was not clearly visible.

Future survey efforts for standing structures will be determined when an undertaking regarding the flood control project is identified and a new area of potential effect can be established based on the scope of the undertaking. At that time additional survey may be needed to further evaluate sites FN1 and FN4 as well as MD00-056. FN1 and FN4 will require owner permission to access their property while site MD00-056 will benefit from additional research to establish a potential pattern book design. These properties will only need further evaluation if they are located within a new APE based on the identified undertaking.

The two farmsteads recommended National Register eligible should be considered in the planning process at all stages. Further documentation efforts for these two properties may include a boundary definition if they are included within the APE of any future undertakings.

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References

Holen, Steve, Terrence Barton, Stanley M. Parks and Dr. David May

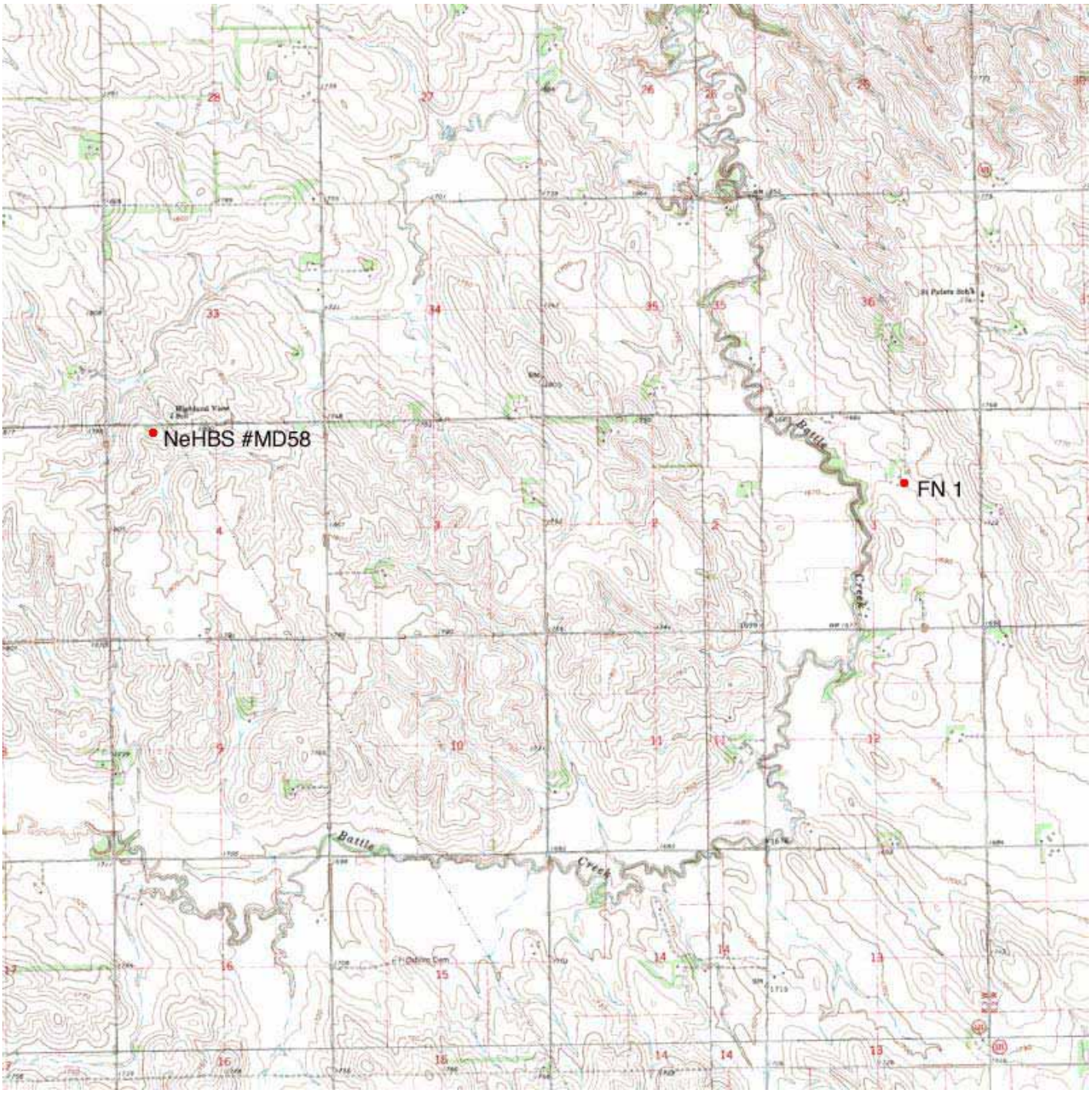
1992 *Geoarcheology and Culture History of the Central Elkhorn River Valley: A Preliminary Survey.* Technical Report 92-01. On file, Archeology Division, Nebraska State Historical Society, Lincoln, Ne.

Nebraska State Historic Preservation Office

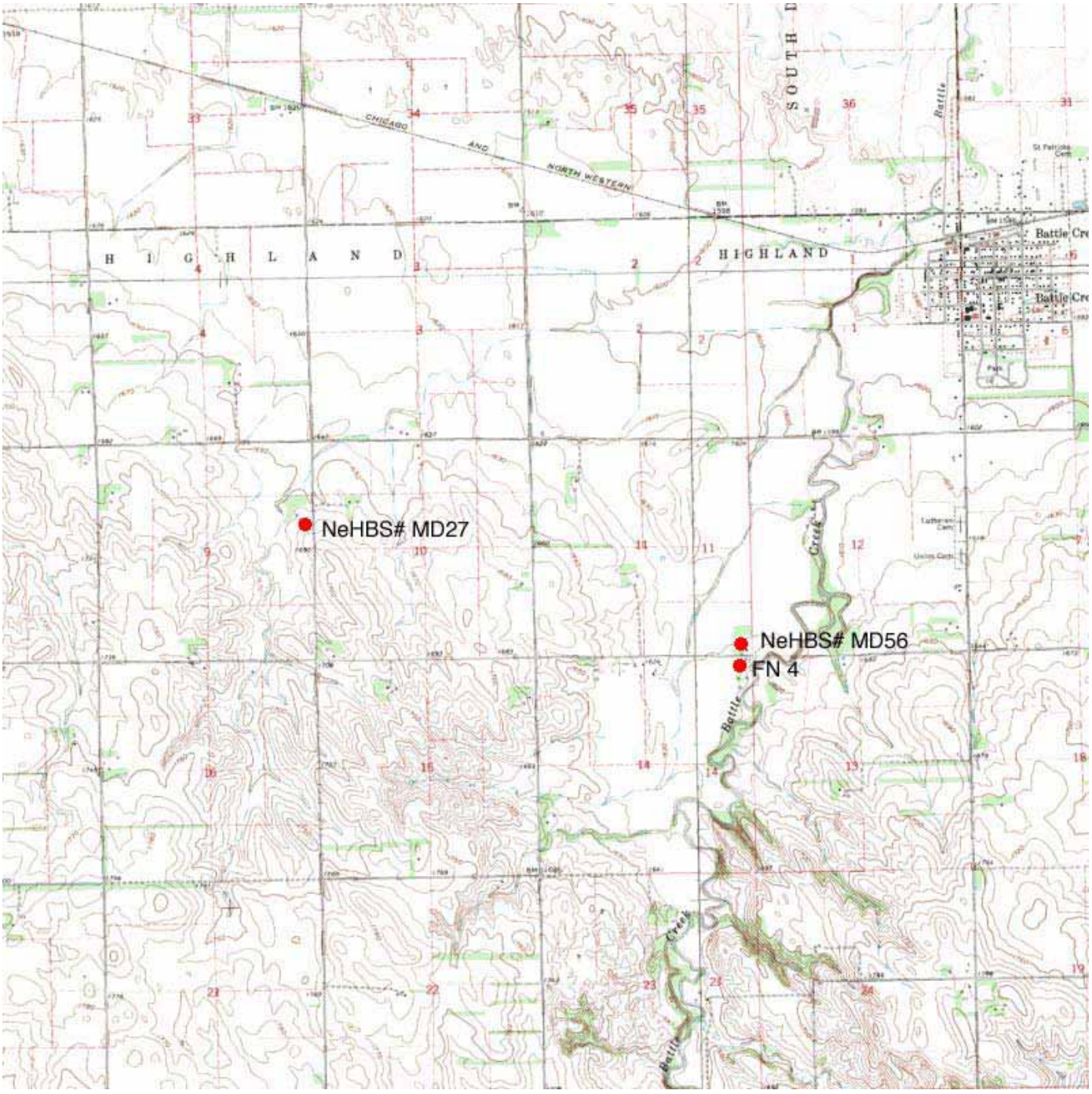
2006 *Archeological Properties Section 106 Guidelines.* Viewed online August 23, 2010 http://www.nebraskahistory.org/histpres/archsurv.htm

2001 Mead and Hunt, Inc. *Madison County Historic Building Survey*.

Various site files and cards



USGS map showing sites MD00-058 and FN1



USGS Topo map showing sites MD00-027, MD00-056, and FN4

UTM Locations of Historic Standing Structures

NeHBS # or Field No.	UTM's, center point (all Zone 14)	NRHP Evaluation
NeHBS # MD27	611043 mE 4648860 mN	Eligible
NeHBS # MD56	614278 mE 4647905 mN	Potentially eligible
NeHBS # MD58	609953 mE 4641310 mN	Eligible
Field No. 1	615493 mE 4640935 mN	Need More Information
Field No. 4	614253 mE 4647760 mN	Need More Information

APPENDIX B

PRELIMINARY GEOTECHNICAL REPORT

MID-STATE
ENGINEERING & TESTING

PRELIMINARY GEOTECHNICAL ENGINEERING REPORT

BATTLE CREEK FLOOD CONTROL ALTERNATIVES MADISON COUNTY, NEBRASKA

M.S. PROJECT NO. 101-53-17
AUGUST 22, 2010
A-2708

Prepared for:

JEO Consulting Group
650 "J" Street, Suite 215
Lincoln, NE. 68508

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ENGINEERING & TESTING

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APPENDICES

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INTRODUCTION

This report presents the results of a preliminary geotechnical investigation performed for the proposed Battle Creek channel realignment and flood control structure in Madison County, Nebraska. This work was authorized by Mr. Mike Placke of the JEO Consulting Group, Inc.

Included in this investigation were six (6) soil borings, laboratory testing, and a report of conclusions and recommendations. The scope of our report was limited to the following:

- Identify insitu geologic conditions,
- Evaluate the engineering properties of the various soil strata,
- Evaluate site suitability with respect to the planned construction.

This report was prepared by Mid-State Engineering and Testing, Inc. by a professional engineer registered in the State of Nebraska. Recommendations are based on the applicable standards of the profession at the time of this study. This report has been prepared for the exclusive use of the JEO Consulting Group, Inc. for specific application to the construction proposed. All work was conducted in accordance with generally accepted soil and foundation engineering practices.

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KEARNEY, NEBRASKA 68847
PHONE (308)-237-0187

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PROJECT DESCRIPTION

At this time, two flood control options are being considered for the City of Battle Creek. The first is to construct a diversion channel around the West side of the Village. The channel would intercept Battle Creek on the West side of Battle Creek, Nebraska and transport water back into Battle Creek about ½ mile North of McCalister Street on the North side of town. A total channel length of about one mile and cut depths of 6 to 26 feet are indicated. Maximum embankment heights of 8 to 10 feet (primarily along the North half) are expected.

The second option includes the construction of a flood control dam on Battle Creek, approximately two miles upstream (south) of Battle Creek. The earthen embankment could be constructed as either a permanent pool structure or a dry dam for temporary flood control.

Its anticipated the structure would be approximately 4000 l.f. in length and constructed at 3H:1V upstream and downstream slopes. A maximum embankment height (above existing grade) of 70 feet is indicated at this time. Preliminary design has a Top of Dike elevation of 1676 feet and a permanent pool elevation of 1643 feet. The 100 year flood elevation is indicated at 1665 feet. The type and location of the outlet structure(s) are undermined at this time.

FIELD WORK

The field investigation was conducted on July 21st, 2010. The exploratory program consisted of a total of six (6) soil borings. DH's 1, 2, and 3 at the proposed dam site and DH's 4, 5, and 6 along the channel realignment. Borings were determined in the field based on plans and stationing provided by the JEO Consulting Group, Inc. Approximate boring locations are noted on the included site plan (Appendix A), Boring Logs (Appendix B) and Soil Profile (Appendix C).

The exploratory borings was advanced to a depth of 15 to 70 feet below existing site elevations with a truck-mounted rotary drilling rig using 4¼ inch continuous flight and hollow stem augers. Soil samples were obtained at the sampling intervals noted on the Boring Logs (Appendix B). Recovered samples were extruded in the field, sealed in plastic containers, labeled, and protected for transportation to the laboratory for testing.

Undisturbed samples, designated "U" samples, were obtained with 3.0-inch (outside diameter), thin-walled, tube samplers hydraulically pushed in general accordance with ASTM D1587-83 (Thin Walled Tube Sampling of Soils). Split-barrel samples, designated "S" samples, were obtained while performing Standard Penetration Tests (SPT) with a 1.50-inch (inside diameter), thick-walled sampler driven in general accordance with ASTM D1586-84 (Penetration Test and Split-Barrel Sampling of Soils). The N-value, reported in blows per foot, equals the number of blows required to drive the split-barrel sampler over the last 12 inches of a normal 18-inch sampling interval.

Field boring logs were prepared by an experienced soils engineer in general accordance with ASTM D2488-84, (Description of Soils by the Visual-Manual Procedure). Stratification lines represent the approximate boundary between soil types. In-situ, the transition between sediments

may be gradual. Water level readings were made in the drill holes at the times and under conditions noted on the boring logs.

LABORATORY TESTING

The field boring logs were reviewed to outline the depths, thickness, and extent the various soil stratum encountered. Based on site stratigraphy and the construction proposed, a testing program was established to evaluate the engineering properties of the bearing strata. Specific tests performed include:

- Soil Moisture Contents,
- Unit Weight Determinations,
- #200 Washed Sieve Analysis,
- Particle Size Analysis,
- Atterberg Limits Testing,
- Unconfined Compression Tests.

All tests were conducted in general accordance with current ASTM standards. Laboratory test results are presented in Appendix D.

In-situ Moisture Contents, Sand Contents, Unit Weights Determinations and the standard penetration testing performed in the field was used to evaluate the overall uniformity/variability of the on-site soils for the determination of bearing capacity, settlement and stability. Unconfined compression tests define the stress/strain relationship of the soils.

Atterberg Limits and Sand Contents were used to determine plasticity characteristics and to classify the soils under the Unified Soil Classification System.

Based on the results of this testing program, the field logs were reviewed and supplemented as shown in Appendix B. These final logs represent our interpretation of the field logs and reflect the additional information gained from the laboratory-testing program.

SITE CONDITIONS

The diversion channel travels through fields and pasture lands, crossing county and private roadways, the cowboy trail and a drainage ditch between 840th Road and the Cowboy trail. The South half of the alignment has a variable topography, while the North half is situated in the Elkhorn River Valley with relatively level terrain.

The upstream dam site is a typical Alluvial setting. The drainageway generally flows in a Northerly direction, bypassing Battle Creek on the West and dumping into the Elkhorn River, approximately 2½ miles North of town. Currently, the main channel is situated on the West side of the drainageway, with relatively level low lying terrace lands extending about 1500 feet East of the current channel. Elevations rise about 100 feet immediately West of the drainageway.

SOIL CONDITIONS

These sites are situated in the Elkhorn River flood plain and adjacent Terrace lands. The generalized subsurface profile for this region consists of Alluvial sediments in the valley bottom, with wind deposited soils over Alluvial Sediments in the upland areas. Within the depths investigated, the subsurface soils encountered consist of Aeolian and Colluvial sediments situated atop Alluvial Clays and Sand deposits. In addition, Altered Loess Deposits were encountered below the Aeolian Sediments in the upland area of the proposed dam site

Aeolian Sediments consist of low and non-plastic wind deposited silts and fine sands. These sediments were encountered in the uplands areas of both the dam site (DH-1, extending to a depth of about 40 feet) and the diversion channel (South half) where Aeolian Sediments were encountered in DH's 4 and 5, extending to depths of 4 and 8 feet respectfully.

These sediments were generally described as light brown, slightly moist to saturated, loose to firm, silty fine sands. In the areas sampled, these deposits exhibited the following range in insitu engineering properties.

Diversion Channel

Soil Moisture (%)	8
Sand Content (%)	58
Field SPT Blow Counts (N)	3 – 5

Dam Site

Soil Moisture (%)	6 – 11
Sand Content (%)	35 – 81
Field SPT Blow Counts (N)	14 – 36

Based on visual and lab evaluation, these deposits classify as low and non-plastic sandy silts (ML) and silty fine sands (SM).

An approximate 20' thick layer of Altered Loess Deposits (Peorian Age) was encountered below the Aeolian Sediments (approximately 40 to 60' depths at the DH-1 location) in the uplands area of the dam site. These deposits were described as brown, grey brown and olive brown, moist to very moist lean clays.

These sediments exhibit the following range in insitu engineering properties.

Soil Moisture (%)	22 – 27
SPT Blow Count (N)	14 – 35
Sand Content (%)	1 – 2
Plastic Index	15

Based on Atterberg Limits Testing, these deposits classify as moderately plastic lean clays (CL).

Colluvial deposits are naturally occurring sediments which accumulate through the action of wind and local wash, generally at the base of surrounding hillsides and in valley bottoms. These

deposits were encountered below the topsoil in boring locations DH-1, 2, 3 and 5 and below the Aeolian Sediments in borings 4 and 6. In most areas, the Colluvial Sediments ranged between 8 and 12 feet in thickness (less in DH's 1 and 5) and were described as very dark grey to olive brown, moist to saturated, firm to stiff, lean clays. These deposits exhibit the following range in in-situ engineering properties:

Diversion Channel

Moisture Content (%)	16 – 31
Dry Unit Weight (pcf)	90 - 105
SPT Blow Counts (N)	4 – 6
Unconfined Compressive Strength (TSF)	0.6 – 2.5

Dam Site

Moisture Content (%)	13 – 26
SPT Blow Counts (N)	3 – 6
Plastic Index	20

Based on Atterberg Limits testing and visual evaluation, these Colluvial sediments classify as moderately plastic lean (CL) clays.

Alternating layers of Alluvial Sands and clays were encountered below the Altered Loess and Colluvial Deposits in all six (6) borings extending beyond the boring depths. The upper Terrace Deposits generally consist of cohesive sandy clays and clayey sands, with occasional thin sand seams. At deeper depths, the sediments transition to sand with occasional clay stringers. These Alluvial Sediments were described as light brown to dark grey, moist to saturated, loose/soft to dense, poorly and well graded sands, clays and clayey sands. These deposits exhibit the following range in in-situ engineering properties:

Diversion Channel

Moisture Contents (%)	13 - 39
Percent Passing #200 Sieve (%)	2 - 64
SPT Blow Counts (N)	4 - 15
Dry Unit Weight (pcf)	81 - 99

Dam Site

Moisture Contents (%)	17 - 33
Percent Passing #200 Sieve (%)	2 - 69
SPT Blow Counts (N)	2 - 55

Based on laboratory testing and visual evaluation, these deposits range in classification from moderately plastic sandy lean clays and clayey sands (CL/SC), to poorly and well graded sands (SP/SW).

GROUNDWATER

Groundwater at the time of drilling was encountered at depths of eight (8) to fifteen (15) feet below existing site elevations at the dam site (DH's 2 and 3). Groundwater along the Diversion Channel was quite variable, with water near the proposed flow line along the Northern half, and 1 to 3 feet above flow line for the South portion of the channel. In addition, perched water was encountered in the upper Aeolian Sediments. Groundwater encountered at this level will most likely have an effect on the construction planned for both sites. It should also be expected that fluctuations in groundwater level will occur due to seasonal variations in rainfall, runoff, temperature, or other factors that may differ from those at the time measurement were made.

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

Subgrade soils throughout both project sites are quite variable ranging from loose blow sands to dense clays and everything in between. While a number of soils related issues will need to be addressed, in general, both flood control options appear feesable if properly designed and constructed.

Diversion Channel

The North half of the diversion channel is situated in the Elkhorn River flood plain with soils consisting of cohesive sandy clays transitioning to clean sands near the proposed flow line. The South half sediments consist of blow sands (up to 10 feet) atop cohesive Colluvial and Alluvial Sediments which extend below the flow line. Issues include perched water seeping out of the upper level Aeolian Sands. While probably not having a big impact on construction, it could result in erosion problems over time. These upper level sands typically require a 4 or 5 H:1V slope for stability.

With respect to embankment construction, there does not appear to be any settlement or foundation stability issues with the in-situ soils. Excluding topsoil and vegetation, it appears all site soils will be suitable for embankment construction. While some sandy soils may be used for embankment construction, there appears to be sufficient cohesive soils on-site to construct and seal new embankments.

Soil moisture throughout the majority of the excavation areas will generally be on the wet side of optimum (excluding the Aeolian Sands). The bottom 3 to 5 feet will be 85 to 100% saturated.

Flood Control Dam

Primary issues for construction of the 70 foot tall flood control structure include.

- The sandy nature of the majority of the site soils expected to be used for embankment construction.
- Expected cut depths between approximate Station 2500 to 3960 will expose clean Alluvial Sands at the base of the pool area.

- The presence of an approximate 20 to 30 foot layer of compressible soils in the areas of the highest embankment (about Station 500 to 3200).

- A relatively high groundwater table lying about 4 to 8 feet below current site elevations in the valley bottom.

- The known variability in soil conditions on each side of the drainageway, and the unknowns between the three soil borings (about 1000' spacing) will need to be better defined to provide embankment design recommendations.

While these issue pose problems which will need to be addressed, we expect this project could be safety constructed. In the event excavation in the pool area can be limited to allow 3 to 4 feet of separation above groundwater, and sufficient cohesive soils are stockpiled for the face of the embankment and exposed sands in the pool areas, its expected a permanent pool structure is feasible.

Due to the expected sandy nature of most embankment fill (the silty sandy Aeolian Deposits), it may be necessary to provide a chimney drain to handle seep water in a permanent pool facility. A chimney drain will not be required for a dry dam.

While there isn't sufficient information at this time to accurately predict total and differential settlement. Maximum total embankment settlement on the order of 1 to 1½ feet are indicated. Its expected some core out will be required below the embankment (deeper fill areas) and for spillway structures (depending on location and deign). Its also possible a core trench will be required below the embankment. Dewatering may be required in these instances.

Again considerable additional investigation will be required to fully evaluate the approximate 4000 foot long embankment and upstream pool area and provide specific design recommendations for the flood control structure.

GENERAL COMMENTS

If any changes in the nature, design, or location of this project are planned, the conclusions and recommendations contained in this report shall not be considered valid unless those changes are reviewed and the conclusions of this report either modified or verified in writing by the Geotechnical engineer.

The analysis and recommendations submitted in this report are based in part upon the data obtained from the six (6) soil borings. The nature and extent of variation of the on-site soils between the borings may not become evident until construction. If variations appear, it will then be necessary to reevaluate the recommendations of this report.

It is recommended the Geotechnical engineer be allowed to review the final design and specifications. It is also recommended that a geotechnical engineer be retained to provide QA/QC engineering and testing services during the excavation, earthwork, and foundation construction phases of the project. This is to verify compliance with the proposed design, project

specifications, or final recommendations and to modify these recommendations if subsurface conditions differ from those expected.

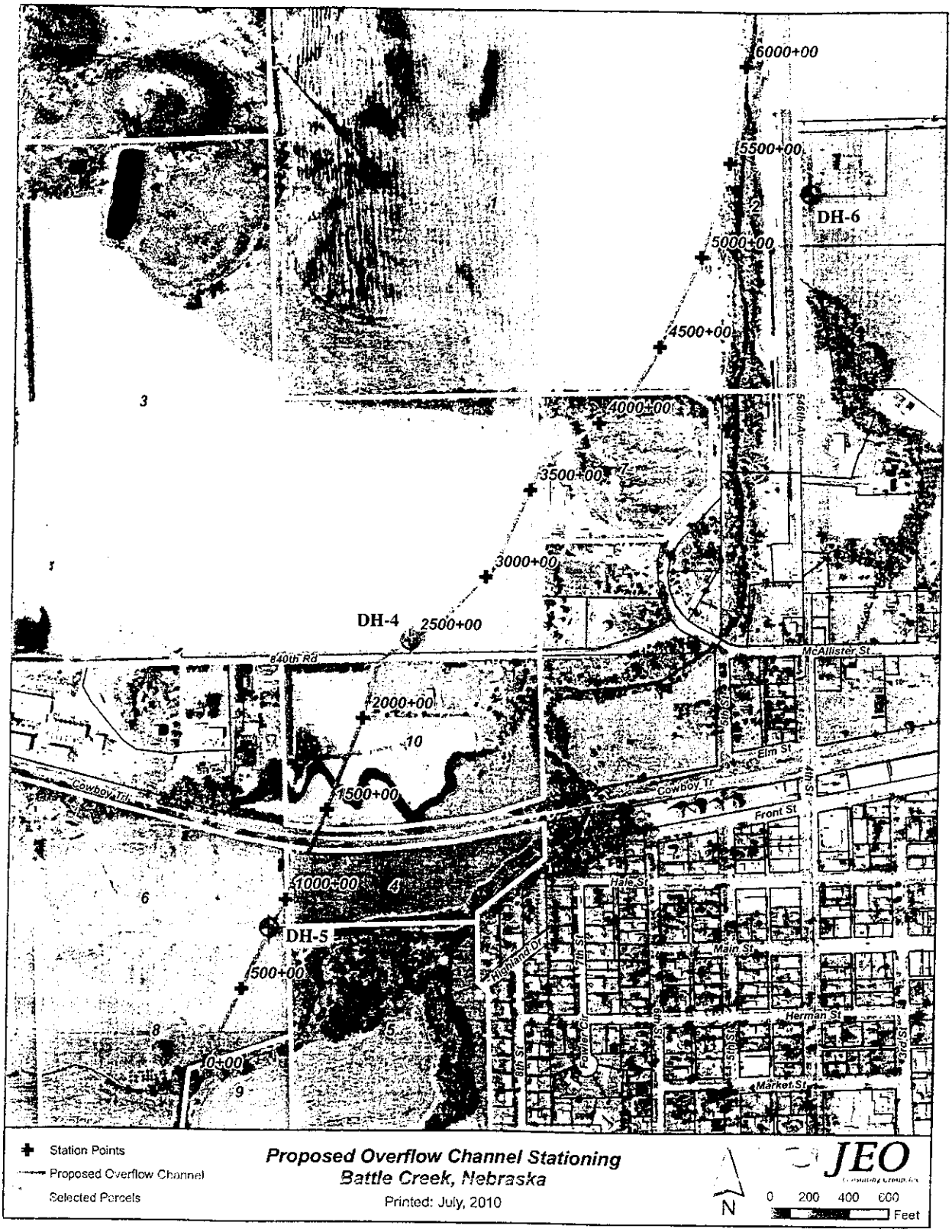
Respectfully submitted,
Mid-State Engineering and Testing, Inc.

Jim Musilek, P.E.
Nebraska Reg. #E-5935

APPENDIX A
SITE PLAN

MID-STATE
ENGINEERING & TESTING, INC.
279 ROAD 'D', COLUMBUS, NE. 68601

SITE PLAN
Battle Creek Flood Control
MADISON COUNTY, NEBRASKA



MID-STATE

ENGINEERING & TESTING, INC.

279 ROAD 'D', COLUMBUS, NE. 68601

SITE PLAN

Battle Creek Flood Control

MADISON COUNTY, NEBRASKA

APPENDIX B
BORING LOGS

MID-STATE ENGINEERING & TESTING, INC.

BORING LOG

PROJECT	Battle Creek Flood Control
LOCATION	Battle Creek, Nebraska
JOB NO.	101-53-17
DATE	7/20/10

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	TOTAL DEPTH
DH-1	N41 - 57'31.9" + W97 - 36' 55.2"			70.0'

WATER LEVEL OBSERVATIONS			TYPE OF SURFACE	DRILLER
WHILE DRILLING	END OF DRILLING	HOURS	Grass	Dale Donoghue
			DRILLING METHOD	LOGGER
None	Encountered		4 1/4" Continuous Flight Auger	Gary Musilek

DEPTH FT.	SAMPLE NO. & TYPE	N* BLOWS / FT	REC %	COLOR	MOIST	CONS.	SOIL TYPE (Class)	GEOLOGIC DESCRIPTION & OTHER REMARKS	MOIST %	DRY WEIGHT PCF	QU TSF	DEPTH FT.
				Brown	Moist	Firm	CL	**Topsoil**				
				Brown	Moist	Firm	CL/ML	**COLLUVIAL DEPOSITS** w/ Roots and Root Holes Carbon and Rust Stains				
	U-1			Light Brn	Slightly Moist	Firm	ML/SM	**AEOLIAN DEPOSITS** w/ Root Hairs				
5							SM		10.7			5
	S-2	5/7/7 (14)										
10												10
	S-3	6/7/8 (15)							9.6			
15												15
	S-4	5/8/11 (19)										
20												20
	S-5	10/11/13 (24)							6.3			
25												25
	S-6	9/13/15 (28)										
30												30
	S-7	15/18/18 (36)							11.3			
35												35

MID-STATE ENGINEERING & TESTING, INC.

BORING LOG

PROJECT: Battle Creek Flood Control
LOCATION: Battle Creek, Nebraska
JOB NO.: 101-53-17
DATE: 7/20/10

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	TOTAL DEPTH
DH-1	N41 - 57'31.9" + W97 - 36' 55.2"			70.0'

DEPTH FT	SAMPLE NO. & TYPE	N° BLOWS / FT	REC %	COLOR	MOIST	CONS.	SOIL TYPE (Class)	GEOLOGIC DESCRIPTION & OTHER REMARKS	MOIST %	DRY WEIGHT PCF	QU TSF	DEPTH FT.
40	S-8	12/19/14 (33)		Grey Brn	Moist	Very Stiff	CL	**ALTERED LOESS (Peorian Age)** w/ Rust and Carbon				40
45	S-9	13/15/20 (35)							22.8			45
				Grey								
50	S-10	11/15/15 (30)							22.0			50
				Olive Brn		Firm						
55	S-11	6/6/8 (14)							26.5			55
60	S-12	7/9/12 (21)							13.1			60
				Light Brn	Slightly Moist	Firm	SP	**ALLUVIAL DEPOSITS** Fine to Medium Sand				
				White								
65	S-13	10/12/16 (28)										65
				Multi-Colored								
							SP/SW	Medium to Coarse Sand				
70	S-14	15/12/12 (24)							1.5			70
								Bottom of Hole 70.0'				
75												75

MID-STATE ENGINEERING & TESTING, INC.

BORING LOG

PROJECT	Battle Creek Flood Control
LOCATION	Battle Creek, Nebraska
JOB NO.	101-53-17
DATE	7/20/10

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	TOTAL DEPTH
DH-2	N41 - 57' 30.4" + W97 - 37' 32.2"			50.0'

WATER LEVEL OBSERVATIONS			TYPE OF SURFACE	DRILLER
WHILE DRILLING	END OF DRILLING	HOURS	Grass	Dale Donoghue
			DRILLING METHOD	LOGGER
15.5'			4 1/4" Continuous Flight Auger	Gary Musilek

DEPTH FT.	SAMPLE NO. & TYPE	N" BLOWS / FT	REC %	COLOR	MOIST	CONS.	SOIL TYPE (Class)	GEOLOGIC DESCRIPTION & OTHER REMARKS	MOIST %	DRY WEIGHT PCF	QU TSF	DEPTH FT.
				Dark Grey	Moist	Firm	CL	**Topsoil (1')**				
				Very Dark Grey	Very Moist	Firm	CL/CH	**COLLUVIAL DEPOSITS** w/ Rust Stains Some Fine Sand				
				Dark Grey	Moist							
5	S-1	2/2/3 (5)							25.9			5
				Brown	Slightly Moist							
10	S-2	3/3/3 (6)							13.7			10
					Moist							
				Dark Grey	Very Moist	Very Soft	CL	**ALLUVIAL TERRACE DEPOSITS** w/ Carbon Stains Sand Trace Gravel				
15	S-3	2/1/2 (3)			Saturated		CL/SC		21.6			15
						Firm	SC					
20	S-4	6/6/6 (12)							17.1			20
				Light Grey		Very Loose	SP	Sand Seam				
25	S-5	4/1/1 (2)							18.9			25
				Dark Grey		Soft	CL	Silty Clays Trace Sand				
30	S-6	3/2/4 (6)							33.0			30
35	S-7	4/4/4 (8)										35

MID-STATE ENGINEERING & TESTING, INC.

BORING LOG

PROJECT	Battle Creek Flood Control
LOCATION	Battle Creek, Nebraska
JOB NO.	101-53-17
DATE	7/20/10

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	TOTAL DEPTH
DH-2	N41 - 57' 30.4" + W97 - 37' 32.2"			50.0'

DEPTH FT.	SAMPLE NO. & TYPE	N* BLOWS / FT	REC %	COLOR	MOIST	CONS.	SOIL TYPE (Class)	GEOLOGIC DESCRIPTION & OTHER REMARKS	MOIST %	DRY WEIGHT PCF	QU TSF	DEPTH FT.
				Dark Grey	Saturated	Soft	CL	**ALLUVIAL TERRACE DEPOSITS**				
				Olive Brn		Firm	SC					
40	S-8	5/7/8 (15)							16.6			40
				Brown	Saturated	Dense	SP/SW	**ALLUVIAL SANDS**				
45	S-9	20/30/25 (55)										45
50	S-10	8/18/26 (44)										50
								Bottom of Hole 50.0'				
55												55
60												60
65												65
70												70
75												75

MID-STATE ENGINEERING & TESTING, INC.

BORING LOG

PROJECT: Battle Creek Flood Control

LOCATION: Battle Creek, Nebraska

JOB NO.: 101-53-17

DATE: 7/21/10

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	TOTAL DEPTH
DH-3	Station 1000+00			30.0'

WATER LEVEL OBSERVATIONS			TYPE OF SURFACE	DRILLER
WHILE DRILLING	END OF DRILLING	HOURS		Dale Donoghue
8.0'			DRILLING METHOD: 4 1/4" Continuous Flight Auger	LOGGER: Darren Betz

DEPTH FT.	SAMPLE NO. & TYPE	N" BLOWS / FT	REC %	COLOR	MOIST	CONS.	SOIL TYPE (Class)	GEOLOGIC DESCRIPTION & OTHER REMARKS	MOIST %	DRY WEIGHT PCF	QU TSF	DEPTH FT.
				Dark Grey	Moist	Firm	CL	**Topsoil (1')**				
				Dark Grey Brown	Moist	Firm	CL	**COLLUVIAL DEPOSITS** w/ Carbon and Rust Stains Some Fine Sand				
						Soft						
5	S-1	2/2/2 (4)							18.9			5
					Very Moist							
10	S-2	1/1/2 (3)			Saturated							10
				Grey Brn	Saturated	Firm	CL/SC	**ALLUVIAL TERRACE DEPOSITS** Sandy Clays w/ Trace Gravel				
15	S-3	4/4/7 (11)							19.8			15
20	S-4	2/2/2 (4)										20
							ML					
25	S-5	2/4/2 (6)							32.1			25
30	S-6	5/9/6 (15)							26.1			30
								Bottom of Hole 30.0'				
35												35

MID-STATE ENGINEERING & TESTING, INC.

BORING LOG

PROJECT	Battle Creek Flood Control
LOCATION	Battle Creek, Nebraska
JOB NO.	101-53-17
DATE	7/21/10

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	TOTAL DEPTH
DH-4	Station 2500+00			25.0'

WATER LEVEL OBSERVATIONS			TYPE OF SURFACE	DRILLER
WHILE DRILLING	END OF DRILLING	HOURS		Dale Donoghue
			DRILLING METHOD	LOGGER
None	Encountered		4 1/4" Continuous Flight Auger	Darren Betz

DEPTH FT.	SAMPLE NO. & TYPE	N" BLOWS / FT	REC %	COLOR	MOIST	CONS.	SOIL TYPE (Class)	GEOLOGIC DESCRIPTION & OTHER REMARKS	MOIST %	DRY WEIGHT PCF	QU TSF	DEPTH FT.
								Topsoil (4")				
				Light Brn	Slightly Moist	Loose	SM	**AEOLIAN DEPOSITS** Silty Fine Sands w/ Rust Stains				
				Brown	Moist							
5	S-1	1/1/2 (3)							8.5			5
				Very Dark Grey	Saturated	Firm	CL/CH	**COLLUVIAL DEPOSITS**				
10	S-2	3/2/3 (5)							25.4			10
					Very Moist	Stiff						
15	U-3								31.2	90.6	1.2	15
				Very Dark Grey		Soft						
20	U-4								23.1	103.0	0.6	20
				Grey	Saturated	Firm	SP/SM	**ALLUVIAL SANDS**				
25	S-5	4/5/9 (14)							15.5			25
								Bottom of Hole 25.0'				
30												30
35												35

MID-STATE ENGINEERING & TESTING, INC.

BORING LOG

PROJECT	Battle Creek Flood Control
LOCATION	Battle Creek, Nebraska
JOB NO.	101-53-17
DATE	7/20/10

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	TOTAL DEPTH
DH-5	Approximately Station 5250+00			15.0'

WATER LEVEL OBSERVATIONS			TYPE OF SURFACE	DRILLER
WHILE DRILLING	END OF DRILLING	HOURS	Grass	Dale Donoghue
			DRILLING METHOD	LOGGER
10.5'			4 1/4" Continuous Flight Auger	Darren Betz

DEPTH FT.	SAMPLE NO. & TYPE	N° BLOWS / FT	REC %	COLOR	MOIST	CONS.	SOIL TYPE (Class)	GEOLOGIC DESCRIPTION & OTHER REMARKS	MOIST %	DRY WEIGHT PCF	QU TSF	DEPTH FT.
				V Dk Gr	Moist	Firm	CL	**Topsoil (8")**				
				Very Dark Grey	Moist	Firm	CL	**COLLUVIAL DEPOSITS** w/ Carbon Stains Rust Stains				
	U-1			Dark Grey					16.5	94.1		5
5				Dark Grey Brown	Moist	Firm	CL	**ALLUVIAL TERRACE DEPOSITS** w/ Some Sand Trace Gravel Carbon and Rust Stains				
	U-2						CL/SC		13.9			10
10	S-3	2/2/2 (4)			Saturated							
				Brown	Saturated	Firm	SP/SC	**ALLUVIAL SANDS** w/ Occasional Thin Clay Stringers Rust				
	S-4	5/7/8 (15)										15
15								**Bottom of Hole 15.0'**				
20												20
25												25
30												30
35												35

MID-STATE ENGINEERING & TESTING, INC.

BORING LOG

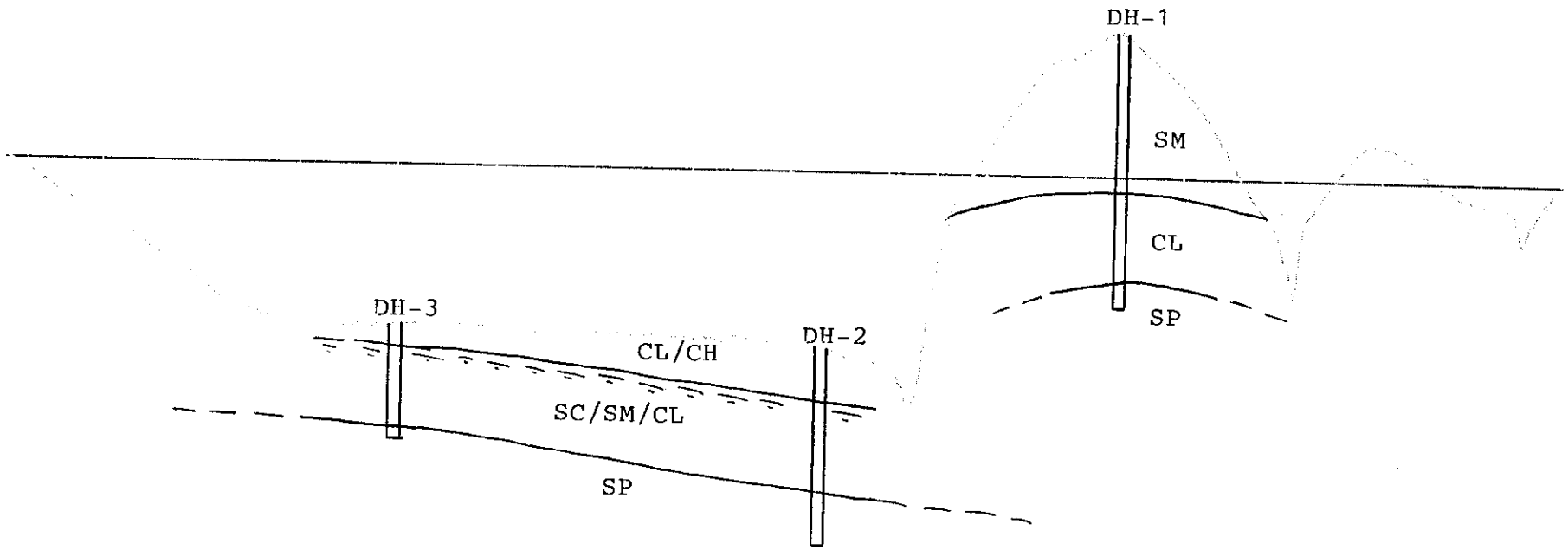
PROJECT	Battle Creek Flood Control
LOCATION	Battle Creek, Nebraska
JOB NO.	101-53-17
DATE	7/21/10

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	TOTAL DEPTH
DH-6	Station 800+00			20.0'

WATER LEVEL OBSERVATIONS			TYPE OF SURFACE	DRILLER
WHILE DRILLING	END OF DRILLING	HOURS	Grass	Dale Donoghue
			DRILLING METHOD	LOGGER
7.0'			4 1/4" Continuous Flight Auger	Darren Betz

DEPTH FT.	SAMPLE NO. & TYPE	N* BLOWS / FT	REC %	COLOR	MOIST	CONS.	SOIL TYPE (Class)	GEOLOGIC DESCRIPTION & OTHER REMARKS	MOIST %	DRY WEIGHT PCF	QU TSF	DEPTH FT.
								Topsoil (4")				
				Light Brn	Moist	Firm	SC/SM	**AEOLIAN DEPOSITS**				
5	S-1	1/2/3 (5)		Olive	Moist	Stiff	CL	**COLLUVIAL DEPOSITS** w/ Carbon and Rust Stains	21.2	104.8	2.5	5
	U-2				Very Moist							
10	U-3				Saturated				28.5			10
				Dark Grey	Saturated	Firm	CL	**ALLUVIAL TERRACE DEPOSITS** w/ Trace Fine Sand Shells				
15	U-4								38.8	81.3	0.9	15
20	U-5								31.3			20
								Bottom of Hole 20.0'				
25												25
30												30
35												35

APPENDIX C
SOIL PROFILE



MID-STATE
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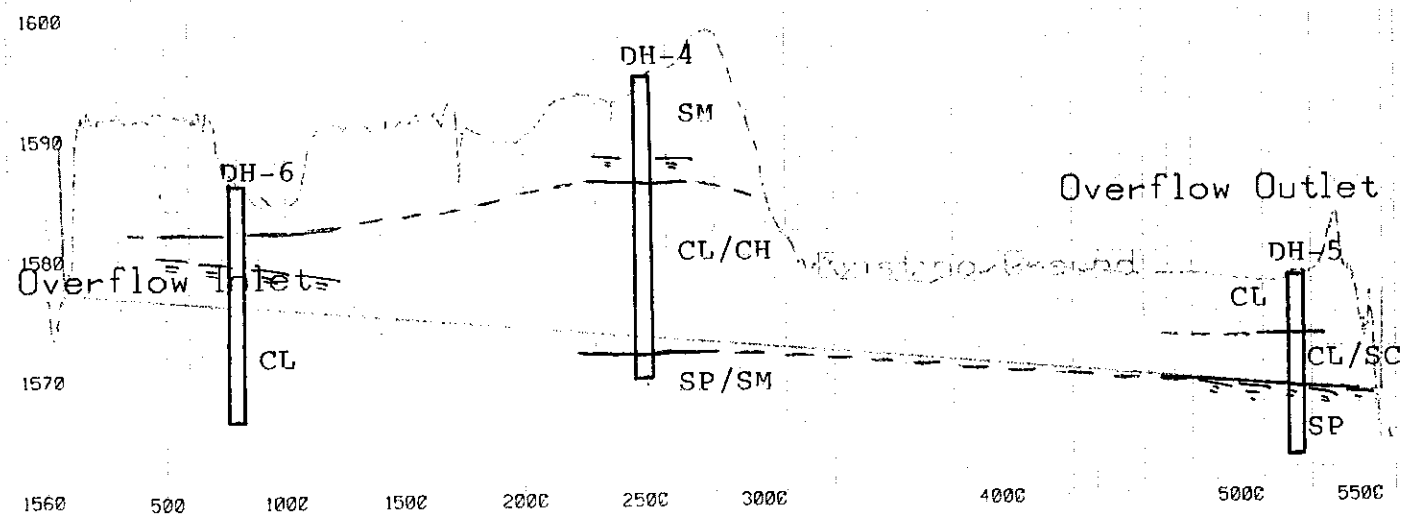
279 ROAD 'D', COLUMBUS, NE. 68601

SOIL PROFILE

BATTLE CREEK FLOOD CONTROL
MADISON COUNTY, NEBRASKA



Profile of Overflow Bottom

MID-STATE

ENGINEERING & TESTING, INC.

279 ROAD 'D', COLUMBUS, NE. 68601

SOIL PROFILE

BATTLE CREEK FLOOD CONTROL

MADISON COUNTY, NEBRASKA

APPENDIX D
SUMMARY OF SOILS TEST

MID-STATE ENGINEERING & TESTING, INC.

SUMMARY OF SOIL TESTS

PROJECT: Battle Creek Flood control

LOCATION: Battle Creek, Nebraska

JOB NO. 101-53-17 DATE 8/6/10

DRILL HOLE NO.	SAMPLE NO.	SAMPLE DEPTH (ft.)	WATER CONTENT %	DENSITY WET (pcf)	DENSITY DRY (pcf)	VOID RATIO (e)	SAT. %	UNCONFINED COMPRESSION QU (tsf)	UNCONFINED COMPRESSION Strain (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	%PASS #200 SIEVE	CLASS.	SPT (N)	REMARKS
DH-1	U-1	3 1/2 - 5'	10.7										64.5			
	S-2	8 1/2 - 10'													14	
	S-3	13 1/2 - 15'	9.6										42.6		15	
	S-4	18 1/2 - 20'													19	
	S-5	23 1/2 - 25'	6.3										28.9		24	
	S-6	28 1/2 - 30'													28	
	S-7	33 1/2 - 35'	11.3										58.1		36	
	S-8	38 1/2 - 40'													33	
	S-9	43 1/2 - 45'	22.8							35	20	15	98.5	CL	35	
	S-10	48 1/2 - 50'	22.0												30	
	S-11	53 1/2 - 55'	26.5												14	
	S-12	58 1/2 - 60'	13.1												21	
	S-13	63 1/2 - 65'													28	
	S-14	68 1/2 - 70	1.5										4.6		24	Washed Sieve Analysis
DH-2	S-1	3 1/2 - 5'	25.9							37	17	20		CL	5	
	S-2	8 1/2 - 10'	13.7										88.8		6	
	S-3	13 1/2 - 15'	21.6												3	
	S-4	18 1/2 - 20'	17.1										32.1		12	
	S-5	23 1/2 - 25'	18.9										69.2		2	
	S-6	28 1/2 - 30'	33.0												6	
	S-7	33 1/2 - 35'													8	
	S-8	38 1/2 - 40'	16.6										34.0		15	
	S-9	43 1/2 - 45'													55	
	S-10	48 1/2 - 50'													44	

MID-STATE ENGINEERING & TESTING, INC.

SUMMARY OF SOIL TESTS

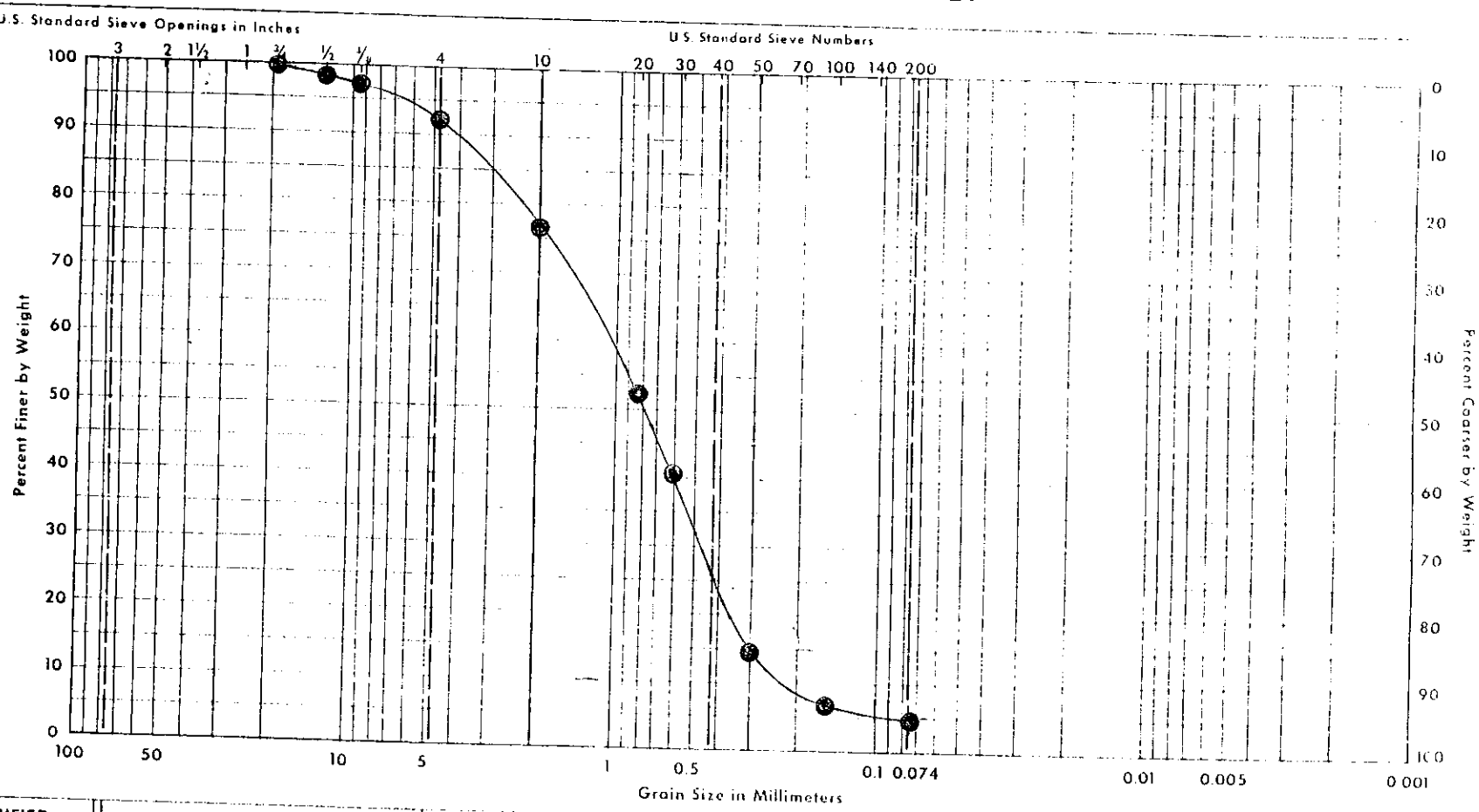
PROJECT Battle Creek Flood control

LOCATION Battle Creek, Nebraska

JOB NO. 101-53-17 **DATE** 8/6/10

DRILL HOLE NO.	SAMPLE NO.	SAMPLE DEPTH (ft.)	WATER CONTENT %	DENSITY WET (pcf)	DENSITY DRY (pcf)	VOID RATIO (e)	SAT. %	UNCONFINED COMPRESSION QU (tsf)	UNCONFINED COMPRESSION Strain (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	%PASS #200 SIEVE	CLASS.	SPT (N)	REMARKS
DH-3	S-1	3 1/2 - 5'	18.9										87		4	
	S-2	8 1/2 - 10'													3	
	S-3	13 1/2 - 15'	19.8										53.3		11	
	S-4	18 1/2 - 20'													4	
	S-5	23 1/2 - 25'	32.1							NP	NP	NP	64.0	SM/ML	6	
	S-6	28 1/2 - 30'	26.1										56.0		15	
DH-4	S-1	3 1/2 - 5'	8.5										42.9		3	
	S-2	8 1/2 - 10'	25.4												5	
	U-3	13 1/2 - 15'	31.2	118.9	90.6	0.860	98	1.2	3.5							
	U-4	18 1/2 - 20'	28.3	126.8	98.8	0.702	100	0.6	11.6							
	S-5	23 1/2 - 25'	15.5												14	
DH-5	U-1	3 1/2 - 5'	16.5	109.6	94.1	0.790	56									
	U-2	8 1/2 - 10'	13.9										64.2			
	S-3	10 - 11 1/2'													4	
	S-4	13 1/2 - 15'													15	
DH-6	S-1	3 1/2 - 5'													6	
	U-2	5 - 6 1/2'	21.2	127.1	104.8	0.608	94	2.5	5.4							
	U-3	8 1/2 - 10'	28.5													
	U-4	13 1/2 - 15'	38.8	112.8	81.3	1.072	98	0.9	11.6							
	U-5	18 1/2 - 20'	31.3													

GRAIN SIZE ANALYSIS CURVES



Drill Hole	Sample No.	Sample Depth	LL	PL	PI	Water Cont. %	Classification
DH-1	S-14	68½-70'				1.5	

Project: Battle Creek Flood Control

Date: 8/6/10 Job No: 101-53-17

MID-STATE

MID-STATE

ENGINEERING & TESTING, INC.
279 Road 'D', Columbus, NE. 68601

SOIL PROPERTIES

UNIFIED SOILS CLASSIFICATION

(Including Identification and Description)

Group Symbols	Typical Names	Value as Subgrade When No Subject to Frost Action	Potential Frost Action	Compressibility and Expansion	Drainage Characteristics	Compaction Equipment	Compacted Dry Unit Weight (pcf) ASTM D-698	Typical Design Values	
								CBR	Subgrade Modulus k lb. per cu. in.
GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Excellent	None to Very Slight	Almost None	Excellent	Crawler-type tractor, rubber tired roller, steel-wheeled roller	125-140	40-80	300-500
GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	Good to Excellent	None to Very Slight	Almost None	Excellent	Crawler-type tractor, rubber tired roller, steel-wheeled roller	110-140	30-60	300-500
GM	Silty gravels, gravel-sand-silt mixtures, <50% Silts & Clays	Good to Excellent	Slight to Medium	Slight	Fair to Poor	Rubber-tired roller Sheepsfoot roller	115-135	20-60	200-500
GC	Clayey gravels, gravel-sand-clay mixtures, <50% Silts & Clays	Good	Slight to Medium	Slight	Poor to Practically Impervious	Rubber-tired roller Sheepsfoot roller	130-145	20-40	200-500
SW	Well-graded sands, gravelly sands, little or no fines	Good	None to Very Slight	Almost None	Excellent	Crawler-type tractor, rubber-tired roller	110-130	20-40	200-400
SP	Poorly-graded sands, gravelly sands, little or no fines	Fair to Good	None to Very Slight	Almost None	Excellent	Crawler-type tractor, rubber-tired roller	105-135	10-40	150-400
SM	Silty sands, sand-silt mixtures <50 % Silts & Clays	Fair to Good	Slight to High	Slight	Fair to Poor	Rubber-tired roller Sheepsfoot roller	120-135	15-40	150-400
SC	Clayey sands, sand-clay mixtures <50 % Silts & Clays	Poor to Fair	Slight to High	Slight to Medium	Poor to Practically Impervious	Rubber-tired roller Sheepsfoot roller	100-135	5-20	100-300
ML	Inorganic silts and very fine sands rock flour, silty fine sands or clayey silts with slight plasticity	Poor to Fair	Medium to Very High	Slight to Medium	Fair to Poor	Rubber-tired roller Sheepsfoot roller, close control of moisture	100-120	15 or Less	100-200
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Poor to Fair	Medium to High	Medium	Practically Impervious	Rubber-tired roller Sheepsfoot roller	90-130	15 or Less	50-150
OL	Organic silts and organic silty clays of low plasticity	Poor	Medium to High	Medium to High	Poor	Rubber-tired roller Sheepsfoot roller	80-105	5 or Less	50-100
MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Poor	Medium to Very High	High	Fair to Poor	Sheepsfoot roller Rubber-tired roller	80-105	10 or Less	50-100
CH	Inorganic clays of high plasticity fat clays	Poor to Fair	High	High	Practically Impervious	Sheepsfoot roller Rubber-tired roller	90-115	15 or Less	50-150
OH	Organic clays of medium to high plasticity, organic silts	Poor to Very Poor	High	High	Practically Impervious	Sheepsfoot roller Rubber-tired roller	80-110	5 or Less	25-100
Pt	Peat and other highly organic soils	Not Suitable	Very High	Very High	Fair to Poor	Compaction Not Practical			

APPENDIX C

BATTLE CREEK DIVERSION CHANNEL ANALYSIS

BATTLE CREEK DIVERSION CHANNEL ANALYSIS

FLOOD CONTROL ALTERNATIVE FEASIBLITY EVALUATION

LOWER ELKHORN NRD AND CITY OF BATTLE CREEK

AUGUST, 2011

1.0 – INTRODUCTION AND PURPOSE

The City of Battle Creek, NE is subject to flooding during large discharge events on the Battle Creek due to flow leaving the main channel and entering the City. The Lower Elkhorn Natural Resources District (LENRD) in coordination with the City of Battle Creek are currently investigating feasible flood control alternatives to reduce flood damages at the City. One alternative under investigation is a proposed open channel that would provide additional flood flow conveyance and reduction of flood elevations during large Battle Creek discharges. This memorandum outlines the procedures and findings of the hydraulic analysis regarding a potential Battle Creek overflow channel. The purpose of this study is to determine the effects a diversion channel would have on the flood hazards and flood elevations along the Battle Creek.

This analysis is a supplement to previous studies and analyses conducted in support of potential flood damage reduction alternatives for the City. In 2007 the City completed a Stormwater Master Plan including a discussion of watershed and channel conveyance improvements in support of flood reduction at the City. In 2009 the City completed the Battle Creek Flooding Evaluation Reconnaissance Level Study which evaluated the effects proposed improvements may have on reducing flooding at the City; a more detailed evaluation of a flood control reservoir and diversion channel was completed later in 2009. The data developed for the 2009 analysis was utilized for this analysis including peak flow and topographic data. More detail of the previous analysis and supporting information can be found in previous summary reports, which are provided as Appendix F to the Battle Creek Flood Control Alternative Feasibility Evaluation.

2.0 – ANALYSIS PROCEDURE AND APPROACH

The City of Battle Creek is located in Madison County near the downstream end of the contributing watershed consisting of approximately 91 square miles of mostly cultivated agricultural land. Currently there are no flood control structures within the watershed. Previous studies indicated a diversion channel may provide the necessary additional conveyance to reduce flooding effects along the Battle Creek, especially at the City. The proposed diversion channel would convey flows from the main Battle Creek channel at a location west of the City to a point downstream; current conceptual alignments indicate the diversion channel could tie back into the main Battle Creek channel west of Highway 121 or at another point north of the Highway 121 bridge.

The peak flow data was previously developed as part of prior studies using a HEC-HMS watershed model, published information, and regression equations. The previously developed peak discharges utilized for this analysis are listed in Table 1.

Table 1, Peak Discharge Information

Location	Annual Chance Exceedance Probability Discharges (cfs)		
	0.1	**0.02**	**0.01**
Upstream Reach	6,608	12,091	14,253
Downstream Reach*	6,998	12,813	15,112
* Two tributaries empty to the Battle Creek at approximately W Martin St.; for modeling purposes the flow change occurs at hydraulic cross section 12866 as shown in Figure 1.			

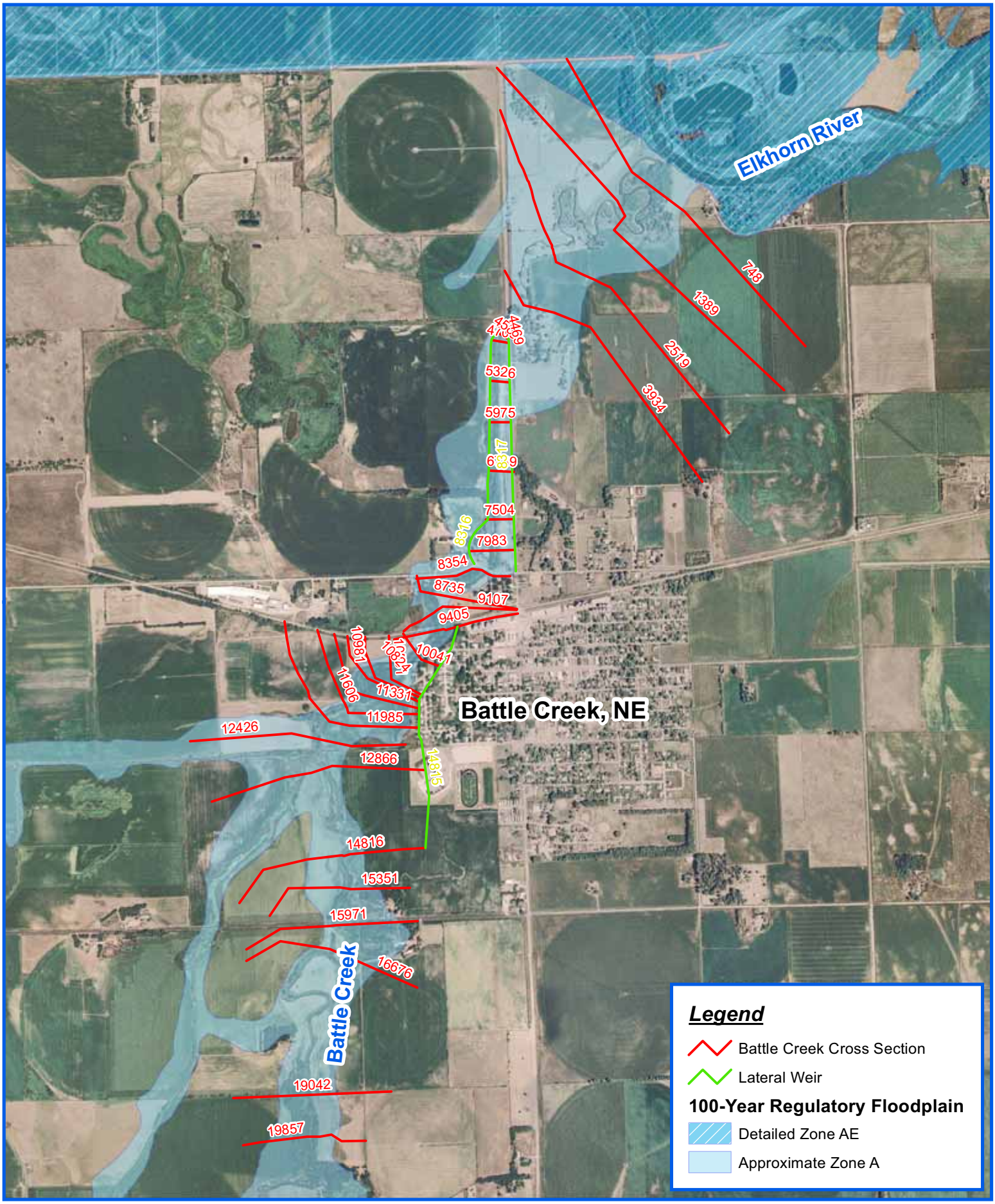
There is no effective regulatory detailed hydraulic model for Battle Creek; the floodplain is delineated as an approximate Zone A. A detailed hydraulic model of the Battle Creek and tributaries was developed during the previous analysis by JEO; the hydraulic model was developed using the above hydrologic information as well as survey data collected by the Nebraska Department of Natural Resources (NDNR). The NDNR survey data was limited to select cross section locations and stream crossing structure data.

The current hydraulic model was developed with the goal of understanding the Battle Creek system under flooding conditions including potential overflow locations. Observations during recent flood events indicate flood waters leave the Battle Creek channel and inundate areas of the City. Due to the limited amount of survey data collected the previous hydraulic model did not analyze or quantify potential overflow effects at the City. Since the previous model was completed topographic light detection and ranging (LiDAR) data was collected providing a greater level of overbank topographic detail. Using this information and the previously collected survey data a refined steady-state hydraulic model was developed for existing and proposed conditions using HEC-River Analysis System (HEC-RAS) software version 4.0 developed by the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center. It should be noted that previous hydraulic models included analyses for tributary channels upstream of the City; the upstream tributaries were ignored in this hydraulic analysis as the Battle Creek was the primary focus.

The existing condition hydraulic model includes overflow lateral weirs at assumed potential overflow locations along the western edge of the City, Highway 121 north of the City, and the left descending bank of the Battle Creek channel north of the City; refer to Figure 1 and Table 2 for overflow weir locations and descriptions.

Table 2, Existing Lateral Weir Description

Location	HEC-RAS River Station	Description
Right descending bank at reach along the western edge of the City	14815	This weir is defined by local high ground in the west portion of the City; no clearly defined overflow location was identified. Overflows in this area can be described as overland flows and shallow flooding through the City, eventually discharging to the Elkhorn River northeast of the City via local and County roadway ditches.
Right descending bank, the Highway 121 roadway embankment north of the City	8317	This weir is defined as the Highway 121 roadway embankment from approximately West McAllister St. to the Highway 121 bridge north of the City. Discharges across this weir are routed to the Battle Creek system downstream (east) of Highway 121.
Left descending bank of the Battle Creek along Highway 121 north of the City	8316	This weir is defined as high ground along the left descending bank of the Battle Creek from approximately W McAllister St. to the Highway 121 bridge north of the City. Discharges across this weir are routed to the lowland agricultural area southwest of Highways 121 and 275; these flows are then routed back to the Battle Creek via a culvert along Highway 121.



N

Feet
0 1,000 2,000

Figure 1: Hydraulic Model Information
Diversion Channel Analysis
Battle Creek, NE

JEO Consulting Group, Inc.

Project No. 091023.00 August 2011

The downstream lateral weirs north of the City (STA 8316 and 8317) were relatively well defined as broad crested weirs across the high ground and highway embankment along the left and right descending banks, respectively. Some interpretation was required for the lateral weir along the west portion of the City (STA 14815) along the western edge of the City due to the lack of a defined weir alignment such as a roadway embankment or other continuous high ground. A combination of LiDAR and USGS topographic data was used to determine the lateral weir alignment; it was assumed that discharges overtopping the local high ground will continue flowing in an easterly direction via overland sheet flow and within local road ditches. A review of the Battle Creek system indicates the lateral weir along the western edge of the City is extremely critical in determining flood hazards and depths within the City; it is also critical in determining the amount of discharges that leave the system thereby reducing downstream Battle Creek channel discharges. A non-exhaustive analysis of various weir alignments along the western edge of the City was performed to determine which location would best represent the flooding conditions. Due to the criticality of the lateral weir along the western edge of the City to determining the discharges in the rest of the system, it is important to note that different interpretations of the weir location may produce different discharge values leaving the system and entering the City.

The lateral weirs were interpolated from the LiDAR topographic data and imported into HEC-RAS. The interpolated data was averaged to produce a relatively smooth embankment line representative of the overflow elevations. The existing conditions model was calculated with all three weirs optimized in HEC-RAS which causes flow conservation where discharges over the weir are to be subtracted from the next downstream cross section. Discharges HEC-RAS calculated as leaving the channel along the western edge of the City were subtracted from main channel discharges downstream of the Cowboy Trail; for example if the upstream discharge was 15,000 cfs and the weir overflow is calculated as 5,000 cfs, the Battle Creek discharge downstream of the City would be 10,000 cfs.

A proposed condition model was developed from the existing condition model. The proposed condition includes the proposed diversion channel placed at HEC-RAS station 12100; this is located at approximately between W Herman St. and W Market St. The conceptual diversion channel was analyzed using a previously determined trapezoidal shape with 125-foot wide bottom, 200-foot wide top, and 10-foot depth; the diversion channel was included in the hydraulic model as a lateral weir structure in HEC-RAS with the tailwater directed to the main Battle Creek channel along Highway 121. Additionally, the proposed diversion channel was the only weir optimized in the proposed condition HEC-RAS calculations; this was done under the assumption that if the diversion channel were in place the system would be designed to limit overflows at other locations, especially along the western edge of the City. The downstream geometry in the initial proposed condition HEC-RAS model was not modified to reflect additional conveyance at the confluence of the diversion and main channels or potential Highway 121 bridge modifications.

An additional proposed condition model was developed including modifications to the downstream cross section geometry at the confluence of the diversion and main channels as well as conceptual expansion of the Highway 121 bridge. The cross sections upstream of the Highway 121 bridge were modified to include a dual stage flood conveyance area conceptually based on the 125-foot bottom width of the diversion channel. The Highway 121 bridge and bounding cross sections were modified to

include an approximate 50-foot increase in conveyance area. This scenario illustrates the potential fully built condition where the geometry of the entire system would be designed to limit or eliminate main channel overflows for the design event, especially along the western edge of the City.

The effects of coincident flooding on both the Battle Creek and Elkhorn River were also included in the analysis. The non-coincident flooding effects were determined by using normal depth boundary condition calculations based on the NDNR survey data. The coincident flooding conditions were modeled for the 1% annual chance exceedance (ACE) discharges on both the Battle Creek and Elkhorn River using a starting water surface on the Elkhorn River; the elevation was based on the flood profile published in the 2005 Madison County FIS. Upstream of Norfolk, NE only the 1% ACE flood profile was available, therefore normal depth was used for discharge frequencies other than the 1% discharge. The Elkhorn River water surface elevation was converted from NGVD 29 vertical datum to NAVD 88 for the analysis using a +0.61-feet conversion determined from the online VERTCON tool (www.ngs.noaa.gov/TOOLS/Vertcon/vertcon.html).

3.0 - FINDINGS

This analysis was conducted to determine the potential overflows leaving the main Battle Creek channel and to determine resultant effects of rerouting these overflows to downstream areas. Three hydraulic scenarios were created in HEC-RAS to determine the existing and proposed conditions. Previously developed hydrologic and topographic data were utilized for the hydraulic modeling; a previously developed hydraulic model was modified to reflect additional topographic LiDAR data.

The previous studies reported that the channel capacity prior to overtopping is approximately 7800 cfs at McAllister St.; this was based on the NDNR survey data and reported based on the point where flows leave the defined main channel, not necessarily where structural flooding occurs. The current existing condition model included overflows modeled as lateral weirs in HEC-RAS based on the LiDAR data. The current model results verify the previously reported approximate channel capacity at the McAllister St. location. The current model also indicated that the delineated lateral weir along the western edge of the City would begin to be overtopped and floodwaters would encroach upon the City during a discharge of approximately 8000 cfs. Accordingly, higher discharges would increase discharges to the City and the extent of flooding. Therefore the lateral weir along the western edge of the City is identified as the critical location for calculating the desired design discharges for any improvement projects. Refer to Table 3 for overflow discharges to the City under existing conditions. It is important to note that due to the lack of a defined lateral weir such as a roadway embankment the analyzed alignment was based on professional judgment, alternate interpretations may result in different overflow locations and discharge amounts. There were no appreciable discharges over the downstream lateral weirs along Highway 121 for optimized discharges up to the 1% ACE event under existing conditions.

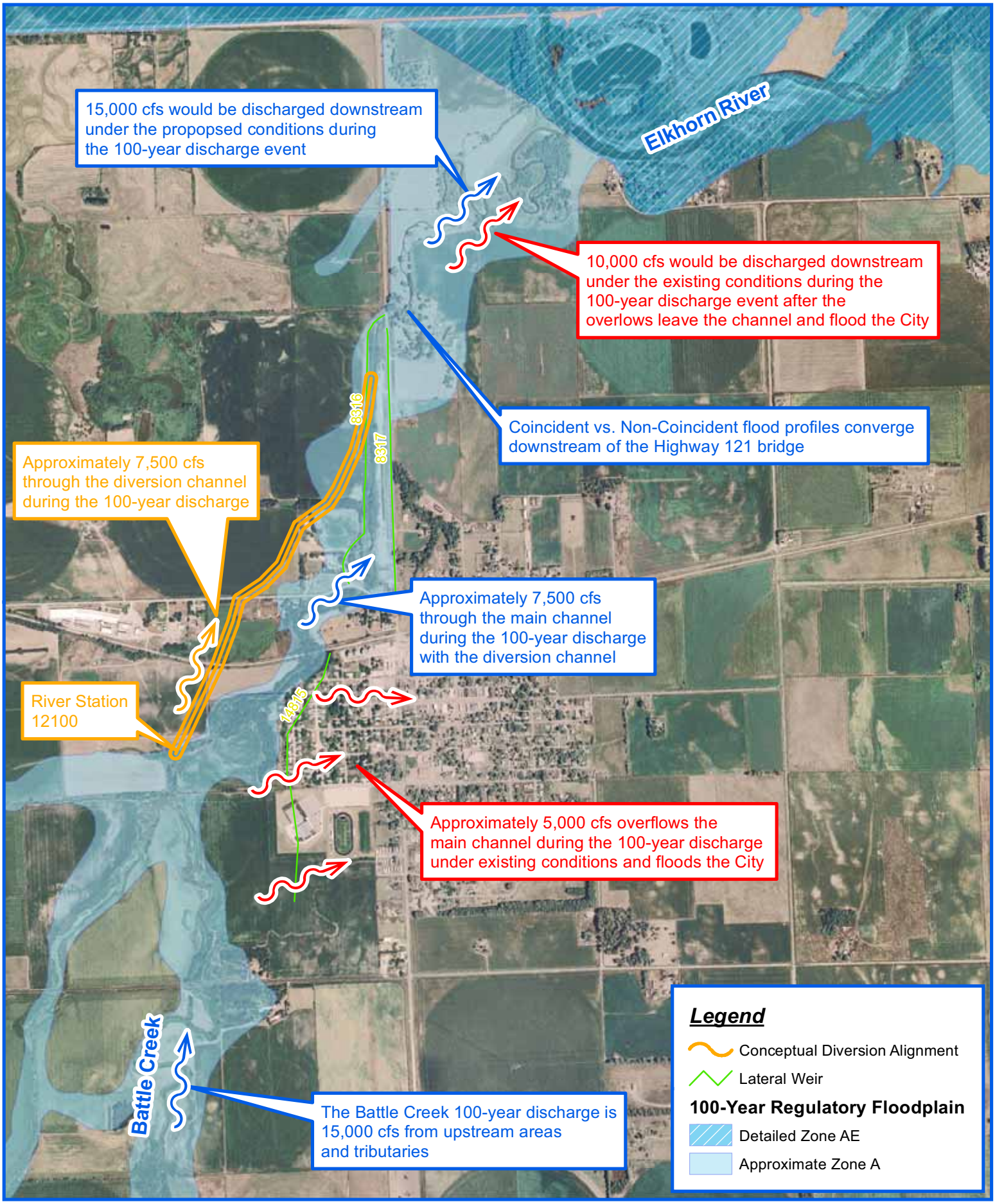
Table 3, Lateral Weir Overflows Along the Western Edge of the City

HEC-RAS River Station	Annual Chance Exceedance Probability	Discharge Over Lateral Weir (cfs)
14815	0.1	102
	0.02	3410
	0.01	4969

The current proposed conditions model indicated that the specified proposed diversion channel dimensions would convey approximately 7,500 cfs during the 1% ACE discharge; refer to Table 4 for the proposed diversion channel discharges. The proposed conditions model also indicated that even with the proposed diversion channel, minor overflows (less than 1000 cfs) into the City may still occur upstream of the proposed diversion channel, south of the high school. The diversion analysis was non-exhaustive and a refined model is expected be completed during a future design phase to ensure the flood reduction goal at the City is met. The proposed diversion structure was placed at a point along the channel that was preliminarily identified as being amenable for flow conveyance without modifying the overall system; the design phase may include additional improvements along the City such as flow directional berms or channel modifications for additional conveyance upstream of the diversion. Refer to Figure 2 for overflow information.

Table 4, Proposed Diversion Channel Discharges

HEC-RAS River Station	Annual Chance Exceedance Probability	Diversion Channel Discharge (cfs)
12100	0.1	2580
	0.02	6329
	0.01	7592



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0 1,000 2,000 Feet

Figure 2: Hydraulic Performance Information
Diversion Channel Analysis
Battle Creek, NE

JEO Consulting Group, Inc.

Project No. 091023.00 August 2011

Both of the proposed condition models with and without geometry modifications indicated a decrease in flood elevations along the western edge of the City due to flow leaving the main channel via the diversion channel and an increase in flood elevations in the reach downstream of the City due to the overall increase in discharge from the diverted flows re-entering the main channel. The additional conveyance area included in the modified geometry condition reduced the flood elevations upstream of the Highway 121 bridge compared to the proposed geometry that was not modified. Table 5 reports the existing condition water surface elevations and the effects the proposed diversion channel has on flood elevations along the main channel during the 1% ACE discharge event.

Table 5, 1% ACE Flood Elevation Information

HEC-RAS River Station	Existing Conditions Water Surface Elevation (ft, NAVD 88)	Proposed Conditions - Change in Water Surface Elevation Compared to Existing Conditions (ft)	
		Without Geometry Modifications (includes only the diversion structure with no other geometry modifications)	With Geometry Modifications (includes cross section and bridge geometry modifications along and at Highway 121, respectively)
19857	1606.37	0.00	0.00
19042	1604.53	0.00	0.00
16676	1600.98	0.00	0.00
15971	1600.97	0.00	0.00
15939	**839th Rd. Bridge**		
15907	1599.35	0.00	0.00
15351	1597.78	0.00	0.00
14816	1596.85	-0.02	-0.02
14815	**Lateral Overflow Weir along the City (Located across cross sections 14816 - 9405)**		
12866	1594.84	0.15	0.15
12426	1593.77	-0.55	-0.55
12100	N/A	**Proposed Lateral Diversion Weir (Centered across cross section 11985)**	
11985	1593.65	-1.32	-1.36
11606	1593.42	-1.45	-1.54
11331	1593.21	-1.36	-1.45
10981	1592.69	-1.66	-1.85
10824	1592.12	-1.48	-1.67
10531	1591.30	-1.26	-1.60
10041	1590.31	-1.09	-1.67
9405	1590.34	-1.21	-1.88
9379.5	**Cowboy Trail Bridge**		
9354	1589.65	-0.70	-1.43
9107	1588.68	-0.27	-1.35
8735	1588.62	-0.26	-1.43
8354	1586.93	1.16	-1.01

Table 5, 1% ACE Flood Elevation Information

HEC-RAS River Station	Existing Conditions Water Surface Elevation (ft, NAVD 88)	Proposed Conditions - Change in Water Surface Elevation Compared to Existing Conditions (ft)	
		Without Geometry Modifications (includes only the diversion structure with no other geometry modifications)	With Geometry Modifications (includes cross section and bridge geometry modifications along and at Highway 121, respectively)
8336	**McAllister St. Bridge**		
8318	1586.69	1.12	-0.93
8317	**Lateral Overflow Weir along Highway 121 (Located across cross sections 8318 - 4469)**		
8316	**Lateral Overflow Weir at left bank along Highway 121 (Located across cross sections 8318 - 4469)**		
7983	1585.94	1.57	-0.93
7504	1585.20	2.09	-0.65
6739	1584.52	2.65	-0.43
5975	1583.12	3.85	0.70
5326	1582.13	3.96	0.48
4703	1579.36	5.50	2.31
4585	1578.64	5.19	-0.13
4469	1578.57	5.29	-0.05
4433	**Highway 121 Bridge**		
4397	1577.16	0.84	0.98
3934	1576.32	0.76	0.76
2519	1574.48	0.73	0.73
1389	1571.71	0.75	0.75
748	1570.57	0.79	0.79

Generally, floodplain regulations require improvements within an approximate Zone A floodplain to limit any increases in flood elevations during the 1% ACE discharge to less than 1-foot. A common cause of the potential increase in flood elevations comes as a result of floodplain conveyance area being built out for various uses, for example commercial development. In the specific case of these Battle Creek diversion channel improvements the flood elevation increases downstream of the City are due to conveying what are considered "additional" flood discharges that would otherwise leave the channel via flooding into the City under the existing conditions. As indicated in the above table the flood elevations are within the 1-foot rise limitation downstream of Highway 121 for both proposed conditions; generally the increase in flood elevations between Highway 121 and the City would not comply with the 1-foot limit without improving the downstream channel and highway bridge conveyance areas. A detailed hydraulic analysis of the exact layout of the proposed cross sections and bridge improvements will be required if design proceeds to ensure flood elevation increases are within regulatory limits. There may be some leeway in the flood elevation increase limits if the areas are reserved from development and if the entity with control over the improvements also controls the areas affected, i.e. the channel conveyance area and adjacent floodplain. Depending on the circumstances, this may require the City or other entity such as the Lower Elkhorn Natural Resources District to purchase right of way or easements to allow for the flood elevation increases that exceed one foot.

The effects of the proposed improvements during coincident flooding periods on the Battle Creek and Elkhorn River were analyzed to determine if the system would be sensitive to those conditions. The analysis was limited to the coincident 1% ACE discharges as only the 1% annual chance profile is published for the Elkhorn River upstream of the City of Norfolk. The elevation difference between the interpolated Elkhorn River profile (from the Madison County FIS) and the elevation calculated from normal depth is 0.56-feet. The profiles calculated for the different boundary conditions converged prior to the Highway 121 bridge, effectively within the Elkhorn River floodplain. Overall this difference is considered negligible and is not anticipated to affect the system appreciably during coincident flooding periods. Refer to Table 6 for information regarding the coincident flood analysis.

Table 6, Coincident Flooding Analysis

HEC-RAS River Station	Battle Creek 1% Flood Elevation (ft, NAVD 88)		Difference (ft)
	Non-coincident Flooding	Coincident Flooding	
748	1571.36	1570.80	0.56
1389	1572.47	1572.60	0.13
2519	1575.21	1575.16	0.05
3934	1577.09	1577.12	0.03
4397	1578.00	1577.99	0.01
4433	**Highway 121 Bridge**		
4469	1583.86	1583.86	0.00

Note: There were no differences between the profiles upstream of the Highway 121 bridge.

4.0 - CONCLUSIONS

The existing regulatory floodplain for the Battle Creek is delineated as an approximate Zone A. This flood hazard area is based on existing topographic hydrologic data such as DEMs and regression equations, respectively. This approximate modeling method did not account for overflows along the channel. The current modeling effort indicates that the flood hazards of the area are significantly larger than currently identified, especially at the City. This information should be reviewed during future flood mapping initiatives as well as for use in benefit/cost analyses prior to flood map revisions.

As indicated in Table 5 the flood elevations are within the 1-foot rise limitation downstream of Highway 121 for both proposed conditions; generally the increase in flood elevations between Highway 121 and the City would not comply with the 1-foot limit without improving the downstream channel and highway bridge conveyance areas. Depending on what is done for the Highway 121 area; land or easement purchase may be necessary in order to account for the additional flows from the diversion channel. Overall the diversion channel appears to be feasible but may require purchase of land rights or easements at select locations due to the level of rise from the additional flows.

APPENDIX D

NRDF FUNDING FEASIBILITY EVALUATION

- *ATTACHMENT A – PROPERTY PHOTOS (ON CD)*

NRDF FUNDING FEASIBILITY EVALUATION

FLOOD CONTROL ALTERNATIVE FEASIBLITY EVALUATION

LOWER ELKHORN NRD AND CITY OF BATTLE CREEK

AUGUST, 2011

1.0 - INTRODUCTION

1.1 – APPROACH TO ANALYSIS OF BENEFITS AND COSTS

A preliminary benefit/cost and rate of return analysis was performed as per the guidelines in section three, Appendix B (Economic Feasibility) of the Nebraska Natural Resources Development Fund (NRDF) guidelines.

The potential overflow channel or dam are both flood control projects and flood control benefits were analyzed as per the NRDF guidelines. In order to complete this review, potential project cost information was obtained from preliminary opinions of cost developed by JEO as part of previous studies. In order to develop average annual damage information and damages avoided/annual benefits, an assessment of both historical damages due to recent flood events as well as a review of predicted potential flooding damages based on flood elevations determined via hydraulic modeling were completed.

For the purposes of assessing modeled flooding risk to properties for this evaluation, the majority of flood elevations utilized are based on predicted sheet flow depths as described in the shallow flooding analysis in Section 2.0. Through the hydraulic analysis of Battle Creek as provided in Appendix C of the Battle Creek Flood Control Alternative Feasibility Evaluation, it was determined that for certain return period events, overflows will exit the channel and enter the City of Battle Creek via overflow of a natural weir, as shown in Figure 1 – Sheet Flow Paths Overview. These flows subsequently sheet flow across the City at a certain depth vs. the grade elevations. As described in the following Section 2.0, these sheet flow depths are 1 foot for the 2% annual chance exceedance flood and 2 feet for the 1% annual chance exceedance flood. There are a few selected properties nearer to the creek channel that fall outside (west) of the weir and the sheet flow area. For these properties, the flood elevations are based on the revised hydraulic model as provided in Appendix C of the Battle Creek Flood Control Alternative Feasibility Evaluation were used.

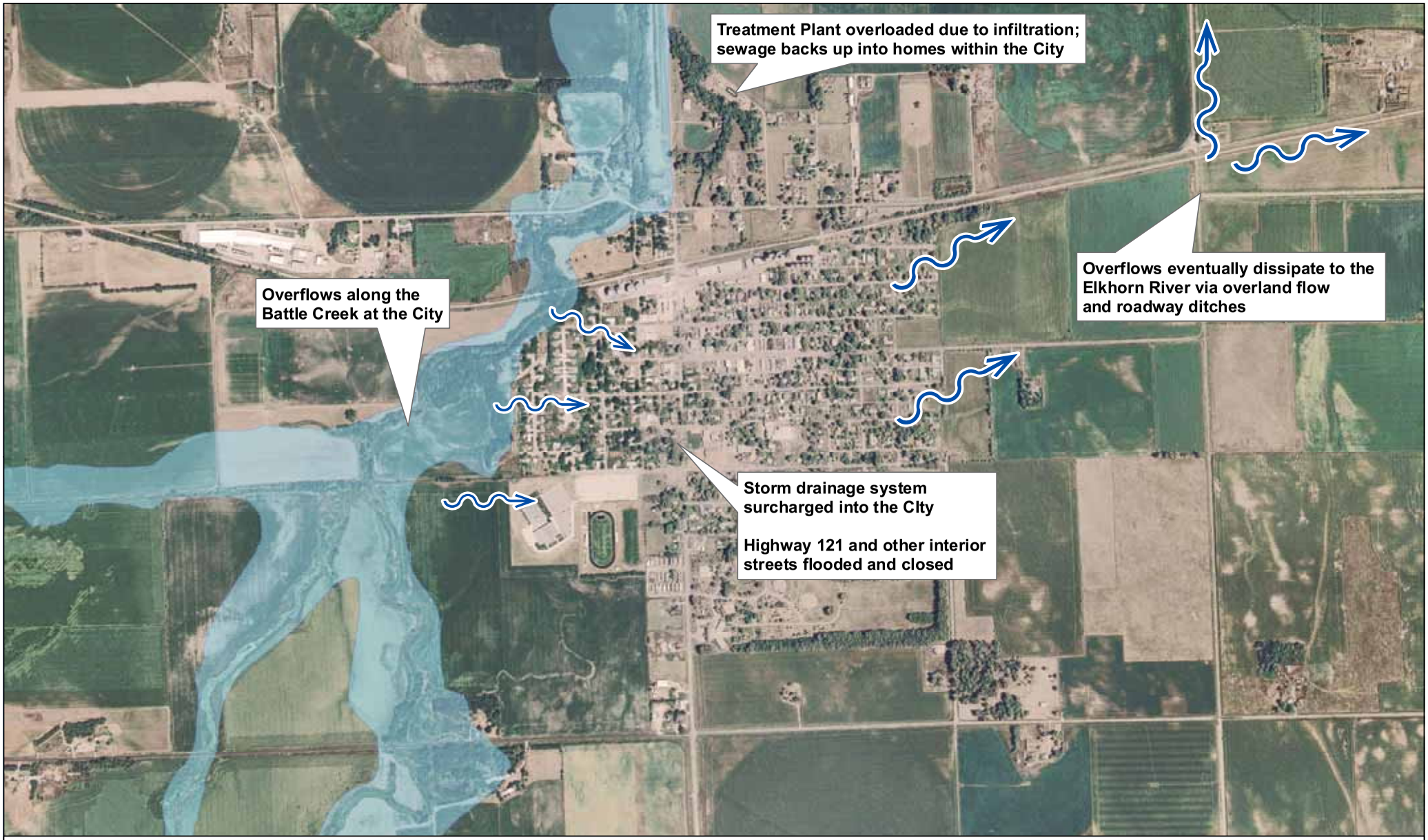


Figure 1 – Sheet Flow Paths Overview

JEO Consulting Group, Inc.

Project No. 091023.00 August 2011

2.0 - BATTLE CREEK SHALLOW FLOODING ANALYSIS

2.1 - PURPOSE

The purpose of this shallow flooding analysis is to determine potential flood depths at the City of Battle Creek created by overflows from the main Battle Creek channel as identified by the diversion channel modeling effort, which can be found in Appendix C of the Battle Creek Flood Control Alternative Feasibility Evaluation. The flood depths are to be used for a cost benefit analysis for potential flood reduction alternatives; this information is presented in Section 3.0. Previous flood events have indicated that the Battle Creek is prone to flows leaving the main channel during large discharge events; these overflows are conveyed via sheet flows within the City causing structural flooding and utility disruption.

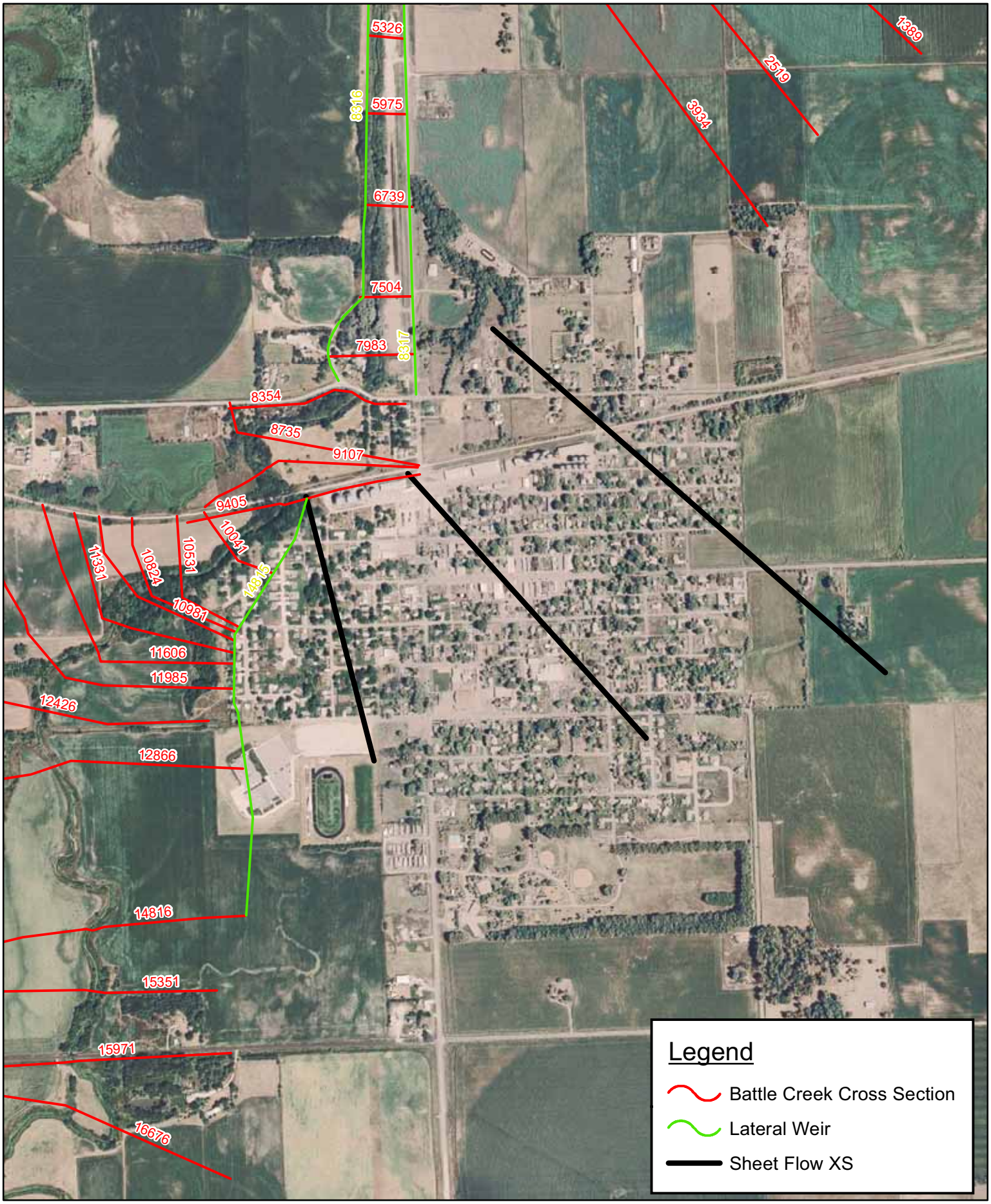
2.2 - PROCEDURE

The City of Battle Creek and Lower Elkhorn Natural Resources District have undergone previous analyses of flooding conditions at the City due to both interior rainfall events and large scale watershed discharges on the Battle Creek. These can be found in Appendix F of the Battle Creek Flood Control Alternative Feasibility Evaluation. Hydrologic and hydraulic information from these previous analyses were utilized in this analysis. Most recently a hydraulic analysis of the Battle Creek was conducted that included overflow lateral weir structures; these structures were analyzed to determine potential overflow discharges along the channel. The lateral weir structure pertinent to this analysis is located along the western edge of the City. The weir alignment and elevations were developed using available LiDAR information. There was no defined overflow point along the weir alignment such as a road embankment; therefore, the weir was developed based on local high ground. Lateral weir structure discharges for each frequency analyzed (10%, 2%, and 1% annual chance exceedance) were then used for this shallow flooding analysis; the discharges can be found in Table 1.

The available LiDAR data and USGS DEM topographic information were used to determine the flow conditions through the City. Review of the information indicated that the ground east of the Battle Creek channel generally falls to the east/northeast; this trend continues east and northeast of the City all the way to the Elkhorn River. Based on the topographic trends, it was decided that significant flows leaving the Battle Creek channel would sheet flow through the City. Previous overflow events indicated that flood waters dissipate slowly through open areas including the right-of-way and low areas within the City; then the overflows are likely collected in local drainage channels and discharge to the Elkhorn River.

The National Flood Insurance Program Guidelines and Specifications for Flood Hazard Mapping Partners regarding shallow flooding analyses were used to develop the analysis. It should be noted that this analysis was not in support of any flood hazard mapping activity and was only developed in support of a flood depth determination to be used for a cost benefit analysis. A simplified normal depth analysis was used to determine the flood depths within the City where the hydraulic radius was assumed to be approximately equal to the flooding depth. The required inputs for the analysis included discharge, roughness coefficient, cross section width, and slope. Three cross section widths were developed within the City based on the topographic data; their alignments and extents were developed from the Battle Creek channel flood zone to higher ground along the south portion of the City. The cross sections are shown in Figure 2 – Sheet Flow Analysis Cross Section Locations. The spacing between the cross sections was approximated based on one-half of the assumed shallow flooding width. A general slope was developed from the cross section locations and topographic information.

A range of appropriate roughness coefficients was determined for each cross section based on land use from aerial photography; this range was utilized to determine the sensitivity of the calculations to the coefficient used. Generally the landuses and roughness coefficients were based on floodplains with short grasses with trees interspersed and roadways, typical of a residential landuse. Typical sheet flow analysis generally does not account for small scale topographic variations and the flood depths and associated risks are averaged over the entire cross section(s). However, since the cross sections were placed in an urban area, consideration was given to significant flow conveyance area being blocked by structures. An approximate width of structures across each cross section was calculated based on aerial photography; additional calculations were completed for each cross section based on an “effective conveyance” width to determine the sensitivity to this variable. Refer to Table 1 for the variables used.



N

0 500 1,000 Feet

Figure 2 – Sheet Flow Analysis Cross Sections Locations

JEO Consulting Group, Inc.

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Table 1, Shallow Flooding Analysis Variables

Cross Section	Lateral Weir Structure Discharge (cfs)			'n' value	Cross Section Width (ft)		Slope (ft/ft)
	10-Year	50-Year	100-Year		Entire Cross Section	Cross Section with Structure Widths Removed	
West	102*	3410	4969	0.06 - 0.30	2250	1550	0.002
Middle					2950	1750	
East					4290	3940	

*The discharge was considered negligible and was not used to determine flood depths.

The analysis was completed using Microsoft Excel spreadsheet software; a simplified Manning's equation was used to calculate a depth at each cross section for each set of varying inputs, roughness and cross section width. Depths at all three cross sections were then averaged for each discharge frequency to develop a standard sheet flow depth across the City for each frequency. Per the Guidelines and Specifications the flood depths were then rounded to either less than one-foot or an integer from one to three feet.

2.3 - CONCLUSIONS

The shallow flooding analysis generally followed the procedures outlined in the National Flood Insurance Program Guidelines and Specifications for Flood Hazard Mapping Partners. The analysis was specifically developed for a cost benefit analysis regarding potential flood reduction strategies in the Battle Creek watershed; it was not developed in support of any flood hazard mapping activity and the information produced should be used with engineering judgment.

The analysis included a sensitivity analysis for varying roughness coefficients and cross section widths. It was determined that the lower portion of the roughness coefficients range was more applicable to the ground characteristics within the City. The calculations were not as sensitive to the effective conveyance width variable as the roughness coefficient. The range of calculated depths with varying inputs was used to determine a general flood depth for each discharge frequency which was then rounded. Refer to Table 2 for the determined flood depths.

Table 2, Shallow Flooding Analysis Flood Depths

Discharge Frequency Return Period	Sheet Flow Depth (ft)
10-Year	N/A
50-Year	1
100-Year	2

These results were subsequently utilized for determining flooding depths and potential damages as part of the cost benefit review for potential flood mitigation alternatives for Battle Creek (overflow channel or dam). Details of this review and how the sheet flow depths were utilized for this purpose are presented in the following Section 3.0.

3.0 - ECONOMIC FEASIBILITY

3.1 – SAMPLE SELECTION AND DAMAGE ESTIMATION

The preliminary review of potential flooding damages for this evaluation was based on a sample set of selected properties that were chosen based on establishing a cross section of properties both inside and outside of the areas impacted by sheet flows as well as a range of values and building use types (i.e., residential, commercial, etc.). Only properties with structures present on them were targeted for a physical field evaluation. Ultimately 53 structures were selected and were used to approximate the potential impacts to the approximately 522 structures within the City as a whole. The selected structures can be seen on the following Figure 3 – Property Sample Selection Overview.

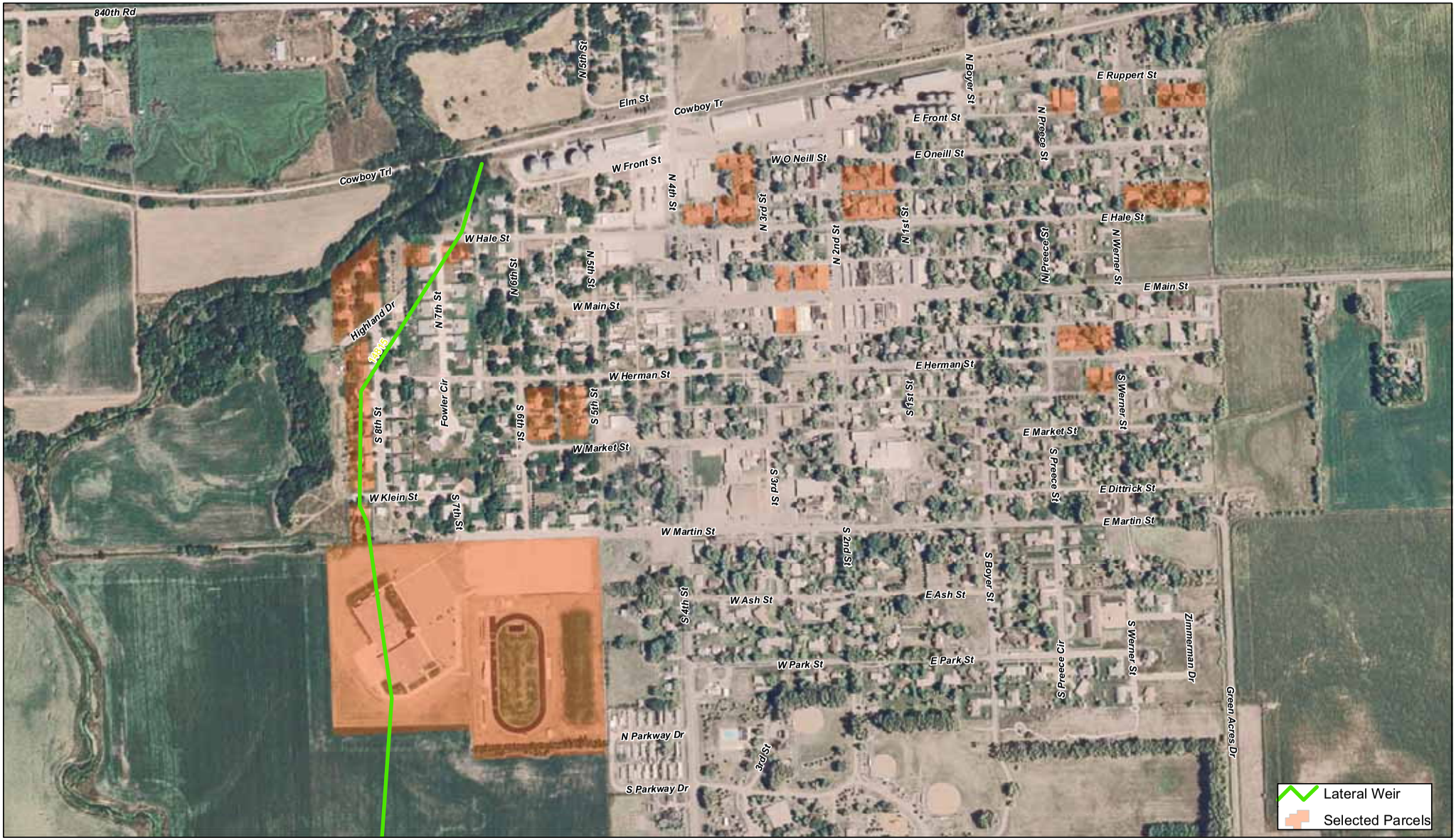
A field survey to determine elevation of the first floor, lowest adjacent grade, highest adjacent grade, and lowest opening of the residential, commercial, and public buildings for the 53 selected structures was conducted by JEO. Building valuations were obtained from the Madison County Assessors Office. The building and content damages were based on the associated depth of the relevant 10%, 2%, and 1% annual chance exceedance flood elevations. Building content value and depth damage factors for both residential and commercial buildings were developed following NRDF guidelines.

In order to evaluate potential damages to building and contents for residential structures, flood depths were determined and compared to the lowest opening elevations as well as the first floor elevations since the first floor elevations are the reference point for determining residential structure damage according to NRDF guidelines. For structures west of the overflow weir location as shown on Figure 3, 10%, 2%, and 1% annual chance exceedance flood elevations from recent hydraulic analyses of the Battle Creek channel were used. For all other structures, sheet flow depths as previously described were used. The sheet flow depths on the property were determined by adding the relevant depth of flooding above grade (1 foot for the 2% annual chance exceedance sheet flow and 2 feet for the 1% annual chance exceedance sheet flow) to the highest adjacent grade for the property. This yielded a reference sheet flow flooding elevation. In all cases, the reference flood elevations were compared to the lowest adjacent grade to determine whether flooding entered the building and at what level; this information was then used to determine the depth of flooding vs. the first floor elevation for the purposes of identifying the percent damage rates utilized for determining predicted damage for each structure. Building types were identified based on photos obtained from the Madison County Assessor site; these photos are arranged by parcel ID and can be found digitally in Attachment A. It was noted that no residential properties experienced damage due to the 10% annual chance exceedance event; this is primarily due to sheet flow being negligible for this event.

For small commercial properties, similar methodology was used according to NRDF guidelines. For the high school property, which was the one public property identified as part of the sample selection, the small business/commercial guidelines were also used. It was noted that no commercial properties experienced damage due to the 10% annual chance exceedance event; this is primarily due to sheet flow being negligible for this event.

Once predicted flooding damages were determined for the selected sample properties for the 2% and 1% annual chance events, several subsets of property categories were identified. These included commercial, residential with a value less than $100,000; residential with a value between $100,000 and $150,000; and residential with a value greater than $150,000. Based on these categories, average damages were determined for the sample set of 53 properties. These averages were then extrapolated to the entire set of 522 properties based on property counts falling within the same categories.

The City of Battle Creek, private insurance agents who serve the residents of Battle Creek, and the Lower Elkhorn Natural Resources District were contacted in regards to road damages, storm sewer, water and sanitary sewer infrastructure damages with the intent of using this information to supplement the predicted direct flooding damages. However, little supplemental information was available. An approximation of $5,000 per property for sewer backup costs for the 1% annual chance event and $2,500 per property for the 2% annual chance event was assumed.



N

0 500 1,000 Feet

Figure 3 – Property Sample Selection Overview

JEO Consulting Group, Inc.

Project No. 091023.00 August 2011

3.2 – PRELIMINARY FINDINGS – OVERFLOW CHANNEL

Under the present conditions, the economic analysis indicates that the City of Battle Creek incurs $426,345 in average annual damage due to the flooding. These damages include building and contents estimated damage from direct flooding as well as estimated sewer backup damages. These damages are summarized in Table 3.

Under the proposed overflow channel condition, the economic analysis indicates that the City of Battle Creek will incur $0 in average annual damage due to flooding based on the return periods reviewed. The average annual benefit due to the proposed flood protection overflow channel is $426,345. See Figure 4 for existing and project condition damage curve.

TABLE 3
DAMAGES WITH AND WITHOUT THE PROPOSED BATTLE CREEK OVERFLOW CHANNEL

DAMAGE COMPONENT	FLOOD FREQUENCY		
	100-YEAR	**50-YEAR**	**10-YEAR**
STRUCTURE AND CONTENT	$8,750,060	$4,382,654	$0
INFRASTRUCTURE (INCLUDING SEWER BACKUP)	$2,610,000	$1,305,000	$0
DAMAGE TOTAL	$11,360,060	$5,687,654	$0
DAMAGE WITH PROPOSED OVERFLOW CHANNEL IN PLACE	$0	$0	$0
PERCENT DAMAGE REDUCTION	100%	100%	NA
AVEARGE ANNUAL DAMAGE UNDER PRESENT CONDITIONS	$426,345		
AVERAGE ANNUAL DAMAGE WITH PROPOSED OVERFLOW CHANNEL IN PLACE	$0		

Costs:
An itemized preliminary opinion of probable cost for the proposed flood protection overflow channel is shown in Table 4.

TABLE 4 - OPINION OF COST FOR BATTLE CREEK FLOOD PROTECTION OVERFLOW CHANNEL

LENGTH	5,480 FEET	
BOTTOM WIDTH	140 FEET	
SIDE SLOPE	3:1	
TOTAL	490,000 CUBIC YARDS	$1,960,000
UTILITY CONFLICTS		$150,000
INSTALL NEW HIGHWAY 121 BRIDGE		$1,000,000
INSTALL NEW SECONDARY ROAD BRIDGE		$420,000
INSTALL NEW PEDESTRIAN BRIDGE		$225,000
SUBTOTAL		$3,755,000
ENGINEERING PERMITTING AND CONSTRUCTION ADMINISTRATION	20%	$551,000
CONTINGENCY	20%	$551,000
PRELIMINARY OPINION OF COST		$4,857,000
LAND ACQUISITION	25 ACRES	$50,000
FARMSTEADS AND BUILDINGS		
TOTAL OPINION OF COST		**$4,907,000**

Cash Flow Stream and Rate of Return:
In accordance with NRDF guidelines, a comparison of project benefits and costs to determine the economic feasibility was done by preparing a cash flow stream for the construction of the proposed overflow channel based on present day dollars.

Tables 5 and 6 show the cash flow stream and Internal Rate-of-Return (IRR) calculation spreadsheets for the proposed flood protection overflow channel, and show the proposed timing of the expenditures and receipt of benefits. The rate of return on investment is 6.60%. The ratio of benefits and costs (B/C ratio) for the overflow channel project is 1.66.

TABLE 5
CASH FLOW STREAM FOR FLOOD PROTECTION OVERFLOW CHANNEL

YEAR	COST/BENEFIT	ITEM	TOTAL
0	**Cost:**	Feasibility Study, Engineering and Inspection (Estimated)	**$551,000**
1-2	**Cost:**	Construction/ Capital Items	**$2,178,000**
3-4	Cost:	Construction/ Capital Items	$2,178,000
		OM&R	$99,200
	Total Costs:		**$2,277,200**
	Benefits:	Flood Damage Reduction	**$213,173**
5-50	**Cost:**	OM&R	**$2,281,600**
	Benefits:	Flood Damage Reduction	**$19,611,870**

TABLE 6
CASH FLOW AND IRR CALCULATION SPREADSHEET FOR PROPOSED OVERFLOW CHANNEL
PROJECT YEAR 0 TO 50

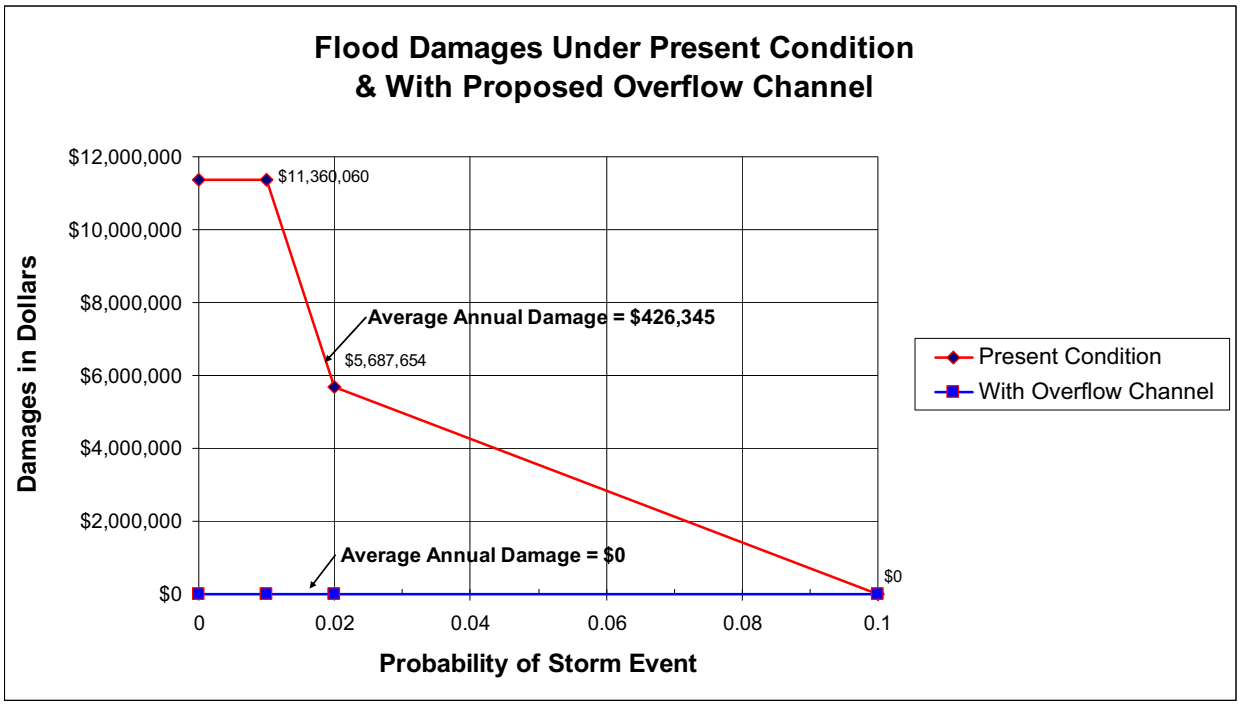
EXISTING CONDITION, AVERAGE ANNUAL DAMAGES = $426,345
WITH OVERFLOW CHANNEL CONDITION, AVERAGE ANNUAL DAMAGES = $0

B/C RATIO **1.66**
RATE OF RETURN **6.60%**

YEAR	PROJECT YEAR	FEASIBILITY ENGINEERING INSPECTION	CAPITAL ITEMS	OM&R	ASSOCIATED COSTS	GROSS COSTS	TOTAL VALUE OF PROJECT (GROSS BENEFITS)	INCREMENTAL BENEFITS (CASH FLOW)	ACCUMULATIVE BENEFITS (CASH FLOW)
2011	0	$551,000	$0	$0	$0	$551,000	$0	-$551,000	-$551,000
2012	1	$0	$1,089,000	$0	$0	$1,089,000	$0	-$1,089,000	-$1,640,000
2013	2	$0	$1,089,000	$0	$0	$1,089,000	$0	-$1,089,000	-$2,729,000
2014	3	$0	$1,089,000	$49,600	$0	$1,138,600	$0	-$1,138,600	-$3,867,600
2015	4	$0	$1,089,000	$49,600	$0	$1,138,600	$213,173	-$925,428	-$4,793,028
2016	5	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	-$4,416,283
2017	6	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	-$4,039,538
2018	7	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	-$3,662,793
2019	8	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	-$3,286,048
2020	9	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	-$2,909,303

2021	10	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	-$2,532,558
2022	11	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	-$2,155,813
2023	12	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	-$1,779,068
2024	13	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	-$1,402,323
2025	14	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	-$1,025,578
2026	15	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	-$648,833
2027	16	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	-$272,088
2028	17	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$104,658
2029	18	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$481,403
2030	19	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$858,148
2031	20	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$1,234,893
2032	21	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$1,611,638
2033	22	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$1,988,383
2034	23	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$2,365,128
2035	24	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$2,741,873
2036	25	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$3,118,618
2037	26	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$3,495,363
2038	27	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$3,872,108
2039	28	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$4,248,853
2040	29	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$4,625,598
2041	30	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$5,002,343
2042	31	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$5,379,088
2043	32	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$5,755,833
2044	33	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$6,132,578
2045	34	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$6,509,323
2046	35	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$6,886,068
2047	36	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$7,262,813
2048	37	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$7,639,558
2049	38	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$8,016,303
2050	39	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$8,393,048
2051	40	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$8,769,793
2052	41	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$9,146,538
2053	42	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$9,523,283
2054	43	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$9,900,028
2055	44	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$10,276,773
2056	45	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$10,653,518
2057	46	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$11,030,263
2058	47	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$11,407,008
2059	48	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$11,783,753
2060	49	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$12,160,498
2061	50	$0	$0	$49,600	$0	$49,600	$426,345	$376,745	$12,537,243
TOTAL		**$551,000**	**$4,356,000**	**$2,380,800**	**$0**	**$7,287,800**	**$19,825,043**	**$12,537,243**	

FIGURE 4
EXISTING AND WITH PROJECT DAMAGE CURVE



3.3 – PRELIMINARY FINDINGS – DAM

Under the proposed dam condition, the economic analysis indicates that the City of Battle Creek will incur $0 in average annual damage due to the flooding. The average annual benefit due to the proposed 100-year flood protection dam is $426,345. It should be noted that recreational benefits were not considered for this evaluation. See Figure 5 for existing and project condition damage curve.

TABLE 7
DAMAGES WITH AND WITHOUT THE PROPOSED BATTLE CREEK DAM

DAMAGE COMPONENT	FLOOD FREQUENCY		
	100-YEAR	50-YEAR	10-YEAR
STRUCTURE AND CONTENT	$8,750,060	$4,382,654	$0
INFRASTRUCTURE (INCLUDING SEWER BACKUP)	$2,610,000	$1,305,000	$0
DAMAGE TOTAL	$11,360,060	$5,687,654	$0
DAMAGE WITH PROPOSED DAM IN PLACE	$0	$0	$0
PERCENT DAMAGE REDUCTION	100%	100%	-
AVEARGE ANNUAL DAMAGE UNDER PRESENT CONDITIONS	$426,345		
AVERAGE ANNUAL DAMAGE WITH PROPOSED DAM IN PLACE	$0		

Costs:
Itemized probable opinion of costs for the proposed flood protection dam is shown in Table 8. The costs are based on preliminary design of the components as described in the Technical Feasibility and the attached appendices of this application.

TABLE 8
OPINION OF COST FOR BATTLE CREEK FLOOD PROTECTION DAM

160 ACRE POOL		
LENGTH	3,954 FEET	
TOP WIDTH	30 FEET	
TOTAL	550,000 CUBIC YARDS	$2,750,000
CLEARING	1 LS	$35,000
PRINCIPAL SPILLWAY	300 FEET	$375,000
PLUNGE POOL	1 LS	$50,000
ROAD CLOSURE AND STRUCTURE REMOVALS		$100,000
SUBTOTAL		$3,310,000
ENGINEERING PERMITTING AND CONSTRUCTION ADMINISTRATION	15%	$496,500
CONTINGENCY	20%	$662,000
PRELIMINARY OPINION OF COST		$4,468,500
LAND ACQUISITION	658 ACRES	$1,184,400
FARMSTEADS AND BUILDINGS		$185,000
TOTAL OPINION OF COST		**$5,837,900**

Cash Flow Stream and Rate of Return:
In accordance with NRDF guidelines, a comparison of project benefits and costs to determine the economic feasibility was done by preparing a cash flow stream for the construction of the proposed dam based on present day dollars.

Tables 9 and 10 show the cash flow stream and Internal Rate-of-Return (IRR) calculation spreadsheets for the proposed flood protection dam in place, and show the proposed timing of the expenditures and receipt of benefits. The rate of return on investment is 5.81%. The ratio of benefits and costs (B/C ratio) for the dam project is 1.54.

TABLE 9
CASH FLOW STREAM FOR FLOOD PROTECTION DAM

YEAR	COST/BENEFIT	ITEM	TOTAL
0	**Cost:**	Feasibility Study, Engineering and Inspection (Estimated)	**$496,500**
1-2	**Cost:**	Construction/ Capital Items	**$2,670,700**
3-4	Cost:	Construction/ Capital Items	$2,670,700
		OM&R	$62,400
	Total Costs:		**$2,733,100**
	Benefits:	Flood Damage Reduction	**$213,173**
5-50	**Cost:**	OM&R	**$1,435,200**
	Benefits:	Flood Damage Reduction	**$19,611,870**

TABLE 10

CASH FLOW AND IRR CALCULATION SPREADSHEET FOR PROPOSED DAM
PROJECT YEAR 0 TO 50

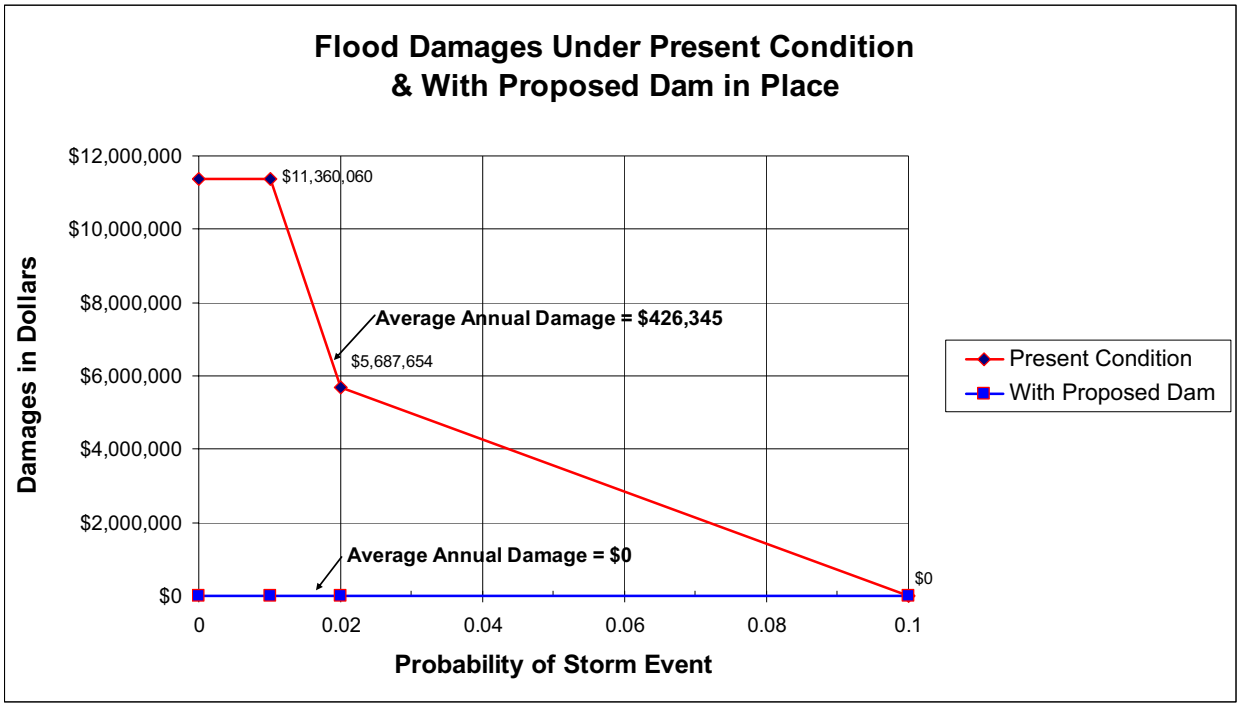
EXISTING CONDITION, AVERAGE ANNUAL DAMAGES = $426,345
WITH DAM CONDITION, AVERAGE ANNUAL DAMAGES = $0

B/C RATIO **1.54**
RATE OF RETURN **5.81%**

YEAR	PROJECT YEAR	FEASIBILITY ENGINEERING INSPECTION	CAPITAL ITEMS	OM&R	ASSOCIATED COSTS	GROSS COSTS	TOTAL VALUE OF PROJECT (GROSS BENEFITS)	INCREMENTAL BENEFITS (CASH FLOW)	ACCUMULATIVE BENEFITS (CASH FLOW)
2011	0	$496,500	$0	$0	$0	$496,500	$0	-$496,500	-$496,500
2012	1	$0	$1,335,350	$0	$0	$1,335,350	$0	-$1,335,350	-$1,831,850
2013	2	$0	$1,335,350	$0	$0	$1,335,350	$0	-$1,335,350	-$3,167,200
2014	3	$0	$1,335,350	$31,200	$0	$1,366,550	$0	-$1,366,550	-$4,533,750
2015	4	$0	$1,335,350	$31,200	$0	$1,366,550	$213,173	-$1,153,378	-$5,687,128
2016	5	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	-$5,291,983
2017	6	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	-$4,896,838
2018	7	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	-$4,501,693
2019	8	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	-$4,106,548
2020	9	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	-$3,711,403
2021	10	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	-$3,316,258
2022	11	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	-$2,921,113
2023	12	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	-$2,525,968
2024	13	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	-$2,130,823
2025	14	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	-$1,735,678
2026	15	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	-$1,340,533
2027	16	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	-$945,388
2028	17	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	-$550,243
2029	18	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	-$155,098
2030	19	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$240,048
2031	20	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$635,193
2032	21	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$1,030,338
2033	22	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$1,425,483
2034	23	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$1,820,628
2035	24	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$2,215,773
2036	25	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$2,610,918
2037	26	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$3,006,063
2038	27	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$3,401,208
2039	28	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$3,796,353
2040	29	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$4,191,498
2041	30	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$4,586,643
2042	31	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$4,981,788
2043	32	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$5,376,933

2044	33	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$5,772,078
2045	34	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$6,167,223
2046	35	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$6,562,368
2047	36	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$6,957,513
2048	37	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$7,352,658
2049	38	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$7,747,803
2050	39	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$8,142,948
2051	40	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$8,538,093
2052	41	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$8,933,238
2053	42	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$9,328,383
2054	43	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$9,723,528
2055	44	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$10,118,673
2056	45	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$10,513,818
2057	46	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$10,908,963
2058	47	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$11,304,108
2059	48	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$11,699,253
2060	49	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$12,094,398
2061	50	$0	$0	$31,200	$0	$31,200	$426,345	$395,145	$12,489,543
TOTAL		**$496,500**	**$5,341,400**	**$1,497,600**	**$0**	**$7,335,500**	**$19,825,043**	**$12,489,543**	

FIGURE 5
EXISTING AND WITH PROJECT DAMAGE CURVE



4.0 – RESULTS AND CONCLUSIONS

Both the potential overflow channel and dam appear feasible based on rate of return, which is 6.60% for the overflow diversion channel and 5.81% for the dam. Due to having a lower cost, the overflow channel has a higher rate of return; however, if recreation or other benefits were to be taken into account for the possible dam this result may vary.

APPENDIX E

HISTORICAL OCCURRENCE INFORMATION (ON CD)

APPENDIX F

HISTORICAL FLOOD PROTECTION EVALUATION REPORTS (ON CD)