DYNEGY

DYNEGY MIDWEST GENERATION, LLC
1500 East Port Plaza Drive
Collinsville, IL 62234

Via UPS

November 6, 2017

Mr. Richard Cobb, P.G.
Deputy Division Manager
Bureau of Water; Division of Public Water Supplies
Illinois Environmental Protection Agency
1021 North Grand Avenue East
Springfield, Illinois 62794-9276

Dear Mr. Cobb:

Re: Vermilion Site
MFV Riverbank Assessment Report

Enclosed please find the riverbank assessment report requested in your May 30, 2017 letter. The report was prepared by Stantec (St. Louis, MO). It addresses access requirements to protect the MFV river bank, current and potential river bank erosion relative to the access requirements, and river bank stabilization options.

The December 1, 2017 report requested in your May 30, 2017 letter is being prepared now.

Should you have any questions regarding the attached data, please feel free to address them to me at 618/343-7761.

Sincerely,
Dynegy Midwest Generation, LLC by its agent Dynegy Operating Company

Rick Diericx
Managing Director – Environmental Compliance

Enclosures

Stantec Consulting Services Inc.
1859 Bowles Avenue Suite 250, Fenton MO 63026-1944

November 2, 2017
File: 175657154

Attention: Mr. Matt Ballance, PE
Dynegy Midwest Generation, LLC
1500 Eastport Plaza Drive
Collinsville, Illinois 62234

Dear Mr. Ballance,

Reference: Vermilion Site Riverbank Assessment

Stantec Consulting Services Inc. (Stantec) is pleased to provide the enclosed report summarizing our assessment of streambank erosion along the Middle Fork Vermilion River at the Vermilion Site. Stantec appreciates the opportunity to work with you on this project. If you have any questions or need additional information, please call.

Regards,

STANTEC CONSULTING SERVICES INC.

Matthew Hoy, PE
Senior Associate
Matthew.hoy@stantec.com

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Senior Principal
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Vermilion Site Riverbank Assessment

Stantec

Prepared for:
Dynegy Midwest Generation, LLC

Prepared by:
Stantec Consulting Services Inc.

November 2, 2017

Table of Contents

LIST OF TABLES

LIST OF FIGURES

ATTACHMENTS

Stantec

1.0 INTRODUCTION

Dynegy Midwest Generation, LLC (DMG)'s Vermilion Site is located northwest of Danville, Illinois. The Middle Fork Vermilion River (i.e. Middle Fork) defines the eastern edge of the Vermilion Site. The Illinois Environmental Protection Agency (IEPA), in a letter dated February 9, 2017, inquired of DMG's plans for closure of the inactive, on-site disposal units and access requirements related to their location near the Middle Fork. The February 9, 2017 letter requested the following information relative to the Middle Fork riverbank:

- Access requirements (between the toe of the unit embankments and the riverbank needed for staging equipment).
- Current riverbank location and potential riverbank erosion relative to the access requirements above.
- Riverbank stabilization options.

This report addresses only the evaluation of the Middle Fork riverbank. Evaluation of closure of the disposal units will be addressed in a separate report.

1.1 PURPOSE

DMG contracted with Stantec Consulting Services Inc. (Stantec) to perform a site review and evaluate conceptual riverbank stabilization alternatives. Specifically, DMG asked that Stantec estimate the rate of erosion of the riverbanks at the Site depicted herein, review constraints at these locations, and review alternatives for riverbank stabilization.

2.0 EXISTING SITE CONDITIONS

Stantec performed an in-field review and collected data associated with the riverbanks along the specified segments of the Middle Fork. Since the existing site conditions vary, the evaluation area was divided into five riverbank segments as listed below and shown on Attachment 1.

Riverbank Segment	Upriver Coordinates	Downriver Coordinates
1	12+00	14+00
2	14+00	17+75
3	17+75	20+00
4	20+00	25+50
5	25+50	29+00

Observations from site visits and analyses of data were used to estimate erosion rates and present alternatives for long-term riverbank stabilization which are described herein.

2.1 GEOMORPHIC CONDITION

Stantec collected basic geomorphic data to develop an understanding of the river's behavior and to guide riverbank stabilization recommendations. A broad level evaluation of channel slope, shape, and pattern based on survey data and aerial photography was performed. The review of the geomorphic conditions of the Site revealed that the Middle Fork riverbanks are eroding.

Riverbank erosion was evident along the right and left descending banks adjacent to the DMG Vermilion Site. The sediment supply of the Middle Fork appears to be moderate to high with point-, mid-channel- and side-channel bars observed. This sediment supply likely contributes to riverbank erosion especially during high water conditions. The vegetation communities along the five riverbank segments were inconsistent, with herbaceous, shrub, and forested portions observed. Segments with vegetative communities with poor rooting depth and density also contribute to riverbank erosion. Survey data collected (by others), geotechnical boring data along the embankments as well as basic geomorphic data have been collected on site to help prepare this analysis. The existing conditions are summarized below and shown in Attachment 1.

2.1.1 Riverbank Segments 1, 3 and 5

Riverbank segments 1, 3 and 5 have an estimated 15- to 30-foot wide moderately sloping bench that separates the toe of the embankment and the top of the riverbank. Some sections were observed with failing gabion baskets while others were simply eroded, near vertical, riverbanks.

2.1.2 Riverbank Segment 2

Riverbank segment 2 has an estimated 30- to 72-foot-wide, gradually sloping bench that separates the toe of the embankment and the top of the riverbank.

2.1.3 Riverbank Segment 4

The line of demarcation between the Middle Fork riverbank and embankment toe was difficult to discern within riverbank segment 4. Deteriorating gabion sections along the riverbank toe were observed along this stretch of the Middle Fork.

2.2 EROSION RATE ASSESSMENT

Stantec has reviewed and performed analyses based on multiple methods to estimate potential erosion and/or riverbank retreat rates along the bank of the Middle Fork at the site. Riverbank erosion and migration is a complex process resulting from various concurrent and potentially synergistic fluvial and geotechnical processes (USDA, 2007; Watson and Basher, 2006). Riverbank erosion rates are dependent on many different factors and characteristics that vary along a specific reach of river, which makes estimating future erosion rates challenging. Some of the factors include local hydraulic slope, depth of flow, duration of flow, flow direction (in reference to adjacent bank), erodibility of bank material, rooting depth, radius of curvature, near bank stress, and bank angle. Stantec utilized both typical year erosion rate estimates and larger, less frequent event-based estimates. The methods evaluated herein, therefore, are intended to provide a range of potential erosion rates along the adjacent riverbank of the Site based on available data, both field collected and remotely sensed. Details regarding the methods are available upon request, but are omitted here for brevity.

Erosion rate estimates using the various methods are presented in Table 1. Rates range between 1.0 and 3.6 feet/year, with a mean value of 2.3 feet/year, if no erosion controls are implemented. Methods that included bend characteristics and flow data were applicable due to a defined bend occurring along the riverbank of concern and available gage flow data just downstream of the site.

Table 1. Erosion rate methods and estimated erosion rates

Method	Estimated Erosion Rate	Notes
Bend Curvature Ratio	2 feet/year	Based on 2017 ortho-imagery
Excess Shear	1.3 feet/year	Rate per event that is at or above bankfull (0.66 ft/bkf event, typically 2 per year = 1.32 feet/year)
Bankfull Discharge	1.0 feet/year	Based on empirical data from global database
Mean Annual Flow	3.3 feet/year	Mean annual flow estimated at 409 cfs
Bend Movement vs. Width	3.6 feet/year	Referenced in USDA National Engineering Handbook

After proper installation of Option 1 identified in this report and with appropriate maintenance, further erosion of the riverbank would not be anticipated for flows up to the design event. Following the installation of Option 2 and after the river has reached the material in the buried riprap trench, further erosion past the buried riprap trench would not be anticipated for flows up to the design event.

3.0 POTENTIAL RIVERBANK STABILIZATION MEASURES

Two primary options for riverbank stabilization have been identified: Rock Toe with Live Branch Layering (LBL) and Buried Riprap Trench.

The sections below provide further detail on these options. The options identify potential long-term measures to reduce the risk of erosion and maintenance along eastern embankments of the Vermilion Site. However, it should be noted that for any alternative selected, occasional maintenance may be required, particularly following major flood events. Also, further analysis during design (such as detailed flood analysis or permitting requirements) may reveal or require additional components to be addressed in the design process.

3.1 OPTION 1: ROCK TOE WITH LIVE BRANCH LAYERING

Option 1, as shown on Figure 1, is to construct a Rock Toe with Live Branch Layering (sometimes referred to as Stone Toe Protection), as well as re-grade a portion of the unit embankment. Excavation/regrading of the unit embankments or riverbank restoration/extension is needed for safe access and construction as well as long term monitoring, inspection, and maintenance. Attachment 3 shows the potential locations for each stabilization measure in Option 1.

Rock Toe with Live Branch Layering (LBL) combines the benefits of a rock toe and bioengineering. Rock Toe with Live Branch Layering is sometimes referred to as Stone Toe Protection. A layer of large graded angular stone is placed at the toe of the at-risk bank and soil lifts wrapped in coir fabric are layered on top with seed and live branches to build and support the riverbank. At the top of the Live Branch Layering, a sloping bench is graded to provide flood relief and help reduce stress on the remaining bank above. This treatment helps stabilize the bank toe and slope above and below the normal water surface elevation, allows for replacement of riverbank volume lost to earlier erosion, and allows for minor manipulation of riverbank slope. The incorporation of vegetation provides some reduction in near bank shear stress by lowering water velocity, enhances riparian zone function, and provides natural aesthetics. The structure can be time- and labor-intensive to install, but once the vegetation establishes, it requires little to no maintenance. Vegetation establishment in the live branch layering will take time, typically 3 years, and must occur before full benefits are realized.

The various elements of this measure are as follows (presented from lowest elevation to highest):

- Rock Toe (below stream bed to bankfull elevation). The bank is excavated below the existing stream toe, creating a trench 2 to 3 feet deep and 5 to 6 feet wide. The side farthest from the stream should be lower than the closest for stability purposes. The trench is then filled with well-graded rock aggregate and followed by additional rock aggregate as needed to reach the specified height. The aggregate selected must have an average size larger than the maximum particle size the stream can displace, but must also contain smaller rocks to allow for aggregate interlock. Material sizing and dimensioning will be further refined in the detailed design phase. The rock size, dimensions and configuration are planned to be designed to withstand shear stresses during the 100-year event on the Middle Fork.

- Live Branch Layering (bankfull to proposed bench elevation). Lifts of soil wrapped in coir fabric, approximately 12 to 15 inches in height, are placed on top of the Rock Toe. Coir lifts are alternated with live branch layering until the required elevation is reached, which will be the proposed bench elevation. Exposed coir surfaces are seeded, and additional live stakes are installed in the top lift. The live branches or live stakes help rebuild eroded banks with a vegetation matrix that provides enhanced shear stress resistance. Live cuttings between the coir lifts bind the lifts together and help tie the structure to the bank once their root systems develop, while vegetative portions extending out from the lifts will slow water velocity and lower shear stress during high-flow events. Herbaceous seeding and additional live staking on the lifts further stabilizes the structure. This treatment is suitable for high stream velocities with erodible soils, a range of stream sizes, correction of toe and bed erosion, and is particularly suited for conditions where the bank cannot be flatter than a 2:1 slope.

- Bench. A sloping bench is left or graded out to provide flood relief and help reduce stress on the remaining bank above.

- Riverbank Restoration. Riverbank restoration is also a possibility in combination with this option, to increase the distance between the river and embankment. Riverbank restoration involves restoring a portion of the riverbank lost to erosion in conjunction with installing the riverbank stabilization measure. This can help smooth bank transitions between different river features, increase the distance between the river and embankment in select locations, and allows a more gradual and stable slope of the riverbank.

Refer to Figure 1 below for a typical cross section of Rock Toe with Live Branch Layering. Option 1, Rock Toe w/ LBL, could be used at any of the five river segments. Due to the existing bench geometry, it is particularly suited for segments 1, 3, 4 and 5. When compared to Option 2: Buried Riprap Trench, Option 1: Rock Toe with Live Branch Layering:

- Reduces the amount of disturbance during construction because less vegetation will need to be removed to construct the measures along the existing bank.

- Reduces further post-construction erosion when compared to a buried riprap trench, which would be setback from the existing bank and would allow the river to erode to the line of protection over time.

- Improves the geomorphic and shear stress conditions within the river.

- Helps smooth bank transitions between different river features.

- Increases the distance between the river and embankment if riverbank restoration is performed in select locations.
- Allows a more gradual and stable slope of the riverbank.
- Is likely more aesthetically pleasing to users of the river.

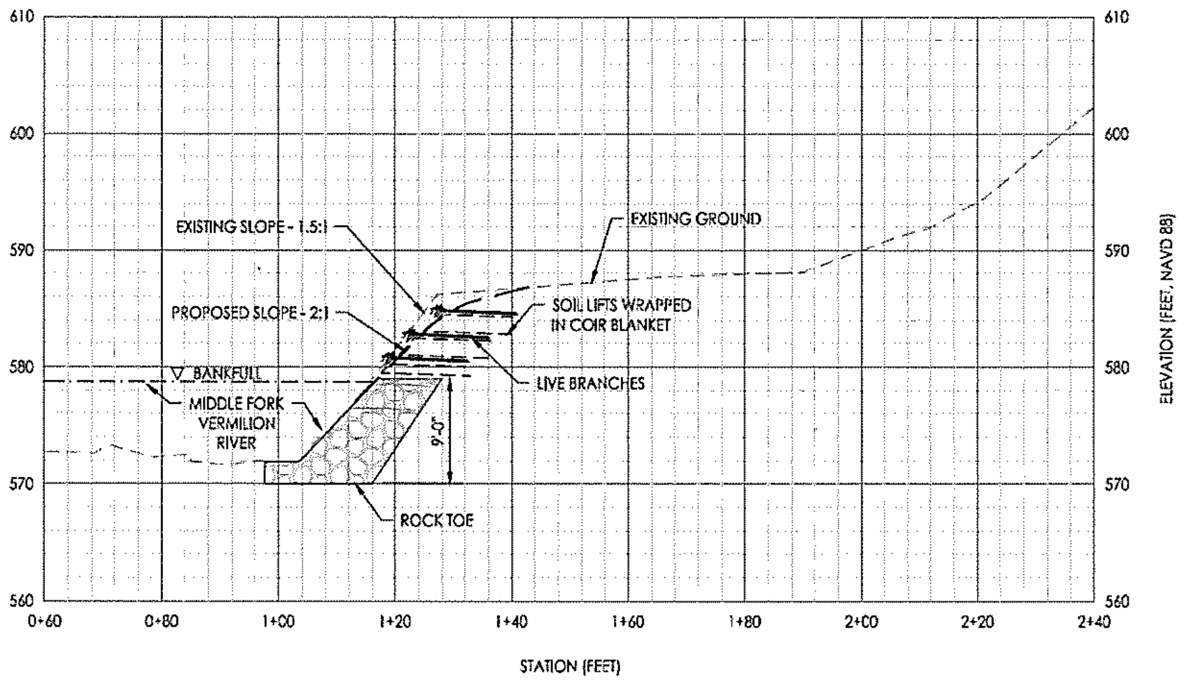

Figure 1. Rock Toe w/ Live Branch Layering (example section)

3.2 OPTION 2: BURIED RIPRAP TRENCH

Option 2, as shown on Figure 2, consists of installing a Buried Riprap Trench and excavating back the embankment in certain areas. This excavation will provide a bench for flood flows and reduce boundary stress during high flows. Attachment 4 displays the potential locations for each stabilization measure in Option 2.

A buried riprap trench is a buried boulder structure placed within the bank-of-concern offset a specified distance from the exposed bank. The toe trench is built such that the base is below the predicted scour depth and extends to a height of the current bankfull flow. Figure 2 shows approximate dimensions of this technique. The back side of the trench and riprap slightly slopes away from the adjacent stream to increase the stability of the stabilization structure and provide more support for the above bank. The buried riprap trench does not provide immediate bank protection or stability; rather, it is intended to become active once the bank has eroded to the riprap. At that point, the rock from the riprap trench acts as a rock toe resisting the erosive forces of the stream and providing a stable base for the above bank. Areas with a narrow bench between the Middle Fork and existing embankments may not be suitable for this treatment without excavating back the embankment.

This method is suitable if the stability of adjacent embankments will not be jeopardized during installation. Further geotechnical analysis of the embankments will be needed to determine strength and stability of the slopes during installation of the buried riprap trench. Riparian vegetation will need to be cleared for this work, removing the natural bank stabilization of riparian vegetation. Once the stream bank has eroded to the buried riprap (rock toe), the banks above the rock toe will be bare, but the rock toe will provide stabilization. Vegetation will then need to be re-established on any exposed riverbank above the riprap toe. The performance of this structure is reliant upon proper geomorphic assessment and relatively accurate future predictions of discharges and stream migration. Riverbank segment 2 has an existing bench where the Buried Riprap Trench could be installed.

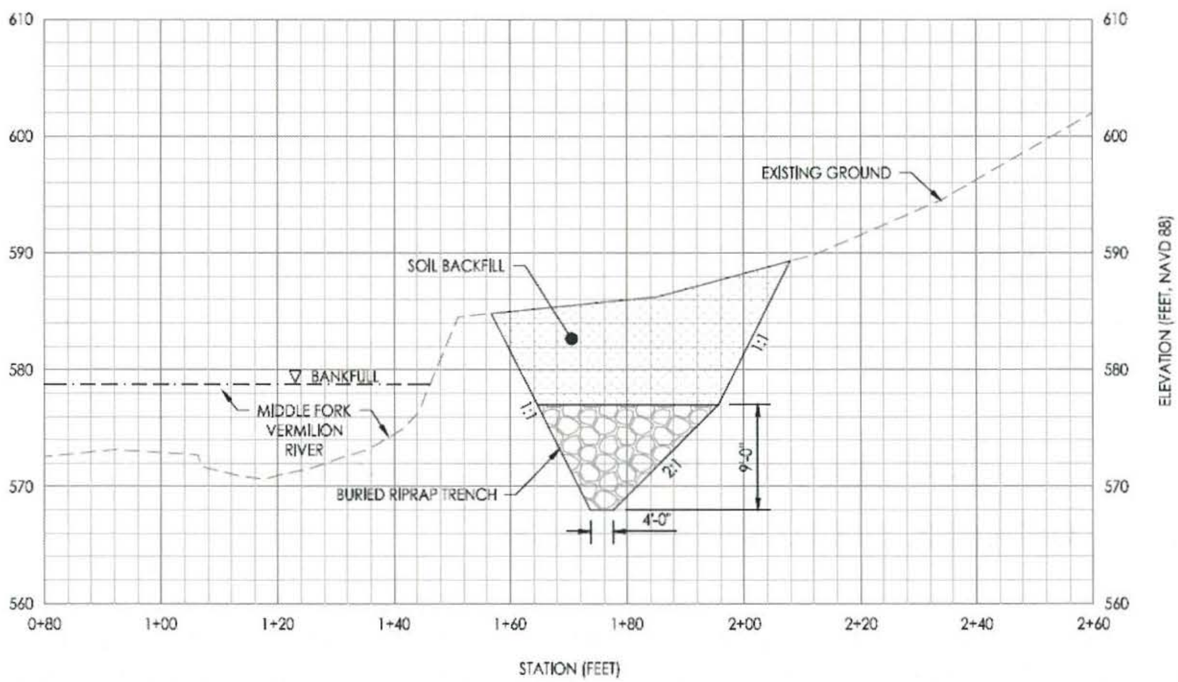

Figure 2. Buried Riprap Trench (example section)

4.0 CONSIDERATIONS

The following sections discuss considerations relative to construction timeframes and access during construction.

4.1 CONSTRUCTION TIMEFRAME

Construction of stabilization measures should be completed when Middle Fork flows are low, typically from June to November. If the entire length of bank is stabilized in one project phase, it will likely take approximately 6-8 months to complete. Individual segments could be completed in shorter timeframes. Planting and bioengineering techniques have different recommended construction seasons than primary excavating and construction aspects. If the Rock Toe with Live Branch Layering method is chosen, it can be installed without the branches during the summer months, if needed, and live stakes may be inserted into the soil wraps during the early spring/winter dormant season. Seed and live branches should be installed no later than mid-April so conflicting construction timing and sequencing objectives should be given careful consideration during planning and design.

4.2 CONSTRUCTION ACCESS

For the purposes of riverbank stabilization construction, as well as inspection and maintenance, a bench width of approximately 30 feet is required adjacent to the embankment toe. Less than 30 feet of bench width is present between the toe of the embankment and the top of the riverbank in some locations. This is not sufficient width for placement of construction equipment on the bench. For the purposes of this report, the outside edge of a 30-foot-wide bench is what is referred to as an initiation line where riverbank stabilization measures need to be initiated to preserve the remaining bench and access along the eastern side of the unit embankments. This initiation line is depicted in Attachment 1. Existing estimated bench widths and slopes between the Middle Fork and the toe of the embankments are shown in Attachment 2. When the river erodes past the initiation line, construction equipment will no longer be able to safely traverse the bench and conduct maintenance or construction activities from the riverbank, and alternative construction options would need to be considered.

Access for inspection and maintenance purposes is limited in select areas, primarily along riverbank segments 1, 3, 4 and 5. As shown in Attachment 1, several areas along riverbank segments 1, 3, 4 and 5 have already crossed the initiation line. The width of remaining bench varies along the riverbank segments between 19 and 72 feet. The average estimated erosion rate of the estimation methods considered was 2.3 feet/year. Using the average erosion/bank retreat rate, it is predicted that the widest bench portions could reach the "initiation line" in 18 years. Some areas currently at or beyond the "initiation line" could have no remaining bench and may erode to the embankment toe in 8 years using the average erosion rate. The stability of the gabion baskets is compromised and it is not possible to reliably predict how long these will continue to function.

In general, access does not appear to be a challenge along riverbank segment 2. A contractor should be able to build a ramp from the perimeter road down to the terrace bench shown on Attachment 2 for construction of riverbank stabilization measures.

The access along riverbank segments 1, 3, 4 and 5 will be more challenging. These areas have less than a 19-foot wide bench from the toe of the embankments in some locations. Work performed from the top of the riverbank area would likely require a re-grading of the embankment to provide the 30-foot bench width. Rock Toe with LBL requires an approximate 30-foot wide bench, while the Buried Riprap Trench would require an approximate 30 to 40-foot wide bench. For a track hoe to work from the bench, the slope would need to be flatter than 10:1.

These stabilization measures can be implemented using a large track hoe with a long reach. The large track hoe with a long reach will allow for deep excavation below the base of the track hoe if working from the bench as well as a long reach across the river if working in the channel and staged on a working platform. A working platform would likely need to be located on the inside of the bend while reaching over the primary flow path and working on the outside banks of the bend. The access points and ability to work from the benches are also subject to slope stability analysis. Slope stability could be a concern for installing the Buried Riprap Trench or working from the bench above unstable riverbanks.

5.0 SUMMARY

Based on the observations and analyses conducted during this assessment, the following information is provided to address the Illinois EPA request:

Access and Erosion Rate. Riverbank segments have 19 to 72 feet of bench width remaining. Riverbank segments 1 and 2 have the greatest potential for riverbank erosion. The potential for riverbank erosion is less within riverbank segments 3, 4 and 5. However, stability of the gabion baskets within riverbank segments 3, 4 and 5 have degraded whereas they are no longer able to reliably prevent future erosion. The distance between the riverbank and the embankment toe is generally less than that along riverbank segment 2. Approximately 30 feet of bench width is needed for inspection, maintenance, and construction of bank stabilization measures. Several areas within riverbank segments 1, 3, 4 and 5 already have less than the required bench width, and will require re-grading of the embankment. It is anticipated that all areas within riverbank segments 1 through 5 will have less than 30 feet of bench width in 18 years based on an average of estimated erosion rates. Implementation of riverbank restoration with Option 1 in riverbank segments 1, 3, 4 and 5 will increase bench width and, with proper maintenance, comprehensively extend the life of the bench width.

Bank Stabilization Measures. It is recommended that Option 1: Rock Toe with Live Branch Layering be constructed along riverbank segments 1, 3, 4 and 5 and that either Rock Toe with Live Branch Layering or Buried Riprap Trench could be constructed along riverbank segment 2. The use of bioengineering techniques reduces near bank stresses and uses strategically placed vegetation to develop a root system that will interlock the bank components. In locations along riverbank segments 1, 3, 4 and 5 where the embankment is less than 30 feet from top of the riverbank, it is recommended that the embankment be re-graded or a portion of the riverbank lost to erosion be restored. In conjunction with installing the riverbank stabilization measure, this can provide a 30-foot bench adjacent to the embankment toe. The combination of these techniques will provide a bench for flood flows, reduce boundary stress during high flows and provide access for future maintenance. After proper installation of Option 1 identified in this report and with appropriate maintenance, further erosion of the riverbank would not be anticipated for flows up to the design event. Following the installation of Option 2 and after the river has reached the material in the buried riprap trench, further erosion past the buried riprap trench would not be anticipated for flows up to the design event.

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Legend

- Project Reach
- Existing Contours

Methods

- Buried Riprap Trench
- Buried Riprap Trench and Excavate Bank Enhancement

0 100 200 400 Feet

1 inch = 200 feet

(At document original size 11X17)

Notes

1. Coordinate System: NAD 1983 StatePlane Illinois East FIPS 1201 Feet

Project Location:
Vermilion Site
Danville, IL

Client/Project
Client: DMG
Title: Attachment 4 - Option 2 - Buried Riprap Trench
Project: Vermilion Site Riverbank Assessment

Figure No.
Attachment 4

Title
Attachment 4 - Option 2 - Buried Riprap Trench

11/01/2017

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Legend

- Project Reach
- Existing Contours

Methods

- Rock Toe w/ LBL
- Rock Toe w/ LBL and Excavate Bank Embankment

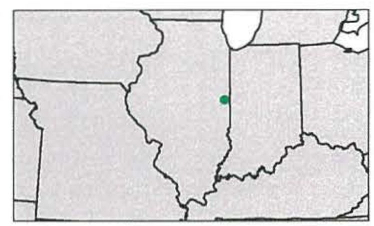
0 100 200 400 Feet

1 inch = 200 feet

(At document original size 11X17)

Notes

1. Coordinate System: NAD 1983 StatePlane Illinois East FIPS 1201 Feet



Project Location:
Vermilion Site
Danville, IL

Client/Project
Client: DMG
Title: Attachment 3 - Option 1 - Rock Toe w/ LBL
Project: Vermilion Site Riverbank Assessment

Figure No.
Attachment 3

Title
Attachment 3 - Option 1 - Rock Toe w/ LBL

11/01/2017

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Legend

- Initiation Line
- Project Reach Map
- Existing Contours Map

Riverbank Conditions

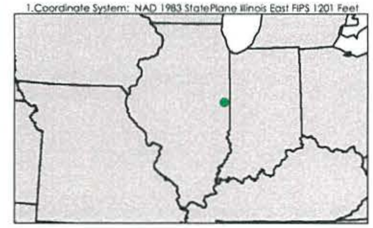
- Segment 1
- Segment 2
- Segment 3
- Segment 4
- Segment 5

0 100 200 400 Feet

1 inch = 200 feet
(At document original size 11X17)

Notes

1.Coordinate System: NAD 1983 StatePlane Illinois East FIPS 1201 Feet



Project Location:
Vermilion Site
Danville, IL

Client/Project
Client: DMG
Title: Attachment 1 - Current Conditions
Project: Vermilion Site Riverbank Assessment

Figure No.
Attachment 1

Title
Attachment 1 - Current Conditions

11/01/2017

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Legend

- Project Reach
- Existing Contours
- Bench Width
- Bench Slope

0 100 200 400 Feet

1 inch = 200 feet

(At document original size 11X17)

Notes

1. Coordinate System: NAD 1983 StatePlane Illinois East FIPS 1201 Feet

Project Location:
Vermilion Facility
Danville, IL

Client/Project
Client: DMG
Title: Attachment 2 - Bench Estimates
Project: Vermilion Site Riverbank Assessment

Figure No.
Attachment 2

Title
Attachment 2 - Bench Estimates

11/01/2017