# BSDMS Summary Report

**73 Pomme De Terre River at CR 22 near Fairfield, MN**

## Site Location:

**Site ID:** 73

**Site Name:** Pomme De Terre River at CR 22 near Fairfield, MN

**County:** Swift

**Nearest City:** Fairfield

**State:** MN

**Latitude:** 452304

**Longitude:** 0955646

**USGS Station ID:**

**Route Number:** 22

**Route Class:** County

**Service Level:** Mainline

**Route Direction:** NA

**Highway Mile Point:**

**Stream Name:** Pomme De Ter

**River Mile:**

**Contact:**

David Mueller
U.S. Geological Survey
9818 Bluegrass Parkway
Louisville, KY 40299

**Publication:**

Mueller, D.S., and Hitchcock, H.A., 1998, Scour measurements at contracted highway crossings in Minnesota, 1997: ASCE, Water Resources Engineering '98, Memphis, TN, p. 210-215.

## Site Description:

Swift county road 22 over the Pomme De Terre River is three-span structure supported by round concrete pile bents. The site is located in a rural / agricultural area. During the flooding in April 1997, the USGS visited this site four times. The cross sections show a progression of scour at the right abutment. During all three visits the floodplain flow was concentrated in the right floodplain. This concentration of flow in the right floodplain is likely due to the channel alignment upstream of the bridge. The field crew searched for but could not define a location of flow reattachment along the right embankment. Flow was towards the main channel along the entire length of the embankment. The flow separated from the right embankment, nearly perpendicular to the main channel flow, and joined the main flow just left of the rightmost pier. During the 4-5-97 visit the flow from the right floodplain was so strong that a standing wave formed upstream of the bridge where the floodplain and main channel flow began mixing. The area from the rightmost pier to the right abutment was primarily slack and reverse flow. A slump failure in the right upstream highway embankment was observed during the last visit on 4-9-97. In July 1997 it was observed that riprap was used to fill scour at the right wingwall.

Cross-section data were collected using a chart-recording echo sounder with the transducer mounted on a knee board. The charts were digitized and scaled. Velocities were measured using standard discharge measurement procedures and a Price AA cup meter.

Manning's n reported the stream data are for the upstream reach. A complete

distribution of Manning's is provide below:

| Upstream | Left | Main | Right | Downstream | Left | Main | Right |
|---|---|---|---|---|---|---|---|
| High | 0.12 | 0.035 | 0.13 | | 0.09 | 0.035 | 0.09 |
| Typical | 0.10 | 0.030 | 0.12 | | 0.08 | 0.030 | 0.08 |
| Low | 0.08 | | 0.08 | | 0.07 | | 0.07 |

## Elevation Reference

**Datum:** MSL

**MSL (ft):**

**Description of Reference Elevation:**

Water-surface elevations were measured from the bridge deck. The elevation of the bridge deck was determined from the bride plans. All measurements were made between the leftmost pier and the left abutment.

| Date | Time | Upstream | Downstream |
|---|---|---|---|
| 4-4-97 | | 1040.13 | 1039.85 |
| 4-5-97 | 1430 | 1040.57 | 1040.27 |
| 4-9-97 | 1800 | 1041.2 | |
| 7-15-97 | 1410 | 1032.75 | |

A local right-hand coordinate system was established with the postive y-axis in the upstream direction and the x-axis parallel to the upstream face of the bridge. This resulted in x-coordinates increasing from right to left. Since step backwater models typically us left to right coordinates, stationing was added which increases from left to right. The stationing on the two sections 500-ft upstream was adjusted so that the main channel aligned with the main channel at the bridge.

## Stream Data

| | | | |
|---|---|---|---|
| **Drainage Area (sq mi):** | 836 | **Floodplain Width:** | Wide |
| **Slope in Vicinity(ft/ft):** | 0.0006 | **Natural Levees:** | Unknown |
| **Flow Impact:** | Straight | **Apparent Incision:** | None |
| **Channel Evolution** | Premodified | **Channel Boundary:** | Alluvial |
| **Armoring:** | Unknown | **Banks Tree Cover:** | Medium |
| **Debris Frequency:** | Unknown | **Sinuosity:** | Meandering |
| **Debris Effect:** | Unknown | **Braiding:** | None |
| **Stream Size:** | Small | **Anabranching:** | Locally |
| **Flow Habit:** | Perennial | **Bars:** | Irregular |
| **Bed Material:** | Sand | **Stream Width Variability:** | Random |
| **Valley Setting:** | Low | | |

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## Roughness Data

**Manning's n Values**

| | Left Overbank | Channel | Right Overbank |
|---|---|---|---|
| **High:** | 0.12 | 0.035 | 0.13 |
| **Typical** | 0.1 | 0.03 | 0.12 |
| **Low:** | 0.08 | | 0.08 |

## Bed Material

| Measurement Number | Yr | Mo | Dy | Sampler | D95 (mm) | D84 (mm) | D50 (mm) | D16 (mm) | SP | Shape | Cohesion |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | BM-54 | 0.46 | 0.4 | 0.15 | 0.03 | 2.65 | | Non-Cohesive |

### Bed Material Comments

**Measurement No:** 1

The samples were collected from the upstream bridge face and appeared consist of non-cohesive fine sandy/silt with the following grain size distribution:

| Size (mm) | 4 | 2 | 1 | .5 | .25 | .125 | .062 | .016 | .004 | .002 |
|---|---|---|---|---|---|---|---|---|---|---|
| % < than | 100 | 99.8 | 99.3 | 97.8 | 76.2 | 42.7 | 27.0 | 10.4 | 8.0 | 7.0 |

The boring logs of the site have been included in the bridge plan profile. Generally the logs indicate sand with some loam layers with fine gravel in the subbottom.

## Bridge Data

**Structure No:** 76518

**Length(ft):** 120.8

**Width(ft):** 39.3

**Number of Spans:** 3

**Vertical Configuration:** Sloping

**Low Chord Elev (ft):** 1041.21

**Upper Chord Elev (ft):** 1041.57

**Overtopping Elev (ft):** 1043

**Skew (degrees):** 15

**Guide Banks:** None

**Waterway Classification:** Main

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## 73 Pomme De Terre River at CR 22 near Fairfield, MN

**Year Built:** 1992

**Avg Daily Traffic:** 222

**Plans on File:** Yes

**Parallel Bridges** No

**Upstream/Downstream:** N/A

**Continuous Abutment:** No

**Distance Between Centerlines:**

**Distance Between Pier Faces:**

**Bridge Description:**

The bridge is a relatively new bridge with wide shoulders and concrete guardrails. The bridge is angled about 15 degrees to the low flow channel. All cross sections collected during the flood were collected approximately parallel to the bridge deck.

## Abutment Data

**Left Station:** 584

**Right Station:** 705

**Left Skew (deg):** 15

**Right Skew (deg)** 15

**Left Abutment Length (ft):** 64

**Right Abutment Length (ft)** 64

**Left Abutment to Channel Bank (ft):** 0

**Right Abutment to Channel Bank (ft):** 0

**Left Abutment Protection:**

**Right Abutment Protection**

**Contracted Opening Type:** III

**Embankment Skew (deg):** -15

**Embankment Slope (ft/ft):** 2

**Abutment Slope (ft/ft)** 2

**Wingwalls:** Yes

**Wingwall Angle (deg):** 90

## Pier Data

| Pier ID | Bridge Station(ft) | Alignment | Highway Station | PierType | # Of Piles | Pile Spacing(ft) |
|---|---|---|---|---|---|---|
| 1 | 666 | 15 | | Group | 5 | 9 |
| 2 | 624 | 15 | | Group | 5 | 9 |

| Pier ID | Pier Width(ft) | Pier Shape | Shape Factor | Length(ft) | Protection | Foundation |
|---|---|---|---|---|---|---|
| 1 | 1.33 | Round | | | Unknown | Unknown |
| 2 | 1.33 | Round | | | Unknown | Unknown |

| Pier ID | Top Elevation(ft) | Bottom Elevation(ft) | Foot or Pile Cap Width(ft) | Cap Shape | Pile Tip Elevation(ft) |
|---|---|---|---|---|---|
| 1 | | | | Unknown | |
| 2 | | | | Unknown | |

## Pier Description

**Pier ID** 1

**Pier ID** 2

The piers are pile bents consisting of 5, 16-inch diameter concrete piles spaced 9 ft apart in a single line. The upstream and downstream piles are battered at 2 on 12.

## Pier Scour Data

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## Abutment Scour

| Measurement Number | Abutment | Date | Time | US/DS | Scour Depth (ft) | Accuracy | Sediment Transport |
|---|---|---|---|---|---|---|---|
| 1 | Right | 4/4/1997 | | Upstream | 3.9 | 1 | Live-bed |
| 2 | Right | 4/5/1997 | | Upstream | 4.1 | 1 | Live-bed |
| 3 | Right | 4/9/1997 | | Upstream | 10 | 1.5 | Live-bed |
| 4 | Left | 4/4/1997 | | Upstream | 3 | 1 | Live-bed |
| 5 | Left | 4/5/1997 | | Upstream | 2.8 | 1 | Live-bed |
| 6 | Left | 4/9/1997 | | Upstream | 2 | 1 | Live-bed |

| Measurement Number | Velocity at Abut(ft/s) | Depth at Abut(ft) | Discharge Blocked(cfs) | Avg Velocity Blocked(ft/s) | Avg Depth Blocked(ft) |
|---|---|---|---|---|---|
| 1 | | 13.9 | | | |
| 2 | 8.3 | 15.6 | | | |
| 3 | 3.3 | 21.1 | | | |
| 4 | | 13 | | | |
| 5 | 5 | 14.3 | | | |
| 6 | 5.1 | 14 | | | |

| Measurement Number | Embankment Length (ft) | Bed Material | D50 (mm) | Sigma | Debris Effect |
|---|---|---|---|---|---|
| 1 | 516 | Unknown | 0.15 | | Unknown |
| 2 | 532 | Unknown | 0.15 | | Unknown |
| 3 | 546 | Unknown | 0.15 | | Unknown |
| 4 | 143 | Unknown | 0.15 | | Unknown |
| 5 | 154 | Unknown | 0.15 | | Unknown |
| 6 | 165 | Unknown | 0.15 | | Unknown |

## Abutment Scour Comments

**MeasurementNo** 1

The reference surface used to determine the depth of abutment scour was the concurrent ambient bed. Therefore, the depth of abutment scour reported is additional local scour below the depth of contraction scour. Based on the cross sections from the bridge plans there appeared to be little contraction scour.

Elevation of reference surfaces used:
4-4-97 1030
4-5-97 1029
4-9-97 1029

The rightmost pier may have had some influence on the depth of scour at the right abutment. It is difficult to separate its effect from the abutment. The abutment had the major effect and all scour is credited to the abutment with no scour reported for the pier.

The velocity reported for “at the abutment” is the maximum velocity observed in the area of the scour hole. Note that the velocity dropped considerably at the right abutment as the scour hole depth increased causing an increase in the flow area. The velocity at the left abutment held steady as did the depth and shape of the scour hole.

**MeasurementNo** 2

**MeasurementNo** 3

**MeasurementNo** 4

**MeasurementNo** 5

**MeasurementNo** 6

## ContractionScour

# BSDMS Summary Report

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| Measurement Number | Contracted Date | Contracted Time | Uncontracted Date | Uncontracted Time | US/DS | Scour Depth(ft) |
|---|---|---|---|---|---|---|
| 1 | 4/4/1997 | | | | | 0 |
| 2 | 4/5/1997 | | | | | 0 |
| 3 | 4/9/1997 | | | | | 0 |

| Measurement Number | Accuracy | Contracted Avg Vel(ft/s) | Contracted Discharge(cfs) | Contracted Depth(ft) | Contracted Width(ft) |
|---|---|---|---|---|---|
| 1 | 1 | | | | |
| 2 | 1 | 4.23 | 4570 | 10.1 | 107 |
| 3 | 1 | 3.79 | 5150 | 12.5 | 109 |

| Measurement Number | Uncontracted Avg Vel(ft/s) | Uncontracted Discharge(cfs) | Uncontracted Depth(ft) | Uncontracted Width(ft) | Channel Contraction Ratio |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |

| Measurement Number | Pier Contraction Ratio | Scour Location | Eccent-ricity | Sediment Transport | Bed Form | Debris Effects |
|---|---|---|---|---|---|---|
| 1 | | Main Channel | | Live-bed | Unknown | Unknown |
| 2 | | Main Channel | | Live-bed | Unknown | Unknown |
| 3 | | Main Channel | | Live-bed | Unknown | Unknown |

| Measurement Number | D95 (mm) | D84 (mm) | D50 (mm) | D16 (mm) | Sigma Bed Material | Bed Material |
|---|---|---|---|---|---|---|
| 1 | | | | | | Non-cohesive |
| 2 | | | | | | Non-cohesive |
| 3 | | | | | | Non-cohesive |

### Contraction Scour Comments

# BSDMS Summary Report

**73 Pomme De Terre River at CR 22 near Fairfield, MN**

**Measurement No.** 1

No hydraulic measurements were made on this date. However, from the channel geometry measurements no contraction scour was observed.

**Measurement No.** 2

Contraction scour was computed as the difference in average bed elevation between uncontracted and contracted sections, adjusted for bed slope.

Based on the elevation of the main channel between the abutment scour holes there appears to be only 1 ft or less of contraction scour and therefore a value of zero contraction scour is reported. No measurements in the uncontracted sections could be made. However, comparisons of the center of the contracted section with the cross section on the bridge plans collected in 1991 showed not change in elevation except in the areas effected by local scour. Thus, a zero contraction scour was reported.

The average depth and velocity of the contracted section were computed from the discharge measurements. The average depth included the abutment scour holes.

**Measurement No.** 3

Contraction scour was computed as the difference in average bed elevation between uncontracted and contracted sections, adjusted for bed slope.

Based on the elevation of the main channel between the abutment scour holes there appears to be only 1 ft or less of contraction scour and therefore a value of zero contraction scour is reported. No measurements in the uncontracted sections could be made.

The average depth and velocity of the contracted section were computed from the discharge measurements. The average depth included the abutment scour holes.

## Stage and Discharge Data

| Peak Discharge | | | | | Flow | | Peak Stage | | | | | Stage | Water | Return |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| year | mo | dy | hr | mi | (cfs) | Qacc | year | mo | dy | hr | mi | (ft) | Temp (C) | Period(yr) |
| | | | | | | | 1997 | 4 | 9 | | | 1041.2 | | |
| | | | | | 5150 | | 1997 | 4 | 5 | | | 1040.6 | | |
| | | | | | 4570 | | 1997 | 4 | 4 | | | 1040.1 | | |

## Hydrograph

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## Supporting Files

PDT22-brgpln-profile.jpg - profile plot from bridge plan, includes bed material information.

Planview.wmf - is a file showing the bridge with a sketch of the channel and the locations of the cross sections. Note the location of the cross sections from the bridge plans located 500 ft upstream and downstream are approximate.

PDT22-pier-details.jpg - scan of bridge plan pier details
PDT22-topo.jpg
PDT22-brgpln-profile.jpg

Photos taken on 7-15-97:

PDT22-ds-bridge.jpg - photo along downstream edge of bridge

PDT22-ds-channel.jpg - photo of main channel downstream

PDT22-ds-lbnk.jpg - photo of left bank downstream from bridge

PDT22-ds-rbnk.jpg - photo of right bank downstream from bridge

PDT22-us-bridge.jpg - photo along upstream edge of bridge

Pictures taken on 10/29/01:
HWY220001.jpeg – Looking downstream at right bend from left upstream fldpln
HWY220002.jpeg – same as 0001
HWY220003.jpeg – Left upstream fldpln near bend closest to bridge
HWY220004.jpeg – Looking upstream at left fldpln, upstream of bridge, OP#2
HWY220005.jpeg – same as 0004
HWY220006.jpeg – same as 0004
HWY220007.jpeg – Looking at upstream right fldpln from roadway, OP#3
HWY220008.jpeg – same as 0007, looking at US x-secs 9 and 10.
HWY220009.jpeg – Looking downstream at right fldpln, OP#4
HWY220010.jpeg – Looking downstream from roadway, OP#4
HWY220011.jpeg – same as 0010
HWY220012.jpeg – Chad Wagner collecting bathymetry data with scour board
HWY220013.jpeg – Scour board collecting bathymetry data
HWY220014.jpeg – same as 0012
HWY220015.jpeg – Looking downstream from bridge deck
HWY220016.jpeg – same as 0015
HWY220017.jpeg – same as 0015
HWY220018.jpeg – Looking upstream from bridge deck
HWY220019.jpeg – Upstream bridge face and area of scour along right bank
HWY220020.jpeg – Looking upstream at channel and left overbank from deck
HWY220021.jpeg – Looking at right abutment from US left bank
HWY220022.jpeg – Looking at bridge from US left bank, in bend
HWY220023.jpeg – Looking upstream at upstream bend from left bank
HWY220024.jpeg – same as 0021
HWY220025.jpeg – Looking at DS right bank from left abutment
HWY220027.jpeg – same as 0025
HWY220028.jpeg – Looking DS from left abutment
HWY220029.jpeg – Looking US at right bank from left abutment
HWY220030.jpeg – Looking US from left abutment
HWY220031.jpeg – Upstream left floodplain, gravel pits
HWY220032.jpeg – same as 0031
HWY220033.jpeg – Downstream left floodplain
HWY220034.jpeg – Looking westward at upstream bridge face from roadway

HWY220035.jpeg – Upstream left overbank
HWY220036.jpeg – Looking eastward at upstream right overbank from roadway
HWY220037.jpeg – Looking westward at bridge from roadway
HWY220038.jpeg – Upstream bridge face and the source of 3 days of pleasant odors
HWY220039.jpeg – Upstream right overbank from bridge deck

CR22PDT.doc - MS Word summary of site, bridge and scour data
CR22PDT.xls - contains the following worksheets

cross sections are label by location upstream (us) or downstream (ds)
distance from bridge
date or source (bp is bridge plans)

See appropriate worksheet
us500_bp
us70_7-15
us50_7-15
us50_7-15(2)
usfv_bp
us0_4-4
us0_4-5
us0_4-9
us0Q_4-5
us0Q_4-9
us0Q_7-15
lsrtww_4-9 - longitudinal section along the right wing wall
lsp1p2_7-15 - longitudinal section between piers 1 and 2
ds0_4-4
ds0_4-5
ds0_7-15
dsfv_bp
ds10_4-9
ds15_4-5
ds20_4-9
ds25_4-4
ds40_4-5
ds50_4-4
ds50_4-9
ds50_7-15
ds80_4-5
ds80_4-5(2)
ds90_4-9
ds100_4-4
ds100_7-15
ds500_bp
Q4-5-97- velocities from discharge measurement on 4-5-97
Q4-9-97 - velocities from discharge measurement on 4-9-97
Q7-15-97 - velocities from discharge measurement on 7-15-97
Hydrograph - hydrograph from nearest gage