

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources or small dams. The community map preparator should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations (BFEs)** and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Elevation Data tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on this FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIS report for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only to landward of 1/2 mile from the American Vertical Datum of 1988 (AVD88) line. Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Elevation Data table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Elevation Data table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic calculations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The projection used in the preparation of this map was Universal Transverse Mercator (UTM) zone 12. The horizontal datum was NAD83. Orthometric elevations, referenced to the datum, were used in the preparation of this FIRM. For adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structures and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Survey Datum of 1973 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov> to contact the National Geodetic Survey at the following address:

National Geodetic Survey
NCEM, 6002012
National Geodetic Survey
33300 N. Highway
1110 East-West Highway
Silver Spring, MD 20910-2897

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (202) 732-3242, or visit its website at <http://www.ngs.noaa.gov>.

Base map information shown on this FIRM was provided in digital format by the United States Department of Agriculture. This information was georeferenced and geotagged from Digital Orthophoto Quarter Quadrangles at a scale of 1:40,000, dated 2001 or later as a part of the National Agriculture Imagery Program.

This map reflects more detailed and up-to-date stream channel configurations than those shown on the previous FIRM for this jurisdiction. The boundaries and floodways that were transferred from the previous FIRM may have been adjusted to conform to these more detailed stream configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contain authoritative hydraulic data) may reflect stream channel dimensions that differ from what is shown on this map.

Corporate limits shown on this map are based on the latest data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels, community map preparator, address, and a listing of communities with numbering National Flood Insurance Program data for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-6115 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by fax at 1-800-358-6115 and by website at <http://www.fema.gov>.

If you have **questions** about this map or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA-MAP (1-877-366-2627) or visit the FEMA website at <http://www.fema.gov>.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SPECIAL SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD)

The 1% annual chance flood (100-year flood) also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Areas in this map subject to flooding by the 1% annual chance flood, areas of Special Flood Hazard include Zone A, AE, AH, AO, X, and V. The base flood elevation is the water surface elevation of the 1% annual chance flood.

- ZONE A:** No Base Flood Elevations determined.
- ZONE AE:** Base Flood Elevations determined.
- ZONE AH:** Flood depths of 1 to 3 feet (locality areas of ponds); Base Flood Elevations determined.
- ZONE AO:** Flood depths of 1 to 3 feet (locality areas of ponds); Base Flood Elevations determined.
- ZONE X:** Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was substantially destroyed. Zone X indicates that the former flood control system is being replaced to provide protection from the 1% annual chance or greater flood.
- ZONE V:** Areas in the potential from 1% annual chance flood to a Federal Flood Protection System under construction; no Base Flood Elevations determined.
- ZONE V:** Coastal flood areas with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE V:** Coastal flood areas with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a river plus any adjacent floodplain areas that must be kept free of obstructions so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X: Areas of 0.2% annual chance flood, areas of 0.2% annual chance flood with average depths of less than 1 foot or with average depth less than 1 foot only, and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE B: Areas determined to be outside the 0.2% annual chance floodplain. Areas in which flood hazards are unassessable, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

OPAs are areas that are normally located within or adjacent to Special Flood Hazard Areas.

OPAs include:

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone A boundary
- Zone V boundary

OPAs also include:

- Boundary showing Special Flood Hazard Areas of adjacent Base Flood Elevations, flood depths or flood velocities
- Base Flood Elevation line and water elevation in feet
- Base Flood Elevation - water surface elevation within zone A
- Base Flood Elevation - water surface elevation within zone V

OPAs also include:

- Base Flood Elevation - water surface elevation within zone A
- Base Flood Elevation - water surface elevation within zone V

OPAs also include:

- Base Flood Elevation - water surface elevation within zone A
- Base Flood Elevation - water surface elevation within zone V

OPAs also include:

- Base Flood Elevation - water surface elevation within zone A
- Base Flood Elevation - water surface elevation within zone V

OPAs also include:

- Base Flood Elevation - water surface elevation within zone A
- Base Flood Elevation - water surface elevation within zone V

OPAs also include:

- Base Flood Elevation - water surface elevation within zone A
- Base Flood Elevation - water surface elevation within zone V

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- Base Flood Elevation - water surface elevation within zone A
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OPAs also include:

- Base Flood Elevation - water surface elevation within zone A
- Base Flood Elevation - water surface elevation within zone V

NOTES TO USERS

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Coastal Base Flood Elevations shown on this map apply only to landward of 1/2 North American Vertical Datum of 1988 (NAVD83) elevations. Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Elevation Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Elevation Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on the FIRM.

Boundaries of the Floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

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The projection used in the preparation of this map was Universal Transverse Mercator (UTM) zone 12. The horizontal datum was NAD83. Orthometric elevations, referenced to mean sea level, provided in FIS reports used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

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NGS Information Services
NGA, NGS212
National Geodetic Survey
MSMC-A, #0002
1310 East-West Highway
Silver Spring, MD 20910-0202

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3046, or visit its website at <http://www.ngs.noaa.gov>.

Base map information shown on this FIRM was provided in digital form by the United States Department of Agriculture. This information was digitized from aerial photography compiled from Digital Orthophoto Quarter Quadrangles at a scale of 1:40,000, dated 2005 or later as a part of the National Agriculture Imagery Program.

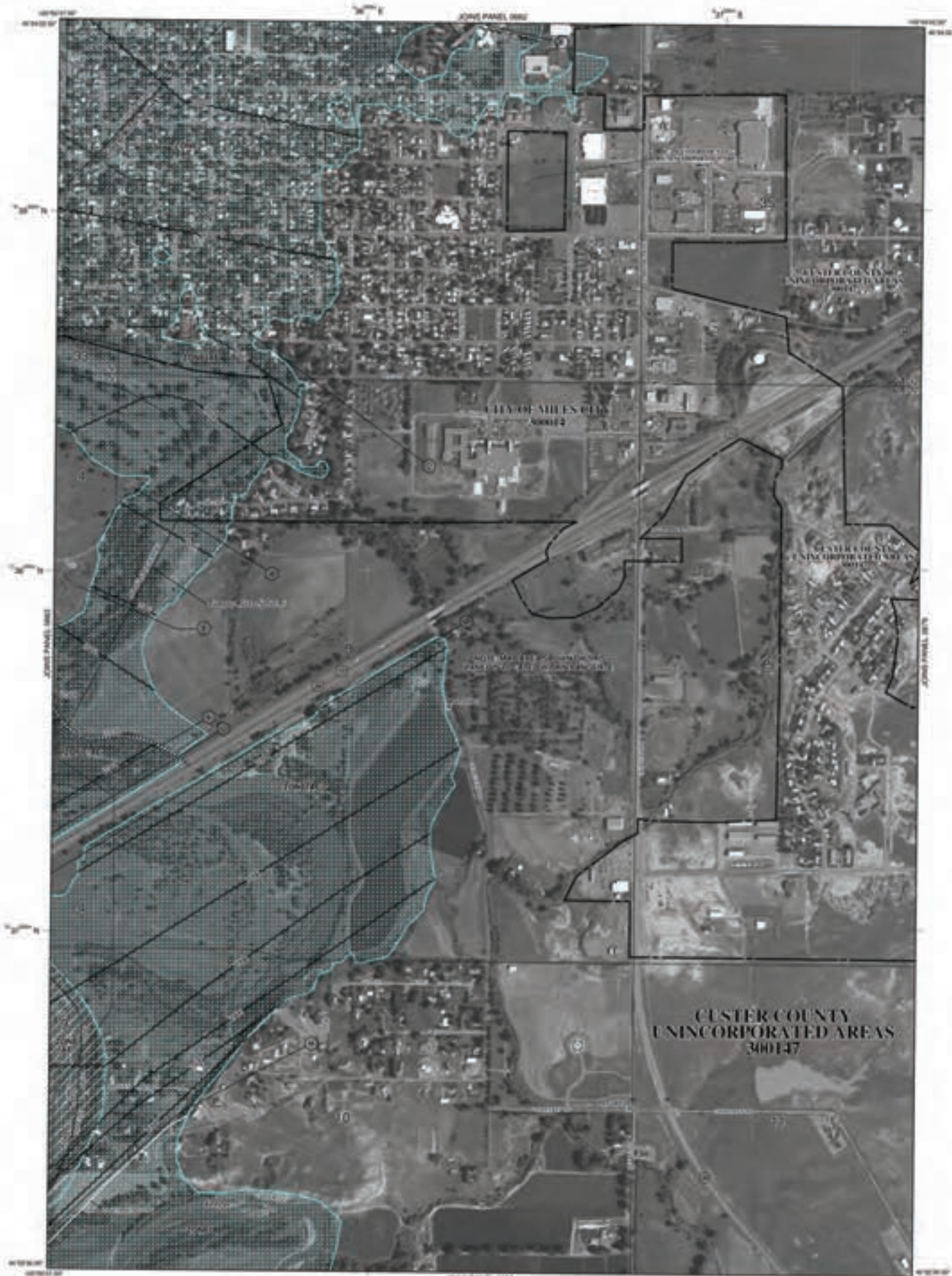
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If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA-5847 (1-877-366-5847) or visit the FEMA website at <http://www.fema.gov>.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SPFH) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood) also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Areas shown on this map are subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zone A, AE, X, V, D, and U. The base flood elevation is the water surface elevation of the 1% annual chance flood.

- Zone A:** No Base Flood Elevations determined.
- Zone AE:** Base Flood Elevations determined.
- Zone X:** Flood depths of 1 to 3 feet (usually about 1 foot on average, average depths determined). The areas of about 100 feet, average depths determined.
- Zone V:** Special Flood Hazard Areas formerly protected from the 1% annual chance flood for a flood control system that was substantially completed. Zone AE indicates that the Special Flood Hazard Areas are being reduced to provide protection from the 1% annual chance flood.
- Zone D:** Area in the protected from 1% annual chance flood by a Federal flood protection system under construction, no Base Flood Elevations determined.
- Zone U:** Coastal flood zone with velocity hazard (wave action) no Base Flood Elevations determined.
- Zone V:** Coastal flood zone with velocity hazard (wave action) no Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

Zone X: Areas of 0.2% annual chance flood, areas of 0.2% annual chance flood with average depths of less than 1 foot or with average depths less than 1 square foot, and areas protected by levees from 1% annual chance flood.

OTHER AREAS

Zone B: Areas determined to be outside the 0.2% annual chance floodplain. Areas in which flood hazards are undetermined, but possible.

CENTRAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

OPAs areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary

0.2% annual chance floodplain boundary

Floodway boundary

Zone A boundary

Zone V boundary

Boundary showing Special Flood Hazard Areas of different base flood elevations, flood depths or flood velocities

Base Flood Elevation line and water elevation in feet

(5, 95)

Base Flood Elevation value where indicated within panel boundaries in feet

* Referenced to the North American Vertical Datum of 1988 (NAVD83)

Coastal flood line

Truncated line

Geographic coordinates referenced to the North American Datum of 1983 (NAD83)

100-year (annual) Transverse Mercator grid data, zone 12

100-foot grid data, Montana State Plane coordinate system, NAD83 (2011)

Base Flood Elevation line and water elevation in feet

Base Flood Elevation value where indicated within panel boundaries in feet

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PANEL 0664D

FIRM
FLOOD INSURANCE RATE MAP
CUSTER COUNTY,
MONTANA
AND INCORPORATED AREAS

PANEL 064 OF 2375
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS	NUMBER	PANEL	SUFFIX
CUSTER COUNTY	300147	064	D
060000 (2011-12)	060000	064	D

MAP NUMBER
30017C0664D
EFFECTIVE DATE
JULY 22, 2010
 Federal Emergency Management Agency

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Control Base Flood Elevations shown on this map apply only to landward of 1/2 North American Vertical Datum of 1988 (NAVD83). Users of this report should be aware that control flood elevations are also provided in the Summary of Elevation Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Elevation Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIS.

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NOAA Information Services
4300, 94002-12
National Geodetic Survey
Silver Spring, MD 20910-9002
1310 East-West Highway
Silver Spring, MD 20910-0202

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (202) 732-3242, or visit its website at <http://www.ngs.noaa.gov>.

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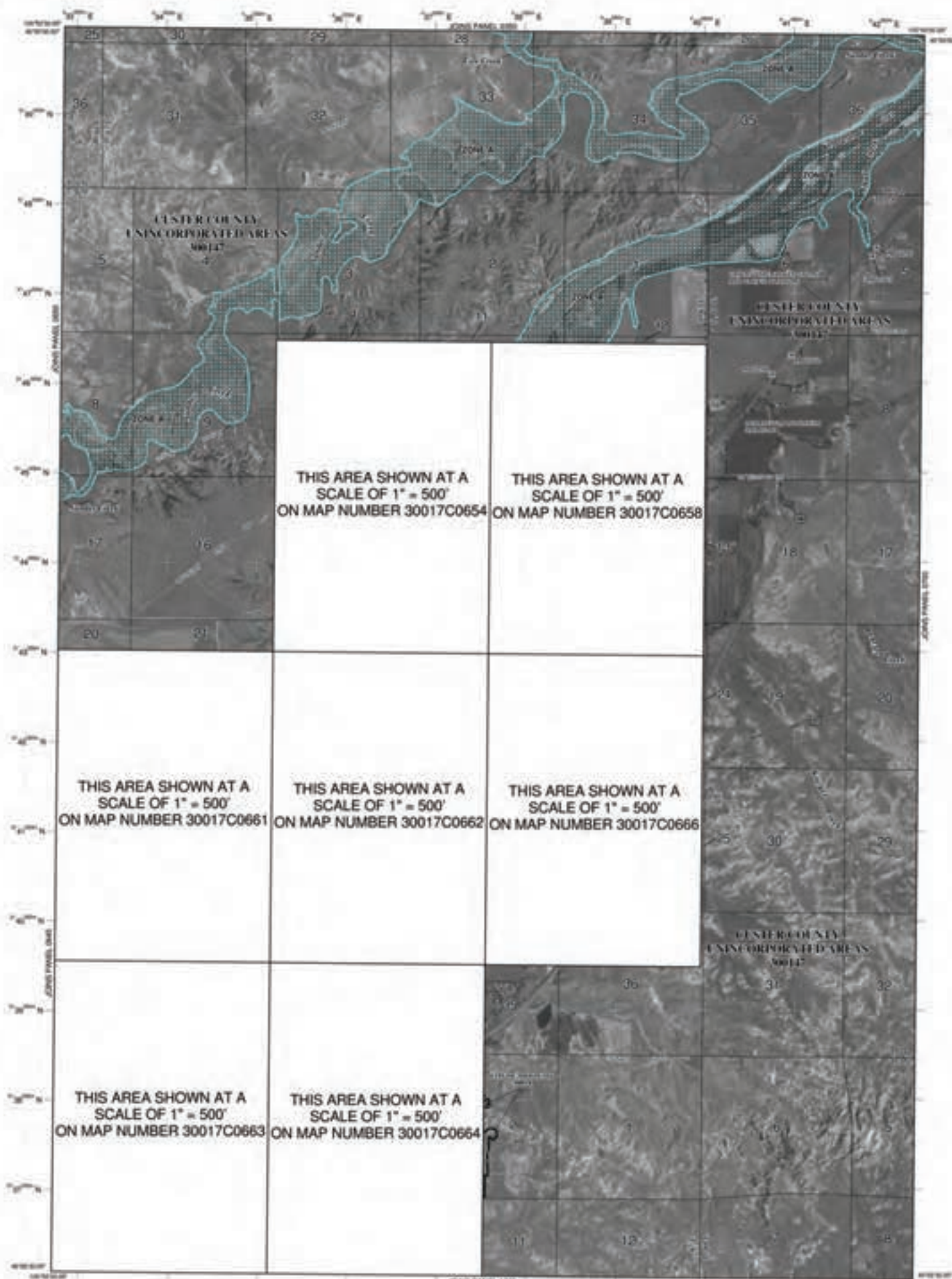
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SPECIAL FLOOD HAZARD AREAS (SPFH) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood) also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Areas in this map subject to flooding by the 1% annual chance flood, areas of Special Flood Hazard include Zone A, AE, AH, AO, AR, A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11, A12, A13, A14, A15, A16, A17, A18, A19, A20, A21, A22, A23, A24, A25, A26, A27, A28, A29, A30, A31, A32, A33, A34, A35, A36, A37, A38, A39, A40, A41, A42, A43, A44, A45, A46, A47, A48, A49, A50, A51, A52, A53, A54, A55, A56, A57, A58, A59, A60, A61, A62, A63, A64, A65, A66, A67, A68, A69, A70, A71, A72, A73, A74, A75, A76, A77, A78, A79, A80, A81, A82, A83, A84, A85, A86, A87, A88, A89, A90, A91, A92, A93, A94, A95, A96, A97, A98, A99, A100, A101, A102, A103, A104, A105, A106, A107, A108, A109, A110, A111, A112, A113, A114, A115, A116, A117, A118, A119, A120, A121, A122, A123, A124, A125, A126, A127, A128, A129, A130, A131, A132, A133, A134, A135, A136, A137, A138, A139, A140, A141, A142, A143, A144, A145, A146, A147, A148, A149, A150, A151, A152, A153, A154, A155, A156, A157, A158, 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NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources or small creeks. The community map legend should be consulted for precise updated information on flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **Special Flood Hazard Areas** (SFHAs) are shown, consult the Flood Profiles and Floodway Data and/or Summary of Floodway Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIS. Users should be aware that BFEs shown on the FIS report represent modeled water-level elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIS report for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only to seaward of 3.0 North American Vertical Datum of 1988 (NAVD 88). Users of this FIS should be aware that coastal flood elevations are also provided in the Summary of Floodway Elevations table in the Flood Insurance Study report for the jurisdiction. Elevations shown in the Summary of Floodway Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIS.

Boundaries of the **Roadways** were contacted at street sections and interpolated between street centers. The boundaries were based on satellite photography with regard to requirements of the National Flood Insurance Program. Roadway widths and other pertinent roadway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The projections used in the preparation of this map was Universal Transverse Mercator (UTM) zone 15. The horizontal datum was NAD83. Contour-splined differences in datum, spherical projection or UTM zones used in the production of FISs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the authority of the FIS.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov> or contact the National Geodetic Survey at the following address:

National Geodetic Survey
NGA, 760415
National Geodetic Survey
NCEC-3, 9000
1111 East-West Highway
Silver Spring, MD 20910-2892

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (800) 735-5048, or visit its website at <http://www.ngs.noaa.gov>.

Base map information shown on this FIS was provided in digital format by the United States Department of Agriculture. This information was georeferenced to the National Geodetic Survey's datum and projected to the North American Vertical Datum of 1988.

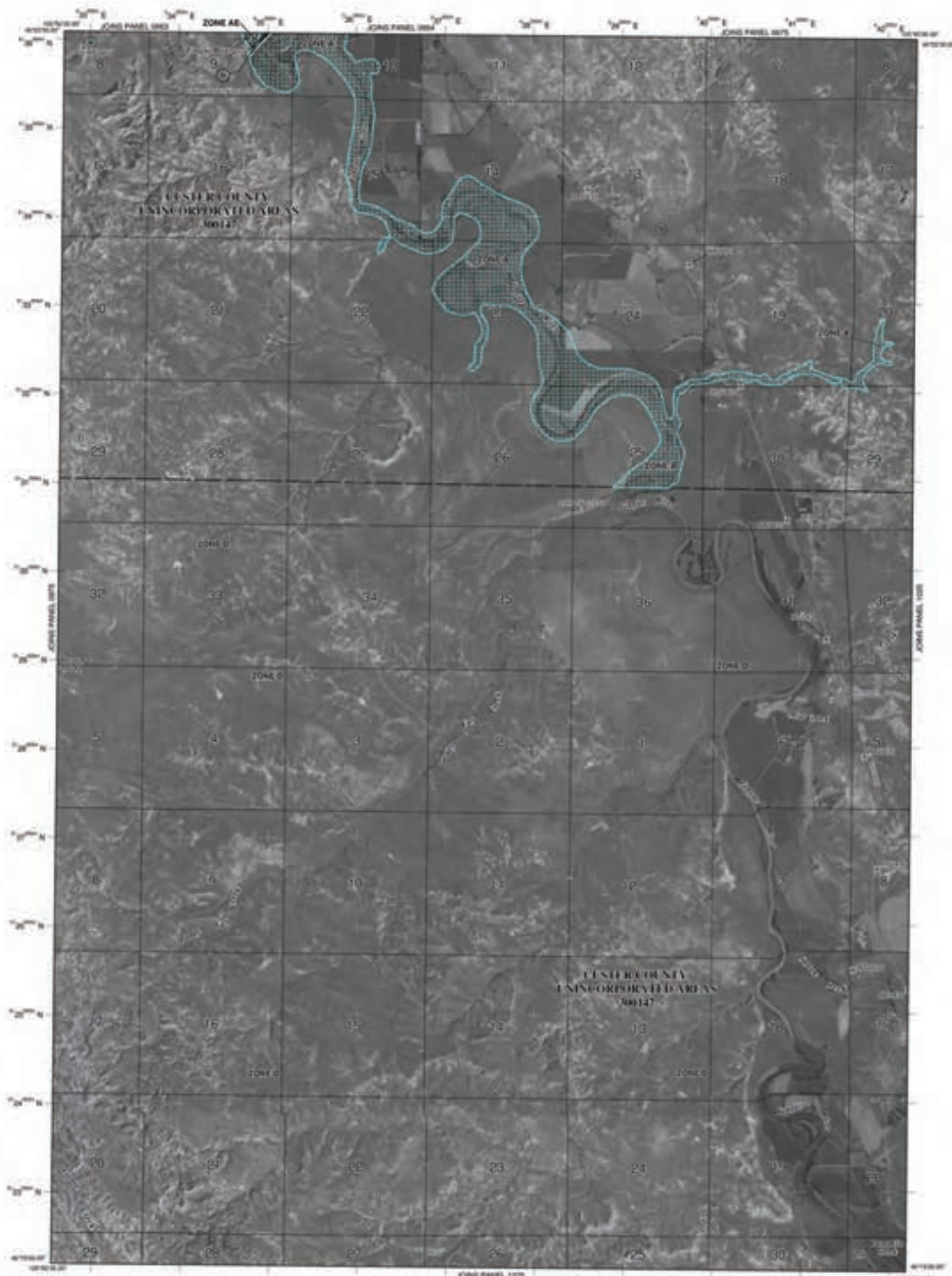
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIS for this jurisdiction. The boundaries and roadways that were transferred from the previous FIS may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report which contain authoritative hydraulic data may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or dis-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels, community map reporting districts, and a listing of communities with corresponding National Flood Insurance Program dates for each community as well as a listing of the panels in which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-6618 for information on available products associated with this FIS. Available products may include georeferenced maps of map changes, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by fax at 1-800-358-6621 and its website at <http://www.fema.gov>.

If you have **questions about this map** or **questions concerning the National Flood Insurance Program** in general, please call 1-877-FEMA-MAP (1-877-366-6247) or visit the FEMA website at <http://www.fema.gov>.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHA) SUBJECT TO FLOODING BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zone A, AE, AH, AO, A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11, A12, A13, A14, A15, A16, A17, A18, A19, A20, A21, A22, A23, A24, A25, A26, A27, A28, A29, A30, A31, A32, A33, A34, A35, A36, A37, A38, A39, A40, A41, A42, A43, A44, A45, A46, A47, A48, A49, A50, A51, A52, A53, A54, A55, A56, A57, A58, A59, A60, A61, A62, A63, A64, A65, A66, A67, A68, A69, A70, A71, A72, A73, A74, A75, A76, A77, A78, A79, A80, A81, A82, A83, A84, A85, A86, A87, A88, A89, A90, A91, A92, A93, A94, A95, A96, A97, A98, A99, A100.

- Zone A:** No Base Flood Elevation determined.
- Zone AE:** Base Flood Elevation determined.
- Zone AH:** Flood depths of 4 to 6 feet (usually areas of arroyos); Base Flood Elevation determined.
- Zone AO:** Flood depths of 1 to 3 feet (usually areas of flood plains); Base Flood Elevation determined.
- Zone A1:** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently abandoned. Special Flood Hazard Area that the former flood control system is being removed to provide protection from the 1% annual chance or greater flood.
- Zone A2:** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevation determined.
- Zone A3:** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevation determined.
- Zone A4:** Coastal flood zone with velocity hazard (wave action); Base Flood Elevation determined.

FLOODWAY AREAS IN ZONE AE
The Floodway is the channel of a stream also any adjacent floodplain areas that must be kept free of obstruction so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS
Zone B: Areas of 0.2% annual chance flood; Areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile, and areas protected by levees from 1% annual chance flood.

OTHER AREAS
Zone C: Areas determined to be outside the 0.2% annual chance floodplain; Areas in which flood heights are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS
Zone D: OTHERWISE PROTECTED AREAS (OPA)

Zone E: Areas and Off-Map areas normally located within or adjacent to Special Flood Hazard Areas.

Zone F: 1% annual chance floodplain boundary.
Zone G: 0.2% annual chance floodplain boundary.
Zone H: Floodway boundary.
Zone I: Zone I boundary.
Zone J: Zone J boundary.

Zone K: Boundary showing Special Flood Hazard Areas of different Base Flood Elevation, flood depths or flood velocities.
Zone L: Base Flood Elevation line and water elevation in feet.
Zone M: Base Flood Elevation water elevation within water elevation in feet.

Zone N: Referenced to the North American Vertical Datum of 1988 (NAVD 88).
Zone O: Zone section line.
Zone P: Truncated line.
Zone Q: Geographic coordinates referenced to the North American Datum of 1983 (NAD 83).
Zone R: 100-meter interval Transverse Mercator grid lines, zone 15.
Zone S: 100-foot grid lines; contours. State Plane coordinates, NAD83/NA 83.
Zone T: State Plane coordinates, NAD83/NA 83.

Zone U: Bench mark spot elevation in feet in lower section of map panel.
Zone V: Map key.

MAP INFORMATION
Date of Map Publication: 07-22-2016
Special Flood Hazard Boundary: FLOOD INSURANCE RATE MAP
Date of FIS: 07-22-2016
Effective Date of Flood Insurance: 07-22-2016

For community map section history prior to community mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-456-6229.



MAP SCALE 1" = 2000'

0 200 400 FEET

0 200 400 METERS

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 10000

FIRM
FLOOD INSURANCE RATE MAP
CUSTER COUNTY,
MONTANA
AND INCORPORATED AREAS

PANEL 1000 OF 3275
SEE MAP INDEX FOR FIRM PANEL LAYOUT

CONTAINS **COMMUNITY** **SUBMIT** **FILE** **SUITE**
CUSTER 30017C 10000

Notes to User: The Map Symbol shown below should be used after purchasing within the Community Map Index and should be used in response to requests for the same.

 **MAP NUMBER**
30017C10000
EFFECTIVE DATE
JULY 22, 2016

Federal Emergency Management Agency

Appendix 3: MDT Bore Samples

LOG OF BORING

MONTANA DEPARTMENT OF TRANSPORTATION
Geotechnical Section

Project Name: Tongue River - Miles City (3989M)						Project Number: BR 2-1(34)2	
Borehole Location: Sta. 71+93.83, 3.0m Lt. of Proj. Centerline						Borehole Number: 3-30-03	
Drilling Equipment: CS 2000 HT						Hammer Type: Automatic	
Drilling Fluid:						Driller: D. Mayberry	
Elevation and Datum: Ground: 719.71						Date Started: 5-13-03	
Casing:						Date Finished: 5-13-03	
Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4464.8778, X = 4090.6776. X and Y based on local Project coordinates.							

DEPTH (m)	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
0.2														ASPHALT, pavement.	0.2	Hollow stem auger with finger bit.
0.9														FILL, gravel, some sand, fine to coarse, angular to subrounded, damp, brown. A-1	0.9	
2.3														FILL, sand, some to trace gravel, fine to coarse, angular to subrounded, damp, brown and tan, very loose, occasional coal fragments. A-1	2.3	
3.5														Sandy SILT, trace gravel, trace organics, damp to moist, brown and light brown, very loose, occasional layers of fine light brown sand. A-4	3.5	
4.0														SAND, trace gravel, fine to coarse, angular to subrounded, damp to wet, mixed mineralogy, loose, occasional coal fragments, occasional cobbles, frequent fragments of red, thermally altered shale. A-1-b	4.0	
6.1														Gravelly SAND, fine to coarse, subangular to subrounded, wet, mixed mineralogy, loose. Gravel is fine to medium, subangular to subrounded, mixed lithologies. A-1-b	6.1	
7.6														GRAVEL, some to trace sand, some silt, fine to coarse, angular to subrounded, wet, gray, medium dense. A-1-a	7.6	
8.1														Bottom of Hole Elev. = 711.6m.	8.1	

Operation Types: ☐ Auger ☐ Casing Advancer ☐ Core Barrel ☐ Drive Casing		Sampler Types: ☒ Split Spoon ☐ Shelby ☐ Bulk Sample ☐ Grab Sample		☐ Penetrometer ☐ Vane Shear ☐ Special Samplers ☐ Testpit		WATER LEVEL OBSERVATIONS While Drilling ☒ 4.7 m Upon Completion of Drilling ☒ Time After Drilling _____ Depth To Water (m) _____ Remarks: _____	
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LOG OF BORING 3989M.GPJ MTDOT.GDT 9/29/04

LOG OF BORING 3989M.GPJ MTDOT.GDT 9/29/04

LOG OF BORING



Geotechnical Section

Project Name: Tongue River - Miles City (3989M)					Project Number: BR 2-1(34)2				
Borehole Location: Sta. 70+93.83, 3.1m Lt. of Proj. Centerline					Borehole Number: 3-32-03		Sheet 1 of 2		
Drilling Equipment: CS 2000 HT					Hammer Type: Automatic		Driller: D. Mayberry		Logger: P. McCann
Drilling Fluid:					Borehole Diameter (mm): 203		Date Started: 5-14-03		Date Finished: 5-14-03
Elevation and Datum: Ground: 720.68 Casing:					Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4422.9619, X = 3999.8894. X and Y based on local Project coordinates.				

DEPTH (m)	DRILL				RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY										
0.2												ASPHALT, pavement.	0.2	Hollow stem auger with finger bit.
0.8					35	18-12-22	7					FILL, sandy gravel, fine to coarse, subangular to subrounded, damp, brown. A-1	0.8	
					20	3-3-3	7					FILL, sand, trace gravel, trace clay, fine to coarse, subangular to subrounded, damp, brown and dark brown, loose to dense. A-1		
					36	2-3-2	5							
3.0					60	1-1-3	13	28	23			Sandy SILT, trace organics, damp to moist, brown and dark brown, very loose to loose. A-4	3.0	
4.3					70	1-2-3	27	---	NP				4.3	
					63	3-4-4	4					SAND, trace gravel, fine to coarse, subangular to subrounded, moist to wet, brown, reddish brown, light brown and light gray, loose to medium dense, occasional coal fragments. A-3		
					80	4-3-5	14	---	NP					
					50	1-3-3	38							
					25	1-5-8	21							
8.5					60	11-10-11	10	---	NP			Silty SAND, some gravel, fine to coarse, angular to rounded, wet, mixed mineralogy, medium dense, frequent cobbles. A-1-b	8.5	

Operation Types: ☐ Auger ☐ Casing Advancer ☐ Core Barrel ☐ Drive Casing	Sampler Types: ☒ Split Spoon ☐ Shelby ☐ Bulk Sample ☐ Grab Sample	☐ Penetrometer ☐ Vane Shear ☐ Special Samplers ☐ Testpit	WATER LEVEL OBSERVATIONS While Drilling ∇ 6.2 m · Upon Completion of Drilling ∇ 6.2 Time After Drilling _____ Depth To Water (m) _____ Remarks: _____
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LOG OF BORING



MONTANA DEPARTMENT
OF TRANSPORTATION

Geotechnical Section

Project Name: Tongue River - Miles City (3989M)						Project Number: BR 2-1(34)2									
Borehole Location: Sta. 70+93.83, 3.1m Lt. of Proj. Centerline						Borehole Number: 3-32-03			Sheet 2 of 2						
Drilling Equipment: CS 2000 HT						Hammer Type: Automatic		Driller: D. Mayberry		Logger: P. McCann					
Drilling Fluid:						Borehole Diameter (mm): 203		Date Started: 5-14-03		Date Finished: 5-14-03					
Elevation and Datum: Ground: 720.68 Casing:						Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4422.9619, X = 3999.8894. X and Y based on local Project coordinates.									
DEPTH (m)	DRILL		CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST SPT	DRY DENSITY (kN/m ³)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
	OPERATION	PRESSURE (MPa)													
					X	80	10-11-20		17				Silty SAND, cont'd.	10.7	
													SAND, trace gravel, fine, subangular to subrounded, wet, gray, dense. A-1	11.0	
													SILTSTONE, moderately weathered, soft field hardness, gray.	11.1	
													Bottom of Hole Elev. = 709.6m.		

Operation Types:		Sampler Types:		WATER LEVEL OBSERVATIONS					
	Auger		Split Spoon		Penetrometer	While Drilling	<u>6.2</u> m	Upon Completion of Drilling	<u>6.2</u> m
	Casing Advancer		Shelby		Vane Shear	Time After Drilling	_____		_____
	Core Barrel		Bulk Sample		Special Samplers	Depth To Water (m)	_____		_____
	Drive Casing		Grab Sample		Testpit	Remarks:	_____		

Project Number: BR 2-1(34)2

Borehole Number: 3-33-03

Sheet 2 of 2

Hammer:
Type: Automatic

Driller: D. Mayberry

Logger: P. McCann

Borehole
Diameter (mm): 203

Date Started: 5-20-03

Date Finished: 5-20-03

Casing:

Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4401.7357, X = 3954.2879. X and Y based on local Project coordinates.

Bottom of Hole Elev. = 706.1m.
WH denotes a zero SPT blow count with
weight of the rods and hammer.

qu = Unconfined Compressive Strength.

Page 21 of 60

MONTANA DEPARTMENT
OF TRANSPORTATION

Project Name: Tongue River - Miles City (3989M)		Project Number: BR 2-1(34)2	
Borehole Location: Sta. 69+93.0, 2.65m Lt. of Proj. Centerline		Borehole Number: 3-34-03	Sheet 1 of 2
Drilling Equipment: CS 2000 HT	Hammer Type: Automatic	Driller: D. Mayberry	Logger: P. McCann
Drilling Fluid:	Borehole Diameter (mm): 203	Date Started: 5-20-03	Date Finished: 5-20-03

Elevation and Datum: Ground: 721.70 Casing:

OG OF BORING 3989M.GPJ MTDOT.GDT 9/28/04

Remarks:

DEPTH (m)

12

14

Of
Ty

LOG OF BORING 3989M.GPJ ATDOT.GDT 9/28/04

LOG OF BORING



MONTANA DEPARTMENT
OF TRANSPORTATION

Geotechnical Section

Project Name: Tongue River - Miles City (3989M)		Project Number: BR 2-1(34)2	
Borehole Location: Sta. 69+93.0, 2.65m Lt. of Proj. Centerline		Borehole Number: 3-34-03	Sheet 2 of 2
Drilling Equipment: CS 2000 HT	Hammer: Automatic	Driller: D. Mayberry	Logger: P. McCann
Drilling Fluid:	Borehole Diameter (mm): 203	Date Started: 5-20-03	Date Finished: 5-20-03

Elevation and Datum: Ground: 721.70	Casing:	Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4380.1494, X = 3908.5995. X and Y based on local Project coordinates.
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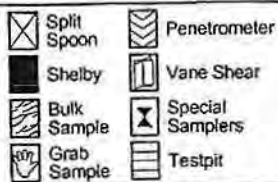
DEPTH (m)	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m ³)	MOISTURE CONTENT	LIQUID LIMIT	PLASTIC LIMIT	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
								SPT			LL	PL				
12																
						X	100	5-18-28		5	—	NP		Sandy GRAVEL, cont'd.	10.7	
														Gravelly SAND, fine to coarse, subangular to subrounded, wet, mixed mineralogy, dense to medium dense, occasional cobbles. A-1-a		
						X	5	5-15-15		25						
14		0.1	22.9	40	50									Sandy SILTSTONE, moderately weathered, soft field hardness, gray.	13.7	Switched to HQ3 coring with surface set bit and water at 13.7m.
															15.2	

Bottom of Hole Elev. = 706.5m.

Operation Types:



Sampler Types:



WATER LEVEL OBSERVATIONS

While Drilling	7.3 m	Upon Completion of Drilling	m
Time After Drilling			
Depth To Water (m)			
Remarks:			

MONTANA DEPARTMENT
OF TRANSPORTATION

Project Name: Tongue River - Miles City (3989M)		Project Number: BR 2-1(34)2	
Borehole Location: Sta. 68+98.4, 26.4m Rt. of Proj. Centerline		Borehole Number: 4-15-01	Sheet <u>1</u> of <u>5</u>
Drilling Equipment: CME 850	Hammer Type: Automatic	Driller: B. Pickett	Logger: P. McCann
Drilling Fluid:	Borehole Diameter (mm): 114	Date Started: 4-11-01	Date Finished: 4-11-01
Elevation and Datum: Ground: 718.81	Casing:		

DRILL										Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4314.0540, X = 3834.8903. X and Y based on local Project coordinates.						
DEPTH (m)	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m ³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
								SPT			LL	PL				
2						X	75	2-3-2		14 20 26	27	22		Sandy SILT, some coarse gravel, damp to wet, brown.	0.8	HW Casing advancer with rock bit.
													Sandy GRAVEL, fine to coarse, subangular to subrounded, damp, mixed lithologies.	1.5		
						X	75	1-3-4		30 10	----	NP		Silty CLAY, moist, light brown, medium stiff, low plasticity, medium toughness.	3.4	
4													SAND, fine, damp to moist, mixed mineralogy, loose.	4.6		
6						X	50	1-8-7		23 11				Sandy GRAVEL, fine to coarse, angular to subrounded, wet, mixed lithologies, medium dense, occasional cobbles/boulders, occasional layers of gray sand.	8.1	
8						X	65	6-13-16		24 7	----	NP				
10						X	70	7-12-13		7 25				SILTSTONE, severely to moderately weathered, soft field hardness, gray, weakly cemented, no reaction to 10% HCl solution.	9.8	
10		3.5	18.3	80	46	X	100	11-13-19	17.0	18				SILTSTONE/SANDSTONE, moderately to		@ 9.75 meters.

Sampler Types:	Split Spoon	Penetrometer
	Shelby	Vane Shear
	Bulk Sample	Special Samplers
	Grab Sample	Testpit

While Drilling 5 m Upon Completion of Drilling 5 4.2
Time After Drilling 16 hrs.
Depth To Water (m) 4.2
Remarks: River elevation on 4-25-01 = 714.2m.

PARTMENT
RTATION

LOG OF BORING



MONTANA DEPARTMENT
OF TRANSPORTATION

Geotechnical Section

Project Name: Tongue River - Miles City (3989M)		Project Number: BR 2-1(34)2	
Borehole Location: Sta. 68+98.4, 26.4m Rt. of Proj. Centerline		Borehole Number: 4-15-01	Sheet 2 of 5
Drilling Equipment: CME 850	Hammer Type: Automatic	Driller: B. Pickett	Logger: P. McCann
Drilling Fluid:	Borehole Diameter (mm): 114	Date Started: 4-11-01	Date Finished: 4-11-01

Elevation and Datum: Ground: 718.81 Casing:

Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4314.0540, X = 3834.8903. X and Y based on local Project coordinates.

DEPTH (m)	DRILL										GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m ³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT		
								SPT			LL	PL		
12		4.1	10.1	70	60				20.1					
14		4.1	10.1	100	32				18.9					
16		4.1	11.4	74	74				18.0					
18		2.8	13.1	6	0									
20		1.4	45.7	60	0									
		1.4	36.6	76	28				16.8					

Operation Types:	☒ Auger	☒ Split Spoon	☒ Penetrometer
	☒ Casing Advancer	☒ Shelby	☒ Vane Shear
	☒ Core Barrel	☒ Bulk Sample	☒ Special Samplers
	☒ Drive Casing	☒ Grab Sample	☒ Testpit
WATER LEVEL OBSERVATIONS			
While Drilling	4.2 m	Upon Completion of Drilling	4.2 m
Time After Drilling	16 hrs.		
Depth To Water (m)	4.2		
Remarks: River elevation on 4-25-01 = 714.2m.			

LOG OF BORING



Geotechnical Section

Project Name: Tongue River - Miles City (3989M)		Project Number: BR 2-1(34)2	
Borehole Location: Sta. 68+98.4, 26.4m Rt. of Proj. Centerline		Borehole Number: 4-15-01	Sheet 3 of 5
Drilling Equipment: CME 850	Hammer Type: Automatic	Driller: B. Pickett	Logger: P. McCann
Drilling Fluid:	Borehole Diameter (mm): 114	Date Started: 4-11-01	Date Finished: 4-11-01

Elevation and Datum: Ground: 718.81	Casing:	Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4314.0540, X = 3834.8903. X and Y based on local Project coordinates.
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DEPTH (m)	DRILL				CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m ³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
	OPERATION	PRESSURE (MPa)	RATE (mph)	SPT													
22	0.7	45.7	56	0											SANDSTONE, cont'd. @ 19.8m, qu = 1179 kPa		
24	0.7	61.0	32	11					16.8						@ 22.9m, qu = 1644 kPa		
26	2.4	30.5	100	32											@ 25.9m, qu = 2042 kPa		
28	0.7	45.7	52	36					16.8						@ 27.7m, qu = 1012 kPa		
30	1.4	36.6	100	70					16.7								
	2.4	36.6	100	80													
	0.0	36.6	60	30					20.0								

Operation Types: ☐ Auger ☐ Casing Advancer ☐ Core Barrel ☐ Drive Casing	Sampler Types: ☐ Split Spoon ☐ Shelby ☐ Bulk Sample ☐ Grab Sample	☐ Penetrometer ☐ Vane Shear ☐ Special Samplers ☐ Testpit	WATER LEVEL OBSERVATIONS While Drilling ☒ m Upon Completion of Drilling ☒ 4.2 Time After Drilling 16 hrs. Depth To Water (m) 4.2 Remarks: River elevation on 4-25-01 = 714.2m.
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PARTIAL
ROTATION

LOG OF BORING



MONTANA DEPARTMENT
OF TRANSPORTATION

Geotechnical Section

Project Name: Tongue River - Miles City (3989M)		Project Number: BR 2-1(34)2	
Borehole Location: Sta. 68+98.4, 26.4m Rl. of Proj. Centerline		Borehole Number: 4-15-01	Sheet 4 of 5
Drilling Equipment: CME 850	Hammer Type: Automatic	Driller: B. Pickett	Logger: P. McCann
Drilling Fluid:	Borehole Diameter (mm): 114	Date Started: 4-11-01	Date Finished: 4-11-01

Elevation and Datum: Ground: 718.81 Casing:

Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4314.0540, X = 3834.8903. X and Y based on local Project coordinates.

DEPTH (m)	DRILL				RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m ³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY										
32		1.2	36.6	80	70		24.1					SANDSTONE, cont'd.		
												@ 30.5m, qu = 8373 kPa		
34		0.7	45.7	100	56							@ 32.3m, qu = 45,196 kPa		
												Occasional coal fragments		
36		1.4	61.0	56	36		16.2					@ 35.4m, qu = 1010 kPa		
												Occasional coal partings and seams		
38		3.5	15.2	92	64									
40		3.5	36.6	90	20									

Operation Types:	☒ Auger ☐ Casing Advancer ☐ Core Barrel ☐ Drive Casing	Sampler Types:	☒ Split Spoon ☐ Shelby ☐ Bulk Sample ☐ Grab Sample	☐ Penetrometer ☐ Vane Shear ☐ Special Samplers ☐ Testpit
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WATER LEVEL OBSERVATIONS

While Drilling 4.2 m Upon Completion of Drilling 4.2 m
 Time After Drilling 16 hrs.
 Depth To Water (m) 4.2
 Remarks: River elevation on 4-25-01 = 714.2m.

LOG OF BORING



Geotechnical Section

Project Name: Tongue River - Miles City (3989M)						Project Number: BR 2-1(34)2							
Borehole Location: Sta. 68+98.4, 26.4m Rt. of Proj. Centerline						Borehole Number: 4-15-01							
Drilling Equipment: CME 850						Hammer Type: Automatic							
Drilling Fluid:						Driller: B. Pickett							
Elevation and Datum: Ground: 718.81						Logger: P. McCann							
Casing:						Borehole Diameter (mm): 114							
						Date Started: 4-11-01							
						Date Finished: 4-11-01							
Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4314.0540, X = 3834.8903. X and Y based on local Project coordinates.													
DEPTH (m)	DRILL			RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
	OPERATION	PRESSURE (MPa)	RATE (mph)										
1											SANDSTONE, cont'd.	40.2	
Bottom of Hole Elev. = 678.6m qu = Unconfined Compressive Strength													

Operation Types:

- ☒ Auger
- ☐ Casing Advancer
- ☐ Core Barrel
- ☐ Drive Casing

Sampler Types:

- ☒ Split Spoon
- ☐ Shelby
- ☐ Bulk Sample
- ☐ Grab Sample

Penetrometer

- ☐ Vane Shear
- ☐ Special Samplers
- ☐ Testpit

WATER LEVEL OBSERVATIONS

While Drilling m Upon Completion of Drilling m

Time After Drilling 16 hrs.

Depth To Water (m) 4.2

Remarks: River elevation on 4-25-01 = 714.2m.

LOG OF BORING

MONTANA DEPARTMENT
OF TRANSPORTATION

Geotechnical Section

Project Name: Tongue River - Miles City (3989M)		Project Number: BR 2-1(34)2	
Borehole Location: Sta. 69+91.4, 17.1m Rt. of Proj. Centerline		Borehole Number: 4-16-01	Sheet 1 of 5
Drilling Equipment: CME 850	Hammer Type: Automatic	Driller: B. Pickett	Logger: P. McCann
Drilling Fluid:	Borehole Diameter (mm): 114	Date Started: 4-16-01	Date Finished: 4-17-01

Elevation and Datum: Ground: 720.43 Casing:

Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4361.5589, X = 3915.4312. X and Y based on local Project coordinates.

DEPTH (m)	DRILL										GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m ³)	MOISTURE CONTENT (%)	LIQUID LIMIT			
								SPT			LL	PL		
0.2													0.2	HW casing advancer with rock bit.
2.0							60	4-3-4	12					TOPSOIL, silty clay, some organics, damp, brown. SILT, trace organics, dry to damp, brown, loose.
3.0							60	1-2-3	26	28	25			Clayey SILT, trace gravel, trace organics, moist, brown and gray, loose to very loose.
4.0							80	2-1-2	29					
5.0							10	2-3-3	30	35	22			
6.0							100	1-1-0	33	16	NP			Sandy GRAVEL, some to trace silt, trace organics, fine to coarse, subangular to subrounded, moist to wet, mixed lithologies, loose to very dense, occasional cobbles/boulders.
7.0							50	5-8-7	14	11	NP			
8.0							33	6-7-6	11					
9.0							100	1-4-5	19	14				
10.0							75	16-18-23	7	6				
							75	30-28-20	7		NP			

Operation Types:

- ☐ Auger
☐ Casing Advancer
☐ Core Barrel
☐ Drive Casing

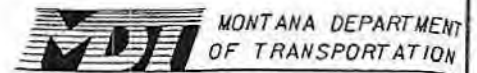
Sampler Types:

- ☒ Split Spoon
☐ Shelby
☐ Bulk Sample
☐ Grab Sample
☐ Penetrometer
☐ Vane Shear
☐ Special Samplers
☐ Testpit

WATER LEVEL OBSERVATIONS

While Drilling 5.2 m Upon Completion of Drilling 5.2 m
 Time After Drilling 17.5 hrs.
 Depth To Water (m) 5.8
 Remarks: River elevation on 4-25-01 = 714.2m.

LOG OF BORING



Geotechnical Section

Project Name: Tongue River - Miles City (3989M)						Project Number: BR 2-1(34)2	
Borehole Location: Sta. 69+91.4, 17.1m Rt. of Proj. Centerline						Borehole Number: 4-16-01	
Drilling Equipment: CME 850						Hammer Type: Automatic	
Drilling Fluid:						Driller: B. Pickett	
Elevation and Datum: Ground: 720.43 Casing:						Logger: P. McCann	
Borehole Diameter (mm): 114						Date Started: 4-16-01	
						Date Finished: 4-17-01	
Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4361.5589, X = 3915.4312. X and Y based on local Project coordinates.							

DEPTH (m)	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
11.3							10	13-18-36	7					Sandy GRAVEL, cont'd.		
12.8		4.1	8.3	80	64		100	30-38-40	17.9	16				SILTSTONE, severely to freshly weathered, soft to medium field hardness, gray and bluish gray, weakly cemented.		@ 12.8 meters, switched to HQ3 coring with surface set bit and water.
14.3		4.1	11.4	100	88				17.6					@ 14.3m, qu = 312 kPa		
15.9		4.8	11.4	100	100				17.0					@ 15.9m, qu = 512 kPa		
16.8														@ 16.8m, qu = 258 kPa		
17.2		3.5	30.5	80	20									SANDSTONE, fine grained, freshly weathered, very soft to hard field hardness, gray and light gray, weakly cemented, occasional coal partings and seams.		
20.0		2.1	30.5	54	0											

Operation Types: ☐ Auger ☐ Casing Advancer ☐ Core Barrel ☐ Drive Casing	Sampler Types: ☐ Split Spoon ☐ Shelby ☐ Bulk Sample ☐ Grab Sample	☐ Penetrometer ☐ Vane Shear ☐ Special Samplers ☐ Testpit	WATER LEVEL OBSERVATIONS While Drilling <u>5.2</u> m Upon Completion of Drilling <u>5.2</u> m Time After Drilling <u>17.5 hrs.</u> Depth To Water (m) <u>5.8</u> Remarks: River elevation on 4-25-01 = 714.2m.
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LOG OF BORING



MONTANA DEPARTMENT
OF TRANSPORTATION

Geotechnical Section

Project Name: Tongue River - Miles City (3989M)		Project Number: BR 2-1(34)2	
Borehole Location: Sta. 69+91.4, 17.1m Rt. of Proj. Centerline		Borehole Number: 4-16-01	Sheet 3 of 5
Drilling Equipment: CME 850	Hammer: Automatic	Driller: B. Pickett	Logger: P. McCann
Drilling Fluid:	Borehole Diameter (mm): 114	Date Started: 4-16-01	Date Finished: 4-17-01

Elevation and Datum: Ground: 720.43 Casing:

Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4361.5589, X = 3915.4312. X and Y based on local Project coordinates.

DEPTH (m)	DRILL				RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m ³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	GRAPHIC LOG
	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY							
				ROCK QUALITY DESIGNATION (RQD)	SAMPLE	SPT					
22	3.5	26.1	54	8			16.6				
24	4.1	18.3	74	14							
26	4.8	18.3	74	22							
28	4.1	18.3	70	40							
30	4.1	9.1	100	90			17.5				
32	0.7	36.6	92	76			16.6				
34	0.7	45.7	86	70			19.8				

MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
SANDSTONE, cont'd.		
@ 22.0m, qu = 2233 kPa		
@ 27.4m, qu = 1533 kPa		
@ 29.3m, qu = 1387 kPa		

Operation Types:	☒ Auger ☐ Casing Advancer ☐ Core Barrel ☐ Drive Casing	Sampler Types: ☒ Split Spoon ☐ Shelby ☐ Bulk Sample ☐ Grab Sample	☐ Penetrometer ☐ Vane Shear ☐ Special Samplers ☐ Testpit
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WATER LEVEL OBSERVATIONS

While Drilling 5.2 m Upon Completion of Drilling 5.2 m
 Time After Drilling 17.5 hrs.
 Depth To Water (m) 5.8
 Remarks: River elevation on 4-25-01 = 714.2m.

LOG OF BORING



Geotechnical Section

Project Name: Tongue River - Miles City (3989M)		Project Number: BR 2-1(34)2	
Borehole Location: Sta. 69+91.4, 17.1m Rt. of Proj. Centerline		Borehole Number: 4-16-01	Sheet 4 of 5
Drilling Equipment: CME 850	Hammer Type: Automatic	Driller: B. Pickett	Logger: P. McCann
Drilling Fluid:	Borehole Diameter (mm): 114	Date Started: 4-16-01	Date Finished: 4-17-01
Elevation and Datum: Ground: 720.43	Casing:		

Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4361.5589, X = 3915.4312. X and Y based on local Project coordinates.

DEPTH (m)	DRILL				RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m ³)	MOISTURE CONTENT (%)	LIQUID LIMIT		GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY					LL	PL				
32		0.7	45.7	95	62		16.6					SANDSTONE, cont'd.		
												@ 31.1m, qu = 1939 kPa		
34		4.1	12.8	90	76							@ 32.6m, qu = 1375 kPa		
36		1.0	36.6	84	60							@ 35.1m, qu = 1575 kPa		
36		1.4	36.6	78	60		16.3					@ 36.9m, qu = 1385 kPa		
38		4.1	8.2	92	70		17.3					SILTSTONE, freshly weathered, soft to medium field hardness, gray, weakly cemented.	37.3	
												@ 37.8m, qu = 1226 kPa	38.3	
												SANDSTONE, fine grained, freshly weathered, very soft to medium field hardness, gray and light gray, weakly cemented, occasional coal partings.		
40		4.1	15.2	70	58		16.5					@ 39.6m, qu = 1978 kPa		

Operation Types: ☒ Auger ☐ Casing Advancer ☐ Core Barrel ☐ Drive Casing	Sampler Types: ☒ Split Spoon ☐ Shelby ☐ Bulk Sample ☐ Grab Sample	☐ Penetrometer ☐ Vane Shear ☐ Special Samplers ☐ Testpit
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WATER LEVEL OBSERVATIONS

While Drilling 5.2 m Upon Completion of Drilling 5.2 m
 Time After Drilling 17.5 hrs.
 Depth To Water (m) 5.8
 Remarks: River elevation on 4-25-01 = 714.2m.

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LOG OF BORING

Project Name: Tongue River - Miles City (3989M)				Project Number: BR 2-1(34)2													
Borehole Location: Sta. 69+91.4, 17.1m Rt. of Proj. Centerline				Borehole Number: 4-16-01	Sheet 5 of 5												
Drilling Equipment: CME 850		Hammer Type: Automatic	Driller: B. Pickett	Logger: P. McCann													
Drilling Fluid:		Borehole Diameter (mm): 114	Date Started: 4-16-01	Date Finished: 4-17-01													
Elevation and Datum: Ground: 720.43		Casing:															
Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4361.5589, X = 3915.4312. X and Y based on local Project coordinates.																	
DEPTH (m)	DRILL	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m ³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
									SPT			LL	PL		SANDSTONE, cont'd.	40.2	

Bottom of Hole Elev. = 680.2m
qu = Unconfined Compressive Strength

Operation Types:	☒ Auger	Sampler Types:	☒ Split Spoon	☒ Penetrometer	WATER LEVEL OBSERVATIONS	
	☒ Casing Advancer		☒ Shelby	☒ Vane Shear	While Drilling	Upon Completion of Drilling
	☒ Core Barrel		☒ Bulk Sample	☒ Special Samplers	Time After Drilling	
	☒ Drive Casing		☒ Grab Sample	☒ Testpit	Depth To Water (m)	
					Remarks: River elevation on 4-25-01 = 714.2m.	

LOG OF BORING



Geotechnical Section

Project Name: Tongue River - Miles City (3989M) Project Number: BR 2-1(34)2

Borehole Location: Sta. 70+58.8, 15.4m Rt. of Proj. Centerline Borehole Number: 4-17-01 Sheet 1 of 1

Drilling Equipment: CME 850 Hammer Type: Automatic Driller: B. Pickett Logger: P. McCann

Drilling Fluid: Borehole Diameter (mm): 203 Date Started: 4-18-01 Date Finished: 4-18-01

Elevation and Datum: Ground: 718.29 Casing:

Notes: Legal Description: 08N47E33CAB. Stationing, offset and elevation provided by District Survey. Y = 4413.1800, X = 4033.7195. X and Y based on local Project coordinates.

DEPTH (m)	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
								SPT			LL	PL				
0.3							60	1-2-2	17					TOPSOIL, silt, trace organics, dry to damp, brown.	0.3	Hollow stem auger with finger bit.
0.8							75	3-2-2	26					Sandy SILT, some clay, trace organics, damp to moist, brown, very loose. A-4	0.8	
1.5							100	1-3-3	6		NP			SILT, trace clay, trace organics, damp to moist, brown, very loose. A-4	1.5	
1.8							70	2-3-3	12					SAND, trace gravel, fine to coarse, subangular to subrounded, damp to moist, mixed mineralogy, loose. A-1-b	1.8	
2.0							75	3-2-2	8					Gravelly SAND, fine to coarse, subangular to subrounded, moist to wet, mixed mineralogy, loose to very loose, occasional coal fragments. Gravel is fine to coarse, subangular to subrounded, mixed lithologies, occasional cobbles. A-1-b	2.0	
3.0							30	2-1-1	16							
4.0							5	2-4-5	16							
6.1							30	3-2-2	18							
6.1							40	12-34-28	9		NP			Sandy GRAVEL, fine to coarse, angular to subrounded, wet, mixed lithologies, very loose. Sand is fine to coarse, subangular to subrounded, mixed mineralogy. A-1-a	6.1	
7.6							25	3-7-14	23		NP			SANDSTONE, fine grained, severely weathered, very soft field hardness, gray, very weakly cemented.	7.6	
8.1														Bottom of Hole Elev. = 710.2m	8.1	

Operation Types:



Sampler Types:



WATER LEVEL OBSERVATIONS

While Drilling 3.3 m Upon Completion of Drilling 4.4 m

Time After Drilling 0.5 hrs.

Depth To Water (m) 3.5

Remarks: River elevation on 4-25-01 = 714.2m.

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Project Name: Tongue River - Miles City (3989M)										Project Number: BR 2-1(34)2																																																																																																																																																																																																																																																						
Borehole Location: Sta. 71+20.5, 19.9m Rt. of Proj. Centerline										Borehole Number: 4-18-01																																																																																																																																																																																																																																																						
Drilling Equipment: CME 850										Hammer Type: Automatic																																																																																																																																																																																																																																																						
Drilling Fluid:										Driller: B. Pickett																																																																																																																																																																																																																																																						
Elevation and Datum: Ground: 718.26 Casing:										Logger: P. McCann																																																																																																																																																																																																																																																						
Borehole Diameter (mm): 203										Date Started: 4-18-01																																																																																																																																																																																																																																																						
										Date Finished: 4-18-01																																																																																																																																																																																																																																																						
Notes: Legal Description: 08N47E33CAB. Stationing, offset and elevation provided by District Survey. Y = 4391.4289, X = 3975.8959. X and Y based on local Project coordinates.																																																																																																																																																																																																																																																																
<table border="1"><thead><tr><th rowspan="2">DEPTH (m)</th><th rowspan="2">OPERATION</th><th rowspan="2">PRESSURE (MPa)</th><th rowspan="2">RATE (mph)</th><th rowspan="2">CORE PERCENT RECOVERY</th><th rowspan="2">ROCK QUALITY DESIGNATION (RQD)</th><th rowspan="2">SAMPLE</th><th rowspan="2">RECOVERY (%)</th><th rowspan="2">STANDARD PENETRATION TEST</th><th rowspan="2">DRY DENSITY (kN/m³)</th><th rowspan="2">MOISTURE CONTENT (%)</th><th rowspan="2">LIQUID LIMIT</th><th rowspan="2">PLASTIC LIMIT</th><th rowspan="2">GRAPHIC LOG</th><th rowspan="2">MATERIAL DESCRIPTION</th><th rowspan="2">DEPTH (m)</th><th rowspan="2">REMARKS</th></tr><tr><th>SPT</th><th>LL</th><th>PL</th></tr></thead><tbody><tr><td>0.2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>2-3-4</td><td>19</td><td></td><td></td><td></td><td></td><td>TOPSOIL, clayey silt, some to trace organics, damp, brown.</td><td>0.2</td><td rowspan="10">Hollow stem augers with finger bit.</td></tr><tr><td>0.5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>1-3-4</td><td>10</td><td></td><td></td><td></td><td></td><td>Clayey SILT, trace gravel, trace organics, damp, brown, loose. A-4</td><td>0.5</td></tr><tr><td>1.0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>2-1-2</td><td>24</td><td></td><td></td><td></td><td></td><td>SILT, some organics, trace sand, trace clay, damp, brown, very loose to loose. A-4</td><td>1.0</td></tr><tr><td>1.5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>4-3-3</td><td>21</td><td></td><td></td><td>NP</td><td></td><td></td><td>1.5</td></tr><tr><td>2.0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>1-1-2</td><td>30</td><td></td><td></td><td></td><td></td><td></td><td>2.0</td></tr><tr><td>2.5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>1-2-3</td><td>17</td><td></td><td></td><td></td><td></td><td></td><td>2.5</td></tr><tr><td>3.0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>3-3-6</td><td>17</td><td></td><td></td><td>NP</td><td></td><td>Gravelly SAND, fine to coarse, subangular to subrounded, wet, mixed mineralogy, loose. Gravel is fine to coarse, subangular to subrounded, mixed lithologies. A-1</td><td>3.0</td></tr><tr><td>4.0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>4.0</td></tr><tr><td>5.0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>2-1-0</td><td></td><td></td><td></td><td></td><td></td><td>Sandy GRAVEL, fine to coarse, subangular to subrounded, wet, mixed lithologies, very loose to dense, occasional cobbles. Sand is fine to coarse, subangular to subrounded, mixed mineralogy. A-1-b</td><td>5.0</td></tr><tr><td>6.0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>6.0</td></tr><tr><td>7.0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>8-20-27</td><td>8</td><td></td><td></td><td>NP</td><td></td><td></td><td>7.0</td></tr><tr><td>8.0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>8.0</td></tr><tr><td>9.0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>9-15-30</td><td>22</td><td></td><td></td><td></td><td></td><td>SILTSTONE/SANDSTONE, severely to moderately weathered, soft field hardness, gray, weakly cemented.</td><td>9.0</td></tr><tr><td>10.0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>16</td><td></td><td></td><td></td><td></td><td>Bottom of Hole Elev. = 710.2m</td><td>10.0</td></tr></tbody></table>												DEPTH (m)	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m ³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS	SPT	LL	PL	0.2								2-3-4	19					TOPSOIL, clayey silt, some to trace organics, damp, brown.	0.2	Hollow stem augers with finger bit.	0.5								1-3-4	10					Clayey SILT, trace gravel, trace organics, damp, brown, loose. A-4	0.5	1.0								2-1-2	24					SILT, some organics, trace sand, trace clay, damp, brown, very loose to loose. A-4	1.0	1.5								4-3-3	21			NP			1.5	2.0								1-1-2	30						2.0	2.5								1-2-3	17						2.5	3.0								3-3-6	17			NP		Gravelly SAND, fine to coarse, subangular to subrounded, wet, mixed mineralogy, loose. Gravel is fine to coarse, subangular to subrounded, mixed lithologies. A-1	3.0	4.0															4.0	5.0								2-1-0						Sandy GRAVEL, fine to coarse, subangular to subrounded, wet, mixed lithologies, very loose to dense, occasional cobbles. Sand is fine to coarse, subangular to subrounded, mixed mineralogy. A-1-b	5.0	6.0															6.0	7.0								8-20-27	8			NP			7.0	8.0															8.0	9.0								9-15-30	22					SILTSTONE/SANDSTONE, severely to moderately weathered, soft field hardness, gray, weakly cemented.	9.0	10.0									16					Bottom of Hole Elev. = 710.2m	10.0
DEPTH (m)	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m ³)	MOISTURE CONTENT (%)	LIQUID LIMIT																		PLASTIC LIMIT	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS																																																																																																																																																																																																																															
												SPT	LL	PL																																																																																																																																																																																																																																																		
0.2								2-3-4	19					TOPSOIL, clayey silt, some to trace organics, damp, brown.	0.2	Hollow stem augers with finger bit.																																																																																																																																																																																																																																																
0.5								1-3-4	10					Clayey SILT, trace gravel, trace organics, damp, brown, loose. A-4	0.5																																																																																																																																																																																																																																																	
1.0								2-1-2	24					SILT, some organics, trace sand, trace clay, damp, brown, very loose to loose. A-4	1.0																																																																																																																																																																																																																																																	
1.5								4-3-3	21			NP			1.5																																																																																																																																																																																																																																																	
2.0								1-1-2	30						2.0																																																																																																																																																																																																																																																	
2.5								1-2-3	17						2.5																																																																																																																																																																																																																																																	
3.0								3-3-6	17			NP		Gravelly SAND, fine to coarse, subangular to subrounded, wet, mixed mineralogy, loose. Gravel is fine to coarse, subangular to subrounded, mixed lithologies. A-1	3.0																																																																																																																																																																																																																																																	
4.0															4.0																																																																																																																																																																																																																																																	
5.0								2-1-0						Sandy GRAVEL, fine to coarse, subangular to subrounded, wet, mixed lithologies, very loose to dense, occasional cobbles. Sand is fine to coarse, subangular to subrounded, mixed mineralogy. A-1-b	5.0																																																																																																																																																																																																																																																	
6.0															6.0																																																																																																																																																																																																																																																	
7.0								8-20-27	8			NP			7.0																																																																																																																																																																																																																																																	
8.0															8.0																																																																																																																																																																																																																																																	
9.0								9-15-30	22					SILTSTONE/SANDSTONE, severely to moderately weathered, soft field hardness, gray, weakly cemented.	9.0																																																																																																																																																																																																																																																	
10.0									16					Bottom of Hole Elev. = 710.2m	10.0																																																																																																																																																																																																																																																	

Operation Types:

- ☐ Auger
- ☐ Casing Advancer
- ☐ Core Barrel
- ☐ Drive Casing

Sampler Types:

- ☐ Split Spoon
- ☐ Shelby
- ☐ Bulk Sample
- ☐ Grab Sample
- ☐ Penetrometer
- ☐ Vane Shear
- ☐ Special Samplers
- ☐ Testpit

WATER LEVEL OBSERVATIONS

While Drilling	3.2 m	Upon Completion of Drilling	4.3 m
Time After Drilling	0.5 hrs.		
Depth To Water (m)	3.4		

Remarks: River elevation on 4-25-01 = 714.2m.

LOG OF BORING



Geotechnical Section

Project Name: Tongue River - Miles City (3989M)				Project Number: BR 2-1(34)2			
Borehole Location: Sta. 71+81.6, 15.7m Rt. of Proj. Centerline				Borehole Number: 4-19-01		Sheet 1 of 1	
Drilling Equipment: CME 850				Hammer Type: Automatic		Driller: B. Pickett	
Drilling Fluid:				Borehole Diameter (mm): 203		Date Started: 4-18-01	
Elevation and Datum: Ground: 718.17				Casing:		Date Finished: 4-18-01	
Notes: Legal Description: 08N47E33CAB. Stationing, offset and elevation provided by District Survey. Y = 4442.6554, X = 4087.4510. X and Y based on local Project coordinates.							

DEPTH (m)	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (ROD)	SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
0.2							40	2-1-2		26				TOPSOIL, silt, some organics, trace clay, damp, brown.	0.2	Hollow stem auger with finger bit.
0.5							100	1-1-2		35	----	NP		SILT, trace clay, trace organics, damp, brown, very loose. A-4	0.5	
1.2							50	3-3-3		7				SILT, some organics, damp, brown, loose. A-4	1.2	
							75	1-2-3		5	----	NP		Gravelly SAND, fine to coarse, subangular to subrounded, damp to wet, mixed mineralogy, loose, occasional coal fragments. Gravel is fine to coarse, subangular to subrounded, mixed lithologies. A-1		
							100	4-4-3		5						
							100	4-3-3		19						
							100	5-4-5		6						
							100	2-5-4		17						
							100			23	----	NP				

Bottom of Hole Elev. = 714.5m

LOG OF BORING 3989M.GPJ MTDOT.GDT 6/28/04

Operation Types:	☐ Auger ☐ Casing Advancer ☐ Core Barrel ☐ Drive Casing	Sampler Types:	☒ Split Spoon ☐ Shelby ☐ Bulk Sample ☐ Grab Sample ☐ Penetrometer ☐ Vane Shear ☐ Special Samplers ☐ Testpit
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WATER LEVEL OBSERVATIONS

While Drilling 3.0 m . Upon Completion of Drilling 3.0 m
 Time After Drilling _____
 Depth To Water (m) _____
 Remarks: River elevation on 4-25-01 = 714.2m.

DEPARTMENT OF TRANSPORTATION

LOG OF BORING

Project Name: Tongue River - Miles City (3989M)		Project Number: BR 2-1(34)2	
Borehole Location: Sta. 72+64.8, 17.3m Rt. of Proj. Centerline		Borehole Number: 4-20-01	Sheet 1 of 1
Drilling Equipment: CME 850	Hammer Type: Automatic	Driller: B. Pickett	Logger: P. McCann
Drilling Fluid:	Borehole Diameter (mm): 203	Date Started: 4-18-01	Date Finished: 4-18-01

Elevation and Datum: Ground: 718.32 Casing:

Notes: Legal Description: 08N47E33CAB. Stationing, offset and elevation provided by District Survey. Y = 4476.1698, X = 4163.6075. X and Y based on local Project coordinates.

DEPTH (m)	DRILL										MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m ³)	MOISTURE CONTENT (%)			
								SPT					
							75	1-0-1		16		0.2	Hollow stem auger with finger bit.
							100	1-3-4		28	26	0.9	
							100	4-5-6		22		1.2	
							75	5-5-5		8	NP	1.8	
													TOPSOIL, silt, some organics, dry to damp, brown. SILT, some sand, trace organics, dry to damp, brown, very loose to loose, frequent coal fragments. Sand is fine to coarse, subangular to subrounded, mixed mineralogy. A-4 Silty CLAY, moist, brown, stiff, high plasticity. A-6 Gravelly SAND, fine to coarse, subangular to subrounded, moist, mixed mineralogy, medium dense to loose. Gravel is fine to coarse, subangular to subrounded, mixed lithologies. A-1-b Bottom of Hole Elev. = 716.5m

Operation Types: ☐ Auger ☐ Casing Advancer ☐ Core Barrel ☐ Drive Casing	Sampler Types: ☐ Split Spoon ☐ Shelby ☐ Bulk Sample ☐ Grab Sample ☐ Penetrometer ☐ Vane Shear ☐ Special Samplers ☐ Testpit	WATER LEVEL OBSERVATIONS While Drilling ☐ m Upon Completion of Drilling ☐ m Time After Drilling _____ Depth To Water (m) _____ Remarks: Groundwater not encountered.
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LOG OF BORING



Project Name: Tongue River - Miles City (3989M)		Project Number: BR 2-1(34)2	
Borehole Location: Sta. 69+47.1, 7.3m Lt. of Proj. Centerline		Borehole Number: 4-21-01	Sheet 1 of 3
Drilling Equipment: CME 850	Hammer Type: Automatic	Driller: B. Pickett	Logger: P. McCann
Drilling Fluid:	Borehole Diameter (mm): 114	Date Started: 4-24-01	Date Finished: 4-24-01
Elevation and Datum: Ground: 714.24	Casing: 714.39	Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4365.1128, X = 3864.9812. X and Y based on local Project coordinates.	

DEPTH (m)	DRILL				SAMPLE	RECOVERY (%)	STANDARD PENETRATION TEST SPT	DRY DENSITY (kN/m ³)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY											
2					X	40	2-3-3	17	---	NP			Sandy GRAVEL, fine to coarse, subangular to subrounded, moist to wet, mixed lithologies, loose, occasional cobbles/boulders.	3.4	HW casing advancer with rock bit.
4		4.8	22.9	100	50	X	100	13-20-27	18				SILTSTONE/SANDSTONE, severely to freshly weathered, soft to very soft field hardness, gray, weakly cemented, occasional coal partings and seams.		@ 3.7m switched to HQ3 coring with surface set bit and water.
6		4.8	15.2	100	70										
8		4.8	9.9	100	90										@ 6.6m, qu = 332 kPa
10		5.5	7.6	100	90										
		4.8	14.1	94	44										

Operation Types: ☒ Auger ☐ Casing Advancer ☐ Core Barrel ☐ Drive Casing	Sampler Types: ☒ Split Spoon ☐ Shelby ☐ Bulk Sample ☐ Grab Sample	☐ Penetrometer ☐ Vane Shear ☐ Special Samplers ☐ Testpit	WATER LEVEL OBSERVATIONS While Drilling ∇ 0.2 m Upon Completion of Drilling ∇ ** Time After Drilling _____ Depth To Water (m) _____ Remarks: ** Casing approx. 0.15m above ground at hole completion. Flow out of casing approx. 7.5 l/min.
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LOG OF BORING



MONTANA DEPARTMENT
OF TRANSPORTATION

Geotechnical Section

Project Name: Tongue River - Miles City (3989M)		Project Number: BR 2-1(34)2	
Borehole Location: Sta. 69+47.1, 7.3m Lt. of Proj. Centerline		Borehole Number: 4-21-01	Sheet 2 of 3
Drilling Equipment: CME 850	Hammer Type: Automatic	Driller: B. Pickett	Logger: P. McCann
Drilling Fluid:	Borehole Diameter (mm): 114	Date Started: 4-24-01	Date Finished: 4-24-01

Elevation and Datum: Ground: 714.24 Casing: 714.39

Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4365.1128, X = 3864.9812. X and Y based on local Project coordinates.

DEPTH (m)	DRILL				RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m ³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	GRAPHIC LOG
	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY							
				ROCK QUALITY DESIGNATION (RQD)	SAMPLE	SPT			LL	PL	
12	4.8	11.4	100	80			17.0				
14	3.5	30.5	20	0							
16	3.5	26.1	42	12			16.0				
18	3.5	18.3	48	16							
20	3.5	15.2	80	50							
22	3.5	14.1	80	36							

SILTSTONE/SANDSTONE, cont'd.

@ 12.7m, $q_u = 640$ kPa

SANDSTONE, fine grained, freshly weathered, very soft to hard field hardness, gray and light gray, very weakly to weakly cemented, occasional coal partings and seams.

@ 15.7m, $q_u = 1324$ kPa

- Operation Types:
- ☒ Auger
 - ☒ Casing Advancer
 - ☒ Core Barrel
 - ☒ Drive Casing

- Sampler Types:
- ☒ Split Spoon
 - ☒ Shelby
 - ☒ Bulk Sample
 - ☒ Grab Sample
 - ☒ Penetrometer
 - ☒ Vane Shear
 - ☒ Special Samplers
 - ☒ Testpit

WATER LEVEL OBSERVATIONS

While Drilling ∇ 0.2 m Upon Completion of Drilling ∇ ** m

Time After Drilling

Depth To Water (m)

Remarks: ** Casing approx. 0.15m above ground at hole completion. Flow out of casing approx. 7.5 l/min.

MONTANA DEPARTMENT
OF TRANSPORTATION

Project Name: Tongue River - Miles City (3989M)		Project Number: BR 2-1(34)2	
Borehole Location: Sta. 69+47.1, 7.3m Lt. of Proj. Centerline		Borehole Number: 4-21-01	Sheet 3 of 3
Drilling Equipment: CME 850	Hammer Type: Automatic	Driller: B. Pickett	Logger: P. McCann
Drilling Fluid:	Borehole Diameter (mm): 114	Date Started: 4-24-01	Date Finished: 4-24-01
Elevation and Datum: Ground: 714.24	Casing: 714.39	Notes: Local Description: 09M47E33CRA Stationing off	

Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4365.1128, X = 3864.9812. X and Y based on local Project coordinates.

[illegible]

Bottom of Hole Elev. = 687.7m
qu = Unconfined Compressive Strength

Operation Types:		Sampler Types:	
	Auger		Split Spoon
	Casing Advancer		Shelby
	Core Barrel		Bulk Sample
	Drive Casing		Grab Sample
			Penetrometer
			Vane Shear
			Special Samplers
			Testpit

While Drilling 0.2 m Upon Completion of Drilling m
Time After Drilling
Depth To Water (m)
Remarks: ** Casing approx. 0.15m above ground at hole completion. Flow out of casing approx. 7.5 l/min.

LOG OF BORING

MONTANA DEPARTMENT
OF TRANSPORTATION

Geotechnical Section

Project Name: Tongue River - Miles City (3989M)						Project Number: BR 2-1(34)2	
Borehole Location: Sta. 69+27.3, 11.2m Lt. of Proj. Centerline						Borehole Number: 4-22-01	
Drilling Equipment: CME 850						Hammer Type: Automatic	
Drilling Fluid:						Driller: B. Pickett	
Elevation and Datum: Ground: 714.24						Logger: P. McCann	
Casing:						Borehole Diameter (mm): 114	
						Date Started: 4-25-01	
						Date Finished: 4-25-01	
Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4360.2992, X = 3845.4026. X and Y based on local Project coordinates.							

DEPTH (m)	DRILL				RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m ³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY										
0.2												WATER, Tongue River	0.2	HW Casing advancer with rock bit.
2					50	12-23-30	8	8	—	NP		Sandy GRAVEL, fine to coarse, subangular to subrounded, wet, mixed lithologies, very dense.		
3.2					100	28-14-25	21	19						
4	4.8	10.8	96	66	100	13-29-39	19	17						
5.5	5.5	10.8										SILTSTONE, severely to freshly weathered, moderate to soft field hardness, gray, weakly cemented.		
6	5.5	16.6	84	72			18.2							
6.7	5.5	14.1	86	60								SILTSTONE/SANDSTONE, freshly weathered, very soft to soft field hardness, gray to greenish gray, weakly cemented, occasional coal partings and seams.		
8	5.5	9.6	100	100										
10	5.5	15.2	100	100										

Operation Types: ☒ Auger ☐ Casing Advancer ☐ Core Barrel ☐ Drive Casing ☒ Split Spoon ☐ Shelby ☐ Bulk Sample ☐ Grab Sample ☐ Penetrometer ☐ Vane Shear ☐ Special Samplers ☐ Testpit		WATER LEVEL OBSERVATIONS While Drilling ∇ 0.0 m Upon Completion of Drilling ∇ 0.0 m Time After Drilling _____ Depth To Water (m) _____ Remarks: River elevation on 4-25-01 = 714.2m.	
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LOG OF BORING



Project Name: Tongue River - Miles City (3989M)						Project Number: BR 2-1(34)2	
Borehole Location: Sta. 69+27.3, 11.2m Lt. of Proj. Centerline						Borehole Number: 4-22-01	
Drilling Equipment: CME 850						Hammer Type: Automatic	
Drilling Fluid:						Driller: B. Pickett	
Elevation and Datum: Ground: 714.24						Logger: P. McCann	
Casing:						Date Started: 4-25-01	
						Date Finished: 4-25-01	
Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4360.2992, X = 3845.4026. X and Y based on local Project coordinates.							

DEPTH (m)	DRILL					RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY	ROCK QUALITY DESIGNATION (RQD)										
12		5.5	16.6	84	52								SILTSTONE/SANDSTONE, cont'd.		
14		5.5	30.5	66	28								SANDSTONE, fine grained, freshly weathered, very soft to hard field hardness, gray and light gray, weakly cemented.	12.8	
		3.5	30.5												
		3.5	45.7	40	0										
16		3.5	22.9	40	0										
18		5.5	16.6	100	80										
20		3.5	36.6	50	0								Frequent coal fragments		

Operation Types: ☐ Auger ☐ Casing Advancer ☐ Core Barrel ☐ Drive Casing	Sampler Types: ☐ Split Spoon ☐ Shelby ☐ Bulk Sample ☐ Grab Sample	☐ Penetrometer ☐ Vane Shear ☐ Special Samplers ☐ Testpit	WATER LEVEL OBSERVATIONS While Drilling ☒ 0.0 m Upon Completion of Drilling ☒ 0.0 m Time After Drilling _____ Depth To Water (m) _____ Remarks: River elevation on 4-25-01 = 714.2m.
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DEPARTMENT OF TRANSPORTATION

LOG OF BORING



MONTANA DEPARTMENT OF TRANSPORTATION

Geotechnical Section

Project Name: Tongue River - Miles City (3989M)		Project Number: BR 2-1(34)2	
Borehole Location: Sta. 69+27.3, 11.2m Lt. of Proj. Centerline		Borehole Number: 4-22-01	Sheet 3 of 3
Drilling Equipment: CME 850		Hammer Type: Automatic	Driller: B. Pickett
Drilling Fluid:		Borehole Diameter (mm): 114	Logger: P. McCann
Ground: 714.24		Date Started: 4-25-01	Date Finished: 4-25-01

Elevation and Datum:		Casing:	Notes: Legal Description: 08N47E33CBA. Stationing, offset and elevation provided by District Survey. Y = 4360.2992, X = 3845.4026. X and Y based on local Project coordinates.
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DEPTH (m)	DRILL				RECOVERY (%)	STANDARD PENETRATION TEST	DRY DENSITY (kN/m ³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (m)	REMARKS
	OPERATION	PRESSURE (MPa)	RATE (mph)	CORE PERCENT RECOVERY										
4.8		36.6										SANDSTONE, cont'd.		
3.5		26.1		60	26									
5.5		26.1												
22												SILTSTONE/SANDSTONE, freshly weathered, very soft to medium field hardness, gray, weakly cemented.		
3.5		61.0		52	0									
5.5		16.6		84	42									
24														
5.5		16.6												

Bottom of Hole Elev. = 689.2m
qu = Unconfined Compressive Strength

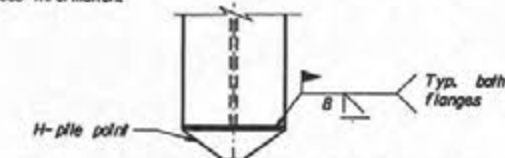
Operation Types:	☐ Auger ☐ Casing Advancer ☐ Core Barrel ☐ Drive Casing	Sampler Types:	☒ Split Spoon ☐ Shelby ☐ Bulk Sample ☐ Grab Sample	☐ Penetrometer ☐ Vane Shear ☐ Special Samplers ☐ Testpit	WATER LEVEL OBSERVATIONS			
					While Drilling	0.0 m	Upon Completion of Drilling	0.0 m
					Time After Drilling			
					Depth To Water (m)			
					Remarks: River elevation on 4-25-01 = 714.2m.			

STATE	PROJECT NUMBER	SHEET NO.
MONTANA	BR 2-1(34)2	B3

NOTES

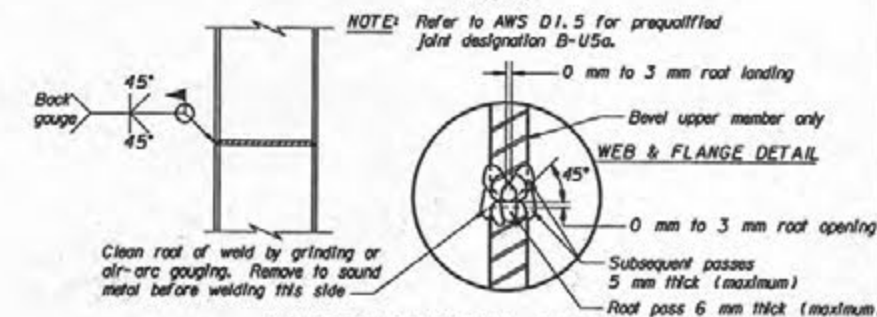
SOILS AND FOUNDATION MATERIALS: The Footing Plan shows points where the State of Montana, Department of Transportation, drilled borings.

The series of numbers on the Log of Borings shows the number of blows from a 63.5 kg hammer with a 0.760 m drop required to drive a 51 mm split spoon sampler 0.150 m (Standard Penetration Test). The length of the split spoon sampler is 0.450 m. The sampler length is measured as three 0.150 m intervals. If the split spoon sampler did not penetrate 0.150 m after 50 blows, the Log of Borings shows the measured penetration within that particular interval. See the Special Provisions for original boring logs and additional subsurface information.



H-PILE POINT WELD PROCEDURE

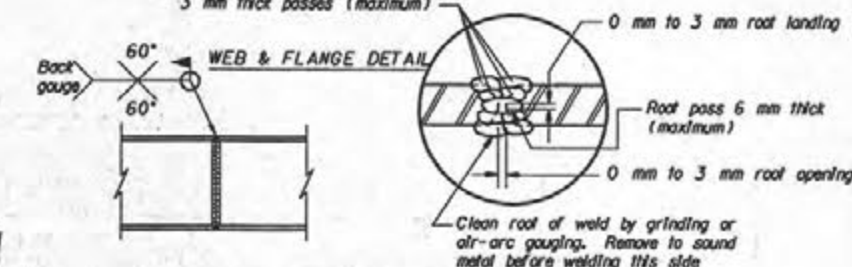
Do not weld web or inside of flanges. Use 7018 SMAW rod. No Scale



PILE EXTENSION AFTER DRIVING

(Pile Vertical)

NOTE: Refer to AWS D1.5 for prequalified joint designation B-U3a. 3 mm thick passes (maximum)



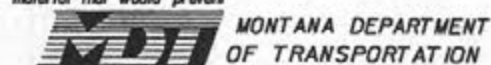
PILE EXTENSION BEFORE DRIVING

(Rotate pile so that all welding is done in a flat position)

PERMISSIBLE WELDED SPLICE DETAILS FOR HP 360 X 152 STEEL PILES

No Scale

NOTE: Use only E7018 or E7028 series electrodes. Maximum electrode size is 5 mm. Prepare the weld surfaces to a smooth, uniform finish. Remove all fine, tears, loose scale, slag, rust, grease, moisture and other material that would prevent proper welding.



BRIDGE OVER TONGUE RIVER

AT STA. 69+42.00

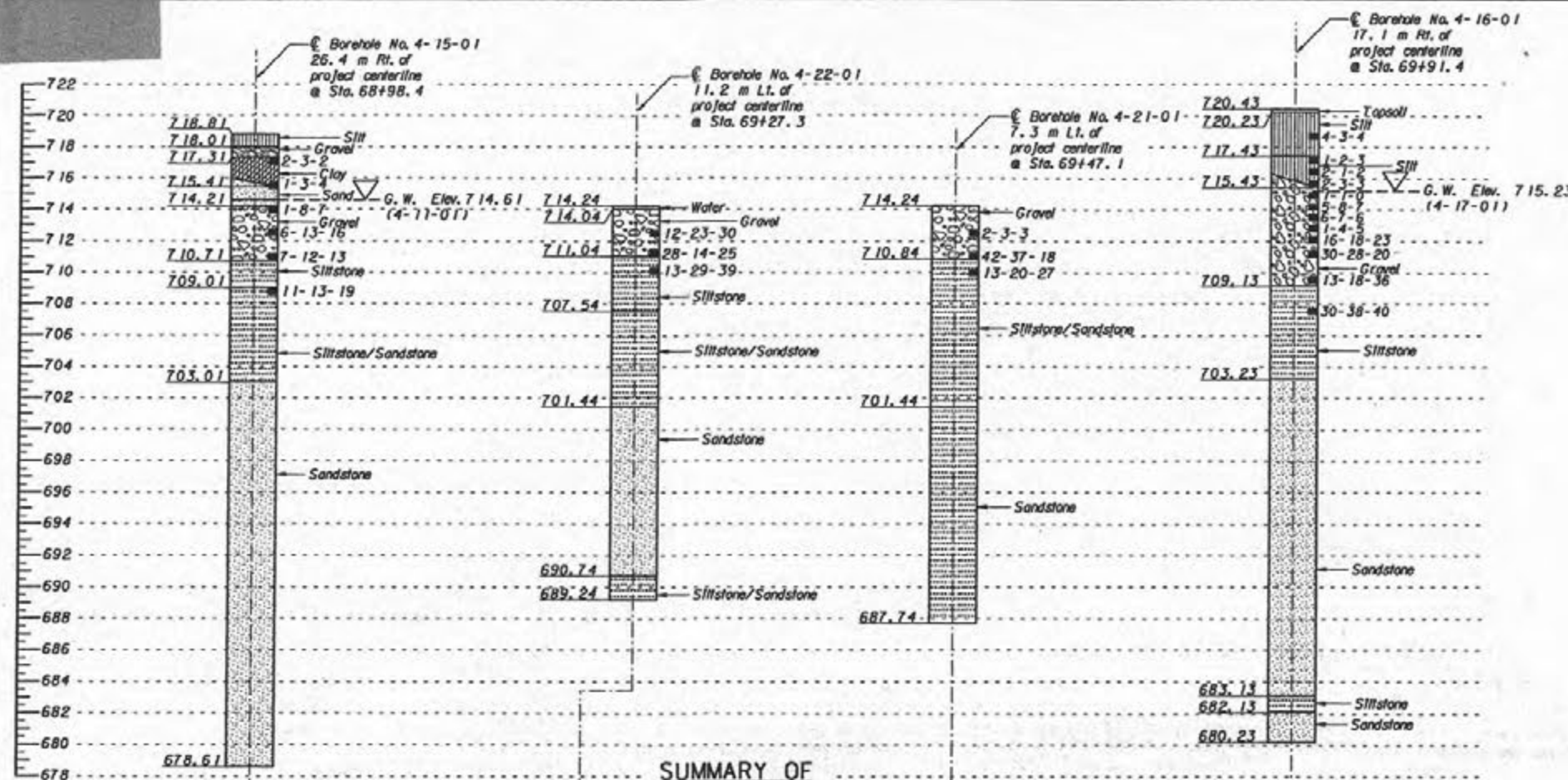
FEDERAL AID PROJECT NO. BR 2-1(34)2

CUSTER COUNTY

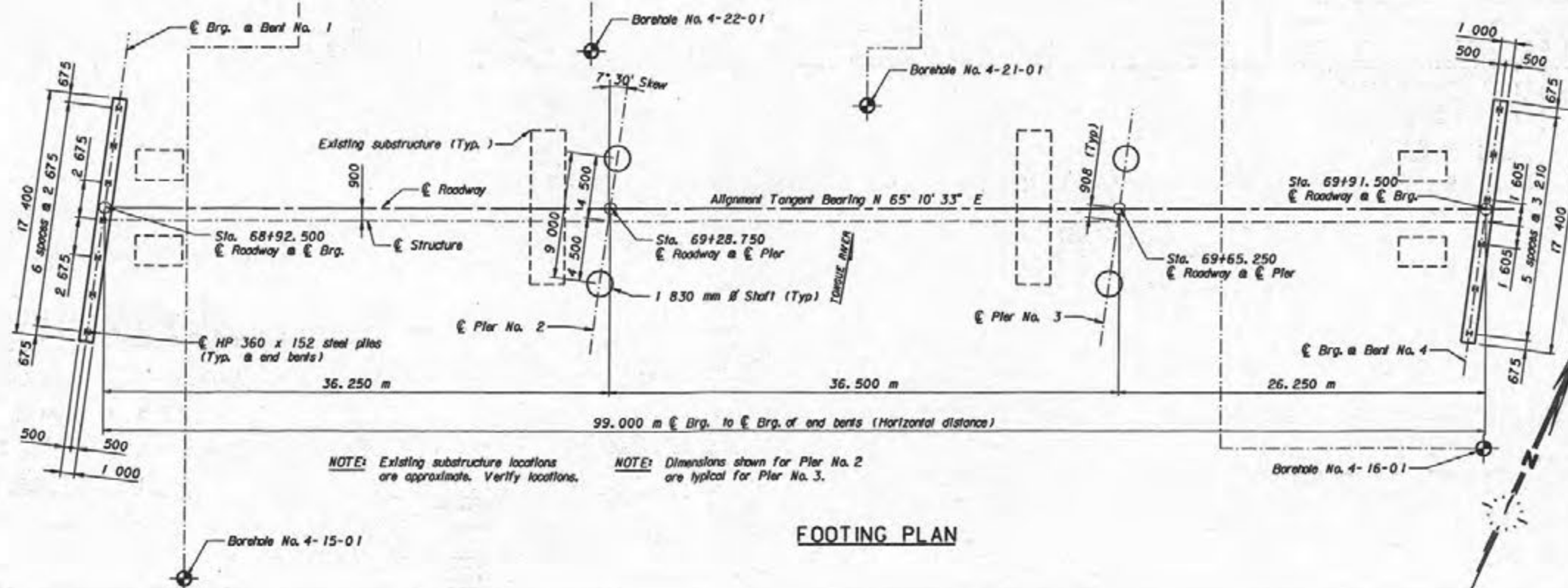
FOOTING PLAN

Scale ~ 1:200

FILENAME: 3989BRFPL001.DGN DRAWING NO. 19503



SUMMARY OF LOG OF BORINGS



NOTE: Existing substructure locations are approximate. Verify locations.

NOTE: Dimensions shown for Pile No. 2 are typical for Pile No. 3.

FOOTING PLAN

DESIGNED	1/12/02	MBL
DRAWN	10/21/02	KSTG
CHECKED	09/26/05	FWB
REVISED		
REVISED		
REVISED		

Appendix 4: SK Geotechnical Bore Samples



2511 Holman Avenue
P. O. Box 80190
Billings, MT 59108-0190
Phone: 406.652.3930
Fax: 406.652.3944

LOG OF BORING

PROJECT: 14-3228G GEOTECHNICAL EVALUATION Flood Control Dikes Miles City, Montana					BORING: ST-1		
LOCATION: See Boring Location Sketch							
DRILLED BY: J. Mattheis		METHOD: 3 1/4" HSA, Automatic		DATE: 6/20/14		SCALE: 1" = 4'	
Elev.	Depth	Symbol	Description of Materials	BPF	WL	MC (%)	Remarks
	0.0		FILL: Sandy Lean Clay, low plasticity, trace small gravel, brown, moist.	9			
			-lense of silty sand	4			
				7			
				7			
				8			
	11.0	SM	SILTY SAND, fine-grained, light brown, moist, loose. (Alluvium)	6			
	14.0		POORLY GRADED GRAVEL with SAND, fine- to coarse-grained, brown, waterbearing, loose to very dense. (Alluvium)	10	▽		An open triangle in the water level (WL) column indicates the depth at which groundwater was first observed while drilling.
		GP		17			
			-trace cobbles	26/50-5"			
	27.0		SANDSTONE, gray, fine-grained, moist, very soft to decomposed.				
	30.3		END OF BORING Waterbearing soils observed at a depth of 15' while drilling	33/50-4"			Water not observed to dry cave-in depth of 13.5' immediately after withdrawal of auger.

BORING BPF WL MC 3228.GPJ LAGNN06.GDT 6/29/14



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LOG OF BORING

PROJECT: 14-3228G GEOTECHNICAL EVALUATION Flood Control Dikes Miles City, Montana					BORING: ST-2		
LOCATION: See Boring Location Sketch							
DRILLED BY: J. Mattheis		METHOD: 3 1/4" HSA, Automatic		DATE: 6/19/14		SCALE: 1" = 4'	
Elev.	Depth	Symbol	Description of Materials	BPF	WL	MC (%)	Remarks
	0.0						
			FILL: Sandy Lean Clay, low plasticity, trace gravel, brown, moist.	15			
				8			
				3			
	6.5		SILTY SAND, fine-grained, light brown, moist, loose. (Alluvium)	10			
		SM		5			
	13.0		POORLY GRADED GRAVEL with SAND, fine- to coarse-grained, brown with trace red, moist to waterbearing, very loose to dense. (Alluvium)	5/4			
				8			
					▽		
		GP		4			
				35			
	28.0		SHALEY SANDSTONE, gray, fine-grained, moist, very soft to decomposed.				
	30.4		END OF BORING	31/50-5"			
							Water down 16' with 24' of hollow-stem auger in the ground. Water not observed to dry cave-in depth of 9' immediately after withdrawal of auger.

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LOG OF BORING

PROJECT: 14-3228G GEOTECHNICAL EVALUATION Flood Control Dikes Miles City, Montana						BORING: ST-3 LOCATION: See Boring Location Sketch		
DRILLED BY: J. Mattheis			METHOD: 3 1/4" HSA, Automatic		DATE: 6/19/14		SCALE: 1" = 4'	
Elev.	Depth	Symbol	Description of Materials	BPF	WL	MC (%)	Remarks	
	0.0							
			FILL: 2" topsoil and root zone over Lean Clay, low plasticity, trace roots, brown, rather dry to moist.	4				
				2				
				3				
				4				
	9.0		-trace small gravel					
		SM	SILTY SAND, fine-grained, brown, wet to waterbearing, very loose. (Alluvium)	3				
				3	▽			
	14.5		POORLY GRADED GRAVEL with SAND, fine- to coarse-grained, brown, waterbearing, loose. (Alluvium)	11				
		GP		8				
				5				
	27.5		SHALE BEDROCK, gray, fine-grained, moist, very soft to decomposed.					
	30.5		END OF BORING	37				
							Waterbearing soils observed at a depth of 12' while drilling. Water not observed to wet cave-in depth of 15' immediately after withdrawal of auger.	

BORING BPF WL MC 3228.GPJ LAGNN06.GDT 6/29/14



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LOG OF BORING

PROJECT: 14-3228G GEOTECHNICAL EVALUATION Flood Control Dikes Miles City, Montana					BORING: ST-4 LOCATION: See Boring Location Sketch		
DRILLED BY: J. Mattheis		METHOD: 3 1/4" HSA, Automatic		DATE: 6/19/14		SCALE: 1" = 4'	
Elev.	Depth	Symbol	Description of Materials	BPF	WL	MC (%)	Remarks
	0.0						
			FILL: 7" topsoil and root zone over Sandy Lean Clay, low plasticity, grayish brown, rather dry.	7			
				10			
	4.5		FILL: Poorly Graded Gravel with Sand, fine- to coarse-grained, brown, moist.	14			
	7.0		FILL: Silty Sand, fine-grained, light brown, rather dry.	9			
	9.0						
		SM	SILTY SAND, fine-grained, brown, rather dry, loose. (Alluvium)	7			
	11.5		POORLY GRADED GRAVEL with SAND, fine- to coarse-grained, light brown, rather dry to waterbearing, loose to very dense. (Alluvium)	48			
				68			
		GP			▽		
				11			
				49			
	27.0		SANDSTONE, gray, fine-grained, moist, very soft to decomposed.				
	30.3		END OF BORING Water down 16' with 19' of hollow-stem auger in the ground	43/50-3"			Water not observed to dry cave-in depth of 7' immediately after withdrawal of auger.

BORING BPF WL MC 3228.GPJ LAGNN06.GDT 6/29/14



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LOG OF BORING

PROJECT: 14-3228G GEOTECHNICAL EVALUATION Flood Control Dikes Miles City, Montana						BORING: ST-5 LOCATION: See Boring Location Sketch		
DRILLED BY: J. Mattheis			METHOD: 3 1/4" HSA, Automatic		DATE: 6/20/14		SCALE: 1" = 4'	
Elev.	Depth	Symbol	Description of Materials	BPF	WL	MC (%)	Remarks	
	0.0		FILL: 5" topsoil and root zone over Sandy Lean Clay, low plasticity, trace small gravel, tan, rather dry.	12				
				10				
				5				
				10				
	9.0							
		SM	SILTY SAND, fine-grained, light brown, moist, loose. (Alluvium)	6				
	11.0							
		CL	LEAN CLAY, low plasticity, brown, wet, rather soft. (Alluvium)	4				
	14.0							
		GP	POORLY GRADED GRAVEL with SAND, fine- to coarse-grained, brown, moist, dense. (Alluvium)	30				
				32				
	24.0							
			SHALE, gray, high plasticity, moist, very soft to decomposed.	28/50-2"				
	29.2							
			END OF BORING Water down 16' with 29' of hollow-stem auger in the ground.	50-2", set				
							Water not observed to dry cave-in depth of 12' immediately after withdrawal of auger.	

BORING BPF WL MC 3228.GPJ LAGNN06.GDT 6/29/14



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LOG OF BORING

PROJECT: 14-3228G GEOTECHNICAL EVALUATION Flood Control Dikes Miles City, Montana					BORING: ST-6		
LOCATION: See Boring Location Sketch							
DRILLED BY: J. Mattheis		METHOD: 3 1/4" HSA, Automatic		DATE: 6/20/14		SCALE: 1" = 4'	
Elev.	Depth	Symbol	Description of Materials	BPF	WL	MC (%)	Remarks
	0.0						
	3.0		FILL: Sandy Lean Clay, low plasticity, trace gravel, brown, moist.	10			
				6			
			FILL: Silty Sand, fine-grained, brown, moist.	5			
				16			
				14			
	11.0		SILTY SAND, fine-grained, brown, moist to wet, loose. (Alluvium)	6			
		SM		6			
	18.0		POORLY GRADED GRAVEL with SAND, fine- to coarse-grained, light brown, waterbearing, medium dense. (Alluvium)	17			
		GP		11			
	30.5		END OF BORING	19			
							Water down 19' with 29' of hollow-stem auger in the ground. Water not observed to dry cave-in depth of 14' immediately after withdrawal of auger.

BORING BPF WL MC 3228.GPJ LAGNN06.GDT 6/29/14

Appendix 5:
100-Year & 500-Year
Preliminary Levee Cost Estimate



PRELIMINARY OPINION OF PROBABLE PROJECT COSTS 100-YEAR PROTECTION
Miles City Certified Levee
1/20/2015

Probable Levee Cost						
No.	Item	Quantity	Unit	Unit Price	Total	Category
1	Property Buyouts	60	EA	\$ 100,000.00	\$ 6,000,000.00	Land
2	Mobilization	1	LS	\$ 1,940,000.00	\$ 1,940,000.00	Mob
3	Site Clearing (Structure Removal, Tree Removal, Clearing & Grubbing)	1	LS	\$ 3,000,000.00	\$ 3,000,000.00	Levee
4	Top Soil Stripping	25,000	CY	\$ 2.00	\$ 50,000.00	Levee
5	Top Soil Import	50,000	CY	\$ 8.00	\$ 400,000.00	Levee
6	Imported Fill Material	350,000	CY	\$ 10.00	\$ 3,500,000.00	Levee
7	Perforated Drainage Pipe	36,000	LF	\$ 8.00	\$ 288,000.00	Levee
8	Coarse Aggregate	9,000	CY	\$ 15.00	\$ 135,000.00	Levee
9	Fine Aggregate	12,000	CY	\$ 15.00	\$ 180,000.00	Levee
10	Flood Wall	20,000	SF	\$ 140.00	\$ 2,800,000.00	Levee
11	Flood Wall Road Closure	2,000	SF	\$ 85.00	\$ 170,000.00	Levee
12	Flood Wall Road Closure Footing	500	SF	\$ 725.00	\$ 363,000.00	Levee
13	Storm Sewer Manholes	75	EA	\$ 4,000.00	\$ 300,000.00	Levee
14	8" PVC Storm Sewer	4,000	LF	\$ 35.00	\$ 140,000.00	Levee
15	Connect to Existing Storm Sewer	75	EA	\$ 1,500.00	\$ 113,000.00	Levee
16	Levee O & M	1	LS	\$ 100,000.00	\$ 100,000.00	Levee
17	Lift Station	4	EA	\$ 350,000.00	\$ 1,400,000.00	Lift
18	Remove Watermain	2,100	LF	\$ 15.00	\$ 32,000.00	Inf
19	Install Watermain	2,100	LF	\$ 60.00	\$ 126,000.00	Inf
20	Remove Sanitary Sewer	450	LF	\$ 15.00	\$ 7,000.00	Inf
21	Install Sanitary Sewer	450	LF	\$ 40.00	\$ 18,000.00	Inf
22	Remove Storm Sewer	200	LF	\$ 15.00	\$ 3,000.00	Inf
23	Install Storm Sewer	200	LF	\$ 75.00	\$ 15,000.00	Inf
24	Removal of Bituminous Material	7,000	SY	\$ 3.00	\$ 21,000.00	Road
25	Type SP 12.5 Non Wearing Course Mixture	1,100	TON	\$ 100.00	\$ 110,000.00	Road
26	Type sp 12.5 Wearing Course Mixture (2, B)	550	TON	\$ 100.00	\$ 55,000.00	Road
27	Bridge Modifications/Replacment	1	LS	\$ 4,000,000.00	\$ 4,000,000.00	Road
28	Recreational Facilities	1	LS	\$ 1,000,000.00	\$ 1,000,000.00	Const
29	Reinforced Concrete Levee Erosion Protection	5,000	SY	\$ 75.00	\$ 375,000.00	Levee
30	West Levee Stormwater Detention Pond	1	LS	\$ 175,000.00	\$ 175,000.00	Levee
31	Turf Establishment	1	LS	\$ 150,000.00	\$ 150,000.00	Const
32	Temporary Erosion Control	1	LS	\$ 150,000.00	\$ 150,000.00	Const
33	Contractor Required Testing	1	LS	\$ 150,000.00	\$ 150,000.00	Const
34	Traffic Control	1	LS	\$ 100,000.00	\$ 100,000.00	Const
				Subtotal	\$ 27,366,000.00	
				Design & Construction Engineering	\$ 4,110,000.00	Engr
				Contingency	\$ 6,000,000.00	Const
				Total	\$ 37,000,000.00	

Creek Re-Grading						
No.	Item	Quantity	Unit	Unit Price	Total	
1	Grading	7,000	CY	\$ 10.00	\$ 70,000.00	Channel
2	Culvert Crossings (Remove existing and replace)	9	EA	\$ 25,000.00	\$ 225,000.00	Channel
3	Pond Property	1	EA	\$ 28,000.00	\$ 28,000.00	Land
4	Pond to Mitigate Lost Storage (Grading, Control Structure, etc.)	1	LS	\$ 1,335,000.00	\$ 1,335,000.00	Channel
Subtotal					\$ 1,658,000.00	
Design & Construction Engineering					\$ 249,000.00	Engr
Contingency					\$ 381,400.00	Const
Total					\$ 2,300,000.00	



PRELIMINARY OPINION OF PROBABLE PROJECT COSTS 500-YEAR PROTECTION
Miles City Certified Levee
1/20/2015

Probable Levee Cost						
No.	Item	Quantity	Unit	Unit Price	Total	Category
1	Property Buyouts	60	EA	\$ 100,000.00	\$ 6,000,000.00	Land
2	Mobilization	1	LS	\$ 2,040,000.00	\$ 2,040,000.00	Mob
3	Site Clearing (Structure Removal, Tree Removal, Clearing & Grubbing)	1	LS	\$ 3,000,000.00	\$ 3,000,000.00	Levee
4	Top Soil Stripping	25,000	CY	\$ 2.00	\$ 50,000.00	Levee
5	Top Soil Import	50,000	CY	\$ 8.00	\$ 400,000.00	Levee
6	Imported Fill Material	450,000	CY	\$ 10.00	\$ 4,500,000.00	Levee
7	Perforated Drainage Pipe	36,000	LF	\$ 8.00	\$ 288,000.00	Levee
8	Coarse Aggregate	8,500	CY	\$ 15.00	\$ 128,000.00	Levee
9	Fine Aggregate	12,000	CY	\$ 15.00	\$ 180,000.00	Levee
10	Flood Wall	20,000	SF	\$ 140.00	\$ 2,800,000.00	Levee
11	Flood Wall Road Closure	2,000	SF	\$ 85.00	\$ 170,000.00	Levee
12	Flood Wall Road Closure Footing	500	SF	\$ 725.00	\$ 363,000.00	Levee
13	Storm Sewer Manholes	75	EA	\$ 4,000.00	\$ 300,000.00	Levee
14	8" PVC Storm Sewer	4,000	LF	\$ 35.00	\$ 140,000.00	Levee
15	Connect to Existing Storm Sewer	75	EA	\$ 1,500.00	\$ 113,000.00	Levee
16	Levee O & M	1	LS	\$ 100,000.00	\$ 100,000.00	Levee
17	Lift Station	4	EA	\$ 350,000.00	\$ 1,400,000.00	Lift
18	Remove Watermain	2,100	LF	\$ 15.00	\$ 32,000.00	Inf
19	Install Watermain	2,100	LF	\$ 60.00	\$ 126,000.00	Inf
20	Remove Sanitary Sewer	450	LF	\$ 15.00	\$ 7,000.00	Inf
21	Install Sanitary Sewer	450	LF	\$ 40.00	\$ 18,000.00	Inf
22	Remove Storm Sewer	200	LF	\$ 15.00	\$ 3,000.00	Inf
23	Install Storm Sewer	200	LF	\$ 75.00	\$ 15,000.00	Inf
24	Removal of Bituminous Material	7,000	SY	\$ 3.00	\$ 21,000.00	Road
25	Type SP 12.5 Non Wearing Course Mixture	1,100	TON	\$ 100.00	\$ 110,000.00	Road
26	Type sp 12.5 Wearing Course Mixture (2, B)	550	TON	\$ 100.00	\$ 55,000.00	Road
27	Bridge Modifications/Replacment	1	LS	\$ 4,000,000.00	\$ 4,000,000.00	Road
28	Recreational Facilities	1	LS	\$ 1,000,000.00	\$ 1,000,000.00	Const
29	Reinforced Concrete Levee Erosion Protection	5,000	SY	\$ 75.00	\$ 375,000.00	Levee
30	West Levee Stormwater Detention Pond	1	LS	\$ 175,000.00	\$ 175,000.00	Levee
31	Turf Establishment	1	LS	\$ 150,000.00	\$ 150,000.00	Const
32	Temporary Erosion Control	1	LS	\$ 150,000.00	\$ 150,000.00	Const
33	Contractor Required Testing	1	LS	\$ 150,000.00	\$ 150,000.00	Const
34	Traffic Control	1	LS	\$ 100,000.00	\$ 100,000.00	Const
Subtotal					\$ 28,459,000.00	
Design & Construction Engineering					\$ 4,270,000.00	Engr
Contingency					\$ 6,550,000.00	Const
Total					\$ 39,280,000.00	

Creek Re-Grading						
No.	Item	Quantity	Unit	Unit Price	Total	
1	Grading	7,000	CY	\$ 10.00	\$ 70,000.00	Channel
2	Culvert Crossings (Remove existing and replace)	9	EA	\$ 25,000.00	\$ 225,000.00	Channel
3	Pond Property	1	EA	\$ 28,000.00	\$ 28,000.00	Land
4	Pond to Mitigate Lost Storage (Grading, Control Structure, etc.)	1	LS	\$ 1,335,000.00	\$ 1,335,000.00	Channel
Subtotal					\$ 1,658,000.00	
Design & Construction Engineering					\$ 250,000.00	Engr
Contingency					\$ 390,000.00	Const
Total					\$ 2,300,000.00	