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I-29 Communications Design Alternatives

Technical Memorandum

October 2001

Prepared for:
North Dakota Department of Transportation

Prepared by:
Advanced Traffic Analysis Center
Upper Great Plains Transportation Institute
North Dakota State University
Fargo, North Dakota

Communication Network Engineers, Inc.
Communication Consultants, Inc.

October 2, 2001

Kiel Ova
Associate Research Fellow
Advanced Traffic Analysis Center
P.O. Box 5074
Fargo, ND 58105

Dear Mr. Ova:

This letter is in response from the Advanced Traffic Analysis Center (ATAC) Request for Service to design a conduit system to be placed along I-29. The purpose of this conduit system will be to provide fiber optic or copper communication cables to collect data and bring back to traffic operation center in Fargo.

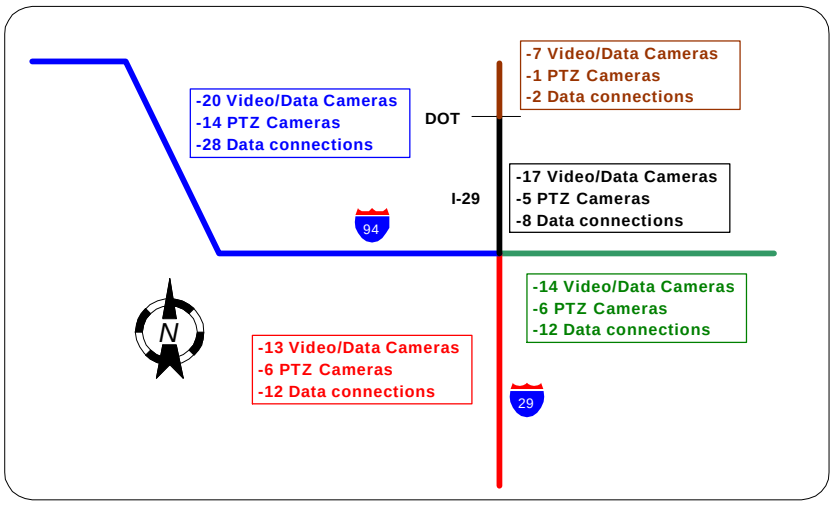
Bandwidth Requirements

The first request was to identify the minimum bandwidth requirements for future fiber installation for ITS communications, with the following assumptions:

a. (3) video/data cameras located at each intersection with off ramps,
b. (2) video cameras per one mile segment (1 camera/mile/direction),
c. (4) data communications per one mile segment (2 connections/mile/direction),
d. continuous communication between operations center and termination/feed point for all video.

Identifying the minimum bandwidth requirements is not feasible at this point. The components listed above have not been chosen and definite equipment locations have not been pin pointed. Since the number and type of components have not been chosen, it is difficult to chose the media type (i.e. – fiber, twisted pair, coaxial cable, or wireless). In an eventual system, a combination of all media types may be likely.

For these reasons, I chose to design a conduit system based upon a fiber-based system for cameras and data. Fiber optics were chosen because they provide the most current and the best transmission currently available. In addition, I also considered the possible need for twisted pair facilities to interconnect data interface panels. The possible fiber and twisted pair requirements were determined upon the criteria set forth above.



The above diagram details the connections needed according to the criteria. Please note that the requirements between the DOT building and Main Avenue are ignored for analysis. It is a short distance and the duct placed for the remainder of the I-29 corridor to I-94 will just be continued to the Main Avenue intersection.

Since the types of cameras to be used are not known, it is difficult to determine exact needs. The worst-case scenario would be 2 fibers per camera (one for video and one for data). This would provide for true, full motion video. Leaving 12 fibers at the end of each route for future growth, the fiber requirement for the cameras would be 242 fibers into the DOT building from the I-29 / I-94 intersection.

Another possible design would be true, full motion video for the PTZ cameras and streaming video for the Autoscope SOLO cameras. The PTZ cameras would still require 2 fibers each or 62 total fibers. For the Autoscope cameras, utilizing streaming video, anywhere from 6 to 36 fibers would be required. This would be determined by the configuration and fiber modem chosen. Adding these number together with the fibers for future growth, we have a fiber requirement of somewhere between 104 and 134 fibers into the DOT building from the I-29 / I-94 intersection.

As far as the data communications, the required media type is not also known. We could use a combination of optics, twisted pair, and wireless. The worst-case scenario would be having to bring back twisted pair for each data access point to the traffic operations center. This is not considered feasible. There will probably be a need for a mix of unknown amount of fibers and twisted pair going into the duct system. This unknown quantity requires an extra duct to be placed to insure that there is room for all media needed.

Possible Design Options

We approached this *initial* design in the following way. We designed a possible route on the west side of the interstate as discussed at the meeting. Handholes (access points) were place on both sides of major overpasses and intermittently along the route as detailed in the request for services (please refer to Attachment 7 to see locations).

The project was separated into three sections: (A) south side of Main Avenue to the south side of I-94, (B) south side of I-94 to south side of 32nd Avenue South, and (C) south side of 32nd Avenue South to 52nd Avenue South. Innerduct shall be placed at a 36" minimum depth and handholes shall be placed according to the installation detail (as seen in a following attachment). This information was provided to a typical telecommunications contractor for pricing. He was instructed to quote several options (which can be seen in Attachment 1). This should allow you to see the cost savings of placing multiple ducts. These options are as follows:

1. All sections, 1 – 2" innerduct
2. All sections, 2 – 2" innerducts
3. Section A, 4 – 2" innerducts
   Section B and C, 2 – 2" innerducts
4. All Sections, 4 – 1¼" innerducts

The main materials needed for this project are the handholes and innerduct. The recommendation for these materials can be found in Attachment 2 and 3, with our recommendation highlighted in yellow. There are several other incidental materials that were included in the quote. They are couplers for the duct, warning signs, and warning tape. A typical telecom contractor should be able to spec these materials.

Cost Estimates

Attachment 1 details the cost estimates that were produced by the chosen telecommunications contractor. These are budgetary estimates only. Numerous factors could affect the total cost. A few of the factors that could affect these costs are as follows:

1. Availability of materials.
2. Availability of contractors.
3. Going wages for state contract jobs.

4. Whether or not steel casings are required by the DOT under all road crossings. This is typically done to protect the innerduct from being compacted.

5. Changes to the route and/or changes to the numbers and locations of handholes.

Recommended Design Option

Communications Consultants recommends Design Option #3. This is the best option considering all factors. At a minimum, two ducts should be placed along the entire route. This would allow one duct for fiber optic cable and one duct for copper cable.

The need for the additional two ducts from Main Avenue to I-94 can be justified in two ways. The first is the fact that this would be the most difficult interstate corridor to construct in all Fargo Metro area. The second is that there are two potential cable routes to tap off of this route, east and west I-94. This would allow for cable to be placed for these routes at a later date than what would be needed for the I-29 corridor.

As can be seen in the estimates, Option 4 is less expensive than Option 3 and provides for four ducts through the whole Main Avenue to 52nd Avenue South corridor. However, 1 ¼" duct provides fewer options for use. Fiber optic cable ranges in size from ¼" to 1 ¼" on average. Multiple fiber cables could not be placed in one 1 ¼" duct, but could be placed in a 2" duct. In addition, 2" duct allows for a larger copper cable to be placed if needed.

Please note that if steel casings are needed at road crossings, the cost could rise to approximately $246,000. This point can be addressed at a later date if needed.

There is one thing that I would like to note on the conduit system design. There will be no above ground appearances with the initial installation of the duct. However, there will be anticipated above ground appearances at a later date. These would include pedestals for grounding / locating of the cables and interface panels for the chosen equipment.

Project Implementation

These estimates should provide you with an approximate cost that you can include for your next year's budget if you would like. Please note that these are just estimates, with assumptions made. Since the duct placement should occur after road construction is complete, it is Communication Consultants recommendation to await the placement of the duct until the exact needs are known further. When the different types of communication media and the instrument's exact locations and numbers are know, it would allow for a more accurate design and estimate.

Communication Consultants would also like to make a few other points. It is recommended that a typical telecommunications contractor (see following attachment) be utilized for the installation of the duct. They are very familiar with this work and would be more efficient in completing the project than a typical road contractor. It is also recommended that prior to construction, an engineering firm complete more detailed staking of the route. This will provide the contractor with a better scope of work and plans to work by as compared to the initial design maps provided to you. It will also increase the accuracy of the estimate provided.

Communication Consultants is very experienced in providing assistance to projects like the one mentioned above. We can provide design services, drafting services, staking, inspection, and the bidding process for the above mentioned above-mentioned project. If the DOT would like to utilize us for any of the process, please have them contact me.

List of Attachments:

1. Cost Estimates
2. Inner Duct RUS Approved Material List
3. Hand Hole RUS Approved Material List
4. Hand Hole Detail Drawing
5. Area Telecommunications Contractor List
6. Area Telecommunications Material Supplier List
7. Proposed System Design Maps (10 + Key Map)

I would suggest that a meeting or conference call be scheduled between you, the appropriate DOT personnel, and myself to fully discuss all points I addressed in this proposal.

If you have any questions or concerns, feel free to contact me. You may reach me via phone number 701-237-3433 or contact me via email: blake@ccfargo.com.

Sincerely,
Communication Consultants, Inc.

Blake T. Griffin

Engineer

Attachment 1
Cost Estimates

1. ALL SECTIONS, 1-2" INNERDUCT

DESCRIPTION		QUANTITY	UNIT PRICE LABOR	UNIT PRICE MATERIALS	UNIT PRICE LAB & MAT	EXT. PRICE LAB & MAT
PLOW	LF	18037.5	$ 2.75	$ 0.53	$ 3.28	$ 59,083.64
BORE	LF	3075	$ 9.50	$ 0.53	$ 10.03	$ 30,828.72
4" CASING (AS NEEDED)	LF		$ 13.00	$ 3.60	$ 16.60	$ -
**ALL CASING PRICES TO BE ADDED TO BORE UNIT PRICE.*						
VAULTS	EA	22	$ 400.00	$ 622.80	$ 1,022.80	$ 22,501.60
SIGNS	EA	20	$ 25.00	$ 21.00	$ 46.00	$ 920.00
					SCENARIO 1. TOTAL	**$ 113,333.96**
					SCENARIO 1. COST/FT	**$ 5.37**

2. ALL SECTIONS, 2-2" INNERDUCTS

DESCRIPTION		QUANTITY	UNIT PRICE LABOR	UNIT PRICE MATERIALS	UNIT PRICE LAB & MAT	EXT. PRICE LAB & MAT
PLOW	LF	18037.5	$ 3.25	$ 1.05	$ 4.30	$ 77,582.90
BORE	LF	3075	$ 11.50	$ 1.05	$ 12.55	$ 38,594.94
6" CASING (AS NEEDED)	LF		$ 16.00	$ 7.32	$ 23.32	$ -
**ALL CASING PRICES TO BE ADDED TO BORE UNIT PRICE.*						
VAULTS	EA	22	$ 400.00	$ 622.80	$ 1,022.80	$ 22,501.60
SIGNS	EA	20	$ 25.00	$ 21.00	$ 46.00	$ 920.00
					SCENARIO 2. TOTAL	**$ 139,599.44**
					SCENARIO 1. COST/FT	**$ 6.61**

3. SECTION A, 4-2" INNERDUCTS; SECTIONS B & C 2-2" INNERDUCTS

DESCRIPTION		QUANTITY	UNIT PRICE LABOR	UNIT PRICE MATERIALS	UNIT PRICE LAB & MAT	EXT. PRICE LAB & MAT
PLOW SECTION A	LF	9262.5	$ 4.25	$ 2.10	$ 6.35	$ 58,839.11
BORE SECTION A	LF	2193.75	$ 15.50	$ 2.10	$ 17.60	$ 38,615.27
PLOW SECTION B & C	LF	8775	$ 3.25	$ 1.05	$ 4.30	$ 37,743.03
BORE SECTION B & C	LF	881.25	$ 11.50	$ 1.05	$ 12.55	$ 11,060.75
6" CASING (AS NEEDED)	LF		$ 16.00	$ 7.32	$ 23.32	$ -
8" CASING (AS NEEDED)	LF		$ 16.00	$ 11.84	$ 27.84	$ -
**ALL CASING PRICES TO BE ADDED TO BORE UNIT PRICE.*						
VAULTS	EA	22	$ 400.00	$ 622.80	$ 1,022.80	$ 22,501.60
SIGNS	EA	20	$ 25.00	$ 21.00	$ 46.00	$ 920.00
					SCENARIO 3. TOTAL	**$ 169,679.75**
					SCENARIO 1. COST/FT	**$ 8.04**

4. ALL SECTIONS, 4-1.25" INNERDUCTS

DESCRIPTION		QUANTITY	UNIT PRICE LABOR	UNIT PRICE MATERIALS	UNIT PRICE LAB & MAT	EXT. PRICE LAB & MAT
PLOW	LF	18037.5	$ 4.00	$ 1.11	$ 5.11	$ 92,236.56
BORE	LF	3075	$ 15.00	$ 1.11	$ 16.11	$ 49,549.32
6" CASING (AS NEEDED)	LF		$ 16.00	$ 7.32	$ 23.32	$ -
**ALL CASING PRICES TO BE ADDED TO BORE UNIT PRICE.*						
VAULTS	EA	22	$ 519.00	$ 622.80	$ 1,141.80	$ 25,119.60
SIGNS	EA	20	25	$ 21.00	$ 46.00	$ 920.00
					SCENARIO 4. TOTAL	**$ 167,825.48**
					SCENARIO 1. COST/FT	**$ 7.95**
WARNING TAPE (APPLICABLE TO ALL SCENARIOS)	LF	18.0375		$ 12.78	$ 12.78	$ 230.52

Attachment 2
Inner Duct Approved Material List

This list of material is provided by the Rural Utility Service. These product manufacturers are approved for RUS contracts which are utilized by typical, rural telephone companies and should suffice the DOT's needs.

Manufacturer	Type Conduit	Catalog Number
	hc - Underground Conduit	
Allwire, Inc.	Flexible plastic	ALLDUCT
American Pipe & Plastics	Plastic	Type B, C, and D
	Plastic	Type EB and DB
	Plastic	PVC Multi-Duct (2,3,4 and 6-way)
Americon International	Flexible plastic	HDPE Duct
	Plastic	PVC Type C
Apache Plastics, Inc.	Plastic	Type EB and Type DB
ARMCO	Plastic	Smooth-Cor Type B and Type C
Arnco	Flexible plastic	HDPE Conduit
Bay Plastics, Inc.	Plastic	Type B and Type C
Bristolpipe	Plastic	Type B, C, and D
	Plastic	Type EB and Type DB
Can-Tex	Plastic	Type EB and Type DB
	Plastic	Type B, C, and D
Carlon	Plastic	Type EB and Type DB
	Plastic	Type B, C, and D
	Plastic	Multi-Gard
Certain-Teed Products Corp.	Plastic	Type EB and Type DB
CIBA-GEIGY**(1)**	Fiberglass	T & D Conduit
Condux International, Inc.	Concrete	Condux
	Plastic	Type EB and Type DB
CSR Polypipe	Flexible plastic	HDPE Duct
Dura-line	Flexible plastic	HDPE Duct
Endot Industries	Flexible plastic	HDPE Duct
Freedom Plastics, Inc.	Plastic	Type C
Hercules, Inc.	Flexible plastic	Corflo plastic conduit
Hurlbut Plastic Pipe	Plastic	Type C
Ingomar Plastic Pipe	Plastic	Type B and Type C
J-M Manufacturing Company	Plastic	Types C, EB, and DB
Kyova	Plastic	Type EB and Type DB
LCP National Plastics, Inc.	Plastic	Type EB and Type DB
	Plastic	Type B and Type C

Manufacturer	Type Conduit	Catalog Number
	hc - Underground Conduit	
Moore DP, LLC	Flexible plastic	HDPE Duct
Northern Pipe Products	Plastic	Type B, C, and D
OMNI	Flexible plastic	HDPE Duct
	Plastic	Multiple plastic conduit (3 & 4 Way)
Petroflex	Flexible plastic	HDPE Duct
	Flexible plastic	Corrugated HDPE Duct
Phillips Products Co., Inc.	Flexible plastic	Driscon 3200
Phone Ducs	Plastic	Multiple plastic conduit (4, 6, & 9 Way)
PLEXCO	Flexible plastic	PLEXCO Duct
PWPipe	Plastic	Type EB and Type DB
	Flexible plastic	HDPE Coiled Duct
Pyramid Industries, Inc.	Plastic	Type EB and Type DM
	Flexible plastic	HDPE Conduit
Quail Plastics	Plastic	Type EB and Type DB
Queen City Plastics	Plastic	Type EB and Type DB
River City Plastics	Plastic	Type EB and Type DB
Sedco	Plastic	Type EB and Type DB
Southern Pipe, Inc.	Plastic	PVC Types EB, DB, and Sch. 40
Tamaqua Cable Products	Flexible plastic	HDPE Duct
Tridyn Industries	Plastic	Type EB and Type DB
Vassallo Industries	Plastic	Type B and Type C
Wesflex	Flexible plastic	Flex-Con

Note: For fiber and plastic conduit, Type I, Type B or Type EB is for concrete encasement and Type II, Type C or Type DB may be directly buried. Schedule 40 is a high strength conduit that may be used for concrete encasement or direct burial. Type D is for exposed installation, as on bridges.

(1) Filament wound fiberglass/epoxy conduit.

The products listed above are for all types of conduit. Highlighted in yellow are the suitable types for the DOT project. The exact specification for this type of duct project should be a orange, plastic innerduct of type SDK13.5 (non-corrugated)

Attachment 3
Handhole Approved Material List

This list of material is provided by the Rural Utility Service. These product manufacturers are approved for RUS contracts which are utilized by typical, rural telephone companies and should suffice the DOT's needs.

Manufacturer	Catalog Number
hh - Handholes(1)(2)	
Handholes for Copper Systems	
Armorcast	6001946 (13x24) 6001640 (17x30) 6001974 (24x36) 6001436 (36x60)
Associated Plastics	1324-1 1730-1 PW2436/18 PW3048/18 PW3048/36 PH3660/36-1 PH3660/18-1
Brooks Products	1324 1730
Carson Industries	1730-13B
CDR Systems (Homac)	TA-1324 TA-1730 TA-3660 TA-2436 TA-3048W TA-3048 TA-3060
Coil Sales (Charles Industries)	FMH 361 FMH 362 FMH 363
Pen-Cell Plastics	PE-10 PE-20 (Restricted to cable sizes up to 100 pairs) PE-36 PE-6HD PE-9HD PE-14HD PE-30HD PE-20HD PE-20U PE-20F PE-30U PE-30F PEM Series
Quazite	PC1324 PC1730 PX1324 PX1730

hh - Handholes[1][2]

Handholes for Fiber Optic Systems

Manufacturer	Catalog Number
Armorcast	6001974 (24x36) 6001430 (30x48) 6001742 (30x60) 6001436 (36x60) 6001691 (39x30DI)
Associated Plastics	PH1324/18 PH1730/18 PH2436/18 PH3048/18 PH3048/36 5430-1 5440-1 PH3660/18-1 PH3660/36-1
CDR Systems (Homac)	TA-1730F TA-2436F TA-3048WF TA-3048F TA-3060F TA-3660F TA-4848F TA-4872F TA-4878F TA-4896F
Coastal Engineered Products	38-00520 38-00521 38-00522 38-00523
Coil Sales (Charles Industries)	FMH 361 FMH 362 FMH 363
Moore Diversified Products, Inc.	MOV-2S/D[3]
Pen-Cell Plastics	PE-14HD PE-20HD PE-20U PE-20F PE-30HD PE-30U PE-30F PE-36HD PE-36A PEM Series
Quazite	PG2436 PG3048 LG3060 LG3660 LR2732

Notes: **(1)** Not for use in areas subject to vehicular traffic.

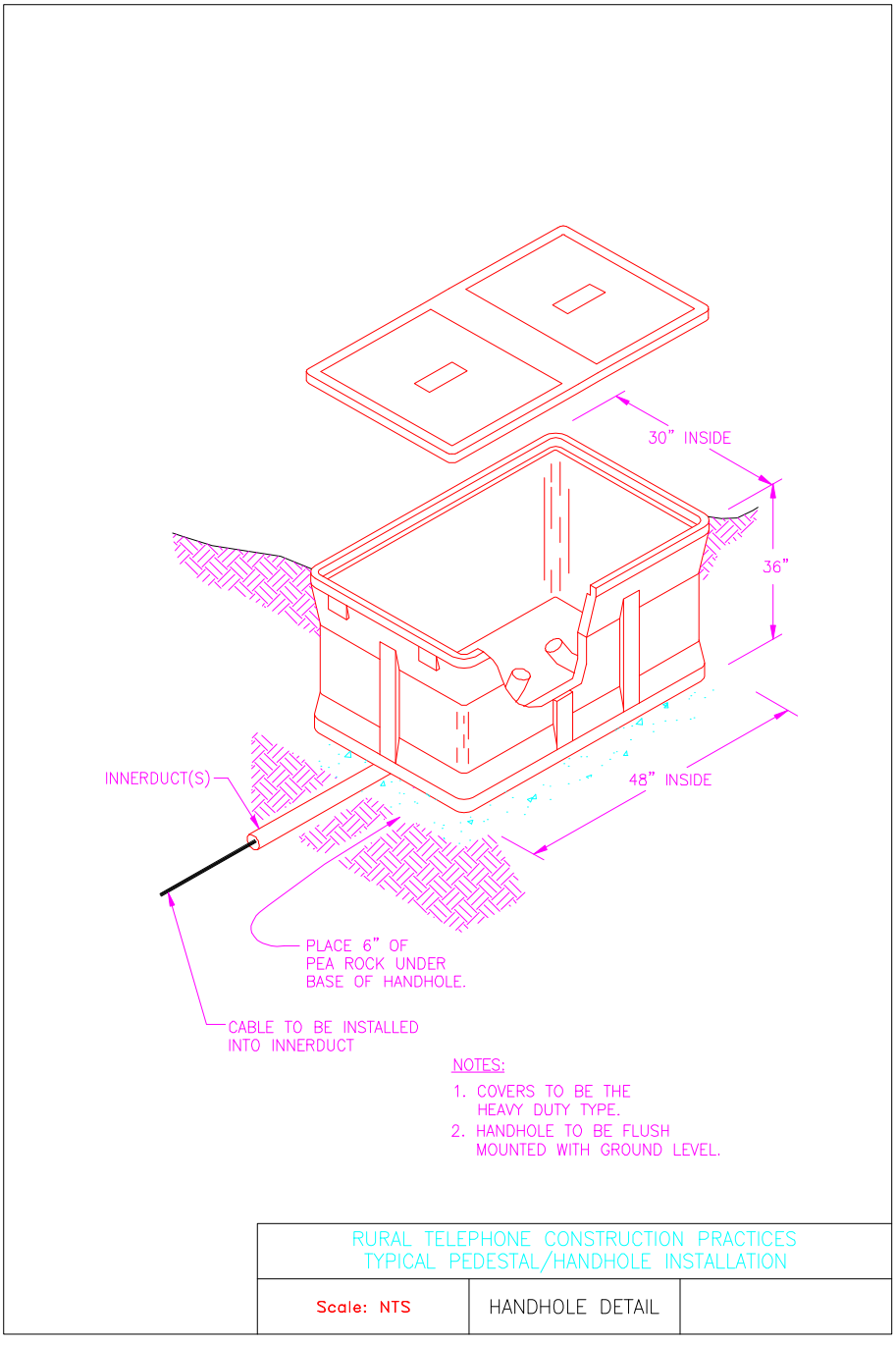
(2) Consult the manufacturer for ordering procedures for handhole depth and lid/cover locking devices and load bearing capacity.

(3) Rated for use in areas subject to vehicular traffic.

The handholes listed above are of various sizes. The exact specifications for the DOT project should be as follows:

Grade level polymer concrete splice box suitable for driveway/parking lot application. The box shall be 30”x48”x36” with no floor or mouse holes. Covers shall be two-piece, two-bolt design. UH shall be set on a bed of pea rock 6”deep and 6” beyond all sides of box.

Attachment 4
Handhole Detail Drawing



Attachment 5
Area Telecommunications Contractor List

- Aerial Contractors, Inc. – West Fargo, ND
- Ernst Trenching – Fargo, ND
- K&H Electric – Linton, ND
- Lopez Construction – Moorhead, MN
- Master Construction – Fargo, ND
- Moorhead Electric – Moorhead, MN
- Riley Brothers Utility Service Company – Morris, MN
- Ripley's, Inc. – Erhard, MN
- Spalj Construction Company, Inc. – Deerwood, MN
- TelCom Construction, LLC – Buffalo, MN
- Wilde Construction, Inc. (MasTec North America, Inc.) – Shevlin, MN

Other contractors and contact information is available from Communication Consultants.

Attachment 6
Area Telecommunications Supplier List

- Border States Electric Supply – Bismarck, ND
- Dakota Supply Group – Fargo, ND
- Graybar Electric – Sioux Falls, SD
- Power and Telephone Supply Co. – Des Moines, IA

Other suppliers and contact information is available from Communication Consultants.