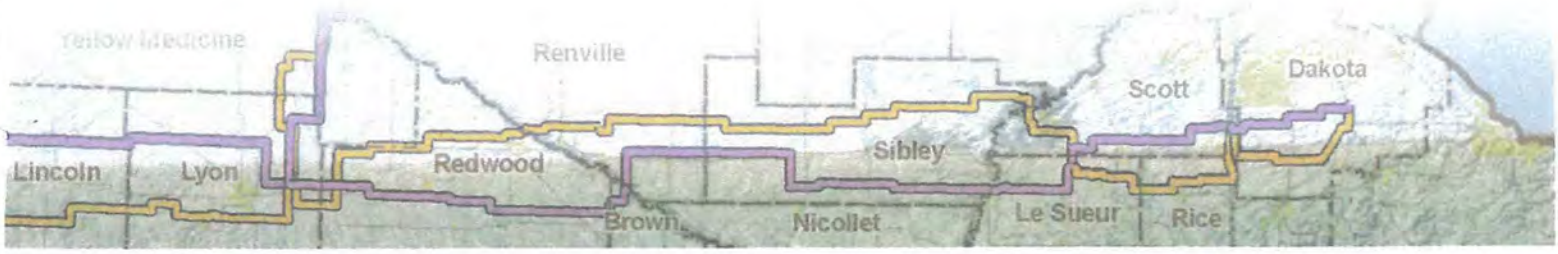


Brookings County – Hampton 345 kV Transmission Line Project

Final Environmental Impact Statement
January, 2010

PUC Docket No. ET2/TL-08-1474

EXHIBIT

tabbies

office of energy security

RESPONSIBLE GOVERNMENT UNIT

Department of Commerce
Office of Energy Security
85 7th Place East, Suite 500
St. Paul, Minnesota 55101-2198

Scott Ek, Project Manager
Energy Facility Permitting
(651) 296-8813
scott.ek@state.mn.us

PROJECT OWNERS

CapX2020
Great River Energy
12300 Elm Creek Boulevard
Maple Grove, MN 55369-4718

Craig Poorker
(888) 473-2279
cpoorker@grenergy.com

CapX2020
Xcel Energy
P.O. Box 9437
Minneapolis, MN 55440-9437

Pamela Rasmussen
(800) 238-7968
pamela.jo.rasmussen@xcelenergy.com

ABSTRACT

Pursuant to the provisions of Minnesota Statutes, Chapter 216E (Power Plant Siting Act), Great River Energy and Xcel Energy (applicants) filed a route permit application with the Minnesota Public Utilities Commission (Commission) on December 29, 2008, for a permit to construct the Brookings County–Hampton 345 kilovolt (kV) transmission line facility consisting of a series of 345-kV and lower-voltage transmission line connections between Brookings County, South Dakota, and the southeast Twin Cities, Minnesota (project).

The proposed project includes a 345 kV high-voltage transmission line, approximately 230 to 270 miles long, depending on the route selected, between the existing Brookings County substation near White, South Dakota, and a new substation near Hampton, Minnesota, as well as a new transmission line between the Lyon County substation near Marshall, Minnesota, and the Minnesota Valley substation near Granite Falls, Minnesota. The project also requires the construction of four new substations, the expansion of four existing substations, and construction of electric system interconnections to tie existing high-voltage transmission lines to the project. Construction of the project is scheduled to begin in fall 2011 with an expected in-service of spring 2013.

The Minnesota Office of Energy Security (OES) issued the draft environmental impact statement for the project on October 20, 2009. As required by Minnesota Rule 7850.2500, subp. 9, OES prepared this final environmental impact statement (FEIS). This FEIS

1.5 Problematic Route Segments

The following is a list of suggested alternative route segments, alternative route alignments, or portions of the applicant's preferred and alternative routes that were found through further analysis in the EIS to have significantly more impacts and obstacles or were far less superior when compared to other similar routes the segment was intended to replace.

For the reasons stated below, OES staff believes the following alternatives should be removed from further consideration for this project:

6P-01, 6P-04, and 6P-05 – HVTLs can conflict with airport navigation systems such as Very High Frequency Omnidirectional Radio Range ("VOR") and Automated Weather Observation Stations ("AWOS). Federal Aviation Administration (FAA) Order 6820.10 "VOR, VOR/DME, and VORTAC Siting Criteria," specifies the distance setback requirements for VOR's from trees, buildings, and metallic structures. These regulations specify that overhead transmission line structures with conductors should be located beyond 1,200 feet of the VOR antenna to avoid communication interference. Additionally, metallic structures are required to subtend vertical angles of 1.2 degrees or less, measured from the ground elevation of the VOR facility. Therefore, according to these FAA guidelines, a VOR air navigational station should not be located within 6,206 feet away from a 130 foot high steel structure in order to avoid potential interference with the operation of the facility. Structures of 175 feet in height should be 8,354 feet away from a VOR.

The location of the Airlake Airport VOR (which is located outside the airport itself) is shown on map in FEIS appendix C, Map (FEIS ID# 262b). As illustrated by this map, route alternative 6P-05 crosses within 50 feet of this VOR. As a result, this alternative is not a viable option. Likewise 6P-04 is just outside the 1,200 foot transmission line setback, making this alternative route an unlikely option also.

Finally, alternative route 6P-01 runs about 4000 feet away from the Airlake Airport VOR, so this route falls within the 6,000-8,000 foot FAA structure setback recommendation. Determining whether there is a transmission line structure option along this route that would be acceptable to the FAA could only be made by filing a notice request from the FAA and /or MN/DOT. The applicants would need to file all necessary notice requirements with FAA and work with both FAA and MN/DOT to ensure compatibility between the transmission lines and air navigation stations and equipment during detailed design should this route be selected in this area.

5P-03 – This alternative route segment would entail running along County Highway 2/Main Street from Jonquil Avenue through the city center of Elko New Market to Interstate 35. There are a combination of variables that make this alternative route

City of Farmington
430 Third Street
Farmington, Minnesota
651.280.6800 • Fax 651.280.6899
www.ci.farmington.mn.us

November 17, 2009

Mr. Scott Ek
Office of Energy Security
85 7th Place East Suite 500
St. Paul, MN 55101-2198

Re: DEIS for Brookings to Hampton 345kV Transmission Line Project
Comments from the City of Farmington

Thank you for the opportunity to review the Brookings County-Hampton 345 kV Transmission Line Draft Environmental Impact Statement (DEIS) dated October 2009. We are commenting on the DEIS, specifically on Segment 6, Lake Marion Substation to Hampton Substation. We understand and appreciate the need to construct this important facility and are writing this letter to support the significant research completed by the applicant to select a preferred route. This letter is not written in opposition of the project, but rather to provide comment on the completeness and accuracy of the DEIS, as additional support for the preferred option, and to provide input related to why alternatives 6P-01, 6P-04, and 6P-05 are not reasonable alternatives for the City of Farmington.

We offer the following comments and observations on these three alternatives.

262a 1. **DEIS Section 6.1.1 – Human Settlement – Visual Impacts**
Farmington is a growing community with a current population close to 20,000. The population doubled between 1990 and 2000 and continues at a rapid pace. It possesses a traditional downtown area, new growth housing areas, farms, open space and natural resources such as the South Creek of the Vermillion River. The alternative alignments would be visible to many residents and businesses and have a significant impact on the viewshed of the City.

There is already an existing HVTL along CSAH 50 and Denmark Avenue as it relates to 6P-01 and part of 6P-05. Installing another line would create a double row of these structures through the area. These lines would traverse populated areas adjacent to homes, schools, and churches. Mitigation for viewshed impacts generally involves screening and/or placing the project in an area with minimum impact. Due to the height of the transmission towers, screening is not possible and therefore placing the towers within the City of Farmington will have a negative impact on the viewshed of the existing community. The impact on having double HVTL on the viewshed for these alignments should be discussed in the EIS.

262b 2. **DEIS Section 6.1.3, 6.1.4, and 7.6 - Residential Development and Displacement :**
There is significant impact to residential properties associated with all three of the routes that pass through the City of Farmington. These three routes all border areas with a considerable number of established residential properties. It appears from mapping and ground review, there are more houses within the 1,000 foot route width than indicated in the DEIS in Farmington. This is outlined in the table below. Additionally, there is a house directly under the diagonal route of 6P-05 where it angles away from 6P-04. Further, some of the residences noted in the DEIS are multi-family dwellings, thus impacting more people. These additional impacts need to be included in the EIS.

262a.

Section 6.1.6 (Existing Utilities) does address the potential conflict with existing utilities to the extent that, "The applicants have stated they would work with landowners and the rural utility providers to avoid direct or indirect impacts to public utilities." and, "It may be necessary for the applicants to work with other public service utilities to relocate their facilities if they conflict with the location of the transmission line."

In addition, Page 6-18 of the applicants' RPA indicates, "The proposed structures would be between 130 and 175 feet tall, typically located just outside the public road ROW. Many of these roads currently do not share a right-of-way with a transmission line, with the exception of power distribution lines serving rural residences and farmsteads. However, the Preferred Route would share right-of-way for short distances in several locations, typically collocating with other routes at entrance and exit points to substations."

An example similar to the city of Farmington's concern with regards to County State-Aid Highway (CSAH) 50 and Denmark Avenue is discussed in the applicants' RPA on page 6-29 and states, "In Dakota County, a home-

Option	*Residences in 150' ROW in EIS*	*Residences in 150' ROW per City review*	*Residences in 1,000' route width in EIS*	*Residences in 1,000' route width per City review*
6P-01	0	0 (14 parcels w/i ROW)	31	33
6P-04	0	0 (1 parcel w/i ROW	0	0
6P-05	1	2 (15 parcels w/i ROW)	16	16

Further, while not all of the houses on Ash Street are within the proposed ROW of 6P-05, two more of them are extremely close (within 5 feet) to the ROW and if this route were to be chosen, they could be displaced.

Not only are there existing structures impacted by the routes, but all three routes border areas identified for new medium to high density residential development (6.0 – 12.0+ dwelling units/acre) in the City's Future Land Use Plan. The construction of route 6P-01, 6P-04 or 6P-05 in Farmington would likely result in portions of these parcels being undevelopable or severely limit the development potential as planned in the City's approved Comprehensive Plan. This is a major impact and a concern of the City of Farmington and ultimately the Met Council, who has approved the City's Comprehensive Plan and zoning density.

262c 3. **DEIS 6.1.4 and 7.6– Displacement of Non-Residential Buildings.**
The DEIS states that buildings would not be allowed within the 150 foot ROW. There are a number of farm outbuildings and other structures along CSAH 50 and Denmark Avenue (including the City's Fire Station) that are extremely close (within 5 feet) of the HVTL ROW that would be affected by this and are not included in the DEIS. Further, the airport's very high frequency omnidirectional radio range (VOR) is located directly within the path of DP-05 in the field west of Ash Street. This will have a significant impact on this airport as well as airports in the region. This impact should be included in the EIS.

262d 4. **DEIS 6.1.6 and 7.6 – Utilities**
The DEIS states that construction of the project is not expected to affect any public utilities. However, there are a number of public and private utilities located within the 150 foot ROW and the 1,000 foot route width.

- **Public Sanitary Sewer:** The City of Farmington recently constructed a 21- inch sanitary sewer line along the west side of Denmark Avenue. There is also a 24-inch sewer along the north side of CSAH 50 between Pilot Knob Road and Denmark Avenue. Further, the Met Council has a 42-inch interceptor line that extends from the border with Lakeville to the east crossing alignments 6P-04 and 6P-05 to the intersection of CSAH 50 and Denmark Avenue. The MCES is constructing a meter for this interceptor within the 6P-04/05 alignment on the western border of Farmington.

- **Public Water Main:** The City has a number of existing and proposed water main lines within the 150 foot ROW and 1,000 foot route width. The existing water main is located along CSAH 50 from near the western border of the City to Denmark Avenue and along Denmark Avenue from CSAH 50 to just north of 220th Street. The City has proposed water main that follows the 6P-04 alignment and water mains that will cross under the 6P-05 alignment.

based daycare facility is located along TH 3/ Chippendale Avenue West, south of the City of Farmington. Electric distribution lines, cable television and telephone lines are located along each of the roads the Preferred Route would follow, providing service to the adjacent homes and businesses. These lines do not present a barrier to construction and operation of the transmission line. It may be necessary for the applicants to work with other public service utilities to relocate their facilities if they conflict with the location of the transmission line." All potential routes are likely to present potential conflicts with other utilities that will have to be addressed during detailed design.

262b.

House locations and numbers (within 500-feet) were reviewed again for the FEIS. The updated house counts (modified slightly from DEIS) and the methods used to produce these data are provided in Appendix F. In addition, we did count multi-unit dwellings where individual units—such as townhomes—were distinguishable. Because the route centerlines we used to calculate the house counts and other methodology differences, our house

- **Other Utilities:** There is buried underground cable both north and south along CSAH 50 and gas lines along CSAH 50 and Denmark Avenue. The Northern Natural Gas Company is located in the northwest quadrant of CSAH 50 and Denmark Avenue. There are existing HVTL power lines along the north side of CSAH 50 and the east side of Denmark Avenue. Xcel Energy has a substation at the southeast quadrant of CSAH 50 and Denmark Avenue.

Construction of 345 kV transmission lines as shown in alternatives 6P-01/04/05 through Farmington would be difficult as the corridor is congested with existing public utilities. Additional transmission lines would not only be difficult to locate in this corridor, but the ability to access and maintain all utilities in the right-of-way would be compromised. Transmission lines constructed near public utilities such as sanitary sewers and water mains must be located sufficiently far away from the utility so that access and maintenance can be maintained to the pipe and manholes. HVTL lines cannot be shielded to protect arcing from backhoes or other construction equipment, thereby limiting effective access to existing systems and constructing planned improvements. Any electrical tower should be a minimum distance away from the pipeline so the utility can be dug up without undermining or adversely affecting the base of any electrical tower. This should be determined on a case by case basis, but in general could be around 50-feet in spacing. Working around or relocating these facilities and the associated underground utilities in this area will make the 6P-01/04/05 options prohibitively expensive and impact the City's existing and proposed infrastructure. These impacts need to be addressed in the EIS.

262e 5. **DEIS Section 6.7/6.8 7.6– Land Use Compatibility and Land-Based Economies**
The DEIS recognizes the land use impact of 6P-01, 6P-04, and 6P-05 on future land use in the City. Farmington is a fast growing suburban community that has grown in population by 54% from 2000 to 2008. With this rapid growth comes significant planning of infrastructure and economic development. All the proposed routes in Farmington are within or adjacent to the current Metropolitan Urban Service Area (MUSA) for some or most of their length. The MUSA is how growth is controlled by the Metropolitan Council and the City has designated these areas for commercial, business, and residential development to meet the Met Council's density requirements. Considering these areas for use as HVTL ROW significantly impacts density and development goals for the City set by Met Council, disrupts economic development, and negates the years of planning completed by the City and its residents for this area. The cost of this impact is significant in actual dollars, but more significant is the time of the many people involved.

- **Businesses:** There are a number of businesses within the City of Farmington affected by the 6P-01 and 6P-05 routes passing through the City. While none of these businesses are within the 150 foot ROW, many of them are within the 1,000 foot route width. The table below outlines the building footprint of the commercial and industrial buildings in Farmington.

Option	*Commercial Building Footprint with 1,000' route width*	*Industrial Building Footprint with 1,000' route width*
6P-01	147,260 sf	40,600 sf
6P-04	0 sf	0 sf
6P-05	7,000 sf	88,000 sf

Not only are there existing structures impacted by two of the routes, but all three routes border areas identified for new commercial, industrial, and residential development in the City's newly adopted Comprehensive Plan. The construction of route 6P-01, 6P-04 or 6P-05 would likely leave these parcels less developable and thus impact economic development in the City.

- **Schools:** Route 6P-01 is proposed along Denmark Avenue and passes by Boeckman Middle School. This school currently has 734 students enrolled and capacity for 1,000 students. Along with the students, there are approximately 80 faculty and staff working in the school. Well over half of the structure for this school sits within the 1000-foot route width for the transmission line.

counts may not match precisely with the City of Farmington's.

262c.

We have prepared a map of the commercial buildings within 150-feet and 500-feet of the initial route centerline in this area that is provided in Appendix C, map FEIS ID#262a. The location of the fire station, for example, is shown on this map.

262d.

Section 6.1.6 (Existing Utilities) does address the potential conflict with existing utilities to the extent that, "The applicants have stated they would work with landowners and the rural utility providers to avoid direct or indirect impacts to public utilities." and, "It may be necessary for the applicants to work with other public service utilities to relocate their facilities if they conflict with the location of the transmission line." (See response to FEIS ID#262a).

262e.

The DEIS does provide overall socioeconomic and human settlement data for each segment analyzed in Section 7.0 of the document. See also response to FEIS ID#262c.

The Christian Life School is located on the south side of CSAH 50. This school has 201 students in kindergarten through 12th grade as well as in their preschool program. In this area, route 6P-01 will pass by the school on CSAH 50. The 1,000-foot route width from route 6P-01 includes a portion of one of the buildings for this school. Additionally, route 6P-04 is proposed on the southern portion of the property for this school. There is a structure completely contained within the 1,000-foot route width from this route.

Based on the proximity of the proposed alignments of alternatives 6P-01 and 6P-04 to schools in this area, the City does not believe that these alignment options are appropriate. While the DEIS mentions that no significant health impacts have been observed from these types of transmission lines, many people remained concerned especially relating to children.

- **Religious Institutions**: There are two churches that lie in the 1000-foot route width for these transmission lines. The Christian Life Church is located on the south side of CSAH 50 in the same location as the Christian Life School. The facility used for worship is completely within the route width for route 6P-01. Alternative 6P-04 passes on the south side of the property for this church. This church has 320 members and average attendance for worship around 200 people.

  The Church of Saint Michael is located on Denmark Avenue at Ash Street. The entire property of this church falls within the 1,000-foot route width of both route 6P-01 and route 6P-05. This church has approximately 1,400 members and average attendance for worship around 800 people.

  The City does not consider any of these three alignments to be suitable based on their proximity to these two churches.

262f 6. **DEIS Section 6.9.2 - Airports**
Although the Airlake Airport is not within the city limits of Farmington, it is in close proximity to the City and the impacts to the three routes reviewed are significant and warrant inclusion in this letter. It should also be noted that additional impact analysis is needed in the EIS for the airport as 6P-05 is aligned so that it impacts the airport's very high frequency omnidirectional radio range (VOR). This would have significant relocation impacts for the VOR and impacts on communication for the local airport as well as any airports in the region. This needs to be addressed in the EIS.

All three routes run along 215th Street in the vicinity of the airport. These portions of the routes lie within the runway flight path and secondary clearance zones for the airport. The FAA restricts poles in this area to 150-feet in height. The standard for a pole carrying 345kV Transmission Lines is 175-feet. In the route selection process, several alternative poles were considered as well as consideration for burying the line in this segment. These options were not found to be feasible or cost effective, and, therefore, not recommended.

The route selection process concluded that development in vicinity of the airport was not recommended because of technical restrictions and additional impacts. The City concurs and supports these conclusions and believes that these alignment options are not viable based on the impacts associated with the airport.

262g 7. **DEIS Section 6.11/6.12 - Wetland / Water Bodies / Flora and Fauna**
Map 7.6-20 in the DEIS does not adequately address temporary and permanent wetland impacts in the City of Farmington. There are many wetland crossings for 6P-01/04/05 in Farmington, but are not noted as wetland impacts. These impacts need to be analyzed more fully in the EIS, especially since the routes are crossing wetlands associated with trout streams. Further, these wetlands are designated as a greenway corridor and protected in the City's Wetland Management Plan (see below). Information should be provided in the EIS if access roads to each tower will need to be constructed and if this is anticipated to impact wetlands.

The City's Wetland Management Plan was completed in 1997 and updated in 2008. A map from the Plan has been attached to these comments for reference. The proposed alignments cross many wetlands that are

262f.

First, regarding the runway flight path, the height of the transmission lines would be restricted to approximately 150-feet, which is feasible.

However, as the comment indicates, there is a Very High Frequency Omnidirectional Radio Range ("VOR") air navigation systems and Automated Weather Observation Stations("AWOS") located in this area. FAA Order 6820.10 "VOR, VOR/DME, and VORTAC Siting Criteria," specifies the distance setback requirements for trees, buildings, and metallic structures. These regulations specify that overhead transmission line structures with conductors should be located beyond 1,200 feet of the VOR antenna to avoid communication interference. Additionally, metallic structures are required to subtend vertical angles of 1.2 degrees or less, measured from the ground elevation of the VOR facility. Therefore, according to these FAA guidelines, a VOR air navigational station should not be located within 6,206 feet away from a 130 foot high steel structure in order to avoid potential interference with the operation of the facility. Structures of 175 feet in height should be 8,354 feet away from a VOR.

classified as "Protect" and this classification indicates that these are high quality wetlands. The City has specific standards for all of their wetlands, which are more restrictive than State and Federal rules.

Based on the National Wetland Inventory, we estimated that each alternative will cross the following wetland acreages within the City:

Alignment	*75 foot ROW width*	*1,000 foot route width*
6P-01	1.8 acres	18.6 acres
6P-04	3.0 acres	13.6 acres
6P-05	2.2 acres	18.3 acres

Both direct and indirect impacts to these wetlands, especially the "protect" wetlands, need to be more fully explored in the EIS. Because of these impacts, these alignment options are not fitting alternatives.

262h 8. **DEIS 6.1.5 – Trees and Windbreaks**
The DEIS indicates that reducing the amount of tree and windbreak removal was identified as important during many of the public meetings. Many of the wetland crossings for 6P-01, 6P-04, and 6P-05 contain trees which provide habitat in the area. Additionally, there is an east/west windbreak in the field associated with the 6P-04 alignment. Trees would either need to be fully removed or topped to accommodate the HVTL in these areas, thus resulting in a negative impact on residents and wildlife in the area.

9. **DEIS Section 6.6 and 7.6– Archeological and Historic Resources**
The City of Farmington is rich in historic architecture. The three routes all impose impacts to historic sites within the City. Sites were identified in the DEIS that were within one-half mile from the centerline routes evaluated for these transmission lines. There were 20 sites identified for alternative 6P-01, 15 for alternative 6P-04 and 12 for alternative 6P-05. While it is understood that the DEIS has not specifically identified the extent and location of these resources due to their sensitive nature, it should be noted that the City is concerned about impacts on these resources and does not see that mitigation of these impacts is feasible based on the proposed impact.

262i 10. **DEIS Section 6.10 - Parks / Recreation Areas**
The Rambling River Park is located to the east of Denmark Avenue near the South Fork of the Vermillion River. This park has many facilities including recreation fields. Two of the baseball fields located on this park are within the route width of 6P-01. There are two additional baseball fields just north of the Rambling River Park on the northeast corner of Denmark Avenue and CSAH 50. This property is owned by the Farmington School District. One of the baseball fields at this location is within the route width of 6P-01.

The South Creek of the Vermillion River is also identified as a Trout Stream in the area crossed by all alternatives 6P-01/04/05. This river is utilized by fisherman and provides recreational opportunity and is directly impacted by these alternatives.

There is a paved trail along the north side of the length of CSAH 50. Additionally, the City is constructing a trail on the south side of CSAH 50 near Denmark Avenue. This area will provide recreational uses for walker and bikers and should be identified in the EIS.

262j 11. **DEIS Section 6.12 and 7.6 - Wildlife**
With any large structure such as, tall buildings, guy wires, wind turbines and transmission lines, there are concerns related to impacts on birds and bats. However, impacts can be reduced if transmission lines are placed in areas where critical habitat for wildlife is less prevalent. The alignment options in the City of Farmington cross a number of wetland and greenway corridor areas. These areas are prime habitat for birds and other wildlife. Placing the transmission lines in these areas will continue to fragment the habitat as well as increase the likelihood of bird and bat collisions. Choosing alignments that have less suitable habitat would reduce this impact.

The location of the Airlake Airport VOR in this area and the applicable setbacks is shown on map FEIS ID#262b in Appendix C. As illustrated by this map and the comment, route alternative 6P-05 crosses within 50 feet of this VOR. As a result, this alternative is not a viable option. Likewise 6P-04 is just outside the 1,200 foot setback, making this alternative route an unlikely option also. Finally, alternative route 6P-01 runs about 4000 feet away from the VOR, which is within the FAA structure setback recommendation. A definitive decision on what the acceptable height of a transmission line structure or design would be for this route segment could only be made by filing a notice request from the FAA and/or MN/DOT. The applicants would need to file all necessary notice requirements with FAA and work with both FAA and MN/DOT to ensure compatibility between the transmission lines and air navigation stations and equipment during detailed design should this route be selected.

262g.

The detailed wetland data used in the DEIS is provided in Appendix B of the FEIS (FEIS ID#46). In addition, the detailed maps of the NWI wetlands in the vicinity of the property near

Thank you for the opportunity to comment on the DEIS. If you have questions or wish to discuss these comments with City Staff, please feel free to call me at 651-280-6820.

Sincerely,
City of Farmington

Lee Smick, AICP
City Planner

Farmington are shown on Figures LH7A and LH7B in Appendix A of the DEIS. Wetland data in the DEIS are based on the National Wetland Inventory. No wetland delineations will be conducted until a route has been chosen where necessary. Therefore, the DEIS wetland data may not match the City of Farmington data precisely. See also response to FEIS ID#188a.

262h.

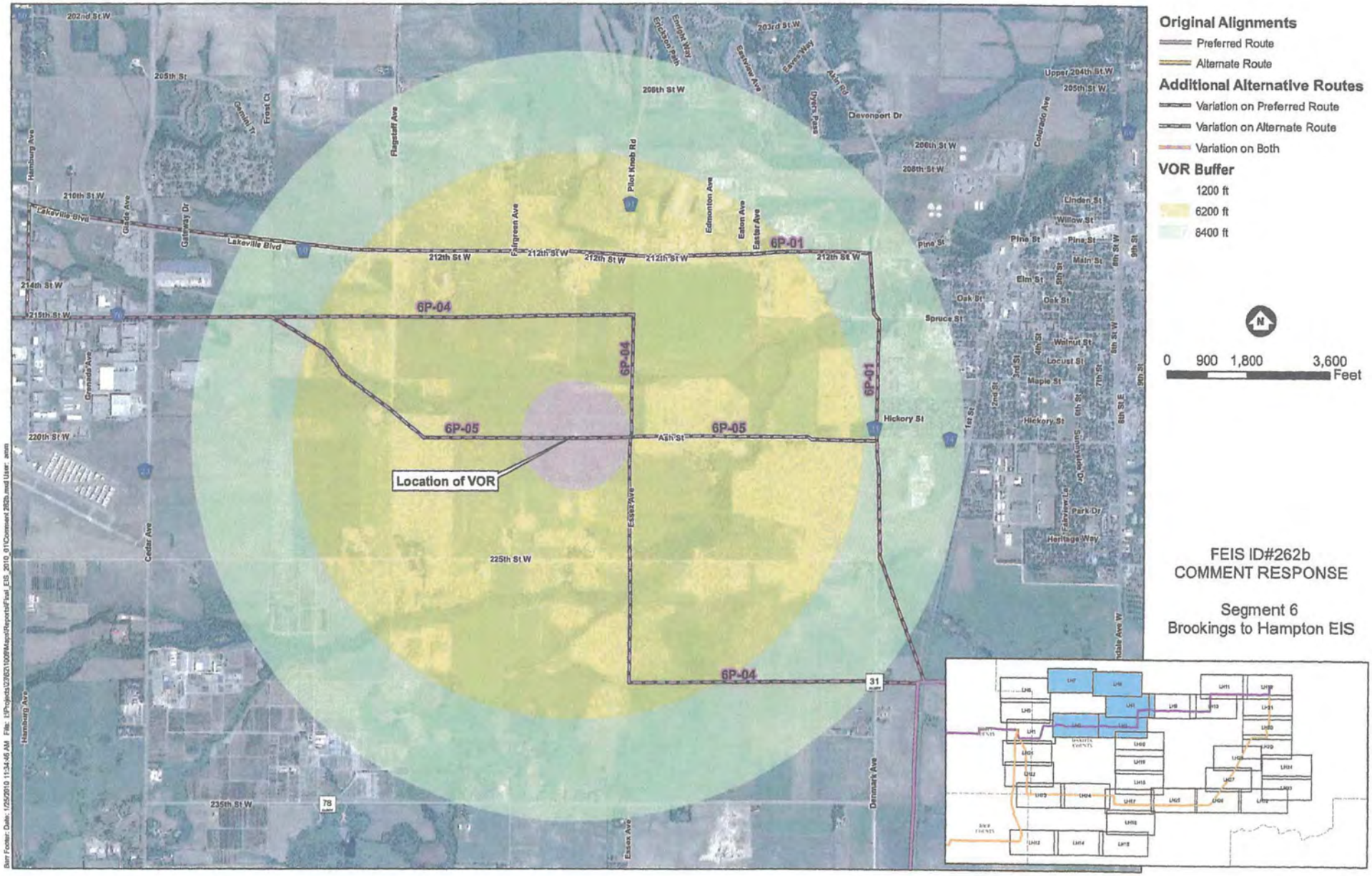
Comments noted.

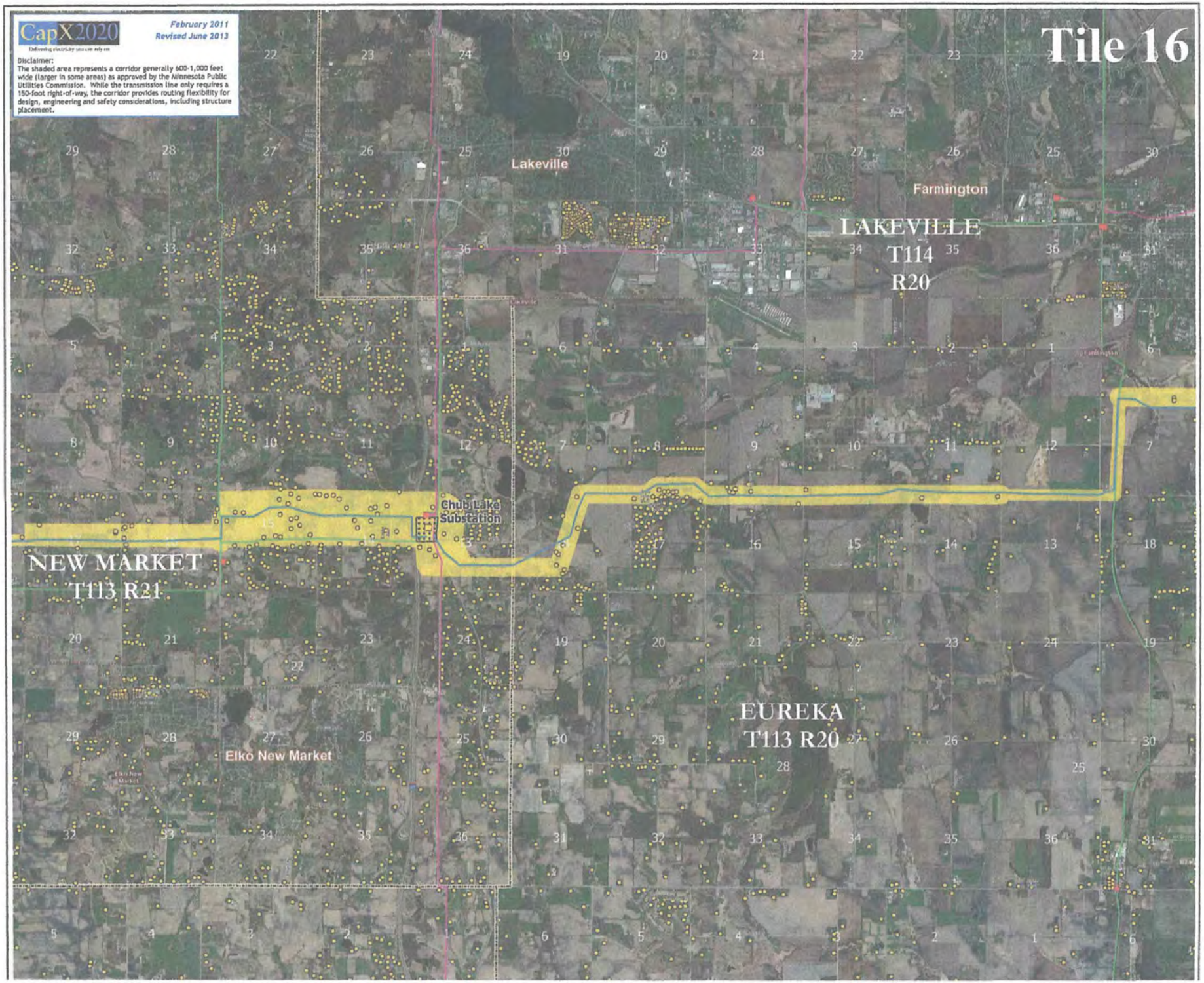
262i.

The DEIS maps note the locations of publically available data of locations of local parks, streams, and similar resources available at the time the RPA and DEIS were completed. The additional existing or planned park and facilities highlighted in the comment are noted.

262j.

Comments noted.


Original Alignments
Preferred Route
Alternate Route
Additional Alternative Routes
Variation on Preferred Route
Variation on Alternate Route
Variation on Both
VOR Buffer
1200 ft
6200 ft
8400 ft
0 900 1,800 3,600 Feet
FEIS ID#262b
COMMENT RESPONSE
Segment 6
Brookings to Hampton EIS
Location of VOR
6P-01
6P-04
6P-05
202nd St W
205th St
208th St W
210th St W
212th St W
214th St W
215th St W
220th St W
225th St W
235th St W
Lakeville Blvd
Flagstaff Ave
Pilot Knob Rd
Edmonton Ave
Eaton Ave
Easter Ave
Fairgreen Ave
Hamburg Ave
Cedar Ave
Essex Ave
Denmark Ave
Colorado Ave
Devonport Dr
Upper 204th St W
Linden St
Willow St
Pine St
Main St
Elm St
Oak St
Spruce St
Walnut St
Locust St
Maple St
Hickory St
Ash St
Park Dr
Heritage Way
Gateway Dr
Grenada Ave
Gaide Ave
Carnahl Tr
Frost Ct
Eagle Path
Knight Way
Eaglesview Ave
Eaves Way
Ashn Rd
Cypress Pass
78
31


CapX2020
February 2011
Revised June 2013
Disclaimer:
The shaded area represents a corridor generally 600-1,000 feet wide (larger in some areas) as approved by the Minnesota Public Utilities Commission. While the transmission line only requires a 150-foot right-of-way, the corridor provides routing flexibility for design, engineering and safety considerations, including structure placement.
Tile 16
Lakeville
Farmington
LAKEVILLE
T114
R20
Chub Lake
Substation
NEW MARKET
T113 R21
Elko New Market
EUREKA
T113 R20

6-3-10. EVALUATING EFFECT ON AIR NAVIGATION AND COMMUNICATION FACILITIES

a. The FAA is authorized to establish, operate, and maintain air navigation and communications facilities and to protect such facilities from interference. During evaluation of structures, factors that may adversely affect any portion or component of the NAS must be considered. Since an electromagnetic interference potential may create adverse effects as serious as those caused by a physical penetration of the airspace by a structure, those effects must be identified and stated. Proposals will be handled, when appropriate, directly with FCC through Spectrum Assignment and Engineering Services.

b. Technical operations services personnel must evaluate notices to determine if the structure will affect the performance of existing or proposed NAS facilities. The study must also include any plans for future facilities, proposed airports, or improvements to existing airports.

c. The physical presence of a structure and/or the electromagnetic signals emanating or reflecting there from may have a substantial adverse effect on the availability, or quality of navigational and communications signals, or on air traffic services needed for the safe operation of aircraft. The following general guidelines are provided to assist in determining the anticipated interference.

1. Instrument Landing System (ILS) – Transmitting antennas are potential sources of electromagnetic interference that may effect the operation of aircraft using an ILS facility. The antenna height, radiation pattern, operating frequency, effective radiated power (ERP), and its proximity to the runway centerline are all factors contributing to the possibility of interference. Normally, any structure supporting a transmitting antenna within the established localizer and/or glide-slope service volume area must be studied carefully. However, extremes in structure height, ERP, frequency, and/or antenna radiation pattern may require careful study of structures up to 30 NM from the ILS frequency's protected service volume area.

(a) ILS Localizer. Large mass structures adjacent to the localizer course and/or antenna array are potential sources of reflections and/or re-radiation that may affect facility operation. The shape and intensity of such reflections and/or re-radiation depends upon the size of the reflecting surface and distance from the localizer antenna. The angle of incidence reflection in the azimuth plane generally follows the rules of basic optical reflection. Normally, in order to affect the course, the reflections must come from structures that lie in or near the on-course signal. Large mass structures of any type, including metallic fences or powerlines, within plus/minus 15 degrees of extended centerline up to 1 NM from the approach end of the runway and any obstruction within 500 feet of the localizer antenna array must be studied carefully. (Refer to FAAO JO 6750.16, Siting Criteria for Instrument Landing Systems).

(b) ILS Glide Slope. Vertical surfaces within approximately 1,000 feet of the runway centerline and located up to 3,000 feet forward of the glide slope antenna can cause harmful reflections. Most interference to the glide slope are caused by discontinuities in the ground surface, described approximately as a rectangular area 1,000 feet wide by 5,000 feet long, extending forward from the glide slope antenna and centered at about the runway centerline. Discontinuities are usually in the form of rough terrain or buildings (refer to FAAO JO 6750.16, Siting Criteria for Instrument Landing Systems).

2. Microwave Landing System (MLS). The guidelines stated for ILS systems above also apply to MLS installations. The established MLS service volume defines the area of concern.

3. Very High Frequency Omni-Directional Radio Range and Tactical Air Navigation Aid (VOR/TACAN). Usually, there should be no reflecting structures or heavy vegetation (trees, brush, etc.) within a 1,000 foot radius of the VOR or the TACAN antenna. Interference may occur from large structures or powerlines up to 2 NM from the antenna. Wind turbines are a special case, in that they may cause interference up to 8 NM from the antenna. (Refer to FAAO 6820.10, VOR, VOR/DME, and TACAN Siting Criteria).

4. Air Route Surveillance Radar/Airport Surveillance Radar (ARSR/ASR). Normally, there should be no reflecting structures within a 1,500-foot radius of the radar antenna. In addition, large reflective structures up to 3 NM from the antenna can cause interference unless they are in the "shadow" of

ATDI

Navigational Aid Clearance Criteria per FAA Order 6820.10

February 2011

MARTIN RAIS

Software Solutions in Radio Communications

What Are Navigational Aids?

Navigational information is provided to airplanes by more than one radio frequency system. Though recent innovations in satellite navigational technology have led to an increase in Global Positioning System (GPS) usage, navigational systems (also known as navigational aids) like non-directional beacons, civilian VOR and DME and the military TACAN are the backbones of air navigation and will continue to be in use for many years to come.

A VOR, or VHF omnidirectional radio, is a radio navigation system that broadcasts a navigational signal as well as voice and identifying information. Commercial aircraft use the VOR signal to determine magnetic bearing to a VOR beacon and to obtain any important broadcast information. The bearing information is obtained from the manner in which the VOR signal is modulated.

A DME, or distance measuring equipment, is another VHF radio system that is used to measure the slant range distance between an aircraft and a DME beacon. It works on radar ranging techniques. A DME station receives and decodes the RF pulse emitted by an airborne transponder and provides a reply after a 50-microsecond delay. Based on the time difference between transmission and arrival at the airborne transponder, the aircraft systems are able to calculate the distance to a DME beacon.

TACAN, or tactical air navigation, is the military combination of the civilian VOR and DME systems. Operating between 960 and 1215 MHz, it is a polar coordinate type radio air navigation system. TACAN is three to nine times as accurate as VOR. When a VOR and a TACAN are co-mounted, the installation is called a VORTAC; in this case, the distance measuring portion of the TACAN is available to both civil and military users while the bearing system is not shared.

Whether an aircraft is civilian or military, the bearing and distance information provided is displayed as two dials to the aircrew, one for each function. The aircrew uses the information provided by the two dials to fly towards a beacon or to establish geographic location with respect to a beacon. The information may also be used to intersect radials and flight paths. The two most common uses of the systems are to navigate along a certain flight path that is defined beacon-to-beacon or to perform an instrument-based approach to an airport.

Interference Caused to Navigational Aids

Much like other radio frequency systems, navigational aids are also subject to interference that may negatively impact the system, causing errors and potentially disabling the system entirely. For air navigation, where precision is important, it is vital to minimize the chances of error or system outage. For that reason, mandates such as the Federal Aviation Authority's Order 6820.10 exist. Entitled VOR, VOR/DME, and VORTAC Siting Criteria, Order 6820.10 establishes important siting criteria for buildings, vegetation, and other structures in the operational volumes of navigational aids. The interference effects of interest are shadowing, reflections, and Fresnel zone clearance.

Shadowing, caused by a tree, a fence, a building, or any tall structure, occurs when electromagnetic energy impacts upon an object and is scattered in various directions, preventing the energy in continuing in its forward path at undiminished power. Thus, a volume is created behind the obstruction where the electromagnetic energy penetrates partially or not at all. If aircraft are to be located in this volume of little to no signal, the communications with navigational aids may become unreliable or be lost completely.

Reflection is a phenomenon directly related to shadowing. When electromagnetic energy is incident upon an obstruction, it is scattered in many directions if the surface is not smooth and in one general direction if the surface is smooth. A single scattered ray or a group of rays scattered in one direction are also known as a reflection, or reflected rays. The reflected rays

might impact other communications systems that operate on similar frequencies, causing interference. The reflected rays may also be reflected in such a way that they arrive at a receiver along with direct rays. Called multipath, the reflected rays may sum constructively or destructively at the receiver, depending on whether the reflected rays arrive in or out of phase with the direct signal. Multipath is directly related to Fresnel zones.

Fresnel zones are concentric elliptical volumes found around a direct signal path line that alternately add or subtract energy from the total amount of energy received. While odd numbered Fresnel zones add energy, even numbered Fresnel zones subtract energy. The closer a Fresnel zone is to the direct path line of the signal, the more energy it contains. For this reason, it is desirable to maintain an unobstructed first Fresnel zone so that all the energy contained within it reaches the receiver. Obstructions within the second Fresnel zone can cause reflections that may sum negatively at the receiver, ultimately lowering the amount of power received or even creating a null in the signal.

Navigational Aid Clearance Analysis in ATDI RF Planning Software

ATDI's RF planning software allows a user to perform a navigational aid obstruction analysis quickly and efficiently. With precise cartography as the foundation for any RF study, the user can select an area and place a navigational aid and individual obstructions within minutes. In the figure below, a hypothetical navigational aid has been placed at Washington Reagan National Airport, located in Arlington County, Virginia.

Figure 1: Hypothetical navigational aid at Reagan National Airport

Now, two types of analysis may be performed. The first type refers to a rule in FAA Order 6820.10 and the second refers to minimum safe altitudes. FAA Order 6820.10 states that any structure that is wholly or partially metallic may not subtend a vertical angle greater than 1.2° with respect to the beacon and measured at ground level from the beacon site. It is important to include Earth dip into the calculation for the utmost accuracy. The figure below portrays the 1.2° criterion as well as the effect of Earth dip.

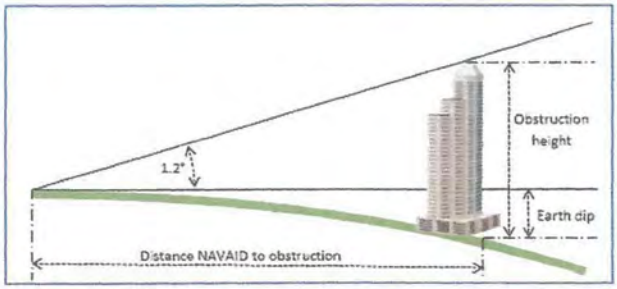


Figure 2: 1.2 degree vertical angle rule

The ATDI software takes into account not only Earth dip, but also any and all terrain features in the area of the navigational aid as well as the height of the obstruction. Once the 1.2 degree rule function is run in the software, the following images is the outcome. The inside of the red contour represents the area where construction of any obstruction that subtends more than 1.2° with respect to the navigational beacon would be in violation of FAA Order 6820.10.

Figure 3: Exclusion zone based on FAA 1.2 degree rule

In this case, the hypothetical exclusion zone affects the entire area of the airport as well as a portion of Arlington County and the Southeast quadrant of the District of Columbia.

The second type of analysis performed by a separate function in the ATDI RF planning tool creates contours based on expected flight altitudes near the navigational aid. The user enters a minimum safe flight altitude and a distance between the navigational beacon and an aircraft for that altitude at which he requires communication unaffected by obstructions. Shadowing and null creation are the two major concerns behind this analysis. The software provides a 360 degree contour based on the flight altitude, distance to the expected obstruction, obstruction height, and variations in the elevation in the area.

The contour that is calculated (shown in red in the figure below) provides for first Fresnel zone clearance of the direct signal from the navigational aid to aircraft. This is provided according to FAA Order 6820.10 in order to minimize the risk of reflections that may negatively sum at the receiver site, potentially creating a null signal.

Figure 4: Flight altitude requirement

Conclusion

Though GPS-based navigation is gaining in popularity, navigational aids such as VOR and DME are and will continue to serve as the navigational backbones for worldwide air travel. Protection of the airspace around them is crucial to maintaining safety in the skies. The implementation of functions based on FAA rules into ATDI RF planning software allows for detailed analysis of potential obstruction issues.

For further information visit:
www.atdi.us.com, www.atdi.com
Tel: 703-848-47-50
© Copyright 2011 ATDI Inc.