FORTISBC

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January 6, 2006

Via email
Original via courier

Mr. Robert J. Pellatt
Commission Secretary
British Columbia Utilities Commission
Box 250, Sixth Floor, 900 Howe Street
Vancouver BC V6Z 2N3

Dear Mr. Pellatt:

Re: Nk'Mip (East Osoyoos) Transmission & Substation CPCN Application - Project #3698407

Please find enclosed 20 copies of the FortisBC response to BCUC Information Request No. 2 and Intervenor Information Requests regarding the above noted project.

In the response to Karow Information Requests 3.9, 3.10, and 3.18.1, references are made to a report from Dr. William H. Bailey PhD. of Exponent, which is found at Karow Appendix 3.9. This report will be distributed no later than Monday, January 9, 2006.

Please also note a typographical error was contained in the response to BCUC IR1, Q3.2 dated December 16, 2005. The response states "...loading value for 2005 is forecast ....". This should read 2025 rather than 2005.

Should the Commission have any questions in this matter, please address your queries to the undersigned at the above address.

Yours truly,

(original signed by G. Isherwood)

George Isherwood
Director, Regulatory Affairs

cc: Registered Intervenors
Osoyoos Public Library

1.0 Reference: Application, p. 27

FortisBC refers to the existing transformer in the West Osoyoos substation as a safety hazard to the employees, public and environment.

Q1.1 Please describe why the transformer is considered to be a safety hazard and discuss the risks to employees, the public and the environment. Please also discuss the likely hood of an incident and the relative consequences of an incident.

A1.1 The level of ethylene gas obtained from the Dissolved Gas Analysis test on Transformer 2 at the Osoyoos Substation indicates localized heating and pyrolysis resulting in a weaker insulation and consequent loss of life. System faults that are a normal occurrence on the 13 kV network may further impose stress to this already weak insulation and may initiate a failure of the insulation system and subsequent failure of the transformer. Transformers are constructed of materials such as metal, porcelain, oil, and paper insulation etc**.** Transformer failure modes range from "very minor" where there is no visible damage to the transformer to "major" where there is bulging of the metal tank, porcelain breakage and on the rare occasion an oil fire. Based on the overall condition assessment, FortisBC considers Transformer 2 at the Osoyoos Substation to have an elevated risk of failure.

FortisBC employs industry standards in the design and construction of its transformer protection systems. While there is no way to eliminate all possible risks and consequences of operating oil-filled transformers, proper power system design and systematic preventive maintenance minimizes such risk and consequences. FortisBC's judgment is outlined in response to BCUC IR1 Q2 FortisBC Capital Expenditure Plan, that if no action is taken, the probability of failure of Transformer 2 at the Osoyoos Substation is high due to its present condition as indicated above. However the probability of a "major" event involving the transformer and the ensuing risk to the various groups under such a scenario is very low. System protection systems are designed to minimize catastrophic damage to the internal working parts of the transformer causing little risk to persons or other equipment.

Some potential risks are as noted:

Employees:

1. Personal injury as a result of being hit by debris if they were present when an explosive failure occurred.
2. Personal injury as a result of power restoration efforts under emergency / unplanned conditions. This is a normal utility condition and is not an undue risk.
3. Personal injury as a result of smoke inhalation (if a transformer oil fire occurred).

Public:

1. Personal injury as a result of smoke inhalation (if a transformer oil fire occurred).
2. Personal injury as a result of being hit by debris if they were in close proximity to the transformer when the explosion occurred. This risk is low due to the wire fence around the substation which prevents close access by the general public.

Environment:

1. Oil Spill / related contamination
2. Minor air pollution as a result of a fire.
3. Incidental damage to adjacent equipment or control buildings.

Q1.2 Please provide photographs of the West Osoyoos substation, showing the proximity of adjacent structures.

A1.2 The photographs are attached as BCUC Appendix A1.2AB, A1.2CD and A1.2EF.

2.0 Reference: BCUC IR Response 10.2, p. 27

Q2.1 Please provide a map similar to those provided in appendix A10.1 for the customer proposed route options.

A2.1 Please refer to BCUC Appendix A2.1 attached.

3.0 Reference: BCUC IR Response 10.2, Route Option A

Q3.1 Please provide photographs showing the proposed pole locations along Kingfisher Drive and the causeway.

A3.1 The spatial location of the poles from Kingfisher Drive and the causeway (Osoyoos Substation to Lakeshore Drive) is indicated in the sketches attached as BCUC Appendix A3.1.1, A3.1.2 and A3.1.3.

Several representative and corresponding photographs of the above referred to poles are included in BCUC Appendix A3.1.4L, A3.1.7L, A3.1.11L, A3.1.16L, A3.1.18L, A3.1.30L and A3.1.34L. (Photos of specific poles are available upon request).

Please note that proposed pole locations are adjacent to existing pole locations and will replace the existing pole.

Q3.2 Please provide cross sectional drawings for several examples of pole locations along Kingfisher drive and the Causeway and provide dimensions of horizontal and vertical measurements. The Cross section should include the entire street and show residences.

A3.2 The cross sectional drawings for several pole locations along Kingfisher Drive and the causeway are attached as BCUC Appendix A3.2a, A3.2b, A3.2c, A3.2d, A3.2e and A3.2f.

The corresponding photographs of the poles are attached as BCUC Appendix A3.2a 6L, A3.2b 8L, A3.2c 9L, A3.2d 10L, A3.2e 19L and A3.2f 20L.

4.0 Reference: BCUC IR Response 10.6, p. 29

Q4.1 What would be the increase in pole heights needed to further reduce EMF levels and what is the associated reduction in EMF levels?

A4.1 Any increase in pole heights would reduce EMF levels at the measured height of 1 meter from the ground level. However, with reference to the response to BCUC IR1, Q10.6, the comparative EMF levels for 55 feet poles and 60 feet poles for the proposed configurations at normal and at maximum load levels are shown below in Figure 4.1a and Figure 4.1b below.

FIGURE 4.1a

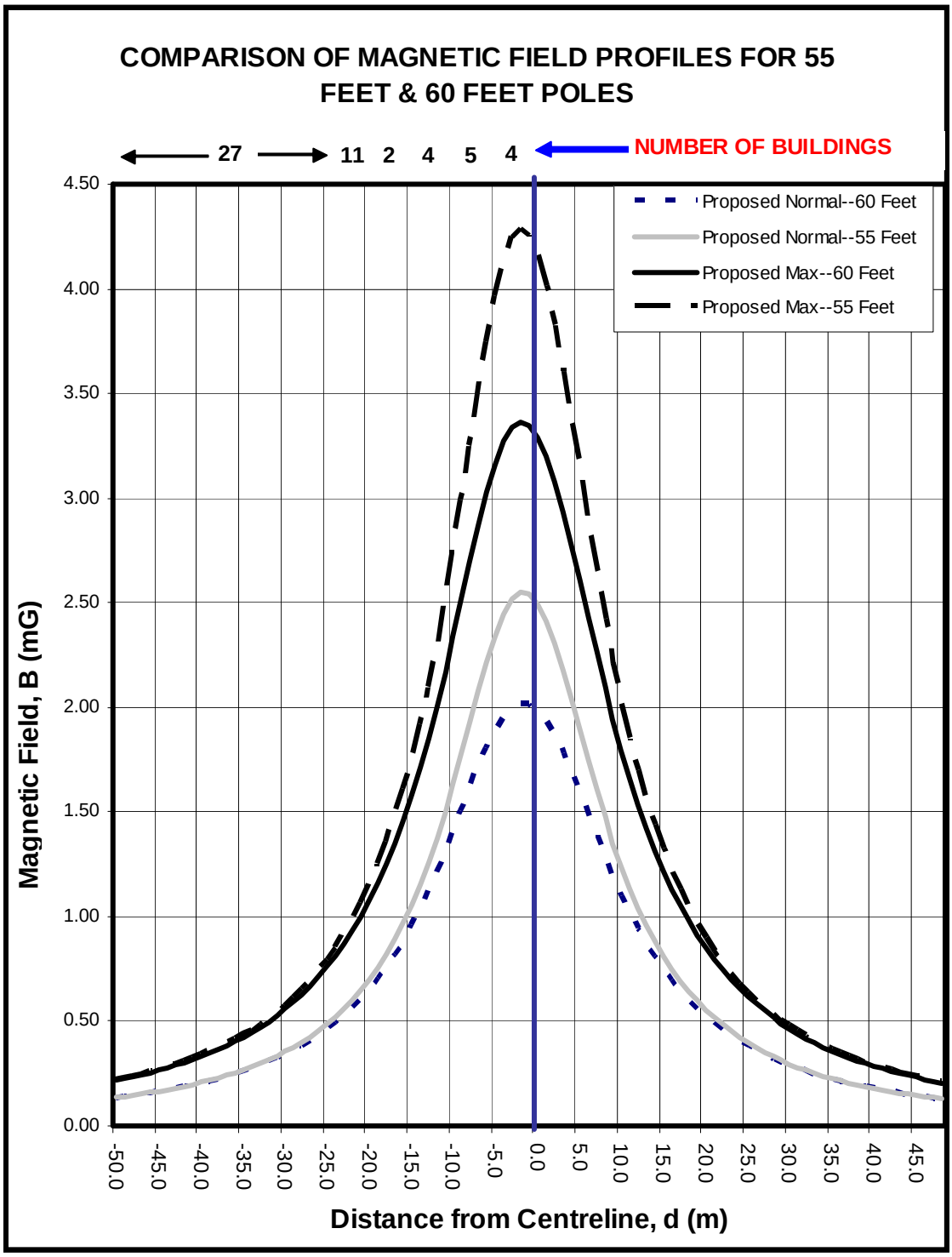
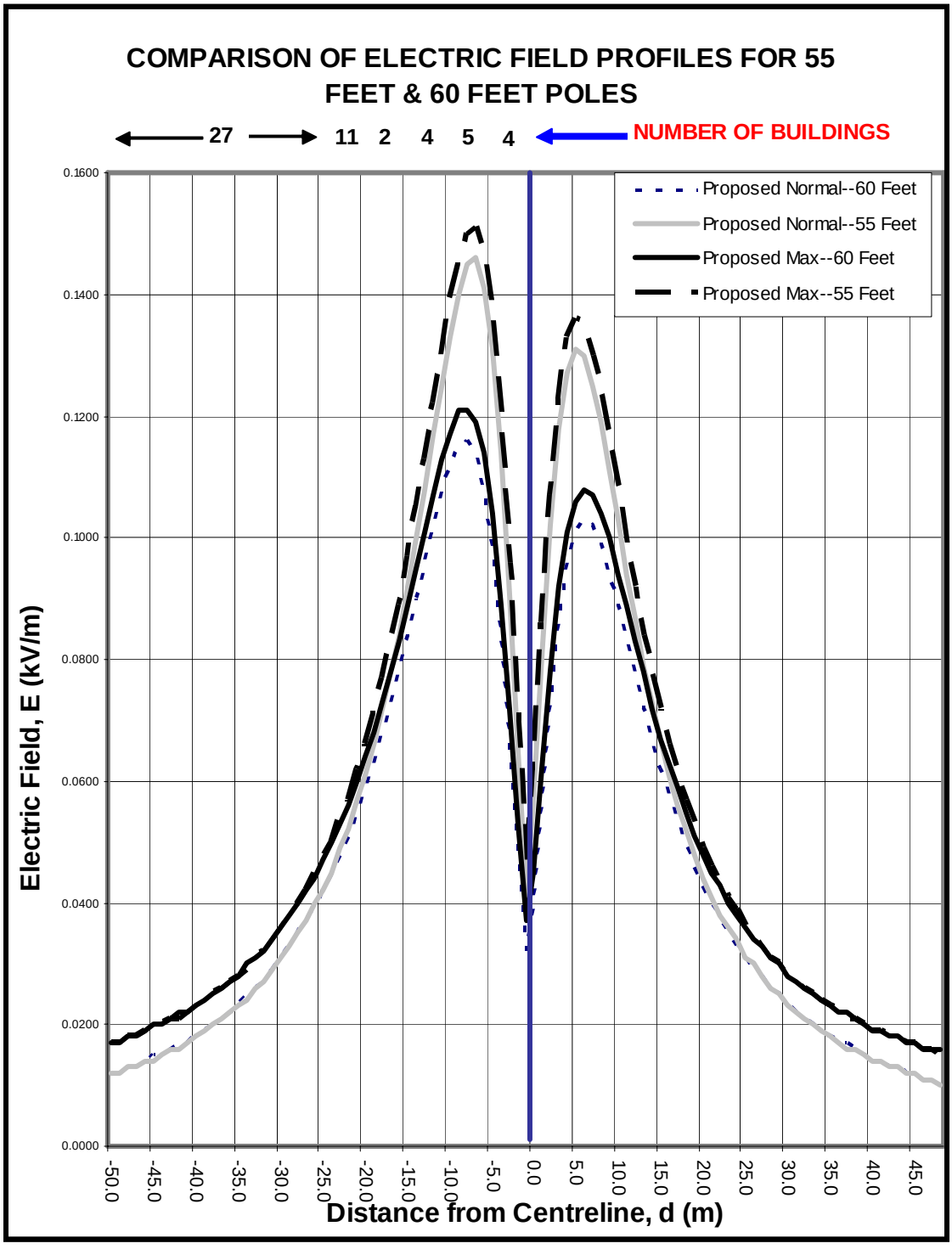
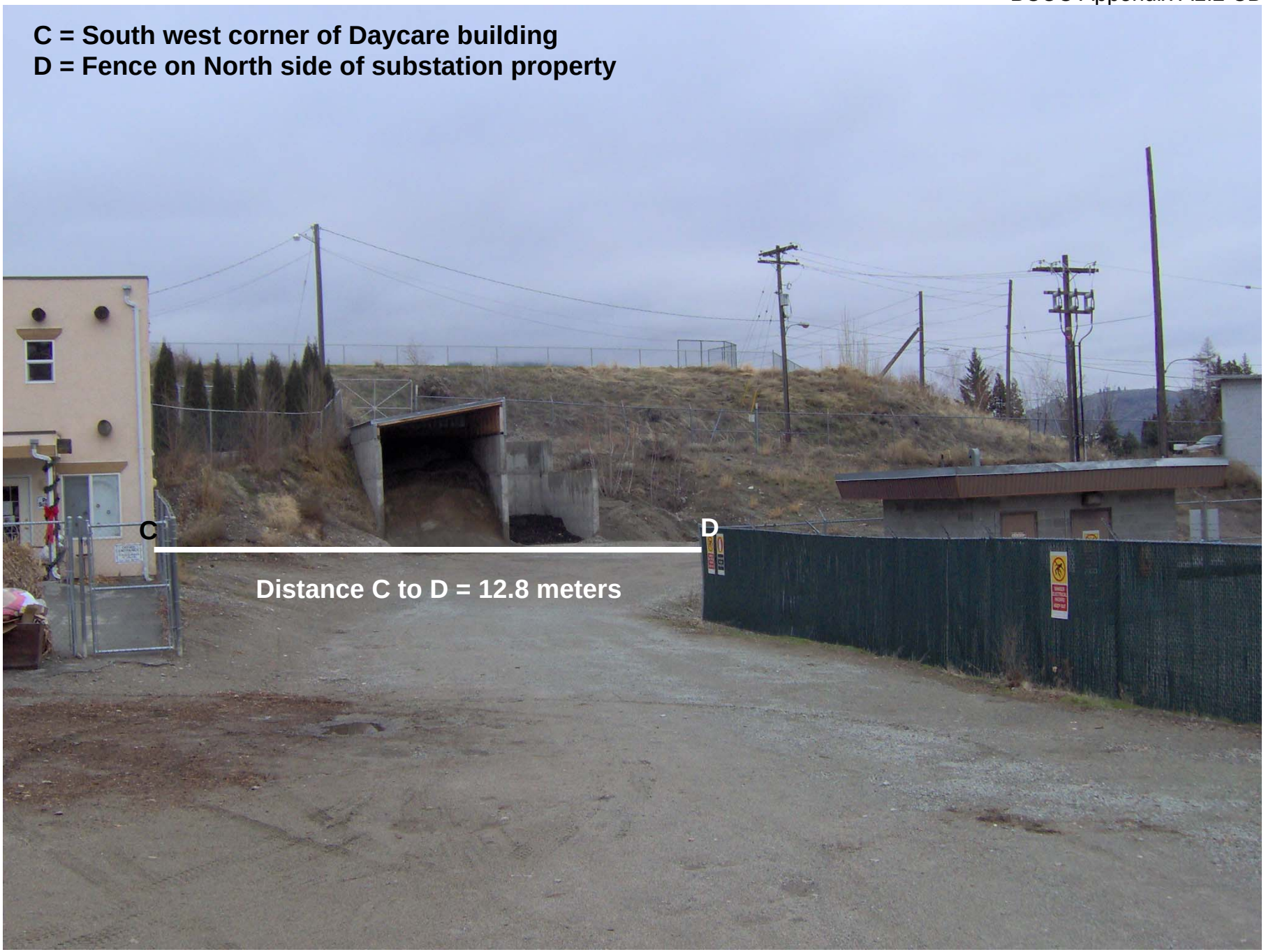

COMPARISON OF MAGNETIC FIELD PROFILES FOR 55 FEET & 60 FEET POLES
27
11
2
4
5
4
NUMBER OF BUILDINGS
Proposed Normal--60 Feet
Proposed Normal--55 Feet
Proposed Max--60 Feet
Proposed Max--55 Feet
Magnetic Field, B (mG)
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
-50.0
-45.0
-40.0
-35.0
-30.0
-25.0
-20.0
-15.0
-10.0
-5.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
Distance from Centreline, d (m)

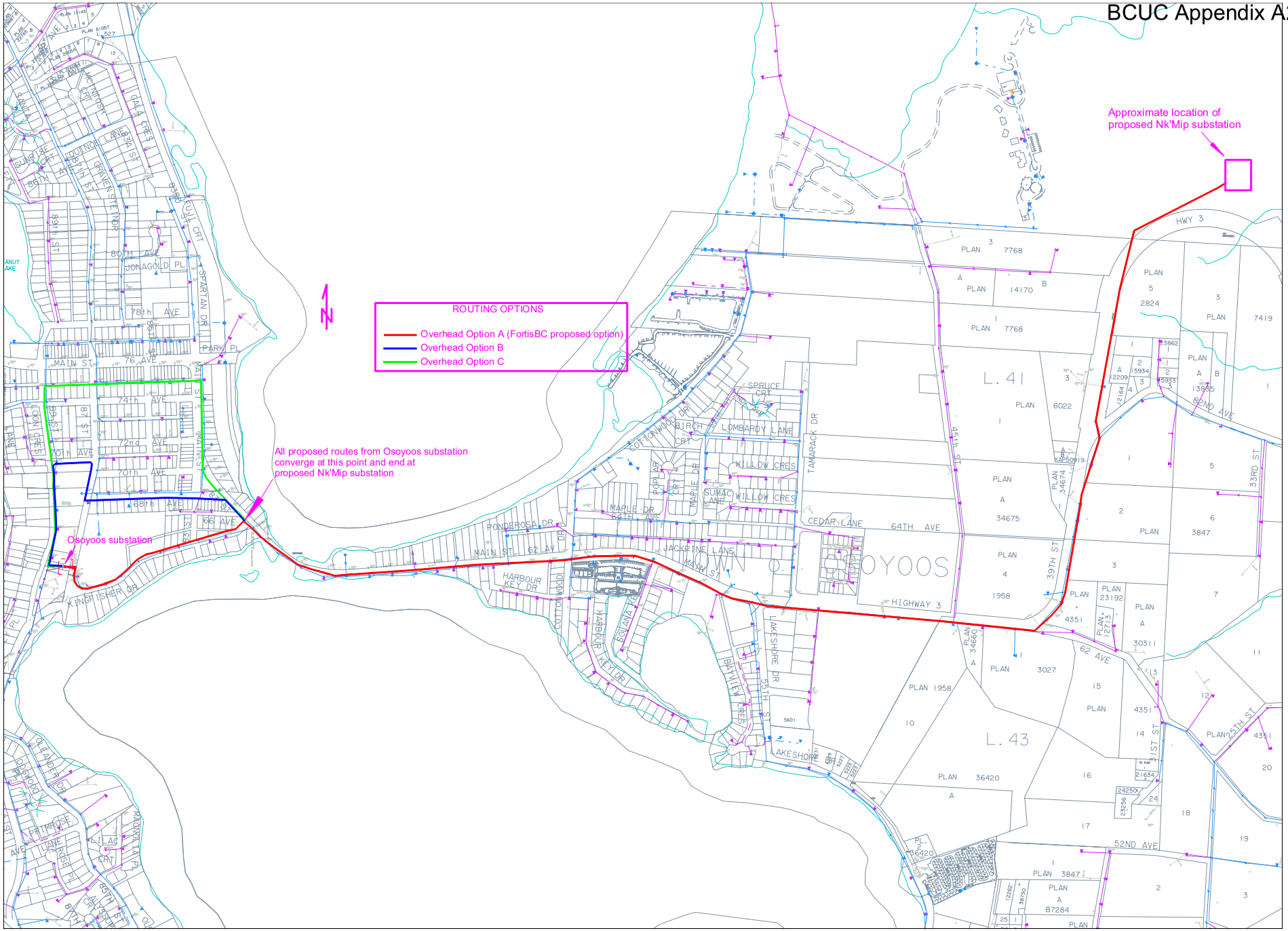
FIGURE 4.1b


COMPARISON OF ELECTRIC FIELD PROFILES FOR 55 FEET & 60 FEET POLES
27
11
2
4
5
4
NUMBER OF BUILDINGS
Proposed Normal--60 Feet
Proposed Normal--55 Feet
Proposed Max--60 Feet
Proposed Max--55 Feet
Electric Field, E (kV/m)
0.1600
0.1400
0.1200
0.1000
0.0800
0.0600
0.0400
0.0200
0.0000
-50.0
-45.0
-40.0
-35.0
-30.0
-25.0
-20.0
-15.0
-10.0
-5.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
Distance from Centreline, d (m)


A = North side of transformer inside substation property
B = South edge of Daycare fence
B
A
Distance A to B = 26.5 meters
DANGER ELECTRICAL HAZARD KEEP OUT
TRESPASSERS WILL BE PROSECUTED


C = South west corner of Daycare building
D = Fence on North side of substation property
C
D
Distance C to D = 12.8 meters


E = East side of existing house across from substation gate
F = Gate on West side of substation property
E
F
Distance E to F = 32.0 meters



Date: 12/28/2005 **Packet:** Oliver_lmc_2005_12_28_1 **User:** lmccarth

Field View

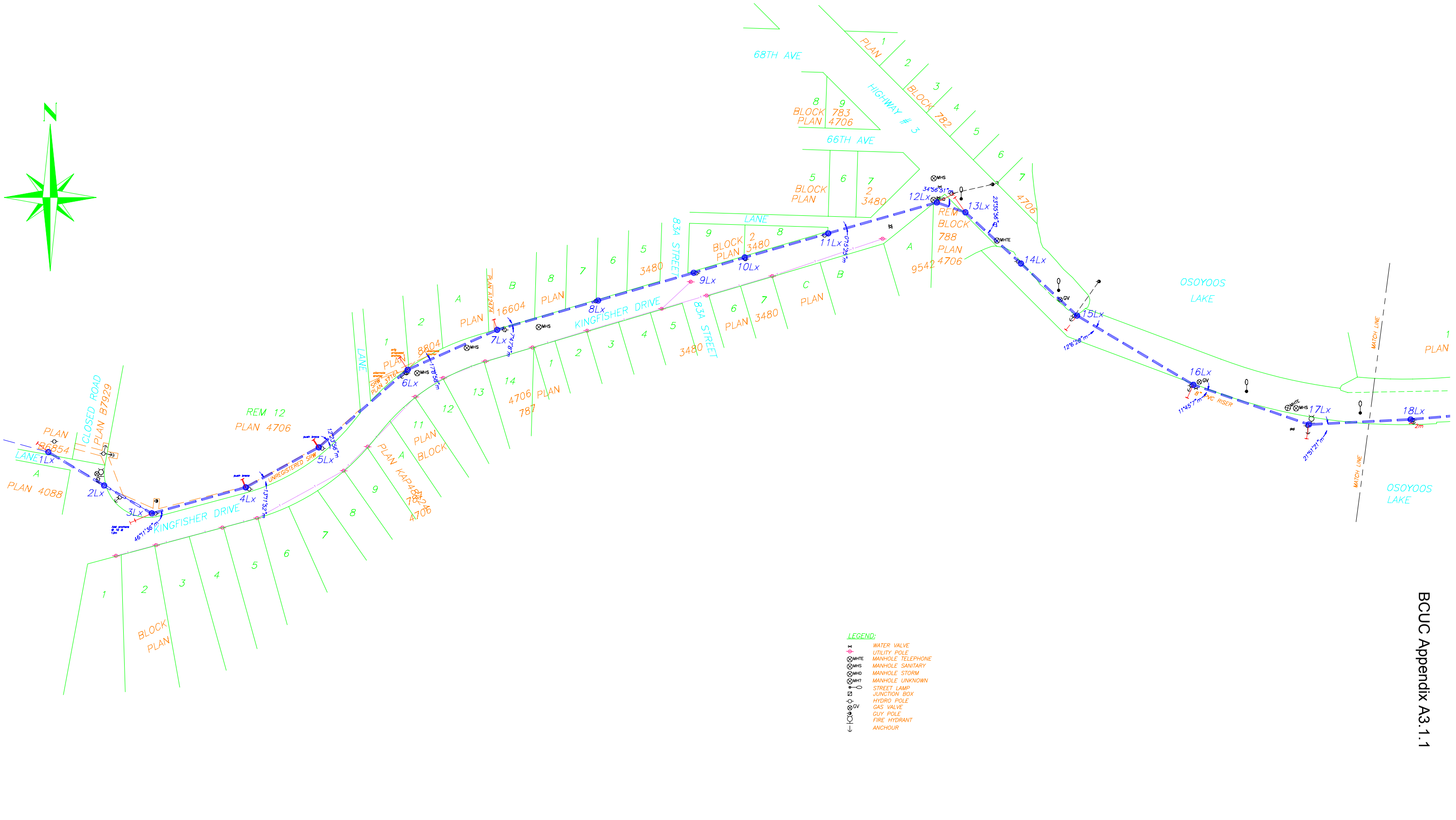
PROPOSED POLE LOCATIONS ALONG KINGFISHER DRIVE AND OSOYOOS CAUSEWAY

B.C.G.S. 82E.003

SCALE : 1:1000

0 10 20 30 40 50 60 70 80m

(ALL DIMENSIONS ARE IN METRES)



LEGEND:

- WATER VALVE
- UTILITY POLE
- MHTE MANHOLE TELEPHONE
- MHS MANHOLE SANITARY
- MHD MANHOLE STORM
- MH? MANHOLE UNKNOWN
- STREET LAMP
- JUNCTION BOX
- HYDRO POLE
- GV GAS VALVE
- GUY POLE
- FIRE HYDRANT
- ANCHOUR

BCUC Appendix A3.1.1

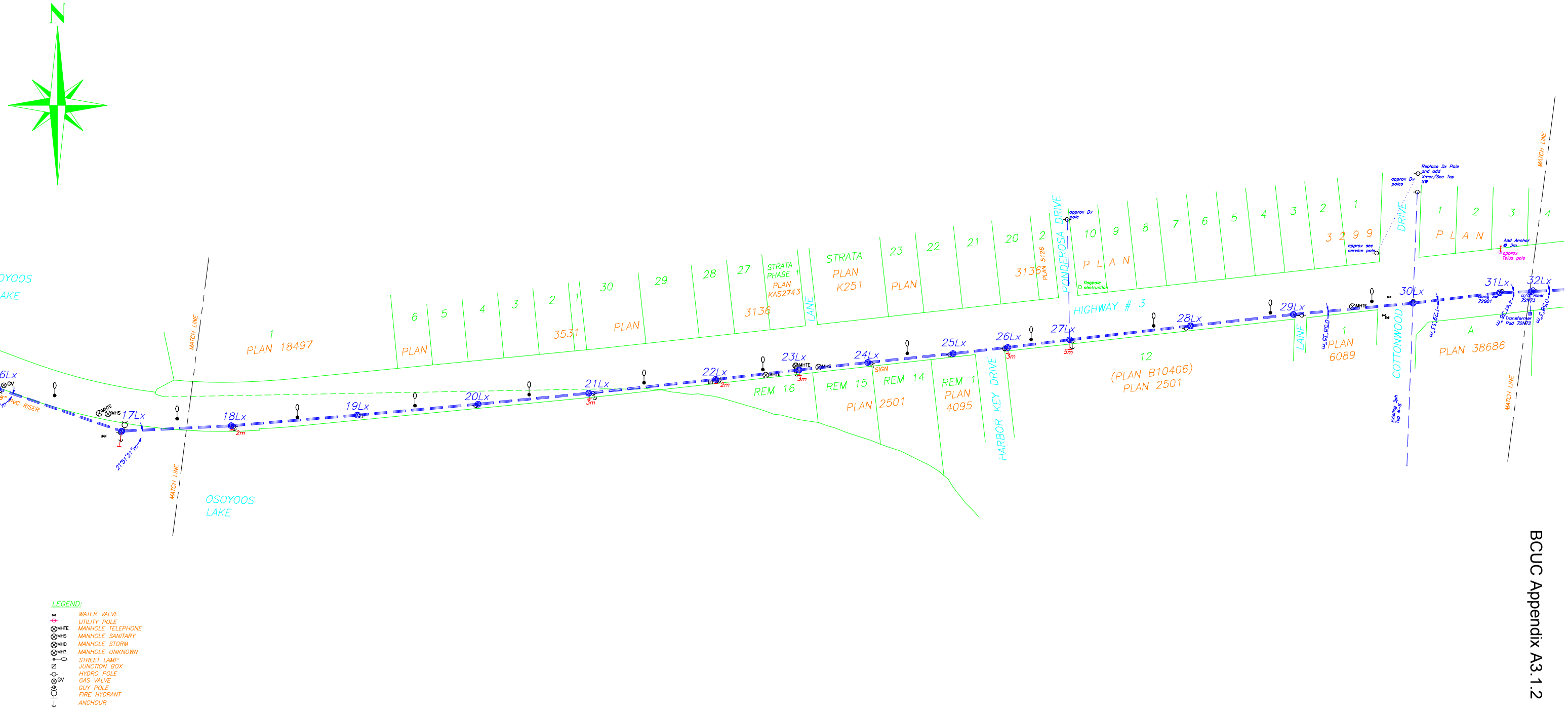
B.C.G.S. 82E.003

SCALE : 1:1000

0 10 20 30 40 50 60 70 80m

(ALL DIMENSIONS ARE IN METRES)

PROPOSED POLE LOCATIONS ALONG KINGFISHER DRIVE AND OSOYOOS CAUSEWAY



LEGEND:

- WATER VALVE
- UTILITY POLE
- MHTE MANHOLE TELEPHONE
- MHS MANHOLE SANITARY
- MHD MANHOLE STORM
- MH? MANHOLE UNKNOWN
- STREET LAMP
- JUNCTION BOX
- HYDRO POLE
- GV GAS VALVE
- GUY POLE
- FIRE HYDRANT
- ANCHOUR

BCUC Appendix A3.1.2

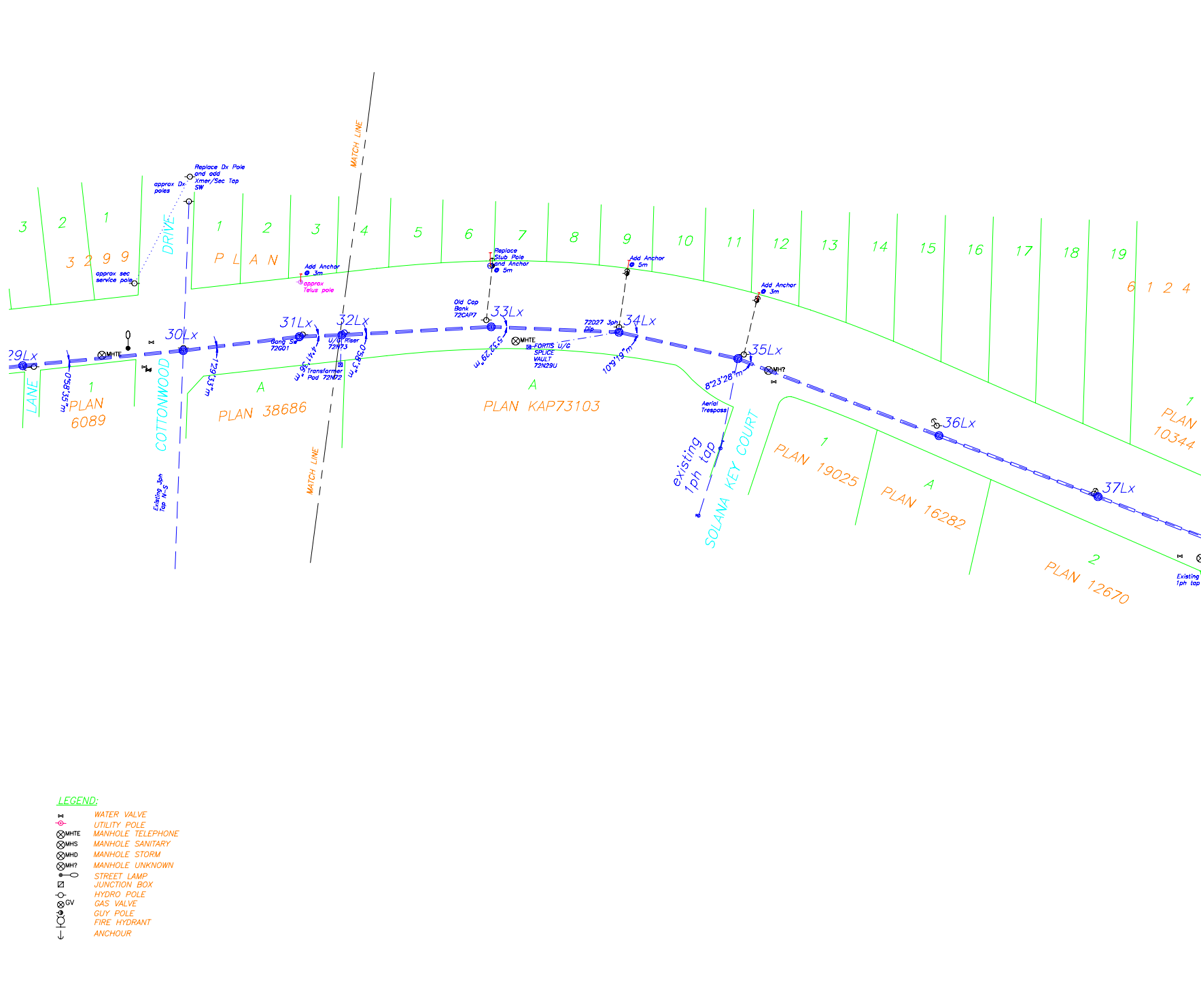
B.C.G.S. 82E.003

SCALE : 1:1000

0 10 20 30 40 50 60 70 80m

(ALL DIMENSIONS ARE IN METRES)

PROPOSED POLE LOCATIONS ALONG KINGFISHER DRIVE AND OSOYOOS CAUSEWAY

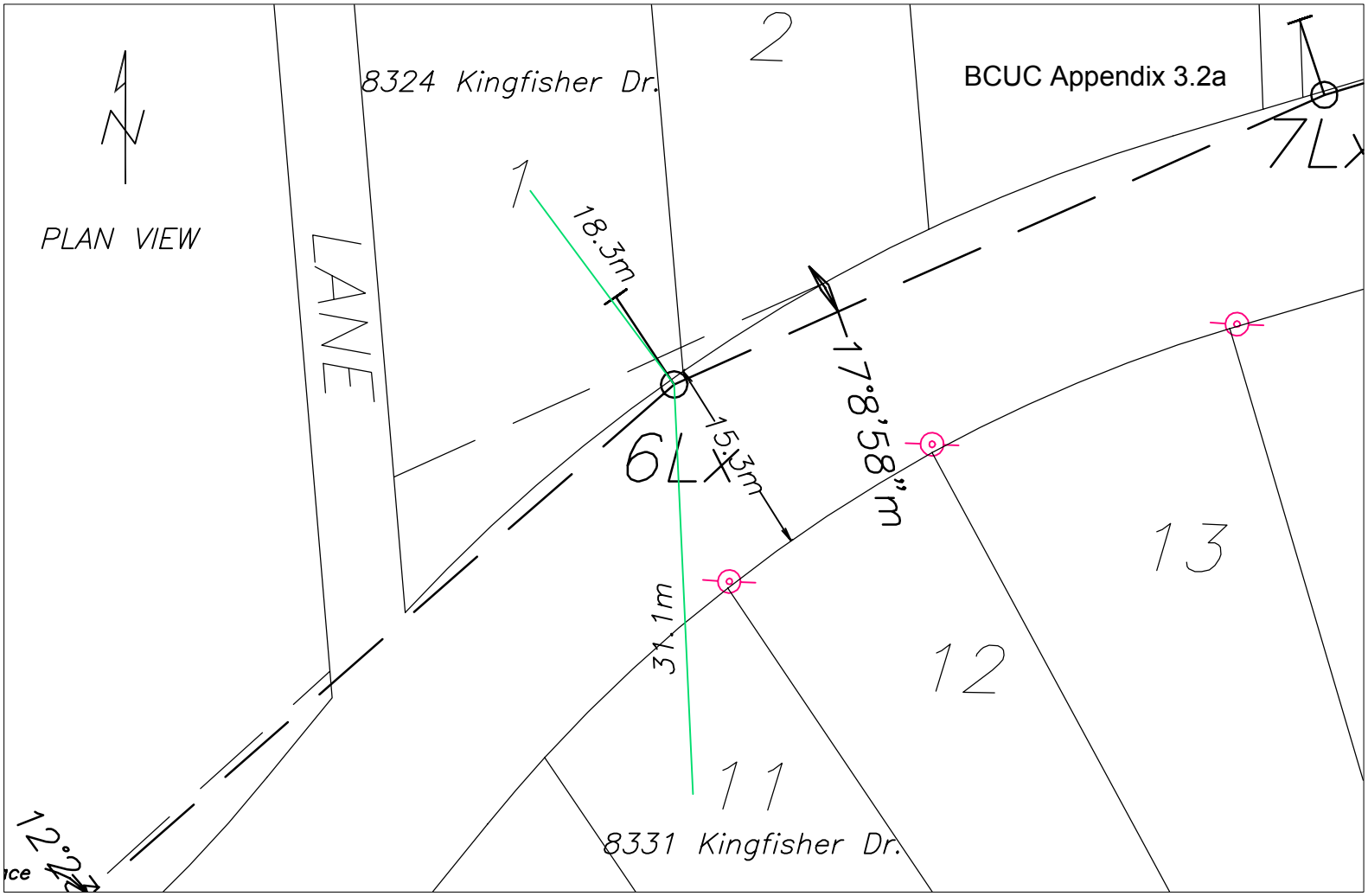


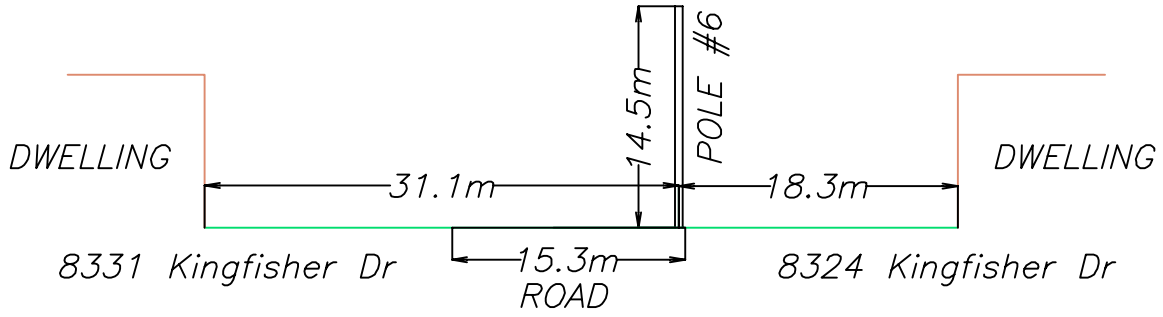
BCUC Appendix A3.1.3


8316

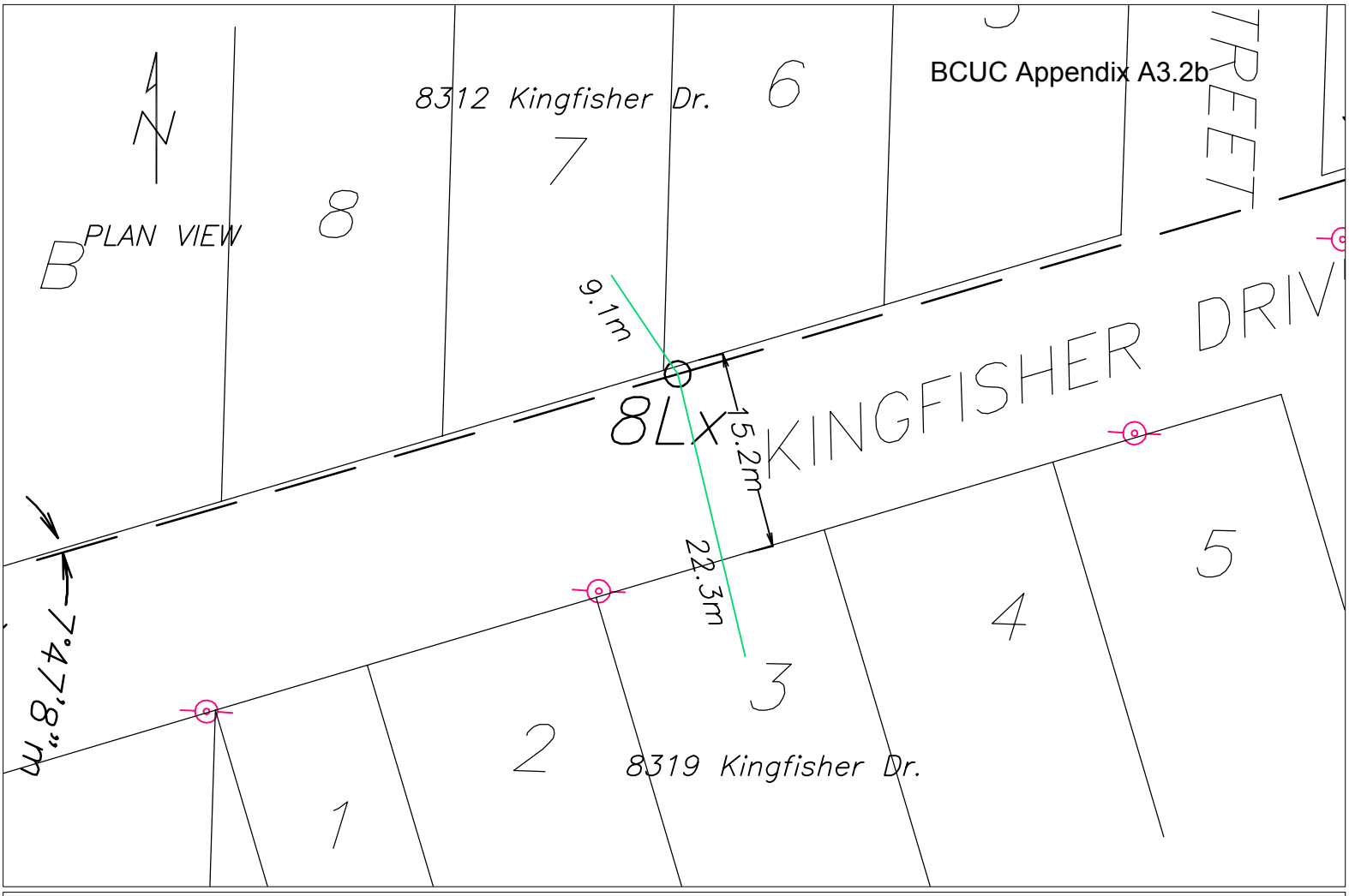

MAIN
STREET
COTTONWOOD

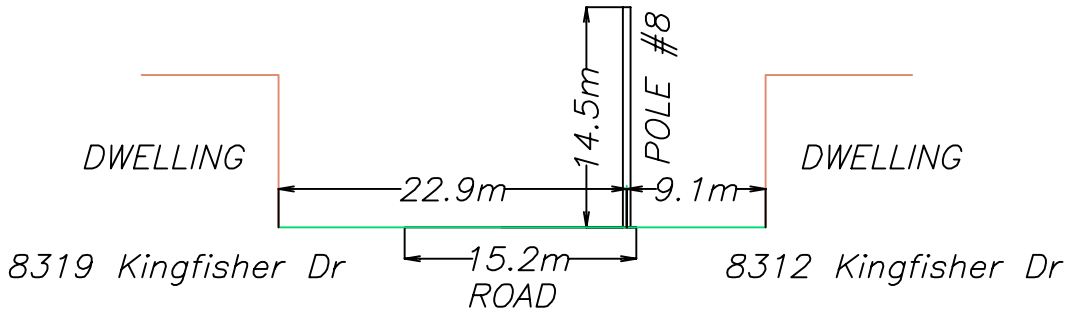

Midway 71
Greenwood 87
Grand Forks 132
SOLD OUT PHASE 1 & 2
Desert Mirage
Condominiums
RETAIL SPACE
SHOW SUITE
OPEN DAILY
10AM - 4PM





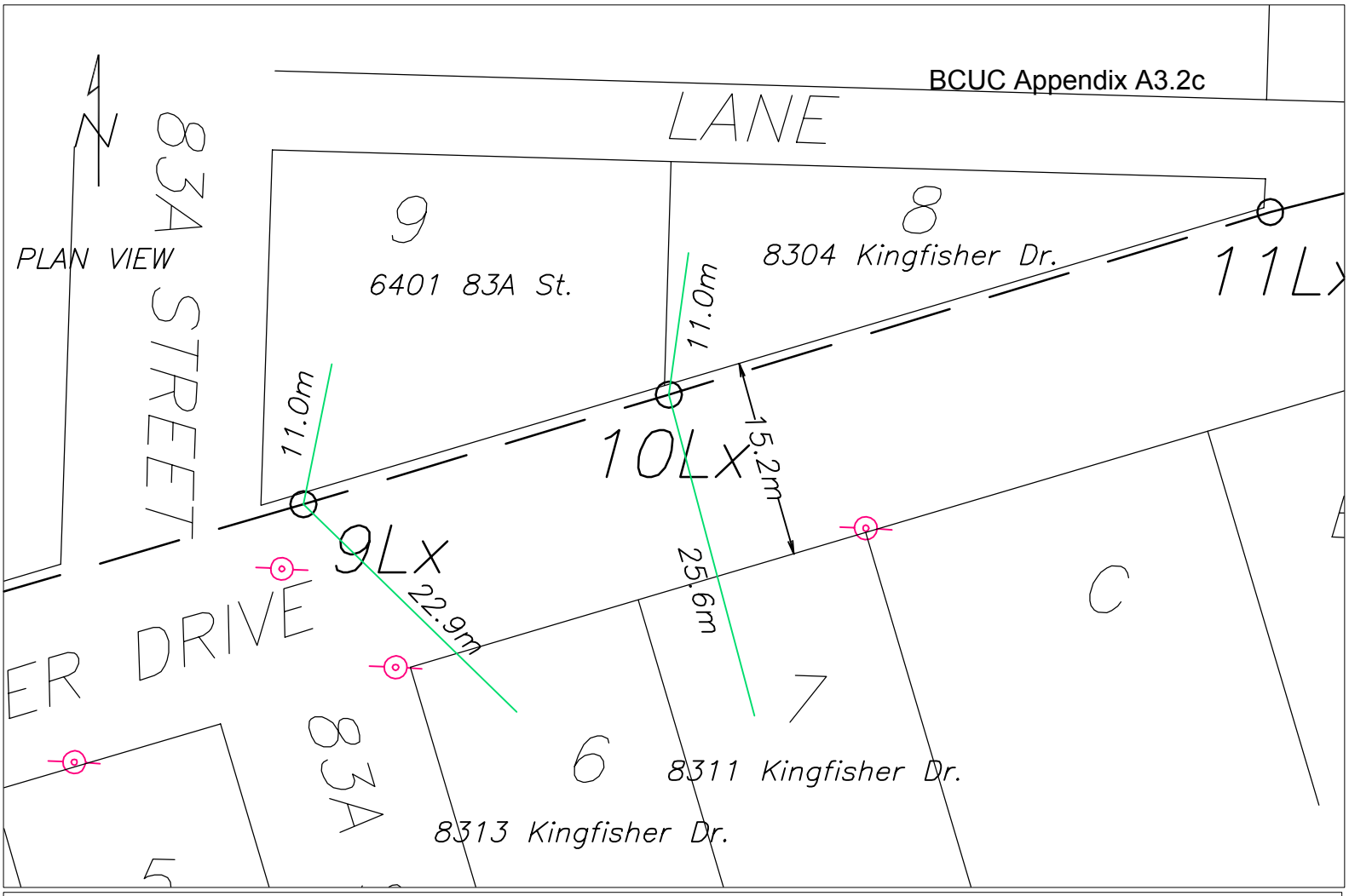
CROSS–SECTION SHOWING KINGFISHER DRIVE AND
HORIZONTAL DISTANCE OF POLE #6 TO EXISTING DWELLINGS

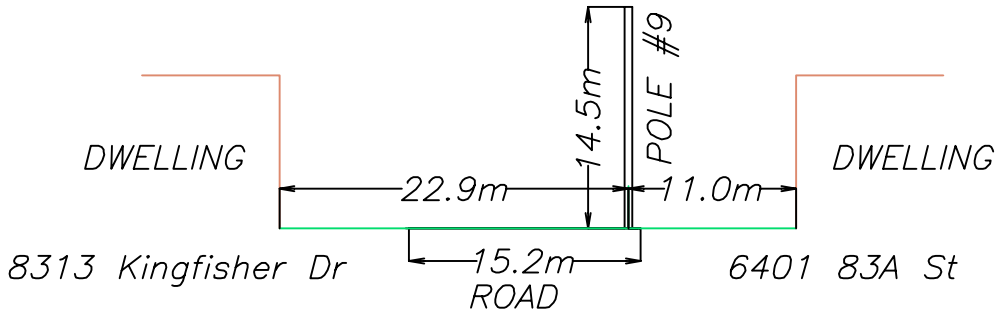




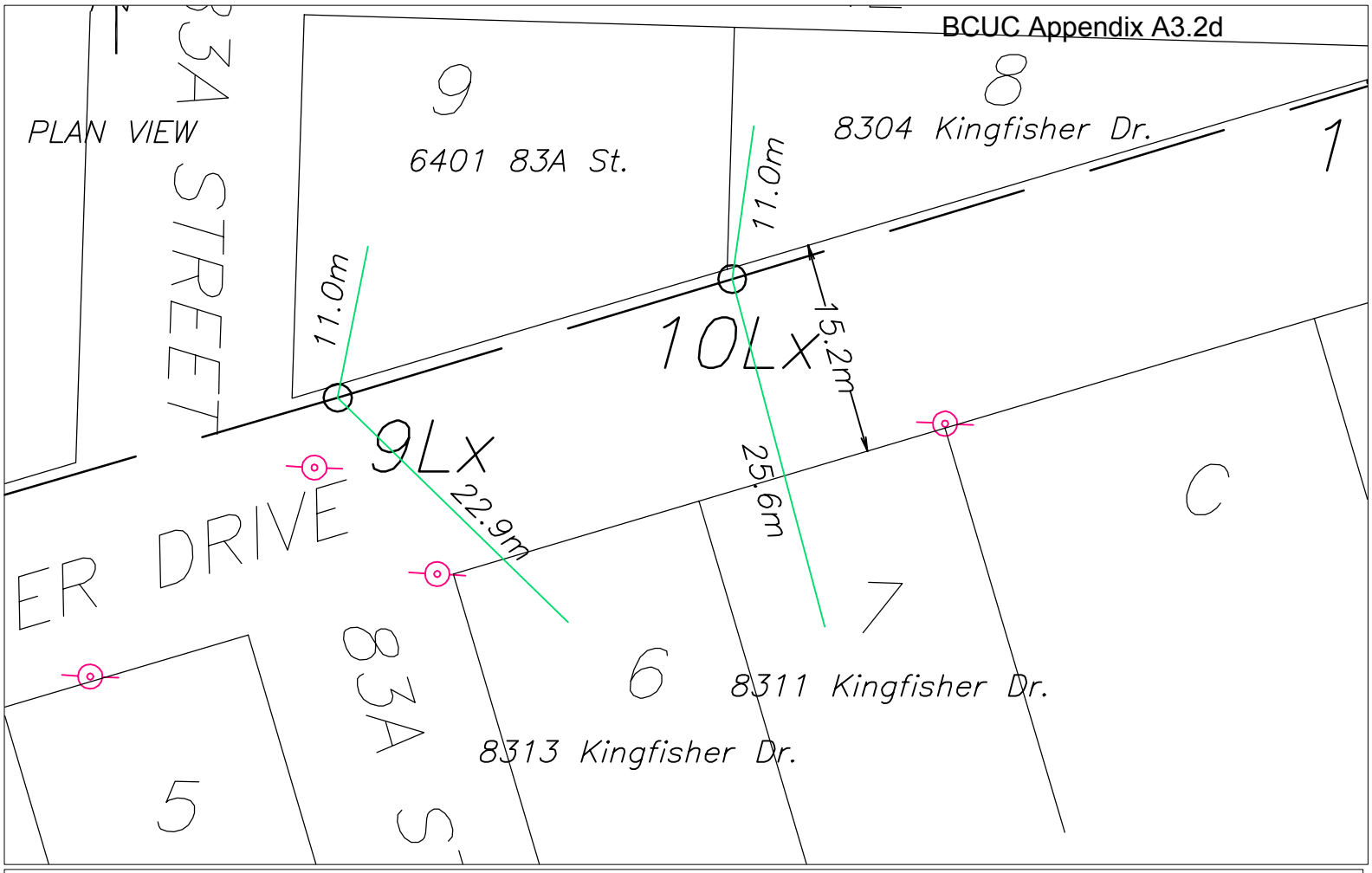
CROSS–SECTION SHOWING KINGFISHER DRIVE AND
HORIZONTAL DISTANCE OF POLE #8 TO EXISTING DWELLINGS

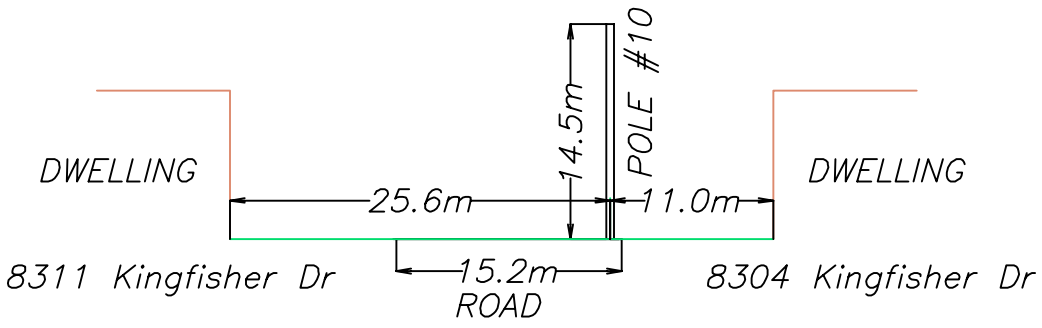

8310



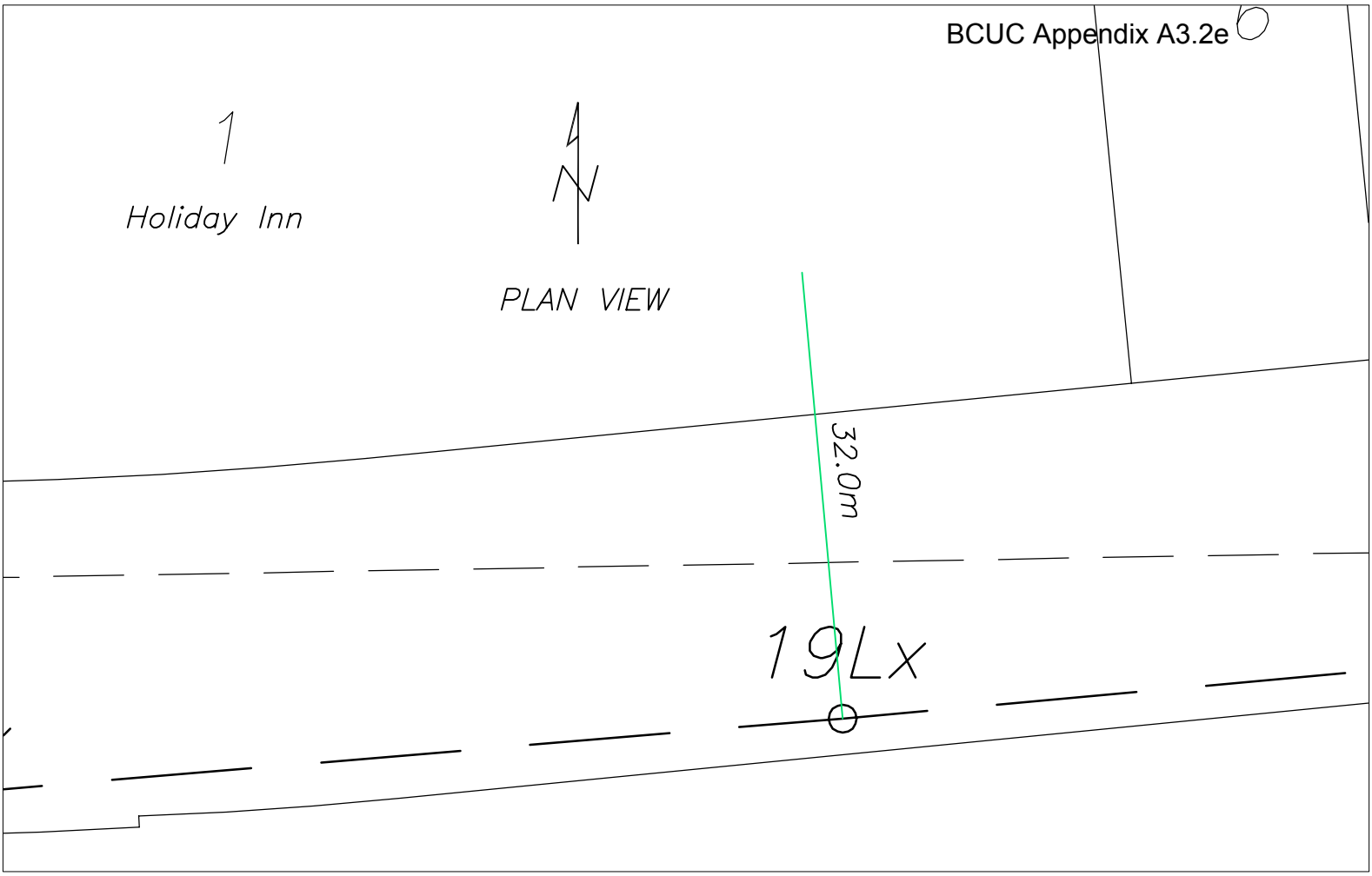


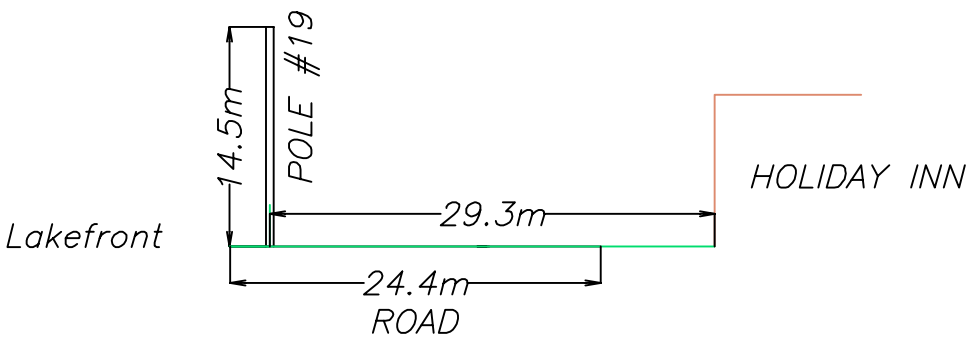
CROSS–SECTION SHOWING KINGFISHER DRIVE AND
HORIZONTAL DISTANCE OF POLE #9 TO EXISTING DWELLINGS



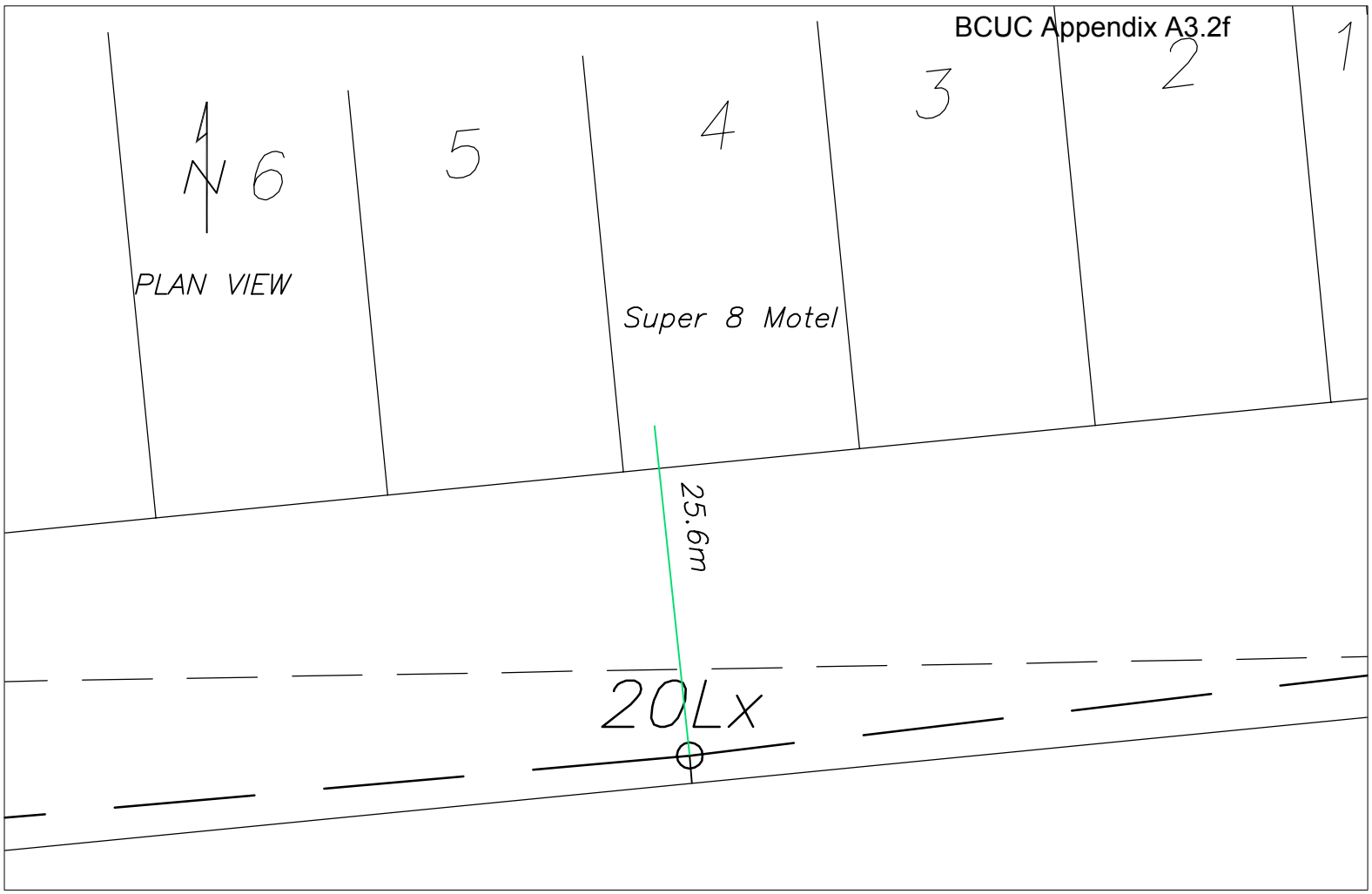


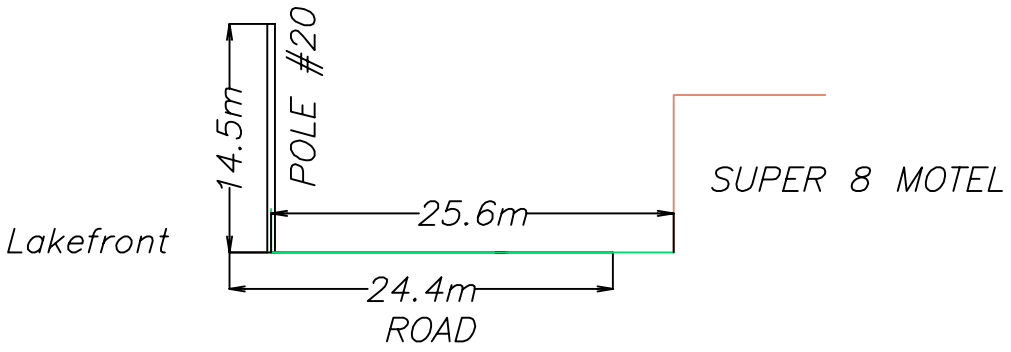
CROSS–SECTION SHOWING KINGFISHER DRIVE AND
HORIZONTAL DISTANCE OF POLE #10 TO EXISTING DWELLINGS





CROSS–SECTION SHOWING KINGFISHER DRIVE AND HORIZONTAL DISTANCE OF POLE #19 TO HOLIDAY INN





CROSS–SECTION SHOWING KINGFISHER DRIVE AND HORIZONTAL DISTANCE OF POLE #20 TO SUPER 8 MOTEL


SUPER 8 MOTEL
SUPER 8 MOTEL
MOTEL

1. General

1.1 Reference: Fortis Application (FA) (B-1 Submitted: 07/11/2005)

Q1.1.1 Reference: FortisBC Application page 2, line 28-29 [FA p2/28-29]
With respect *"total installed capacity of 30 MVA of the West Osoyoos Substation by 2011"* does that mean that Osoyoos' electricity service is still warranted until the year 2011?

A1.1.1 The above statement indicates that load-forecast studies show that in 2011 the total load in the Osoyoos area (east and west combined) is expected to surpass the total installed capacity of the West Osoyoos Substation, which is 30 MVA. The role of the existing Osoyoos (West) substation under such a scenario is detailed in the Nk'Mip Transmission & Substation Project CPCN Application - Item 4.

Q1.1.2 FA p3/3-4: *"The system studies also indicate that by 2010 -2011 the load on 44-Line which serves Pine Street and West Osoyoos substations will exceed the capacity of 45 MVA."*
Please state, whether 44-Line will warrant service until 2010-2011?

A1.1.2 Please see the response to BCUC IR1, Q2.2.

Q1.1.3 FA p4/14-16 *"FortisBC has consulted and sought feedback from provincial and local governments, First Nations, affected landowners, area residents and other stakeholders in the development of this project."*
Please provide

Q1.1.3.1 List of affected landowners and area residents consulted at what days

A1.1.3.1 The Table below shows the addresses of the properties where FortisBC made contact with the residents with regards to transmission line easements during June to October 2005:

1. 5806 68th Avenue
2. 8324 Kingfisher
3. 8322 Kingfisher
4. 8320 Kingfisher
5. 8316 Kingfisher
6. 8314 Kingfisher
7. 8321 Kingfisher
8. 8310 Kingfisher
9. 8308 Kingfisher
10. 6401 83rd Street
11. 8304 Kingfisher
12. 8303 Kingfisher
13. Village of Osoyoos
14. 7307 Main St
15. 6901 Main St
16. Main St
17. 6311 Jackpine Lane
18. 6305 Jackpine Lane
19. 15 Solana Key Ct
20. 5914 Main St
21. 5501 Main St

Q1.1.3.2 The issues discussed,

A1.1.3.2 FortisBC discussed the general need for the distribution line and transmission line facilities and the specific need for the easements associated with the poles and anchors on the property of the landowners.

Q1.1.3.3 Whether affected landowners have been made aware of the electro pollution Please note: if Fortis hesitates to release names of affected landowners and residents, then provide data without mentioning names, however the information requested to provide with names submitted to the Commission.

A1.1.3.3 Information with respect to EMF was not provided to specific landowners. FortisBC did, however, distribute brochures from Health Canada and the US National Institutes of Environmental Health Sciences to the attendees of the open house held on October 20, 2005. These brochures describe the nature and characteristics of EMF in detail and include the organization's scientific consensus as to whether residential EMF exposure is associated with adverse health effects.

Q1.1.3.4 Please provide copies of all information passed/sent to all property owners and tenants.

A1.1.3.4 Specific landowners and/or tenants were contacted directly in two ways:

1. where easements are required, the resident was contacted in person by a land agent to discuss the details of the easement
2. by letter to invite them to the October 20th Open House

Please also refer to Karow C1-2 (dated Nov 16, 2005) & C1-7 (dated Nov 30, 2005) response to Q4d.

Q1.1.4 FA p3/4: Please give exact location on a scaled map (1: 250 or 1: 350) the Pine Street Substation; the location is not exactly located on the map. Please also give exact location on a scaled map (1:250 or 1:350) of the proposed Bentley Substation.

A1.1.4 The requested maps are attached as Karow Appendix 1.1.4a (Pine Street) and Karow Appendix 1.1.4b (Bentley).

Q1.1.5 FA p6/12-13: "…[the proposed transmission line] *is envisaged to be constructed ….initially as a double circuit overbuild of the existing 13 kV Osoyoos Feeder 2."* Please state how long the proposed transmission line (TL) will be *initially* constructed as a double circuit overbuild? What exactly are the plans after this initially constructed double circuit overbuild?

A1.1.5 The proposed facilities are planned to be constructed as a double circuit, with one circuit on the top of the poles insulated for 63 kV and one circuit approximately 13 feet below the top of the pole insulated for 13 kV. Initially both circuits will be operated at 13 kV; however, after the substation is constructed in late 2006, the top circuit will be converted to a 63 kV transmission line. No new construction would be required to convert the voltage from 13 kV to 63 kV.

For further information please refer to Nk'Mip (East Osoyoos) Transmission & Substation Project CPCN Application - Item 1, Executive Summary, page 3, lines 14 to 20.

Q1.1.6 Please state whether any of the of the facilities mentioned below, will ever be used for redirecting and/or transporting electricity to/from out of country (to/from U.S.) or to/from Alberta, if so, please give details as well:

1.1.6.1 Osoyoos Substation,

1.1.6.2 Proposed Nk'Mip Substation,

1.1.6.3 Pine Street Substation,

1.1.6.4 Bentley Substation, and

1.1.6.5 Any one of the transmission lines connected to those substations (1.7. - 1.7.4)

A1.1.6 Currently, FortisBC does not have any plans to use these facilities to transport electricity in/out of the province.

Q1.1.7. Please provide a complete hard copy of the environmental impact assessment for the Nk'Mip Substation as well for the proposed Transmission Line with its alternative route options.

If an environmental assessment has not been done for either one, please state reasons why, and if done provide copies to participants.

A1.1.7 Please refer to the response to BCUC IR1, Q9.1.

Q1.1.8.1 FA p7/ Please state whether the proposed transmission line will be built according to a Canadian code similar to the U.S. National Electrical Code. If so, how can a copy be obtained for short time inquiry use?

A1.1.8.1 The proposed transmission and distribution lines will be constructed in compliance with the CSA Standard C22.3 No. 1-01 Overhead Systems. For further information please refer to page 7 in Appendix A of the CPCN

Application. Industry specifications and standards may be obtained by contacting the relevant "Specifications & Standards Organizations".

Q1.1.8.2 Please state which code sets standards of where and how close transmission lines and distribution lines can be constructed to roadways, public/private properties, and public/residential buildings, including hospitals and schools.

A1.1.8.2 The proposed transmission and distribution lines will be constructed in compliance with the CSA Standard C22.3 No. 1-01 Overhead Systems.

Q1.1.9. FA Appendix C/p4: Members of the Osoyoos Council and senior staff participated in an information meeting with FortisBC on January 17, 2005. Please provide all correspondence, records, reports, minutes, etc. of all discussions, including any support and/or interest expressed from the Mayor & Council and from the Township of Osoyoos

A1.1.9 Please refer to page 4 in Appendix C of the CPCN Application & Karow IR C1-8 (dated Nov 30, 2005) Q2.0.

Q1.1.10.1 FA Appendix C: Why has Fortis not established a summary of impacts and mitigation for the proposed <u>transmission line</u> including for all the alternative route options in areas other than on Osoyoos Indian Band area? Please provide an environmental impact assessment for <u>all</u> areas of the transmission line route, including the optional routes.

A1.1.10.1 Please refer to the response to BCUC IR1, Q9.1.

Q1.1.10.2 Please provide a summary of impacts and mitigation for the proposed transmission line and all alternative routes.

A1.1.10.2 Please refer to the response to BCUC IR1, Q9.1.

Q1.1.11.1 FA Appendix E What is the anticipated time frame for recovery of the transmission line and substation cost, please provide separately.

A1.1.11.1 Both transmission and substation costs are recovered over a period of 50 years.

Q1.1.11.2 Is recovery of proposed project already also in the present rate increase CPCN application before BCUC included? If yes, at what percentage of the rate increase? Please explain maximum Rate Impact and One-Time Equivalent Rate Impact in more detail and in lay-man's language.

A1.1.11.2 Yes, the impact of this project is included in FortisBC's application for 2006 rates ("2006 Revenue Requirements"). The 2006 Revenue Requirements Application requests an increase of 5.9% to rates effective January 1, 2006. The expected rate impact of this project, shown in Appendix E of the CPCN Application is 0.1% in 2006 and a further 0.49% in 2007.

The Revenue Requirements Analysis for the proposed project (Appendix E of the CPCN Application) includes a calculation of the rate impact in each year arising from the proposed project, compared to the previous year's rates. It is calculated as:

$$\frac{\text{Project Revenue Requirement Year 1} - \text{Project Revenue Requirement Year 0}}{\text{Total Revenue Requirement in Year 1}}$$

The rate impact is generally greatest in the year immediately following completion of the project, and declines in future years. For the proposed Nk'Mip Substation Project, the rate increases (over the previous year) are:

2006	0.10%
2007	0.49%
2008	0.00%
2009	0.00%

In 2013 and beyond, the revenue requirement associated with the project begins to decrease and the rate impact becomes negative, -0.1% annually.

The Maximum Rate Impact is 0.49%, that is, the largest one-time rate increase associated with the stream of revenue requirements for the project.

Because the revenue requirements associated with the project result in varying levels of rate increases and decreases over the life of the project, FortisBC also calculates a "One-Time Equivalent" Rate Impact. It is the ratio of the value in the current year of the project revenue stream to the current year value of total revenue requirements over the project life. It is calculated as:

$$\frac{\text{Net Present Value of Project Revenue Requirements over Project Life}}{\text{Net Present Value of Total Revenue Requirements over Project Life}}$$

Q1.1.12 FA Appendix A10.1.C Please discuss with pros and cons an alteration of dotted route as per Option 2 with an alteration: using the existing TL44 up to near the crossing the Okanagan River Channel, tie into a second transmission line to continue parallel to and East of the River Channel and Okanagan Lake, then leading to proposed Nk'Mip Substation, instead of constructing the dotted line marked transmission line from proposed Bentley Substation through the mountain area to the Nk'Mip Substation. In another words an upgraded TL44 will be divided into 2 lines, the second one being a new line to connect to Nk'Mip substation.

A1.1.12 The above configuration will achieve the following:

1. Create adequate capacity for the load in East Osoyoos which is forecast to exceed 15 MVA by 2010.
2. Improve the voltage profile to end line customers due to reduction in distribution feeder lengths.

The above will result in the following deficiencies:

1. Addition of approximately 14 km of transmission line at an estimated cost of $2.8 million will increase the vulnerability of the transmission line network to outages, as there will be no discrimination for faults between the Osoyoos West and Osoyoos East (Nk'Mip) legs of the network. This could be mitigated by the

construction of a switching station at the tap point, but this would increase costs further.

2. The proposed routing increases the impact to surrounding landowners and land uses where it crosses from west to east near the north end of Osoyoos Lake. The FortisBC proposed route from Bentley to Nk'Mip uses land that, where practical, is not in commercial or residential use. The "Karow" customer proposed route would increase the net impact to those lands. This in turn is expected to have an ROW cost, estimated at $2.0 million.
3. N-1 contingency with transmission line cannot be met due to radial configuration of the network and an event on the line will result in total outage in the Oliver-Osoyoos region.
4. Will require a looped configuration as determined by load requirement and reliability issues in the future.
5. Technically and financially inferior to preferred Option 1 as submitted in the CPCN Application.
6. Technically inferior to Option 2 as submitted in the CPCN Application.
7. The financial implication is estimated as:

a. Nk'Mip Substation	$5.25 million
b. Nk'Mip Double Circuit Distribution	$0.70 million
c. Salvage costs	$0.20 million
d. Nk'Mip Distribution	$0.25 million
e. Nk'Mip Substation Land Cost	$1.00 million
f. 44 Line Tee Off 63 kV Line	$2.80 million
g. Transmission ROW	$2.00 million
NET ESTIMATED COST:	$12.20 million

NET COST DIFFERENTIAL W.R.T. "OPTION 1": $3.23 million

In summary, this "Karow proposed alternate route" increases land impact, increases cost and reduces reliability.

1.2 Fortis Response to BCUC Info Request # 1

Q1.2.1 Fortis Response page 13/ A8.3 [FR p13/A8.3]: *"council members and mayor asked several questions…"* Please state the nature of all the questions asked other than costs, including answers.

A1.2.1 Please refer to page 4 of Appendix C of the CPCN Application and the response to Karow C1-8 (dated Nov 30, 2005) Q 2.0.

Q1.2.2 FR p20/Typical Noise Levels: Please provide noise levels at certain distances from right next to the transformer to distances at 10ft, 25ft, 50ft, 100ft, 200ft.

A1.2.2 The noise level at a distance "r" from a noise source can be theoretically calculated as a "Rule-of-Thumb" by the following formula:

(Noise level at a distance "r") = (Noise level at a distance of "1 meter") – (20 log "r")

The above considers no reverberation of sound and presence of no other sound sources in the specific environment under study. The standard for maximum allowable noise at 1 meter from the source is 74dbA. (Please also refer to the response to BCUC IR1, Q9.6). Therefore, typical noise levels expected at the above distances will be as follows:

1. Noise at 10 feet (3.0 meters) = 64.3 dbA
2. Noise at 25 feet (7.6 meters) = 56.4 dbA
3. Noise at 50 feet (15.2 meters) = 50.3 dbA
4. Noise at 100 feet (30.5 meters) = 44.3 dbA
5. Noise at 200 feet (38.3 meters) = 38.3 dbA

Q1.2.3 Please provide noise levels for appliances as listed on page 20 at distances 10ft, 25ft, 50ft, 100ft, 200ft.

A1.2.3 As noted above, the noise level at a distance "r" from a noise source can be theoretically calculated as a "Rule-of-Thumb" by the following formula:

(Noise level at a distance "r") = (Noise level at a distance of "1 meter") – (20 log "r")

The above assumes that the receiving point of the noise is not influenced by other noise sources and no noise is reflected to the receiving point / no reverberation of sound waves. Based on the rule of thumb and the Typical Noise Level data, the calculated noise levels at the requested distances from each of the appliances have been indicated in the Table below.

APPLIANCE TYPE	TYPICAL NOISE LEVELS (dbA) AT DISTANCES OF:					
	1 m / 3.3 Ft	**3.04 m / 10 Ft**	**7.6 m / 25 Ft**	**15.3 m / 50 Ft**	**30.5 m / 100 Ft**	**61 m / 200 Ft**
	Typical dbA	**Calculated dbA**	**Calculated dbA**	**Calculated dbA**	**Calculated dbA**	**Calculated dbA**
Computer	**41**	31	23	17	11	5
Typical Living Room	**40**	30	22	16	10	4
Forced Hot Air Heating System	**47**	37	29	23	17	11
Microwave	**57**	47	39	33	27	21
Clothes Dryer	**57**	47	39	33	27	21
Dishwasher	**65**	55	47	41	35	29
Kitchen Exhaust Fan, High	**70**	60	52	46	40	34
Air Popcorn Popper	**81**	71	63	57	51	45
Hairdryer	**87**	77	69	63	57	51
Vacuum Cleaner	**86**	76	68	62	56	50
Lawn Mower	**92**	82	74	68	62	56
Food Processor	**96**	86	78	72	66	60
Circular Saw	**102**	92	84	78	72	66

Q1.2.4 FR p20/A9.7 and Appendix A9.7: please provide impressum of the magazine that contains Chapman's study.

A1.2.4 The magazine that contains Dean Chapman's study is "Right of Way" issue—November / December 2005. The magazine is published by the International Right of Way Association

Address: 19750 South Vermont Avenue, Suite 220, Torrance, CA 90502-1144.

Telephone: (310) 538-0233

Fax: (310) 538-1471

E-Mail: info@irwaonline.org

Website: http://www.irwaonline.org/publications/right_of_way/index.cfm

Q1.2.5 Please provide a CV of Dean Chapman.

A1.2.5 A CV for Dean Chapman is not presently available.

Q1.2.6 Please provide a study/studies of power lines' EMF impacts on residential property value.

A1.2.6 FortisBC is not aware of any studies that specifically measure the impact of EMF from power lines on residential property values; studies typically focus on possible visual impacts of power lines as opposed to "EMF impacts." Furthermore, EMF is not generally isolated as a specific factor in real estate evaluations. Real estate reports typically presume that prospective buyers will be influenced by multiple factors. An excerpt from Exhibit C1-32 Evidence #19, submitted by H. Karow, states "When buying property, people are likely to consider many factors, such as schools, community services, scenic beauty, recreational opportunities, or distance to work. The relative importance of each of these factors varies among individuals. Likewise, the importance of a nearby power line varies among people."

Q1.2.7 Has Fortis queried the BC Assessment Branch to determine the impact of electropollution (various electric forces mentioned in section 2.) caused by/ associated with/ /emanating from power lines, including the proposed line?

A1.2.7 FortisBC has not questioned the BC Assessment Branch to the impact of what Mr. Karow refers to as "electropollution.". As the presence of a power line is not considered during assessment, it is unlikely that any effects, real or perceived are included in the assessment criteria, although FortisBC has not confirmed that this is the position of BC Assessment.

Q1.2.8 FR p20 – 21 A9.8 The EMF issue is controversial, a coin has tow sides. Fortis has placed it's EMF position to position of national and international bodies, as mentioned on page 21. My evidence # 20 includes several commentaries by Dr. Louis Slesin in his Microwave News, an internationally well respected independent journal, without any industry funding to my knowledge.

Q1.2.8.1 Please indicate Fortis' position to each of Dr. Slesin's.

A1.2.8.1 FortisBC's position with respect to the possible health effects of EMF exposure is outlined in response to BCUC IR1 Q 9.8. In summary, FortisBC maintains a position that is based on peer-reviewed, original research and the scientific consensus of the numerous independent expert panels that have reviewed this issue (including the WHO, the ICNIRP, the NIEHS and the FPTRPC, as described in the response to BCUC IR1 Q9.8).

Q1.2.8.2 In case Fortis does not agree with the commentaries in whole or part, please state why.

A1.2.8.2 Please see the response to Karow Q1.2.8.1 above.

Q1.2.9 FR p22/A10.1 Please provide a map also for Route Option 1C

A1.2.9 Please note that there is no Route Option 1C in FortisBC response to BCUC IR1 Q10.1.

Q1.2.10 FR p23/A10.2 Please provide an aerial map (1:3,000) for the east section of the transmission line, so to being able to see the impacts on and the numbers of properties nearest on both side of the proposed transmission line.

A1.2.10 A copy of the requested map is attached as Karow Appendix 1.2.10

Q1.2.11 Please provide an aerial map (1:3,000) indicating existing line coming from area 115th Street and 62nd Avenue to the substation.

A1.2.11 A copy of the requested map is attached as Karow Appendix 1.2.11

Q1.2.12 FR Appendix A10.1D Please provide an aerial map (1:3,000) indicating existing transmission line, proposed new Osoyoos Substation, Feeders 1 and 2 (double ckt constr.), and Feeders 3 and 4 (new double cct. constr. Express to East Osoyoos)

A1.2.12 A copy of the requested map is attached as Appendix 1.2.12

Q1.2.13 FR p 14 A8.5.2 Please provide specification of submarine cable

A1.2.13 Submarine cables are custom made using comprehensive technical specifications based on detailed engineering study and analysis. The specification for the noted cable has not been developed.

Q1.2.14 FR p 14 A8.5.2 Please provide an aerial photo (1:3,000) indicating submarine cable location and tie in to overhead transmission line (please provide more than one optional routes).

A1.2.14 A copy of the requested map is attached as Appendix 1.2.14

Q1.2.15 FR p25 Please provide an amended Table 5 (FA p33) with incremental costs of constructing a submarine cable bypassing the bridge/narrow causeway and also provide amended Table 8 (FA/p39) accordingly.

A1.2.15 Below is an amended Table 5 (from page 14 / 33 of the CPCN Application) with incremental costs of installing submarine cable bypassing the causeway:

SL.	COMPONENT OF PROJECT	ITEM IDENTIFICATION	ITEM COST ($million)	Reference
1	Nk'Mip Substation	Nk'Mip Distribution Source	5.25	CPCN Table 1, Pg 14
2	Nk'Mip Transmission Stage 1	Underground Transmission from West Osoyoos Substation to the beach near Kingfisher Drive, Submarine Cable across the lake to the beach beyond the Causeway, underground cable from the	4.20	BCUC IR1 Q10.3 (3)
3	Nk'Mip Transmission Stage 2	Transmission line from Cottonwood Drive to proposed Nk'Mip Substation	1.30	
4	Nk'Mip Distribution	Nk'Mip Distribution	0.25	CPCN Table 1, Pg 14
5	Land Cost	Substation Land Acquisition & Development Cost	1.00	CPCN Table 1, Pg 14
6	Nk'Mip Transmission Stage 2 Salvage	Salvage	0.07	CPCN Table 1, Pg 14
AMENDED PROJECT COST			**$12.07 million**	

Amended Table 8 (CPCN—Nk'Mip, Pg 39) with incremental costs of installing submarine cable bypassing the Causeway:

SL.	TECHNICAL & FINANCIAL PARAMETERS	OPTION 1 (Amended)	OPTION 2	OPTION 3	Reference
1	Capital & Salvage Cost (2006)	$12.07 million	$15.20 million	$14.30 million	CPCN Table 8, Pg 39 & Table above
2	Future Cost (2011)	$6.07 million	$0.20 million	$7.35 million	CPCN Table 8, Pg 39
3	NPV of Revenue Requirements	$16.81 million	$16.58 million	$19.38 million	Amended Data
4	Maximum Rate Impact	0.67% (2007)	0.73% (2007)	0.74% (2007)	Amended Data
5	One Time Equivalent Rate Impact	0.70%	0.69%	0.81%	Amended Data

Q1.2.16 FR p25 Please provide amended Table 7 (FA p38) with incremental costs of constructing a submarine cable by bypassing the bridge/narrow causeway and also amend Table 8 (FA/p39) accordingly.

A1.2.16 FortisBC's Nk'Mip (East Osoyoos) Transmission & Substation Project CPCN Application, Table 7, page 38, (Option 3) considers construction of a new substation at West Osoyoos only and there is no provision as per this Option for a transmission circuit crossing over to East Osoyoos. Hence the query is not relevant in this case.

Q1.2.17 Please state whether Fortis is aware of activities of states, counties and communities have adopted rules, ordinances and/or standards addressing EMF exposures lower than those ones, recommended by the national and international bodies as mentioned on page 21, FA A9.8?

A1.2.17 Please see the response to Karow Q1.2.17.1.

Q1.2.17.1 If Fortis is aware, please state as many as possible by also providing copies of those rules or standards.

A1.2.17.1 The question may be referring specifically to rules, ordinances and standards within the United States. There are currently no standards put forth by the US federal government for limiting exposure to power frequency (60 hertz) fields based on health effects. While six states have guidelines or standards for electric fields on, or at the edge of the right-of-way (ROW), only two states, Florida and New York, have enacted standards to limit magnetic fields at the edge of ROWs from transmission lines (150 mG and 200 mG, respectively). The intention for limiting magnetic fields at the edge of the ROW was not based on established health effects; rather, the intent was to maintain the *status quo* so that fields from new transmission lines would be no higher than those produced by existing transmission lines.

FortisBC is not in a position to provide an exhaustive list of rules, ordinances and standards at a level lower than the federal or state level or those that may have been proposed in foreign countries:

Q1.2.17.2 Please explain why those states, counties and communities (section 1.2.17) - who adopted stricter EMF exposures and/or transmission line restrictions- despite the recommendations of the national and international bodies as mentioned on page 21, FA A9.8?

A1.2.17.2 Please see the response to Karow Q.1.2.17.1.

Q1.3 Transmitting electricity out of Fortis' Kootenay-Okanagan –Similkameen service area

Q1.3.1 Will any of the existing and new facilities (Bentley or Alternative Terminal, West Osoyoos Substation, new West Osoyoos Substation near Pine Street, Nk'Mip Substation and the connecting transmission lines be ever directly or indirectly used for transmitting electricity to out of province of British Columbia and/or across the Canada U.S. border? If so, please state when and give details of loads to be exported.

A1.3.1 Currently, FortisBC has no plans to use these facilities to transport electricity in/out of the province. Please also refer to the response to Karow Q1.1.6

Q1.3.2 Will electricity be "exported" to out of Fortis' Kootenay-Okanagan-Similkameen service area via selling electricity to other electric companies?

A1.3.2 FortisBC plans to use its electrical facilities for the purpose of delivering a safe and reliable electrical service to its customers in its service territory. Some of its customers are municipal utilities.

Q1.3.3 Will other electric companies use Fortis power lines for transmitting power?

A1.3.3 Please note that FortisBC offers Open Access Transmission Service, in accordance with its BCUC approved "Wholesale Transmission Access Tariff."

2. Physical Aspects of Proposed Project's Electropollution

Q2.1 FR p 14 A8.5.2 Please provide magnetic field profile (as far as to the 0.3 milliGauss border) for medium and maximum load for the submarine cable.

A2.1 FortisBC does not have the requested data.

Q2.2 FR p26/A10.4 To be able to double check the electric and magnetic field Values and profiles by my EMF expert, please provide for lines in all options, including for the submarine cable specifications in a way that that mathematical calculation (via computer program) is possible. Specification to include

2.2.1 design of all different poles

2.2.2 number of current carriers (including carriers of distribution line as well attached to same poles)

2.2.3 their spatial positions (distance above ground, from center pole and between the wires)

2.2.4 configuration

2.2.5 brand/material of conductors

A2.2 The combined response to Q2.2.1 to Q2.2.5 is as follows:

1. Parameters for a single circuit 12.47 kV line:
    a. Ambient temperature assumed: 40ºC
    b. Average sag used in the analysis (S_{av} = 2/3 * S)
    c. Voltage assumed to be 105% of nominal
    d. Currents based on defined load at nominal voltage
    e. Phase conductors: 477 kcmil ACSR
    f. Neutral Conductors: 3/0 neutral at 2.6 m below pole top
    g. Ruling Span: 60 m ruling span

h. Pole Height: 40 foot poles assumed. This is the minimum. Provision for secondary circuit and/or joint use would demand taller poles (10 or 15 foot taller). Taller poles would cause reduced field strength due to increased separation from the measurement plane.

i. Hardware dimensions are defined according to today's standard structure (9 foot cross-arm)

j. Please refer to structure diagram for a single circuit 12.47 kV line (Figure 1) below.

2. Parameters for 63 kV/12.47 kV Transmission Line:

a. Pole length 55' on flat ground

b. Pole height may be higher at non-flat terrain only flat terrain considered

c. Transmission Post Insulator length is 25" horizontal or vertical

d. Distance between transmission conductors in Classic Delta Configuration - 1.9m

e. Distance between lower Transmission Conductor and 13 kV under built - 3.0m at the structure

f. Under built is in horizontal configuration

g. Please also refer to dimensions in attached sketch

h. Transmission Conductor size - 477 kcmil ACSR

i. Ruling Span—90 m (Typically)

j. Sag expected at mid-span—varies with load current and ambient temperature

k. Pole below GL: Assumed 10% + 2 foot setting as per industry standard (e.g., 7.5 foot for 55 foot pole)

l. Please refer to Structure diagram for a 63 kV/12.47 kV Transmission Line, Figure 2 below.

3. Nk'Mip Project 63kV/12.47kV Transmission Line, 55ft Poles Coordinates and Variables for EMF Calculations

Description	AC ('A') or DC ('D')	Bundle 'x' Coordinate (m)	Bundle 'y' Coordinate (m)	Number of Sub - conductors	Sub - conductor Diameter (mm)	Bundle Sub - conductor Spacing (cm)	Phase Voltage (kVrms)	Phase Angle	Phase Current (kA)	User Specified Gradient Option
Nk'Mip Project 63kV/12.47kV Transmission Line, 55ft Poles										
Proposed Normal: 10MVA ABC over -1MVA ABC Lag 30deg										
'Top A '	'A'	-0.94	12.03	1	20.68	0	38.19	0	0.092	0
'Top B '	'A'	-0.15	13.78	1	20.68	0	38.19	240	0.092	0
'Top C '	'A'	0.94	12.03	1	20.68	0	38.19	120	0.092	0
'Bottom A'	'A'	-1.09	9.28	1	20.68	0	7.56	330	-0.046	0
'Bottom B'	'A'	0.48	9.12	1	20.68	0	7.56	210	-0.046	0
'Bottom C'	'A'	1.09	9.28	1	20.68	0	7.56	90	-0.046	0
'Neutral '	'A'	-0.22	6.77	1	12.75	0	0	0	0	0
Nk'Mip Project 63kV/12.47kV Transmission Line, 55ft Poles										
Proposed Maximum : 16MVA ABC over -2MVA ABC Lag 30deg										
'Top A '	'A'	-0.94	12.02	1	20.68	0	38.19	0	0.147	0
'Top B '	'A'	-0.15	13.77	1	20.68	0	38.19	240	0.147	0
'Top C '	'A'	0.94	12.02	1	20.68	0	38.19	120	0.147	0
'Bottom A'	'A'	-1.09	9.27	1	20.68	0	7.56	330	-0.093	0
'Bottom B'	'A'	0.48	9.11	1	20.68	0	7.56	210	-0.093	0
'Bottom C'	'A'	1.09	9.27	1	20.68	0	7.56	90	-0.093	0
'Neutral '	'A'	-0.22	6.77	1	12.75	0	0	0	0	0

4. Parameters for submarine cable:

Please refer to the response to Karow Q2.a, above.

FIGURE 1: THREE PHASE PRIMARY SINGLE TANGENT 12.47 kV STRUCTURE

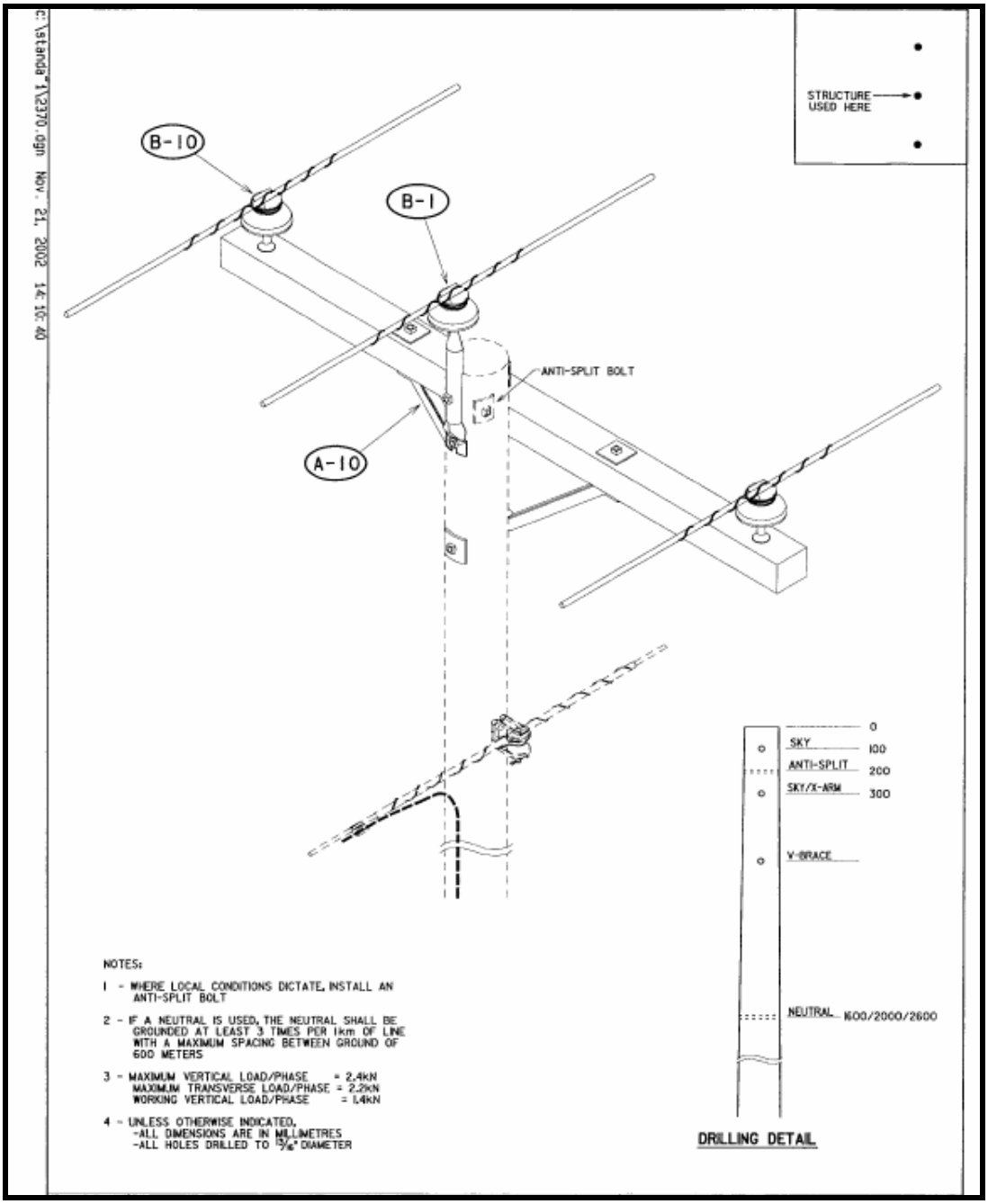
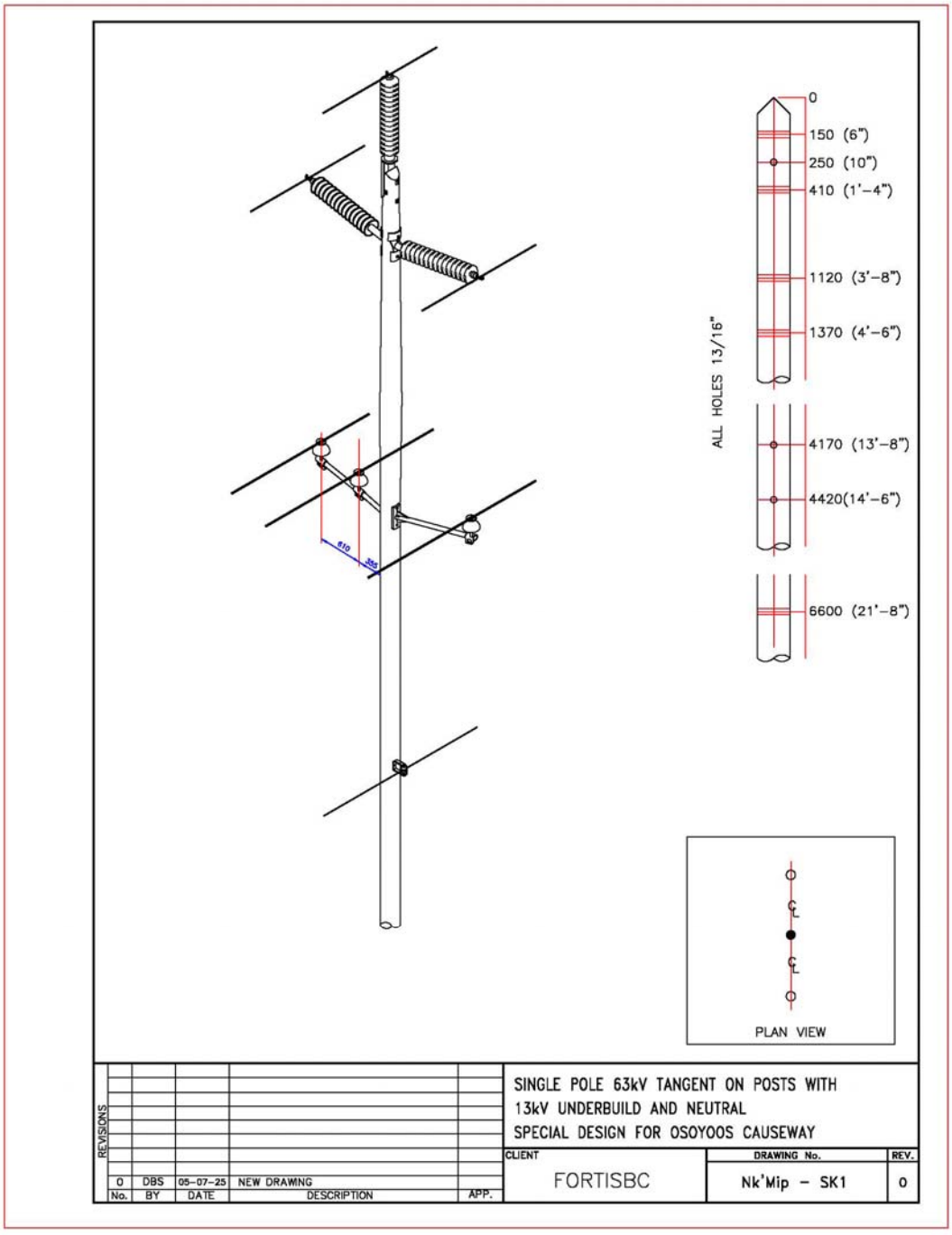


FIGURE 2: THREE PHASE 63 kV/12.47 kV TRANSMISSION LINE STRUCTURE



Q2.2.5.1 for all different lines each:

Q2.2.5.2 maximum possible/allowable load for the line due to material specification

A2.2.5.1 & 2.2.5.2

The Normal Ampacity of 477 Kcmil ACSR (summer): 763 Amps

The Normal Ampacity of 477 Kcmil ACSR (winter): 915 Amps

Q2.2.5.3 normal planned load within the next 5,10 and 25 years

Q2.2.5.4 maximum peak loads within the next 5,10 and 25 years

A2.2.5.3 & 2.2.5.4

Please refer to Nk'Mip (East Osoyoos) Transmission & Substation Project CPCN Application, Table 4, page 29 and Figure 12, page 30, and BCUC IR1, Q3.1 and Q3.2.

Q2.2.5.5 Indicate average duration of maximum peak loads

A2.2.5.5. Average duration of maximum peak loads is typically 1.5 hrs.

Q2.2.6 Please provide normal and maximum electric and magnetic profiles (as far down as to 0.3 milliGauss) for the present/existing 13kV line in the middle of Kingfisher Drive.

A2.2.6 Please refer to the response to BCUC IR1, Q10.4.

Q2.2.7 Same as request in 2.2.6, however for the new proposed constructed transmission line in combination of existing distribution line below.

A2.2.7 Please refer to the response to BCUC IR1, Q10.4.

Q2.2.8 please provide normal and maximum electric and magnetic profiles (as far down as to 0.3 milliGauss) for the present combined transmission and distribution lines at the intersection of Kingfisher Drive and 89 Street.

A2.2.8 Please refer to the response to BCUC IR1, Q10.4.

Q2.2.9 Same as request 2.2.8, however with the new proposed constructed transmission line on Kingfisher Drive in place.

A2.2.9 Please refer to the response to BCUC IR1, Q10.4.

Q2.3 FR p26/A10.4 please amend table on bottom of this page with the loads for given values of magnetic and electric fields as per table on this page.

A2.3 The load details for the EMF profiles are as follows:

Present Normal:	6.5 MVA on the 13 kV Distribution Line
Present Maximum:	10.0 MVA on the 13 kV Distribution Line
Proposed Normal:	10.0 MVA on the 63 kV Transmission Line & 1.0 MVA on the 13 kV Distribution Line
Proposed Maximum:	16.0 MVA on the 63kv Transmission Line & 2.0 MVA on the 13 kV Distribution Line

Q2.4 FR p27/Figure 1a Please provide loads for the four magnetic profiles.

A2.4 Please refer to the response to Karow Q2.2.9 above

Q2.5 FR p27/Figure 1a Please provide the actual calculated magnetic field value numbers at distances of every 5 meters from the centre of the line as far as down to 0.1 MilliGauss on a table for all four magnetic field profiles shown on Figure 1a.

A2.5 Please refer to the response to BCUC IR1, Q10.4.

Q2.6 FRp28/Figure 1b Please provide loads for the four electric profiles.

A2.6 Please refer to the response to Karow Q2.2.9 above

Q2.7 FRp28/Figure 1b Please provide the actual calculated electric field value numbers at distances of every 5 meters from the centre of the line as far as down to 0.1 milliGauss on a table for all four electric field profiles shown on Figure 1b

A2.7 Please refer to the response to BCUC IR1, Q10.4.

Q2.8 FRp24 Please define in more details of property and property owners and their tenants being "impacted directly" and " impacted indirectly", by also stating the numbers of impacted properties (with/without buildings) do also include the numbers opposite the road side where the power line is placed.

A2.8 The term "impacted directly" is used to define those properties that will have poles and/or conductors either on or immediately adjacent to (i.e. a few feet away at most) them. This includes those landowners from whom an easement would be required, as well as those to whom no formal request would be required.

"Impacted indirectly" refers to those properties that are on the same street as the circuit but located on the opposite side as those directly impacted properties.

The numbers for Options 1B and 1C would vary slightly as final design proceeded. Easements for poles and guy wire anchors would be sought on certain properties that are located across the street from poles that are angled or dead-ended. This would have the effect of increasing the "impacted directly" customers and proportionally reducing the indirect category.

The numbers noted includes both sides of the street.

Q2.9 FRp29/A10.5 Please state all possible measures that can mitigate EMF levels, besides as stated in A10.5 & A10.6. Please discuss why those other mitigation measures will not be incorporated in proposed line project, and please state the extra incremental costs for those measures.

A2.9 Please refer to the response to BCUC IR1, Q10.5, Q10.6 and Q10.7

Q2.10 Comparison chart of magnetic field levels from different appliance sources

For clear information of affected parties and in order to avoid misunderstandings of EMF levels at various distances from sources mentioned below, please supply a table in good readable format containing

- **the lowest,**
- **mean, and**
- **highest**

Reading of the appliances at distances from the sources:

10cm, 30cm, 50cm,1m, 2m, 3m, 5m, 10m, 25m, 50m, 100m, 150m, 200m, 250m, 300m:

2.10.1 electric shaver

2.10.2 electric toothbrush

2.10.3 can opener

2.10.4 hair dryer

2.10.5 light dimmer switch

2.10.6 non-digitale radio alarm clock

2.10.7 digitale radio alarm clock

A2.10.1 - 2.10.7

FortisBC does not have the requested information. You may consult the NIEHS brochure EMF: Questions & Answers (Karow Appendix A5.0.6) to obtain some of the above requested readings pertaining to 2.10.1 (electric shaver), 2.20.4 (hair dryer). This brochure also includes readings of magnetic fields measured near other sources for which readings were not requested.

Q2.10.8 distribution line (as per existing line in the middle of kingfisher Drive)

A2.10.8 Please refer to the response to BCUC IR1, Q10.4.

Q2.10.9 transmission line TL 44 with no under-built distribution line

A2.10.9 FortisBC does not find this query to be relevant to the specific project.

Q2.10.10 Transmission line TL 44 with under-built distribution line right next to West Osoyoos Substation.

A2.10.10 Please refer to the response to BCUC IR1, Q10.4.

It may however be noted here that while response to BCUC IR1, Q10.4, does not consider a specific location, it considers overall generalized situations for Transmission Line with under built distribution and also Distribution Lines under normal and maximum loading conditions. The specific scenario in the above Query is covered under response to the BCUC IR1, Q10.4.

Q2.11 Please state the average ambient magnetic field levels in the middle of homes in a typical town like Osoyoos and same for homes on a country side with no transmission lines near by (not closer than 250 m) and at the end of a distribution line. Please provide source, author and web site/contact link.

A2.11 FortisBC does not have access to the specific data that is requested. Deadman et al (1999) have reported that the average magnetic fields encountered by children in British Columbia at home are 1.18 mG (daytime) and 0.97 mG (during sleep).

Higher magnetic field levels are measured near distribution lines and transmission lines. However, since the intensity of magnetic fields diminishes quickly with distance from the source, few homes are close enough to transmission lines for the lines to have a large effect on the magnetic field level within the home.

Q2.12 Fiber optic/micro wave/radio wave/internet

Q2.12.1 Please state whether proposed transmission line and/or distribution lines will be used for telecommunication purposes

Q2.12.2 If so, please explain in details by also addressing the specific technique used, including frequencies.

Q2.12.3 If so, please state all companies which will be using either transmission or distribution line for this communication purpose.

Q2.12.4 If so, please state specifically, whether any of the lines will be used for internet communications.

Q2.12.5 If not yet, but sometimes in the future, will the use of the lines for internet communication purpose need special permit applied with which agency?

Q2.12.6 In case the lines will be used directly or indirectly by communication companies, what revenues will be expected from these companies?

Q2.12.7 Please state, whether Fortis will ever install or allow installing by other companies radio/microwave transmitter antennas on the power line pylons or anywhere on the new and existing substation in/near Osoyoos? If so, please give details.

Q2.12.8 Please, in layman's language, explain the difference of single phase magnetic fields and rotating magnetic fields, and state what kind of magnetic fields the proposed transmission line, and distribution lines usually have.

A2.12 The responses to Karow Q2.12.1 to Q2.12.8 are summarized as follows:

The transmission and distribution line conductors shall not be used for the purpose of telecommunication. However, the poles and structures may be utilized for installing communication cables for the purpose of Protection and Control and Monitoring or for communication purposes through the use of joint use agreements with other utilities.

FortisBC does not currently offer nor does it plan to offer Internet services to the general public.

FortisBC has not been approached, nor has it sought to offer access to power line structures for the purposes of installing third-party telecommunications antennas. In general, the mountainous terrain of the FortisBC service-area does not lend itself to having telecommunications antennas installed in the valley bottom where most transmission lines are located.

The conductors used for power distribution and transmission each have single-phase magnetic fields that pulsate at the power frequency rate (60 cycles per second).

2.13 Other electric forces adherent with power lines

Q2.13.1 Please state which one of the following electric forces would be present with, or directly/indirectly caused by, or emanating from proposed substation and proposed power lines. Please also explain in layman's language how those electric forces could be mitigated:

2.13.1.1 Stray voltages
2.13.1.2 Ground currents
2.13.1.3 Harmonics
2.13.1.4 Transients
2.13.1.5 Radio & microwaves
2.13.1.6 Coronas

A2.13.1 All the items noted are associated with the generation, transmission and utilization of a safe and efficient electrical service, but should not be confused with forces (*cf.* answers to Q6.1.1 and Q6.1.2). Ground currents, for instance, include all paths of charge conduction completing the utility power circuit. These currents are not equivalent to a force, nor do they pose a risk with standard safety practices in the

industry. FortisBC follows "good utility practices" and designs substations and power lines to minimize any of the undesired effects listed above. "Good utility practices" include proper grounding and protection of electrical equipment.

Two of the items listed above - harmonics and transients - are most often produced at troublesome levels by customers' equipment, rather than utility equipment (please refer to IEEE Standard 519, "IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems"). Harmonic distortion and transients are normal indicators of the "power quality" at a site, and are exacerbated by switching loads and motors (to name two noisy sources) operated by customers in the vicinity.

3. Biological Aspects of Proposed Project's Electropollution

Please answer the following question by question for participants' better understanding, please in more detailed layman's language. It is important that the EMF issue is fully understood so that affected people can make an informed decision and submission!

Q3.1 Reference: *"EMFs are a by-product of electricity and, after more than 20 years pf research worldwide, there is no conclusive scientific evidence that they have negative health effects."*

Q3.1.1 Please give a more detailed definition –in layman's language- of the terms

Q3.1.1.1 <u>"conclusive scientific evidence"</u> in general

A3.1.1.1 "Conclusive scientific evidence" is theoretically a scientific consensus where the evidence provides a clear conclusion in either direction – strong evidence or no evidence in support of a causal relationship. In order to arrive at a conclusion about a particular scientific question, the research that is considered comes from several disciplines – epidemiology studies, animal studies and studies in cells and tissues. Scientific panels are organized to weigh each piece of research based

on its strengths and weaknesses, and arrive at a scientific consensus – this is referred to as a weight-of-evidence review. A scientific consensus is the collective judgment and opinion of expert scientists in a particular field.

Q3.1.1.2 Please explain the term "conclusive"

A3.1.1.2 "Conclusive" means putting an end to a question or discussion because the evidence is quite strong.

Q3.1.1.3 If a group of experts is involved, when is an evidence being approved as conclusive at what percentage of the members of the expert group

A3.1.1.3 Scientists prefer to assess the weight of the evidence by examining the strengths and limitations of the research. Their conclusion is generally written as a consensus. The specific definitions and guidelines regarding consensus for each group are set either by the members or the sponsoring organization.

Q3.1.1.4 What meets the criteria of an evidence being "scientific"'

A3.1.1.4 In general, evidence is "scientific" if it is gathered by scientists from experiments and observational studies that follow scientific procedures developed to ensure objectivity.

Q3.1.1.5 What is classified as "evidence", which criteria must an evidence meet?

A3.1.1.5 Each panel has pre-determined criteria for the type and quality of "scientific evidence" that will be considered in its weight-of-evidence review. At the minimum, evidence should be published in a peer-reviewed journal and gathered using established and validated methods appropriate to the field of research.

Q3.1.1.6 **To which scientific groups is referred when stating that there is no "scientific conclusive evidence" meaning there must be a group of scientists doing EMF research and discussion, and the come to a conclusion. Please state all the EMF experts/groups.**

A3.1.1.6 Numerous national and international organizations responsible for health decisions have convened groups of scientists to review the body of EMF research. These panels include the following (the citation indicates the most recent review):

- the Canadian Federal-Provincial-Territorial Radiation Protection Committee, the ELF Working Group (FPTRPC, 2005);
- the National Radiological Protection Board of Great Britain, the Advisory Group on Non-ionising Radiation (NRPB, 2004);
- the Health Council of the Netherlands, Electromagnetic Fields Committee (HCN, 2005);
- the International Commission on Non-Ionizing Radiation Protection, ICNIRP Standing Committees I-III (ICNIRP, 2003);
- the International Agency for Research on Cancer, IARC Working Group on the Evaluation of Carcinogenic Risks to Humans: Non-Ionizing Radiation, Static and Extremely Low Frequency (ELF) Fields (IARC, 2002); and
- the National Institute for Environmental Health Sciences, Working Group (NIEHS, 1998; NIEHS, 1999).
- the National Academy of Sciences, Committee to Review the Research Activities Completed Under the Energy Policy Act of 1992 (NAS, 1999)

Q3.1.1.7 Please state whether the experts/groups as mentioned in 3.1.1.6. do have industry ties or former industry backgrounds.

A3.1.1.7 While the details of the selection and inclusion process differ between organizations, all selection procedures involved careful consideration of the individual's professional background and expertise, including disclosure of any potential conflicts of interest. The goal of committee selection is to ensure an independent, unbiased group that reflects the different research approaches required to address questions about health. Further information can be extracted from the documents cited in response to Q3.1.1.6.

Q3.1.1.8 Please state all EMF experts/groups/organization, who also have industry-independent members.

A3.1.1.8 Please see the response to Karow Q.3.1.1.7 above.

Q3.2 Please state whether EMFs also have positive heath effects, if so, which ones?

A3.2 The search for beneficial health effects from exposure to electricity or EMF has a long history reaching back to ancient times. While there are reported beneficial responses to high intensity pulsed magnetic fields, e.g., accelerated healing of bone fractures, and alleviation of depression, the weight of the scientific evidence does not indicate that either beneficial or adverse responses to EMF occur at the very much lower intensities encountered in our communities and workplaces.

Q3.3 For comparison of statement in section 3.1, please state at least three non-EMF related cases/issues where there was/is <u>"conclusive scientific evidence"</u> of adverse health effects, please include criteria and state the mechanism and cause.

A3.3 Using the method described in Q 3.1.1, the International Agency for Research on Cancer assembles expert panels to assess the carcinogenic risks to humans posed by a variety of exposures. Among others, asbestos, tobacco smoking, and solar radiation are classified as known human carcinogens (IARC 1986, 1997, 1992). In particular,

there is a scientific consensus of causality for smoking and lung cancer, asbestos and lung cancer, and sunlight and melanoma. For complete details on the causal mechanisms, consult the aforementioned citations.

Q3.4 Please state whether there is any scientific conclusive evidence that power line frequency – EMFs <u>don't</u> have negative healthy effects? If so, please name the evidences.

A3.4 Neither individual scientists nor scientific organizations can easily prove the absence of a hypothesized effect. For example, to dispute the claim that Winston Churchill is alive and living in Argentina would require examination of every resident of that country. On the other hand, if a man presents himself as Winston Churchill, scientists could examine him and perform tests to evaluate the validity of his claim. Proof of safety is an ongoing process in which scientists continually test hypotheses in different ways. Thus, science cannot prove the absence of a hypothesized adverse effect – but it can determine through extensive testing that, with the continued absence of supporting evidence for the hypothesized effect, the potential for risk becomes very, very small.

Q3.5 When stating that*"there is no conclusive scientific evidence that EMFs have negative health effects,"* in Fortis opinion, does that mean that EMFs are safe and/or have no adverse direct or indirect biological effects?

A3.5 The question is assumed to pertain to levels of EMF that are typically encountered in the community. FortisBC's position with respect to the possible health effects of EMF exposure is outlined in responses to BCUC IR1 Q 9.8 and Karow IR 3.1.1.6.

Q3.6 Please define the term more detailed: "<u>limited</u> evidence", please explain also whether limited evidence is equal to "no evidence" ?

A3.6 The question appears to refer to the term 'limited evidence' as used in the IARC rating system for summarizing evidence that supports carcinogenicity. In the case of the epidemiology data, if a positive association between an exposure and cancer is

found for which a causal interpretation is considered to be credible but factors such as chance, bias and confounding cannot be ruled out with reasonable confidence, the epidemiologic evidence is rated as "limited evidence of carcinogenicity." Limited evidence could be interpreted as "no conclusive evidence of carcinogenicity."

Q3.7 As mentioned above in section 3.1., EMFs are a <u>byproduct</u> of electricity, would Fortis agree that EMFs can be also classified/termed as pollution? If not, please explain why not.

A3.7 FortisBC believes that this is a subjective question. Pollution may be defined as the disbursal of an agent into the environment from man-made or natural sources, with the implication that it is harmful. EMFs are produced by charges and the flow of electric currents in both natural and man-made sources, including the earth, the human body and from the use of electricity. As detailed in the response to BCUC IR1 Q9.8, the scientific consensus is that the evidence has not established that EMFs at the levels typically found in the environment are harmful.

Q3.8 We are often referred to "peer-reviewed" EMF studies.

Q3.8.1 Please explain who is qualified to be a peer, and how is he/she chosen as a peer?

A3.8.1 Peer reviewers are scientists who are trained and experienced in the specific technical disciplines relevant to the study being considered whether for publication, a proposal for research funding, or a topic to be reviewed. The editor of the scientific journal who has been assigned to review a paper, or papers, on a subject identifies two or more individuals to review the paper. Peer reviewers are typically drawn from scientists known in the field, including those who have previously published in the topic relevant to the study. Editors of each journal, with their affiliation, are listed in the front of each issue of the journal. Many journals list their peer reviewers at the end of each volume.

Q3.8.2 Please explain how i.e. EMF studies are peer reviewed?

A3.8.2 EMF studies are peer reviewed in the same manner as research in any other biomedical field. Scientists submit a description of their work to technical or scientific journals for peer review and consideration for publication. Such reports include all of the information needed to justify the study's conclusions or permit another researcher to repeat or modify the research. This information includes the study's purpose and hypothesis; the study design; a description of exposures, procedures and results; a discussion of the strengths and limitations of the particular work; and conclusions. Some journals request that a statement signed by each author declaring their specific contribution to the work and any financial or other competing interests accompany the submission. The editors of the journal distribute the paper to two or more reviewers, who prepare comments for the authors and a recommendation to the editor as to whether the article should be published. The feedback process allows the authors to address the minor comments of the reviewers. The editorial board makes the final decision for publication by considering the goals and scope of the journal, the reviewers' recommendations, and the authors' responses.

Q3.8.3 When an EMF study has been peer-reviewed, would be the list of peers and the peers' comments on the studies be available to the public?

A3.8.3 No. The names of specific peer reviewers of a study are typically not disclosed to the authors or the general public. The editor transmits to the authors only the comments and questions generated by the reviewers. The reviewers' anonymity is maintained to encourage a candid critique of the study under consideration. However, the list of scientists who provided reviews for a specific journal is usually published in the journal at the end of the year.

Q3.8.4 In Fortis opinion, are there possibilities of EMF studies being biased, if so how and why?

A3.8.4 In general terms, bias is defined as a preference or an unfair influence, especially one that inhibits impartial judgment. In scientific terms, bias has a different meaning and does not refer to conscious partiality or prejudice. Rather, bias refers to any systematic error, or trend in the collection, analysis, interpretation, publication or review of data, that can lead to conclusions that are systematically different from the truth (Last, 2001). In FortisBC's opinion, the possibility that the results of EMF studies are biased (that is, unfairly influenced) is of minimal concern because the methods of science are designed to root out subjective influences. These standard scientific procedures include the use of control groups, blinding of researchers and human subjects to information that could influence their decisions, thorough documentation, measuring and counting equitably in all experimental groups, and the peer review process.

The extent to which a study uses appropriate and objective scientific procedures is evaluated more than once by independent parties. The first evaluation occurs when a proposal describing the study's design and methods is submitted to a funding organization, such as the National Institutes of Health, which entails an extensive peer-review and feedback process. Another evaluation occurs after the study is complete and peer reviewers and editors evaluate the study for publication, including the extent to which scientific methods have been applied (as described in Q 3.8.2). Finally, the study's objectivity is considered again when the research is evaluated collectively in the context of other studies in a weight-of-evidence review, which is designed to put more emphasis on studies with the most reliable designs.

Q3.9 Reference: Exhibit C1-17 This exhibit contains my one page summary/assessment of EMF biological studies mentioned in Chapter 2 (Exposure Assessment and Non-Cancer Human Health Studies), Chapter 3 (Human Studies of EMF and Cancer) and Chapter 4 (Effects of EMF on Animals and Plants) of the Power Administration book *"Electrical and Biological Effects of Transmission Lines: A Review"*
This summary/assessment concludes that out of 571 studies mentioned in these three chapters, 267 studies showed positive results, classified as statistically significant and/or that do show association with EMF's but not containing studies with little or weak associations. This means that 46.67% of these studies show an association to EMF exposure, does Fortis agree with this finding; if not please explain why not.

A3.9 The nature of "positive results" is undefined and is not highly informative given the complexity and diversity of studies. Furthermore, the report under consideration was published in 1996, and, therefore, does not include relevant research that has been published since then. Please also see Dr. Bailey's report attached as Karow Appendix 3.9.

Q3.10 Reference: C1- Exhibits containing EMF studies: please respond to each of the, Fortis does not agree that EMFs are associated with adverse biological effects, if so, please explain why:

3.10.1 C1-3 CORE Evidence dated November 27, 2005 C.U.R.E booklet

3.10.2 C1-4 Letter dated November 28, 2005 – Evidence No. 2 Nam BCTC VITR EMF

3.10.3 C1-9 December 1, 2005 – Submission of Evidence No. 3 regarding Dr. Cherry's ICNIRP Criticism

3.10.4 C1-10 December 1, 2005 – Submission of Evidence No. 4 regarding paper by Dr. Maxey

3.10.5 C1-11 December 1, 2005 – Submission of Evidence No. 5 regarding paper by Dr. Cherry

3.10.6 C1-12 December 1, 2005 – Submission of Evidence No. 6 – Article by Dr. Milham

3.10.7 C1-13 December 2, 2005 – Submission of Evidence No. 7 – ISIS Press Release

3.10.8 C1-14 December 5, 2005 – Submission of Evidence No. 8 Burch / Kato rotating EMF studies

3.10.9 C1-18 December 9, 2005 – Evidence No. 12 attaching The Draper Study "Childhood cancer in relation to distance from high voltage power lines in England and Wales: a case-control study"

3.10.10 C1-20 December 12, 2005 excerpts from Evidence 11b (Exhibit C1-17) BPAB Chapter 2

3.10.11 C1-21 December 23, 2005 Chapter 3 excerpt from Evidence 11b (Chapter 4 still to follow)

3.10.12 C1-25 December 15, 2005 filing Evidence No. 16 Sept11/05 Sunday Times EMF article

3.10.13 C1-26 December 17, 2005 filing Evidence No. 17 Havas critical review US NRC/NIEHS

3.10.14 C1-22 December 12, 2005 filing Evidence No. 13 Gustav Melatonin

A3.10 Many of these items have not been published in peer-reviewed scientific journals (Exhibits C1-3, C1-4, C1-9, C1-11, C1-13, C1-20, C1-21, C1-22, C1-25) and are, therefore, not suitable for the purposes of risk assessment. Other items (C1-10, C1-12, C1-14, C1-18, C1-26) represent only a tiny fraction of the available scientific literature on these topics. FortisBC could not draw a valid conclusion about an association of EMF with adverse biological effects from the submitted items and therefore relies upon the assessments of the peer-reviewed scientific literature by the IARC, NIEHS, FTPRPC and others for guidance to answer such questions. Please also see Dr. Bailey's report attached as Karow Appendix 3.9.

Q3.11 Rotating magnetic fields

Q3.11.1 Please state whether rotating magnetic fields do have a different biological effects than the standard single phase magnetic fields.

A3.11.1 The available scientific data is insufficient to answer this question.

Q3.11.2 Please state a list of EMF studies done with rotating magnetic field exposures, please name the studies and the authors.

A3.11.2 Fulfilling this request would be overly time-consuming, burdensome, and unlikely to shed light on relevant issues.

Q3.12 Transients

Q3.12.1 Please state a list studies done with special attention also of transients exposures, please name the studies and the authors.

A3.12.1 Fulfilling this request would be overly time-consuming, burdensome, and unlikely to shed light on relevant issues.

Q3.12.2 Do those studies mentioned in response to 3.11.1 have a greater association to adverse biological effects than the conventional EMFs?

A3.12.2 Please see the response to Karow Q3.11.1 above.

Q3.13 Please state the natural unaffected body voltage of humans, what is the normal value?

A3.13 The question is too vague to provide an answer. The term "body voltage" requires a definition.

Q3.14 Please state the body voltage of humans near a power lines of different voltages (13kV and 63kV and 113 kV)

A3.14 Please see the response to Karow Q3.13 above.

Q3.15 Please explain whether the increased body voltage is due to an alternative current in the body exposed to power line electric forces.

A3.15 Please see the response to Karow Q3.13 above.

Q3.16 What would be about the upper safe level of body voltage (milliVolt)?

A3.16 Please see the response to Karow Q3.13 above.

Q3.17 The International Agency for Research on Cancer (IARC) classified ELF magnetic fields as possible carcinogenic, meaning a possible adverse biological effect. In this classification, does Fortis dispute an association also of power line's possible carcinogenic biological effect in humans?

A3.17 Fortis BC does not dispute that the IARC classified ELF magnetic fields (which, by definition, include those generated by power lines) as possibly carcinogenic. It is important to consider, however, that the term 'possibly carcinogenic' is used by the IARC very differently than it is used by laypersons. In evaluating exposures for which there are concerns about cancer, such as EMF, the IARC has an established method for classifying exposures based on the strength of the scientific research. These categories are intentionally meant to err on the side of caution, giving more weight to the possibility that the exposure is truly carcinogenic and less weight to the possibility that the exposure is not carcinogenic. If the research data meets a certain set of criteria, then the IARC method requires that the exposure be classified in a particular category. The category "possibly carcinogenic" denotes exposures for which there is limited evidence of carcinogenicity in epidemiology studies and less than sufficient evidence of carcinogenicity in studies of experimental animals. This category also includes exposures such as pickled vegetables and coffee.

Q3.18 FR Appendix A9.8.3, page 498, middle of second column: In this section discussed is the possible *"link between exposure to ELF magnetic fields and an elevated risk of cancer…",* and then it is referred that *"[t]o date there have been more than a dozen studies on childhood cancer and exposure to power-frequency magnetic fields in the home produced by nearby power lines…",* which findings of

these studies "*relating to leukemia are the most consistent. Out of 13 studies, all but five reported relative risk estimated of between 1.5 and 3.0.*"

Q3.18.1 Would Fortis agree that those 5 studies show an association of power-frequency magnetic fields in homes produced by nearby power lines and adverse biological effect in humans?

A3.18.1 We believe this question is referring to the 8 studies with a risk estimate between 1.5 and 3.0. FortisBC would not disagree that these studies reported an association. FortisBC agrees these studies report associations with estimated levels of magnetic fields in the home, and that the sources of the fields include power lines. However, these associations have not been interpreted either by the authors of the document quoted by Mr. Karow, or by the authors of these 8 studies and the scientists who have reviewed them for national and international agencies (NAS, 1999; NIEHS, 1998; ICNIRP, 2003; IARC, 2002, NRPB, 2004) as demonstrating that power frequency magnetic fields causes adverse biological effects, including cancer in humans. Please also see Dr. Bailey's report attached as Karow Appendix 3.9.

Q3.18.2 Please explain in lay-mans language "relative risk between 1.5 and 3.0"

A3.18.2 The association between a particular disease and exposure is measured quantitatively by using a relative risk. A relative risk is expressed as the ratio of the rate of disease among persons who are exposed to the rate of disease among persons who are unexposed. The studies in question estimated the relative risk by the odds ratio, which is a ratio of the odds of exposure in persons with a disease to that of persons without that disease. The general interpretation of a relative risk, or odds ratio, equal to 1.0, is that the exposure is not associated with the disease. If the estimate of effect is great than 1.0, the inference is that higher exposures are associated with higher rates of disease. On the other hand, if the

estimate of effect is less than 1.0, the inference is that exposure is associated with a lower rate of disease. However, these interpretations assume that chance is an unlikely explanation for the result; and the interpretation becomes doubtful to the extent the results are affected by systematic error (bias) or confounding.

Therefore, a relative risk between 1.5 and 3.0 means that, in the studies under consideration, the estimated exposure of children with leukemia was somewhere in the range 1.5 - 3 times greater than for children without leukemia who were selected as controls.

Q4. Proposed Project's Impact on Property Devaluation

Please state whether property devaluation are associated to near by power lines, in particular, see

Q4.1.1 Exhibit C1-24 December 13, 2005 filing Evidence No. 15 realtor affidavit - prop. dev.# 1

A4.1.1 Please refer to the response to Wonch & White IR1, Q9.7.

Q4.1.2 My Evidence # 19, containing 5 reports of property devaluation associated with near-by power lines.

A4.1.2 Please refer to the response to Wonch & White IR1, Q9.7

Q4.1.3 If Fortis is in the believe that proximity of utilities facilities (substation, power lines, transformers) do not have any negative impact on property value (property devaluation) would Fortis be prepared to sign a bond that is adjusted to the relative cost of property and housing, so that, when the property is sold or disposed of in an estate, any loss will be compensated by Fortis?

A4.1.3 Such a measure would be inappropriate and unacceptable. The issue of property valuation is in large part subject to buyer/seller discretion, real time market forces and

length of time on the market, to name but a few of the weighted factors. Just as multiple appraisers who review the same property will often provide differing appraisal values, assigning a specific "actual" value to any individual property is not possible in practice. Indeed, extracting two quotes from the reports cited in 4.1.2 previous,

> *"A power line may either increase or decrease an individual's perception of a property's worth. This perception is indicative of how much one is willing to pay for the property (the fair market value)."*
>
> *"Other amenities, such as proximity to schools or jobs, lot size, square footage of a house, and neighborhood characteristics, tend to have a much greater effect on sale price than the presence of a power line."*

Therefore, if a buyer feels neutral about the presence of a power line but is adverse to a road widening, and the latter occurs, the property price may "suffer" due to an effect that is completely unrelated to the power line. Entering into a compensation agreement such as the one contemplated in this question would put upward financial pressure on FortisBC ratepayers with no benefit to them. For this reason, FortisBC would not enter into any such agreement.

Q5. Proposed Project's Impact on Insurances

Q5.1 Has Fortis done an assessment with regard to how property/house insurances may be impacted by power lines very close by? If so please provide. If not, please explain why Fortis has not considered this type of impact.

A5.1 FortisBC has not assessed the impact of power lines on the insurance premiums or deductibles as they apply to houses or properties. While it is at the insurance industry's discretion to assess risk and assign costs accordingly, FortisBC is not aware of any insurance company, in British Columbia or elsewhere that penalizes a

homeowner or property owner who owns facilities adjacent to or in proximity to electrical power lines. When assessing the risk of a new policy applicant, the location of power lines in relation to the property is not normally part of the assessment process.

Q5.2 In 1996 a major Swiss insurance company, Swiss Re, issued a warning to the insurance industry. Swiss Re's publication "Electrosmog - a phantom risk" [1996] raises serious concerns as to the exposure of the insurance industry to future liability for claims from "electro smog". As this publication warns:

"...The EMF problem is more dangerous and more threatening for the insurance industry than has generally been supposed - due not to incalculably small health risks, but to the incalculably great risk of sociopolitical change. From the insurance point of view, the EMF issue is a typical example of what has become known as a "phantom risk": that is, a prospective hazard, the magnitude of which cannot be gauged and which perhaps does not even exist, but which is nonetheless real - if only in that it causes anxiety and provokes legal actions. Apart from the urgent need for measures to limit losses in the EMF area, there is the more comprehensive task of developing new strategies for dealing with risks of technological development and of sociopolitical change..."

Would Fortis agree that there can be an association between proximity of power lines and impact on property and/or health insurance?

A5.2 FortisBC does not agree that there is any association between proximity of power lines and impact on property and/or health insurance. As it pertains to property insurance, please refer to the response to Q5.1 above. In relation to health insurance, FortisBC is not aware of any precedence, either within the British Columbian or any other health jurisdiction where an applicant for health insurance was penalized or denied coverage due to the fact they reside or work within a zone that is influenced by electrical or magnetic fields.

6. Proposed Project's Impact on Legal Issues

Q6.1 Does Fortis agree with the physical actions as stated in 6.1.1 and 6.1.2 below? If not, please explain why not, and correct where necessary.

Q6.1.1 an electric field is a field extending outward in all directions. Electrical fields consist of electrical forces exerted by charged particles such as protons, electrons and ions. A charge placed in the volume of space or in the surrounding medium has a force exerted on it. Thus power lines' electric field radiation is a physical force or associated with a physical force.

A6.1.1 FortisBC does not agree that the electric field is a physical force or necessarily associated with a physical force. For the following, please refer to IEEE Standard Dictionary of Electrical and Electronics Terms (IEEE Standard 100-1998). The electric field is a property of a location or point in space and its electrical environment, and describes the forces that would be experienced by a charged body in that space by virtue of its charge. The electric field is not itself equivalent to the force, nor will it develop a force on bodies that are not charged.

Q6.1.2 a magnetic field is an entity produced by moving electric charges (electric currents) that exerts a force on other moving charges. A force is an external cause responsible for any change of a physical system. (For instance, a person holding a dog by a rope is experiencing the force applied by the rope on their hand, and the cause for its pulling forward is the force exercised by the rope). Thus power lines' magnetic field radiation is a physical force or associated with a physical force.

A6.1.2 FortisBC does not agree that the magnetic field is a physical force or necessarily associated with a physical force. For the following, please refer to IEEE Standard Dictionary of Electrical and Electronics Terms (IEEE Standard 100). The magnetic field is a state of region in space, and describes the forces that would be experienced by a moving charge (or magnetic material) in proportion to its charge and velocity. The magnetic field is not itself equivalent to the force, and will not

develop a force on bodies that do not conduct charge, or do not have a magnetic moment. The dog example therefore is not applicable.

Q6.2 Power lines electric forces' impact in the environment past the utilities encroachment and represents a physical attack, meaning an assault causing bodily injury to persons (magnetic fields are physically attacking, they do induce currents in conductive materials, including human bodies, animals and plants). Does Fortis agree with this statement, if not, please explain why not.

A6.2 FortisBC does not agree that the proposed power lines or the electric and magnetic fields associated with their operation would cause a physical attack on persons, animals, or plants. Please see the responses to BCUC IR1 Q9.8 and Karow Q3.7, Q6.1.1 and Q6.1.2.

Q6.3 The power lines' direct and/or indirect electric forces do physically act by: impacting/intruding/invading/infringing/entering the environment/property and body of victims without the victims being informed or invited, and without given the victims a chance of informed consent. Does Fortis agree with this statement, if not please explain why not, if necessary correct this statement.

A6.3 FortisBC does not agree with this statement. Please also see the response to Karow Q6.2 above.

References

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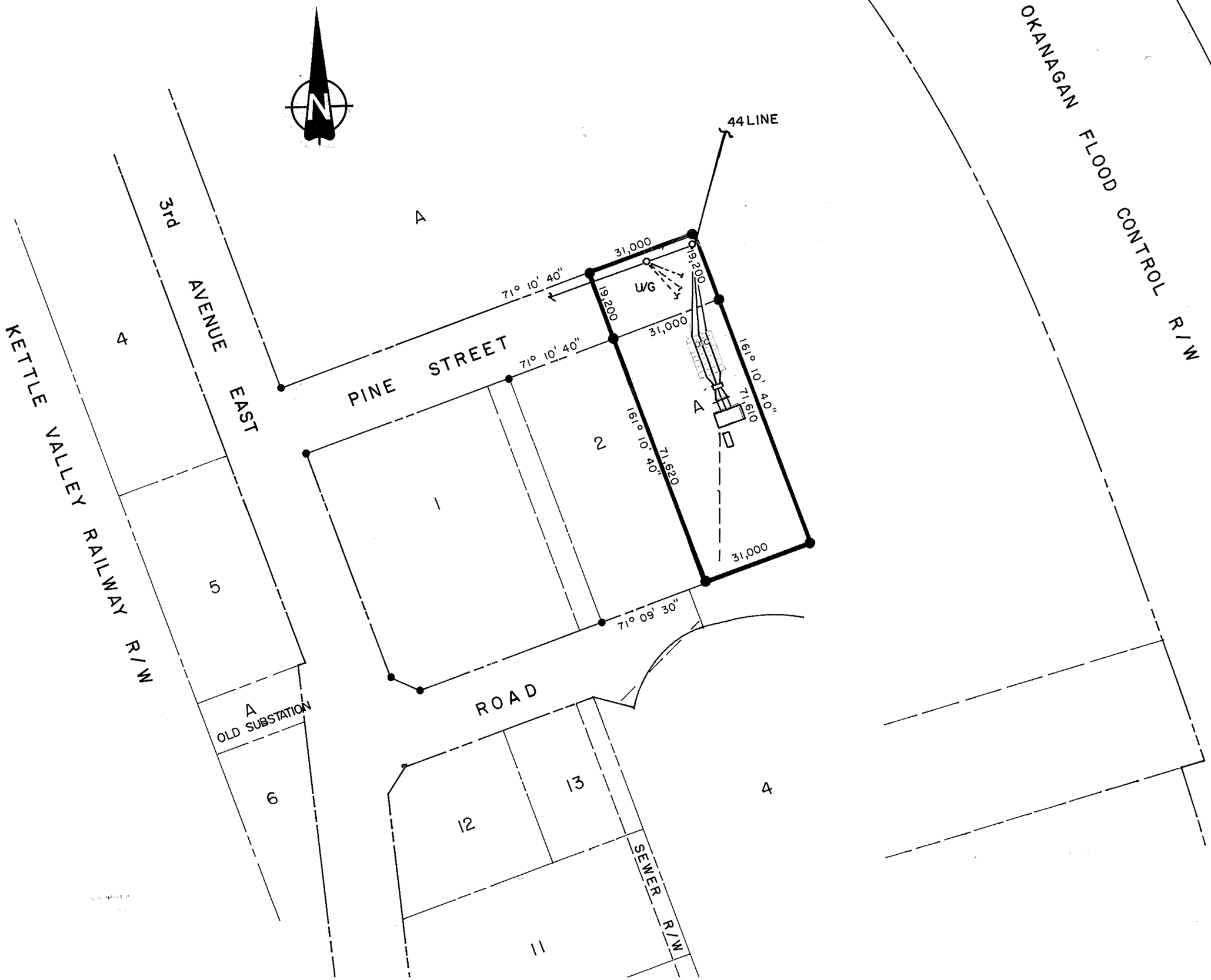
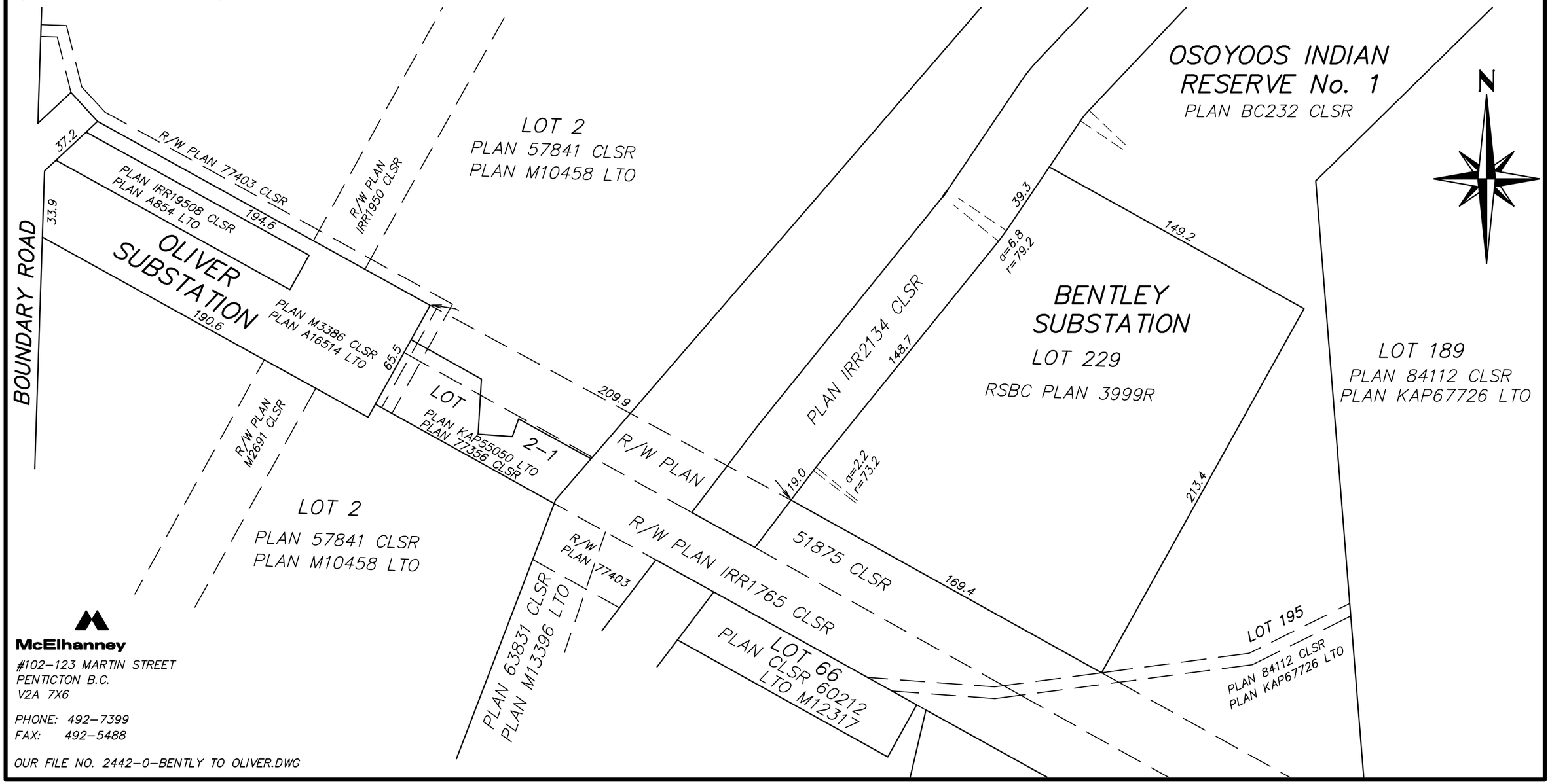

N
44 LINE
A
3rd AVENUE EAST
KETTLE VALLEY RAILWAY R/W
OKANAGAN FLOOD CONTROL R/W
PINE STREET
71° 10' 40"
31,000
19,200
U/G
19,200
31,000
71° 10' 40"
161° 10' 40"
71,610
A
161° 10' 40"
71,620
31,000
71° 09' 30"
ROAD
4
5
1
2
A
OLD SUBSTATION
6
12
13
11
SEWER R/W
4

SKETCH PLAN OF EXISTING FORTIS R/W BETWEEN BENTLEY AND OLIVER SUBSTATIONS, OSOYOOS INDIAN RESERVE No. 1

SCALE : 1:2000

0 50 100 150 200m

(ALL DIMENSIONS ARE IN METRES)



McElhanney
#102–123 MARTIN STREET
PENTICTON B.C.
V2A 7X6

PHONE: 492–7399
FAX: 492–5488

OUR FILE NO. 2442–0–BENTLY TO OLIVER.DWG

FORTISBC

Q-1.2.10
Nk'Mip Routing Options

N

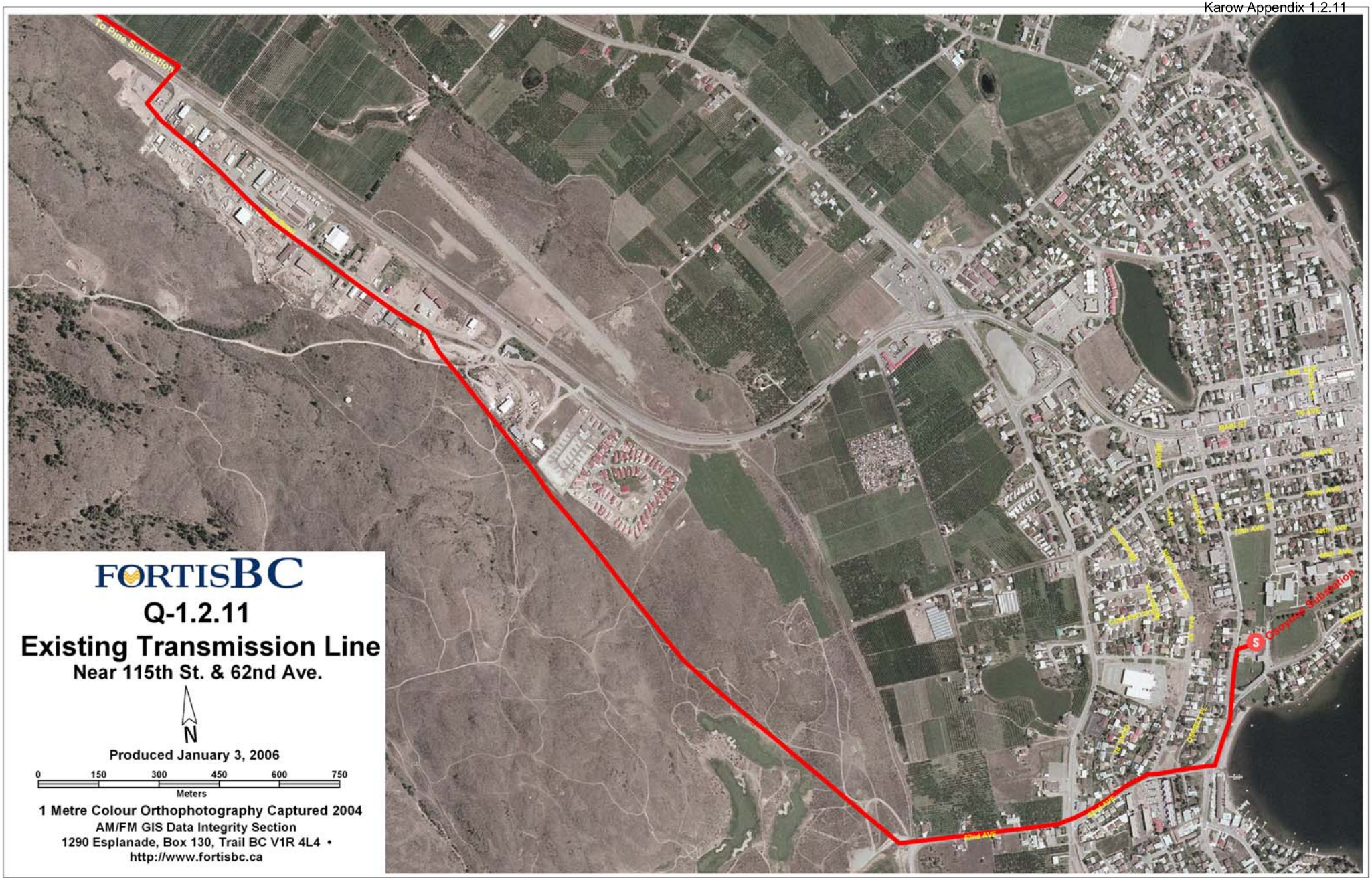
Produced January 3, 2006

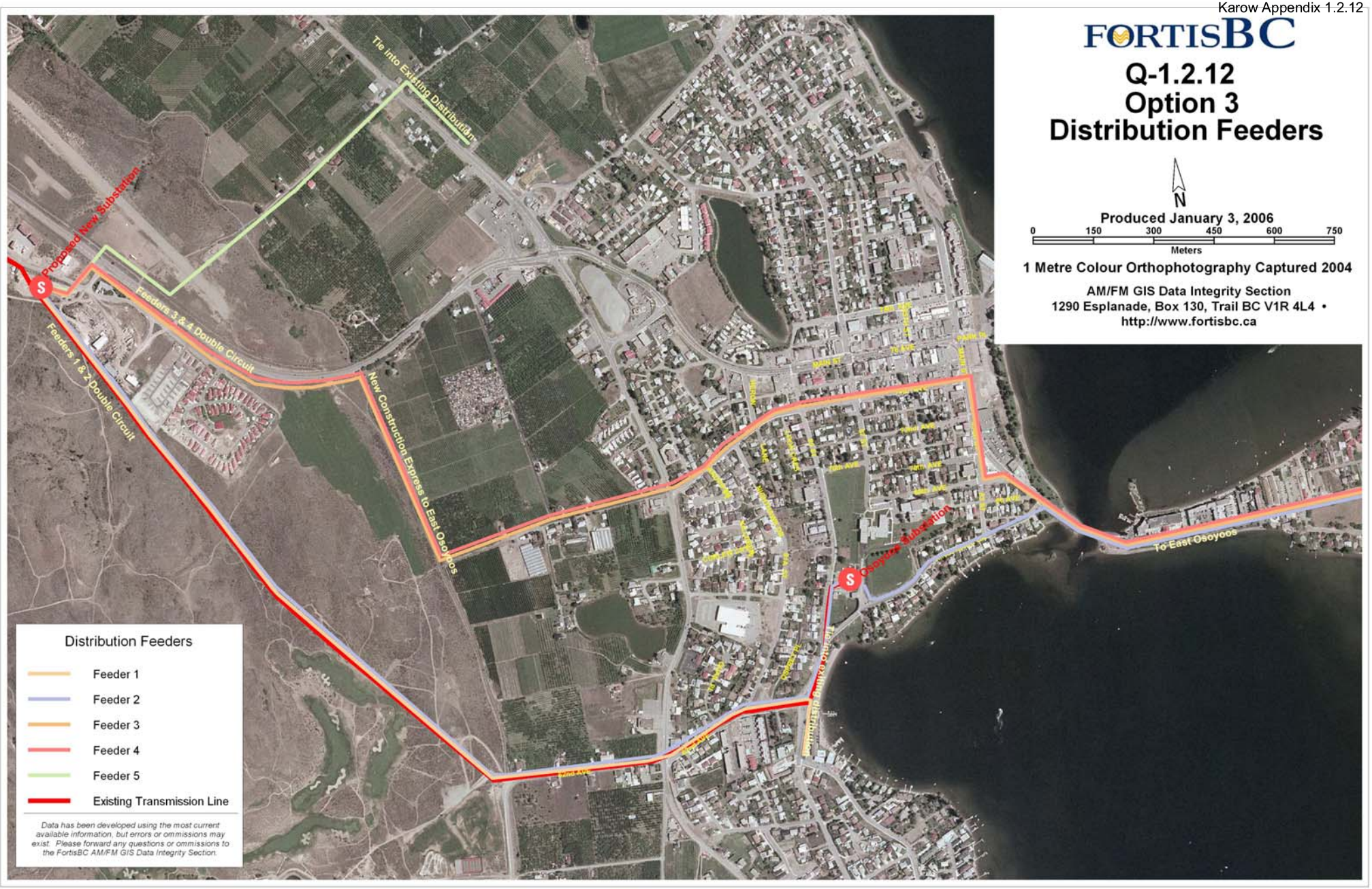
0 150 300 450 600 750

Meters

1 Metre Colour Orthophotography Captured 2004

AM/FM GIS Data Integrity Section
1290 Esplanade, Box 130, Trail BC V1R 4L4 •
http://www.fortisbc.ca


To Pine Substation
Cranbrook Substation
62nd AVE
62nd AVE
FORTISBC
Q-1.2.11
Existing Transmission Line
Near 115th St. & 62nd Ave.
N
Produced January 3, 2006
0 150 300 450 600 750
Meters
1 Metre Colour Orthophotography Captured 2004
AM/FM GIS Data Integrity Section
1290 Esplanade, Box 130, Trail BC V1R 4L4 •
http://www.fortisbc.ca


FORTISBC
Q-1.2.12
Option 3
Distribution Feeders
N
Produced January 3, 2006
0 150 300 450 600 750
Meters
1 Metre Colour Orthophotography Captured 2004
AM/FM GIS Data Integrity Section
1290 Esplanade, Box 130, Trail BC V1R 4L4 •
http://www.fortisbc.ca
Tie into Existing Distribution
Proposed New Substation
Feeders 3 & 4 Double Circuit
Feeders 1 & 2 Double Circuit
New Construction Express to East Osoyoos
Osoyoos Substation
To East Osoyoos
Distribution Feeders
Feeder 1
Feeder 2
Feeder 3
Feeder 4
Feeder 5
Existing Transmission Line
Data has been developed using the most current available information, but errors or ommissions may exist. Please forward any questions or ommissions to the FortisBC AM/FM GIS Data Integrity Section.

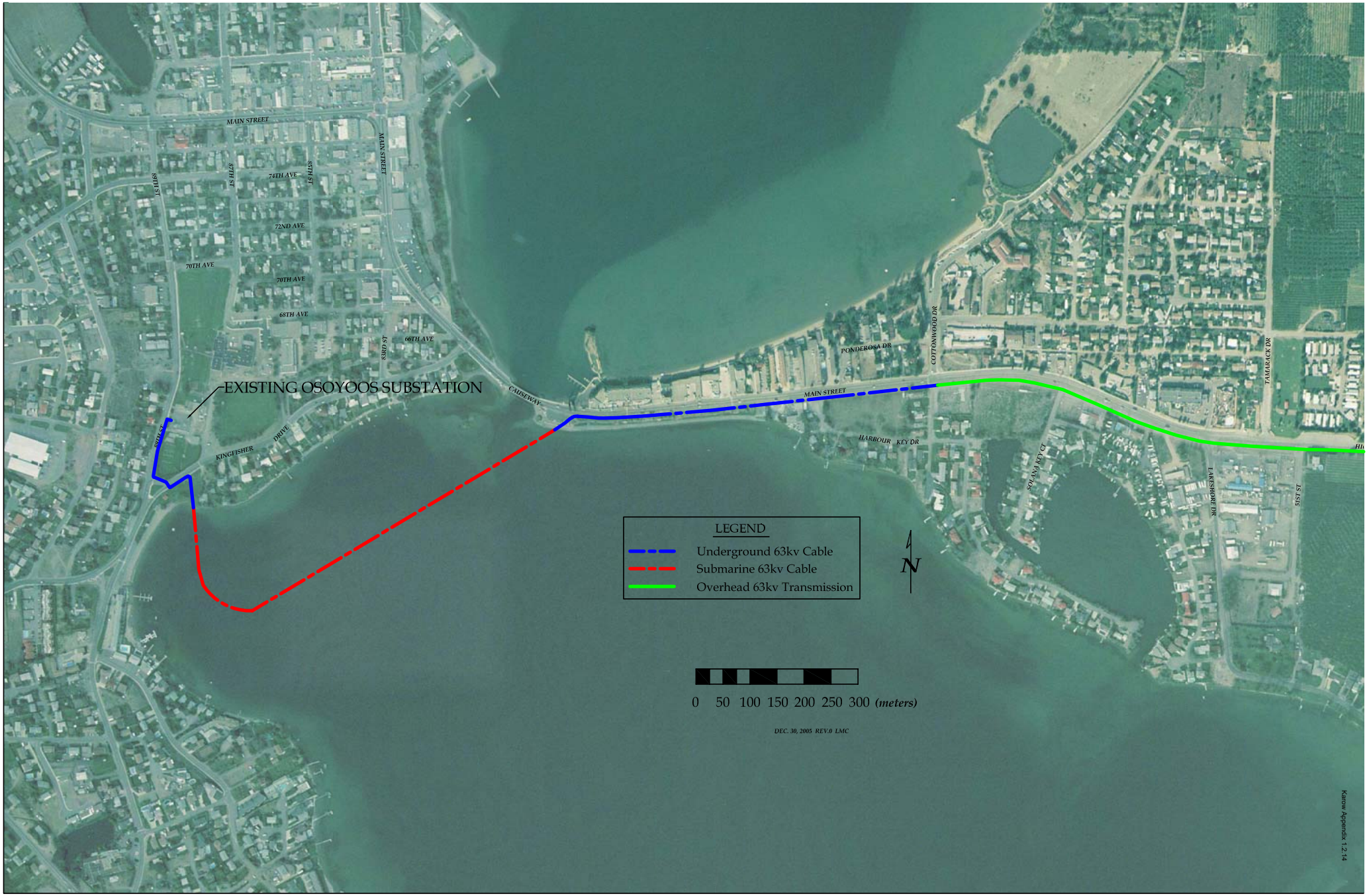

MAIN STREET
MAIN STREET
89TH ST
87TH ST
85TH ST
74TH AVE
72ND AVE
70TH AVE
70TH AVE
68TH AVE
66TH AVE
83RD ST
EXISTING OSOYOOS SUBSTATION
CAUSEWAY
MAIN STREET
PONDEROSA DR
COTTONWOOD DR
TAMARACK DR
HARBOUR KEY DR
SOLANA KEY CT
LAKESHORE DR
51ST ST
KINGFISHER DRIVE
LEGEND
Underground 63kv Cable
Submarine 63kv Cable
Overhead 63kv Transmission
N
0 50 100 150 200 250 300 (meters)
DEC. 30, 2005 REV.0 LMC
Karow Appendix 12.14

Exhibit C1-2 (dated Nov 16, 2005) and Exhibit C1-7(dated Nov 30, 2005):

Q4a. Please state the numbers of properties in close proximity to proposed project's facilities (all options), including all properties that will be totally and/or partially affected from the highest reading milliGauss AC magnetic field down to a reading of 0.3 milliGauss at any time of the year

A4a. Please refer to the response to BCUC IR1, Q10.4

Q4b. Please provide names, address, phone- and fax numbers of residents/tenants and owners of these affected properties (max mG - 0.3 milliGauss AC magnetic field range)

A4b. FortisBC's privacy policy and privacy laws prohibit the release of the information requested.

Q4c. Please provide aerial orthophotos map of the project with the proposed options marked into these orthopothos. These orthophotos in a scale of 1: 750 or 1:1000.

A4c. Please refer to the response to BCUC IR1, Q10.2.

Q4d. Please provide list of landowner and residents contact, indicating location (a special map -scale 1:1000-to be provided with numbers indicating contacted property tenants and owners), construction to occur including hydro posts and transformers, legal status, date of all notices (whether via letters, phone or direct contact), land owner and residents' comment/position, mitigation). Please indicate whether tenants or owners or both of them have been contacted.

A4d. The Table below shows the addresses of the properties where FortisBC made contact with the residents with regards to transmission line easements during June to October 2005:

1. 5806 68th Avenue
2. 8324 Kingfisher
3. 8322 Kingfisher
4. 8320 Kingfisher
5. 8316 Kingfisher
6. 8314 Kingfisher
7. 8321 Kingfisher
8. 8310 Kingfisher
9. 8308 Kingfisher
10. 6401 83rd Street
11. 8304 Kingfisher
12. 8303 Kingfisher
13. Village of Osoyoos
14. 7307 Main St
15. 6901 Main St
16. Main St
17. 6311 Jackpine Lane
18. 6305 Jackpine Lane
19. 15 Solana Key Ct
20. 5914 Main St
21. 5501 Main St

Q4e. Please provide facility maps, scale 1: 2000, with all indicated options marked into. Property lines should be able to be identified.

A4e. Please refer to the response to BCUC IR1, Q10.1 and Q10.2.

Q4f. Please provide maps, scale 1: 750 , property lines should be able to be identified, with the 0.3 milliGauss, and 2.0 mG and 4.0mG lines drawn into the map, so property residents and owners can find out how their property and house are affected at what magnetic field level.

A4f. Please refer to the response to BCUC IR1, Q10.4.

Exhibit C1-8 (dated Nov 30, 2005):

Q1.0 Please provide a list of all the ads run in papers throughout the service territory, including a copy of those, in case they differ, including copies of all different lay out of the ads.

A1.0 The layouts of the advertisements are as follows:

Public Open House

Osoyoos 63kV Tie and Nk'Mip Substation Projects

FortisBC invites you to attend our public open house to learn more about the Osoyoos 63kV Transmission Line Tie-in Project and the proposed Nk'Mip Substation Project. Our Project Team will provide information on all aspects of the projects including system engineering, the environment, scheduling, and crew and public safety.

Where and when:
Elks Hall
October 20, 2005
7 pm to 9 pm
6210 - 97th St., Osoyoos

More info:
Call our Customer Contact Centre
Monday to Friday 7am to 7pm
1-866-4FORTIS (1-866-436-7847)
or visit www.fortisbc.com

This project is one of many taking place throughout the FortisBC service territory aimed at replacing aging infrastructure and meeting growing customer electrical load requirements.

FORTISBC

BRITISH COLUMBIA UTILITIES COMMISSION

FortisBC Inc.

Application for a Certificate of Public Convenience and Necessity for the Nk'Mip (East Osoyoos) Transmission & Substation Project

Notice of Oral Public Hearing

Date: Saturday, January 21, 2006
Time: 8:30 a.m.
Location: Osoyoos Seniors' Centre, 17 Park Place, Osoyoos, B.C.
Telephone: (250) 495-6175

The FortisBC Application

On October 12, 2005, FortisBC applied to the Commission for approval of a Certificate of Public Convenience and Necessity ("CPCN") to construct and operate the proposed Nk'Mip (East Osoyoos) Transmission and Substation project that is projected to cost $8.97 million. The project consists of a distribution source substation in East Osoyoos, a 63 kV transmission line from the West Osoyoos Substation to the Nk'Mip Substation and a distribution feeder. The project will also provide for a future 138 kV tie to the future Bentley Substation. The project is required as a result of customer growth in the Osoyoos area.

The Regulatory Process

The Commission Panel has determined that the FortisBC CPCN Application will be reviewed by way of an Oral Public Hearing to be held in Osoyoos, B.C.

The Commission has determined that no Participant Funding will be available for this proceeding.

Public Inspection of the Documents

The FortisBC CPCN Application and supporting material will be made available for inspection at the Utility's Head Office in Kelowna at the Landmark IV, 5th Floor, 1628 Dickson Avenue, Kelowna, B.C., its Trail Office at 1290 Esplanade, Trail, B.C., the Public Library in Osoyoos, B.C., and the British Columbia Utilities Commission, Sixth Floor, 900 Howe Street, Vancouver, B.C.

The FortisBC CPCN Application is available for viewing on the FortisBC website at www.fortisbc.com. The application, including all documents will be posted on the Commission's website at www.bcuc.com.

Interventions

Persons who expect to actively participate in the FortisBC proceeding should register as Intervenors with the Commission, in writing, by Wednesday, November 30, 2005 identifying their interest in the CPCN Application. Intervenors will receive copies of the CPCN Application and all correspondence and filed documentation and should provide an e-mail address if available.

Persons not expecting to actively participate, but who have an interest in the proceeding and who have not already registered, should register as Interested Parties with the Commission, in writing, by identifying their interest in the CPCN Application. Interested Parties will receive a copy of the Executive Summary, the Application section of the CPCN Application and all Orders issued.

REGULATORY TIMETABLE

Action	Date
■ Registration of Intervenor and Interested Parties with the Commission	Wed., Nov. 30, 2005
■ Commission Information Request No. 1 to FortisBC	Fri., Dec. 2, 2005
■ FortisBC Responses to Commission Information Request No. 1	Fri., Dec. 16, 2005
■ Intervenor Information Requests and Commission Information Request No. 2	Fri., Dec. 23, 2005
■ FortisBC Response to Intervenor Information Requests and Commission Information Request No. 2	Fri., Jan. 6, 2006
■ Oral Public Hearing	Sat., Jan. 21, 2006
■ FortisBC Argument	Fri., Jan. 27, 2006
■ Intervenor Argument filed with the Commission and FortisBC	Fri., Feb. 3, 2006
■ Final Argument from FortisBC	Fri., Feb. 10, 2006

Further Information

For further information, please contact Mr. Robert J. Pellatt, Commission Secretary, as follows:

Telephone: (604) 660-4700
Facsimile: (604) 660-1102
E-Mail: Commission.Secretary@bcuc.com
Telephone: (B.C. Toll Free) 1-800-663-1385

Q2.0 Please provide a list of with whom Fortis met of the town council (please state names), when, how often, what was discussed (please give thorough details, including all issues addressed) and what was the result of those meetings and the position the councilors.

A2.0 FortisBC met once with the Town Council on January 17, 2005 at 10:30 am. The meeting was not part of the official agenda so no minutes were taken, and an attendance list is not available. However, it is known that Mayor John Slater, CAO Elsie Lemke and Councilor Tom Shields were in attendance along with at least two other councilors.

A short presentation was made that described the FortisBC System Development Plan, the impacts of that plan on the South Okanagan and especially the Osoyoos area. Issues discussed included:

- The rapid growth rate in the South Okanagan and the resulting electrical load
- The reliability history and the present existing risk due to the radially fed system
- Options for the Osoyoos area
- Cost impacts
- Proposed solution, which is the overhead route down Kingfisher Drive and across the causeway

A discussion was held on the cost differences between the various overhead and underground options, including wood verses steel poles. The route selection was also discussed, and the concept of minimum impact to the town at a reasonable cost was conveyed. Following the discussion, the Mayor and councilors in attendance indicated their support and offered a letter of support for the project.

Please also refer to the response to BCUC IR1, Q8.3.

Q3.0 Please provide a list of with whom Fortis met of the school board (please state names), when, how often, what was discussed (please give thorough details, including all issues addressed) and what was the result of those meetings and the position the school board members.

A3.0 The meeting was "in-camera", and therefore no minutes are available. The meeting was attended by Mrs. June Harrington (Chairperson), Mr. Terry Killough (Secretary-Treasurer), several other member of Board of School Trustees & District Staff along with other likely stakeholders. The discussion was much the same as described in the response to Q2.0, above. As well the three overhead routes as outlined in BCUC IR1 Q10.2 were discussed. The Board indicated that they preferred the FortisBC proposed route along Kingfisher Drive.

Q4.0 Please provide info about the town hall meeting: where, how often, when, at what clock time of the day, how many people showed up, please provide list of names of the people attending the meeting, and a list of what the questions were asked by the people.

A4.0 The public meeting was held at the Elk's hall in Osoyoos on October 20, 2005. The meeting was scheduled to run from 7:00-9:00 pm; it started on time and the discussion ended at approximately 10:00 pm. Approximately 46 members of the public attended the meeting.

The meeting was structured as follows:

- 7:00 – 7:30 pm: Open house - to allow attendees to gather general information from company representatives on various topics
- 7:40 – 9:40 pm: Formal interactive presentation on the System Development Plan, the impacts in the Osoyoos area, the impacts of local load growth and the options evaluated to supply that load
- 9:40 – 10:00 pm: Open house

Verbatim minutes were not taken, and therefore it is impossible to list all of the specific questions that were asked by attendees. However, a detailed summary of the event is attached for reference.

1. Summary Report of Open House: (Karow Appendix A4.0)
   Nk'Mip Open House Summary dated October 20, 2005

Q5.0 Also, please state what kind of info brochures were distributed and what kind of maps were displayed during the town hall meeting and a list of all issues Fortis has been addressed to the people. Please provide details about kind of maps and their scale.

A5.0 There were two methods used to provide written information to attendees of the open house. First, the room was populated with information stations on various topics related to the following (the poster board graphics used in the presentation is attached for reference):

1. Karow Appendix A5.0.1 Safety & Service
2. Karow Appendix A5.0.2 Project Overview
3. Karow Appendix A5.0.3 Engineering & Design
4. Karow Appendix A5.0.4 Schedule, Cost & Benefit
5. Karow Appendix A5.0.5 Environment

Information handouts on the issue of Electric and Magnetic Fields were also provided. As this can be a confusing issue for the layperson, FortisBC thought it helpful to offer some information sourced from both Health Canada and the US based National Institutes of Health. Both groups are recognized as unbiased sources of health information. Copies of these documents are also attached.

Maps were not used in the presentation. Rather, a satellite image of the Osoyoos area was used to depict the routing detail. A copy of the image is available at BCUC IR1, Q-10.2.

Other attachments:

1. Karow Appendix A5.0.6 EMF - Q&A
2. Karow Appendix A5.0.7 Health Canada on EMF

Q6.0 Fortis states *"we notified all residents along the entire proposed route",*

Q6a. Please state which is the route Fortis is proposing by detailing the streets the power line is running along.

A6a. For details, please refer to the response to BCUC IR1, Q 10.2.

Q6b. Why is Fortis so sure about the one and only proposed route to be built, and by not also considering the other options and sub-options and contacting those people along/near the other options and sub-options?

A6b. For details, please refer to the response to BCUC IR1, Q10.2.

Q6c. Please provide a list of names Fortis has so far contacted, please include date, time, whether the person/s were tenants or owners of the property to be listed by numbers of streets and all the topics to be addressed during the contact.

A6c. For details please refer to the response to Q4d on page 1 above (Exhibit C1-2 (dated Nov 16, 2005) and Exhibit C1-7(dated Nov 30, 2005).

Exhibit C1-15 (dated Dec 5, 2005):

QC1-15.1 FortisBC took some pictures and EMF readings under the power lines in Osoyoos. Fortis was approached by some people and were asked questions, including what the reading was under the power line adjacent to their homes. Applicant to please report briefly about the information provided and please also give details about the EMF measurements, including exact location (street, how many feet under / off the line, and whether this line was a distribution and / or transmission line) and at what time of the day how many measurements were taken.

AC1-15.1 In order to respond to BCUC IR1, Q10.4, with respect to the proposed transmission line route, FortisBC measured the distances from the Distribution Circuit Centre Line to the buildings along Kingfisher Drive and along Highway 3 from Kingfisher Drive to Cottonwood Drive. The distance from the Distribution Circuit Centre Line to the buildings ranges from 4 meters to 73 meters.

The Company also measured magnetic fields under the Distribution Circuit Centre Line along the same route. The magnetic field measured directly under the centerline of the distribution circuit, at approximately 1 meter above the ground ranged from 7.5 mG to 21.4 mG.

Exhibit C1-16 (dated Dec 5, 2005):

QC1-15.1 Please inform about FortisBC's relationship, etc, to EPRI (Electric Power Research Institute).

AC1-15.1 FortisBC has no formal relationship with EPRI.

Email dated December 7, 2005

Re: General info request re: previous procedure hearing web site link

Q1. Could your office please provide me the direct BCUC web site link to Aquila's Application for the South Okanagan Supply Reinforcement Program (SOSRP), similar to the present Fortis Nk'Mip procedure web site: http://www.bcuc.com/ApplicationView.aspx?ApplicationId=93 ,so that I can access/read/and/or download submitted exhibits from the Aquila's application/hearing case.

A1. The web link to the South Okanagan Supply Reinforcement Project is as follows: http://www.fortisbc.com/about/regulation/SouthOkanaganSubstationProject.html

Exhibit C1-22 (dated Dec 13, 2005):

QC1-22.1a Does Fortis agree that attached Gustav research and therein referred studies confirm that electromagnetic fields and waves have the potential of and / are associated with suppressing nocturnal melatonin levels

AC1-22.1a The unpublished paper by student K. Gustavs refers to a select number of studies that report changes in melatonin levels in serum or the pineal gland in animals or humans in relation to changes in the earth's geomagnetic field, AC electric fields, or AC and DC magnetic fields. However, the student systematically excluded studies with results contrary to her hypothesis that electromagnetic fields suppress nocturnal melatonin levels. Considering the totality of the literature, there is little experimental support for the hypothesis that power frequency EMF adversely affects melatonin levels (NIEHS, 1998;

IARC, 2002; ICNIRP, 2003, NRPB, 2004)

QC1-22.1b If Fortis does not agree, please state where in this research and state reasons why Forts does not agree.

AC1-22.1b Please see the response to AC1-22.1a above.

Exhibit C1-23 (dated Dec 14, 2005):

It has come to my attention that the binder in the Osoyoos Library has not been supplemented since long ago:

Q1: Please state, when was the subject application binder submitted to the Osoyoos Public Library for public use?

AC1-23.1 The binder containing the Application as well as Commission Order G-114-05 was couriered to the Osoyoos Library from our Trail Office on November 8, 2005.

Q2: Please state, which documents as mentioned in BCUC's website http://www.bcuc.com/Documents/Proceedings/2005/DOC 9194 EXHIBIT%20LIST%20-%20FBC NkMip.pdf have been supplemented into the binder or by providing an additional binder, and please state the dates when these documents were submitted into the library.

AC1-23.2 The binder in the Osoyoos library should contain the following:

1. Application dated October 12, 2005; sent to the library on November 8, 2005
2. Commission Order G-114-05 dated November 3, 2005; sent to the library on November 8, 2005
3. BCUC Information Request #1: Responses dated December 16, 2005; forwarded to the library on the December 16, 2005
4. Intervenor Information Request: Responses dated January 6, 2006;

forwarded to the library on the January 6, 2006.

Consistent with past practice, we forward all FortisBC generated material to the library.

Q3: **Please state whether all registered and interested parties have been supplied with hard copy of the application, please state dates. That also and especially with respect of registered people who rely on postal / courier delivery of all documents.**

AC1-23.3 Circulation of hard copies of the Application to intervenors began when it was filed on October 12 and continues to present date.

Q4: **Please inform when parties will be supplied with hard copies of documents as listed in http://www.bcuc.com/Documents/Proceedings/2005/DOC 9194 EXHIBIT%20LIST%20-%20FBC NkMip.pdf , so far I have not received one. Due to limited resources, myself and others depend upon hard copies to study / work with so being able to prepare submissions into the hearing.**

AC1-23.4 It is FortisBC's practice to provide intervenors with its Information Request Responses on the date they are filed with the BCUC. The Company does not provide copies of intervenor information request / intervenor evidence to other registered intervenors or to the library.

Please also refer to the BC Utilities Commission Document filing protocol.

References

International Agency for Research on Cancer (IARC). IARC monographs on the evaluation of carcinogenic risks to humans. Volume 80: static and extremely low-frequency (ELF) electric and magnetic fields. IARC Press, Lyon, France, 2002.

International Commission on Non-Ionizing Radiation Protection (ICNIRP). Exposure to Static and Low Frequency Electromagnetic Fields, Biological Effects and Health Consequences (0-100 kHz) – Review of the Scientific Evidence on Dosimetry, Biological Effects, Epidemiological Observations, and Health Consequences Concerning Exposure to Static and Low Frequency Electromagnetic Fields (0-100 kHz). Matthes R, McKinlay AF, Bernhardt JH, Vecchia P, Beyret B (eds.). International Commission on Non-Ionizing Radiation Protection, 2003a.

National Institute of Environmental Health Sciences (NIEHS). Assessment of health effects from exposure to power-line frequency electric and magnetic fields: working group report. NIH Publication No. 98-3981. Research Triangle Park, NC: National Institute of Environmental Health Sciences of the U.S. National Institutes of Health, 1998.

National Radiological Protection Board (NRPB). Review of the Scientific Evidence for Limiting Exposure to Electromagnetic Fields (0-300 GHz) National Radiological Protection Board, Volume 15, No 3, 2004.

Osoyoos 63kV Tie-in & Nk'Mip Substation Open House

- Summary Report

Prepared by Frances Maika

VOX Communications

October 25, 2005

TABLE OF CONTENTS

SUMMARY

On October 20, 2005, the Osoyoos 63kV Tie-in & Nk'Mip Substation Project Team held a public open house at the Elks Hall in Osoyoos. The open house was held for the benefit of the community of Osoyoos, and for residents and landowners along the proposed project corridors on Kingfisher Drive and the Highway 3 causeway in particular. Project team members provided information and answered questions on engineering; the environment; safety; scheduling, cost, and benefits; and the overall project with the aid of large posterboards and printed handouts. The project team also presented a 35-minute Powerpoint overview of upgrades to FortisBC's transmission system in the southern Interior, and information on the Osoyoos projects specifically.

The open house served several purposes: to inform attendees of proposed and preferred transmission line routes and substation locations as well as rationale for those routes and locations; to inform attendees of other proposed and ongoing upgrades to the FortisBC transmission system across the southern BC Interior; to hear responses, reactions, and gather information from attendees on the subject of the proposed projects; and to gather information on the effectiveness of the open house format and preferences for future public communications about the Osoyoos projects and other area projects.

The open house format paired with a short presentation and longer question and answer session led to a lively but polite atmosphere in which the project team was able to speak with publics and stakeholders and address their questions and concerns. It is a format recommended for future public information sessions, and should be advertised as including an informational meeting and Q & A session so attendees are clear about the format and time for each portion of the open house.

Attendance at the open house was fairly high (+/- 50) compared with other open house sessions held by FortisBC in the Okanagan to date. A BC Utilities Commission representative was present and spoke about the role of the BCUC and the hearing process during the question and answer period. Local media attended and their published accounts of the open house will provide additional information about public response to the open house and a snapshot of what media heard from project team members and their fellow citizens during the presentation and question and answer session.

Most attendees voiced in person and in questionnaires that they were pleased with the information provided to them, the format in which that information was presented, and stated that they wished to continue receiving timely updates through either another open house or a newsletter.

1 Background

The town of Osoyoos is located in the southeast corner of the Okanagan region approximately 21 kilometres southeast of Oliver. The system Load in the East Osoyoos area grew at an average rate of 22% during Years 2002 / 04, predominantly due to in-migration from urban centres outside of the Okanagan. The rapid immigration is expected to continue over the forecast period, producing ongoing load growth well above the system average. This will create a capacity shortfall in the Osoyoos area and in particular with the existing distribution supply across the narrow East-West Causeway.

The scope of the Nk'Mip (East Osoyoos) Substation Project will include the proposed substation, the transmission tie to the West Osoyoos Substation and three distribution feeders to connect to the existing network. The proposed transmission interconnection from the Nk'Mip Substation to Bentley, which will bring the entire Osoyoos network into a looped system, will be dealt with as part of a separate project - the Bentley Project - during 2008 / 09. The Osoyoos 63kv Upgrade & Tie-in is also a separate project; however, it is integral to meeting the goals of the Nk'Mip and Bentley projects.

2 Introduction

During the planning phase of the Nk'Mip (East Osoyoos) Substation Project and the related Osoyoos 63kV Upgrade and Tie Project, FortisBC became aware of the need for a public process to communicate details of the project to the public and stakeholders.

FortisBC held a public open house on October 20, 2005 in Osoyoos to directly communicate details of the two projects to the public and stakeholders, and to allow those who attend to talk to the various project team members. The open house was advertised two weeks prior in the Osoyoos Times newspaper, on local radio, and through approximately 50 individual invitations hand-delivered or mailed to area landowners, local government, the BCUC, and the Osoyoos Indian Band.

The open house option was selected among various communications approaches because in the time available before the project is slated to begin, the open house format allows for the most direct communication with a relatively large number of people, and puts a human face on the projects via conversations between project team members and open house attendees, while at the same time it allows FortisBC to gauge public interest in the projects and identify any outstanding issues that may need to be addressed.

3 Open House

3.1 Format

Upon entry to the open house, attendees encountered a reception station where they were asked to sign in, pick up an open house agenda, make themselves a name tag, and collect a questionnaire/comment sheet for completion and return on their way out. Attendees then progressed through five stations arranged roughly in a semi-circle around the meeting area, and had access to refreshments at the back of the meeting hall.

Four foot by six foot poster boards backed each of the five stations, showing photos and text related to different areas of the projects (see Appendix A). Handouts of poster board information were available at each station along with Health Canada information on electric and magnetic fields (EMF) available at the Environment station (see Appendix B). Coffee, tea, water, juice, and snacks were provided at a separate refreshment table.

The open house was set up with a minimum of chairs near the posterboard stations, so that attendees were encouraged to move through each of the stations in a casual and conversational atmosphere, ask questions and speak in person to each project team member with greater ease than in a formal presentation setting. Chairs were set up as needed in the presentation area, and extra chairs added as new people arrived during and before the presentation.

Stations and their respective project team representatives were as follows:

1. Reception/Greeting/Sign-in/Exit surveys – Frances Maika, VOX Communications; Lisa McCarthy, FortisBC
2. Project Overview – Keith Sones and Edgar Frank, FortisBC
3. Engineering – Dennis Schlender, DBS Energy
4. Environment– Brad Wright, FortisBC
5. Safety – Bob Gibney and Lisa McCarthy, FortisBC
6. Scheduling and Cost – Keith Sones and Joyce Martin, FortisBC

Other project team members present: Ron Pavlakovic and Kim McKechnie of Lands West Property Services.

3.2 Project Team Presentation and Question/Answer Session

Thirty minutes into the open house - at 7:30pm - the open house moderator (Frances Maika) asked everyone to find a seat, and introduced all project team members present. Two members of the project team (project planner Edgar Frank and project manager Keith Sones) then presented a 35-minute overview of upgrades to FortisBC's transmission system in the southern Interior, and information on the Osoyoos project including route rationale and proposed schedule. A 30-minute question and answer session followed until about 8:40pm.

One attendee dominated this session, taking about 20 minutes to read a series of letters written by her husband who was unable to attend the meeting, and whose comments she wished other attendees, and the BCUC representative present in particular, to hear. After about ten minutes, the moderator interrupted the letter-reading to ask others present if they wished to continue to listen or allow for further questions and answers. Most of those in the audience appeared interested and either voiced or nodded that they wanted the reader to continue. At the same time, the letter-reader reacted emotionally to the interruption, and demanded to be allowed to continue. The moderator stepped back and allowed the reading to continue. Once the reading ended, the project manager responded to each main point in the letters, and took other questions from the audience.

BC Utilities Commission (BCUC) representative Bob Rerie was present at the open house, and took time during the question and answer session to speak, and clarified for all those present what role the BCUC plays in regulating public and private utilities in the province. He explained that any member of the public can act as an intervenor during a BCUC written or public hearing process. He explained that leading up to the process, the BCUC reviews FortisBC's certificate of public convenience and necessity (CPCN), and intervenor comments are included and considered before a final decision is made by the BCUC based on all evidence received from the utility and all intervenors. Keith Sones informed everyone present that the CPCN is available in full on the FortisBC Web site at www.fortisbc.com. Mr. Rerie also explained that the next step after the public open house is for the BCUC to review the CPCN, and that once a decision has been made to hold a public hearing the Commission issues an Order and Notice of Public Hearing which is published in local newspapers in the service area of the utility. He stated that this order starts the public hearing process and contains information such as location, starting date, and intervention deadline dates, and often includes a list of issues that will be considered. Attendees nodded and appeared to appreciate hearing that a regulatory process was in place to consider and receive their input on the projects.

Two members of the local print media were also present for the duration of the open house. Reporters interviewed various attendees as well as project team members after the question and answer period ended. Their newspaper reports following the meeting will serve as additional information about public response to the open house and will provide another snapshot of what attendees heard from project team members and their fellow citizens during the presentation and question and answer session.

At about 8:40pm, the moderator asked those in attendance whether they wished to continue the question and answer format, and receiving an overwhelming affirmative response, the comment, question and answer session continued until 9:30pm when the session returned to open house format for the final twenty minutes until 10:00pm. The presentation and question and answer sessions were originally scheduled to end at 8:00pm, but because interest was high and questions and comments were many, this format continued an hour and a half longer than anticipated, and the open house ended an hour later than scheduled.

At the end of the open house, several attendees commented to the moderator that they felt accidentally or intentionally ignored, and that some attendees spoke too long or too often at the expense of others who wished to speak. Others commented that they appreciated that most people had a chance to speak, that the meeting was well-moderated, and that the project manager answered their questions or responded to comments clearly and in great detail.

Based upon open house attendance and participation, most attendees appeared to appreciate that more than the originally scheduled time had been provided for questions, comments, and answers.

3.3 Responses to Public Open House Questionnaire

The following is a compilation of responses to questionnaires completed and collected at the open house.

Thirteen of 46 confirmed attendees (about 28%) completed and returned questionnaires. Several attendees stated they planned to complete the questionnaire at home following the open house; therefore, a few questionnaires may be mailed to FortisBC in the future.

QUESTIONNAIRE - OSOYOOS 63KV TIE-IN & NK'MIP SUBSTATION OPEN HOUSE

YOUR INPUT IS IMPORTANT TO US. Please let us know what you think of our efforts to keep you informed.

(Please circle the response that best describes your answer)

a) How did you hear about this open house?

FortisBC Letter Radio Ad Newspaper Ad Other (please describe) _____.

(4) ***(4)*** ***Neighbours (4); Gov't reps (1) Osoyoos Now (2)***

b) Is the meeting time and day appropriate?

Yes ***(13)*** No ***(0)*** If No, what time and day do you suggest?

_____.

c) Were our HANDOUTS helpful in increasing your understanding of the projects?

Very helpful ***(2)*** Helpful ***(3)*** Somewhat Helpful Somewhat Unhelpful Unhelpful
Very Unhelpful ***(8 – no response)***

d) Was our PRESENTATION helpful in increasing your understanding of the projects?

Very helpful ***(3)*** Helpful ***(6)*** Somewhat Helpful ***(2)*** Somewhat Unhelpful Unhelpful
Very Unhelpful ***(2 – no response)***

e) Were our PROJECT TEAM members able to answer your questions? (strongly agree means you think they were very much able to answer your questions; strongly disagree means they were completely unable to answer your questions)

Strongly Agree ***(2)*** Agree ***(4)*** Somewhat Agree ***(1)*** Somewhat Disagree ***(1)***
Disagree ***(1)*** Strongly Disagree ***(3 – no response)***

f) Please respond to the following statement: "The open house helped me understand the Osoyoos 63kV Tie-in & Nk'Mip Substation projects."

Strongly Agree ***(2)*** Agree ***(7)*** Somewhat Agree ***(2)*** Somewhat Disagree ***(1)***
Disagree Strongly Disagree ***(3 – no response)***

g) How would you prefer to be kept informed of future and ongoing projects in the Osoyoos and Okanagan area? Please number your choices in order of preference, 1 being the most preferred, and 5 being the least preferred.

(3 most preferred) Newsletter **(2 most preferred)** Electronic newsletter **(0)** FortisBC Web site **(5 most preferred)** Open house **(2 most preferred)** Other: (newspaper ads; Intervenor via BCUC) **(1 - no response)**

Please let us know what you liked about the open house, what we can do to improve it, or what you disliked about it:

- Too much time allowed for 1st woman – as it shortened time for others.
- Misinformation by some people.
- Excellent presentation: done slowly enough. Moderator allowed those who wished to speak equal opportunities; clearly explained now costs are evaluated.
- Hate open houses.
- Not bad for the contentious issue. Good control.
- Fortis didn't seem to be open to ideas, suggestions, or options put forth.
- Re: introductions – have people at the front instead of hiding at the back.
- Advertised as open house – not presentation. Q & A forum most confusing – people think they can drop in but really can't. No moderation – some people asked multiple questions while others never got an opportunity to be acknowledged once!

h) Additional comments or questions for our Project Team (use other side of paper if necessary):

- Not required. Carry on and provide the power that is needed.
- You should have told the people that the 60kV tie was for emergency only. If you're telling the truth about the 138kV line on residential.
- Please call your sessions, "informational meetings." An open house is usually drop-in without formal presentations.
- How did a town of this importance in tourism allow its planning for future development to have such hindsight?
- Thank God the Utilities Commission gentleman was in attendance.
- How are we going to meet the growth of the Okanagan?
- Will the First Nations allow the substation on their land?
- Osoyoos is attracting high-end development and thus a more sophisticated resident, plus our dependency on tourism as our main industry. Aesthetics become very important. We also have more and more people who would gladly contribute to these aesthetics. Thus burying the line is really [preferable]. Could I suggest whoever makes these decisions to go and have dinner at Sol [restaurant] and sit at a window table and try to enjoy the gorgeous view through the existing wires. How much worse will more wires make it? Check into how much damage was done by the storms in '98 along Kingfisher when large trees and roofs were blown off.

Thank you – we appreciate your comments. Please leave your completed form it in the collection box provided at the sign-in table. For more information or to tell us more, please contact Project Manager Keith Sones at 1-866-4FORTIS (1-866-436-7847) or write to us at

Attn: Keith Sones, Senior Project Manager
Osoyoos 63kV Tie-in & Nk'Mip Substation Projects
FortisBC

PO Box 130, 1290 Esplanade
Trail, BC V1R 4L4

3.4 Verbal comments

- More time required for review of options by the community before a single option is selected.
- Clear list of options with their individual costs should be provided by FortisBC, in particular the cost of putting the 63kV system underground, the cost of taking an alternate route to Kingfisher Drive, as well as the cost of moving the West Osoyoos substation and putting the entire transmission system underground.
- One attendee asked whether FortisBC had considered the option of building the transmission system further south from Kingfisher Drive, and crossing Osoyoos Lake underwater.
- One landowner asked for information about EMF as she has a concern about the proximity of her existing balcony to the proposed 63kV conductors
- Another landowner had a strong opinion that new networks of cable, whether Telus, Shaw, or Fortis, be installed underground to reduce the 'line pollution' that now exists.

4 Conclusion and Recommendations

4.1 Open House Format vs. Public Meeting Format

Many of those who attended voiced their approval of the meeting format. Some commented that they had not expected a formal presentation and would like to have known about it in the advertising for the open house so they could arrive on time.

4.2 Public Information

Questionnaire respondents narrowly prefer future project public communications to take place via another open house (first choice for five respondents; second choice for two respondents). However, once all choices are ranked, the overall close second choice is communications via newsletter (first choice for three respondents; second choice for two respondents; third choice for two respondents); the third choice is via electronic newsletter, and the fourth choice is via the FortisBC Web site.

4.3 Open House Attendance

Forty-six people signed-in at the open house, and approximately four people either refused to sign in or came in late and failed to sign in. This means that a total of about 50 people attended.

Those who attended and completed a questionnaire commented unanimously that they found the day and time of the open house appropriate. They stated that they found out

about the open house through newspaper ads, a letter from FortisBC, from neighbours, local government, and community representatives.

Following the open house, many attendees will serve as emissaries among their neighbours, coworkers, and families so that open house information is expected to reach well beyond those who attended.

FORTISBC

Osoyoos 63kV Tie & Nk-Mip (East Osoyoos)Substation

SAFETY & SERVICE

Built in the 1960's, the 13kV system that runs from the West Osoyoos Substation to Highway 3 along Kingfisher Drive is in need of upgrading. Service and safety of this system have become an increasing concern, and power demands will surpass transmission system capacity by the end of June 2006. Upgrading to an efficient, modern system that can carry a full 63kv load will ensure system reliability and safety for workers and the public.

SAFETY AT WORK AND AROUND YOUR PROPERTY

As part of our commitment to worker and public safety, FortisBC will identify, assess and control workplace hazards through:

- Strict adherence to Employee Health and Safety (EHS) policy & procedure
- Systematic analysis of environment health and safety hazards at work sites
- Control measures to eliminate or reduce risks and hazards
- Worker competency and safety training programs
- Regular EHS inspection requirements
- Emergency response planning requirements
- Incident reporting, investigation and remediation
- Program documentation, records maintenance and administration

CONTINGENCY PLANS

Methods of supplying power until new construction and upgrades are completed may include local on-site generation (diesel units) on the east side of Osoyoos lake, or temporary power interruptions. FortisBC will keep you informed should contingency plans come into effect.

If you have any safety concerns about FortisBC projects, please contact 1-866-4FORTIS (436-7847).

[photo of worker in safety gear]

FORTISBC

Osoyoos 63kV Tie & Nk-Mip (East Osoyoos)Substation

PROJECT OVERVIEW

A GROWING POPULATION

The Osoyoos 63kV Tie-in and Nk-Mip (East Osoyoos) Substation projects are critical to short and long-term expansion and economic growth in Osoyoos and the Okanagan region. People continue to move to the Okanagan from other areas, and in-migration is expected to continue through the next decade.

PLANNING NOW FOR FUTURE NEEDS

In order to meet ongoing and future power needs, FortisBC proposes to upgrade the existing transmission line along Kingfisher Drive and the Osoyoos causeway from 13kV to 63kV and to construct a new substation about 2.5 kilometres north-west of Anarchist Mountain in East Osoyoos. The proposed *Nk-Mip Substation* is an essential hub in a more reliable and robust transmission system to supply power to the greater Osoyoos area through 2011 and beyond.

Construction of the Osoyoos 63kV Tie-in and *Nk-Mip Substation* is proposed to begin in spring 2006, with completion by late fall 2006.

INCREASED SAFETY AND RELIABILITY

These projects will increase public and worker safety, reduce operating and maintenance costs over the long term, and improve service reliability for the benefit of all FortisBC customers in Osoyoos and the Okanagan.

FortisBC welcomes your questions and comments. For more information contact Project Manager Keith Sones at (250) 368-0533.

[Scenic photo looking down mountain at Osoyoos valley] or [Overview Map of the Okanagan region]

FORTISBC

Osoyoos 63kV Tie & Nk-Mip (East Osoyoos)Substation

ENGINEERING AND DESIGN

Considerations in system design include:

- Number and location of existing circuits within the right-of-way
- Safety
- System reliability
- Adjacent facilities and structures
- Access
- Existing poles
- Ease of construction
- Economics

PROPOSED LOCATION AND ROUTES

The proposed route for the upgraded 63kV line is along Kingfisher Drive to the Osoyoos Causeway (Highway 3A), feeding East Osoyoos and connecting to the proposed Nk'Mip Substation about 2.5 kilometres northwest of Anarchist Mountain.

STRUCTURES AND CAPACITY

The existing 13kV transmission line will be upgraded and consolidated to include cables and other hardware on a single structure carrying 63-kV (kilovolt) transmission; distribution; transformers and services; and fibre optic cable required for metering, protection and control. The proposed Nk'Mip Substation will include two new transformers with capabilities to terminate up to six 13kV distribution feeders, and allow a much greater electrical load on the overall system than with the existing West Osoyoos substation alone.

The result will be efficient delivery of power, increased safety, and reliable, affordable service to customers.

[photos of types of structures to be used]

FORTISBC

Osoyoos 63kV Tie & Nk-Mip (East Osoyoos)Substation

SCHEDULE, COST & BENEFITS

PROPOSED SCHEDULE

- BC Utilities Commission approval – Winter 2005
- Route selection completed – November 2005
- Station construction starts –Spring 2006
- Line construction starts –Spring 2006
- Energize new 63 kV line and station –Late fall 2006

COMMITMENT TO RELIABLE, LOW COST ELECTRICITY

FortisBC is committed to providing reliable, low cost electricity to our customers. To keep that commitment we ensure that upgrades to transmission systems are economically sound over the long term. We also promote cost-effective energy conservation by all our employees and customers.

PROJECT COSTS & BENEFITS

The estimated total capital cost of the Osoyoos 63kV Tie & Nk-Mip (East Osoyoos) Substation projects is $8.97 million. This translates into a rate increase of [put rate info. here] per customer for 2006.

The Osoyoos projects are expected to create [put # here] person hours of employment and [$ million] in construction dollars to the direct benefit of many local workers and businesses.

[Photo of a FortisBC employee or a community scene showing people]

FORTISBC

Osoyoos 63kV Tie & Nk-Mip (East Osoyoos)Substation

ENVIRONMENT

We believe that a vital part of doing business in British Columbia is being keenly aware of the unique environments in which we operate and of our responsibility to be good stewards of land, air, water and resources entrusted to us.

We ensure that our company and our contractors comply with all national, provincial and regional environmental laws and regulations, and we actively participate in development of these laws and regulations to protect the environment and the public.

ENVIRONMENTALLY SOUND PROJECTS

FortisBC has conducted an environmental and archaeological assessment of the proposed Nk'Mip Substation site, and ensured that proposed upgrades to the 13kV system along Kingfisher Drive and Highway 3 are environmentally sound.

CLEAR INFORMATION ON ENVIRONMENTAL ISSUES

We are happy to provide the public and stakeholders with transparent and up-to-date information the environment and power utility projects. If you want to know more about the type of power poles we use, current research into electric and magnetic fields around power lines, or to review our environmental reports, please contact Project Manager Keith Sones at (250) 368-0533.

[photo of Nk'Mip site showing grassland or the like]

June 2002

EMF

Electric and Magnetic Fields Associated with the Use of Electric Power

Questions & Answers

prepared by the
National Institute of Environmental Health Sciences
National Institutes of Health

EMF RAPID
Electric and Magnetic Fields Research and Public Information Dissemination Program

sponsored by the
NIEHS/DOE EMF RAPID Program

Contents

Introduction

Since the mid-twentieth century, electricity has been an essential part of our lives. Electricity powers our appliances, office equipment, and countless other devices that we use to make life safer, easier, and more interesting. Use of electric power is something we take for granted. However, some have wondered whether the electric and magnetic fields (EMF) produced through the generation, transmission, and use of electric power [power-frequency EMF, 50 or 60 hertz (Hz)] might adversely affect our health. Numerous research studies and scientific reviews have been conducted to address this question.

Unfortunately, initial studies of the health effects of EMF did not provide straightforward answers. The study of the possible health effects of EMF has been particularly complex and results have been reviewed by expert scientific panels in the United States and other countries. This booklet summarizes the results of these reviews. Although questions remain about the possibility of health effects related to EMF, recent reviews have substantially reduced the level of concern.

The largest evaluation to date was led by two U.S. government institutions, the National Institute of Environmental Health Sciences (NIEHS) of the National Institutes of Health and the Department of Energy (DOE), with input from a wide range of public and private agencies. This evaluation, known as the Electric and Magnetic Fields Research and Public Information Dissemination (EMF RAPID) Program, was a six-year project with the goal of providing scientific evidence to determine whether exposure to power-frequency EMF involves a potential risk to human health.

In 1999, at the conclusion of the EMF RAPID Program, the NIEHS reported to the U.S. Congress that the overall scientific evidence for human health risk from EMF exposure is weak. No consistent pattern of biological effects from exposure to EMF had emerged from laboratory studies with animals or with cells. However, epidemiological studies (studies of disease incidence in human populations) had shown a fairly consistent pattern that associated potential EMF exposure with a small increased risk for leukemia in children and chronic lymphocytic leukemia in adults. Since 1999, several other assessments have been completed that support an association between childhood leukemia and exposure to power-frequency EMF. These more recent reviews, however, do not support a link between EMF exposures and adult leukemias. For both childhood and adult leukemias, interpretation of the epidemiological findings has been difficult due to the absence of supporting laboratory evidence or a scientific explanation linking EMF exposures with leukemia.

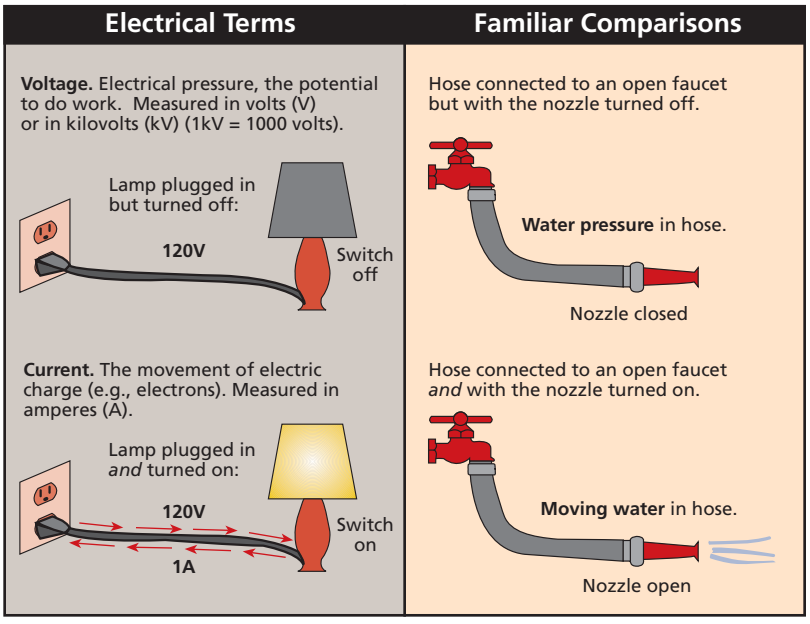
EMF exposures are complex and exist in the home and workplace as a result of all types of electrical equipment and building wiring as well as a result of nearby power lines. This booklet explains the basic principles of electric and magnetic fields, provides an overview of the results of major research studies, and summarizes conclusions of the expert review panels to help you reach your own conclusions about EMF-related health concerns.

1 EMF Basics

This chapter reviews terms you need to know to have a basic understanding of electric and magnetic fields (EMF), compares EMF with other forms of electromagnetic energy, and briefly discusses how such fields may affect us.

Q A What are electric and magnetic fields?

Electric and magnetic fields (EMF) are invisible lines of force that surround any electrical device. Power lines, electrical wiring, and electrical equipment all produce EMF. There are many other sources of EMF as well (see pages 33–35). The focus of this booklet is on power-frequency EMF—that is, EMF associated with the generation, transmission, and use of electric power.



Voltage produces an electric field and current produces a magnetic field.

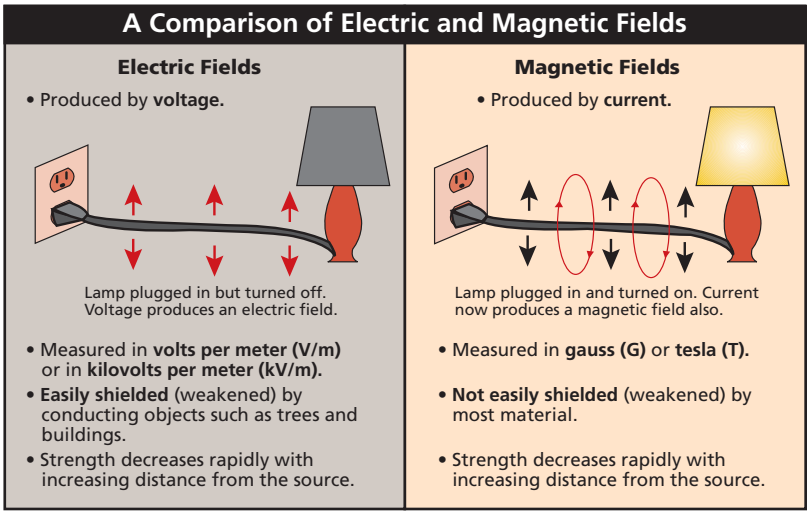
Electric fields are produced by voltage and increase in strength as the voltage increases. The electric field strength is measured in units of volts per meter (V/m). Magnetic fields result from the flow of current through wires or electrical devices and increase in strength as the current increases. Magnetic fields are measured in units of gauss (G) or tesla (T).

Most electrical equipment has to be turned on, i.e., current must be flowing, for a magnetic field to be produced. Electric fields are often present even when the equipment is switched off, as long as it remains connected to the source of electric power. Brief bursts

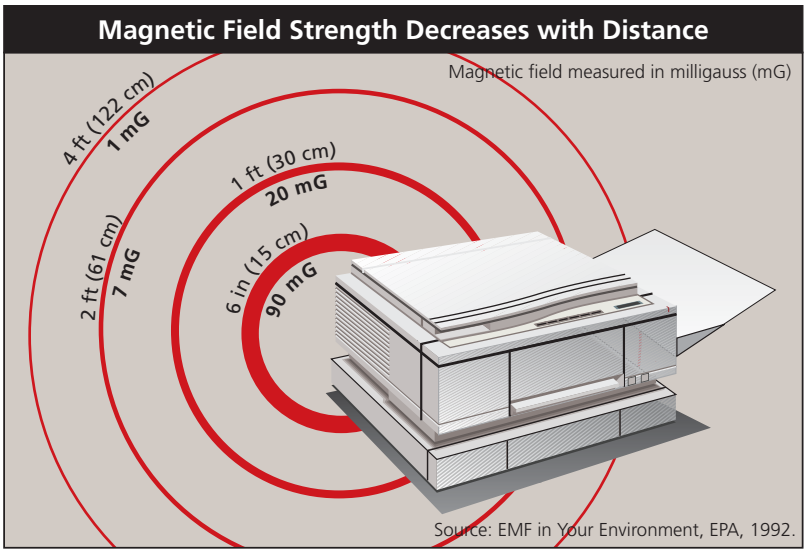
of EMF (sometimes called "transients") can also occur when electrical devices are turned on or off.

Electric fields are shielded or weakened by materials that conduct electricity—even materials that conduct poorly, including trees, buildings, and human skin. Magnetic fields, however, pass through most materials and are therefore more difficult to shield. Both electric fields and magnetic fields decrease rapidly as the distance from the source increases.

Even though electrical equipment, appliances, and power lines produce both electric and magnetic fields, most recent research has focused on potential health effects of magnetic field exposure. This is because some epidemiological studies have reported an increased cancer risk associated with estimates of magnetic field exposure (see pages 19 and 20 for a summary of these studies). No similar associations have been reported for electric fields; many of the studies examining biological effects of electric fields were essentially negative.



An appliance that is plugged in and therefore connected to a source of electricity has an electric field even when the appliance is turned off. To produce a magnetic field, the appliance must be plugged in and turned on so that the current is flowing.



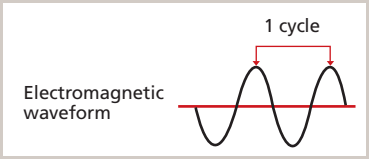
You cannot see a magnetic field, but this illustration represents how the strength of the magnetic field can diminish just 1–2 feet (30–61 centimeters) from the source. This magnetic field is a 60-Hz power-frequency field.

Characteristics of electric and magnetic fields

Electric fields and magnetic fields can be characterized by their wavelength, frequency, and amplitude (strength). The graphic below shows the waveform of an alternating electric or magnetic field. The direction of the field alternates from one polarity to the opposite and back to the first polarity in a period of time called one cycle. Wavelength describes the distance between a peak on the wave and the next peak of the same polarity. The frequency of the field, measured in hertz (Hz), describes the number of cycles that occur in one second. Electricity in North America alternates through 60 cycles per second, or 60 Hz. In many other parts of the world, the frequency of electric power is 50 Hz.

Frequency and Wavelength

Frequency is measured in hertz (Hz).
1 Hz = 1 cycle per second.



Examples:

Source	Frequency	Wavelength
Power line (North America)	60 Hz	3100 miles (5000 km)
Power line (Europe and most other locations)	50 Hz	3750 miles (6000 km)

Q A How is the term EMF used in this booklet?

The term "EMF" usually refers to electric and magnetic fields at extremely low frequencies such as those associated with the use of electric power. The term EMF can be used in a much broader sense as well, encompassing electromagnetic fields with low or high frequencies (see page 8).

Measuring EMF: Common Terms

Electric fields

Electric field strength is measured in volts per meter (V/m) or in kilovolts per meter (kV/m). 1 kV = 1000 V

Magnetic fields

Magnetic fields are measured in units of gauss (G) or tesla (T). Gauss is the unit most commonly used in the United States. Tesla is the internationally accepted scientific term. 1 T = 10,000 G

Since most environmental EMF exposures involve magnetic fields that are only a fraction of a tesla or a gauss, these are commonly measured in units of microtesla (μT) or milligauss (mG). A milligauss is 1/1,000 of a gauss. A microtesla is 1/1,000,000 of a tesla. 1 G = 1,000 mG; 1 T = 1,000,000 μT

To convert a measurement from microtesla (μT) to milligauss (mG), multiply by 10.
1 μT = 10 mG; 0.1 μT = 1 mG

When we use EMF in this booklet, we mean extremely low frequency (ELF) electric and magnetic fields, ranging from 3 to 3,000 Hz (see page 8). This range includes power-frequency (50 or 60 Hz) fields. In the ELF range, electric and magnetic fields are not coupled or interrelated in the same way that they are at higher frequencies. So, it is more useful to refer to them as "electric and magnetic fields" rather than "electromagnetic fields." In the popular press, however, you will see both terms used, abbreviated as EMF.

This booklet focuses on extremely low frequency EMF, primarily power-frequency fields of 50 or 60 Hz, produced by the generation, transmission, and use of electricity.

Q How are power-frequency EMF different from other types of electromagnetic energy?

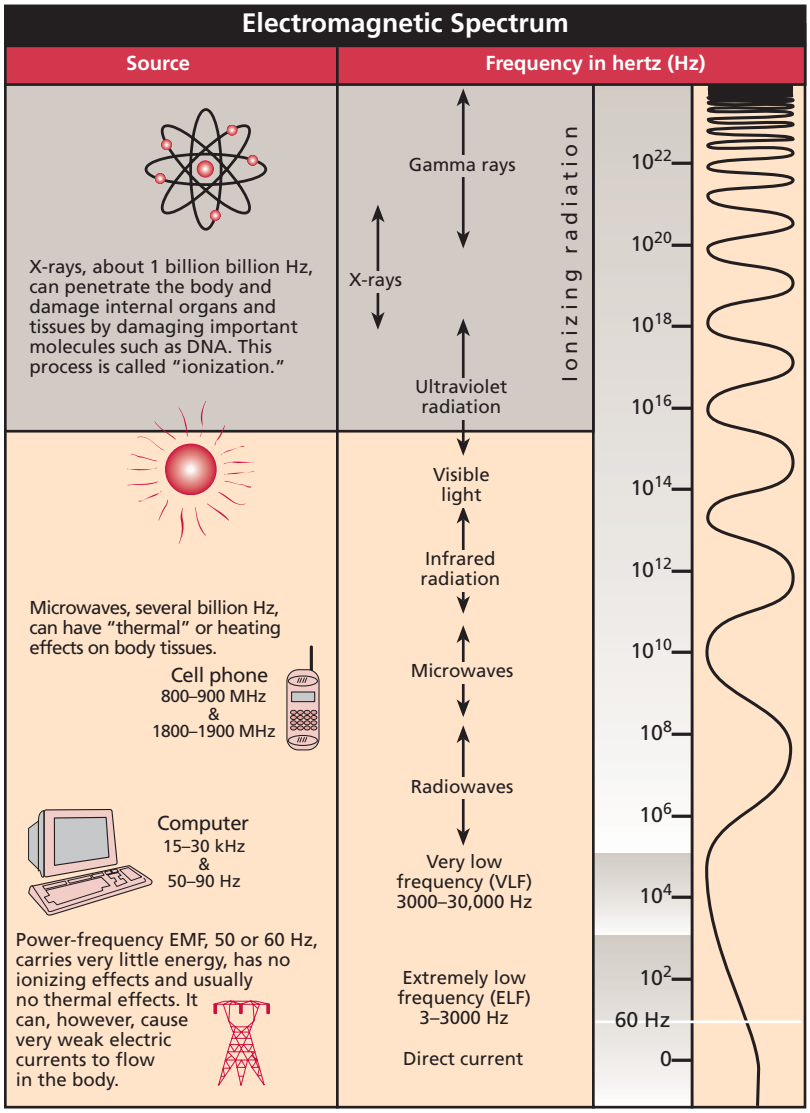
A X-rays, visible light, microwaves, radio waves, and EMF are all forms of electromagnetic energy. One property that distinguishes different forms of electromagnetic energy is the frequency, expressed in hertz (Hz). Power-frequency EMF, 50 or 60 Hz, carries very little energy, has no ionizing effects, and usually has no thermal effects (see page 8). Just as various chemicals affect our bodies in different ways, various forms of electromagnetic energy can have very different biological effects (see "Results of EMF Research" on page 16).

Some types of equipment or operations simultaneously produce electromagnetic energy of different frequencies. Welding operations, for example, can produce electromagnetic energy in the ultraviolet, visible, infrared, and radio-frequency ranges, in addition to power-frequency EMF. Microwave ovens produce 60-Hz fields of several hundred milligauss, but they also create microwave energy inside the oven that is at a much higher frequency (about 2.45 billion Hz). We are shielded from the higher frequency fields inside the oven by its casing, but we are not shielded from the 60-Hz fields.

Cellular telephones communicate by emitting high-frequency electric and magnetic fields similar to those used for radio and television broadcasts. These radio-frequency and microwave fields are quite different from the extremely low frequency EMF produced by power lines and most appliances.

Q How are alternating current sources of EMF different from direct current sources?

A Some equipment can run on either alternating current (AC) or direct current (DC). In most parts of the United States, if the equipment is plugged into a household wall socket, it is using AC electric current that reverses direction in the electrical wiring—or alternates—60 times per second, or at 60 hertz (Hz). If the equipment uses batteries, then electric current flows in one direction only. This



The wavy line at the right illustrates the concept that the higher the frequency, the more rapidly the field varies. The fields do not vary at 0 Hz (direct current) and vary trillions of times per second near the top of the spectrum. Note that 10^4 means 10 x 10 x 10 x 10 or 10,000 Hz. 1 kilohertz (kHz) = 1,000 Hz. 1 megahertz (MHz) = 1,000,000 Hz.

produces a "static" or stationary magnetic field, also called a direct current field. Some battery-operated equipment can produce time-varying magnetic fields as part of its normal operation.

Q What happens when I am exposed to EMF?

A In most practical situations, DC electric power does not induce electric currents in humans. Strong DC magnetic fields are present in some industrial environments, can induce significant currents when a person moves, and may be of concern for other reasons, such as potential effects on implanted medical devices (see page 47 for more information on pacemakers and other medical devices).

AC electric power produces electric and magnetic fields that create weak electric currents in humans. These are called "induced currents." Much of the research on how EMF may affect human health has focused on AC-induced currents.

Electric fields

A person standing directly under a high-voltage transmission line may feel a mild shock when touching something that conducts electricity. These sensations are caused by the strong electric fields from the high-voltage electricity in the lines. They occur only at close range because the electric fields rapidly become weaker as the distance from the line increases. Electric fields may be shielded and further weakened by buildings, trees, and other objects that conduct electricity.

Magnetic fields

Alternating magnetic fields produced by AC electricity can induce the flow of weak electric currents in the body. However, such currents are estimated to be smaller than the measured electric currents produced naturally by the brain, nerves, and heart.

Q Doesn't the earth produce EMF?

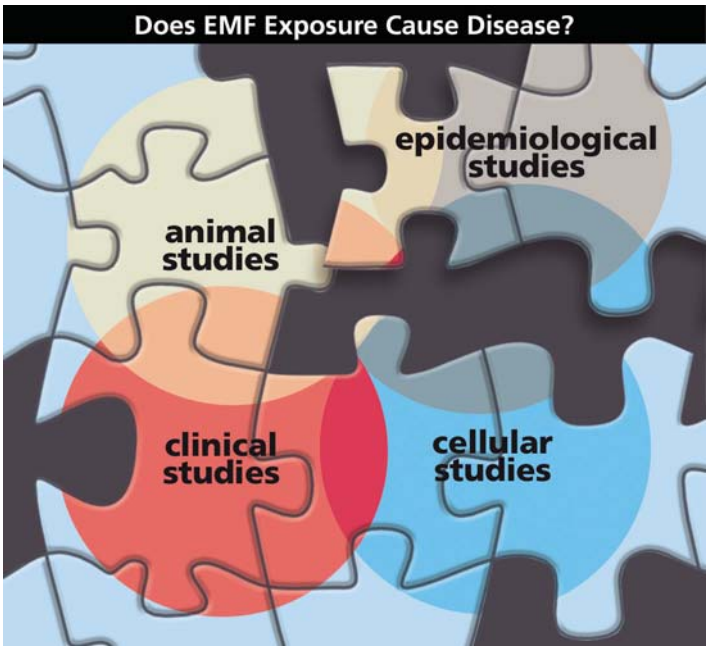
A Yes. The earth produces EMF, mainly in the form of static fields, similar to the fields generated by DC electricity. Electric fields are produced by air turbulence and other atmospheric activity. The earth's magnetic field of about 500 mG is thought to be produced by electric currents flowing deep within the earth's core. Because these fields are static rather than alternating, they do not induce currents in stationary objects as do fields associated with alternating current. Such static fields can induce currents in moving and rotating objects.

2 Evaluating Potential Health Effects

This chapter explains how scientific studies are conducted and evaluated to assess potential health effects.

Q How do we evaluate whether EMF exposures cause health effects?

A Animal experiments, laboratory studies of cells, clinical studies, computer simulations, and human population (epidemiological) studies all provide valuable information. When evaluating evidence that certain exposures cause disease, scientists consider results from studies in various disciplines. No single study or type of study is definitive.



Laboratory studies and human studies provide pieces of the puzzle, but no single study can give us the whole picture.

Laboratory studies

Laboratory studies with cells and animals can provide evidence to help determine if an agent such as EMF causes disease. Cellular studies can increase our understanding of the biological mechanisms by which disease occurs. Experiments with animals provide a means to observe effects of specific agents under carefully controlled conditions. Neither cellular nor animal studies, however, can recreate the complex nature of the whole human organism and its environment. Therefore, we must use caution in applying the results of cellular or animal studies directly to humans or concluding that a lack of an effect in laboratory studies proves that an agent is safe. Even with these limitations, cellular and animal studies have proven very

useful over the years for identifying and understanding the toxicity of numerous chemicals and physical agents.

Very specific laboratory conditions are needed for researchers to be able to detect EMF effects, and experimental exposures are not easily comparable to human exposures. In most cases, it is not clear how EMF actually produces the effects observed in some experiments. Without understanding how the effects occur, it is difficult to evaluate how laboratory results relate to human health effects.

Some laboratory studies have reported that EMF exposure can produce biological effects, including changes in functions of cells and tissues and subtle changes in hormone levels in animals. It is important to distinguish between a biological effect and a health effect. Many biological effects are within the normal range of variation and are not necessarily harmful. For example, bright light has a biological effect on our eyes, causing the pupils to constrict, which is a normal response.

Clinical studies

In clinical studies, researchers use sensitive instruments to monitor human physiology during controlled exposure to environmental agents. In EMF studies, volunteers are exposed to electric or magnetic fields at higher levels than those commonly encountered in everyday life. Researchers measure heart rate, brain activity, hormonal levels, and other factors in exposed and unexposed groups to look for differences resulting from EMF exposure.

Epidemiology

A valuable tool to identify human health risks is to study a human population that has experienced the exposure. This type of research is called epidemiology.

The epidemiologist observes and compares groups of people who have had or have not had certain diseases and exposures to see if the risk of disease is different between the exposed and unexposed groups. The epidemiologist does not control the exposure and cannot experimentally control all the factors that might affect the risk of disease.

Most researchers agree that epidemiology—the study of patterns and possible causes of diseases—is one of the most valuable tools to identify human health risks.

Q How do we evaluate the results of epidemiological studies of EMF?

A Many factors need to be considered when determining whether an agent causes disease. An exposure that an epidemiological study associates with increased risk of a certain disease is not always the actual cause of the disease. To judge whether an agent actually causes a health effect, several issues are considered.

Strength of association

The stronger the association between an exposure and disease, the more confident we can be that the disease is due to the exposure being studied. With cigarette smoking and lung cancer, the association is very strong—20 times the normal risk. In the studies that suggest a relationship between EMF and certain rare cancers, the association is much weaker (see page 19).

Dose-response

Epidemiological data are more convincing if disease rates increase as exposure levels increase. Such dose-response relationships have appeared in only a few EMF studies.

Consistency

Consistency requires that an association found in one study appears in other studies involving different study populations and methods. Associations found consistently are more likely to be causal. With regard to EMF, results from different studies sometimes disagree in important ways, such as what type of cancer is associated with EMF exposure. Because of this inconsistency, scientists cannot be sure whether the increased risks are due to EMF or other factors.

Biological plausibility

When associations are weak in an epidemiological study, results of laboratory studies are even more important to support the association. Many scientists remain skeptical about an association between EMF exposure and cancer because laboratory studies thus far have not shown any consistent evidence of adverse health effects, nor have results of experimental studies revealed a plausible biological explanation for such an association.

Reliability of exposure information

Another important consideration with EMF epidemiological studies is how the exposure information was obtained. Did the researchers simply estimate people's EMF exposures based on their job titles or how their houses were wired, or did they actually conduct EMF measurements? What did they measure (electric fields, magnetic fields, or both)? How often were the EMF measurements made and at

what time? In how many different places were the fields measured? More recent studies have included measurements of magnetic field exposure. Magnetic fields measured at the time a study is conducted can only estimate exposures that occurred in previous years (at the time a disease process may have begun). Lack of comprehensive exposure information makes it more difficult to interpret the results of a study, particularly considering that everyone in the industrialized world has been exposed to EMF.

Confounding

Epidemiological studies show relationships or correlations between disease and other factors such as diet, environmental conditions, and heredity. When a disease is correlated with some factor, it does not necessarily mean that the correlated factor causes the disease. It could mean that the factor occurs together with some other factor, not measured in the study, that actually causes the disease. This is called confounding.

For example, a study might show that alcohol consumption is correlated with lung cancer. This could occur if the study group consists of people who drink and also smoke tobacco, as often happens. In this example, alcohol use is correlated with lung cancer, but cigarette smoking is a confounding factor and the true cause of the disease.

Statistical significance

Researchers use statistical methods to determine the likelihood that the association between exposure and disease is due simply to chance. For a result to be considered "statistically significant," the association must be stronger than would be expected to occur by chance alone.

Meta-analysis

One way researchers try to get more information from epidemiological studies is to conduct a meta-analysis. A meta-analysis combines the summary statistics of many studies to explore their differences and, if appropriate, calculates an overall summary risk estimate. The main challenge faced by researchers performing meta-analyses is that populations, measurements, evaluation techniques, participation rates, and potential confounding factors vary in the original studies. These differences in the studies make it difficult to combine the results in a meaningful way.

Pooled analysis

Pooled analysis combines the original data from several studies and conducts a new analysis on the primary data. It requires access to the original data from individual studies and can only include diseases or factors included in all the studies, but it has the advantage that the same parameters can be applied to all studies. As with meta-analysis, pooled analysis is still subject to the limitations of the experimental

design of the original studies (for example, evaluation techniques, participation rates, etc.). Pooled analysis differs from meta-analysis, which combines the summary statistics from different studies, not their original data.

Q How do we characterize EMF exposure?

A No one knows which aspect of EMF exposure, if any, affects human health. Because of this uncertainty, in addition to the field strength, we must ask how long an exposure lasts, how it varies, and at what time of day or night it occurs. House wiring, for example, is often a significant source of EMF exposure for an individual, but the magnetic fields produced by the wiring depend on the amount of current flowing. As heating, lighting, and appliance use varies during the day, magnetic field exposure will also vary.

For many studies, researchers describe EMF exposures by estimating the average field strength. Some scientists believe that average exposure may not be the best measurement of EMF exposure and that other parameters, such as peak exposure or time of exposure, may be important.

Q What is the average field strength?

A In EMF studies, the information reported most often has been a person's EMF exposure averaged over time (average field strength). With cancer-causing chemicals, a person's average exposure over many years can be a good way to predict his or her chances of getting the disease.

There are different ways to calculate average magnetic field exposures. One method involves having a person wear a small monitor that takes many measurements over a work shift, a day, or longer. Then the average of those measurements is calculated. Another method involves placing a monitor that takes many measurements in a residence over a 24-hour or 48-hour period. Sometimes averages are calculated for people with the same occupation, people working in similar environments, or people using several brands of the same type or similar types of equipment.

Q How is EMF exposure measured in epidemiological studies?

A Epidemiologists study patterns and possible causes of diseases in human populations. These studies are usually observational rather than experimental. This means that the researcher observes and compares groups of people who have had certain diseases and exposures and looks for possible "associations." The epidemiologist must find a way to estimate the exposure that people had at an earlier time.

Association

In epidemiology, a positive association between an exposure (such as EMF) and a disease is not necessarily proof that the exposure *caused* the disease. However, the more often the exposure and disease occur together, the stronger the association, and the stronger is the possibility that the exposure may increase the risk of the disease.

Some exposure estimates for residential studies have been based on designation of households in terms of "wire codes." In other studies, measurements have been made in homes, assuming that EMF levels at the time of the measurement are similar to levels at some time in the past. Some studies involved "spot measurements." Exposure levels change as a person moves around in his or her environment, so spot measurements taken at specific locations only approximate the complex variations in exposure a person experiences. Other studies measured magnetic fields over a 24-hour or 48-hour period. Exposure levels for some occupational studies are measured by having certain employees wear personal monitors. The data taken from these monitors are sometimes used to estimate typical exposure levels for employees with certain job titles. Researchers can then estimate exposures using only an employee's job title and avoid measuring exposures of all employees.

Methods to Estimate EMF Exposure

Wire Codes

A classification of homes based on characteristics of power lines outside the home (thickness of the wires, wire configuration, etc.) and their distance from the home. This information is used to code the homes into groups with higher and lower predicted magnetic field levels.

Spot Measurement

An instantaneous or very short-term (e.g., 30-second) measurement taken at a designated location.

Time-Weighted Average

A weighted average of exposure measurements taken over a period of time that takes into account the time interval between measurements. When the measurements are taken with a monitor at a fixed sampling rate, the time-weighted average equals the arithmetic mean of the measurements.

Personal Monitor

An instrument that can be worn on the body for measuring exposure over time.

Calculated Historical Fields

An estimate based on a theoretical calculation of the magnetic field emitted by power lines using historical electrical loads on those lines.

3 Results of EMF Research

This chapter summarizes the results of EMF research worldwide, including epidemiological studies of children and adults, clinical studies of how humans react to typical EMF exposures, and laboratory research with animals and cells.

Q Is there a link between EMF exposure and childhood leukemia?

A Despite more than two decades of research to determine whether elevated EMF exposure, principally to magnetic fields, is related to an increased risk of childhood leukemia, there is still no definitive answer. Much progress has been made, however, with some lines of research leading to reasonably clear answers and others remaining unresolved. The best available evidence at this time leads to the following answers to specific questions about the link between EMF exposure and childhood leukemia:

Is there an association between power line configurations (wire codes) and childhood leukemia? No.

Is there an association between measured fields and childhood leukemia? Yes, but the association is weak, and it is not clear whether it represents a cause-and-effect relationship.

Q What is the epidemiological evidence for evaluating a link between EMF exposure and childhood leukemia?

A The initial studies, starting with the pioneering research of Dr. Nancy Wertheimer and Ed Leeper in 1979 in Denver, Colorado, focused on power line configurations near homes. Power lines were systematically evaluated and coded for their presumed ability to produce elevated magnetic fields in homes and classified into groups with higher and lower predicted magnetic field levels (see discussion of wire codes on page 15). Although the first study and two that followed in Denver and Los Angeles showed an association between wire codes indicative of elevated magnetic fields and childhood leukemia, larger, more recent studies in the central part of the United States and in several provinces of Canada did not find such an

association. In fact, combining the evidence from all the studies, we can conclude with some confidence that wire codes are not associated with a measurable increase in the risk of childhood leukemia.

The other approach to assessing EMF exposure in homes focused on the measurements of magnetic fields. Unlike wire codes, which are only applicable in North America due to the nature of the electric power distribution system, measured fields have been studied in relation to childhood leukemia in research conducted around the world, including Sweden, England, Germany, New Zealand, and Taiwan. Large, detailed studies have recently been completed in the United States, Canada, and the United Kingdom that provide the most evidence for making an evaluation. These studies have produced variable findings, some reporting small associations, others finding no associations.

National Cancer Institute Study

In 1997, after eight years of work, Dr. Martha Linet and colleagues at the National Cancer Institute (NCI) reported the results of their study of childhood acute lymphoblastic leukemia (ALL). The case-control study involved more than 1,000 children living in 9 eastern and midwestern U.S. states and is the largest epidemiological study of childhood leukemia to date in the United States. To help resolve the question of wire code versus measured magnetic fields, the NCI researchers carried out both types of exposure assessment. Overall, Linet reported little evidence that living in homes with higher measured magnetic-field levels was a disease risk and found no evidence that living in a home with a high wire code configuration increased the risk of ALL in children.

United Kingdom Childhood Cancer Study

In December 1999, Sir Richard Doll and colleagues in the United Kingdom announced that the largest study of childhood cancer ever undertaken—involving nearly 4,000 children with cancer in England, Wales, and Scotland—found no evidence of excess risk of childhood leukemia or other cancers from exposure to power-frequency magnetic fields. It should be noted, however, that because most power lines in the United Kingdom are underground, the EMF exposures of these children were mostly lower than 0.2 microtesla or 2 milligauss.

After reviewing all the data, the U.S. National Institute of Environmental Health Sciences (NIEHS) concluded in 1999 that the evidence was weak, but that it was still sufficient to warrant limited concern. The NIEHS rationale was that no individual epidemiological study provided convincing evidence linking magnetic field exposure with childhood leukemia, but the overall pattern of results for some methods of measuring exposure suggested a weak association between increasing exposure to EMF and increasing risk of childhood leukemia. The small number of cases in these studies made it impossible to firmly demonstrate this association. However, the fact that similar results had been observed in studies of different populations using a variety of study designs supported this observation.

A major challenge has been to determine whether the most highly elevated, but rarely encountered, levels of magnetic fields are associated with an increased risk of leukemia. Early reports focused on the risk associated with exposures above 2 or 3 milligauss, but the more recent studies have been large enough to also provide some information on levels above 3 or 4 milligauss. It is estimated that 4.5% of homes in the United States have magnetic fields above 3 milligauss, and 2.5% of homes have levels above 4 milligauss.

What is Cancer?

Cancer

"Cancer" is a term used to describe at least 200 different diseases, all involving uncontrolled cell growth. The frequency of cancer is measured by the incidence—the number of new cases diagnosed each year. Incidence is usually described as the number of new cases diagnosed per 100,000 people per year.

The incidence of cancer in adults in the United States is 382 per 100,000 per year, and childhood cancers account for about 1% of all cancers. The factors that influence risk differ among the forms of cancer. Known risk factors such as smoking, diet, and alcohol contribute to specific types of cancer. (For example, smoking is a known risk factor for lung cancer, bladder cancer, and oral cancer.) For many other cancers, the causes are unknown.

Leukemia

Leukemia describes a variety of cancers that arise in the bone marrow where blood cells are formed. The leukemias represent less than 4% of all cancer cases in adults but are the most common form of cancer in children. For children age 4 and under, the incidence of childhood leukemia is approximately 6 per 100,000 per year, and it decreases with age to about 2 per 100,000 per year for children 10 and older. In the United States, the incidence of adult leukemia is about 10 cases per 100,000 people per year. Little is known about what causes leukemia, although genetic factors play a role. The only known causes are ionizing radiation, benzene, and other chemicals and drugs that suppress bone marrow function, and a human T-cell leukemia virus.

Brain Cancer

Cancer of the central nervous system (the brain and spinal cord) is uncommon, with incidence in the United States now at about 6 cases in 100,000 people per year. The causes of the disease are largely unknown, although a number of studies have reported an association with certain occupational chemical exposures. Ionizing radiation to the scalp is a known risk factor for brain cancer. Factors associated with an increased risk for other types of cancer—such as smoking, diet, and excessive alcohol use—have not been found to be associated with brain cancer.

To determine what the integrated information from all the studies says about magnetic fields and childhood leukemia, two groups have conducted pooled analyses in which the original data from relevant studies were integrated and analyzed. One report (Greenland et al., 2000) combined 12 relevant studies with magnetic field measurements, and the other considered 9 such studies (Ahlbom et al., 2000). The details of the two pooled analyses are different, but their findings are similar. There is weak evidence for an association (relative risk of approximately 2) at exposures above 3 mG. However, few individuals had high exposures in these studies; therefore, even combining all studies, there is uncertainty about the strength of the association.

The following table summarizes the results for the epidemiological studies of EMF exposure and childhood leukemia analyzed in the pooled analysis by Greenland et al. (2000). The focus of the summary review was the magnetic fields that occurred three months prior to diagnosis. The results were derived from either calculated historical fields or multiple measurements of magnetic fields. The North American

Residential Exposure to Magnetic Fields and Childhood Leukemia

	Magnetic field category (mG)					
	>1 – ≤2 mG		>2 – ≤3 mG		>3 mG	
First author	Estimate	95% CL	Estimate	95% CL	Estimate	95% CL
Coghill	0.54	0.17, 1.74	No controls		No controls	
Dockerty	0.65	0.26, 1.63	2.83	0.29, 27.9	No controls	
Feychting	0.63	0.08, 4.77	0.90	0.12, 7.00	4.44	1.67, 11.7
Linet	1.07	0.82, 1.39	1.01	0.64, 1.59	1.51	0.92, 2.49
London	0.96	0.54, 1.73	0.75	0.22, 2.53	1.53	0.67, 3.50
McBride	0.89	0.62, 1.29	1.27	0.74, 2.20	1.42	0.63, 3.21
Michaelis	1.45	0.78, 2.72	1.06	0.27, 4.16	2.48	0.79, 7.81
Olsen	0.67	0.07, 6.42	No cases		2.00	0.40, 9.93
Savitz	1.61	0.64, 4.11	1.29	0.27, 6.26	3.87	0.87, 17.3
Tomenius	0.57	0.33, 0.99	0.88	0.33, 2.36	1.41	0.38, 5.29
Tynes	1.06	0.25, 4.53	No cases		No cases	
Verkasalo	1.11	0.14, 9.07	No cases		2.00	0.23, 17.7
Study summary	0.95	0.80, 1.12	1.06	0.79, 1.42	1.69*	1.25, 2.29
	1 – <2 mG		2 – <4 mG		≥4 mG	
**United Kingdom	0.84	0.57, 1.24	0.98	0.50, 1.93	1.00	0.30, 3.37

95% CL = 95% confidence limits.
Source: Greenland et al., 2000.

* Mantel-Haenszel analysis (p = 0.01). Maximum-likelihood summaries differed by less than 1% from these summaries; based on 2,656 cases and 7,084 controls. Adjusting for age, sex, and other variables had little effect on summary results.

** These data are from a recent United Kingdom study not included in the Greenland analysis but included in another pooled analysis (Ahlbom et al. 2000). The United Kingdom study included 1,073 cases and 2,224 controls.

For this table, the column headed "estimate" describes the relative risk. Relative risk is the ratio of the risk of childhood leukemia for those in a magnetic field exposure group compared to persons with exposure levels of 1.0 mG or less. For example, Coghill estimated that children with exposures between 1 and 2 mG have 0.54 times the risk of children whose exposures were less than 1 mG. London's study estimates that children whose exposures were greater than 3 mG have 1.53 times the risk of children whose exposures were less than 1 mG. The column headed "95% CL" (confidence limits) describes how much random variation is in the estimate of relative risk. The estimate may be off by some amount due to random variation, and the width of the confidence limits gives some notion of that variation. For example, in Coghill's estimate of 0.54 for the relative risk, values as low as 0.17 or as high as 1.74 would not be statistically significantly different from the value of 0.54. Note there is a wide range of estimates of relative risk across the studies and wide confidence limits for many studies. In light of these findings, the pooling of results can be extremely helpful to calculate an overall estimate, much better than can be obtained from any study taken alone.

studies (Linet, London, McBride, Savitz) were 60 Hz; all other studies were 50 Hz. Results from the recent study from the United Kingdom (see page 17) are also included in the table. This study was included in the analysis by Ahlbom et al. (2000). The relative risk estimates from the individual studies show little or no association of magnetic fields with childhood leukemia. The study summary for the pooled analysis by Greenland et al. (2000) shows a weak association between childhood leukemia and magnetic field exposures greater 3 mG.

Q Is there a link between EMF exposure and childhood brain cancer or other forms of cancer in children?

A Although the earliest studies suggested an association between EMF exposure and all forms of childhood cancer, those initial findings have not been confirmed by other studies. At present, the available series of studies indicates no association between EMF exposure and childhood cancers other than leukemia. Far fewer of these studies have been conducted than studies of childhood leukemia.

Q Is there a link between residential EMF exposure and cancer in adults?

A The few studies that have been conducted to address EMF and adult cancer do not provide strong evidence for an association. Thus, a link has not been established between residential EMF exposure and adult cancers, including leukemia, brain cancer, and breast cancer (see table below).

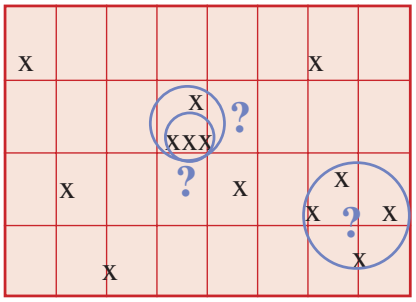
Residential Exposure to Magnetic Fields and Adult Cancer

			Results (odds ratios)		
First author	Location	Type of exposure data	Leukemia	CNS tumors	All cancers
Coleman	United Kingdom	Calculated historical fields	0.92	NA	NA
Feychting and Ahlbom	Sweden	Calculated & spot measurements	1.5*	0.7	NA
Li	Taiwan	Calculated historical fields	1.4*	1.1	NA
Li	Taiwan	Calculated historical fields		1.1 (breast cancer)	
McDowall	United Kingdom	Calculated historical fields	1.43	NA	1.03
Severson	Seattle	Wire codes & spot measurements	0.75	NA	NA
Wrensch	San Francisco	Wire codes & spot measurements	NA	0.9	NA
Youngson	United Kingdom	Calculated historical fields	1.88	NA	NA

CNS = central nervous system.
*The number is statistically significant (greater than expected by chance).
Study results are listed as "odds ratios" (OR). An odds ratio of 1.00 means there was no increase or decrease in risk. In other words, the odds that the people in the study who had the disease (in this case, cancer) and were exposed to a particular agent (in this case, EMF) are the same as for the people in the study who did not have the disease. An odds ratio greater than 1 may occur simply by chance, unless it is statistically significant.

Q Have clusters of cancer or other adverse health effects been linked to EMF exposure?

A An unusually large number of cancers, miscarriages, or other adverse health effects that occur in one area or over one period of time is called a "cluster." Sometimes clusters provide an early warning of a health hazard. But most of the time the reason for the cluster is not known. There have been no proven instances of cancer clusters linked with EMF exposure.



The definition of a "cluster" depends on how large an area is included. Cancer cases (x's in illustration) in a city, neighborhood, or workplace may occur in ways that suggest a cluster due to a common environmental cause. Often these patterns turn out to be due to chance. Delineation of a cluster is subjective—where do you draw the circles?

Q If EMF does cause or promote cancer, shouldn't cancer rates have increased along with the increased use of electricity?

A Not necessarily. Although the use of electricity has increased greatly over the years, EMF exposures may not have increased. Changes in building wiring codes and in the design of electrical appliances have in some cases resulted in lower magnetic field levels. Rates for various types of cancer have shown both increases and decreases through the years, due in part to improved prevention, diagnosis, reporting, and treatment.

Q Is there a link between EMF exposure in electrical occupations and cancer?

A For almost as long as we have been concerned with residential exposure to EMF and childhood cancers, researchers have been studying workplace exposure to EMF and adult cancers, focusing on leukemia and brain cancer. This research began with surveys of job titles and cancer risks, but has progressed to include very large, detailed studies of the health of workers, especially electric utility workers, in the United States, Canada, France, England, and several Northern European countries. Some studies have found evidence that suggests a link between EMF exposure and both leukemia and brain cancer, whereas other studies of similar size and quality have not found such associations.

California

A 1993 study of 36,000 California electric utility workers reported no strong, consistent evidence of an association between magnetic fields and any type of cancer.

Canada/France

A 1994 study of more than 200,000 utility workers in 3 utility companies in Canada and France reported no significant association between all leukemias combined and cumulative exposure to magnetic fields. There was a slight, but not statistically significant, increase in brain cancer. The researchers concluded that the study did not provide clear-cut evidence that magnetic field exposures caused leukemia or brain cancer.

North Carolina

Results of a 1995 study involving more than 138,000 utility workers at 5 electric utilities in the United States did not support an association between occupational magnetic field exposure and leukemia, but suggested a link to brain cancer.

Denmark

In 1997 a study of workers employed in all Danish utility companies reported a small, but statistically significant, excess risk for all cancers combined and for lung cancer. No excess risk was observed for leukemia, brain cancers, or breast cancer.

United Kingdom

A 1997 study among electrical workers in the United Kingdom did not find an excess risk for brain cancer. An extension of this work reported in 2001 also found no increased risk for brain cancer.

Efforts have also been made to pool the findings across several of the above studies to produce more accurate estimates of the association between EMF and cancer (Kheifets et al., 1999). The combined summary statistics across studies provide insufficient evidence for an association between EMF exposure in the workplace and either leukemia or brain cancer.

Q Have studies of workers in other industries suggested a link between EMF exposure and cancer?

A One of the largest studies to report an association between cancer and magnetic field exposure in a broad range of industries was conducted in Sweden (1993). The study included an assessment of EMF exposure in 1,015 different workplaces and involved more than 1,600 people in 169 different occupations. An association was reported between estimated EMF exposure and increased risk for chronic lymphocytic leukemia. An association was also reported between exposure to magnetic fields and brain cancer, but there was no dose-response relationship.

Another Swedish study (1994) found an excess risk of lymphocytic leukemia among railway engine drivers and conductors. However, the total cancer incidence (all tumors included) for this group of workers was lower than in the general Swedish population. A study of Norwegian railway workers found no evidence for an association between EMF exposure and leukemia or brain cancer. Although both positive and negative effects of EMF exposure have been reported, the majority of studies show no effects.

Q Is there a link between EMF exposure and breast cancer?

A Researchers have been interested in the possibility that EMF exposure might cause breast cancer, in part because breast cancer is such a common disease in adult women. Early studies identified a few electrical workers with male breast cancer, a very rare disease. A link between EMF exposure and alterations in the hormone melatonin was considered a possible hypothesis (see page 24). This idea provided motivation to conduct research addressing a possible link between EMF exposure and breast cancer. Overall, the published epidemiological studies have not shown such an association.

Q What have we learned from clinical studies?

A Laboratory studies with human volunteers have attempted to answer questions such as,

Does EMF exposure alter normal brain and heart function?
Does EMF exposure at night affect sleep patterns?
Does EMF exposure affect the immune system?
Does EMF exposure affect hormones?

The following kinds of biological effects have been reported. Keep in mind that a biological effect is simply a measurable change in some biological response. It may or may not have any bearing on health.

Heart rate

An inconsistent effect on heart rate by EMF exposure has been reported. When observed, the biological response is small (on average, a slowing of about three to five beats per minute), and the response does not persist once exposure has ended.

Two laboratories, one in the United States and one in Australia, have reported effects of EMF on heart rate variability. Exposures used in these experiments were relatively high (about 300 mG), and lower exposures failed to produce the effect. Effects have not been observed consistently in repeated experiments.

Sleep electrophysiology

A laboratory report suggested that overnight exposure to 60-Hz magnetic fields may disrupt brain electrical activity (EEG) during night sleep. In this study subjects were exposed to either continuous or intermittent magnetic fields of 283 mG. Individuals exposed to the intermittent magnetic fields showed alterations in traditional EEG sleep parameters indicative of a pattern of poor and disrupted sleep. Several studies have reported no effect with continuous exposure.

Hormones, immune system, and blood chemistry

Several clinical studies with human volunteers have evaluated the effects of power-frequency EMF exposure on hormones, the immune system, and blood chemistry. These studies provide little evidence for any consistent effect.

Melatonin

The hormone melatonin is secreted mainly at night and primarily by the pineal gland, a small gland attached to the brain. Some laboratory experiments with cells and animals have shown that melatonin can slow the growth of cancer cells, including breast cancer cells. Suppressed nocturnal melatonin levels have been observed in some studies of laboratory animals exposed to both electric and magnetic fields. These observations led to the hypothesis that EMF exposure might reduce melatonin and thereby weaken one of the body's defenses against cancer.

Many clinical studies with human volunteers have now examined whether various levels and types of magnetic field exposure affect blood levels of melatonin. Exposure of human volunteers at night to power-frequency EMF under controlled laboratory conditions has no apparent effect on melatonin. Some studies of people exposed to EMF at work or at home do report evidence for a small suppression of melatonin. It is not clear whether the decreases in melatonin reported under environmental conditions are related to the presence of EMF exposure or to other factors.

Q What effects of EMF have been reported in laboratory studies of cells?

A Over the years, scientists have conducted more than 1,000 laboratory studies to investigate potential biological effects of EMF exposure. Most have been *in vitro* studies; that is, studies carried out on cells isolated from animals and plants, or on cell components such as cell membranes. Other studies involved animals, mainly rats and mice. In general, these studies do not demonstrate a consistent effect of EMF exposure.

Most *in vitro* studies have used magnetic fields of 1,000 mG (100 µT) or higher, exposures that far exceed daily human exposures. In most incidences, when one laboratory has reported effects of EMF exposure on cells, other laboratories have not been able to reproduce the findings. For such research results to be widely accepted by scientists as valid, they must be replicated—that is, scientists in other laboratories should be able to repeat the experiment and get similar results. Cellular studies have investigated potential EMF effects on cell proliferation and differentiation, gene expression, enzyme activity, melatonin, and DNA. Scientists reviewing the EMF research literature find overall that the cellular studies provide little convincing evidence of EMF effects at environmental levels.

Q Have effects of EMF been reported in laboratory studies in animals?

A Researchers have published more than 30 detailed reports on both long-term and short-term studies of EMF exposures in laboratory animals (bioassays). Long-term animal bioassays constitute an important group of studies in EMF research. Such studies have a proven record for predicting the carcinogenicity of chemicals, physical agents, and other suspected cancer-causing agents. In the EMF studies, large groups of mice or rats were continuously exposed to EMF for two years or longer and were then evaluated for cancer. The U.S. National Toxicology Program (http://ntp-server.niehs.nih.gov/) has an extensive historical database for hundreds of different chemical and physical agents evaluated using this model. EMF long-term bioassays examined leukemia, brain cancer, and breast cancer—the diseases some epidemiological studies have associated with EMF exposure (see pages 16–23).

Several different approaches have been used to evaluate effects of EMF exposure in animal bioassays. To investigate whether EMF could promote cancer after genetic damage had occurred, some long-term studies used cancer initiators such as ultraviolet light, radiation, or certain chemicals that are known to cause genetic damage. Researchers compared groups of animals treated with cancer initiators to groups treated with cancer initiators and then exposed to EMF, to see if EMF exposure promoted the cancer growth (initiation-promotion model). Other studies tested the cancer promotion potential of EMF using mice that were predisposed to cancer because they had defects in the genes that control cancer.

Animal Leukemia Studies: Long-Term, Continuous Exposure Studies, Two or More Years in Length

First author	Sex/species	Exposure/animal numbers	Results
Babbitt (U.S.)	Female mice	14,000 mG, 190 or 380 mice per group. Some groups treated with ionizing radiation.	No effect
Boorman (U.S.)	Male and female rats	20 to 10,000 mG, 100 per group	No effect
McCormick (U.S.)	Male and female mice	20 to 10,000 mG, 100 per group	No effect
Mandeville (Canada)	Female rats	20 to 20,000 mG, 50 per group *In utero* exposure	No effect
Yasui (Japan)	Male and female rats	5,000 to 50,000 mG, 50 per group	No effect

10 milligauss (mG) = 1 microtesla (μT) = 0.001 millitesla (mT)

Leukemia

Fifteen animal leukemia studies have been completed and reported. Most tested for effects of exposure to power-frequency (60-Hz) magnetic fields using rodents. Results of these studies were largely negative. The Babbitt study evaluated the subtypes of leukemia. The data provide no support for the reported epidemiology findings of leukemia from EMF exposure. Many scientists feel that the lack of effects seen in these laboratory leukemia studies significantly weakens the case for EMF as a cause of leukemia.

Breast cancer

Researchers in the Ukraine, Germany, Sweden, and the United States have used initiation-promotion models to investigate whether EMF exposure promotes breast cancer in rats.

The results of these studies are mixed; while the German studies showed some effects, the Swedish and U.S. studies showed none. Studies in Germany reported effects on the numbers of tumors and tumor volume. A National Toxicology Program long-term bioassay performed without the use of other cancer-initiating substances showed no effects of EMF exposure on the development of mammary tumors in rats and mice.

The explanation for the observed difference among these studies is not readily apparent. Within the limits of the experimental rodent model of mammary carcinogenesis, no conclusions are possible regarding a promoting effect of EMF on chemically induced mammary cancer.

Other cancers

Tests of EMF effects on skin cancer, liver cancer, and brain cancer have been conducted using both initiation-promotion models and non-initiated long-term bioassays. All are negative.

Three positive studies were reported for a co-promotion model of skin cancer in mice. The mice were exposed to EMF plus cancer-causing chemicals after cancers

had already been initiated. The same research team as well as an independent laboratory were unable to reproduce these results in subsequent experiments.

Non-cancer effects

Many animal studies have investigated whether EMF can cause health problems other than cancer. Researchers have examined many endpoints, including birth defects, immune system function, reproduction, behavior, and learning. Overall, animal studies do not support EMF effects on non-cancer endpoints.

Q Can EMF exposure damage DNA?

A Studies have attempted to determine whether EMF has genotoxic potential; that is, whether EMF exposure can alter the genetic material of living organisms. This question is important because genotoxic agents often also cause cancer or birth defects. Studies of genotoxicity have included tests on bacteria, fruit flies, and some tests on rats and mice. Nearly 100 studies on EMF genotoxicity have been reported. Most evidence suggests that EMF exposure is not genotoxic. Based on experiments with cells, some researchers have suggested that EMF exposure may inhibit the cell's ability to repair normal DNA damage, but this idea remains speculative because of the lack of genotoxicity observed in EMF animal studies.

4 Your EMF Environment

This chapter discusses typical magnetic field exposures in home and work environments and identifies common EMF sources and field intensities associated with these sources.

Q A How do we define EMF exposure?

Scientists are still uncertain about the best way to define "exposure" because experiments have yet to show which aspect of the field, if any, may be relevant to reported biological effects. Important aspects of exposure could be the highest intensity, the average intensity, or the amount of time spent above a certain baseline level. The most widely used measure of EMF exposure has been the time-weighted average magnetic field level (see discussion on page 15).

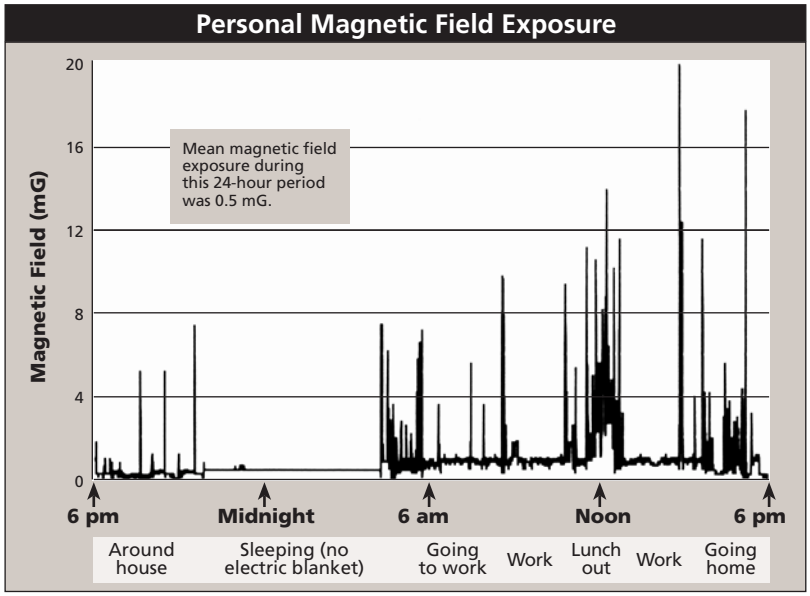
Q A How is EMF exposure measured?

Several kinds of personal exposure meters are now available. These automatically record the magnetic field as it varies over time. To determine a person's EMF exposure, the personal exposure meter is usually worn at the waist or is placed as close as possible to the person during the course of a work shift or day.

EMF can also be measured using survey meters, sometimes called "gaussmeters." These measure the EMF levels in a given location at a given time. Such measurements do not necessarily reflect personal EMF exposure because they are not always taken at the distance from the EMF source that the person would typically be from the source. Measurements are not always made in a location for the same amount of time that a person spends there. Such "spot measurements" also fail to capture variations of the field over time, which can be significant.

Q What are some typical EMF exposures?

A The figure below is an example of data collected with a personal exposure meter.



In the above example, the magnetic field was measured every 1.5 seconds over a period of 24 hours. For this person, exposure at home was very low. The occasional spikes (short exposure to high fields) occurred when the person drove or walked under power lines or over underground power lines or was close to appliances in the home or office.

Several studies have used personal exposure meters to measure field exposure in different environments. These studies tend to show that appliances and building wiring contribute to the magnetic field exposure that most people receive while at home. People living close to high voltage power lines that carry a lot of current tend to have higher overall field exposures. As shown on page 32, there is considerable variation among houses.

Q What are typical EMF exposures for people living in the United States?

A Most people in the United States are exposed to magnetic fields that average less than 2 milligauss (mG), although individual exposures vary.

The following table shows the estimated average magnetic field exposure of the U.S. population, according to a study commissioned by the U.S. government as part

of the EMF Research and Public Information Dissemination (EMF RAPID) Program (see page 50). This study measured magnetic field exposure of about 1,000 people of all ages randomly selected among the U.S. population. Participants wore or carried with them a small personal exposure meter and kept a diary of their activities both at home and away from home. Magnetic field values were automatically recorded twice a second for 24 hours. The study reported that exposure to magnetic fields is similar in different regions of the country and similar for both men and women.

Estimated Average Magnetic Field Exposure of the U.S. Population

Average 24-hour field (mG)	Population exposed (%)	95% confidence interval (%)	People exposed* (millions)
> 0.5	76.3	73.8–78.9	197–211
> 1	43.6	40.9–46.5	109–124
> 2	14.3	11.8–17.3	31.5–46.2
> 3	6.3	4.7–8.5	12.5–22.7
> 4	3.6	2.5–5.2	6.7–13.9
> 5	2.42	1.65–3.55	4.4–9.5
> 7.5	0.58	0.29–1.16	0.77–3.1
> 10	0.46	0.20–1.05	0.53–2.8
> 15	0.17	0.035–0.83	0.09–2.2

*Based on a population of 267 million. This table summarizes some of the results of a study that sampled about 1,000 people in the United States. In the first row, for example, we find that 76.3% of the sample population had a 24-hour average exposure of greater than 0.5 mG. Assuming that the sample was random, we can use statistics to say that we are 95% confident that the percentage of the overall U.S. population exposed to greater than 0.5 mG is between 73.8% and 78.9%. Source: Zaffanella, 1993.

The following table shows average magnetic fields experienced during different types of activities. In general, magnetic fields are greater at work than at home.

Estimated Average Magnetic Field Exposure of the U.S. Population for Various Activities

Average field (mG)	Population exposed (%)				
	Home	Bed	Work	School	Travel
> 0.5	69	48	81	63	87
> 1	38	30	49	25	48
> 2	14	14	20	3.5	13
> 3	7.8	7.2	13	1.6	4.1
> 4	4.7	4.7	8.0	< 1	1.5
> 5	3.5	3.7	4.6		1.0
> 7.5	1.2	1.6	2.5		0.5
> 10	0.9	0.8	1.3		< 0.2
> 15	0.1	0.1	0.9		

Source: Zaffanella, 1993.

Q What levels of EMF are found in common environments?

A Magnetic field exposures can vary greatly from site to site for any type of environment. The data shown in the following table are median measurements taken at four different sites for each environment category.

EMF Exposures in Common Environments
Magnetic fields measured in milligauss (mG)

Environment	Median* exposure	Top 5th percentile
OFFICE BUILDING		
Support staff	0.6	3.7
Professional	0.5	2.6
Maintenance	0.6	3.8
Visitor	0.6	2.1
SCHOOL		
Teacher	0.6	3.3
Student	0.5	2.9
Custodian	1.0	4.9
Administrative staff	1.3	6.9
HOSPITAL		
Patient	0.6	3.6
Medical staff	0.8	5.6
Visitor	0.6	2.4
Maintenance	0.6	5.9
MACHINE SHOP		
Machinist	0.4	6.0
Welder	1.1	24.6
Engineer	1.0	5.1
Assembler	0.5	6.4
Office staff	0.7	4.7
GROCERY STORE		
Cashier	2.7	11.9
Butcher	2.4	12.8
Office staff	2.1	7.1
Customer	1.1	7.7

*The median of four measurements. For this table, the median is the average of the two middle measurements.
Source: National Institute for Occupational Safety and Health.

Q What EMF field levels are encountered in the home?

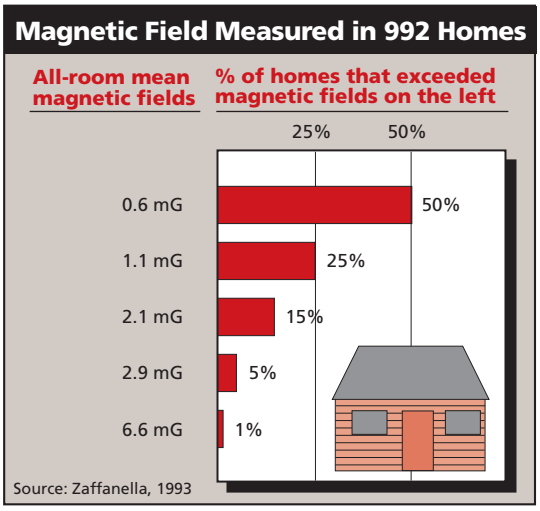
A

Electric fields

Electric fields in the home, on average, range from 0 to 10 volts per meter. They can be hundreds, thousands, or even millions of times weaker than those encountered outdoors near power lines. Electric fields directly beneath power lines may vary from a few volts per meter for some overhead distribution lines to several thousands of volts per meter for extra high voltage power lines. Electric fields from power lines rapidly become weaker with distance and can be greatly reduced by walls and roofs of buildings.

Magnetic fields

Magnetic fields are not blocked by most materials. Magnetic fields encountered in homes vary greatly. Magnetic fields rapidly become weaker with distance from the source.



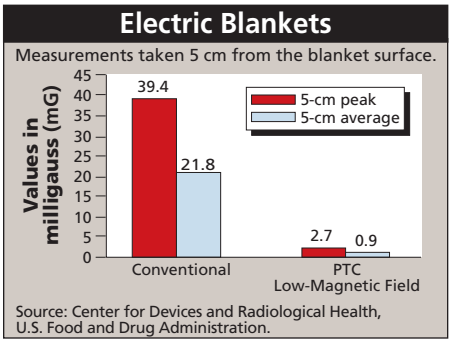
The chart on the left summarizes data from a study by the Electric Power Research Institute (EPRI) in which spot measurements of magnetic fields were made in the center of rooms in 992 homes throughout the United States. Half of the houses studied had magnetic field measurements of 0.6 mG or less, when the average of measurements from all the rooms in the house was calculated (the all-room mean magnetic field). The all-room mean magnetic field for all houses studied was 0.9 mG. The measurements were made away from electrical appliances and reflect primarily the fields from household wiring and outside power lines.

If you are comparing the information in this chart with measurements in your own home, keep in mind that this chart shows averages of measurements taken throughout the homes, not the single highest measurement found in the home.

Q A What are EMF levels close to electrical appliances?

Magnetic fields close to electrical appliances are often much stronger than those from other sources, including magnetic fields directly under power lines. Appliance fields decrease in strength with distance more quickly than do power line fields.

The following table, based on data gathered in 1992, lists the EMF levels generated by common electrical appliances. Magnetic field strength (magnitude) does not depend on how large, complex, powerful, or noisy the appliance is. Magnetic fields near large appliances are often weaker than those near small devices. Appliances in your home may have been redesigned since the data in the table were collected, and the EMF they produce may differ considerably from the levels shown here.



The graph shows magnetic fields produced by electric blankets, including conventional 110-V electric blankets as well as the PTC (positive temperature coefficient) low-magnetic-field blankets. The fields were measured at a distance of about 2 inches from the blanket's surface, roughly the distance from the blanket to the user's internal organs. Because of the wiring, magnetic field strengths vary from point to point on the blanket. The graph reflects this and gives both the peak and the average measurement.

Sources of Magnetic Fields (mG)*

	Distance from source 6″	1′	2′	4′
Office Sources				
AIR CLEANERS				
Lowest	110	20	3	–
Median	180	35	5	1
Highest	250	50	8	2
COPY MACHINES				
Lowest	4	2	1	–
Median	90	20	7	1
Highest	200	40	13	4
FAX MACHINES				
Lowest	4	–	–	–
Median	6	–	–	–
Highest	9	2	–	–
FLUORESCENT LIGHTS				
Lowest	20	–	–	–
Median	40	6	2	–
Highest	100	30	8	4
ELECTRIC PENCIL SHARPENERS				
Lowest	20	8	5	–
Median	200	70	20	2
Highest	300	90	30	30
VIDEO DISPLAY TERMINALS (see page 48) (PCs with color monitors)**				
Lowest	7	2	1	–
Median	14	5	2	–
Highest	20	6	3	–
Bathroom Sources				
HAIR DRYERS				
Lowest	1	–	–	–
Median	300	1	–	–
Highest	700	70	10	1
ELECTRIC SHAVERS				
Lowest	4	–	–	–
Median	100	20	–	–
Highest	600	100	10	1

	Distance from source 6″	1′	2′	4′
Workshop Sources				
BATTERY CHARGERS				
Lowest	3	2	–	–
Median	30	3	–	–
Highest	50	4	–	–
DRILLS				
Lowest	100	20	3	–
Median	150	30	4	–
Highest	200	40	6	–
POWER SAWS				
Lowest	50	9	1	–
Median	200	40	5	–
Highest	1000	300	40	4
ELECTRIC SCREWDRIVERS (while charging)				
Lowest	–	–	–	–
Median	–	–	–	–
Highest	–	–	–	–

	Distance from source 1′	2′	4′
Living/Family Room Sources			
CEILING FANS			
Lowest	–	–	–
Median	3	–	–
Highest	50	6	1
WINDOW AIR CONDITIONERS			
Lowest	–	–	–
Median	3	1	–
Highest	20	6	4
COLOR TELEVISIONS**			
Lowest	–	–	–
Median	7	2	–
Highest	20	8	4

Continued

Sources of Magnetic Fields (mG)*

	Distance from source			
	6″	1′	2′	4′
Kitchen Sources				
BLENDERS				
Lowest	30	5	–	–
Median	70	10	2	–
Highest	100	20	3	–
CAN OPENERS				
Lowest	500	40	3	–
Median	600	150	20	2
Highest	1500	300	30	4
COFFEE MAKERS				
Lowest	4	–	–	–
Median	7	–	–	–
Highest	10	1	–	–
DISHWASHERS				
Lowest	10	6	2	–
Median	20	10	4	–
Highest	100	30	7	1
FOOD PROCESSORS				
Lowest	20	5	–	–
Median	30	6	2	–
Highest	130	20	3	–
GARBAGE DISPOSALS				
Lowest	60	8	1	–
Median	80	10	2	–
Highest	100	20	3	–
MICROWAVE OVENS***				
Lowest	100	1	1	–
Median	200	4	10	2
Highest	300	200	30	20
MIXERS				
Lowest	30	5	–	–
Median	100	10	1	–
Highest	600	100	10	–

	Distance from source			
	6″	1′	2′	4′
Kitchen Sources				
ELECTRIC OVENS				
Lowest	4	1	–	–
Median	9	4	–	–
Highest	20	5	1	–
ELECTRIC RANGES				
Lowest	20	–	–	–
Median	30	8	2	–
Highest	200	30	9	6
REFRIGERATORS				
Lowest	–	–	–	–
Median	2	2	1	–
Highest	40	20	10	10
TOASTERS				
Lowest	5	–	–	–
Median	10	3	–	–
Highest	20	7	–	–
Bedroom Sources				
DIGITAL CLOCK****				
Lowest		–	–	–
Median		1	–	–
High		8	2	1
ANALOG CLOCKS (conventional clockface)****				
Lowest		1	–	–
Median		15	2	–
Highest		30	5	3
BABY MONITOR (unit nearest child)				
Lowest	4	–	–	–
Median	6	1	–	–
Highest	15	2	–	–

Continued

Sources of Magnetic Fields (mG)*

	Distance from source 6″	1′	2′	4′
Laundry/Utility Sources				
ELECTRIC CLOTHES DRYERS				
Lowest	2	–	–	–
Median	3	2	–	–
Highest	10	3	–	–
WASHING MACHINES				
Lowest	4	1	–	–
Median	20	7	1	–
Highest	100	30	6	–
IRONS				
Lowest	6	1	–	–
Median	8	1	–	–
Highest	20	3	–	–

	Distance from source 6″	1′	2′	4′
Laundry/Utility Sources				
PORTABLE HEATERS				
Lowest	5	1	–	–
Median	100	20	4	–
Highest	150	40	8	1
VACUUM CLEANERS				
Lowest	100	20	4	–
Median	300	60	10	1
Highest	700	200	50	10
SEWING MACHINES				
Home sewing machines can produce magnetic fields of 12 mG at chest level and 5 mG at head level. Magnetic fields as high as 35 mG at chest level and 215 mG at knee level have been measured from industrial sewing machine models (Sobel, 1994).				

Source: EMF In Your Environment, U.S. Environmental Protection Agency, 1992.

* Dash (–) means that the magnetic field at this distance from the operating appliance could not be distinguished from background measurements taken before the appliance had been turned on.

** Some appliances produce both 60-Hz and higher frequency fields. For example, televisions and computer screens produce fields at 10,000-30,000 Hz (10-30 kHz) as well as 60-Hz fields.

*** Microwave ovens produce 60-Hz fields of several hundred milligauss, but they also create microwave energy inside the appliance that is at a much higher frequency (about 2.45 billion hertz). We are shielded from the higher frequency fields but not from the 60-Hz fields.

**** Most digital clocks have low magnetic fields. In some analog clocks, however, higher magnetic fields are produced by the motor that drives the hands. In the above table, the clocks are electrically powered using alternating current, as are all the appliances described in these tables.

Q A What EMF levels are found near power lines?

Power transmission lines bring power from a generating station to an electrical substation. Power distribution lines bring power from the substation to your home. Transmission and distribution lines can be either overhead or underground. Overhead lines produce both electric fields and magnetic fields. Underground lines do not produce electric fields above ground but may produce magnetic fields above ground.

Power transmission lines

Typical EMF levels for transmission lines are shown in the chart on page 37. At a distance of 300 feet and at times of average electricity demand, the magnetic fields from many lines can be similar to typical background levels found in most homes. The distance at which the magnetic field from the line becomes indistinguishable from typical background levels differs for different types of lines.

Power distribution lines

Typical voltage for power distribution lines in North America ranges from 4 to 24 kilovolts (kV). Electric field levels directly beneath overhead distribution lines may vary from a few volts per meter to 100 or 200 volts per meter. Magnetic fields directly beneath overhead distribution lines typically range from 10 to 20 mG for main feeders and less than 10 mG for laterals. Such levels are also typical directly above underground lines. Peak EMF levels, however, can vary considerably depending on the amount of current carried by the line. Peak magnetic field levels as high as 70 mG have been measured directly below overhead distribution lines and as high as 40 mG above underground lines.

Q How strong is the EMF from electric power substations?

A In general, the strongest EMF around the outside of a substation comes from the power lines entering and leaving the substation. The strength of the EMF from equipment within the substations, such as transformers, reactors, and capacitor banks, decreases rapidly with increasing distance. Beyond the substation fence or wall, the EMF produced by the substation equipment is typically indistinguishable from background levels.

Q Do electrical workers have higher EMF exposure than other workers?

A Most of the information we have about occupational EMF exposure comes from studies of electric utility workers. It is therefore difficult to compare electrical workers' EMF exposures with those of other workers because there is less information about EMF exposures in work environments other than electric utilities. Early studies did not include actual measurements of EMF exposure on the job but used job titles as an estimate of EMF exposure among electrical workers. Recent studies, however, have included extensive EMF exposure assessments.

A report published in 1994 provides some information about estimated EMF exposures of workers in Los Angeles in a number of electrical jobs in electric utilities and other industries. Electrical workers had higher average EMF exposures (9.6 mG) than did workers in other jobs (1.7 mG). For this study, the category "electrical workers" included electrical engineering technicians, electrical engineers, electricians, power line workers, power station operators, telephone line workers, TV repairers, and welders.

Typical EMF Levels for Power Transmission Lines*

115 kV

	Approx. Edge of Right-of-Way	15 m (50 ft)	30 m (100 ft)	61 m (200 ft)	91 m (300 ft)
Electric Field (kV/m)	1.0	0.5	0.07	0.01	0.003
Mean Magnetic Field (mG)	29.7	6.5	1.7	0.4	0.2

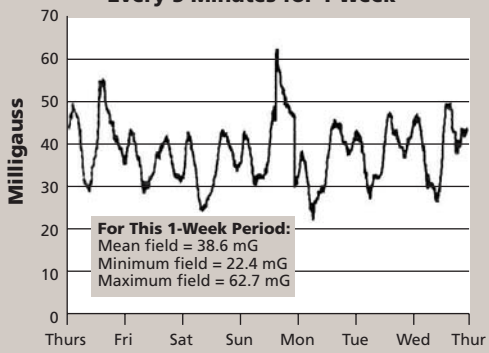
230 kV

	Approx. Edge of Right-of-Way	15 m (50 ft)	30 m (100 ft)	61 m (200 ft)	91 m (300 ft)
Electric Field (kV/m)	2.0	1.5	0.3	0.05	0.01
Mean Magnetic Field (mG)	57.5	19.5	7.1	1.8	0.8

500 kV

	Approx. Edge of Right-of-Way	20 m (65 ft)	30 m (100 ft)	61 m (200 ft)	91 m (300 ft)
Electric Field (kV/m)	7.0	3.0	1.0	0.3	0.1
Mean Magnetic Field (mG)	86.7	29.4	12.6	3.2	1.4

Magnetic Field from a 500-kV Transmission Line Measured on the Right-of-Way Every 5 Minutes for 1 Week



Electric fields from power lines are relatively stable because line voltage doesn't change very much. Magnetic fields on most lines fluctuate greatly as current changes in response to changing loads. Magnetic fields must be described statistically in terms of averages, maximums, etc. The magnetic fields above are means calculated for 321 power lines for 1990 annual mean loads. During peak loads (about 1% of the time), magnetic fields are about twice as strong as the mean levels above. The graph on the left is an example of how the magnetic field varied during one week for one 500-kV transmission line.

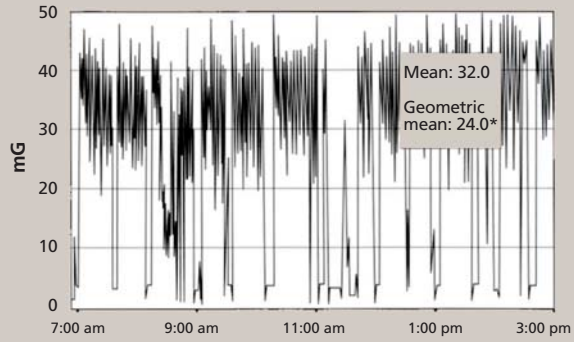
*These are typical EMFs at 1 m (3.3 ft) above ground for various distances from power lines in the Pacific Northwest. They are for general information. For information about a specific line, contact the utility that operates the line.
Source: Bonneville Power Administration, 1994.

Q A What are possible EMF exposures in the workplace?

The figures below are examples of magnetic field exposures determined with exposure meters worn by four workers in different occupations. These measurements demonstrate how EMF exposures vary among individual workers. They do not necessarily represent typical EMF exposures for workers in these occupations.

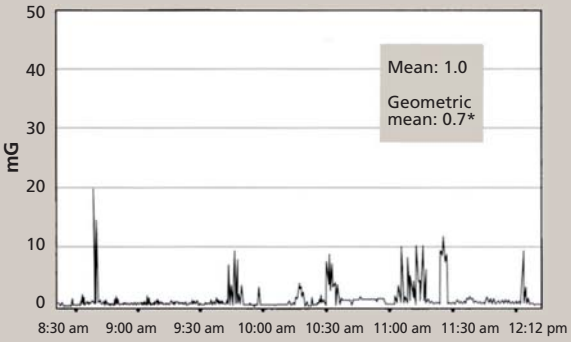
Magnetic Field Exposures of Workers (mG)

Sewing machine operator in garment factory



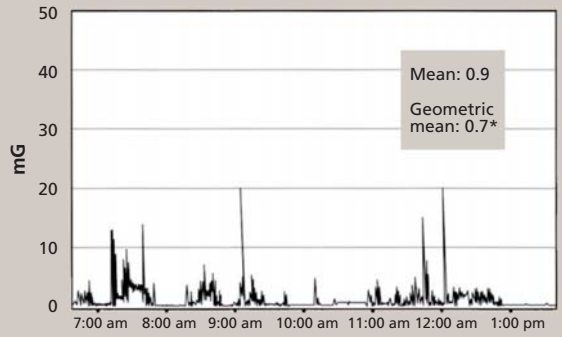
The sewing machine operator worked all day, took a 1-hour lunch break at 11:15 am, and took 10-minute breaks at 8:55 am and 2:55 pm.

Maintenance mechanic



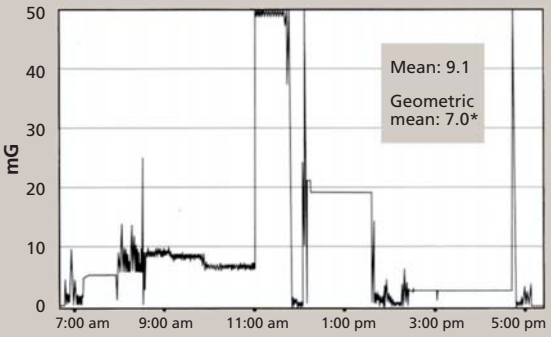
The mechanic repaired a compressor at 9:45 am and 11:10 am.

Electrician



The electrician repaired a large air-conditioning motor at 9:10 am and at 11:45 am.

Government office worker



The government worker was at the copy machine at 8:00 am, at the computer from 11:00 am to 1:00 pm and also from 2:30 pm to 4:30 pm.

*The geometric mean is calculated by squaring the values, adding the squares, and then taking the square root of the sum.
Source: National Institute for Occupational Safety and Health and U.S. Department of Energy.

The tables below and on page 41 can give you a general idea about magnetic field levels for different jobs and around various kinds of electrical equipment. It is important to remember that EMF levels depend on the actual equipment used in

EMF Measurements During a Workday

Industry and occupation	ELF magnetic fields measured in mG: Median for occupation*	ELF magnetic fields measured in mG: Range for 90% of workers**
ELECTRICAL WORKERS IN VARIOUS INDUSTRIES		
Electrical engineers	1.7	0.5–12.0
Construction electricians	3.1	1.6–12.1
TV repairers	4.3	0.6–8.6
Welders	9.5	1.4–66.1
ELECTRIC UTILITIES		
Clerical workers without computers	0.5	0.2–2.0
Clerical workers with computers	1.2	0.5–4.5
Line workers	2.5	0.5–34.8
Electricians	5.4	0.8–34.0
Distribution substation operators	7.2	1.1–36.2
Workers off the job (home, travel, etc.)	0.9	0.3–3.7
TELECOMMUNICATIONS		
Install, maintenance, & repair technicians	1.5	0.7–3.2
Central office technicians	2.1	0.5–8.2
Cable splicers	3.2	0.7–15.0
AUTO TRANSMISSION MANUFACTURE		
Assemblers	0.7	0.2–4.9
Machinists	1.9	0.6–27.6
HOSPITALS		
Nurses	1.1	0.5–2.1
X-ray technicians	1.5	1.0–2.2
SELECTED OCCUPATIONS FROM ALL ECONOMIC SECTORS		
Construction machine operators	0.5	0.1–1.2
Motor vehicle drivers	1.1	0.4–2.7
School teachers	1.3	0.6–3.2
Auto mechanics	2.3	0.6–8.7
Retail sales	2.3	1.0–5.5
Sheet metal workers	3.9	0.3–48.4
Sewing machine operators	6.8	0.9–32.0
Forestry and logging jobs	7.6	0.6–95.5***

Source: National Institute for Occupational Safety and Health.
ELF (extremely low frequency)—frequencies 3–3,000 Hz.
* The median is the middle measurement in a sample arranged by size. These personal exposure measurements reflect the median magnitude of the magnetic field produced by the various EMF sources and the amount of time the worker spent in the fields.
** This range is between the 5th and 95th percentiles of the workday averages for an occupation.
*** Chain saw engines produce strong magnetic fields that are not pure 60-Hz fields.

the workplace. Different brands or models of the same type of equipment can have different magnetic field strengths. It is also important to keep in mind that the strength of a magnetic field decreases quickly with distance.

If you have questions or want more information about your EMF exposure at work, your plant safety officer, industrial hygienist, or other local safety official can be a good source of information. The National Institute for Occupational Safety and Health (NIOSH) is asked occasionally to conduct health hazard evaluations in workplaces where EMF is a suspected cause for concern. For further technical assistance contact NIOSH at 800-356-4674.

Q A What are some typical sources of EMF in the workplace?

Exposure assessment studies so far have shown that most people's EMF exposure at work comes from electrical appliances and tools and from the building's power supply. People who work near transformers, electrical closets, circuit boxes, or other high-current electrical equipment may have 60-Hz magnetic field exposures of hundreds of milligauss or more. In offices, magnetic field levels are often similar to those found at home, typically 0.5 to 4.0 mG. However, these levels can increase dramatically near certain types of equipment.

EMF Spot Measurements

Industry and sources	ELF magnetic fields (mG)	Other frequencies	Comments
ELECTRICAL EQUIPMENT USED IN MACHINE MANUFACTURING			
Electric resistance heater	6,000–14,000	VLF	
Induction heater	10–460	High VLF	
Hand-held grinder	3,000	–	Tool exposures measured at operator's chest.
Grinder	110	–	Tool exposures measured at operator's chest.
Lathe, drill press, etc.	1–4	–	Tool exposures measured at operator's chest.
ALUMINUM REFINING			
Aluminum pot rooms	3.4–30	Very high static field	Highly-rectified DC current (with an ELF ripple) refines aluminum.
Rectification room	300–3,300	High static field	
STEEL FOUNDRY			
Ladle refinery			
Furnace active	170–1,300	High ULF from the ladle's big magnetic stirrer	Highest ELF field was at the chair of control room operator.
Furnace inactive	0.6–3.7	High ULF from the ladle's big magnetic stirrer	Highest ELF field was at the chair of control room operator.
Electrogalvanizing unit	2–1,100	High VLF	
TELEVISION BROADCASTING			
Video cameras (studio and minicams)	7.2–24.0	VLF	
Video tape degaussers	160–3,300	–	Measured 1 ft away.
Light control centers	10–300	–	Walk-through survey.
Studio and newsrooms	2–5	–	Walk-through survey.
HOSPITALS			
Intensive care unit	0.1–220	VLF	Measured at nurse's chest.
Post-anesthesia care unit	0.1–24	VLF	
Magnetic resonance imaging (MRI)	0.5–280	Very high static field, VLF and RF	Measured at technician's work locations.
TRANSPORTATION			
Cars, minivans, and trucks	0.1–125	Most frequencies less than 60 Hz	Steel-belted tires are the principal ELF source for gas/diesel vehicles.
Bus (diesel powered)	0.5–146	Most frequencies less than 60 Hz	
Electric cars	0.1–81	Some elevated static fields	
Chargers for electric cars	4–63	–	Measured 2 ft from charger.
Electric buses	0.1–88	–	Measured at waist. Fields at ankles 2-5 times higher.
Electric train passenger cars	0.1–330	25 & 60 Hz power on U.S. trains	Measured at waist. Fields at ankles 2-5 times higher.
Airliner	0.8–24.2	400 Hz power on airliners	Measured at waist.
GOVERNMENT OFFICES			
Desk work locations	0.1–7	–	Peaks due to laser printers.
Desks near power center	18–50	–	
Power cables in floor	15–170	–	
Building power supplies	25–1,800	–	
Can opener	3,000	–	Appliance fields measured 6 in. away.
Desktop cooling fan	1,000	–	Appliance fields measured 6 in. away.
Other office appliances	10–200	–	

Source: National Institute for Occupational Safety and Health, 2001.
ULF (ultra low frequency)—frequencies above 0, below 3 Hz.
ELF (extremely low frequency)—frequencies 3–3,000 Hz.
VLF (very low frequency)—frequencies 3,000–30,000 Hz (3–30 kilohertz).

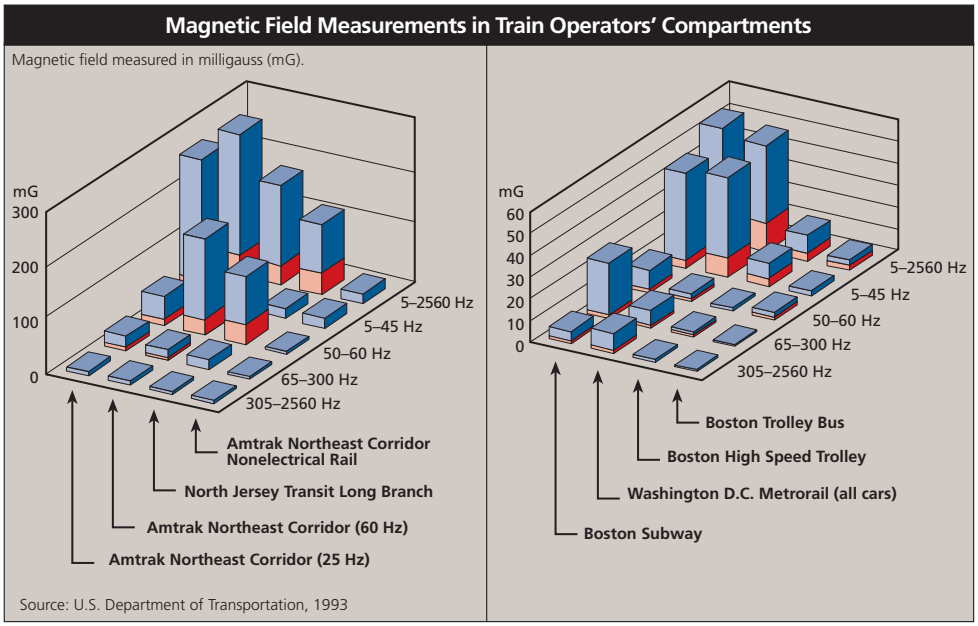
Q A What EMF exposure occurs during travel?

Inside a car or bus, the main sources of magnetic field exposure are those you pass by (or under) as you drive, such as power lines. Car batteries involve direct current (DC) rather than alternating current (AC). Alternators can create EMF, but at frequencies other than 60 Hz. The rotation of steel-belted tires is also a source of EMF.

Most trains in the United States are diesel powered. Some electrically powered trains operate on AC, such as the passenger trains between Washington, D.C. and New Haven, Connecticut. Measurements taken on these trains using personal exposure monitors have suggested that average 60-Hz magnetic field exposures for passengers and conductors may exceed 50 mG. A U.S. government-sponsored exposure assessment study of electric rail systems found average 60-Hz magnetic field levels in train operator compartments that ranged from 0.4 mG (Boston high speed trolley) to 31.1 mG (North Jersey transit). The graph on the next page shows average and maximum magnetic field measurements in operator compartments of several electric rail systems. It illustrates that 60 Hz is one of several electromagnetic frequencies to which train operators are exposed.

Workers who maintain the tracks on electric rail lines, primarily in the northeastern United States, also have elevated magnetic field exposures at both 25 Hz and 60 Hz. Measurements taken by the National Institute for Occupational Safety and Health show that typical average daily exposures range from 3 to 18 mG, depending on how often trains pass the work site.

Rapid transit and light rail systems in the United States, such as the Washington D.C. Metro and the San Francisco Bay Area Rapid Transit, run on DC electricity. These DC-powered trains contain equipment that produces AC fields. For example, areas of strong AC magnetic fields have been measured on the Washington Metro close to the floor, during braking and acceleration, presumably near equipment located underneath the subway cars.



These graphs illustrate that 60 Hz is one of several electromagnetic frequencies to which train operators are exposed. The maximum exposure is the top of the blue (upper) portion of the bar; the average exposure is the top of the red (lower) portion.

Q How can I find out how strong the EMF is where I live and work?

A The tables throughout this chapter can give you a general idea about magnetic field levels at home, for different jobs, and around various kinds of electrical equipment. For specific information about EMF from a particular power line, contact the utility that operates the line. Some will perform home EMF measurements.

You can take your own EMF measurements with a magnetic field meter. For a spot measurement to provide a useful estimate of your EMF exposure, it should be taken at a time of day and location when and where you are typically near the equipment. Keep in mind that the strength of a magnetic field drops off quickly with distance.

Independent technicians will conduct EMF measurements for a fee. Search the Internet under "EMF meters" or "EMF measurement." You should investigate the experience and qualifications of commercial firms, since governments do not standardize EMF measurements or certify measurement contractors.

At work, your plant safety officer, industrial hygienist, or other local safety official can be a good source of information. The National Institute for Occupational Safety and Health (NIOSH) sometimes conducts health hazard evaluations in workplaces where EMF is a suspected cause for concern. For further technical assistance, contact NIOSH at 800-356-4674.

Q How much do computers contribute to my EMF exposure?

A Personal computers themselves produce very little EMF. However, the video display terminal (VDT) or monitor provides some magnetic field exposure unless it is of the new flat-panel design. Conventional VDTs containing cathode ray tubes use magnetic fields to produce the image on the screen, and some emission of those magnetic fields is unavoidable. Unlike most other appliances which produce predominantly 60-Hz magnetic fields, VDTs emit magnetic fields in both the extremely low frequency (ELF) and very low frequency (VLF) frequency ranges (see page 8). Many newer VDTs have been designed to minimize magnetic field emissions, and those identified as "TCO'99 compliant" meet a standard for low emissions (see page 48).

Q What can be done to limit EMF exposure?

A Personal exposure to EMF depends on three things: the strength of the magnetic field sources in your environment, your distance from those sources, and the time you spend in the field.

If you are concerned about EMF exposure, your first step should be to find out where the major EMF sources are and move away from them or limit the time you spend near them. Magnetic fields from appliances decrease dramatically about an arm's length away from the source. In many cases, rearranging a bed, a chair, or a work area to increase your distance from an electrical panel or some other EMF source can reduce your EMF exposure.

Another way to reduce EMF exposure is to use equipment designed to have relatively low EMF emissions. Sometimes electrical wiring in a house or a building can be the source of strong magnetic field exposure. Incorrect wiring is a common source of higher-than-usual magnetic fields. Wiring problems are also worth correcting for safety reasons.

In its 1999 report to Congress, the National Institute of Environmental Health Sciences suggested that the power industry continue its current practice of siting power lines to reduce EMF exposures.

There are more costly actions, such as burying power lines, moving out of a home, or restricting the use of office space that may reduce exposures. Because scientists are still debating whether EMF is a hazard to health, it is not clear that the costs of such measures are warranted. Some EMF reduction measures may create other problems. For instance, compacting power lines reduces EMF but increases the danger of accidental electrocution for line workers.

We are not sure which aspects of the magnetic field exposure, if any, to reduce. Future research may reveal that EMF reduction measures based on today's limited understanding are inadequate or irrelevant. No action should be taken to reduce EMF exposure if it increases the risk of a known safety hazard.

5 EMF Exposure Standards

This chapter describes standards and guidelines established by state, national, and international safety organizations for some EMF sources and exposures.

Q A Are there exposure standards for 60-Hz EMF?

In the United States, there are no federal standards limiting occupational or residential exposure to 60-Hz EMF.

At least six states have set standards for transmission line electric fields; two of these also have standards for magnetic fields (see table below). In most cases, the maximum fields permitted by each state are the maximum fields that existing lines produce at maximum load-carrying conditions. Some states further limit electric field strength at road crossings to ensure that electric current induced into large metal objects such as trucks and buses does not represent an electric shock hazard.

State Transmission Line Standards and Guidelines

	Electric Field		Magnetic Field	
State	On R.O.W.*	Edge R.O.W.	On R.O.W.	Edge R.O.W.
Florida	8 kV/m[a] 10 kV/m[b]	2 kV/m	—	150 mG[a] (max. load) 200 mG[b] (max. load) 250 mG[c] (max. load)
Minnesota	8 kV/m	—	—	—
Montana	7 kV/m[d]	1 kV/m[e]		
New Jersey	—	3 kV/m		
New York	11.8 kV/m 11.0 kV/m[f] 7.0 kV/m[d]	1.6 kV/m	—	200 mG (max. load)
Oregon	9 kV/m	—	—	—

*R.O.W. = right-of-way (or in the Florida standard, certain additional areas adjoining the right-of-way). kV/m = kilovolt per meter. One kilovolt = 1,000 volts. [a]For lines of 69-230 kV. [b]For 500 kV lines. [c]For 500 kV lines on certain existing R.O.W. [d]Maximum for highway crossings. [e]May be waived by the landowner. [f]Maximum for private road crossings.

Two organizations have developed voluntary occupational exposure guidelines for EMF exposure. These guidelines are intended to prevent effects, such as induced currents in cells or nerve stimulation, which are known to occur at high magnitudes, much higher (more than 1,000 times higher) than EMF levels found typically in

occupational and residential environments. These guidelines are summarized in the tables on the right.

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) concluded that available data regarding potential long-term effects, such as increased risk of cancer, are insufficient to provide a basis for setting exposure restrictions.

The American Conference of Governmental Industrial Hygienists (ACGIH) publishes "Threshold Limit Values" (TLVs) for various physical agents. The TLVs for 60-Hz EMF shown in the table are identified as guides to control exposure; they are not intended to demarcate safe and dangerous levels.

ICNIRP Guidelines for EMF Exposure

Exposure (60 Hz)	Electric field	Magnetic field
Occupational	8.3 kV/m	4.2 G (4,200 mG)
General Public	4.2 kV/m	0.833 G (833 mG)

International Commission on Non-Ionizing Radiation Protection (ICNIRP) is an organization of 15,000 scientists from 40 nations who specialize in radiation protection.
Source: ICNIRP, 1998.

ACGIH Occupational Threshold Limit Values for 60-Hz EMF

	Electric field	Magnetic field
Occupational exposure should not exceed	25 kV/m	10 G (10,000 mG)
Prudence dictates the use of protective clothing above	15 kV/m	–
Exposure of workers with cardiac pacemakers should not exceed	1 kV/m	1 G (1,000 mG)

American Conference of Governmental Industrial Hygienists (ACGIH) is a professional organization that facilitates the exchange of technical information about worker health protection. It is not a government regulatory agency.
Source: ACGIH, 2001.

Q Does EMF affect people with pacemakers or other medical devices?

A According to the U.S. Food and Drug Administration (FDA), interference from EMF can affect various medical devices including cardiac pacemakers and implantable defibrillators. Most current research in this area focuses on higher frequency sources such as cellular phones, citizens band radios, wireless computer links, microwave signals, radio and television transmitters, and paging transmitters.

Sources such as welding equipment, power lines at electric generating plants, and rail transportation equipment can produce lower frequency EMF strong enough to interfere with some models of pacemakers and defibrillators. The occupational exposure guidelines developed by ACGIH state that workers with cardiac pacemakers should not be exposed to a 60-Hz magnetic field greater than 1 gauss (1,000 mG) or a 60-Hz electric field greater than 1 kilovolt per meter (1,000 V/m) (see ACGIH guidelines above). Workers who are concerned about EMF exposure effects on pacemakers, implantable defibrillators, or other implanted electronic medical devices should consult their doctors or industrial hygienists.

Nonelectronic metallic medical implants (such as artificial joints, pins, nails, screws, and plates) can be affected by high magnetic fields such as those from magnetic resonance imaging (MRI) devices and aluminum refining equipment, but are generally unaffected by the lower fields from most other sources.

The FDA MedWatch program is collecting information about medical device problems thought to be associated with exposure to or interference from EMF. Anyone experiencing a problem that might be due to such interference is encouraged to call and report it (800-332-1088).

Q What about products advertised as producing low or reduced magnetic fields?

A Virtually all electrical appliances and devices emit electric and magnetic fields. The strengths of the fields vary appreciably both between types of devices and among manufacturers and models of the same type of device. Some appliance manufacturers are designing new models that, in general, have lower EMF than older models. As a result, the words "low field" or "reduced field" may be relative to older models and not necessarily relative to other manufacturers or devices. At this time, there are no domestic or international standards or guidelines limiting the EMF emissions of appliances.

The U.S. government has set no standards for magnetic fields from computer monitors or video display terminals (VDTs). The Swedish Confederation of Professional Employees (TCO) established in 1992 a standard recommending strict limits on the EMF emissions of computer monitors. The VDTs should produce magnetic fields of no more than 2 mG at a distance of 30 cm (about 1 ft) from the front surface of the monitor and 50 cm (about 1 ft 8 in) from the sides and back of the monitor. The TCO'92 standard has become a *de facto* standard in the VDT industry worldwide. A 1999 standard, promulgated by the Swedish TCO (known as the TCO'99 standard), provides for international and environmental labeling of personal computers. Many computer monitors marketed in the U.S. are certified as compliant with TCO'99 and are thereby assured to produce low magnetic fields.

Beware of advertisements claiming that the federal government has certified that the advertised equipment produces little or no EMF. The federal government has no such general certification program for the emissions of low-frequency EMF. The U.S. Food and Drug Administration's Center for Devices and Radiological Health (CDRH) does certify medical equipment and equipment producing high levels of ionizing radiation or microwave radiation. Information about certain devices as well as general information about EMF is available from the CDRH at 888-463-6332.

Q Are cellular telephones and towers sources of EMF exposure?

A Cellular telephones and towers involve radio-frequency and microwave-frequency electromagnetic fields (see page 8). These are in a much higher frequency range than are the power-frequency electric and magnetic fields associated with the transmission and use of electricity.

The U.S. Federal Communications Commission (FCC) licenses communications systems that use radio-frequency and microwave electromagnetic fields and ensures that licensed facilities comply with exposure standards. Public information on this topic is published on two FCC Internet sites: http://www.fcc.gov/oet/info/documents/bulletins/#56 and http://www.fcc.gov/oet/rfsafety/

The U.S. Food and Drug Administration also provides information about cellular telephones on its web site (http://www.fda.gov/cdrh/ocd/mobilphone.html).

6 National and International EMF Reviews

This chapter presents the findings and recommendations of major EMF research reviews, including the U.S. government's EMF RAPID Program.

Q What have national and international agencies concluded about the impact of EMF exposure on human health?

A Since 1995, two major U.S. reports have concluded that limited evidence exists for an association between EMF exposure and increased leukemia risk, but that when all the scientific evidence is considered, the link between EMF exposure and cancer is weak. The World Health Organization in 1997 reached a similar conclusion.

The two reports were the U.S. National Academy of Sciences report in 1996 and, in 1999, the National Institute of Environmental Health Sciences report to the U.S. Congress at the end of the U.S. EMF Research and Public Information Dissemination (RAPID) Program.

The U.S. EMF RAPID Program

Initiated by the U.S. Congress and established by law in 1992, the U.S. EMF Research and Public Information Dissemination (EMF RAPID) Program set out to study whether exposure to electric and magnetic fields produced by the generation, transmission, or use of electric power posed a risk to human health. For more information about the EMF RAPID Program, visit the web site (http://www.niehs.nih.gov/emfrapid).

The U.S. Department of Energy (DOE) administered the overall EMF RAPID Program, but health effects research and risk assessment were supervised by the National Institute of Environmental Health Sciences (NIEHS), a branch of the U.S. National Institutes of Health (NIH). Together, DOE and NIEHS oversaw more than 100 cellular and animal studies, as well as engineering and exposure assessment studies. Although the EMF RAPID Program did not fund any additional epidemiological studies, an analysis of the many studies already conducted was an important part of its final report.

The electric power industry contributed about half, or $22.5 million, of the $45 million eventually spent on EMF research over the course of the EMF RAPID Program. The NIEHS received $30.1 million from this program for research, public outreach, administration, and the health assessment evaluation of extremely low frequency (ELF) EMF. The DOE received approximately $15 million from this program for engineering and EMF mitigation research. The NIEHS contributed an additional $14.5 million for support of extramural and intramural research including long-term toxicity and carcinogenicity studies conducted by the National Toxicology Program.

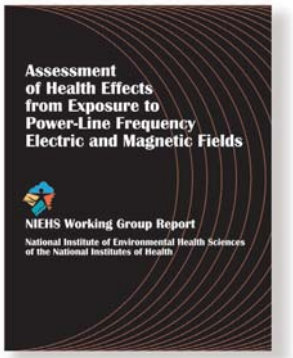
EMF RAPID Program Interagency Committee

- National Institute of Environmental Health Sciences
- Department of Energy
- Department of Defense
- Department of Transportation
- Environmental Protection Agency
- Federal Energy Regulatory Commission
- National Institute of Standards and Technology
- Occupational Safety and Health Administration
- Rural Electrification Administration

An interagency committee was established by the President of the United States to provide oversight and program management support for the EMF RAPID Program. The interagency committee included representatives from NIEHS, DOE, and seven other federal agencies with EMF-related responsibilities.

The EMF RAPID Program also received advice from a National EMF Advisory Committee (NEMFAC), which included representatives from citizen groups, labor, utilities, the National Academy of Sciences, and other groups. They met regularly with DOE and NIEHS staff to express their views. NEMFAC meetings were open to the public. The EMF RAPID Program sponsored citizen participation in some scientific meetings as well. A broad group of citizens reviewed all major public information materials produced for the program.

NIEHS Working Group Report 1998



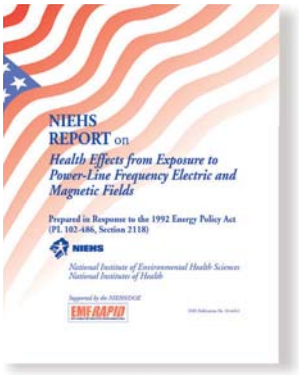
In preparation for the EMF RAPID Program's goal of reporting to the U.S. Congress on possible health effects from exposure to EMF from power lines, the NIEHS convened an expert working group in June 1998. Over 9 days, about 30 scientists conducted a complete review of EMF studies, including those sponsored by the EMF RAPID Program and others. Their conclusions offered guidance to the NIEHS as it prepared its report to Congress.

Using criteria developed by the International Agency for Research on Cancer, a majority of the members of the working group concluded that exposure to power-frequency EMF is a possible human carcinogen.

The majority called their opinion "a conservative public health decision based on limited evidence for an increased occurrence of childhood leukemias and an increased occurrence of chronic lymphocytic leukemia (CLL) in occupational settings." For these

diseases, the working group reported that animal and cellular studies neither confirm nor deny the epidemiological studies' suggestion of a disease risk. This report is available on the NIEHS EMF RAPID web site (http://www.niehs.nih.gov/emfrapid).

NIEHS Report to Congress at Conclusion of EMF RAPID Program



In June 1999, the NIEHS reported to the U.S. Congress that scientific evidence for an EMF-cancer link is weak.

The following are excerpts from the 1999 NIEHS report:

> The NIEHS believes that the probability that ELF-EMF exposure is truly a health hazard is currently small. The weak epidemiological associations and lack of any laboratory support for these associations provide only marginal, scientific support that exposure to this agent is causing any degree of harm.
>
> The scientific evidence suggesting that extremely low frequency EMF exposures pose any health risk is weak. The strongest evidence for health effects comes from associations observed in human populations with two forms of cancer: childhood leukemia and chronic lymphocytic leukemia in occupationally exposed adults. While the support from individual studies is weak, the epidemiological studies demonstrate, for some methods of measuring exposure, a fairly consistent pattern of a small, increased risk with increasing exposure that is somewhat weaker for chronic lymphocytic leukemia than for childhood leukemia. In contrast, the mechanistic studies and the animal toxicology literature fail to demonstrate any consistent pattern across studies, although sporadic findings of biological effects (including increased cancers in animals) have been reported. No indication of increased leukemias in experimental animals has been observed.

The full report is available on the NIEHS EMF RAPID web site (http://www.niehs.nih.gov/emfrapid).

No regulatory action was recommended or taken based on the NIEHS report. The NIEHS director, Dr. Kenneth Olden, told the Congress that, in his opinion, the conclusion of the NIEHS report was not sufficient to warrant aggressive regulatory action.

The NIEHS did not recommend adopting EMF standards for electric appliances or burying electric power lines. Instead, it recommended providing public information about practical ways to reduce EMF exposure. The NIEHS also suggested that power companies and utilities "continue siting power lines to reduce exposures and . . . explore ways to reduce the creation of magnetic fields around transmission and distribution lines without creating new hazards." The NIEHS encouraged manufacturers to reduce magnetic fields at a minimal cost, but noted that the risks do not warrant expensive redesign of electrical appliances.

The NIEHS also encouraged individuals who are concerned about EMF in their homes to check to see if their homes are properly wired and grounded, since incorrect wiring or other code violations are a common source of higher-than-usual magnetic fields.

National Academy of Sciences Report

In October 1996, a National Research Council committee of the National Academy of Sciences (NAS) released its evaluation of research on potential associations between EMF exposure and cancer, reproduction, development, learning, and behavior. The report concluded:

> Based on a comprehensive evaluation of published studies relating to the effects of power-frequency electric and magnetic fields on cells, tissues, and organisms (including humans), the conclusion of the committee is that the current body of evidence does not show that exposure to these fields presents a human-health hazard. Specifically, no conclusive and consistent evidence shows that exposures to residential electric and magnetic fields produce cancer, adverse neurobehavioral effects, or reproductive and developmental effects.

The NAS report focused primarily on the association of childhood leukemia with the proximity of the child's home to power lines. The NAS panel found that although a link between EMF exposure and increased risk for childhood leukemia was observed in studies that had estimated EMF exposure using the wire code method (distance of home from power line), such a link was not found in studies that had included actual measurements of magnetic fields at the time of the study. The panel called for more research to pinpoint the unexplained factors causing small increases in childhood leukemia in houses close to power lines.

World Health Organization International EMF Project

The World Health Organization (WHO) International EMF Project, with headquarters in Geneva, Switzerland, was launched at a 1996 meeting with representatives of 23 countries attending. It was intended to respond to growing concerns in many member states over possible EMF health effects and to address the conflict between such concerns and technological and economic progress. In its advisory role, the WHO International EMF Project is now reviewing laboratory and epidemiological evidence, identifying gaps in scientific knowledge, developing an agenda for future research, and developing risk communication booklets and other public information. The WHO International EMF Project is funded with contributions from governments and institutions and is expected to provide an overall EMF health risk assessment. Additional information about this program can be found on the WHO EMF web site (http://www.who.int/peh-emf).

As part of this project, in 1997 a working group of 45 scientists from around the world surveyed the evidence for adverse

EMF health effects. They reported that, "taken together, the findings of all published studies are suggestive of an association between childhood leukemia and estimates of ELF (extremely low frequency or power-frequency) magnetic fields."

Much like the 1996 U.S. NAS report, the WHO report noted that living in homes near power lines was associated with an approximate 1.5-fold excess risk of childhood leukemia. But unlike the NAS panel, WHO scientists had seen the results of the 1997 U.S. National Cancer Institute study of EMF and childhood leukemia (see page 17). This work showed even more strongly the inconsistency between results of studies that used a wire code to estimate EMF exposure and studies that actually measured magnetic fields.

Regarding health effects other than cancer, the WHO scientists reported that the epidemiological studies "do not provide sufficient evidence to support an association between extremely-low-frequency magnetic-field exposure and adult cancers, pregnancy outcome, or neurobehavioural disorders."

World Health Organization International Agency for Research on Cancer

The WHO International Agency for Research on Cancer (IARC) produces a monograph series that reviews the scientific evidence regarding potential carcinogenicity associated with exposure to environmental agents. An international scientific panel of 21 experts from 10 countries met in June 2001 to review the scientific evidence regarding the potential carcinogenicity of static and ELF (extremely low frequency or power-frequency) EMF. The panel categorized its conclusions for carcinogenicity based on the IARC classification system—a system that evaluates the strength of evidence from epidemiological, laboratory (human and cellular), and mechanistic studies. The panel classified power-frequency EMF as "possibly carcinogenic to humans" based on a fairly consistent statistical association between a doubling of risk of childhood leukemia and magnetic field exposure above 0.4 microtesla (0.4 μT, 4 milligauss or 4 mG).

In contrast, they found no consistent evidence that childhood EMF exposures are associated with other types of cancer or that adult EMF exposures are associated with increased risk for any kind of cancer. The IARC panel reported that no consistent carcinogenic effects of EMF exposure have been observed in experimental animals and that there is currently no scientific explanation for the observed association between childhood leukemia and EMF exposure. Further information can be obtained at the IARC web sites (http://www.iarc.fr and http://monographs.iarc.fr).

International Commission on Non-Ionizing Radiation Protection

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) issued exposure guidelines to guard against known adverse effects such as stimulation of nerves and muscles at very high EMF levels, as well as shocks and burns caused by touching objects that conduct electricity (see page 47). In April 1998, ICNIRP revised its exposure guidelines and characterized as "unconvincing" the evidence for an association between everyday power-frequency EMF and cancer.

European Union

In 1996, a European Union (EU) advisory panel provided an overview of the state of science and standards among EU countries. With respect to power-frequency EMF, the panel members said that there is no clear evidence that exposure to EMF results in an increased risk of cancer.

Australia—Radiation Advisory Committee Report to Parliament

In 1997, Australia's Radiation Advisory Committee briefly reviewed the EMF scientific literature and advised the Australian Parliament that, overall, there is insufficient evidence to come to a firm conclusion regarding possible health effects from exposure to power-frequency magnetic fields.

The committee also reported that "the weight of opinion as expressed in the U.S. National Academy of Sciences report, and the negative results from the National Cancer Institute study (Linet et al., 1997) would seem to shift the balance of probability more towards there being no identifiable health effects" (see pages 17 and 53).

Canada—Health Canada Report

In December 1998, a working group of public health officers at Health Canada, the federal agency that manages Canada's health care system, issued a review of the scientific literature regarding power-frequency EMF health effects. They found the evidence to be insufficient to conclude that EMF causes a risk of cancer.

The report concluded that while EMF effects may be observed in biological systems in a laboratory, no adverse health effects have been demonstrated at the levels to which humans and animals are typically exposed.

As for epidemiology, 25 years of study results are inconsistent and inconclusive, the panel said, and a plausible EMF-cancer mechanism is missing. Health Canada pledged to continue monitoring EMF research and to reassess this position as new information becomes available.

Germany—Ordinance 26

On January 1, 1997, Germany became the first nation to adopt a national rule on EMF exposure for the general public. Ordinance 26 applies only to facilities such as overhead and underground transmission and distribution lines, transformers, switchgear and overhead lines for electric-powered trains. Both electric (5 kV/m) and magnetic field exposure limits (1 Gauss) are high enough that they are unlikely to be encountered in ordinary daily life. The ordinance also requires that precautionary measures be taken on a case-by-case basis when electric facilities are sited or upgraded near homes, hospital, schools, day care centers, and playgrounds.

Great Britain—National Radiological Protection Board Report

The National Radiological Protection Board (NRPB) in Great Britain advises the government of the United Kingdom regarding standards of protection for exposure to non-ionizing radiation. The NRPB's advisory group on non-ionizing radiation periodically reviews new developments in EMF research and reports its findings. Results of the advisory group's latest review were published in 2001. The report reviewed residential and occupational epidemiological studies, as well as cellular, animal, and human volunteer studies that had been published.

The advisory group noted that there is "some epidemiological evidence that prolonged exposure to higher levels of power frequency magnetic fields is associated with a small risk of leukaemia in children." Specifically, the NRPB advisory group's analysis suggests "that relatively heavy average exposures of 0.4 μT [4 mG] or more are associated with a doubling of the risk of leukaemia in children under 15 years of age." The group pointed out, however, that laboratory experiments have provided "no good evidence that extremely low frequency electromagnetic fields are capable of producing cancer."

Scandinavia—EMF Developments

In October 1995, a group of Swedish researchers and government officials published a report about EMF exposure in the workplace. This "Criteria Group" reviewed EMF scientific literature and, using the IARC classification system, ranked occupational EMF exposure as "possibly carcinogenic to humans." They also endorsed the Swedish government's 1994 policy statement that public exposure limits to EMFs were not needed, but that people might simply want to use caution with EMFs.

In 1996, five Swedish government agencies further explained their precautionary advice about EMF. EMF exposure should be reduced, they said, but only when practical, without great inconvenience or cost.

Health experts in Norway, Denmark, and Finland generally agreed in reviews published in the 1990s that if an EMF health risk exists, it is small. They acknowledged that a link between residential magnetic fields and childhood leukemia cannot be confirmed or denied. In 1994, several Norwegian government ministries also recommended increasing the distance between residences and electrical facilities, if it could be done at low cost and with little inconvenience.

Q What other U.S. organizations have reported on EMF?

A American Medical Association

In 1995, the American Medical Association advised physicians that no scientifically documented health risk had been associated with "usually occurring" EMF, based on a review of EMF epidemiological, laboratory studies, and major literature reviews.

American Cancer Society

In 1996, the American Cancer Society released a review of 20 years of EMF epidemiological research including occupational studies and residential studies of

adult and childhood cancer. The society noted that some data support a possible relationship of magnetic field exposure with leukemia and brain cancer, but further research may not be justified if studies continue to find uncertain results. Of particular interest is the summary of results from eight studies of risk from use of household appliances with relatively high magnetic fields, such as electric blankets and electric razors. The summary suggested that there is no persuasive evidence for increased risk with more frequent or longer use of these appliances.

American Physical Society

The American Physical Society (APS) represents thousands of U.S. physicists. Responding to the NIEHS Working Group's conclusion that EMF is a possible human carcinogen, the APS executive board voted in 1998 to reaffirm its 1995 opinion that there is "no consistent, significant link between cancer and power line fields."

California's Department of Health Services

In 1996, California's Department of Health Services (DHS) began an ambitious five-year effort to assess possible EMF public health risk and offer guidance to school administrators and other decision-makers. The California Electric and Magnetic Fields (EMF) Program is a research, education, and technical assistance program concerned with the possible health effects of EMF from power lines, appliances, and other uses of electricity. The program's goal is to find a rational and fair approach to dealing with the potential risks, if any, of exposure to EMF. This is done through research, policy analysis, and education. The web site has educational materials on EMF and related health issues for individuals, schools, government agencies, and professional organizations (http://www.dhs.ca.gov/ps/deodc/ehib/emf).

Q What can we conclude about EMF at this time?

A Electricity is a beneficial part of our daily lives, but whenever electricity is generated, transmitted, or used, electric and magnetic fields are created. Over the past 25 years, research has addressed the question of whether exposure to power-frequency EMF might adversely affect human health. For most health outcomes, there is no evidence that EMF exposures have adverse effects. There is some evidence from epidemiology studies that exposure to power-frequency EMF is associated with an increased risk for childhood leukemia. This association is difficult to interpret in the absence of reproducible laboratory evidence or a scientific explanation that links magnetic fields with childhood leukemia.

EMF exposures are complex and come from multiple sources in the home and workplace in addition to power lines. Although scientists are still debating whether EMF is a hazard to health, the NIEHS recommends continued education on ways of reducing exposures. This booklet has identified some EMF sources and some simple steps you can take to limit your exposure. For your own safety, it is important that any steps you take to reduce your exposures do not increase other obvious hazards such as those from electrocution or fire. At the current time in the United States, there are no federal standards for occupational or residential exposure to 60-Hz EMF.

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Health Canada Santé Canada

It's Your Health

ELECTRIC AND MAGNETIC FIELDS AT EXTREMELY LOW FREQUENCIES

The Issue

There are concerns that daily exposure to electric and magnetic fields (EMFs) may cause health problems. These concerns are reflected in a number of reports that have attempted to link EMF exposure to a variety of health issues, including childhood cancer.

Background

Electricity plays a central role in modern society. It is used to light homes, prepare food, run computers and operate other household appliances, such as TVs and radios. In Canada, appliances that plug into a wall socket use electric power that flows back and forth at a frequency of 60 cycles per second (60 hertz).

Every time you use electricity and electrical appliances, you are exposed to electric and magnetic fields (EMFs) at extremely low frequencies (ELF). The term "extremely low" is used to describe any frequency below 300 hertz. EMFs produced by the transmission and use of electricity belong to this category.

Electric and Magnetic Fields (EMFs)

Electric and magnetic fields are invisible forces that surround electrical equipment, power cords, and wires that carry electricity, including outdoor power lines. You cannot see or feel EMFs.

Electric Fields: These are formed whenever a wire is plugged into an outlet, even when the appliance is not turned on. The higher the voltage, the stronger the electric field.

Magnetic Fields: These are formed when electric current is flowing within a device or wire. The greater the current, the stronger the magnetic field.

Electric and magnetic fields can occur separately or together. For example, when you plug the power cord for a lamp into a wall socket, it creates an electric field along the cord. When you turn the lamp on, the flow of current through the cord creates a magnetic field. Meanwhile, the electric field is still present.

The Strength of EMFs

Electric and magnetic fields are strongest when close to their source. As you move away from the source, the strength of the fields fades rapidly. This means you are exposed to stronger electric and magnetic fields when standing close to a source (e.g., right beside a transformer box or under a high voltage power line), and you are exposed to weaker fields as you move away. When you are indoors at home, the magnetic fields from high voltage power lines and transformer boxes are very weak when compared to the fields from electrical household appliances.

Typical Canadian Exposures to EMFs at ELF

On a daily basis, most Canadians are exposed to EMFs generated by household wiring, fluorescent lighting, and any electrical appliance that plugs into the wall, including hair dryers, vacuum cleaners and toasters. In the work-place, common sources include video display terminals (computer monitors), air purifiers, photocopiers, fax machines, fluorescent lights, electric heaters and electric tools in machine shops, such as drills, power saws, lathes and welding machines.

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Typical Exposures Present No Known Health Risks

Research has shown that EMFs from electrical devices and power lines can induce weak electric currents to flow through the human body. However, these currents are much smaller than those produced naturally by your brain, nerves and heart, and are not associated with any known health risks.

There have been many studies about the effects of exposure to electric and magnetic fields at extremely low frequencies. Scientists at Health Canada are aware that some studies have suggested a possible link between exposure to ELF fields and certain types of childhood cancer. However, when all of the studies are evaluated, the evidence appears to be very weak.

After a recent evaluation of the scientific data, the International Agency for Research on Cancer classified ELF magnetic fields as "possibly carcinogenic" to humans based on studies of childhood cancer. However, the evidence is not strong enough to conclude that EMFs definitely cause cancer in children. More studies are needed to draw firm conclusions.

Concerns about Electromagnetic Interference

At typical exposure levels, EMFs may cause interference with electronic devices. For example, office workers may notice image movement (jitter) on their computer screens if the computer is in an area where magnetic fields are slightly above typical levels found in offices. Some sources that generate these slightly elevated levels are the cables that bring electrical power into an office area, and common electrical equipment, such as power transformers.

Magnetic fields that cause jitter on computer screens are well below the levels that would cause human health effects. To solve the jitter problem, simply move the computer to another part of the room where the magnetic fields are weaker.

Minimizing Your Risk

You do not need to take action regarding typical daily exposures to electric and magnetic fields at extremely low frequencies. There is no conclusive evidence of any harm caused by exposures at levels normally found in Canadian living and working environments.

Health Canada's Role

Health Canada, along with the World Health Organization, monitors scientific research on EMFs and human health as part of its mission to help Canadians maintain and improve their health. At present, there are no Canadian government guidelines for exposure to EMFs at ELF. Health Canada does not consider guidelines necessary because the scientific evidence is not strong enough to conclude that typical exposures cause health problems.

Some national and international organizations have issued exposure guidelines for EMFs at ELF. However, these guidelines are not based on a consideration of risks related to cancer or other health problems. Rather, the point of the guidelines is to make sure that the electric currents in the body caused by exposure to EMFs are not stronger than the ones produced naturally by the brain, nerves and heart. For the most part, typical EMF exposures in Canadian homes, offices and other work sites, are far below these guidelines.

Need More Info?

For further information contact:
The Consumer and Clinical Radiation Protection Bureau
Health Canada
775 Brookfield Road
Ottawa, Ontario K1A 1C1
Telephone: (613) 954-6699
Fax: (613) 952-7584
E-mail: CCRPB-PCRPCC @hc-sc.gc.ca

Also, see the following Fact Sheets on the World Health Organization (WHO) Web site:

- Electromagnetic Fields and Public Health: Extremely Low Frequency(ELF) at www.who.int/docstore/peh-emf/publications/facts_press/efact/efs205.html
- Electromagnetic Fields and Public Health: Extremely Low Frequency Fields and Cancer at www.who.int/docstore/peh-emf/publications/facts_press/efact/efs263.html

And visit these Web sites:

The International Agency for Research on Cancer (IARC), Static and extremely low-frequency (ELF) electric and magnetic fields. Report No. 80 at http://193.51.164.11/htdocs/monographs/vol80/80.html

The U.S. National Institute of Environmental Health Sciences (NIEHS), Questions and Answers about EMF at www.niehs.nih.gov/emfrapid/booklet/home.htm

Also, see:

It's Your Health, Safety of Exposure to Electric and Magnetic Fields from Computer Monitors and Other Video Display Terminals at http://www.hc-sc.gc.ca/english/iyh/products/vdt.html

Additional It's Your Health articles can be found at:
www.healthcanada.ca/iyh
You can also call (613) 957-2991

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Canada

At this time, and by copy of this letter, we are requesting that FortisBC provide the Town of Osoyoos with the following information:

Q1. Cost estimate for overhead vs underground lines;

A1. Please see the response to BCUC IR1, Q10.3.

Q2. If overhead lines are chosen, what will they look like?

A2. Please refer to the attached photographs referenced below, which have been altered to show the addition of the transmission circuit. It provides a good representation of what the overhead lines will look like. Approximately 10 to 13 feet will be added to the top of each existing pole to accommodate the addition of the transmission line insulators and conductor.

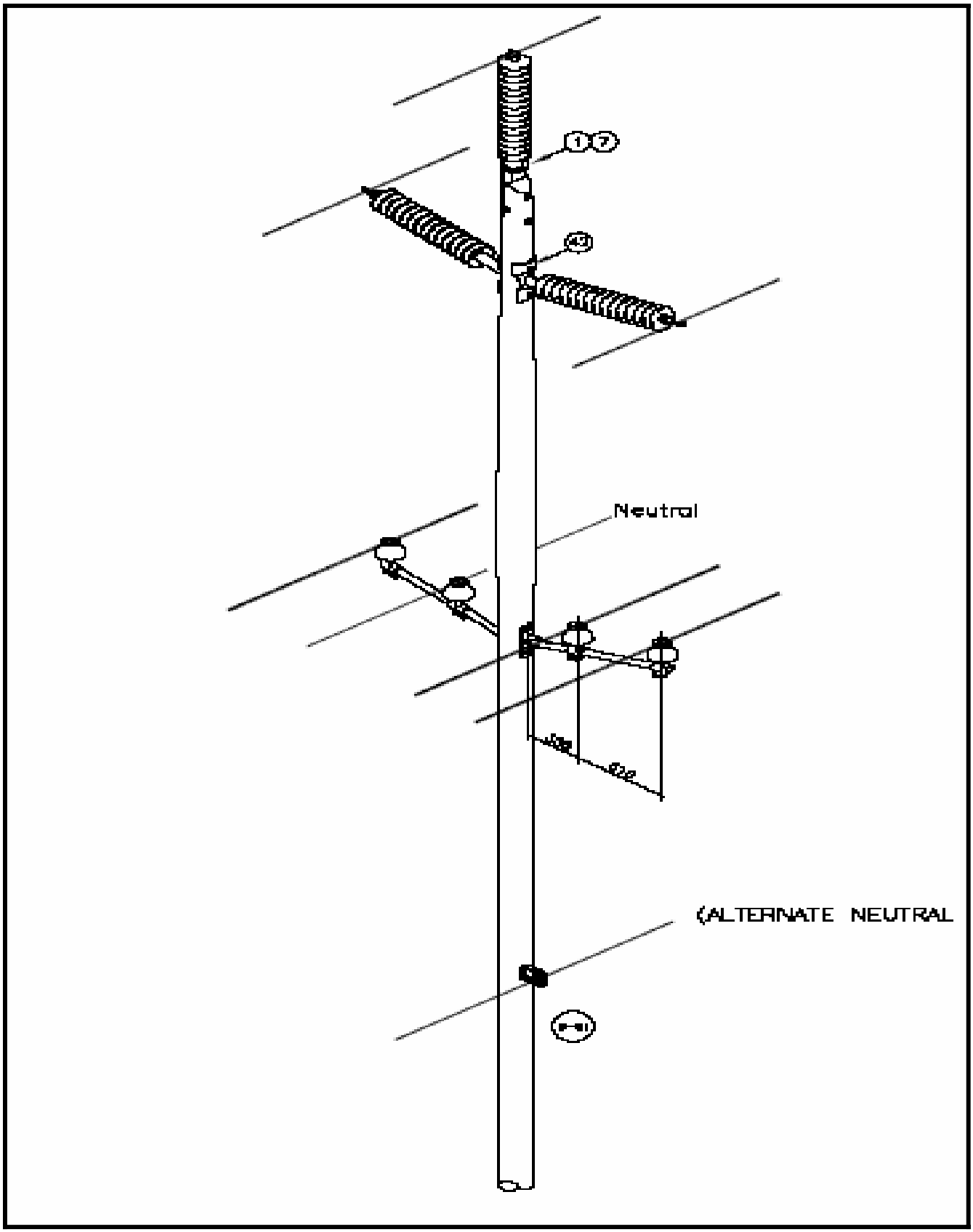
1. Appendix A2.1
2. Appendix A2.2
3. Appendix A2.3

Also attached as Appendix A2.4 is a drawing (not to scale) depicting a similar structure.

Q3. What are cost estimates for using alternative routes (i.e. relocating the electrical substation to the Industrial Park)?

A3. The cost estimate for relocating the electrical substation to the Industrial Park (Option 3, pages 36 - 38 of the CPCN Application) is $ 14.3 million.

Cost estimates for other options are included in the response to BCUC IR1, Q10.2.


Neutral
ALTERNATE NEUTRAL

Reference: FortisBC Inc. response to Commission Information Request No. 1

A8.5 (4)

Q1. Please provide pictures of self-supporting structures.

A1. Pictures of laminated self supporting wood poles are attached as Appendix A1.1, A1.2 and A1.3. It should be noted that the actual size of the structures required in Osoyoos may vary from the supplied pictures.

Q2. What is the cost of self-supporting structures in comparison to guyed poles?

A2. The cost of constructing the double circuit line from the West Osoyoos substation to Lakeshore Drive using self supporting structures is estimated to cost an additional $900,000, as compared to line construction with conventional wood guyed poles. This incremental cost does not include the cost of rerouting existing underground facilities such as gas, water, sewer, etc. The use of self supporting structures requires a caisson to be installed at the base of each pole for support, which may cause other underground facilities to be relocated.

Q9.3 A9.3

Overhead Option A skirts the shore of Osoyoos Lake down Highway 3 and along Kingfisher Drive. The trees on Kingfisher Drive are home to the Bald Eagle from fall to late spring.

Q3. Why was an environmental impact report on this sensitive route not done?

A3. A preliminary environmental impact review was done by FortisBC employees and determined that the present power line is in a landscaped setting and environmental impact would be minimal. No raptor nesting or perching sites were associated or identified with the power line. The area is disturbed (from a natural setting) and maintained in a non-natural state. The addition of new poles on an existing right-of-way and removal of the existing power poles would have little impact on the environment. Further environmental review is scheduled as the line and pole locations are established.

Q4. How does construction along this lakeshore route comply with the regulations of the Riparian Act?

A4. There is no Riparian Act in BC. The question may be directed toward the Fish Protection Act and the associated Riparian Areas Regulation, (B.C. Reg. 376/2004 Scheduled for adoption by Okanagan-Similkameen area March 31, 2006).

Purposes of the Riparian Areas regulation are listed as:

2 The purposes of this regulation are

(a) to establish directives to protect riparian areas from development so that the areas can provide natural features, functions and conditions that support fish life processes,

The preliminary environment review has not established any FortisBC activities that would interfere with features or functions that support fish life processes.

Q9.7 A9.7

Q5. Who did Fortis query at the BC Assessment Branch to determine the impact of a wood pole transmission line in proximity to residential housing?

A5. The response was solicited from the BC Assessment branch by contacting the Kelowna field office. The specific person contacted was not recorded.

Q6. Did Fortis contact anyone else in order to do an assessment with regard to how property values may be affected by this project, in particular the transmission line? If no, why not?

A6. FortisBC contacted Lands West Property Services, a professional land services company to provide an assessment of the impact of the transmission line on property values. Lands West provides services to numerous government and utility agencies as well as private sector companies and individuals. Segments of the industry served include transportation, utilities, electrical transmission, telecommunications, pipelines, and fibre optics. Focused areas of practice include property and right of way negotiation/acquisition, project management, site selection analysis, valuation services,

asset management, information systems design and preliminary environmental assessments.

Lands West used a variety of sources from Canada and the United States to assess the impact. Specifically, they engaged the services of Interwest Property Services from Phoenix, Arizona to provide a third party assessment of the proposed Osoyoos project. Based on the circumstances, both organizations concluded that the financial impact on residential properties adjacent to the proposed transmission circuit is negligible or non-existent.

A copy of the summary letter from Lands West Property Services is attached as Appendix A6.

Q7. What is the property value impact of self-supporting structure transmission lines in proximity to residential housing?

A7. The reports cited in A6 above do not contemplate specific structure types. However, the areas assessed by Interwest in their review of industrial properties (refer to BCUC IR1, Q9.7 and Appendix A9.7) did include a variety of structure types and voltages, and a change to these variables did not alter the report conclusion of virtually no loss of property value.

Q8. How is the American study on the impact of transmission lines on property values in an Industrial area relevant to the impact of transmission lines in proximity to residential housing?

A8. While there is anecdotal interest in the impact of power lines on adjacent land, there is no significant body of empirical research publicly available. The report by Interwest does offer some insight into the phenomenon, albeit a slightly different focus than that seen in Osoyoos.

Ql0.2 Al0.2

Q9. What is the cost of the rebuild of the 40-year-old distribution line on Kingfisher Drive?

A9. The cost of rebuilding of the 40-year-old distribution line on Kingfisher Drive is estimated at approximately $200,000.

Q10. Explain how it was determined that Transmission Line Overhead (Customer proposed); Option C, running lines down an alley that parallels Main Street, would have more of a visual impact on the general public than Transmission Line Overhead (FortisBC proposed): Option A, a main tourist corridor.

A10. The response to BCUC IR1, Q10.2 states that the line, if constructed along the Option C route, "increases the visibility of the line to the general public". It does not state that it will have a greater visual impact than if it were built along Kingfisher Drive, the Option A route. This statement is made since the poles and wires will be higher and more visible that the poles and wires that are currently in place in the alley south of Main Street. In addition, there will be more transmission infrastructure constructed in total than in Option A. For this reason, the Option C route has a greater overall impact than Option A.

Ql0.3 Al0.3

Q11. What is the cost of Underground Transmission (with/without distribution line rebuild) from West Osoyoos substation to Kingfisher and Highway 3?

A11. The cost of Underground Transmission without distribution line rebuild from West Osoyoos substation up to the junction of Kingfisher Drive and Highway 3 is estimated at $ 1.0 million

The cost of Underground Transmission with overhead distribution line rebuild from West Osoyoos substation up to the junction of Kingfisher Drive and Highway 3 is estimated at $ 1.2 million

The accuracy level of the above estimations is ± 25%.

Q12. What is the cost of Underground Transmission from Kingfisher Drive and Highway 3 to Cottonwood Drive?

A12. The cost of Underground Transmission from the junction of Kingfisher Drive and Highway 3 to Cottonwood Drive is estimated at $ 1.4 million

The accuracy level of the above estimation is ± 25%.

Q13. When determining the cost of Underground Transmission, has Fortis taken into consideration the use of the existing conduit placed under Pioneer Walkway?

A13. FortisBC is of the understanding that there are currently six ten-inch polyethylene conduits buried along the south side of the causeway. However, the estimates provided in the CPCN application and the subsequent IRs, assume that these ducts are not in useable condition due to the following reasons:

1. The ducts were installed several years ago without the benefit of FortisBC inspection to determine whether they were installed with adequate protection, drainage or spacing.

2. Information indicates the possibility that sections of the duct has been damaged during underground maintenance and / installation works by various utilities over time.

3. Installation / laying of transmission cables were not contemplated when the above ducts were installed.

However, if the existing ducts are found to be adequate from the point of view of capacity, spacing, protection, deterioration and physical damage, then the installation cost of the project may be reduced by up to a maximum of $500,000.


OLD
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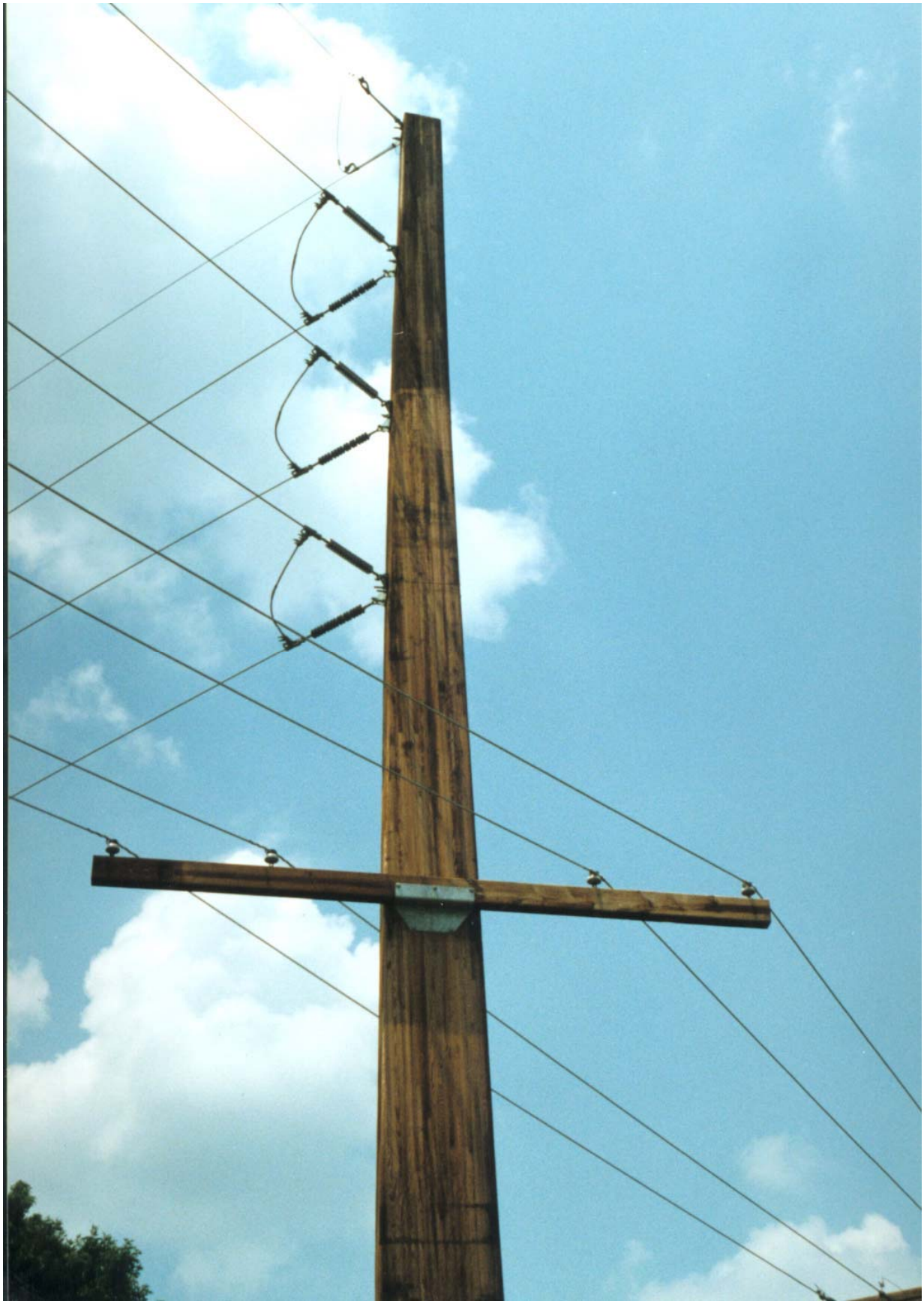

Wonch White Appendix A1.3

Lands West PROPERTY SERVICES INC.
#518, 22 – 2475 Dobbin Road, Westbank, B.C. V4T 2E9
Tel: (250) 769-5571 Fax: (250) 769-5511

December 15, 2005

Fortis BC
1290 Esplanade, Box 130
Trail, B.C.
V1R 4L4

Attention: Mr. Keith Sones, Senior Project Manager

Dear Mr. K. Sones,

Re: **NK'MIP Transmission & Substation Project – 60kV Tie Between East & West Osoyoos Substations**

Further to your inquiry regarding the effect of the upgrade of the electrical distribution lines extending from the West Osoyoos Substation along Kingfisher Road and the Osoyoos Causeway from a 13kV corridor to a combination 13kV and 60kV transmission system, our experience has shown that there is negligible impact to property value associated with these types of facilities in proximity to residential properties.

In the subject instance, the Project is an upgrade of the existing 13kVdistribution facilities with the addition of a 60kV overbuild transmission line. The corridor will, in both the before and after situation, principally remain static with only some nominal modification of structure locations dictated by engineering requirements – a shift of structure locations within 2metres. It is proposed to remain on the north side of Kingfisher Road, onto which the majority of the single-family residential improvements front. The existing, and proposed future, alignment will remain either in road/utility allowance or nominally in the front yard setback areas of the residences.

Both US and Canadian studies involving the effects of high voltage transmission lines on residential developments have indicated that the impact to value is negligible, if any. Published reports on the effect on value of high voltage transmission lines on industrial property values supports the conclusions in the residential studies. Both the Canadian and US studies have focused on high voltage transmission line corridors, in contrast to low voltage, distribution corridors.

Considering that the Project is replacing existing structures, the developed residential properties are already visually impacted, and the change-out of the poles and the addition of the 60kV lines at the top of the structures does not further impede the visual aesthetics.

Considering that the Project consists principally of a 60kV transmission line upgrade on a 13kV distribution corridor, wherein the corridor is within the road allowance and front yard setback areas of the residences, and there is no impact to the property building envelopes, no diminution in value is estimated as a result of the rebuild of the existing structures on the abutting residential properties.

There are generally no property value impacts to residential, commercial or industrial properties that are adjacent to distribution/transmission facilities, unless there is a demonstration of an impediment to fully utilize the property as categorized and classified by local governmental regulations. Only in instances where facilities impede the physical usability of a property, would there be an actual negative impact on the value of the property. This would necessitate a quantification of the impact to value and result in the payment of compensation.

I trust that you find the foregoing useful for your current purposes. Please let me know if you require any additional information or clarification of the information provided.

Yours truly,

Ron Pavlakovic
B.A., RI(BC), SR/WA, FRI(A)