EVERSOURCE ENERGY

107 Selden Street
Berlin, CT 06037

May 23, 2017

Ms. Melanie Bachman
Acting Executive Director
Connecticut Siting Council
Ten Franklin Square
New Britain, CT 06051

Re: Docket No. LIFE-CYCLE 2017

Dear Ms. Bachman:

This letter provides the response to requests for the information listed below.

Response to CSC-01 Interrogatories dated 04/10/2017
CSC-001, 002, 003, 004, 005, 006, 007, 008, 009, 010, 011, 012, 013, 014, 015, 016, 017, 018, 019, 020, 021, 022, 023, 024, 025, 026, 027, 028, 029, 030, 031, 032, 033

Very truly yours,

Kathleen Shanley lsk

Kathleen Shanley
Manager
Transmission, Siting
As Agent for CL&P
dba EversourceEnergy

cc: Service List

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
For new overhead transmission line installations in Connecticut, what transmission structure designs, including structure material and conductor arrangement (e.g. single-circuit vertical steel monopole), are mostly commonly used and for what reason(s)?

Response:
The Connecticut Light and Power Company d/b/a Eversource Energy's (Eversource) typical standard structure designs remain as they have been for many years. Its standard designs are H-frame (horizontal conductor configuration), and monopole designs with either vertical conductor configuration or "delta" conductor configuration. Standard voltages for its new transmission line construction remain 115 kilovolt (kV) and 345 kV.

Eversource has standardized on steel as the preferred material for transmission structures. Steel transmission structures can be either a weathering steel or galvanized steel finish. Eversource's use of "light-duty" or "wood pole equivalent" (WPE) steel, has increased dramatically in recent years due to its resiliency, longevity and cost-efficient qualities. WPE steel poles have replaced the use of natural round wood in most Eversource applications.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
What structure designs, including structure material and conductor arrangements, are no longer used and for what reason(s)?

Response:
Eversource has been utilizing steel as the predominant structure material, including light-duty or wood pole equivalent steel on H-Frame structures, for the reasons stated in its response to question CSC-001. While Eversource's use of wood and laminated wood materials has become less frequent than in the past, these materials still have benefits under certain applications, and are still used by Eversource in those applications.

Eversource continues to use all conductor configurations discussed in previous life-cycle studies (horizontal, delta and vertical). The selection of the particular configuration to be used, is based on the specifics of each project.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Of the overhead configurations listed in response to Question 1, what configurations would Eversource consider prudent for life cycle analysis? Please complete the table provided with current first cost per circuit mile and losses for each of the noted configurations.

First Costs		**Losses**	
Poles & Foundations		Conductor Size & Type	
Conductor & Hardware		Resistance	
Site Work		Peak Line Current	
Construction		Load Growth	
Engineering		Loss Factor	
Sales Tax		Energy Cost	
Project Management		Energy Cost Escalation	

Response:
Eversource considers all of the listed construction types as options for overhead transmission line construction. Estimates have been developed for the most common configurations, H Frame and Delta for 115-kV and 345-kV lines, in the categories requested in the attached table.

Eversource Energy - Typical OH Transmission Types

Life-Cycle Cost Components - Estimated Overhead Construction Costs/ Typical Mile

Cost Category	115-kV H Frame - Wood or WPE Steel	115-kV Delta - Steel Monopole	345-kV H Frame - Wood or WPE Steel	345-kV Delta - Steel Monopole
Poles & Foundations	$401,388	$389,178	$552,417	$647,972
Conductor & Hardware	$284,831	$284,920	$936,212	$950,212
Site Work	$1,251,722	$1,138,647	$1,485,238	$1,370,938
Construction	$1,498,192	$1,401,242	$1,741,367	$1,781,478
Engineering	$343,613	$321,399	$471,523	$475,060
Sales Tax	$0	$0	$0	$0
Project Management	$171,807	$160,699	$235,762	$237,530
Totals	**$3,951,553**	**$3,696,086**	**$5,422,517**	**$5,463,190**

Typical Overhead - Electrical, Loss and Cost Assumptions				
Value	**115-kV H Frame - Wood or WPE Steel**	**115-kV Delta - Steel Monopole**	**345-kV H Frame - Wood or WPE Steel**	**345-kV Delta - Steel Monopole**
Conductor Size & Type	1272 kcmil ACSS 54/19 Pheasant	1272 kcmil ACSS 54/19 Pheasant	2 conductor x 1590 kcmil ACSS 54-19 Falcon	2 conductor x 1590 kcmil ACSS 54-19 Falcon
Resistance (ohms / mile)	0.0741	0.0741	0.0602	0.0602
Peak Line Current (first year)	1000	1000	1000	1000
Load Growth	-0.07%	-0.07%	-0.07%	-0.07%
Loss Factor	0.3800	0.3800	0.3800	0.3800
Energy Cost ($/MWH)	$100	$100	$100	$100
Energy Cost Escalation	-4%	-4%	-4%	-4%

Life Cycle Cost Component				
Value	**115-kV H Frame - Wood or WPE Steel**	**115-kV Delta - Steel Monopole**	**345-kV H Frame - Wood or WPE Steel**	**345-kV Delta - Steel Monopole**
First Capital Costs	$3,951,553	$3,696,086	$5,422,517	$5,463,190
O&M Costs (PV)	$173,803	$173,803	$173,803	$173,803
Cost of Losses (PV)	$486,596	$486,596	$197,659	$197,659
Total Life-Cycle Costs	**$6,555,204**	**$6,174,106**	**$8,460,606**	**$8,521,280**

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Complete the table provided with current first cost per circuit mile and losses for each of the following overhead electric transmission line configurations, if not already addressed in Question 3:
a) 115 kilovolt (kV) wood H-frame
b) 115 kV steel delta
c) 345 kV wood H-frame
d) 345 kV steel delta

First Costs		**Losses**	
Poles & Foundations		Conductor Size & Type	
Conductor & Hardware		Resistance	
Site Work		Peak Line Current	
Construction		Load Growth	
Engineering		Loss Factor	
Sales Tax		Energy Cost	
Project Management		Energy Cost Escalation	

Response:
The requested information is included in the table response to Question 3.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Complete the table provided with first cost per circuit mile and losses for each of the following underground electric transmission line configurations:
a)115 kV high pressure fluid filled (HPFF) pipe
b) 345 kV HPFF
c) 115 kV cross-linked polyethelene (XLPE)
d) 345 kV XLPE

First Costs		**Losses**	
Ducts & Vaults		Cable Size & Type	
Cable & Hardware		Resistance	
Site Work		Peak Line Current	
Construction		Load Growth	
Engineering		Loss Factor	
Sales Tax (X %)		Energy Cost	
Project Management		Energy Cost Escalation	

Response:
The attached table identifies the first cost categories, loss calculation variables and total life cycle cost components for the four requested underground transmission construction types.

Eversource Energy - Typical UG Transmission Types

Life-Cycle Cost Components - Estimated Underground Construction Costs/ Typical Mile

First Costs	XLPE 115-kV	HPFF 115-kV	XLPE 345-kV	HPFF 345-kV
	Single Circuit	Single Circuit	Single Circuit	Single Circuit
Ducts & Vaults	$5,050,285	$3,498,986	$5,400,873	$3,501,991
Cable & Hardware	$4,143,127	$3,421,151	$4,947,648	$3,936,850
Site Work	$1,549,416	$1,548,327	$1,549,449	$1,549,657
Construction	$2,506,270	$2,129,280	$2,564,069	$2,156,746
Engineering	$1,324,910	$1,059,774	$1,446,204	$1,114,524
Sales Tax (X %)	$0	$0	$0	$0
Project Management	$927,437	$794,831	$1,084,653	$891,620
Totals	**$15,501,445**	**$12,452,349**	**$16,992,895**	**$13,151,388**

Typical Underground - Electrical, Loss and Cost Assumptions				
Value	**XLPE 115-kV**	**HPFF 115-kV**	**XLPE 345-kV**	**HPFF 345-kV**
Cable Size & Type	3000 kcmil XLPE	2500 kcmil HPFF	3000 kcmil XLPE	2500 kcmil HPFF
Resistance	0.0268	0.0317	0.0268	0.0317
Peak Line Current	1000	1000	1000	1000
Load Growth	-0.70%	-0.70%	-0.70%	-0.70%
Loss Factor	0.3800	0.3800	0.3800	0.3800
Energy Cost	$100	$100	$100	$100
Energy Cost Escalation	-4%	-4%	-4%	-4%

Life Cycle Cost Component				
Value	**XLPE 115-kV**	**HPFF 115-kV**	**XLPE 345-kV**	**HPFF 345-kV**
First Capital Costs	$15,501,445	$12,452,349	$16,992,895	$13,151,388
O&M Costs	$188,087	$188,087	$188,087	$188,087
Cost of Losses	$175,989	$208,166	$175,989	$208,166
Total Life-Cycle Costs	**$23,470,168**	**$18,957,434**	**$25,693,289**	**$19,999,405**

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
For variables listed under Losses in Questions 3, 4 and 5, provide the origin of the value.

Response:

For factors associated with load growth and forecasting, The 2017 ISO NE Forecast Report of Capacity, Energy, Loads and Transmission (CELT) was referenced, using data for ISO NE control area, summer peak, net PV and PDR, 50/50.

For load and loss factors, actual 2016 loads were used as found in the published ISO NE 2016 SMD data Hourly load data for ISO NE Control Area (DA Demand).

Other values are established using Eversource values as appropriate, and professional judgement.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Provide the following variables for cost calculations including the origin of the value:
a) Capital recovery factor, _____
b) Operation and maintenance cost escalation, and _____
c) Discount rate. _____

Response:
Below are the variables for cost calculations including the origin of the value:

Capital Recovery Factor	12.51%	Using information filed July 29, 2016 in FERC's Participating Transmission Owner's Administrative Committee (PTO AC) Informational Filing in RT04-2.
Operation and Maintenance Cost Escalation	2%	(Professional judgement)
Discount Rate	8%	(Prior LCC filing and professional judgement)

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Provide the rationale of including or not including the following overhead transmission line configurations:
a) Lattice structures
b) Laminate structures; and
c) Vertical conductor design.

Response:
Lattice structures have rarely been used for new transmission line construction in Connecticut in recent years. There have not been a sufficient number of new lattice installations to justify their inclusion in the life-cycle cost analysis.

With the increased use of light-duty steel, and some recent failures of laminated wood components, Eversource expects that the use of laminated wood structures will be limited in Connecticut. Laminated structures have shown to be susceptible to degradation from environmental factors, and in most applications do not provide sufficient cost advantage to justify their use. Because their past and future use is estimated to be very limited, the inclusion of laminated wood structures is also not warranted

Vertical conductor designs are still used and have been considered in this life-cycle analysis. The vertical configuration uses the narrowest amount of space within a right-of-way and is sometimes the only option available when right-of-way width is limited.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Discuss the applicability of life cycle cost analysis for double circuit configurations. Is there a multiplier that can be applied to account for a second circuit to the transmission line configurations?

Response:
Double-circuit construction is still utilized with some frequency in Connecticut and could still be considered in transmission line life-cycle cost analysis.

Eversource does not use such a multiplier to estimate costs for double-circuit construction. It may be feasible to develop such a multiplier to apply to estimates for single-circuit, vertical monopole construction, to derive a very high-level, order of magnitude value for double-circuit transmission line construction.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Provide costs per circuit mile of the past five years for operation and maintenance of Eversource's existing overhead transmission lines in accordance with Federal Energy Regulatory Commission (FERC) Accounts 560, 563, 564, 568, 571, and 572.

Response:

The attached table provides the requested transmission operation and maintenance (O&M) costs for Eversource over the past 5 years.

Eversource Energy Operation & Maintenance Costs

CT Only - FERC Form 1, years 2012-2016

Line	Costs by FERC Account	2012	2013	2014	2015	2016
1	560 - Operation Sup & Eng	$5,927,627	$5,466,318	$6,424,314	$5,885,071	$4,266,394
2	563 - Overhead Line Expenses	$772,267	$427,939	$454,579	$581,082	$1,906,232
3	564 - Underground Line Expenses	$197,001	$0	$715,065	$890,213	$1,213,150
4	568 - Maintenance Sup & Eng	$4,503,081	$3,405,433	$2,606,138	$1,286,749	$1,037,786
5	571 - Maintenance of Overhead Lines	$8,516,922	$6,812,415	$6,625,324	$5,928,681	$17,689,548
6	572 - Maintenance of Underground Lines	($80,493)	$1,152,626	$382,344	$846,609	$127,129
	Total O&M Costs	*$19,836,405*	*$17,264,731*	*$17,207,764*	*$15,418,405*	*$26,240,239*
7	Overhead Transmission Lines (Miles)	1636.0	1645.9	1645.9	1678.7	1678.7
8	Underground Transmission Lines (Miles)	135.0	135.0	136.4	136.4	136.4
	Total Transmission Lines (Miles	1771	1780.89	1782.33	1815.09	1815.09
9	% of Overhead to total	92.4%	92.4%	92.3%	92.5%	92.5%
10	% of Underground to total	7.6%	7.6%	7.7%	7.5%	7.5%
	O&M Cost Per Circuit Mile - Overhead Transmission					
560 / 568	Supervision Costs (line 1+4)	10,430,708	8,871,751	9,030,452	7,171,820	5,304,180
	% of Overhead to Total (line 9)	92.38%	92.42%	92.34%	92.48%	92.48%
	Supervision % allocated to Overhead	9,635,595	8,199,230	8,339,158	6,632,716	4,905,466
563 / 571	Direct Overhead Costs (line 2+5)	13,020,003	10,217,848	9,231,462	7,215,430	18,727,334
	Total Overhead Costs	22,655,598	18,417,078	17,570,620	13,848,146	23,632,800
	Overhead Circuit Miles (line 7)	1636	1645.89	1645.89	1678.65	1678.65
	O&M Costs - Overhead Trans. Per Circuit Mile	$13,848	$11,190	$10,675	$8,250	$14,078
		12.12%	-19.20%	-4.60%	-22.72%	70.66%
				5 year O&M Cost Average - OH		$11,608
	O&M Cost Per Circuit Mile - Underground Transmission					
560 / 568	Supervision Costs (line 1+4)	10,430,708	8,871,751	9,030,452	7,171,820	5,304,180
	% of Underground to Total (line 10)	7.62%	7.58%	7.66%	7.52%	7.52%
	Supervision % allocated to Underground	795,113	672,521	691,294	539,104	398,714
564 / 572	Direct Underground Costs (line 3+6)	116,508	1,152,626	1,097,409	1,736,822	1,340,279
	Total Underground Costs	911,621	1,825,147	1,788,703	2,275,926	1,738,993
	Underground Circuit Miles (line 8)	135	135	136.44	136.44	136.44
	O&M Costs - Underground Trans.Per Circuit Mile	$6,753	$13,520	$13,110	$16,681	$12,745
		-71.25%	100.21%	-3.03%	27.24%	-23.59%
				5 year O&M Cost Average - UG		$12,562

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Provide costs per circuit mile of the past five years for operation and maintenance of Eversource's existing underground transmission lines in accordance with FERC Accounts 560, 563, 564, 568, 571, and 572.

Response:
See table in response to previous question Q-CSC-010.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Provide costs per mile of the past five years for Eversource's vegetation management activities for transmission line rights-of-way.

Response:
Costs for the past five years for vegetation management activities on Eversource's transmission rights-of-way are as follows:

	Expenditures	Expenditures Per Mile ROW
2012	$2,908,202	$3,504
2013	$4,088,833	$4,926
2014	$4,316,664	$5,201
2015	$5,387,575	$6,491
2016	$15,183,949	$18,294

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Is Eversource's vegetative management cost part of the FERC Accounts 571 and/or 572?

Response:
Transmission Vegetation Management costs are part of FERC Accounts 571.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Provide an updated breakdown of Eversource's existing transmission facilities by length, voltage, construction type, and single/double circuit.

Response:
The attached table provides the information on Eversource's transmission line facilities as reported in FERC Form 1. The information on construction type is difficult to summarize due to the mixed use of various construction types on lines in the Eversource transmission system.

Eversource Transmission Summary 2016				
Connecticut Transmission Lengths		Length (in Structure miles)		Total Ckt Miles
	# Circuits	On Pri Str	On Str of Another line	
Total Transmission Miles	**219**	**1445.2**	**353.3**	**1798.5**
345-kV Total	**34**	**527.6**	**11.7**	**539.3**
345-kV OH	29	480.2	11.7	491.9
345-kV UG	5	47.4		47.4
138-kV Total	**3**	**16.8**	**0.0**	**16.8**
138-kV OH	0	0.0		0.0
138-kV UG	3	16.8		16.8
115-kV Total	**170**	**832.9**	**309.5**	**1142.3**
115-kV OH	149	763.6	309.5	1073.0
115-kV UG	21	69.3		69.3
69-kV Total	**12**	**67.9**	**32.1**	**100.0**
69-kV OH	11	65.1	32.1	97.2
69-kV UG	1	2.8		2.8

Source: The Connecticut Light & Power Company; 2016 FERC Form 1

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
List all relevant standards applicable to transmission resources for the following categories (if standards differ between overhead and underground or 115kV and 345kV please so state):
a. Reliability
b. Security
c. Vegetation Management, and
d. Storm hardening.

Response:

a. The following standards apply to Reliability:

I. North American Electric Reliability Corporation (NERC) TPL-001-4 Transmission System Planning Performance Requirements
II. Northeast Power Coordinating Council (NPCC) Regional Reliability Reference Directory # 1 Design and Operation of the Bulk Power System
III. Independent System Operator- New England (ISO-NE) PP 03 Reliability Standards for the New England Area Pool Transmission Facilities

b. NERC has issued numerous standards for governing the protection of critical infrastructure of the bulk power transmission system, which includes transmission resources. These are referred to as the Critical Infrastructure Protection (CIP) program. The CIP program coordinates all of NERC's efforts to improve the North American power system's security. These efforts include standards development, compliance enforcement, assessments of risk and preparedness, the dissemination of critical information and raised awareness regarding key security issues. The following standards are currently subject to enforcement:

I. CIP-002-5.1a Cyber Security — BES Cyber System Categorization
II. CIP-003-6 Cyber Security - Security Management Controls
III. CIP-004-6 Cyber Security - Personnel & Training
IV. CIP-005-5 Cyber Security - Electronic Security Perimeter(s)
V. CIP-006-6 Cyber Security - Physical Security of BES Cyber Systems
VI. CIP-007-6 Cyber Security - System Security Management
VII. CIP-008-5 Cyber Security - Incident Reporting and Response Planning
VIII. CIP-009-6 Cyber Security - Recovery Plans for BES Cyber Systems
IX. CIP-010-2 Cyber Security - Configuration Change Management and Vulnerability Assessments
X. CIP-011-2 Cyber Security - Information Protection

XI. CIP-014-2 Physical Security

c. The following standards apply to Vegetation Management

1. North American Electric Reliability Corporation (NERC) Transmission Vegetation Management Standard FAC-003-4

2. American National Standards Institute (ANSI) Z-133 Standards for Arboriculture Operations

3. American National Standards Institute (ANSI) A-300 - Tree Care Practices

d. There are no national standards for storm hardening for transmission line construction. Eversource has performed a review of structure capacity, at the recommendation of the Davies Report *[Final Report on Connecticut Light and Power's Emergency Preparedness and Response to Storm Irene and the October Nor'easter, February 27, 2012*] in the analysis of structures for storm resiliency.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
The National Electric Safety Code and the State of Connecticut Building Code have been updated. How may these updated codes impact life cycle costs and identify those relevant code changes.

Response:
The changes to the National Electric Safety Code (NESC) for 2017 are still under review but are not expected to have any effect on Eversource's current transmission line design standards or life cycle costs.

The Connecticut Building Code does not apply to transmission line construction, so those changes to the Building Code also will not affect transmission line life cycle costs.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Where are the costs associated with applicable standards and environmental permits found in first costs?

Response:
Costs associated with obtaining siting and environmental permits and approvals are included in the Engineering costs.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Does Eversource agree with the list of environmental permits/certificate approvals in Table 8-2 in the Life Cycle 2012 final report dated November 12, 2012? If not, list other permitting authorities.

Response:
The list should be updated:

- In the cell for CT DEEP, add Natural Diversity Database (NDDB) review for CT endangered, threatened, and special concern species
- In the cell for CT DEEP, remove "Approval for temporary disturbance of more than 5 acres of land" as it is duplicative of the Stormwater Pollution Prevention entry.
- In the cell for CT DEEP, remove "Stream Channel Encroachment Line Permit" because the program no longer exists.
- In the cell for State Historic Preservation Commission, remove the phrase "approval by finding of no adverse effect"
- In the cell for US Army Corp of Engineers, add "408 permit for altering federal land public works projects" (such as dams/levees)
- Add US Fish and Wildlife Service Endangered Species Act review

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Describe the effects on life cycle costs applicable for underground/overhead transmission lines as it pertains to those entities referenced in Question 10.

Response:
The estimated typical costs for securing all permits and regulatory approvals are included in the first costs for the line configurations listed above. Therefore, the life cycle costs associated with those same categories have already included any effects associated with securing permits and approvals.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Does Eversource agree that approximately 40 years is a reasonable value to assign to an overhead or underground transmission line's useful life? If not, what typical life expectancies would Eversource use for each of the transmission line configurations identified in Questions 1 and 2?

Response:
In the Siting Council's 2006 proceeding, Eversource stated that for transmission line life cost analysis, the estimated life span for transmission lines is 40 years and Eversource affirmed this statement in the 2011 proceedings. Eversource continues to believe that this estimated life is reasonable for life cycle analysis and asset depreciation ("book-life") purposes.

In its responses to prior transmission line life cycle cost interrogatories, Eversource has also stated that transmission lines have reliably and safely performed for longer periods if well maintained and with life-extending component replacements (e.g., wood cross-arms, shield wires, conductor splices). With such considerations, life expectancies would remain as provided in prior life-cycle analyses, and as stated in the 1996 Acres Report:

- Wood Pole 40 years
- Steel Pole 60 years
- Underground Cable 35 to 40 years
-

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Would Eversource consider constructing new 69-kV transmission lines in Connecticut?

Response:
At this time, Eversource sees no opportunities in the immediate planning horizon for the addition of new 69-kV transmission lines in Connecticut.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Are polymer insulators the preferred type of insulators? Have they largely replaced porcelain or glass insulators?

Response:
At transmission voltages, Eversource has continued to standardize on porcelain insulators, and has started to utilize toughened glass insulators on some projects. Polymer is not preferred at transmission voltages, due primarily to historical issues with brittle rod failures. In addition, there is no accepted practice for testing non-ceramic (e.g. Polymer) insulators for defects in support of live line work. As a result, Eversource has eliminated the use of non-ceramic insulators going forward.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Describe how leak prevention and containment measures used on HPFF cable systems could impact life-cycle costs.

Response:
Leak prevention measures have always been integrated into Eversource's design of HPFF systems, and therefore, the costs of such measures would have been reflected in the CSC's prior life-cycle study estimates. Leak prevention starts with a high-quality corrosion coating of the pipe, careful testing of the coating several times during the construction, and placing a high-quality backfill around the pipes. A cathodic protection system is provided to protect the pipe in the event of unknown or unreported damage to the pipe's corrosion coating. The pipe coating and the cathodic protection system are included in periodic maintenance procedures for the line to maintain the quality of the leak prevention systems. Measures to reduce fluid loss consist of containment volumes designed into foundations under the pump plant/fluid expansion tank enclosures. Also included are a variety of pressure gauges and alarms to detect low fluid pressure or frequently-operating pumps that might indicate a leak in the system, and valves to isolate appropriate portions of the system.

Any additional mechanical protection or containment measures, or leak detection systems, that are installed to reduce the frequency and extent of HPFF fluid leaks would add significantly to the initial capital cost and to the life-cycle cost of HPFF cable systems, due to both the initial and ongoing operating and maintenance costs of such measures. Because of the very low frequency of leaks, any resulting lower O&M cost of leak repair and remediation would not compensate for the extra capital cost, and therefore the total life-cycle cost would be higher.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Has Eversource researched or evaluated the use of composite conductors for transmission lines to increase line capacity? If so, what is estimated life cycle cost impact? Please break into first cost and ongoing cost elements.

Response:
Eversouce has not performed a detailed evaluation of the use of these conductors for increasing the capacity rating of an entire line, or new construction . Eversource has utilized, in certain limited applications, composite core conductors, but not for any appreciable line segment length.

Eversource has used composite high temperature, low sag (HTLS) conductors on a limited basis, primarily at a couple of long river crossing spans, where ceramic core conductors have allowed for reduced conductor sag, and allowed for preservation of existing towers. The costs for these conductors is significantly greater than that of ACSS (4 to 5 times greater, as referenced in prior life cycle reports), and these conductors require specialized construction methods and tools that add additional costs.

Eversource's standardization on the use of ACSS for new transmission construction (in place of ACSR conductors) has increased the capacity of transmission lines, at relatively low, or no cost impact to projects.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Does Eversource anticipate utilizing ACSS conductors as a common practice or would ACSR or other conductor types be used for overhead lines?

Response:
Eversource has standardized on the use of ACSS conductors for new transmission line construction. However, in some instances, project specific requirements may necessitate the use of other conductor types (such as alternate high temperature low sag conductor or ACSR).

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Has Eversource experienced, in the last five years, issues with construction or maintenance of transmission lines in locations that required special processes or procedures due to environmental sensitivity? If so, please describe the situations and the cost impacts.

Response:

Eversource routinely encounters environmental issues associated with construction and maintenance of transmission lines in locations that require special processes or procedures due to environmental sensitivity.

Eversource reviews construction and maintenance projects for environmentally sensitive areas and utilizes its Construction and Maintenance Best Management Practices ("C&M BMPs") when working in wetland areas and for stormwater management--erosion and sediment control. For example, construction mats are used when vehicles require access to minimize damage to wetland areas in accordance with local, state and federal regulations. Stormwater management controls are required in accordance with state and federal regulations during maintenance and construction activities.

In addition to following the C&M BMPs, Eversource also protects endangered species by hiring biologists, educating all construction crews and installing protective fencing to ensure that rare, threatened, or endangered species are not adversely affected by construction projects. Where feasible, the company will also work during different times of the year to help prevent adverse effects to the environment.

A summary of the general issues and associated cost impacts follow:

<u>Wetland Area Protection</u>

· Construction mat Access Roads: $75/linear foot installed
· Construction mat Work pads: approximately, $45,000 per work pad (100 ft x 100 ft) installed and removed (assuming two months of rental).

<u>Stormwater Management</u>

· Silt fences and hay bales: $7/linear foot installed.
· Culverts: $7,000/pipe installed (steel corrugated - 18 inch diameter, 20 feet in length).
· Site restoration (grading, mulch, seeding, etc.): $25,000/mile.

State regulations and requirements require special handling and disposal of contaminated and/or polluted soil and water encountered during excavation activities for overhead and underground facilities.

Soil disposal (testing, transporting and disposal)

· Largest Cost was Haddam - GHCC Autotransformer Substation Expansion Project ; Eversource spent approximately $**1.2 million** on soil management.

Other recent projects: Bloomfield - Windsor Upgrade Project - approximately $500,000

SWCT 1682 Line Rebuild Project- approximately $200,000
Plumtree Cap Bank Installation Project - approximately $125,000
Haddam Neck Substation Fence Project - approximately $75,000

Endangered Species Protection Act (state & federal)

· Identification (biological surveys) and avoidance of endangered species have impacted scheduled (time of year restrictions) and incurred costs. For example, the requirement to have a herpetologist on site during construction to protect Timber Rattlesnakes for a recent project was $12,000.

Invasive Species Control Plans

· 2017 Invasive Species evaluation and reporting costs for the Greater Springfield Reliability Project, 1990 Line Structure Replacement Project and the Interstate Reliability Project were $11,500, $8,000, and $44,000, respectively.

Eversource has experienced delays in permitting as a result of delays in U.S. Army Corps of Engineers applications needed to satisfy the consultation requirements of Section 106 of the National Historic Preservation Act.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
ISO-New England (ISO-NE) has issued planning and operating standards for design and operation of transmission facilities. One standard prescribes transmission line ratings for normal conditions, short-term emergency and long-term emergency conditions. Does Eversource expect the standards to impact transmission line life-cycle costs, and if so, to what extent?

Response:
ISO-NE rating criteria from Planning Procedure 7 has been in effect for many years and is already considered in the Eversource design standards and estimated costs. There is no impact to life cycle costs.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Has Eversource identified other ISO-NE policies or operating procedures that are anticipated to impact transmission line life-cycle costs? If so, what are they and what is the anticipated impact?

Response:
Eversource is not aware of any ISO-NE policies or operating procedures that impact transmission line life cycle costs. However, Eversource's experience with the ISO-NE Transmission Cost Allocation process has shown that costs over and above those to site and build a feasible and practical transmission line in Connecticut are allocated 100 percent to Connecticut customers. For example, if the cost of a new transmission line is higher because part of it was constructed underground at higher cost when a lower cost overhead line was feasible and practical to build, the extra costs would be disallowed for regional cost recovery.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Under what conditions would Eversource consider using high voltage direct current (HVDC) lines for long-distance power transfers? How would the life cycle costs of HVDC lines compare to high voltage alternating current (HVAC) transmission lines?

Response:
The discussion of "High Voltage Direct Current (HVDC) Typical Costs" in the Council's *Life Cycle 2012* in section 4.3.2 remains appropriate. In order to provide a solution to a transmission reliability need in the State of Connecticut, HVDC lines offer fewer system benefits than most AC options and HVDC lines would have a greater cost.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Does Eversource believe that its transmission line capital and construction costs are higher, on par, or lower than other Northeast Power Coordinating Council region utilities? If higher or lower, by what percentage and perceived reason?

Response:
Eversource does not believe that its cost of capital for transmission line projects is materially different than that of other northeastern utilities with areas of similar geographic features (population density, topography and terrain, rock and water features, etc.).

It is very difficult to compare transmission line construction costs between utilities and projects in the Northeast because costs can vary widely depending upon project-specific features. These features include line routing, terrain and topographical features, sub-soil obstructions, wetland impact avoidance and mitigation, EMF mitigation, circuit outage availability, seasonal impacts, work hour/day restrictions, and special permit conditions.

Transmission projects in areas of higher population densities and greater density of existing infrastructure, tend to face more challenges in siting and permitting, engineering and construction. Connecticut is a predominantly urban and suburban state, with substantial infrastructure. This can result in line designs that have many angles, and several highway and railroad crossings, which adds to the cost and complexity of a line. In some areas of the state there is no room for additional lines on existing rights-of-way and the adjacent lands are so densely developed that new rights-of-way are very difficult to acquire. Managing these challenges can result in added costs for those projects in urban areas, as opposed to projects constructed elsewhere in New England (such as Maine, Vermont or New Hampshire), in predominantly rural areas.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Does Eversource believe that its transmission line operation and maintenance costs are higher, on par, or lower than other Northeast Power Coordinating Council region utilities? If higher or lower, by what percentage and perceived reason?

Response:
Eversource estimates that its transmission line operating and maintenance costs are within the range experienced by other Northeastern utilities. Cost differences among companies may typically be attributed to differences in the density and types of existing right-of-way vegetation, mix of line structures (wood pole, steel pole and lattice steel), average age of transmission line plant, mix of rural versus urban location and local labor markets.

Some costs associated with rights-of-way reclamation activity were incurred in 2016 that have driven costs higher than in previous years; however because this reclamation activity is being driven by North American Electric Reliability Corporation reliability criteria, costs related to similar activities may be reflected in other utilities' costs as well.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Are there any updates or changes to the coordination of transmission and distribution planning activities within Eversource or in conjunction with the ISO New England Regional System Planning process? If so, please discuss the changes and the impacts they have on transmission line life-cycle costs.

Response:
For typical projects there have not been any significant changes to the coordination of transmission and distribution planning activities within Eversource or in conjunction with the ISO-New England Regional System.

Witness: **Eversource Panel**
Request from: **Connecticut Siting Council**

Question:
Provide any comments and/or suggestions regarding how the Council's Life Cycle 2012 report could be improved.

Response:
Eversource can offer no suggestions at this time.