Weston J. Davis

Education
Bachelor of Science, New York State College of Environmental Science and Forestry at Syracuse University, Syracuse, NY
Master of Science ,Forestry, University of New Hampshire, Durham, NH
Master of Science, Business, Husson College, Bangor, ME
Short course on Herbicide Use, Purdue University, Lafayette, IN

Work Experience
USFS Experiment Station/University of NH, Durham NH – research assistant: Focus in three areas: hazard rating stands of forest trees, tree response to pruning, and decay patterns in trees.
Lucas Tree Expert Company, Portland, Maine – Field supervisor for transmission and distribution crews performing utility work in Maine, New Hampshire and Massachusetts.
Central Maine Power Company, Augusta, Maine Manager – Vegetation Management Operations.
IUSA – Program Manager - Overall responsibility for distribution and transmission vegetation management operations for NYSEG, RG&E, and CMP.

Professional Licenses/Certifications
Maine Master Pesticide Applicator License – CMA1311 (2, 6A, 6B))
Maine Arborist License – FCL&U 937
Maine Professional Registered Forester – LF959
International Society of Arboriculture – Certified Arborist – NE-0212A

Professional Affiliations
Former Chairman – Electric Council of New England – Vegetation Management Task Force
Former Board of Directors – Maine Arborist Association
Current member – Maine Arborist Association
Former Chairman – Edison Electric Institute - Vegetation Management Task Group
Current member – Edison Electric Institute – Vegetation Management Task Group
Former Board of Directors – Utility Arborists Association
Member of International Society of Arboriculture
Former Chairman of Maine Integrated Pest Management Council
Current Member of Maine Integrated Pest Management Council
Project Canopy Leadership Team – State of Maine Community Forest Council
Former Chairman – Maine Urban Forestry Council
Member of the first NERC Vegetation Management Standard Drafting Team
Chairman of Hallowell Tree Board – Community Volunteer
City of Hallowell Tree Warden – Community Volunteer

Publications

"Potential Hazard Rating System for Fir Stands Infested with Budworm Using Cambial Electrical Resistance," Weston Davis, Walter Shortle, and Alex Shigo, 1980 Canadian Journal of Forest Research.

"Seasonal Changes in Electrical Resistance of Inner Bark in Read Oak, Red Maple, and Eastern White Pine," by Weston Davis, Alex Shigo, and Richard Weyrick, 1979. Forest Science.

Monthly reports in the Utility Arborist Association Newsletter

Bill Ransom

PROFESSIONAL EXPERIENCE

Iberdrola USA Management Corporation **2011 - Present**

2011 – Present **<u>Director – Asset Management and Maintenance</u>**
I direct Iberdrola USA's programs and policies related to the maintenance and assessment of electric transmission, distribution, and substation assets for CMP, NYSEG, and RGE. Primarily, this involves the oversight of the company's line and substation test and inspection programs, routine and preventative maintenance programs, and T&D vegetation management. Additionally, I oversee the asset condition assessment process, including asset class health index and risk analysis, and capital/maintenance remediation recommendation.

New York State Electric & Gas (NYSEG) **2010 - 2011**

2010 - 2011 <u>Manager - Regional Operations, Lancaster/Lockport Divisions</u>
I managed the activities of a highly skilled workforce of professional and craft workers, in the delivery of electricity to approximately 176,000 customers in a 1,800 sq mile portion of western New York State. This involved the coordination of all aspects of employee relations, labor relations, public relations, construction management, and safety program administration.

New York State Electric & Gas (NYSEG) **2004 - 2010**
Rochester Gas & Electric (RG&E)

2004 – 2010 <u>Director - Regional Operations, West Region</u>
I directed the activities of a highly skilled workforce of over 250 professional and craft workers, in the delivery of electricity and natural gas to approximately 280,000 customers in a 3,000sq mile portion of western New York State. This involved the tactical coordination of all aspects of electric and gas field operations including but not limited to employee relations, labor relations, public relations, construction management, oversight of safety programs; customer satisfaction programs; reliability infrastructure improvements; emergency response; and field engineering..

New York State Electric & Gas Corporation (NYSEG) **1988 - 2004**

2000 – 2004 <u>Division Operations Manager, Lancaster</u>
I managed the day to day activities of 150 employees engaged in the design, engineering, and safe operation of electric transmission and distribution facilities, that served approximately 170,000 electric customers in western NY.

1993 – 2000 <u>Supervising Field Engineer, Brewster Division</u>
I Supervised 10 electric field planners engaged in the design and engineering of electric distribution systems.

1990 – 1993 Staff <u>Engineer, Substations & Protection Engineering – Binghamton Corporate</u>
Under the direction of the corporate substations and protection engineering manager, I was responsible for the design and engineering of system protection schemes (relay packages & settings).

1988 – 1990 <u>Key Account Manager, Market Services – Binghamton Division</u>
In this role I managed account relationships for large commercial and industrial energy services customers.

EDUCATION/CERTIFICATIONS

MBA, Organizational Management - Syracuse University, Syracuse, NY - 2003
Bachelor of Science, Electrical Engineering- Penn State University, State College, PA - 1987
Licensed Professional Engineer – New York State

PAUL J. APPELT
520 Business Park Circle
Stoughton, Wisconsin 53589-3399
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Fax (608) 877-1172
pappelt@eci-consulting.com

PROFESSIONAL EXPERIENCE

ENVIRONMENTAL CONSULTANTS, INC., Stoughton, Wisconsin **1999 to Present**

President (September 2006 - Present)

Provides corporate leadership for ECI, including oversight of all field operations for the Consulting Services, Total Management Services, Field Services, and Information Management Services business units.

Vice President, Consulting Services (2003-2006)

Provides leadership of ECI's consulting services business unit. This business unit focuses on assisting utility management through diagnostic vegetation management program assessments, vegetation management program development, research-based reliability improvement strategies and outsourcing of line clearance program management. Other consulting services provided include: litigation support, wood pole and joint facilities management planning, transmission right-of-way studies, training services, practical research projects, special studies and information services (production monitoring software and record keeping services, and handheld data collection).

Director, Consulting Services (2000-2002)

Responsible for oversight and direction of the consulting services business unit including distribution line clearance studies, wood pole and joint facilities management plans, transmission ROW studies, turnkey vegetation management operations, training services, practical research projects, information services, litigation support and special studies.

Senior Project Manager (1999-2000)

Responsible for management of ECI's benchmarking programs and development of management planning services for utility wood pole maintenance/joint attachments, litigation related consulting services.

COMMONWEALTH EDISON COMPANY, Chicago, Illinois **1985 to 1999**

System Vegetation Management Superintendent (1993 to 1999)

Responsible for vegetation management including: line clearance, tree maintenance, landscape repair, landscape site maintenance as well as wood pole inspection and maintenance throughout the 44,000 mile transmission and distribution (T&D) system. Managed $40 million to $70 million in contracts annually.

- Supervised 27-member department, which directed activities for 1200 contract personnel.
- Led development and implementation of incentive-based landscape repair contracts, which reduced completion times by over 50% while maintaining or increasing quality.
- Initiated studies resulting in efficiency improvements:
  - NPV analysis of tree removal/replacement versus periodic pruning.
  - Efficacy of wood pole supplemental preservative treatment.
  - Wood pole replacement versus reinforcement.
- Co-chaired teams which developed innovative approaches to tree maintenance and wood chip disposal contracting that aligned cost reduction objectives while improving effectiveness.
- Functioned as expert witness on serious claims litigation.
- Assisted in negotiations with regional telephone company regarding shared costs for pole maintenance and tree maintenance related to jointly owned facilities.
- Designed research based brochures addressing customer concerns about tree maintenance.
- Implemented pruning standards change together with a customer notification program based on a combination of personal contact and written materials; recognized by Chairman of the Illinois Commerce Commission for public relations initiative.
- Prepared company responses to inquiries from regulators including Illinois Commerce Commission.

System Line Clearance Coordinator (1988 to 1993)

Responsible for functional control of all line clearance activities and right-of-way vegetation management on the T&D system including contracts specification creation. Direct responsibility for administration and planning of wood pole maintenance contracts.

- Implemented first company electronic database for line clearance records.
- Initiated major review and analysis of distribution line clearance program achieving cost, customer service, reliability and safety objectives. Presented to company officers.

Foreman – Northwest Area (1985 to 1988)

Supervised seven contract line clearance crews and the right-of-way mowing contract in the area.

VILLAGE OF DOWNERS GROVE, Downers Grove, Illinois **1976 to 1985**

Village Forester

Responsible for general administration of forestry department programs including: parkway tree maintenance, Dutch elm disease and gypsy moth control, grounds maintenance, tree planting and leaf pick up. Additional responsibilities included: supervision of personnel, budget preparation, policy and program recommendation, contract management, technical arboricultural consultation to individual homeowners, tree appraisal, landscape planning, public relations and assistance with general administration of Public Works Department.

DAVEY TREE EXPERT COMPANY, Kent, Ohio **1975 to 1976**

Foreman
Progressive experience gained in all aspects of residential tree care including pruning, cabling and bracing, planting, spraying, fertilizing, systemic injection and utility line clearance.

CITY OF APPLETON, Appleton, Wisconsin **1975**

Forestry Technician
Responsible for Dutch elm disease surveillance and resident notification, cost analysis of wood disposal/utilization operation, arboricultural consultation to individual homeowners.

EDUCATION

B.S., Forestry, Michigan Technological University, Houghton, Michigan, 1975

PUBLICATIONS/PAPERS

Appelt, Paul. 1985. "A New Eradication Strategy for Small, Remote Gypsy Moth Infestations." Journal of Arboriculture, Vol. 11, No. 8, August 1985.

Appelt, Paul and Herbert Schroeder. 1985. "Public Attitudes Toward A Municipal Forestry Program." Journal of Arboricultural, Vol. 11, No. 1, January 1985.

Appelt, Paul and John Goodfellow. 2004. "Research on How Trees Cause Interruptions – Applications to Vegetation Management." IEEE Rural Electric Power Conference, May 2004.

Appelt, Paul. 2004. "Utility Vegetation Management – Use of Reliability Centered Maintenance Concepts to Improve Performance." EPRI Technical Update, Product ID #1008859, Palo Alto, CA, April 2004.

Appelt, Paul. 2004. "Electric Distribution Hazard Tree Risk Reduction Strategies." EPRI Technical Report, Product ID #1008480, Palo Alto, CA, November 2004.

Appelt, P. and D. Gartman. 2004. Integrated Vegetation Management on Natural Gas Pipeline Rights-of-Way. Presentation to the Environmental Concerns in Right-of-way Management 8th International Symposium. September 12-16, 2004. Saratoga Springs, New York, USA.

Appelt, Paul and Anne Beard. 2006. "Components of an Effective Vegetation Management Program." IEEE Rural Electric Power Conference, April 2006.

Appelt, Paul. 2009. "Why a Strategic Plan for Vegetation Management Is a Critical Asset Management Decision Support Component". EPRI Fifth Power Delivery Asset Management Conference, November 4-6, 2009.

Appelt, Paul. 2011. "Urban Trees and Power Lines – 30 Years of Compatible Results". Poster Session, Urban Tree Growth Symposium at the Morton Arboretum in Lisle, Illinois, September 12-13, 2011.

Miller, Randall H. 2014 Integrated Vegetation Management for Utility Rights-of-Way Best Management Practices, Second Edition. International Society of Arboriculture, P.O. Box 3129 Champaign, Illinois 61826. Review Committee member.

PROFESSIONAL AFFILIATIONS

International Society of Arboriculture
International Society of Arboriculture, Board of Directors, 1989 to 1995
Journal of Arboriculture Editorial Board, 1993 - 1995
Illinois Urban Forestry Advisory Council, 1990-1995
Illinois Arborist Association, President, 1986 (Board member and officer previous years)
American Wood Preservers Association
Edison Electric Institute
Utility Arborist Association

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(608) 877-1170
www.eci-consulting.com

J. M. SPARKMAN, JR.

PROFESSIONAL EXPERIENCE

ENVIRONMENTAL CONSULTANTS, INC., Stoughton, Wisconsin **December 2012 to Present**

Manager, Consulting Services

Responsible for oversight and direction of the ECI's consulting services business unit including distribution line clearance studies, wood pole and joint facilities management plans, transmission ROW studies, gas pipeline assessment and mapping, training services, practical research projects, litigation support and special studies.

ENVIRONMENTAL CONSULTANTS, INC., Stoughton, Wisconsin **2010 to December 2012**

Senior Project Manager

Provides overall direction, coordination, implementation, control and execution to specific assigned projects. This includes acquiring resources and coordinating the efforts and logistics of team members and third-party contractors or consultants in order to deliver projects according to schedule. Responsible for data analysis, formulating specific program recommendations based on analysis and the delivery of final project reports to clients.

FLORIDA POWER & LIGHT COMPANY, West Palm Beach, Florida **1991 to April 2010**

Regional Lead

Held several positions of increasing responsibility within the Vegetation Management business unit. As a Utility Arborist, responsibilities included the administration of the North Area line clearing contract and the oversight of over 6,000 distribution miles. This included the monitoring of crew productivity to control line clearing costs, monitoring reliability performance and quality assurance for compliance to contract terms. Routinely worked directly with city, county, and municipal officials as well as FPL customers to promote and educate proper vegetation management pruning techniques.

After recognizing the need for dedicated internal data and program support within the business unit in 1999, and appointed as Senior Systems Analyst, responsibilities included system reliability monitoring, forecasting and tracking to ensure compliance with system goals, variance analysis, countermeasure development, budget preparation, and upper level reporting.

In 2002, became the supervisor of the newly created Vegetation Management Project Management Office. Responsible for all core project management functions of the group. Responsible for managing budget development, contract development, goals and targets, performance indicator development, policy and process development, programming and systems support, claims processing, legal expert witness support including depositions and court trials, Florida Public Service Commission inquiry response, rate case support, and other administrative functions. Supervised the invoice process, approval and payment for the FPL Vegetation Management business unit with over $65M in annual contractor invoices. Coordinated crew, logistical functions, storm costs estimates, and accruals as part of the General Office Command Center storm team for 3 major hurricanes impacting FPL in 2004 and 2005 totaling more than $150M in tree related restoration expenses.

In 2008 after the Project Management Office was combined though necessity with the Contract Payment Center and Central Maintenance Budget group, was offered an opportunity to supervise the vegetation operations for the East Region of the FPL service territory. This included 7 counties from Palm Beach County north to the Brevard County line with over 8,600 miles of distribution overhead lines. Directly supervised a staff of two FPL Arborists and five Contract Arborists and managed the activities of 150 tree crew resources. Developed RISK analysis procedures for Vegetation Management in order to better prioritize, assign, and mitigate reliability performance issues.

EDUCATION

B.S. - Forestry, Virginia Polytechnic Institute and State University (VA Tech) College of Forestry and Wildlife, 1988.

PROFESSIONAL AFFILIATIONS

International Society of Arboriculture (ISA)
Utility Arborist Association (UAA) – Wisconsin Chapter

CERTIFICATES

ISA Certified Arborist SO 0418A
YCA Project Management Certification

**BEFORE THE
STATE OF NEW YORK
PUBLIC SERVICE COMMISSION**

Petition of New York State Electric & Gas Corporation for Authorization to Implement Full-Cycle Distribution Vegetation Management	Case 13-E-_____

PETITION OF NEW YORK STATE ELECTRIC & GAS CORPORATION FOR AUTHORIZATION TO IMPLEMENT FULL-CYCLE DISTRIBUTION VEGETATION MANAGEMENT

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Dated: March 15, 2013

**BEFORE THE
STATE OF NEW YORK
PUBLIC SERVICE COMMISSION**

Petition of New York State Electric & Gas Corporation for Authorization to Implement Full-Cycle Distribution Vegetation Management	:	Case 13-E-_____

PETITION OF NEW YORK STATE ELECTRIC & GAS CORPORATION FOR AUTHORIZATION TO IMPLEMENT FULL-CYCLE DISTRIBUTION VEGETATION MANAGEMENT

I. INTRODUCTION

New York State Electric & Gas Corporation ("NYSEG" or the "Company") hereby seeks approval from the New York State Public Service Commission ("Commission") to implement full-cycle vegetation management for its overhead distribution system. Specifically, the Company respectfully requests Commission authorization to implement an initial full-cycle distribution vegetation management reclamation program (the "Reclamation Cycle") and, thereafter, enter into a full-cycle, long-term distribution vegetation management maintenance program (the "Long-Term Maintenance Cycle"), as recommended by Environmental Consultants, Inc.[1] NYSEG also seeks authorization to implement a temporary surcharge until the full cost of the distribution vegetation management program is embedded in a new rate plan.

Over the past few years, a number of significant storm events, including Hurricane Sandy, Tropical Storm Irene and Tropical Storm Lee, have impacted NYSEG's service territory. Most recently, Hurricane Sandy had a dramatic impact on certain areas of

1 As discussed in more detail herein, the Reclamation Cycle includes a four-year cycle with mid-cycle for 34.5 kV, five-year cycle for 12.5-19.9 kV, and five-year cycle for less than 12.5 kV. The Long-Term Maintenance Cycle includes a four-year cycle on the 34.5 kV lines with a targeted mid-cycle program for the three-phase portions, a four-year cycle on three-phase with a five-year cycle on single-phase lines for voltages between 12.5 kV and 19.9 kV, and a five-year cycle on all voltages below 12.5 kV.

NYSEG's service territory. NYSEG's Liberty and Brewster divisions were particularly hard hit by Hurricane Sandy. The severity of the recent storms, along with the distribution vegetation management recommendations contained in the Company's recent management audit, have highlighted and escalated the importance of a full-cycle distribution vegetation management program for NYSEG. Tree related outages represent over a third of customer interruptions on the NYSEG system. It is imperative that this Petition be addressed now so that the Company can implement full-cycle distribution vegetation management as soon as possible. As such, the Company respectfully requests a July 2013 Commission order to allow the Company a smooth transition for the preparation, issuance, negotiations and awarding of Requests for Proposals ("RFPs") for an effective start date of January 1, 2014.

II. BACKGROUND AND OVERVIEW

A. NYSEG's Historical and Current Distribution Vegetation Management

NYSEG's electric distribution system is not on a full-cycle vegetation management program.[2] Historically, NYSEG's distribution vegetation management has generally included a three-year cycle for the three-phase portions of the 34.5 kV circuits, a five-year cycle for non-34.5 kV three-phase lines and 34.5 kV single-phase lines, and a priority-driven approach (indeterminable cycle) for the remaining non-34.5 kV single-phase lines. Attached hereto as Exhibit A is additional detail regarding NYSEG's historical tree trimming practices, including five years of the Company's historical miles trimmed per voltage class and five years of the Company's vegetation management actual expenditures. Exhibit A, page 2, illustrates the number of tree caused outages on the NYSEG system. As shown on the exhibit, NYSEG's historical five-year average of customer interruptions indicates approximately 36% of customers

[2] NYSEG has over 29,000 miles of overhead distribution lines.

are affected by tree caused outages and 42% of customer hours are associated with tree caused outages.

As part of NYSEG's most recent rate plan, the Commission approved distribution vegetation management expenditure levels that allowed NYSEG to begin movement toward full-cycle trim for all of its distribution system. The Commission-approved annual distribution vegetation management funding for calendar years 2011, 2012 and 2013 was $16.66 million, $18.66 million and $20 million, respectively.[3] The annual funding level estimates included the assumption that the Company would incur approximately $3.55 million annually in hot spot crew costs. The Rate Plan also included a negative revenue adjustment if NYSEG failed to meet a specified distribution trimming target mileage on an annual basis.[4] NYSEG has met the target mileage under the Rate Plan, including attaining the 2012 target mileage by the end of November.

In 2011, NYSEG spent $23.8 million on distribution vegetation management. This amount included $13.8 million of planned maintenance, $2.9 million hot spot work and $7.1 million for incremental reliability.[5] The 2011 work consisted of 2,716 planned miles (i.e., 548 miles 34.5 kV, 1,205 miles 15 kV, and 963 miles 5 kV). The cost of the planned maintenance equated to $5,078 per mile ($13.8 million/2,716 miles). The Company's incremental reliability spend focused on targeted mileage and hot spot work in areas with emerging reliability issues. In 2011, NYSEG trimmed 2,949 miles of distribution circuits in total (planned and incremental

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3 Case 09-E-0715, et al. – Proceeding on Motion of the Commission as to the Rates, Charges, Rules and Regulations of New York State Electric & Gas Corporation and Rochester Gas and Electric Corporation for Electric and Gas Service, Joint Proposal, § XIII and Appendix Q (July 14, 2010), approved, Case 09-E-0715, et al., Order Establishing Rate Plan (Sept. 21, 2010). The amounts shown for 2011 and 2012 reflect the rate allowances on a calendar year basis from Rate Plan Appendix C.

4 Id. at Appendix Q.

5 NYSEG had estimated a 2011 incremental reliability spend level of $8.6 million, which included an accrual estimate at year end. In 2012, the actual billed charges for 2011 turned out to be $1.5 million less than what was accrued and a commensurate adjustment was made on the Company's books.

reliability mileage work). The Company's Annual Electric Vegetation Management Report, filed with the Commission on March 15, 2012 with a revision filed on April 2, 2012 contains additional information. A copy of the April 2, 2012 filing is attached hereto as Exhibit B.[6]

Beginning in 2012, the Company increased its focus on priority circuits impacting the most customers. In 2012, NYSEG spent $19.1 million on distribution vegetation management, of which $15.55 million was planned maintenance and $3.53 million was hot spot work. The vegetation management covered 2,782 planned miles, which included 329 miles 34.5 kV, 1,582 miles 15 kV, and 871 miles 5 kV. The cost of the planned maintenance was $5,589 per mile (i.e., $15.55 million/2,782 miles). NYSEG filed its Annual Electric Vegetation Management Report for 2012 with the Commission yesterday. A copy of the report is attached hereto as Exhibit C.

In the first quarter of 2012, NYSEG issued RFPs for its 2013 distribution vegetation management work. The RFP process for the 2013 plan was executed such that contracts were signed and purchase orders were issued for the work in December 2012. Contractors began work on the 2013 plan on January 2, 2013 as recommended in the Liberty Management Audit. NYSEG plans to clear 2890 miles of distribution vegetation in 2013. A summary of the 2013 plan is shown in Tables 1 and 2 below.[7]

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6 Case 09-E-0715, et al., Annual Electric Vegetation Management Report (filed March 15, 2012 with a revised filing on April 2, 2012).

7 In anticipation of Commission approval, the Company is seeking RFP bids which would reflect an incremental spend in 2014.

Table 1 - 2013 NYSEG Distribution Vegetation Management Summary of Planned Expenditures

TABLE 1

2013	NYSEG Planned
Maintenance	$16,228,720
Hot Spot	$3,771,280
Grand Total	$20,000,000

Table 2 – 2013 NYSEG Distribution Vegetation Management Mileage Clearance Planned Expenditures by Voltage Class

TABLE 2

NYSEG	NYSEG Distribution Miles Planned 2013	34.5 kV Miles	34.5 kV Cost	15 kV Miles	15 kV Cost	5 kV Miles	5 kV Cost	Total Planned Cost
Maintenance Program	2890	1009	$4,750,913	1135	$6,542,722	746	$4,935,085	$16,228,720

B. Environmental Consultants, Inc.'s Recommendations

NYSEG hired Environmental Consultants, Inc. ("ECI") to undertake a distribution system cycle optimization study ("ECI Report"). As demonstrated in Appendix I to the ECI Report, ECI is a leading provider of vegetation management consulting services. ECI has forty years of consulting experience in the electric utility industry. ECI has helped over 170 utilities develop new or improved distribution and/or transmission vegetation management programs. A copy of the ECI Report is attached hereto as Exhibit D.

ECI analyzed, among other items, trees per mile, tree species and tree re-growth data in NYSEG's service territory. ECI studied the tree density and tree workload characteristics in NYSEG's service territory. The percentage of tree workload adjacent to multi-phase lines, the percentage of trees within contact with conductors, the percentage of trees overhanging the conductors, the percentage of hazard trees with obvious defects and the top trims as a percentage of all trims are important considerations when determining optimal cycle lengths.

Table 6 in the ECI Report summarizes trees per mile for multi-phase lines, trees in contact, overhanging trees, hazard trees and top pruning workload by division.[8] As shown in Table 6, the total average trees per mile for the NYSEG system is 86. This is slightly less than the average utility for which ECI has comparable data. However, tree density varies significantly from division to division and often within a division depending on circuit location. As reflected in Table 6, the total average trees per mile by division ranges from 56 in Elmira and Plattsburgh to 162 in Brewster and 175 in Liberty.

ECI also studied the types of trees and associated growth in NYSEG's service territory.[9] As noted by ECI, one of the primary considerations in determining the appropriate maintenance cycle for the NYSEG distribution system is the rate at which the trees grow after being pruned. ECI used tree regrowth data, species frequency and the percent of each species that require either top or side pruning to project average tree regrowth and the amount of line contact by varying maintenance cycles. The overall growth rates of top and side pruned trees on the NYSEG system is shown in Figure 8 of the ECI Report.[10] Figure 9 presents the percentage of trees that can be expected to be in direct contact with conductors each year after pruning.[11]

Tree clearance is also a major factor to the total cost of pruning.[12] Trees in close proximity to the conductors require additional steps and safety measures for the tree crew which can significantly impact productivity. Less productivity equals higher costs. Table 8 of the ECI Report demonstrates that 50% of the trees on the NYSEG system were within four feet of the

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8 ECI Report at 14.

9 Id. at 16, 21-22 and Appendices A and B.

10 Id. at 22.

11 Id. at 23.

12 Id. at 17.

conductors at the time of the workload survey with potential to make line contact within two growing seasons.[13]

Based on its evaluation of the NYSEG system, ECI made several recommendations to move NYSEG toward an optimal vegetation management approach with full-cycle maintenance on all distribution voltages.[14] ECI also recommended long-term vegetation maintenance strategies.

ECI specifically recommends that NYSEG implement an initial Reclamation Cycle in which full-cycle maintenance of the three-phase portions of 34.5 kV circuits will continue while NYSEG moves to full circuit maintenance on all remaining circuits including laterals.[15] The Reclamation Cycle includes an eighteen-month phase-in to ramp up NYSEG's workforce and contractors in the most effective manner. The Reclamation Cycle includes a four-year cycle with mid-cycle for 34.5 kV, five-year cycle for 12.5-19.9 kV, and five-year cycle for less than 12.5 kV.[16] Given that the Reclamation Cycle will include full circuit pruning on laterals that have not been trimmed in a number of years, the cost per mile during this phase is estimated to be higher than the 35 kV circuits that have been trimmed on a regular cycle.[17]

After the Reclamation Cycle, ECI recommends that NYSEG enter into a long-term maintenance cycle. ECI anticipates "that the maintenance cost per mile will be reduced significantly (an approximately 40% reduction from the reclamation time frame) in the second

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13 Id.

14 Id. at 4, 23-45.

15 Id. at 3-4, 27-28.

16 Id.

17 Id.

cycle and beyond as there will be lower workload, increased productivity due to trees no longer growing through the conductors, and fewer trees and brush requiring removal."[18]

ECI provided two options for the Reclamation Cycle and four options for the long-term maintenance cycle. The ECI Report includes Customers Interrupted projections for each option and projected budgets. Estimated annualized costs of the Reclamation Cycles range from $62.9 million to $68.2 million with the long-term vegetation maintenance costs ranging from $35 million to $42.5 million.[19]

ECI specifically recommends the following for NYSEG:

1. Reclamation Option 2 for the first cycle, which includes a four-year cycle on the 34.5 kV lines with a targeted mid-cycle program for the three-phase portions, and a five-year cycle on all remaining voltages. All circuits are to be pruned to the full NYSEG clearance specifications;
2. An eighteen (18) month ramp-up period for the implementation of the first cycle; and
3. Option 2 for the second cycle and beyond (i.e., the Long-Term Maintenance Cycle), which includes a four-year cycle on the 34.5 kV lines with a targeted mid-cycle program for the three-phase portions, a four-year cycle on three-phase with a five-year cycle on single-phase lines for voltages between 12.5 kV and 19.9 kV, and a

18 Id. at 3.

19 Id. at 3 and Appendix C.

five-year cycle on all voltages below 12.5 kV. All circuits are to be pruned to the full NYSEG clearance specifications.[20]

ECI also addressed potential herbicide usage.[21] The ECI Report notes that the effectiveness of selective herbicide applications has been well documented through long-term studies on utility rights-of-way in the central and northeastern United States. As discussed in the ECI Report and shown in Figure 18, "[r]esults from treatment simulation models developed through these studies project that sites dominated by deciduous species would nearly double in stem density by the end of two cycles if simply cut without a follow-up herbicide application."[22] NYSEG intends to explore with certain localities the use of herbicides in an environmentally acceptable way.

The ECI recommendations are generally supportive of Recommendations 11.7 and 11.8 from the Company's 2012 Management Audit. Recommendation 11.7 states that the Company should "move to a five-year trim cycle on all circuits."[23] Recommendation 11.8 suggests that the Company should "[a]chieve the benefits of using herbicides in the distribution vegetation management program."[24]

NYSEG respectfully requests Commission approval to implement the ECI recommendations as described herein and in the ECI Report.

20 Id. at 4, 27-29 and Appendix D.

21 Id. at 39-44.

22 Id.

23 Case 10-M-0551 – Comprehensive Management Audit of Iberdrola, S.A., Iberdrola USA, Inc., New York State Electric & Gas Corporation and Rochester Gas and Electric Corporation, Final Report, at p. XI-68 (June 4, 2012).

24 Id. at p. XI-69.

C. NYSEG's Reclamation Cycle Implementation Plan

NYSEG has developed an implementation plan for the Reclamation Cycle (the "Plan"). The Plan is attached hereto as Exhibit E ("the Plan"). The Plan addresses circuit prioritization and scheduling, personnel, work acceptance and auditing, customer relations and tracking/record keeping.

III. DISCUSSION

A. Full-Cycle Distribution Vegetation Management Is Beneficial

The ECI Report discusses the benefits associated with NYSEG's implementation of full-cycle distribution vegetation management. As discussed in the ECI Report, "[t]rees are a leading cause of service interruptions at NYSEG and at most utilities."[25] Vegetation management programs are "key strategic initiatives designed to manage risks through the efficient and cost-effective maintenance of vegetation posing an immediate or potential threat to the electric delivery system."[26] Such risks include but are not limited to system reliability, infrastructure equipment and public safety. These risks are recognized in the National Electric Safety Code[27] and the New York State Public Service Commission's tree trimming targets. The ECI Report also references several advantages of the Reclamation Cycle and long-term maintenance cycle, including the potential for 1) reduction in storm restoration time and cost; 2) maintenance of acceptable reliability with potential for improvement in system reliability; 3) improved customer satisfaction; 4) improved public relations image; 5) improved safety to NYSEG workers,

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25 ECI Report at 18.

26 Id. at 7.

27 "Vegetation that may damage ungrounded supply conductors should be pruned or removed. Vegetation management should be performed as experience has shown to be necessary." National Electrical Safety Code § Section 218(A) (2012).

NYSEG contractor workers and the public; and 6) reduction in customer trim requests and associated costs.[28]

In specific, ECI made several recommendations "to move NYSEG toward full-cycle maintenance on all distribution voltages that will improve system reliability and in a cost effective manner."[29] According to the ECI Report, the completion of the Reclamation Cycle would improve reliability in tree outages per 100 miles. NYSEG can also anticipate reduced restoration time and cost for storm restoration as the Reclamation Cycle is completed.[30] During the Long-Term Maintenance Cycle, NYSEG can expect reliability to remain steady with a slight improvement over time. NYSEG can also anticipate reduced customer tickets and the reduced need for hot-spot pruning.[31]

NYSEG is not proposing to change its reliability metrics at this time. The Company believes it is necessary to first implement the Reclamation Plan, develop a base line and then adjust metrics accordingly. As stated above, NYSEG expects reliability improvements over time and requests that it be allowed to analyze the impacts of implementing the plan before adjusting metrics.

B. Full-Cycle Distribution Vegetation Management Is Cost Effective

The ECI Report also addresses the costs of NYSEG's implementation of full-cycle (five-year) distribution vegetation management. The anticipated annual cost (in 2012 dollars) for ECI's recommended approach, including an 18 month ramp-up period, is \$36.8 million in year one, \$66.5 million in year two, \$70.4 million in years three and four, \$62 million in year five,

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28 ECI Report at 35.

29 Id. at 3.

30 Id. at 4.

31 Id. at 4, 18-22.

and $37.9 million thereafter for the recommended five-year Long-Term Maintenance Cycle.[32] Compared to the $20 million annual amount currently included in rates, the incremental 2014 cost is expected to be $16.8 million (i.e., $36.8 million - $20 million). The incremental 2015 cost is expected to be $46.5 million (i.e., $66.5 million - $20 million). As noted previously, these expected costs are stated in 2012 dollars. The final cost will depend on the responses to the Company's RFPs.

The ECI Report also presents a net present value ("NPV") analysis, which compares the fifteen-year NPVs of continuing the current vegetation management practices and expenditure levels (not moving to a full-cycle trim for all circuits) to ECI's recommended approach.[33] Appendix E of the ECI Report presents two versions of the NPV analysis (using different discount rates) and associated assumptions. The analysis anticipates several benefits from a systematic and proactive maintenance strategy. However, many of the qualitative benefits of moving to a full-cycle trim for all circuits are not able to be included in this quantitative analysis, but would not be achieved if NYSEG continues its current vegetation management practices.

The analysis resulted in a NPV for the proposed program of $774 million over 15 years, which is 2.8% lower than the NPV of the current program. Assumptions included a 4.1% discount rate and $3.4 million in annual costs associated with the safety-related claims, deterioration in customer and governmental satisfaction, and periodic mitigation related to major events made worse by infrequent tree maintenance. To the extent that these costs exceed $3.4 million annually, the NPV becomes more favorable toward the recommended program strategy. It is likely that these average annual costs could easily exceed $3.4 million by at least $1.5

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[32] Id. at 4 and Appendices C and D.

[33] Id. at 34-35 and Appendix E.

million per year. A second analysis, using a 7.48% discount rate resulted in a 1.1% percent higher NPV for the full-cycle program when compared to the current program.

In light of the benefits and cost-effectiveness of a full-cycle distribution vegetation management program, NYSEG respectfully requests Commission approval to implement the ECI recommendations as described herein and in the ECI Report.

C. NYSEG's Proposed Cost Recovery Mechanism

NYSEG respectfully requests recovery of the incremental vegetation management costs through a separate monthly surcharge until the cost of the full-cycle trim program can be incorporated into the Company's delivery rates. The Company proposes to implement a monthly surcharge beginning January 2014 for the recovery of incremental vegetation management costs. NYSEG's 2014 base delivery rates will include $20 million for distribution vegetation management. Incremental costs above the $20 million will form the creation of the surcharge. Based on the estimates contained in this filing, NYSEG's surcharge during 2014 will be for $16.8 million. The actual surcharge will be based on the expected actual costs from third party vegetation management contractor responses to the Company's RFP bidding process.

NYSEG will fully reconcile the costs associated with implementing a full-cycle trim program. The Company will track and reconcile actual costs with recoveries. Any deferred costs or credits (with interest) will be recovered or returned to customers in the following year's surcharge or included in base delivery rates if rates have been reset due to a rate filing.

NYSEG proposes to create a separate Vegetation Management Surcharge for each service class. The incremental costs of the full-cycle trim program will be allocated to each service class based on the non-coincident peak allocation factors from NYSEG's 2008 Embedded Cost of Service Study filed in its last rate filing (i.e., Case 09-E-0715). Since these incremental costs are distribution-related, the transmission and subtransmission service classes

(Service Classes 3-S, 7-3 and 7-4) will not receive an allocation of costs and separate Vegetation Management Surcharges will not apply to these classes. For each non-demand metered service class, NYSEG will a create class specific volumetric surcharge rate on a ¢/kWh basis. For each demand metered service class, NYSEG will a create class specific demand surcharge rate on a $/kW basis. The Company anticipates that the creation, testing and implementation of class specific Vegetation Management Surcharges will take three months.

IV. CONCLUSION

For the reasons set forth above, NYSEG respectfully requests authorization to implement the distribution vegetation management recommendations contained within the ECI Report and to recover the costs through the mechanism discussed herein. The Company also respectfully requests a July 2013 Commission order to allow the Company a smooth transition for the preparation, issuance, negotiations and awarding of RFPs for an effective start date of January 1, 2014.

Dated: March 15, 2013

Respectfully submitted,

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On behalf of New York State Electric & Gas Corporation

LIST OF EXHIBITS

NYSEG **Exhibit A**
Historical Distribution Vegetation Management Information **Page 1 of 2**
($000)

	2008	2009	2010	2011	2012
Distribution Spending	**$ 9,976**	**$ 11,467**	**$ 10,857**	**$ 23,798**	**$ 19,078**
Mileage Cleared	**1,732**	**2,096**	**2,168**	**2,716**	**2,782**
Mileage Detail					
34.5 kV	NYSEG did not maintain mileage clearance by voltage category during these years.		660	548	329
15 kV			1,008	1,205	1,582
5 kV			500	963	871
Total	**1,732**	**2,096**	**2,168**	**2,716**	**2,782**

Note
1 - Distribution spending from NYSEG Annual Reliability Reports and Vegetation management reports of 2011 and 2012.

NYSEG **Exhibit A**
Tree Caused Interruptions 2008 through 2012 **Page 2 of 2**

	Tree Totals			Tree % to All			Totals - No Storm Ints		
	Ints	CstAff	CstHrs	Ints	CstAff	CstHrs	Ints	CstAff	CstHrs
2008	4,124	349,066	886,527	41.2%	36.6%	44.8%	10,020	953,108	1,980,215
2009	4,238	366,008	815,384	44.0%	39.7%	44.1%	9,632	922,379	1,848,503
2010	4,310	345,165	837,664	44.1%	35.4%	43.3%	9,770	975,379	1,934,746
2011	4,330	371,322	820,690	42.2%	36.1%	38.6%	10,272	1,028,868	2,127,895
2012	4,267	276,702	688,273	45.3%	33.0%	41.1%	9,424	839,413	1,675,697
5 Yr Avg	4,254	341,653	809,708	43.3%	36.2%	42.3%	9,824	943,829	1,913,411

IBERDROLA USA

Revised – April 2, 2012

NYSEG and RG&E

Annual Electric Vegetation Management Report

Revised – April 2, 2012

Revised – April 2, 2012

This Revised Report is submitted as a replacement of the Companies (NYSEG and RG&E) Distribution Vegetation Management Report of March 15, 2012. The revisions clarify the Companies 2011 distribution vegetation management amounts and additional vegetation maintenance actions.

NYSEG Electric and RG&E Electric Vegetation Management Reporting and Planning

This report has been prepared to meet the information requested in Appendix Q of the Joint Proposal in the Companies' latest Rate Plan associated with cases 09-E-0715 and 09-E-0717.

NYSEG 2011 Distribution Vegetation Management

In 2010 an RFP was issued for 2,702 miles of distribution line vegetation clearing at NYSEG, to be completed in 2011. The following companies submitted bids: Asplundh Tree Expert Company, Lewis Tree Service, Nelson Tree Expert Company, Birchcrest Tree Care & Landscaping Company, and K.W. Reese. Contracts were awarded to the lowest bidder for specific NYSEG operating divisions. The 2011 average cost for distribution vegetation mileage clearing at NYSEG was $5,078 per mile. The circuit selection was based on a combination of SAIFI worst performing circuits, and time since last cleared.

RG&E 2011 Distribution Vegetation Management

In 2010 an RFP was issued for 1,103 miles of distribution line vegetation clearing at RG&E, to be completed in 2011. This RFP was sent concurrently with the NYSEG RFP. The following companies submitted bids: Asplundh Tree Expert Company, Lewis Tree Service, and Birchcrest Tree Care & Landscaping. Contracts were awarded to the lowest bidder for specific RG&E operating divisions. The 2011 average cost for distribution vegetation mileage clearing work at RG&E was $3,077 per mile. The circuit selection was based on a combination of SAIFI worst performing circuits, and time since last cleared.

IBERDROLA USA

Revised – April 2, 2012

Table 1 - 2011 NYSEG/RG&E Summary of Budgeted and Actual Expenditures for Distribution Vegetation Maintenance

TABLE 1

2011	NYSEG Budgeted	NYSEG Actuals	RG&E Budgeted	RG&E Actuals
Maintenance (Miles)[1]	$14,113,052	$13,791,718	$3,573,751	$3,581,737
Hot Spot[2]	$2,556,948	$2,879,066	$3,026,249	$3,436,405
Additional Vegetation Maintenance[3]	$0	$8,604,011	$0	$3,379,901
Total	$16,670,000	$25,274,795	$6,600,000	$10,398,043

1. Maintenance – Planned annual distribution circuit clearing miles.
2. Hot Spot – Planned annual distribution circuit hot spotting.
3. Additional Vegetation Maintenance – Vegetation maintenance for emerging 2011 distribution system improvements beyond planned work.

Table 2 – Actual 2011 NYSEG/RG&E Distribution Vegetation Expenditures and Mileage by Voltage Class, for Planned Circuit Maintenance

TABLE 2

NYSEG	Distribution Miles Completed 2011	34.5 kV Miles	34.5 kV Cost	15 kV Miles	15 kV Cost	5 kV Miles	5 kV Cost	Total Cost
Maintenance Program (Miles)	2716	548	$1,922,907	1205	$6,611,599	963	$5,257,212	$13,791,718
RG&E	**Distribution Miles Completed 2011**	**34.5 kV Miles**	**34.5 kV Cost**	**15 kV Miles**	**15 kV Cost**	**5 kV Miles**	**5 kV Cost**	**Total Cost**
Maintenance Program (Miles)	1164	296	$1,073,290	571	$965,728	297	$1,542,719	$3,581,737

IBERDROLA USA

Revised – April 2, 2012

2011 NYSEG/RG&E Distribution Vegetation Maintenance Beyond Planned Work

Electric reliability challenges were faced at both NYSEG and RGE in 2011 as a result of numerous events outside of the Companies' control (these events have been documented in the annual report filed by the Companies in accordance with Appendix P of the Joint Proposal in the Companies' latest Rate Plan). By the summer of 2011, both Companies were trending towards not achieving their respective SAIFI metrics. Based on projections for the remainder of 2011, an action plan was implemented to assure that the SAIFI metrics would be achieved at both Companies. Distribution circuit vegetation work was an essential part of this reliability improvement initiative. The first phase of this program involved identifying vegetation hot spot issues on the worst 100 performing distribution circuits at both RG&E and NYSEG. The second phase involved identifying vegetation hot spot issues on the next 100 worst performing circuits at NYSEG. For both phases, internal field forces surveyed the circuits for immediate tree threats. As work plans were developed, the Companies requested additional crews from its vegetation contractors; however the vegetation vendors did not have the local capacity to take on the additional work. Thus, to accomplish the work plan the Companies paid a premium by way of mobilization, per diems, and demobilization costs associated with the use of out of town tree crews as compared to the planned annual maintenance program. In addition, this targeted maintenance involved heavier tree density, multiple contractor setup/breakdown costs, and competition with neighboring utilities for crew resources due to other weather related events in the summer and fall of 2011.

In addition to the mileages shown in table 4 below, the companies estimate that 14,000 spans were cut with 67,219 trees either removed or pruned with this additional vegetation maintenance effort.

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Revised – April 2, 2012

Table 3 - 2011 Additional NYSEG/RG&E Distribution Vegetation Maintenance Expenditures

TABLE 3

2011 Additional Distribution Vegetation Maintenance		
	NYSEG	RG&E
Additional Vegetation Mileage	$2,350,725	$1,209,000
Additional Vegetation Hot Spot	$6,253,286	$2,170,901
Total	$8,604,011	$3,379,901

Table 4 - 2011 NYSEG/RG&E Additional Distribution Vegetation Miles Cleared

TABLE 4

2011 Additional Vegetation Miles		
	NYSEG	RG&E
Miles	233	120

Table 5 - 2011 NYSEG/RG&E Total Distribution Miles

TABLE 5

Total Miles Cleared		
2011	NYSEG	RG&E
Maintenance (Miles)	2716	1164
Additional Vegetation Mileage	233	120
Total	2949	1284

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Revised – April 2, 2012

NYSEG 2012 Distribution Vegetation Management

For 2012 NYSEG plans on clearing 2786 miles of distribution vegetation. A summary of the 2012 plan is shown in tables 6 and 7.

RG&E 2012 Distribution Vegetation Management

For 2012 RG&E plans on clearing 1104 miles of distribution vegetation. A summary of the 2012 plan is shown on tables 6 and table 7.

Table 6 - Planned 2012 NYSEG/RG&E Distribution Vegetation Clearance by Voltage Class

TABLE 6

Company	Distribution Miles Planned 2012	Cost	34.5 kV Miles	15 kV Multi-phase Miles	5 kV Multi-phase Miles
NYSEG Subtotal	2786	$15,206,654	406	1124	1256
RG&E Subtotal	1104	$4,370,040	91	634	379
Total	3890				

Table 7 - Planned 2012 NYSEG/RG&E Distribution Vegetation Mileage and Hotspot Expenditures

TABLE 7

2012 Planned	NYSEG	RG&E
Maintenance (Miles)	$15,206,654	$4,370,040
Hot Spot	$3,463,346	$2,229,960
Total	$18,670,000	$6,600,000

NYSEG RG&E

March 14, 2013

VIA ELECTRONIC SERVICE

Honorable Jeffrey Cohen
Acting Secretary
New York State Public Service Commission
Three Empire State Plaza
Albany, NY 12223-1350

Re: Cases 09-E-0715, 09-G-0716, 09-E-0717 and 09-G-0718 – Proceeding on Motion of the Commission as to the Rates, Charges, Rules and Regulations of New York State Electric & Gas Corporation and Rochester Gas and Electric Corporation for Electric and Gas Service

Dear Secretary Cohen:

Pursuant to Appendix Q, of the Joint Proposal approved by the New York State Public Service Commission's Order Establishing Rate Plan, issued and effective September 21, 2010, in the above-referenced proceeding, New York State Electric & Gas Corporation ("NYSEG") and Rochester Gas and Electric Corporation ("RG&E") respectfully submit the attached Annual Electric Vegetation Management report.

If you have any questions, please contact me at 607.762.8710.

Respectfully submitted,

Lori A. Cole
Manager - Regulatory & Tariffs
Rates and Regulatory Economics

Attachment

NYSEG and RG&E Annual Electric Vegetation Management Report

March 14, 2013

NYSEG and RG&E Distribution Vegetation Management Reporting & Planning

This report has been prepared to meet the information requested in Appendix Q of the Joint Proposal in the Companies' latest Rate Plan associated with cases 09-E-0715 and 09-E-0717.

NYSEG 2012 Distribution Vegetation Management

In 2011 an RFP was issued for 2,782 miles of distribution line vegetation clearing at NYSEG, to be completed in 2012. The following companies submitted bids: Asplundh Tree Expert Company, Lewis Tree Service, Nelson Tree Expert Company, Trees Inc., Birchcrest Tree Care & Landscaping Company, and K.W. Reese. Contracts were awarded to the lowest bidder for specific NYSEG operating divisions. The 2012 average cost for distribution vegetation mileage clearing work at NYSEG was $5,589 per mile. The circuit selection was based on a combination of SAIFI worst performers, and time since last cleared.

RG&E 2012 Distribution Vegetation Management

In 2011 an RFP was issued for 1,104 miles of distribution line vegetation clearing at RG&E, to be completed in 2012. This RFP was sent concurrently with the NYSEG RFP. The following companies submitted bids: Asplundh Tree Expert Company, Lewis Tree Service, and Birchcrest Tree Care & Landscaping. Contracts were awarded to the lowest bidder for specific RG&E operating divisions. The 2012 average cost for distribution vegetation mileage clearing work at RG&E was $4,173 per mile. The circuit selection was based on a combination of SAIFI worst performers, and time since last cleared.

Table 1 - 2012 NYSEG/RG&E Distribution Vegetation Management Summary of Planned and Actual Expenditures

TABLE 1

2012	NYSEG Planned	NYSEG Actuals	RG&E Planned	RG&E Actuals
Maintenance (Mileage)	$15,206,654	$15,547,476	$4,370,040	$4,607,032
Hot Spot	$3,393,346	$3,530,801	$2,229,960	$2,184,614
Grand Total	$18,600,000	$19,078,277	$6,600,000	$6,791,646

Table 2 – 2012 NYSEG/RG&E Distribution Vegetation Management Mileage Clearance and Actual Expenditures by Voltage Class

TABLE 2

NYSEG	NYSEG Distribution Miles Completed 2012	34.5 kV Miles	34.5 kV Cost	15 kV Miles	15 kV Cost	5 kV Miles	5 kV Cost	Total Cost
Maintenance Program	2782	329	$1,808,214	1582	$8,685,425	871	$5,053,837	$15,547,476
RG&E	**RG&E Distribution Miles Completed 2012**	**34.5 kV Miles**	**34.5 kV Cost**	**15 kV Miles**	**15 kV Cost**	**5 kV Miles**	**5 kV Cost**	**Total Cost**
Maintenance Program	1104	155	$586,658	568	$1,925,872	381	$2,094,502	$4,607,032

2012 NYSEG/RG&E Hot Spot Program

The hot spot program is designed primarily to focus on emerging issues that, if not addressed, could negatively impact electric system reliability. Hot spot dollars are also utilized to address specific unplanned customer requests. The hot spot work in 2012 included work on 5,747 spans at NYSEG and 3,864 spans at RG&E; over 2,600 tree removals at NYSEG and over 600 tree removals at RG&E; and over 19,000 trees pruned at NYSEG and over 11,000 trees pruned at RG&E.

2011 Distribution Spending

During each calendar year, the Company estimates its accruals for invoices not received. In 2011, NYSEG and RG&E overestimated its expected invoices. In 2012, NYSEG and RG&E recorded adjusting entries to reduce the 2011 spending by $1,477,021 and $2,326,891 respectively, for the over accrual in 2011. This is typical accrual accounting with adjustments for final received invoices / payments the following year. Table 3 below illustrates the final 2011 distribution spending amounts.

Table 3 – 2011 Final Distribution Vegetation Management Expenditures

TABLE 3

2011	NYSEG 2011 As filed in April 2012 Report	NYSEG 2011 As adjusted to reflect actual invoices	RG&E 2011 As filed in April 2012 Report	RG&E 2011 As adjusted to reflect actual invoices
Maintenance (Mileage), Hot Spot and Additional Maintenance	$25,274,795	$23,797,774	$10,398,043	$8,071,152

NYSEG and RG&E 2013 Distribution Vegetation Management

RFPs for the 2013 distribution vegetation management work for NYSEG and RG&E were issued in the first quarter of 2012. The RFP process for the 2013 plan was executed such that contracts were signed and purchase orders were issued for the work in December 2012, consistent with recommendation 11.6 of the recently completed Management Audit. Contractors began work on the 2013 plan on January 2. The plan for 2013 is to clear 2,890 miles of distribution vegetation at NYSEG and 1,110 miles of distribution vegetation at RG&E. A summary of the 2013 plan is shown in tables 4 and 5.

Table 4 - 2013 NYSEG/RG&E Distribution Vegetation Management Summary of Planned Expenditures

TABLE 4

2013	NYSEG Planned	RG&E Planned
Maintenance	$16,228,720	$5,343,414
Hot Spot	$3,771,280	$1,256,586
Grand Total	$20,000,000	$6,600,000

Table 5 – 2013 NYSEG/RG&E Distribution Vegetation Management Mileage Clearance and Planned Expenditures by Voltage Class

TABLE 5

NYSEG	NYSEG Distribution Miles Planned 2013	34.5 kV Miles	34.5 kV Cost	15 kV Miles	15 kV Cost	5 kV Miles	5 kV Cost	Total Planned Cost
Maintenance Program	2890	1009	$4,750,913	1135	$6,542,722	746	$4,935,085	$16,228,720
RG&E	**RG&E Distribution Miles Planned 2013**	**34.5 kV Miles**	**34.5 kV Cost**	**15 kV Miles**	**15 kV Cost**	**5 kV Miles**	**5 kV Cost**	**Total Planned Cost**
Maintenance Program	1110	136	$580,332	575	$2,319,656	399	$2,443,426	$5,343,414

ENVIRONMENTAL CONSULTANTS, INC.

NYSEG
Distribution System
Cycle Optimization Study

Prepared for
NYSEG, Iberdrola USA

March 1, 2013 (REDACTED)

Prepared by
Environmental Consultants, Inc.
520 Business Park Circle
Stoughton, WI 53589

CONTENTS

EXECUTIVE SUMMARY

This document presents the Environmental Consultants, Inc. (ECI) recommendations for vegetation maintenance cycles on the New York State Electric and Gas (NYSEG) overhead distribution system. It includes methodologies, projections, analysis and recommendations designed to assist NYSEG in optimizing the management of vegetation on its distribution system.

ECI utilized NYSEG system vegetation workload data and tree re-growth simulation for NYSEG clearance specifications as a basis for the cycle recommendations. Historic NYSEG reliability data for storm and non-storm vegetation-caused outages and vegetation maintenance history were evaluated (by voltage and construction type) to identify reliability variations for different maintenance histories and to formulate projections of reliability savings for several cycle recommendations. Additionally, a field review of five NYSEG operating divisions was conducted of current and past vegetation maintenance practices.

NYSEG vegetation maintenance has historically included a three-year cycle for the three-phase portions of the 34.5 kV circuits; a five-year cycle for non-34.5 kV three-phase lines and 34.5 kV single-phase lines; and an undeterminable cycle for the remaining non-34.5 kV single-phase lines.

ECI has made several recommendations to move NYSEG toward full cycle maintenance on all distribution voltages in order to improve system reliability in a cost-effective manner. Recommendations for a long-term vegetation maintenance strategy are also included.

Recommendations suggest an initial five-year reclamation period, during which maintenance of the three-phase portions of 34.5 kV circuits will continue while striving to include full circuit maintenance on all remaining circuits, including the laterals. Because this first cycle (reclamation cycle) includes full circuit pruning on laterals that have not been maintained in many years, the cost per mile during this phase will be significantly higher than the 35 kV circuits that have been maintained on a regular cycle. After the reclamation cycle (four years on the 34.5 kV circuits and five years on the remaining voltages) it is recommended that NYSEG enter into a long-term maintenance cycle. It is anticipated that the maintenance cost per mile will be reduced significantly in the second cycle and beyond as there will be a lower workload, increased productivity due to trees no longer growing between the conductors, and fewer trees and brush requiring removal.

ECI has provided two possible options for the reclamation cycle and four options for the long-term maintenance cycle. The associated Customers Interrupted (CI) projections for each option are included in this report. Projected budgets for the reclamation cycles range from $62.9 million to $68.2 million annually (current annual budget is $18 million). The long-term vegetation maintenance budget options range in cost from $35 million to $42.5 million annually. It is projected that at the conclusion of the first cycle of full circuit pruning, vegetation caused interruptions will be reduced.

An important consideration in reducing future workload and vegetation maintenance cost is the utilization of herbicides when trees or brush are removed. Long-term studies have shown that the consistent use of herbicides as a part of a vegetation maintenance program can reduce the cost per acre treated in future maintenance cycles by as much as 86 percent. The budget calculations provided in the cycle cost estimates include the optimal brush maintenance prescription strategy. The inclusion of herbicide treatment as a part of the long-term maintenance cycle is estimated to provide no appreciable increase to the overall brush maintenance costs.

ECI recommendations:

- ECI recommends the implementation of Reclamation Option 2 for the first cycle. This includes a four-year cycle on the 34.5 kV lines with a targeted mid-cycle program for the three-phase portions, and a five-year cycle on all remaining voltages. All circuits are to be pruned to the full NYSEG clearance specifications. Anticipated annual cost for the first four years is $62.9 million dropping to $54.6 million in the fifth year after completion of the first 34.5 kV cycle. NYSEG can anticipate reduced tree-caused interruptions as well as reduced restoration time and reduced costs for storm restoration as the cycle is completed.
- Implementation of the first cycle via an 18-month ramp-up period is recommended (see Appendix D). A planned, steady increase in workforce over time provides the most cost-effective approach to reaching full workforce strength. This approach avoids hardships to both NYSEG and contractor staff during the ramp-up period.
- ECI recommends Option 2 for the second cycle and beyond (long-term maintenance cycle). This includes a four-year cycle on the 34.5 kV lines with a targeted mid-cycle program for the three-phase portions; a four-year cycle on three-phase; a five-year cycle on single-phase lines for voltages between 12.5 kV and 19.9 kV; and a five-year cycle on all voltages below 12.5 kV. All circuits should be pruned to the full NYSEG clearance specifications. Anticipated average annual cost for this five-year maintenance cycle is $38 million; reliability should remain steady during the maintenance cycle with a slight improvement over time. NYSEG can anticipate reduce customer requests and the reduced need for hot-spot pruning.

It is important to note that when referring to the recommended cycle lengths by circuit and voltage class as described above, the voltage is determined at the circuit level only and is defined by the primary voltage of the circuit as it comes out of the substation. All associated laterals, even though potentially at a lower voltage, should be maintained according to the schedule of the primary substation voltage.

GLOSSARY OF TERMS

Brush– a tree stem less than 4 inches in diameter that may reach the conductor at maturity.

CI - reliability term for the number of customers interrupted.

Clearance – The distance between vegetation and the conductors.

Cycle Buster – a tree that will re-grow near or into the electrical conductors prior to the next scheduled maintenance activity.

Electrical Mode of Failure – when a tree branch becomes a fault current pathway between conductors and/or ground, resulting in short circuit fault on the electrical system.

Fault – A fault is an unintended, abnormal flow of electrical current within a circuit. In a power system, a fault occurs when a conductive path is formed between an energized conductor and another phase conductor, the system neutral, or ground.

Hand cutting – control of vegetation using hand-operated tools.

Interruption – As per IEEE 1366, an interruption is "the loss of service to one or more customers connected to the distribution portion of the system. It is the result of one or more component outages, depending on system configuration."

Mechanical Mode of Failure - physical damage to the electrical system that causes an interruption, such as a falling tree.

Mechanical mowing (brush mowing) minimally-selective means of clearing undesirable vegetation utilizing different mowing units for different situations.

N - Reliability term for number of outages.

Reclamation – re-establishing a right-of-way that is not currently managed to the full extent of its easement or ownership rights and intended purposes. Conditions on a right-of-way in need of reclaiming include tall, dense amounts of undesirable vegetation. Reclamation usually involves initial non-selective methods of mowing or hand-cutting, or broadcast application of herbicides.

Recloser – A recloser is a protective device which attempts to clear a transient fault by removing power from the system for a short period of time. Note that each recloser operation results in a momentary interruption.

Single-phase lateral – A single-phase lateral is a portion of a radial distribution circuit that branches off from a three-phase section, consisting of a single-phase conductor and neutral. A fault on a single-phase lateral does not typically result in the interruption of power to the three-phase section it is attached to if it is fused (has a protective device).

Three-phase feeder section – A three-phase section of line is the portion of a distribution circuit consisting of three-phase conductors and a system neutral. A fault on a three-phase section of line will result in the interruption of power to all three-phase and single-phase sections of line downstream of the faulted section.

Tree – A woody plant normally maturing at 20 feet or more in height, usually with a single trunk, unbranched for several feet above ground with a definite crown. Any trunk that is over 4 inches diameter can be considered a tree.

Voltage gradient – A voltage gradient is the voltage spread across a distance. For example, 7,200V applied across 3 feet would result in a voltage gradient of 2,400 volts per foot.

NYSEG

Distribution System Cycle Optimization Study

1 Introduction

Vegetation management programs are key strategic initiatives designed to manage risks through the efficient and cost-effective maintenance of vegetation posing an immediate or potential threat to the electric delivery system. These include risks to: system reliability, infrastructure equipment, regulatory compliance, public safety, environmental stewardship, and customer relations. Managing these risks can be an expensive undertaking, as vegetation management is often one of the single largest preventative maintenance expenditures for most utilities across the United States. Consequently, utilities are constantly challenged to improve their vegetation management programs to yield better operational benefits and to optimize returns on their investments.

Identifying the optimum vegetation maintenance cycle(s) is a critical component to establishing an efficient line clearance program strategy that effectively manages risks. A one-year change in cycle length can influence annual expenditure requirements by at least 10 percent. Choosing the wrong cycle can result in wasted funding and resources, compromise reliability, and/or expose the utility to other risks.

Optimum vegetation maintenance cycles are the preventative maintenance intervals that best address the utility's exposure to known risks (i.e. tree-caused outages, regulatory mandates for cycle lengths, etc.) and do so in the most cost-effective manner. Optimum maintenance cycles are normally established to meet a variety of corporate and regulatory objectives. Target maintenance intervals may differ for varying maintenance/operational objectives or for different system components and may be modified by evaluated field conditions.

New York State Electric and Gas (NYSEG), a subsidiary of IBERDROLA USA, is a major provider of electric service to over 878,000 customers in central, eastern, and western New York. The NYSEG electric distribution system is comprised of over 34,200 miles of distribution line which includes approximately 30,000 miles of overhead distribution. NYSEG is working to identify effective approaches to optimizing circuit vegetation maintenance cycles for its overhead distribution system across 13 operational divisions that include: Auburn, Binghamton, Brewster, Elmira, Geneva, Hornell, Ithaca, Lancaster, Liberty, Lockport, Mechanicville, Oneonta, and Plattsburgh.

ECI was commissioned in June of 2010 to perform a comprehensive study that documented the quantity and characteristics of the existing tree and brush workload on the overhead portion of the IBERDROLA USA distribution system, which included NYSEG. The results of the workload study performed in 2010 serves as a basis for the cycle recommendations presented in this analysis.

This document presents the ECI recommendations for vegetation maintenance cycles on the NYSEG overhead distribution system. It includes methodologies, projections, analysis and recommendations designed to assist NYSEG in optimizing the management of vegetation on its distribution system.

2 Study Methodology

2.1 Workload Study Methodology

NYSEG vegetation workload was projected through a 2010 random sample survey within each division. Each sample point selected was one mile in length. The procedures used were similar to those used in over 100 similar surveys conducted by ECI.

Consistent, accurate inventory data was ensured through effective quality control procedures and included audits of randomly selected sample locations. Approximately six percent of the total inventory points were audited to validate field collection accuracy.

The 2010 workload study resulted in an estimate of total distribution system vegetation workload within ±5 percent sampling error rate at the 90 percent level of confidence within each of the defined divisions. Table 1 identifies the division and mileage attributes associated with the 2010 study.

Table1.Division Study Design Layout with Mileage Attributes

OPCO	***Division***	***Total OH Distribution Miles***	***Single-Phase Miles***	***Multi-Phase Miles***
NYSEG	Auburn	1,125.53	789.52	336.01
NYSEG	Binghamton	3,096.09	2,397.47	698.62
NYSEG	Brewster	1,609.13	992.30	616.83
NYSEG	Elmira	2,371.03	1,687.02	684.01
NYSEG	Geneva	2,144.91	1,592.51	552.40
NYSEG	Hornell	2,085.16	1,625.37	459.79
NYSEG	Ithaca	2,022.76	1,563.35	459.41
NYSEG	Lancaster/ Lockport[1]	2,901.18	1,586.94	1,314.24
NYSEG	Liberty	2,045.11	1,491.21	553.90
NYSEG	Mechanicville	1,786.22	1,368.66	417.56
NYSEG	Oneonta	5,090.71	3,892.68	1,198.03
NYSEG	Plattsburgh	2,030.09	1,500.45	529.64
Total NYSEG:		**28,307.92**	**20,487.48**	**7,820.44**

2.2 Cycle Optimization Methodology

The steps to identifying optimum vegetation maintenance cycle(s) included:

1. Defining operational objectives served as the starting point for identifying the cycle length options.
2. Review current line clearing specifications and past practices affecting customer satisfaction and local regulations.
3. Define reliability goals.
4. Address the specific vegetation concerns that have a direct influence on the reliability risks and risks to the infrastructure equipment. Understanding the vegetative environment around the electrical system and more importantly, how the facility assets are influenced by that vegetation, was key to determining an optimum maintenance cycle(s). Tree branches can become a fault pathway for high-current, low-impedance sustained faults. The relative risk of this type of tree-caused interruption is dependent on voltage gradient, branch diameter and other factors, including tree species. Therefore, an understanding of typical construction types (number of phases present and spacing) and voltage was critical to understanding relative interruption risk for different parts of the distribution system.

[1] Lockport Division totals 198.67 miles.

5. ECI performed a thorough analysis of the historical tree reliability data. This served as a benchmark for measuring anticipated changes to reliability as a result of the recommended changes to the vegetation management strategy. It was also used to determine the potential benefits of variable cycle lengths based on line construction attributes (i.e., three-phase vs. single phase, voltage). By combining data gathered through the field survey, the historical reliability data, and other identified cycle risk parameters (e.g., mileage requirements, pruning specifications and guidelines, etc.), optimum cycle lengths recommendation and budget requirements were determined.
6. Vegetation characteristics (gathered in the 2010 workload study) such as species frequency, regrowth rates, tree densities, clearances at the time of pruning, and current tree-to-conductor clearance were considered. The workload estimates drive the future budget requirements. The species frequency survey measured the relative distribution of species on the utility system, which when combined with the species regrowth analysis, was used to ascertain the current risk level and set target cycle lengths based on the probability for line contact over varying cycle lengths. ECI accomplished this task through the use of its exclusive Tree Growth Simulation Model. The Tree Growth Simulation Model was used to support the appropriate cycle length recommendations.
7. As part of the overall optimum cycle analysis, a field review of current vegetation conditions on the NYSEG distribution system was performed. The field review was required in order to identify the effectiveness of past pruning practices and to validate adherence to current pruning clearance standards and guidelines since these standards were a major component in calculating the effectiveness of any cycle recommendations.

3 Distribution System Vegetation Workload

Workload projections from the 2010 study were developed for the NYSEG primary distribution system. The workload projections are based on the total number of primary overhead distribution miles as provided by NYSEG and identified in Table 1. Workload projections do not include vegetation associated with stand-alone secondary or service wires, or mileage associated with the transmission system. These facilities were not included in the scope of this study.

3.1 Total Workload Projections

Workload projections were estimated using the mean trees per mile of the sample population multiplied by the total distribution miles.

Trees were classified as requiring either top or side pruning, removal of overhanging branches or removal. Brush acreage projections are for the actual acres of brush that will require maintenance. It is not a total projection of right-of-way acres which may also contain low-growing species that will not present future maintenance concerns.

Table 2. Projected Vegetation Workload on the NYSEG Distribution System

	OH Miles	*TOP Trims*	*SIDE Trims*	*OVER-HANG Trims*	*REMOVAL OPP. (4-12")*	*TOTAL TREES*	*HAZARD Trees*	*BRUSH ACRES*
Total NYSEG:	**28,307.92**	**508,044**	**1,394,914**	**208,368**	**315,994**	**2,427,321**	**34,414**	**3,591**

3.2 Tree Density

The average tree and brush density information is provided in Table 3. The system trees per mile should be understood to range from 81.8 to 90.5, based on the ±5.2% sampling error achieved through the random sample survey.

Table 3. Average Tree and Brush Acreage Densities on the NYSEG System

	TOP Trims per Mile	*SIDE Trims per Mile*	*OVER-HANG Trims per Mile*	*REMOVAL OPP. (4-12") per Mile*	*TOTAL Trees per Mile*	*Sampling Error*	*HAZARD Trees in ROW per Mile*	*BRUSH ACRES per Mile*
Total NYSEG:	**18**	**49**	**7**	**11**	**86**	**±5.2**	**1.22**	**0.13**

In 1993 ECI conducted a comprehensive study of the NYSEG vegetation management program. Since that time, tree density has increased by approximately 11 trees per mile, from 75 to the current 86 mean trees per mile (Table 4). The lack of consistent, full-circuit cyclic vegetation maintenance in the past has increased work volume and outage exposure (interruption potential) due to trees. The brush acres decreased from 0.50 acres per mile in 1993 to 0.13 acres per mile in 2010. This may be a result of the growth of brush over time (Figure 1 provides an illustration of this conversion of brush to trees).

Table 4. NYSEG Workload Projection Comparison 1993 to 2010

	1993 Total Trees/ Mile	*2010 Total Trees/ Mile*	*1993 Brush Acres/ Mile*	*2010 Brush Acres/ Mile*	*1993 Line Miles*	*2010 Line Miles*	*1993 Wooded Miles*	*2010 Wooded Miles*
Total NYSEG:	**75**	**86**	**0.50**	**0.13**	**29,899**	**28,308**	**69.2%**	**71.2%**

Figure 1. Left: Maintained right-of-way, light brush. Right: Without herbicides brush grows into small trees

Figure 2 provides a comparison of tree density with other utilities. NYSEG tree density of 86 trees per mile is slightly lower than the average utility for which ECI has comparable data. Tree density on the NYSEG system does vary significantly from division to division and often within a division depending on circuit location.

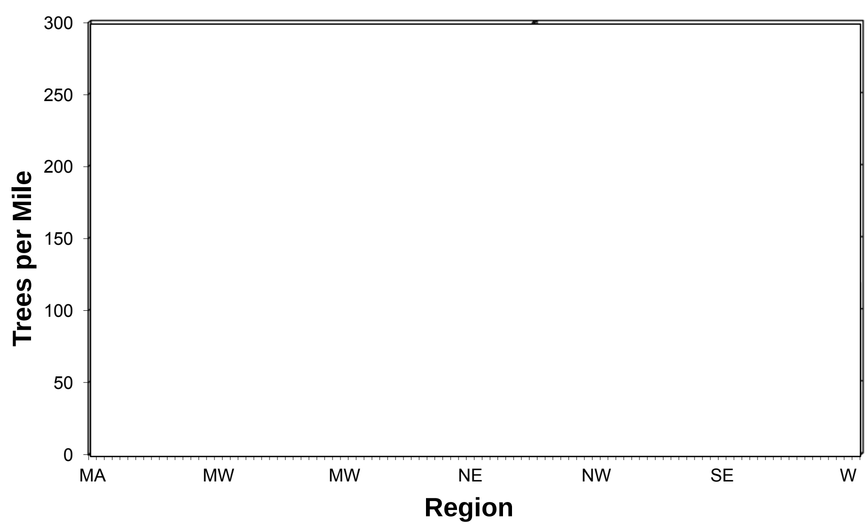

Figure 2. NYSEG trees per overhead circuit mile compared to others

3.3 Tree Workload Characteristics

The following tree workload characteristics are those attributes specific to the tree conditions that best summarize the overall risks.

- Percentage of tree workload adjacent multi-phase lines– Phase-to-phase voltage gradients are usually higher than phase to neutral voltage gradients for a given voltage and therefore represent a higher risk of a tree limb becoming a high current fault pathway and interruptions on multi-phase lines normally affect more customers.
- Percentage of trees within in contact with conductors – the more trees that are in contact with conductors or that have grown between conductors, the greater the potential for trees to become fault pathways leading to sustained interruptions. The survey considered any tree within one foot of the conductor as being in contact.
- Percentage of trees overhanging the conductors– the more trees that overhang conductors, the greater the risk that falling branches will result in interruption of electric service.
- Percentage of hazard trees – trees with obvious defects, which predispose trees to failure increase the potential for interruptions should those trees fall on overhead lines.
- Top trims as a percentage of all trims– trees growing directly under overhead power lines which pose the greatest risk in re-growth and cost to maintain.

These risk factors are important considerations when determining optimal cycle lengths. Table 5shows the percentage of the tree work load for each risk factor as it relates to the total workload.

Table 5. NYSEG Workload Characteristics and Risk Factors for Consideration

	Total Trees	*% Multi-Phase*	*% Trees in Contact with Conductor*	*% Trees within 0-4 foot of Conductor*	*% Overhang*	*% Hazard Trees*	*% Top Trims*
Total NYSEG:	**2,427,321**	**26%**	**22%**	**50%**	**9%**	**1%**	**24%**

Table 6 summarizes trees per mile for multi-phase lines, trees in contact, overhanging trees, hazard trees and top pruning workload by division. In comparing the risk factors by trees per mile, divisions can be directly compared to each other as they relate to overall system risk.

Table 6. Risk Factors Expressed as Trees per Mile by Division

	Total Average Trees per Mile	***Multi-Phase***	***Trees within 1 foot of Conductor***	***Overhang***	***Hazard Trees***	***Top Trims***
Auburn	63	63	11	10	2	14
Binghamton	70	71	18	5	1	20
Brewster	162	152	34	13	5	15
Elmira	56	56	10	7	0	17
Geneva	60	52	9	10	1	16
Hornell	84	85	17	3	0	19
Ithaca	80	81	35	2	0	17
Lancaster/ Lockport	136	127	37	8	1	49
Liberty	175	174	26	9	4	10
Mechanicville	123	116	29	10	3	10
Oneonta	62	53	13	14	1	5
Plattsburgh	56	41	8	8	1	4
Total NYSEG:	**86**	**84**	**19**	**7**	**1**	**18**

3.4 Demographic Characteristics

Figure 3 shows that a majority of (66 percent) of the NYSEG distribution tree workload is located within rural areas (top bar). As defined in the field survey instructions, an urban designation indicates that the area is densely populated, primarily residential, commercial, or otherwise developed for human use, and that the landscape under the conductors is actively maintained. Suburban indicates that the area is slightly less dense (i.e. ½ acre lots, etc.) but still primarily residential and the landscape under the conductors is actively maintained. Rural indicates scattered houses among agricultural or forest lands, with little or no landscape maintenance.

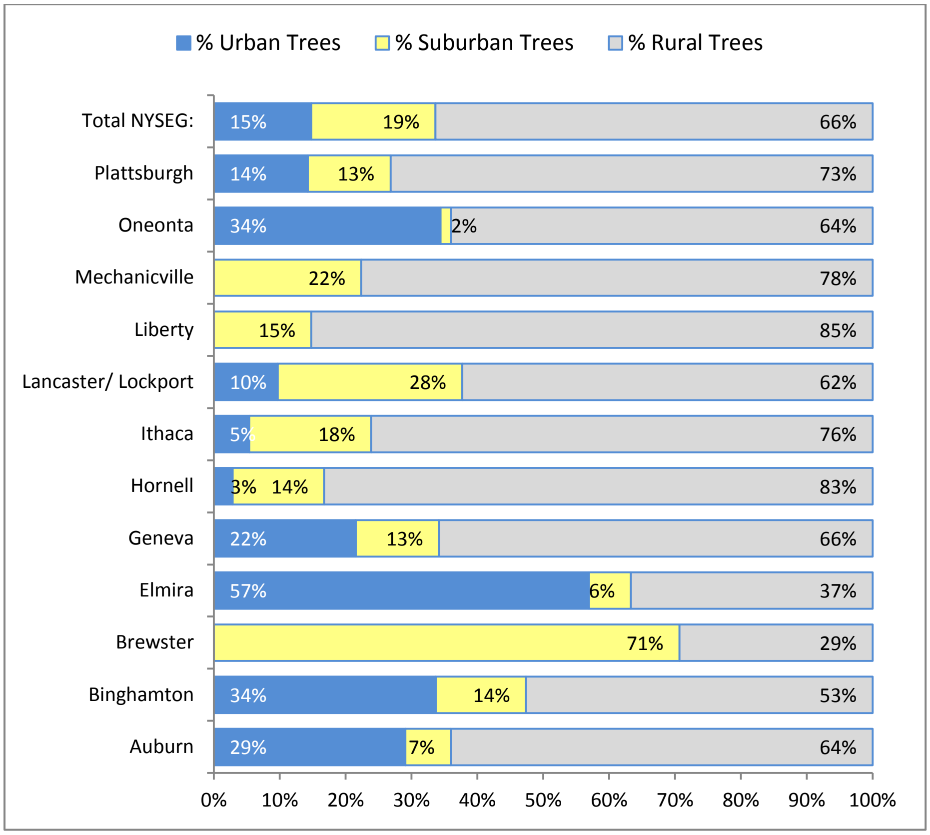

Figure 3. Demographic Characteristics of Tree Workload on the NYSEG Distribution System

The demographic stratification is important in understanding the potential cost per mile variations. Urban line miles tend to be more expensive to maintain, primarily due to the lack of line accessibility, maintenance of traffic requirements and increased travel time due to traffic, yard trees, customer issues, and debris disposal issues to name a few. Rural lines on the other hand tend to be the least expensive since those line miles tend to be more accessible to equipment and generally offer a wider range of maintenance options (i.e. mechanical trimming, mowing, etc.). Therefore, in interpreting Figure 3,the Elmira division could be expected to have higher cost per mile than in Liberty division provided other factors such as tree density are the same.

3.5 Accessibility Characteristics

Survey locations were identified as accessible if the trees or distribution facilities were accessible to a standard aerial lift truck for maintenance purposes at the time the survey was completed. Twelve percent of the workload was characterized as inaccessible to aerial lift trucks where trees must be climbed for maintenance. The remaining 88 percent of the total tree workload on the NYSEG system is accessible to aerial lift trucks.

3.6 Facilities Characteristics

Approximately 74 percent of the NYSEG system vegetation workload is associated single-phase lines, while about 26 percent of the tree workload is associated with multi-phase lines. Past maintenance work has focused on maintenance of multi-phase portions of circuits.

3.7 Species Composition

The most frequently occurring 90 percent of tree species on the NYSEG distribution system are listed in Appendix A. Species are listed in order of relative frequency encountered during the survey.

3.8 Brush Workload

It is projected that there is approximately 3,600 acres of brush on the total NYSEG distribution system. System brush acres are categorized in Table 7 for height and density classes.

Table 7. Brush Acres on the NYSEG Distribution System by Density and Height Classes

	Average Density[2]			*Average Height*			
	Light	***Medium***	***Heavy***	***<6 Feet***	***6-12 Feet***	***12-18 Feet***	***>18 Feet***
Total NYSEG:	**598**	**1,636**	**1,356**	**357**	**1,528**	**1,689**	**17**

Brush workload on the NYSEG distribution system is primarily comprised of medium and heavy density brush. Brush height is also typically between 6 and 18 feet throughout the system.

Based on ECI's field observations, the off-road brush lends itself to mechanical mowing and this would be a recommended treatment option for the initial reclamation cycle, with the addition of herbicide treatment for all cut stems. Road-side brush removal lends itself hand cutting and herbicide treatment.

[2] Density classes are as follows: Light = 0 to 35 percent cover
Medium = 35 to 70 percent cover
Heavy = 70 to 100 percent cover

3.9 Tree Clearance from Conductors

Tree clearance is a major contributor to the total cost of pruning. Trees in close proximity to the conductors require additional steps and safety measures for the tree crew which can significantly impact productivity. Less productivity equals higher costs.

Table 8 shows the percentage of the total tree workload broken down by its relative clearance to the conductor. Of significant importance is the 50 percent of the trees on the NYSEG system that are within four feet of the conductors and have the potential to make line contact within two growing seasons. This could be a significant cost driver in future maintenance costs.

Table 8. Percentage of Tree Workload by Clearance Class on the NYSEG System

	Average Distance to Conductors					
	0-1 ft.	*2-4 ft.*	*5-7 ft.*	*8-10 ft.*	*11-15 ft.*	*>15 ft.*
Total NYSEG:	**22%**	**28%**	**25%**	**14%**	**6%**	**5%**

3.10 National Electric Safety Code

When high numbers of trees are capable of contact with the conductors, they may present a threat to the integrity of the distribution system. The National Electric Safety Code (NESC – C2-2012) Section 218[3] states, “Trees that may damage ungrounded supply conductors should be pruned or removed. Vegetation management should be performed as experience has shown to be necessary.” Section 218 does not specifically state that clearance between vegetation and energized lines should be maintained. Moreover, the industry has not interpreted this rule to mean that mandatory clearances between vegetation and energized conductors be maintained at all times. The 2012 modification to the Code also notes that it is not practical to prevent all tree-conductor contacts on overhead lines.

Many utilities in North America consider 10 percent tree contact with the conductors to be a reasonable goal for their distribution line clearance program in order to minimize the potential threat of interference with conductors. Many utilities exceed this level of tree-line contact. It is important to note that the detailed conditions associated with trees in contact with conductors are key determinants of the impact of those contacts on system performance. ECI research has documented the importance of voltage stress gradient, stem diameter and tree species as they relate to a tree branch becoming a fault pathway leading to a sustained interruption. ECI observed a high level of contact

[3] The appendix contains the full text of the modified Section 218.

on lower voltage lines. These conditions and incidental contact between a small tree branch and a conductor normally remain high impedance faults, but can contribute to conductor failure and downed wire incidents.

3.11 New York State Public Service Commission

NYSEG has committed to the New York State Public Service Commission (NYSPSC) to trim a minimum of 2,700 miles per year on the distribution system. NYSEG's goal is to reach full cycle clearing for all types of lines as quickly and cost-effectively as practical so that the number of tree-caused interruptions and customers interrupted can be reduced.

4 Cycle Optimization

Vegetation workload data together with regulatory requirements, operational objectives, reliability trends, species regrowth data, production, cost data, and other measurable risks, were used to model viable cycle options. This section identifies cycle options and relative benefits and costs.

4.1 Reliability Analysis

Trees are a leading cause of service interruptions at NYSEG and at most utilities. One useful means of comparing effectiveness of vegetation management programs is on the basis of tree-caused outages per 100 miles. Figure 4 compares NYSEG's tree-caused outage frequency to various benchmark indices for primary voltages. NYSEG reported an average of 14 tree-related outages per 100 mile for the years 2006-2012[4].

[4] This is based on the number of non-storm interruptions due to vegetation both within and outside the right-of-way. Total vegetation-caused outages (non-storm only) between 2006 and 2012 were or 29,287 or an average of 4,184 per year.

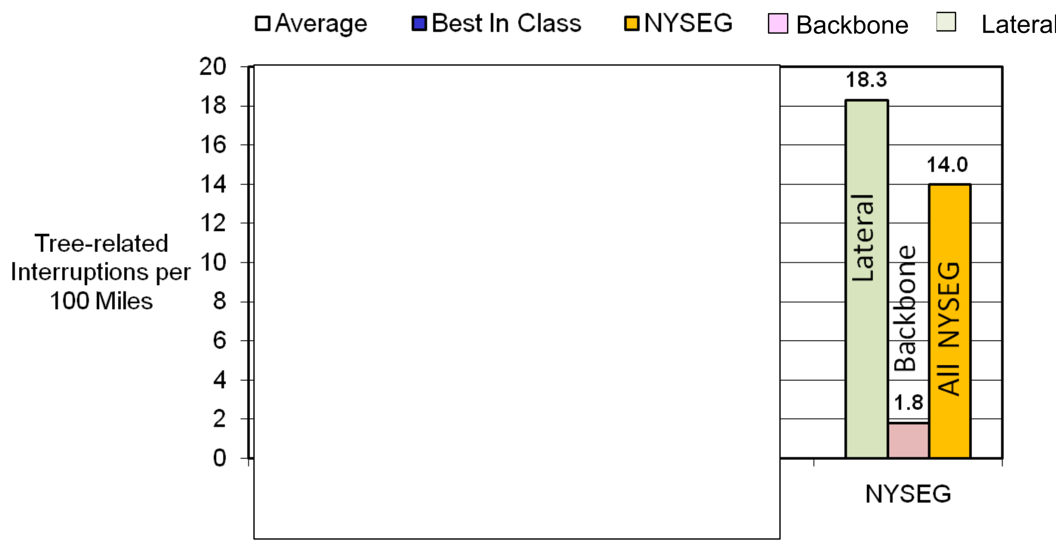

Figure 4. Reliability Comparison to Others: NYSEG seven-year (2006-2012) average primary tree-related interruption events (N) per 100 miles compared to Benchmark groups

Another common metric used to assess the effectiveness of a distribution line clearance program is primary interruptions per 1,000 trees. The primary tree-caused interruptions per 1,000 trees metric relates more directly to outage exposure than does the outages per 100 miles metric. Figure 5 presents NYSEG's reported interruption annual average between 2006 and 2012 per 1,000 trees based on ECI's projection of tree workload on the primary distribution system. NYSEG's tree-caused interruptions per 1,000 trees for all construction types, is higher than many others in the industry. However, when considering only three-phase backbone construction, NYSEG's interruption rate per 1,000 trees is below an average of 56 utilities and below the best in class utilities as well. This suggests that NYSEG has done a very good job at maintaining vegetation on the three-phase portions of the system. This is evidenced from the past maintenance work concentrating only on three-phase and not pruning the single and two-phase taps on any kind of a regular maintenance cycle. The opportunity to improve system performance for NYSEG is in increased maintenance efforts on the single and two-phase portions of all circuits.

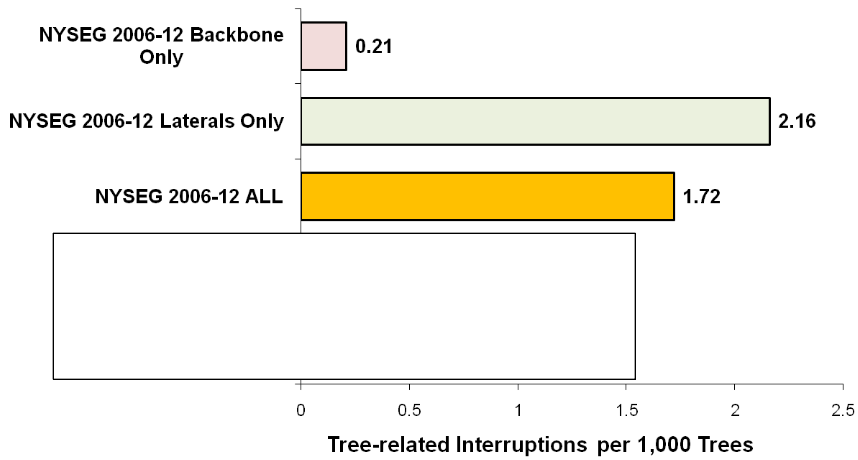

Figure5. NYSEG Annual Non-storm Tree-related Primary Outage Events per 1,000 Trees Compared to Others

ECI analyzed the reliability data provided by NYSEG for the years of 2006 through 2012 to identify historical performance trends, identify specific area of opportunity to improve reliability through variable maintenance cycles, and to gather specific information necessary for the forecasting of reliability metrics based on maintenance cycle alternatives. The reliability trend is useful for helping to determine, for instance, which voltages or phasing types are currently the main driver for reliability events. Figure 6 summarizes NYSEG's tree-caused interruption events (N) and tree-caused Customer Interruptions (CI) per 100 miles from 2006 to 2012. Figure 7 summarizes NYSEG's tree-caused Interruptions and Customer Interruptions per 1,000 trees for the same time period. Tree-caused interruption data was analyzed in an effort to correlate vegetation maintenance history with reliability results. The analysis did not find a trend or a correlation between circuit trim date and reliability. ECI believes that the lack of a clear relationship between circuit maintenance and subsequent reliability at the circuit level is due to the lack of consistent, full circuit cyclic vegetation maintenance (trimming only three-phase portions of circuits or performing spot trimming on the entire circuit) and lack of accuracy in some of the maintenance history.

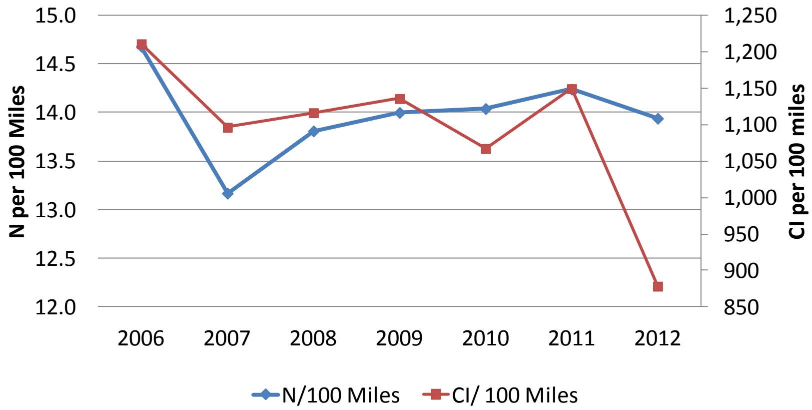

Figure 6. Tree-caused Interruptions (N) and Customer Interruptions (CI) per 100 Miles Trees by Year

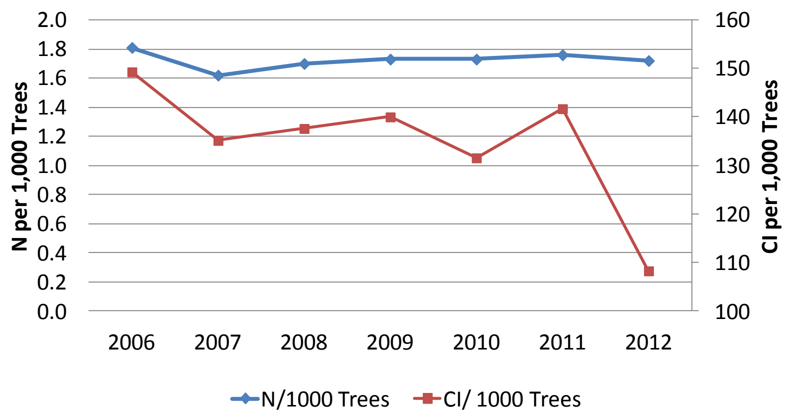

Figure 7. Tree-caused Interruptions (N) and Customer Interruptions (CI) per 1,000 Trees by Year

4.2 Growth Data Analysis

One of the primary considerations in determining the appropriate maintenance cycle for the NYSEG distribution system is the rate at which the trees grow after being pruned. Tree regrowth data, species frequency and the percent of each species that require either top or side pruning was used to project average tree regrowth and the amount of line contact by varying maintenance cycle lengths. ECI utilized regrowth rate data for the most commonly occurring tree species on the NYSEG distribution system taken from previous similar studies in adjacent geographic regions. Overall growth rates per year for top-pruned and side-pruned trees are summarized in Figure 8.

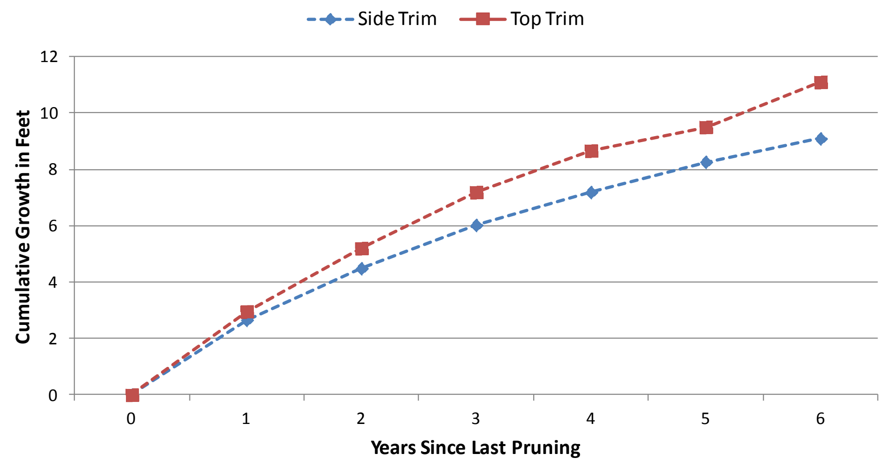

Figure 8. Mean Growth Rates of Top- and Side-Pruned Trees on the NYSEG System

Simulations of tree regrowth across the NYSEG system over several years were made to project tree-conductor contact percentages by years since pruning. Line contact (contact percent by years since last pruning) was expressed for a group of trees reflecting the NYSEG species distribution, all pruned in the same year to show the estimated percentage of contact each year after pruning. Figure 9 presents the percentage of trees that can be expected to be in direct contact with conductors each year after pruning, assuming that the clearance at time of pruning is ten feet (NYSEG's current clearance standard). Of note is the amount of trees that have been in contact with the conductors for multiple years, which increases safety and reliability risks.

Another simulation (contact percent by cycle length), summarized in Table 9, was conducted for the system to show the average percent contact for all trees on the system by varying maintenance cycle lengths. Contact by cycle length takes into account that circuits will be in varying states of maintenance (i.e. some maintained in year one, some in year two, etc.).

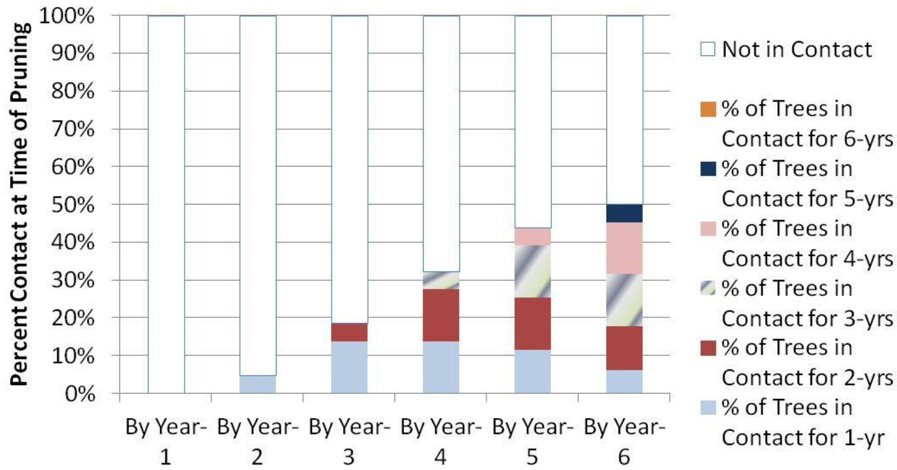

Figure 9. Estimated Average Percentage of Tree Contact on Each Year Following Initial Pruning at 10 Foot (Contact Percent by Years since Last Pruning)

Table 9. Estimate Average Tree-Line Contact by Varying Maintenance Cycles (Average of all species for both top and side pruning)

Clearance at Time of Pruning (ft.)	1 Year Cycle	2 Year Cycle	3 Year Cycle	4 Year Cycle	5 Year Cycle	6 Year Cycle
1	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
2	82.6%	88.8%	92.0%	93.7%	94.9%	95.7%
3	60.2%	71.3%	78.6%	83.0%	86.0%	88.2%
4	41.8%	55.9%	65.1%	71.7%	76.2%	79.8%
5	22.4%	39.7%	50.8%	58.8%	64.6%	69.7%
6	10.0%	26.4%	38.7%	47.3%	54.3%	60.1%
7	4.3%	16.2%	28.4%	37.1%	44.1%	50.2%
8	2.0%	9.9%	20.2%	28.4%	35.2%	41.2%
9	0.8%	5.1%	13.1%	20.4%	26.9%	32.9%
10	0.1%	2.5%	7.8%	14.0%	20.0%	25.0%
11	0.0%	1.3%	4.7%	9.3%	14.3%	18.5%
12	0.0%	0.4%	2.4%	5.5%	9.7%	13.3%
13	0.0%	0.2%	1.3%	3.2%	6.3%	9.4%
14	0.0%	0.1%	0.6%	1.9%	4.0%	6.5%
15	0.0%	0.1%	0.3%	1.1%	2.6%	4.4%

5 Recommendations

5.1 Maintenance Strategy Alternatives

NYSEG has been following a modified time-based scheduling system in some of their reporting areas. The cycle length is determined by voltage and construction type (single-phase vs. three-phase). The date of last maintenance as well as circuit reliability is also taken into consideration in selection of circuits for maintenance. NYSEG vegetation-caused interruptions are high by industry norms, based on both tree density exposure (Figure 5) and exposure miles (Figure 4). Funding and work accomplishment has varied somewhat from year to year and the cyclic approach has varied from division to division (some following a cycle model but excluding single-phase construction, others doing complete circuit pruning aiming for a five-year cycle, and others implementing complete circuit trimming to the extent budget allows).

The relationship between contact with conductors and interruption risk is not always well understood. ECI has conducted research into failure modes associated with sustained tree-caused faults, the impact of contact with conductors on momentary interruptions and power quality (see Appendix G), and the relative impedance of different tree species. The body of research conducted by ECI and others has led to the creation of a tree fault pathway model for development of interruptions through the electric mode of failure. [5]

The tree fault pathway model identifies four primary factors that influence whether or not a tree branch crossing two primary distribution phases (or phase and neutral) will result in an interruption. Of all the variables studied, voltage gradient, branch diameter, internal moisture content (living or dead branch) and species were found to contribute most to conditions that will allow fault current levels across a tree branch to become high enough to activate protection devices. Voltage gradient is a function of both the voltage differential between two points, and their distance apart. Figure 10 illustrates a condition observed by ECI on another utility system that represents low outage risk (and in fact was not causing an outage) as a result of low voltage gradient and low internal branch moisture. Tree branch fault pathways where voltage gradients are below 2 kV per foot seldom result in sustained low impedance faults under any circumstances.

[5] Appelt, P.J., Goodfellow, J.W., "Research on How Trees Cause Interruptions- Applications to Vegetation Management", IEEE 2004 Rural Electric Power Conference, Scottsdale, Arizona, May 2004.

Figure 10. Small, dead, silver maple branch across two phases spaced relatively far apart (low voltage gradient) did not result in an interruption

The multiple research efforts conducted by ECI confirmed that the formation of the carbon path (pyrolized wood) is essential for the electrical fault to occur. Without a completed carbon path no fault occurs. However, once a carbon path is fully developed across a branch bridging two phases or a phase and a neutral, overcurrent protective devices will detect what has become a low-impedance fault, and operate as designed, creating an interruption. Conclusions further indicated:

> *"Based on the laboratory testing and field demonstrations completed, it is evident that tree contact with single-phase conductors on 15 kV class distribution circuits represents very low risk of causing a sustained or momentary interruption. Nor will incidental tree contact with a single-phase line cause a significant voltage sag or dip. Power quality measurements completed in the field demonstrations indicated no degradation in power quality.*
>
> *It may be safe to conclude that there is minimal risk of an interruption when a tree on a typical distribution line contacts one phase of a multiphase distribution circuit. There is a risk of an interruption when a tree (or branch) provides a fault pathway between energized phases or between an energized phase and system neutral. It should be noted that this discussion applies only to the electrical failure mode through tree limbs and not mechanical failure."*

Figure 11 represents a 50-month post-outage investigations study at another utility. The graph illustrates the impact of tree growth outages vs. other tree-caused interruptions (broken limbs, broken trunks, etc.). The bottom shaded area represents outages from tree growth while the area above represents all other outages cause by trees. Many utilities that have performed detailed investigations into the conditions that lead to tree-caused interruptions have found that 70 to 90 percent of tree-caused interruptions are associated with limb or trunk failures. Periodic maintenance helps to limit both mechanical and electrical modes of failure.

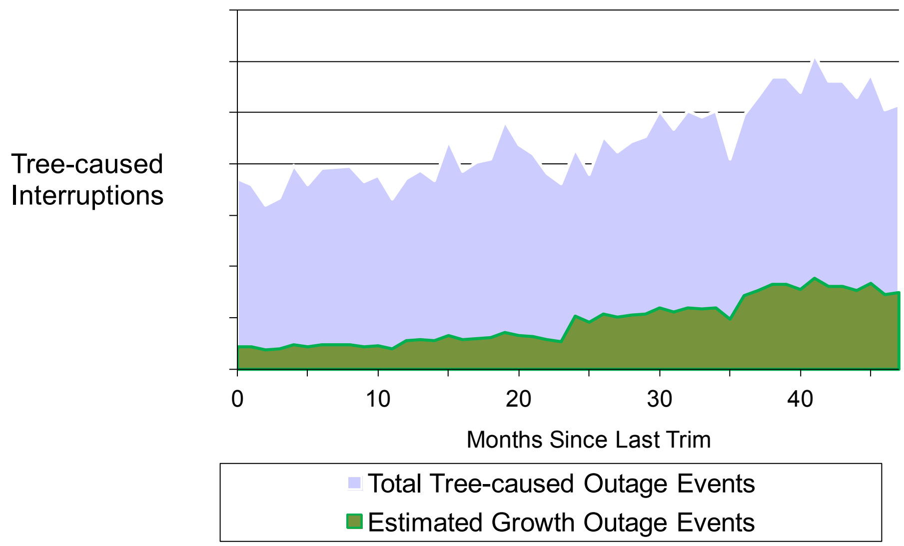

Figure 11. Outage causes by month since last trim (ECI study at another utility)

Maintenance strategies are often thought of in terms of cycle lengths or planned years between maintenance. However, not all circuits or system components have the same risk or the same impact on overall system performance. The potential for a tree branch to become a pathway for a sustained interruption is higher for multi-phase lines than for single-phase lines, and higher for a 34 kV line than for a 4 kV line. Construction types, as well as voltage, carry varying degrees of tree-related risk to system integrity, and the cycle lengths of different system components having impacts on NYSEG customers. Although more intensive management is required, split cycles (based on construction type, voltage, tree density and clearance opportunities) and targeted mid-cycle inspections (with selective maintenance of multi-phase lines) can help maintain acceptable levels of reliability at lower overall costs. ECI recommends that NYSEG:

1. **Establish Reclamation Cycle**: In the first five years, institute a vegetation maintenance program that completes maintenance the 34.5 kV distribution circuits on a 4-year cycle with a mid-cycle inspection and selective maintenance. Over the first 12 to 18 months, ramp up contractor line clearance crews to prune the 12.5 to 19.2 kV circuits in their entirety then begin full circuit pruning of circuits below 12.5 kV, with all reclamation work (full circuit maintenance) completed by the end of the fifth year.
2. **Establish a Long-term Maintenance Cycle:** Following reclamation, begin implementation of long-term maintenance cycles to maintain / improve system reliability in the most cost effective manner. It is further recommended that consideration be given to increasing pruning clearance on some of the fastest growing

species. Six fast-growing species (Norway maple, silver maple, ash, sugar maple, red maple, and black locust) represent 43 percent of the total tree population. Increasing pruning clearance and/or removal of the fastest growing tree species will reduce future workload that will result in a lowering future cyclic maintenance costs.

Table 10, summarizes ECI's recommendation for a five-year Reclamation Cycle for adoption on the NYSEG system. Cost projections for the reclamation cycle options are also found in Tables 15 and 16.

Table 13 summarizes several options for a Long-term Maintenance Cycle. Cost projections for these recommendations are provided in detail in Table 17 of this report. There are numerous program cycle options that were considered, however, ECI believes that Option 2, which includes full circuit pruning, provides consistent reliability to customers.

5.2 Cycle Comparisons (Reclamation vs. Long-term Maintenance)

ECI proposes a two-phased approach to achieving improved system reliability related to tree-caused outages.

Phase I: The first five-year cycle would be a reclamation cycle where existing maintenance practices would continue and, through additional funding, maintenance of single-phase portions of circuits would be included as a part of full circuit maintenance. All pruning/line-clearance work would be accomplished in accordance with existing NYSEG vegetation maintenance specifications. All rights-of-way would be re-cleared of vegetation to meet these specifications. To achieve efficient implementation, the inclusion of full circuits pruning of those below 12.5 kV would be ramped up over a 12- to 18-month period. This would provide adequate time to pre-plan the work; prepare bid packages; provide adequate customer pre-notification; secure additional staff to assist in contractor auditing and customer contact; provide time for contractors to secure additional resources over time. See Appendix D for the budget cash flow (with 18-month ramp-up) for the recommended reclamation cycle with mid-cycle. Mileage completion targets are also included.

There are two options within the reclamation phase for maintenance of 34.5 kV circuits (both shown in Table 10): conducting all 34.5 kV pruning on a three-year cycle or pruning on a four-year-cycle with a mid-cycle inspection and pruning. ECI's recommendation is found in Table 11. The cost differences between these two approaches can be seen in Tables 15 and 16.

Table 10. Reclamation Cycle Recommendations (first 5-years)

Component	Description
34 kV	▪ 3-year cycle (full circuit) *or* ▪ *4-year (full circuit) cycle with mid-cycle*
12.5-19.9 kV	▪ 5-year cycle: full circuit
Below 12.5 kV	▪ 5-year cycle: full circuit maintenance with a 12 to 18 month ramp-up

Table 11. ECI Recommended Reclamation Cycle

	Reclamation Program Description
Reclamation Cycle-Option 2: *A five-year program to reclaim NYSEG clearance standards on all circuits.*	**34.5 kV**: a 4-year complete circuit maintenance cycle for 34.5 kV lines with a mid-cycle inspection and pruning of "cycle buster" trees on three-phase line sections only. **12.5 kV – 19.3 kV:** a 5-year complete circuit maintenance cycle. **Under 12.5 kV:** a 5-year complete circuit maintenance cycle with a 12 – 18 month crew ramp-up period. Treat all cut stumps of trees and brush with herbicides. 4-year cycle for the sub-transmission.

Phase II: Upon completion for the reclamation cycle (five-years) the second and subsequent cycles would be based on achieving a long-term approach to cyclic vegetation maintenance based on a levelized annual workload. The reclamation cycle will have re-cleared the right-of-way thus the maintenance cycle will consist of pruning and periodic treatment of brush on the right-of-way. Table 12 provides four options for long-term cyclic maintenance. ECI recommends Option 2 (Table 13) for the long-term maintenance. ECI believes this option to provide the best overall program to address re-growth and as well as address issues on the 34.5 kV system every two years via the mid-cycle inspection.

Table 12. Long-term Maintenance Cycle Options

Component	Option 1	Option 2 ECI Recommended	Option 3	Option 4
34kV	▪ 3-year cycle	▪ 4-year cycle + Mid-cycle selective	▪ 4-year cycle	▪ 5-year cycle
12.5-19.9kV	▪ 4-year cycle	▪ 4-year cycle (Multi-phase) ▪ 5-year cycle (1-phase)	▪ 5-year cycle	▪ 5-year cycle
Below 12.5kV	▪ 5-year cycle	▪ 5-year cycle	▪ 6-year cycle	▪ 5-year cycle

Table 13. ECI Recommended Long-Term Maintenance Cycle recommendation

Long-term Program Maintenance Description	
Long-term maintenance Cycle *Maintenance of vegetation clearance achieved during the Reclamation Cycle at a lower annual cost.*	• 34.5 kV: 4-year cycle, complete circuit trim + mid-cycle • 12.5 kV – 19.3 kV: Multi-phase on 4-year cycle, single-phase on a 5-year cycle, complete circuit trim • Under 12.5 kV: 5-year cycle , complete circuit trim • Consider increasing clearance on fastest growing tree species from 10' to 12'. Mid-cycle selectively prune all multi-phase and selected single-phase pole locations with critical equipment (transformers, cut-outs, etc.) • Continue removal of tall-growing tree species on right-of-way growing under conductors (currently being topped) • Consider a hazard tree removal on multi-phase portions of circuits, beginning with 34.5 kV lines

5.3 Estimated Costs

The budget projections for the reclamation and long-term maintenance cycle are based on the tree pruning production and cost assumptions in Table 14 in 2012 dollars. The equivalent cost per mile of the unit price buildup for tree pruning, tree removal and brush control is $4,947 for multi-phase 34.5 kV and $8,914 for all other voltage and construction types in the five-year reclamation cycle. A detailed breakout of the associated cost per mile for each option of the reclamation and long-term maintenance cycles can be found in Appendix C. The NYSEG 2013 Division average bid costs for tree pruning, tree removal and brush control range from about $4,878 to $8,233 per mile for a mix of voltages.

Table 14. Tree Pruning Production and Cost Assumptions for Budget Calculations in 2012 Dollars

Cycle Type	Construction Type	Man-Hrs./Tree	Cost per Hour (2012)	Cost / Tree Pruned
Reclamation Cycle	34.5kV Single-phase Multi-phase	 2.2 1.1	 $56.51 $56.51	 $124.32 $62.16
	<34.5kV Single-phase Multi-phase	 2.2 1.4	 $56.51 $56.51	 $124.32 $79.11
Long-term Maintenance Cycle	34.5kV Single-phase Multi-phase	 1.1 .9	 $56.51 $56.51	 $62.16 $50.88
	<34.5kV Single-phase Multi-phase	 1.1 .9	 $56.51 $56.51	 $62.16 $50.86

The costs associated with Reclamation Cycle options are found in Table 15 and 16. The Long-term Maintenance Cycle options are found in Table 17.

Table 15. Reclamation Cycle Estimated Annual Costs in 2012 Dollars: 3-Year Cycle 34.5 kV and 5-Year Cycle for Other Voltages

Component	Estimated Annual Cycle Cost (years 1-3)	Estimated Annual Cycle Cost (years 4-5)	Reclamation Crews Required
34kV (3-year full circuit)	Tree $22,085,217 Brush $563,657 Haz Tree $140,399 Svc Tree $245,418 **$ 23,034,691**	Tree $10,979,031 Brush $563,657 Haz Tree $140,399 Svc Tree $245,418 **$ 11,928,505**	Bucket: 88 Manual: 10 Total: 98
12.5-1 9.9kV (5-year full circuit)	Tree $18,448,929 Brush $459,210 Haz Tree $189,655 Svc Tree $207,510 **$ 19,305,304**	Tree $18,448,929 Brush $459,210 Haz Tree $189,655 Svc Tree $ 207,510 **$ 19,305,304**	Bucket: 74 Manual: 8 Total: 82
Below 12.5kV (5-year full circuit)	Tree $20,216,412 Brush $501,362 Haz Tree $207,921 Svc Tree $ 17,072 **$ 21,142,767**	Tree $20,216,412 Brush $501,362 Haz Tree $207,921 Svc Tree $217,072 **$ 21,142,767**	Bucket: 81 Manual: 9 Total: 90
Contract Work Planners	**$1,200,000**	**$1,200,000**	Average: 12
Hot-Spot	**$3,500,000**	**$3,500,000**	
TOTAL	**$68,182,762**	**$57,076,576**	**Bucket: 243** **Manual: 27** **Total: 270**
5-Yr TOTAL		**$318,701,438**	

Table 16. Reclamation Cycle Estimated Annual Cost in 2012 Dollars: 4-Year Cycle 34.5 kV + Mid-Cycle and 5-Year Cycle for Other Voltages

Component	Estimated Annual Cycle Cost (years 1-4)	Estimated Annual Cycle Cost (year 5)	Reclamation Crews Required
34kV (4-year full circuit with mid-cycle)	Tree $16,563,913 Brush $422,743 Haz Tree $140,399 Midcyc $330,401 Svc Tree $202,618 **$ 17,660,074**	Tree $8,234,273 Brush $422,743 Haz Tree $140,399 Midcyc $330,401 Svc Tree $202,618 **$ 9,330,434**	Bucket: 68 Manual: 7 Total: 75
12.5-19.9kV (5-year full circuit)	Tree $18,448,929 Brush $459,210 Haz Tree $189,655 SvcTree $228,428 **$ 19,326,222**	Tree $18,448,929 Brush $459,210 Haz Tree $189,655 Svc Tree $228,428 **$ 19,326,222**	Bucket: 74 Manual: 8 Total: 82
Below 12.5kV (5-year full circuit)	Tree $20,216,412 Brush $501,362 Haz Tree $207,921 Svc Tree $238,954 **$ 21,164,649**	Tree $20,216,412 Brush $501,362 Haz Tree $207,921 Svc Tree $238,954 **$ 21,164,649**	Bucket: 81 Manual: 9 Total: 90
Contract Work Planners	**$1,200,000**	**$1,200,000**	Average: 12
Hot-Spot	**$3,500,000**	**$3,500,000**	
TOTAL	**$62,850,945**	**$54,521,305**	**Bucket: 223** **Manual: 24** **Total: 247**
5-Yr. TOTAL		**$305,925,085**	

Table 17. Long-Term Maintenance Cycle (Following Reclamation Cycle) Options and Associated Cost Estimates

	Option 1	Option 2 ECI Recommended	Option 3	Option 4
Budget Categories				
Tree	$34,989,062	$30,379,465	$27,813,210	$28,020,914
Brush	$1,639,031	$1,415,396	$ 1,299,754	$1,298,766
Mid-cycle		$330,401		
Hazard Tree	$430,380	$430,380	$ 430,380	$430,380
Svc Tree	$670,000	$670,000	$ 670,000	$670,000
Cont. Work Planners	$1,200,000	$1,200,000	$1,200,000	$1,200,000
Hot-spot	$3,500,000	$3,500,000	$3,500,000	$3,500,000
Total	**$ 42,428,474**	**$ 37,925,642**	**$ 34,913,344**	**$35,120,060**
Number of Preventive Maintenance Crews Required	Bucket: 145 Manual: 15 Total: 160	Bucket: 127 Manual: 13 Total: 140	Bucket: 115 Manual: 12 Total: 127	Bucket: 116 Manual: 12 Total: 128

34.5 kV Cycle Cost Option Analysis

ECI has proposed two options for the 34.5 kV maintenance cycle: 1) a three-year cycle; and 2) a four-year cycle with a mid-cycle inspection and pruning. A net present value (NPV) analysis of the proposed three-year cycle compared to a four-year cycle + mid-cycle inspection and trim suggests a benefit to the four-year cycle with mid-cycle. ECI made several assumptions in this analysis: 1) this analysis is for the backbone three-phase 34.5 kV only, 2) the initial year trim cost is $4,948 per mile, 3) the mid-cycle cost is $712 per mile. This is graphically represented in Figure 12. Over a 13-year period, the NPV of the three-year cycle cost per mile would be approximately $18,342 and the four-year cycle + mid-cycle cost per mile would be about $16,209 or an 11.5 percent savings over the three-year cycle option.

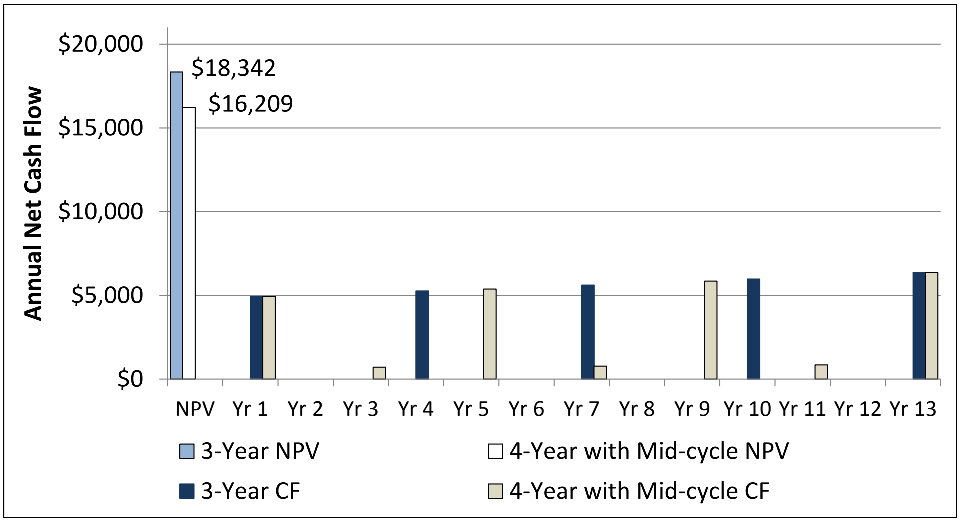

Figure 12. Net Present Value Analysis of 34.5 kV Long-term Cycle Options (3-year vs. 4-year +mid-cycle – includes initial trim for both options and a 6.5% interest rate and 2.13 percent escalation rate)

When a four-year cycle is compared to a five-year cycle, it is recognized that there are some increases in biomass and maintenance time associated with the increase in cycle length. However, those increases are not as significant as the cost of maintaining 25 percent more miles each year. Shorter cycles should provide some enhanced benefits to warrant the additional cost. These benefits, some of which can be documented, include:

- Reduced interruptions associated with tree growth
- Reduced customer interruptions (CI) associated with tree failure/breakage
- Reduced restoration costs proportional to the reduction in interruptions
- Reduced customer inquiries and complaints regarding trees in close proximity to conductors
- Reduced outage restoration cost commensurate with the reduction in number of outage events.

Long-Term Cycle Cost Analysis of Options

On the basis of the vegetation workload survey, growth study and historic production costs, proposed program cycle and funding, many program alternatives were reviewed by ECI.

It should be noted that the term "cycle" is a planning term reflecting the average frequency circuits must be trimmed. Specific conditions will necessitate circuit-specific variance around this average cycle length. Reliability metrics and field observations should be used to modify the preventive maintenance strategy in order to complete highest risk circuits first during a scheduling year, or push individual circuits forward or backward by one year.

Table 17 summarizes the cost for all four options. Option 2 is ECI's Recommended option where cycle is based on circuit voltage (34.5 kV= four-year + mid-cycle; 12.5-19.9 kV = four-year cycle multi-phase and five-year cycle single-phase; under 12.5 kV circuits = five-year cycle).

Several metrics were calculated for this cycle strategy recommendation. They include impact on long-term tree contact with conductors, projected tree-caused interruptions, and interruptions avoided through regular tree maintenance. Option 2 is expected to provide the greatest improvement in reliability while maintaining relatively low long-term annual cost. Option 1, while the most expensive, will provide the maximum reliability improvements at the end of year five.

The analysis of cost presented in Table 17 for the long-term maintenance cycle options do not reflect cost reductions that would result through the use of herbicides during of the reclamation cycle. If herbicides were used to treat cut stumps during reclamation, it is estimated that long-term brush maintenance costs could be reduced by 40 to 60 percent.

Net Present Value Analysis: Current Funding versus ECI Recommended Maintenance Options

A NPV analysis was made of the costs to continue a vegetation management program at current funding levels compared to the estimated costs of ECI's proposed maintenance cycles over a 15-year period. ECI's proposed Reclamation Cycle (Option 2, Table 11 and Figure 12) and Long-term Maintenance Cycle (Option 2, Table 12 and Figure 13) were used for the NPV calculations. Annual cash flows from this analysis are graphically represented in Figure 13. Two versions of the NPV analysis and associated assumptions can be found in Appendix E using two different discount rates. The analysis anticipates several benefits from a systematic and proactive cyclic maintenance strategy. Some of the benefits of the recommended program include avoidance of costs associated with the following four categories

1. Liability related to utility worker and public safety
2. Deterioration in customer satisfaction
3. Deterioration in governmental satisfaction
4. Major event mitigation

The analysis resulted in a NPV for the proposed program of $774M over 15 years, which is 2.8 percent lower than the NPV of the current program. Assumptions included a 4.1 percent discount rate and $3.4M in annual costs associated with the safety-related claims, deterioration in customer and governmental satisfaction and periodic mitigation related to major events made worse by infrequent tree maintenance. To the extent that these costs exceed $3.4M annually, the NPV becomes more favorable toward the recommended program strategy. It is likely that these average annual costs could easily exceed $3.4M by at least $1.5M per year. A second analysis, using a 7.48 percent discount rate resulted in a 1.1 percent higher NPV for the full cycle program when compared to the current program.

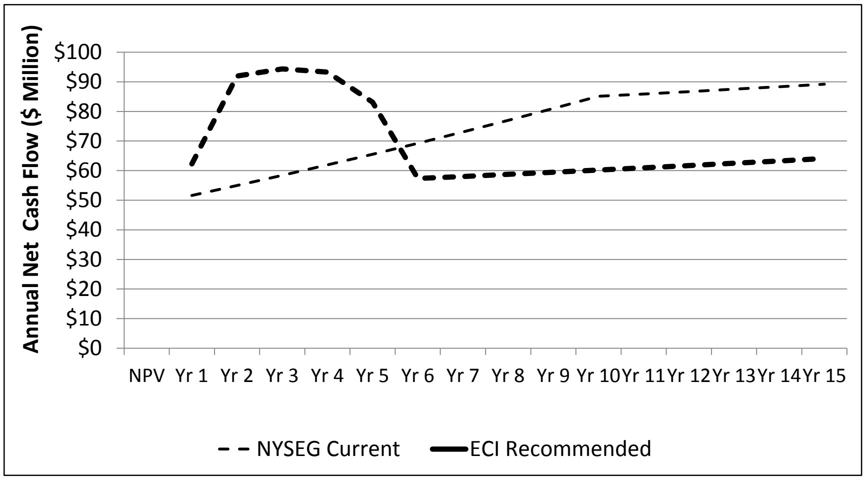

Figure 13. Net present value analysis of NYSEG current funding compared to ECI recommended programcost estimate (Reclamation Cycle Option 2 and Long-term maintenance Option 2) at 4.1 percent interest rate (provided by NYSEG) and 2.13 percent escalation rate (US 10-Year CPI estimate by CBO in 2010) applied to the ECI recommendation

5.3.1 Advantages of Regular Vegetation Maintenance

The advantages to NYSEG in adopting these two strategies (Reclamation Cycle and Long-term Maintenance Cycle) are:

1. Maintenance of acceptable reliability with potential for improvement in system tree-related reliability (SAIFI and CAIDI).
2. Improved customer satisfaction.
3. Improved public relations image.
4. Improved safety to NYSEG workers, NYSEG contractor workers and the public (reduced danger of contact with energized overhead electric conductors). Regular cyclic maintenance will aid in the reduction of broken limbs falling on NYSEG overhead conductors (one of the leading causes of tree-caused interruptions on NYSEG). Regular maintenance will also reduce the number of poly-coated line burn downs (incidents of live wire on the ground) as NYSEG clearances are achieved throughout the system on all voltages and construction types.
5. Reduction in storm restoration time and cost.
6. Reduction in customer trim requests (customer tickets) and associated cost.

While the evidence to support regular vegetation maintenance is strong, the economic cost for deferring maintenance adds additional justification (see Appendix F).

5.3.2 Unscheduled Work

Best practice vegetation management programs commonly have been able to limit unscheduled or reactive work. Many utilities that have that practice cyclic vegetation management have noticed a reduction in cost associated with unscheduled work. Over time, the need for some of this work should decrease as the average cycle length decreases. As full circuit pruning occurs on a regular cycle on the NYSEG system, the percent of trees within five feet of the conductors will decrease as will the associated "hot-spot" workload.

5.3.3 Reliability and Tree-Line Contact Impacts

An analysis of NYSEG tree-caused interruption data determined that there is little correlation between tree-related interruptions and years since last maintenance. NYSEG has not been engaged in the current program long enough to draw any conclusions about the impact of recent changes to program. NYSEG does not perform a postmortem on tree-caused interruptions to clearly define or segregate outages by cause type (growth, broken limb, broken trunk, up-rooted tree) therefore, a clear relationship between growth-caused outages and cycle length cannot be made. However, based on ECI's workload survey the percentage of trees by proximity to the conductors is available as summarized in Table 18. It should be noted that 50 percent of the total tree population on the NYSEG system is within five feet of the conductors.

Table 18. Tree Population Clearance to Conductor

Clearance	0-1ft	2-4ft	5-7ft	8-10ft	11-15ft	15+ft	*TOTAL*
Percent	22%	28%	25%	14%	6%	5%	100%

Observations made by ECI on other utility systems support the premise that contact between trees and distribution conductors results in outage events only under certain circumstances and is not as common as outage from trees that fall or break. In order to achieve significant reductions in total tree-caused outages, both growth and tree failure causes must be addressed. NYSEG's tree-caused interruption rate per 1,000 trees in Figure 5 was 1.7 interruptions. A reasonable goal for NYSEG is 1.1 interruptions per 1,000 trees following regular maintenance. ECI's projections for reliability improvement are based on achieving this target.

Figure 14 illustrates the projected total annual non-storm CI avoided each year for two funding scenarios. Projected improvements are based on application of existing clearance standards and full circuit pruning among all voltages classes. Figure 15 presents ECI's recommended program option (Reclamation Option 2 plus Option 2), including a mid-cycle inspection and tree maintenance on trees that will re-grow into the conductors prior to next scheduled pruning, focusing on vegetation near poles containing critical infrastructure equipment (transformers, cut-outs, etc.). The associated mid-cycle inspection cost is included in the cyclic cost in Tables 15 and 16. Figure 14 illustrates the opportunity for projected tree-caused CI reductions for two reclamation cycle options.

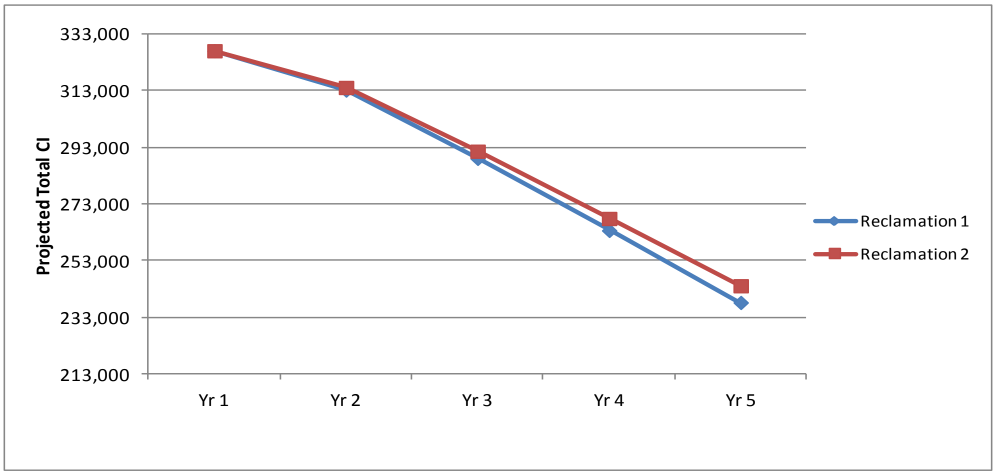

Figure 14. NYSEG Projected Non-storm Tree-caused Customer Interruptions (CI) Projected per Year for the Reclamation Cycle Options

Figure 15 shows the predicted impact on N (number of tree-caused interruptions for storm and non-storm) based on current level of program funding remaining unchanged vs. the ECI recommend level of spending.

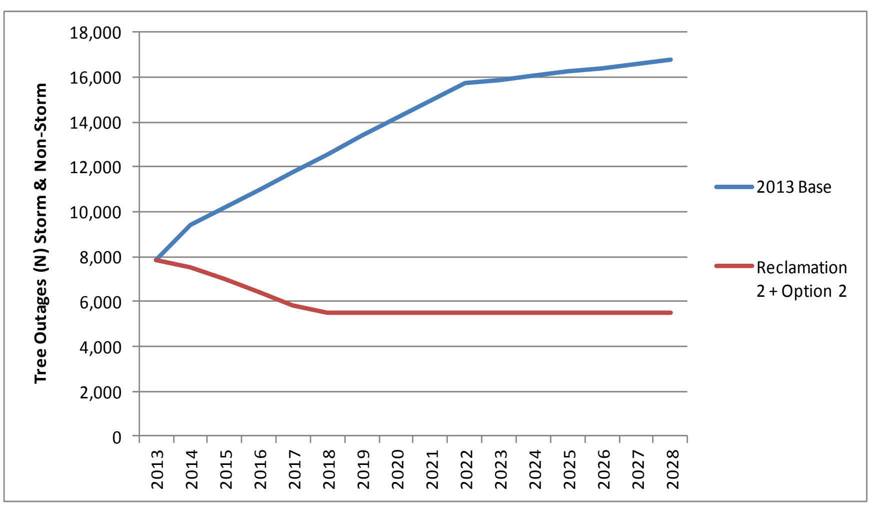

Figure 15. A 16-year Projection of All Vegetation-Caused Interruption Events (N) for the Current Program Compared to the RecommendProgram

Figure 16 illustrates the projected interruptions per 1,000 trees at the end of the Reclamation Cycle (five-years) as compared to the current system tree-caused interruptions per 1,000 trees. NYSEG system improvement is based on moving from 1.7 to 1.1 interruptions per 1,000 trees.

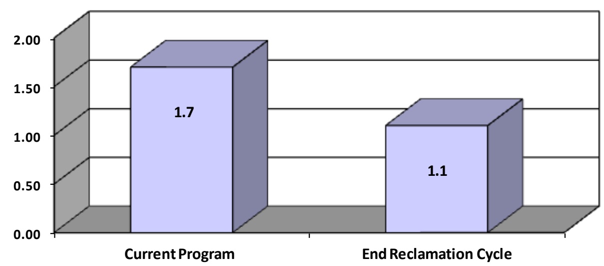

Figure 16. Projected non-storm tree related interruptions per 1,000 trees improvement compared to the current maintenance strategy

ECI conducted an analysis at a Midwestern utility looking at the relationship of outage events per mile vs. the last trim date. Figure 17 illustrates that outage events per mile remain relatively flat for years one through seven. However, there was a 105 percent increase in annual interruptions per mile on circuits where the last maintenance occurred eight to twenty years ago. The NYSEG system could expect interruption events per year to occur at a similar magnitude as in Figure 17.

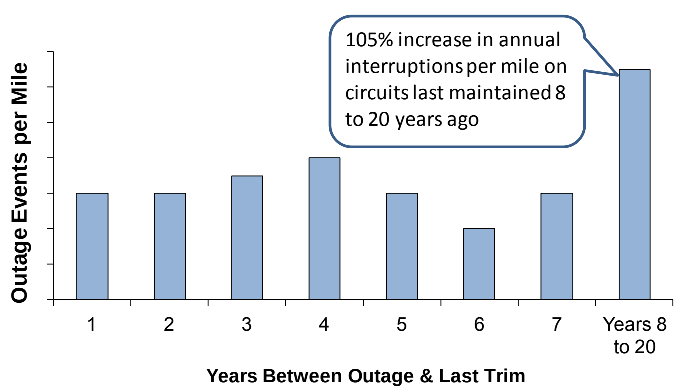

Figure 17. Tree-caused Outage Events per Mile Data from a Midwestern Utility Based on Year Since last Maintenance

5.3.4 Brush Control and Integrated Vegetation Management

Integrated Vegetation Management (IVM) is the process of using biological, chemical, cultural, manual, or mechanical maintenance techniques to control undesirable vegetation. The selection of control options is based on effectiveness, site characteristics, environmental impacts, safety, and economics.

IVM is recognized as an industry best practice, and it is therefore recommended that NYSEG adopt this strategy for the maintenance of undesirable brush on its rural distribution system. In general, manual, mechanical (mowing) with the addition of chemical control methods will be the most appropriate brush maintenance operations for the NYSEG distribution system.

Brush Control

Hand cutting deciduous brush without applying a follow-up herbicide application to the stump surface will permit the vegetation to re-sprout, thus requiring future maintenance. Trimming brush and/or allowing it to mature results in its becoming a more expensive, and often permanent, part of the workload. Neither of these brush management techniques is cost effective.

ECI recommends that NYSEG aggressively ground-line cut brush, but also begin to treat deciduous cut stumps of trees and brush with appropriate herbicides whenever possible. This will prevent future expansion of the distribution workload and future line clearance cost increases.

In the more rural areas, there is opportunity to treat brush less than six to eight feet tall with either foliar or basal herbicide applications, avoiding hand cutting. Taller standing dead brush can become a source of complaints, and taller brush can be difficult to control with foliar applications without risking exposure to off-target plants. Over 77 percent of the brush acres on the NYSEG system was found to be in rural settings, while only 58 percent of the miles

Herbicide Use

The use of herbicides is essential if NYSEG is to maximize the benefits of its distribution tree and brush removal programs. Herbicide use is an important component of an IVM strategy. Herbicides have not been utilized in recent years at NYSEG on the distribution system.

The effectiveness of selective herbicide applications has been well documented through long-term studies on utility rights-of-way in the central and northeastern United States. Results from treatment simulation models developed through these studies project that sites dominated by deciduous species would nearly double in stem density by the end of two cycles if simply cut without a follow-up herbicide application (Figure 18). These same sites would be expected to exhibit about a 50 percent reduction in stem density over the same time period if treated with a selective herbicide application.

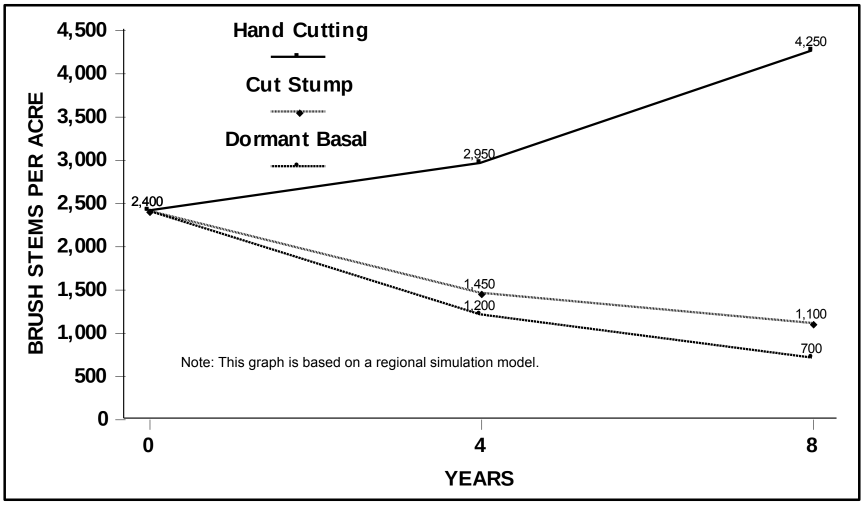

Figure 18. Effectiveness of Herbicides for Control of Brush Over Time

An important consideration is that use of herbicides must be environmentally safe and professionally supervised to maintain public acceptance. Line clearance crews performing herbicide applications should receive proper training in species identification and herbicide application methods. A Regional Arborist (a licensed pesticide applicator in the state of New York) should be responsible for the implementation of a comprehensive herbicide use policy and for selecting approved herbicides. Professional supervision by the Line Clearance Foremen is essential to ensure safe, effective application on appropriate species and sites. Herbicide application contractors are currently required to be licensed by the State of New York and retain liability insurance associated with herbicide application. NYSEG must require contractors to demonstrate compliance with regulatory rules and frequently inspect operations to assure that contractors are operating safely and professionally.

Herbicide use cost is dependent on the method of application (cut-stump, cut-stubble, low volume foliar, etc.). Figure 19 summarizes the relative annual cost per acre for various right-of-way treatment methods over two to three maintenance cycles[6]. The annual cost per acre for the consistent use of herbicides over three

[6] Abrahamson, L, C. Nowak, P. Charlton, P. Snyder. Cost Effectiveness of Herbicide and Non-Herbicide Vegetation Management Methods for Electric Utility Rights-of-Way in the Northeast. State-of-the-Art Review and Annotated Bibliography. 1992. (high-volume foliar herbicide application)

cycles is 85 percent less than hand cutting and 83 percent less than hand cutting followed by mowing. Herbicide cost is a relatively small component of the vegetation maintenance cost per mile[7]. The use of herbicides to control brush regrowth is not required in every span and the amount of brush suitable for treatment as well as the potential application method varies by circuit (urban vs. rural).

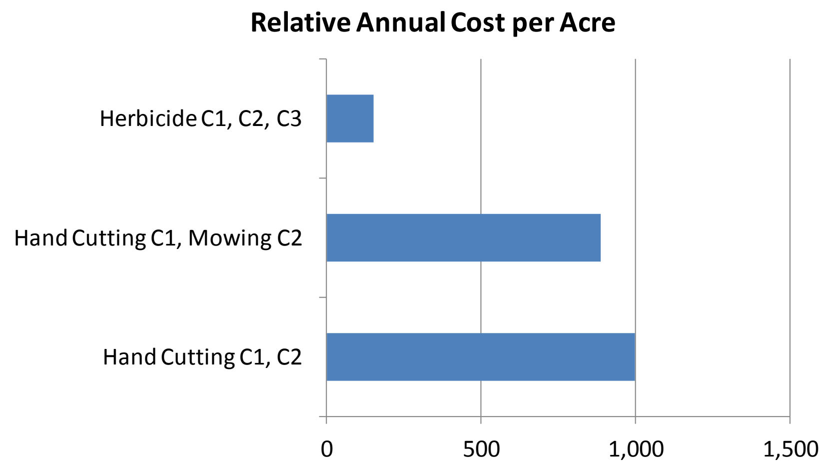

Figure 19. Relative Cost of Herbicide Use Over 2 to 3 Cycles (C1-cycle 1; C2-cycle 2; C3-cycle 3)

There are two distinct herbicide treatment methods for treating brush on a distribution system, foliar and cut stump. The method of herbicide treatment is dependent on: 1) the height of the brush (foliar for brush under six-foot in height, cut stump where trees/brush has been removed); 2) the physical location of the brush (urban vs. rural). As illustrated in Table 7 on page 16, NYSEG currently has few opportunities for foliar application of herbicides[8]. This is due to brush height at the time of the workload survey as well as the location of brush (urban areas, along streams and reservoirs, in residential settings, etc.).

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[7] Recent NYSEG lump sum bids documented a 4.5 percent premium ($280 per mile) for initial use of herbicides to treat cut stumps.

[8] NYSEG has approximately 3,591 acres of brush suitable for herbicide treatment as determined in the recent ECI workload study (Feb. 2011). However, only 10 percent of these acres contain brush under six-foot in height, the remaining 90 percent of the bush acres are not suitable for foliar herbicide treatment due to brush height in excess of six-foot.

Based on ECI's recent experience with foliar herbicide application contracts on distribution systems, NYSEG can expect a foliar herbicide cost per mile in the range of $300 to $400 per treated acre (cost of foliar herbicide treatment crew including herbicide). ECI used $400 per acre in budget forecast calculations for the foliar portion of the NYSEG system.

The greatest potential for herbicide use on the NYSEG system is through the use of cut stump treatment. When trees and stems of brush are removed, the appropriate herbicide should be applied to the freshly cut stump surface. This will prevent sprout re-growth, eliminating future tree and brush workload. Figure 20 provides an illustration from the NYSEG system of what occurs when stumps are not treated with herbicides at the time the tree/brush was removed.

Figure 20. Result of no herbicide treatment: left - one growing season; right-5 to 6 years re-growth

The combined cost for tree removal and brush cutting and treating is $1,200 per circuit mile. The herbicide material portion of this cost is estimated at $38 per mile[9]. Table 19 provides a graphic representation of the herbicide cost per acre of the total cut and treat cost per acre. Through a minor investment in cut stump treatment during the first cycle, there is the potential significantly reduce[10] the $1,200 cost per mile for reclearing of tree and brush from stump sprouts on NYSEG's 3,000 cut/treat miles in subsequent cycles.

[9] Material cost per mile based on 2011 actual cost per mile experienced at a similar utility.
[10] CMP has experienced a 75-80 percent reduction of trees/brush in subsequent cycles. ECI has observed up to an 80 percent reduction at other utilities throughout the United States when herbicides have been used on stumps of removed trees/brush.

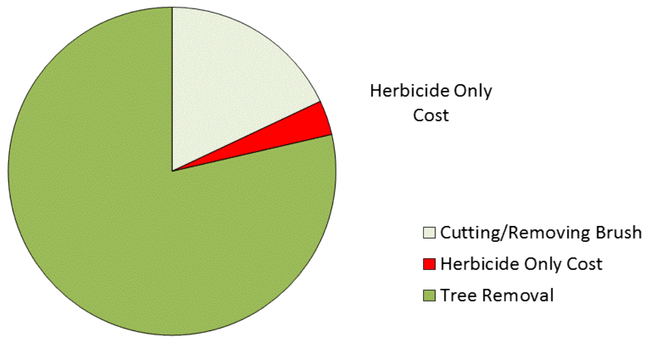

Figure 21. Cost Components of Tree and Brush Removal and Treating on One Mile of the NYSEG System

Herbicide Safety and Risk Assessments

Modern herbicides control resprouting by blocking chemicals needed by plants to convert water, sunlight and nutrients into food for growth. Since these same chemicals are not present in animals and humans, the herbicides are very low in toxicity to people or animals. Without any food, the treated weed trees on the right-of-way wither and decompose. Treated stumps dry out and don't re-sprout.

Herbicides commonly used for stump treatments are U.S. EPA-registered general use products that are commonly available at local garden centers and hardware stores. No special license is required to purchase these products. Prior to registration by the EPA for use, herbicides undergo rigorous testing to assure the public that proper use of these products will not result in adverse risk to human health, wildlife or the environment.

Approved herbicides are safe for humans and the environment and do not cause adverse effects that are unacceptable. In this context, risk assessment is the process by which the likelihood of unacceptable adverse effects from the use of various methods of vegetation management can be determined.

An extensive report prepared by ECI provided the technical basis for and a summary of the risk to human health, wildlife and the environment from the use of 10 herbicides by a New York utility. These herbicide uses included broadcast foliar, selective foliar, basal bark and cut stump applications. This assessment concluded that the margins of safety for herbicide use by the utility that commissioned the assessment were "adequate to assure protection of human health of workers and the general public."

ECI also completed an environmental impact statement resulting in the authorization of herbicides to control right-of-way vegetation in the Allegheny National Forest in

Pennsylvania. Subsequent evaluation of herbicide use in the National Forest confirmed safe and effective use of foliar herbicides to control brush on utility right-of-way.

The human health risk assessment methodology used in these reports was the one generally recognized by the scientific community (National Research Council) as necessary to characterize the potential adverse human health effects of chemicals in the environment. It is the same process used in judging the human health risk from cosmetics, food additives, pharmaceuticals, various household chemicals and many other materials.

Herbicide Acceptance by Wildlife Groups

Stump control herbicides are used not only by electric utilities, but also by the Nature Conservancy on projects designed to limit the spread of invasive and non-native trees and shrubs. Groups such as the National Wild Turkey Federation, Buckmasters, Butterfly Lovers International and Quail Unlimited have encouraged utilities to implement an "Integrated Vegetation Management" approach to maintaining utility rights-of-way that appropriately utilizes herbicides as a component in the control of right-of-way vegetation. They have recognized that environmental benefits of herbicides, when properly used, outweigh any adverse risk and are far more desirable than the alternatives to herbicide use, such as frequent mowing or hand cutting of undesirable trees.

Significant research has been undertaken over the past 50 years to document the impact of right-of-way herbicide use on the environment, wildlife and management costs. Much of this research has been conducted by ECI and its university research associates. Stems per acre decrease over time through the use of herbicides, as does associated maintenance costs.

5.4 Revised Program Integration

Implementation of ECI's recommended optimum program will require careful planning and an orderly sequence of events. The anticipated steps to full implementation are:

1. Approved funding: The level of implementation for the full program recommendations will be dependent on the level of regulatory support for the associated funding.
2. Additional planning and lead time to ramp up contractor line clearance work force to desired maintenance levels over 18 months.
3. Addition assistance for Regional Arborists as a great deal of planning must be done to implement the recommendation (circuit priority, bid vs. T&M, pre-planning cyclic maintenance and identification of hazard trees, inspection and

tree identification for mid-cycle programs, audit of contractor work, program roll-out to municipalities and public, etc.).

4. Additional time to secure and train contract labor to assist with added contractor auditing/QA, customer notification and addressing increased volume of customer tickets.
5. Roll out increased NYSEG vegetation maintenance strategy to customers, state and municipalities.

Appendix A

Species List

Common Name	*Scientific Name*
Maple, Norway	Acer platanoides
Maple, silver	Acer saccharinum
Ash	Fraxinus spp.
Maple, sugar	Acer saccharum
Maple, red	Acer rubrum
Locust, black	Robinia pseudoacacia
Spruce, blue	Picea pungens
Spruce, Norway	Picea abies
Pine, eastern white	Pinus strobus
Honeylocust	Gleditsia triacanthos
Pine, red	Pinus resinosa
Oak, northern red	Quercus rubra
Cottonwood, eastern	Populus deltoides
Apple	Malus spp.
Birch, paper (white)	Betula papyrifera
Box-elder	Acer negundo
Willow, black	Salix nigra
Elm, American	Ulmus americana
Aspen, quaking	Populus tremuloides
Spruce, red	Picea rubens
Cherry, black	Prunus serotina
Walnut, black	Juglans nigra
Ash, white	Fraxinus americana
Ash, black	Fraxinus nigra
Pine, other	Pinus spp.
Willow, weeping	Salix babylonica
Spruce, black	Picea mariana
Arborvitae	Thuja spp.
Pine, Scots	Pinus sylvestris
Ash, green	Fraxinus pennsylvanica
Oak, black	Quercus velutina
Willow	Salix spp.
Pine, Austrian	Pinus nigra
Pine, pitch	Pinus rigida
Poplar, white	Populus alba
Birch, gray	Betula populifolia
Sumac, staghorn	Rhus typhina
Other Species	

Appendix B

Growth Study Information

Species	Pruning Type	Feet of Growth By Age of Sprout 1 Yr.	2 Yrs.	3 Yrs.	4 Yrs.	5 Yrs.	6 Yrs.
SILVER MAPLE	Side Mean	4.4	7.6	9.8	11.6	13.1	14.0
	Std Dev (±)	1.9	2.3	2.5	3.1	3.1	2.5
	Top Mean	6.4	9.2	11.7	13.3	14.2	14.6
	Std Dev (±)	1.7	1.4	1.9	2.3	2.7	2.1
BLACK WILLOW	Side Mean	5.8	7.7	9.4	10.9	12.3	13.8
	Std Dev (±)	1.3	1.7	2.0	2.3	2.8	2.5
	Top Mean	6.1	9.0	11.0	13.7	15.6	17.2
	Std Dev (±)	1.3	1.5	1.8	2.1	2.7	2.1
EASTERN COTTONWOOD	Side Mean	3.5	5.9	8.3	9.5	10.8	12.1
	Std Dev (±)	1.3	1.7	2.0	22.3	2.8	2.5
	Top Mean	4.9	7.5	10.3	12.5	14.0	17.4
	Std Dev (±)	1.3	1.5	1.8	2.1	2.7	2.1
BOX ELDER	Side Mean	3.3	6.0	8.4	10.3	12.0	12.8
	Std Dev (±)	1.3	1.7	2.0	2.3	2.8	2.5
	Top Mean	4.3	7.4	9.8	11.8	13.6	15.4
	Std Dev (±)	1.3	1.5	1.8	2.1	2.7	2.1
BLACK LOCUST	Side Mean	3.3	5.5	6.5	7.8	9.7	10.1
	Std Dev (±)	1.3	1.7	1.6	1.7	1.9	1.9
	Top Mean	4.2	7.3	9.8	11.3	11.6	1.2
	Std Dev (±)	1.2	1.6	2.0	0.6	2.7	3.1
SUGAR MAPLE	Side Mean	2.8	5.0	6.8	8.2	9.3	10.1
	Std Dev (±)	1.4	1.7	2.1	2.5	3.1	4.9
	Top Mean	4.2	7.2	9.1	10.9	12.7	13.3
	Std Dev (±)	1.9	2.1	2.3	2.8	2.9	0.9
AMERICAN ELM	Side Mean	3.2	5.7	7.7	9.0	8.6	10.0
	Std Dev (±)	1.3	18.0	2.2	2.4	2.3	3.9
	Top Mean	4.1	6.5	8.3	10.2	10.0	11.3
	Std Dev (±)	1.3	1.5	2.0	1.9	2.8	3.1
BLACK WALNUT	Side Mean	3.3	5.4	7.2	8.8	10.3	11.7
	Std Dev (±)	1.3	1.7	2.0	2.3	2.8	2.5
	Top Mean	4.0	7.2	9.3	11.6	13.0	14.1
	Std Dev (±)	1.3	1.5	1.8	2.1	2.7	2.1
RED MAPLE	Side Mean	3.0	4.9	6.9	7.6	8.3	8.8
	Std Dev (±)	1.2	1.7	2.2	2.1	2.2	0.6
	Top Mean	3.8	5.7	7.4	7.8	8.2	9.3
	Std Dev (±)	1.0	1.1	1.3	1.8	2.1	2.1
HONEYLOCUST	Side Mean	2.8	5.3	6.9	8.1	9.4	10.0
	Std Dev (±)	1.3	1.7	2.0	2.3	2.8	2.5
	Top Mean	3.8	6.3	9.9	12.5	14.8	19.5
	Std Dev (±)	1.3	1.5	1.8	2.1	2.7	2.1

		Feet of Growth By Age of Sprout					
Species	Pruning Type	1 Yr.	2 Yrs.	3 Yrs.	4 Yrs.	5 Yrs.	6 Yrs.
NORWAY MAPLE	Side Mean	2.8	5.3	7.0	8.1	8.7	9.0
	Std Dev (±)	1.3	1.7	2.0	2.3	2.8	2.5
	Top Mean	3.7	5.7	7.5	9.2	9.4	10.9
	Std Dev (±)	1.3	1.5	1.8	2.1	2.7	2.1
WHITE ASH	Side Mean	2.3	4.9	7.0	7.8	8.1	8.3
	Std Dev (±)	1.0	1.8	2.5	2.7	5.3	2.5
	Top Mean	3.7	6.8	9.7	12.0	13.6	14.7
	Std Dev (±)	1.1	1.2	1.1	1.8	2.7	2.1
QUAKING ASPEN	Side Mean	2.6	4.4	6.2	8.1	9.4	11.1
	Std Dev (±)	1.3	1.7	2.0	2.3	2.8	2.5
	Top Mean	3.6	6.3	9.0	11.4	13.4	15.9
	Std Dev (±)	1.3	1.5	1.8	2.1	2.7	2.1
PAPER BIRCH	Side Mean	2.6	4.5	6.3	7.6	8.6	9.9
	Std Dev (±)	1.3	1.7	2.0	2.3	2.8	2.5
	Top Mean	3.1	5.0	7.3	8.8	10.3	12.4
	Std Dev (±)	1.3	1.5	1.8	2.1	2.7	2.1
BLACK CHERRY	Side Mean	2.8	5.1	6.5	7.5	8.8	9.7
	Std Dev (±)	1.3	1.7	2.0	2.3	2.8	2.5
	Top Mean	3.0	5.7	7.4	8.8	9.5	10.6
	Std Dev (±)	1.3	1.5	1.8	2.1	2.7	2.1
ASH	Side Mean	1.9	3.6	5.3	6.0	6.8	7.4
	Std Dev (±)	1.3	1.7	2.0	2.3	2.8	2.5
	Top Mean	2.5	4.8	7.8	9.1	10.6	12.2
	Std Dev (±)	1.3	1.5	1.8	2.1	2.7	2.1
NORTHERN RED OAK	Side Mean	0.9	1.9	3.2	4.1	4.7	6.0
	Std Dev (±)	0.4	0.7	1.0	1.2	1.1	1.3
	Top Mean	1.8	3.7	5.5	6.6	7.3	7.6
	Std Dev (±)	0.5	1.7	2.6	3.1	2.8	1.2
BLUE SPRUCE	Side Mean	0.8	1.4	2.2	2.8	3.4	6.0
	Std Dev (±)	0.6	0.8	1.0	1.5	2.4	1.7
	Top Mean	1.3	2.3	3.4	4.3	5.3	6.3
	Std Dev (±)	0.6	1.1	1.6	1.8	2.2	1.2
NORWAY SPRUCE	Side Mean	0.9	1.3	2.5	3.3	4.0	4.4
	Std Dev (±)	0.5	0.5	0.7	1.0	2.4	1.7
	Top Mean	1.3	2.4	3.7	4.8	5.5	6.0
	Std Dev (±)	0.6	1.0	1.3	1.6	2.4	1.2
EASTERN WHITE PINE	Side Mean	0.8	1.8	2.7	3.8	4.8	5.4
	Std Dev (±)	0.7	1.1	1.4	1.9	2.4	1.7
	Top Mean	1.2	2.8	4.3	5.8	6.8	8.1
	Std Dev (±)	0.6	1.1	1.8	2.0	1.9	1.2
RED PINE	Side Mean	0.8	1.5	2.3	2.9	3.8	4.5
	Std Dev (±)	0.6	0.8	1.0	1.5	2.4	1.7
	Top Mean	1.0	2.2	3.3	4.6	5.5	6.3
	Std Dev (±)	0.6	1.1	1.6	1.8	2.2	1.2

GROWTH BY TRIM TYPE AND AGE				
GROWTRND.SAS NO. 2				
BASED ON FIRST SIMULATION ONLY - NYSEG				
Obs	TRIMTYPE	AGE	GROWTH	
1	S	1	2.6475	
2	S	2	4.5244	
3	S	3	6.0897	
4	S	4	7.2405	
5	S	5	8.2279	
6	S	6	9.0863	
7	T	1	3.2254	
8	T	2	5.3584	
9	T	3	7.2712	
10	T	4	8.7190	
11	T	5	9.3791	
12	T	6	11.0533	

Appendix C

Annual Cycle Budget Recommendations by Voltage

These tables present estimated budgets by activity and respective miles and include an estimate of CI (customers interrupted) avoided[11] compared to the current program.

I. Reclamation Cycle 3yr (34kV), 5yr (12.5-19.9 kV), 5yr (<12.5 kV):

Maint. Type	VM Activity	Budget Year 1-3	Budget Year 4-5	Miles	Cost/Mile Year 1-3	Cost/Mile Year 4-5	CI Avoided
Scheduled	Tree Pruning & Removal	$60,750,558	$49,644,371	7,013	$8,663	$7,079	88,888
	34 kV: All	*$22,085,217*	*$10,979,031*	*2,569*	*$8,598*	*$4,274*	
	12.2-19.9 kV: Single Phase	*$14,128,122*	*$14,128,122*	*1,464*	*$9,651*	*$9,651*	
	Multi-Phase	*$4,320,807*	*$4,320,807*	*708*	*$6,103*	*$6,103*	
	<12.2 kV: Single-Phase	*$16,794,910*	*$16,794,910*	*1,713*	*$9,806*	*$9,806*	
	Multi-Phase	*$3,421,502*	*$3,421,502*	*559*	*$6,118*	*$6,118*	
	Mid-Cycle (34 kV)	$0	$0	0	$0	$0	
	Brush	$1,524,229	$1,524,229				
	34 kV: All	*$563,657*	*$563,657*	*2,569*	*$219*	*$219*	
	12.2-19.9 kV: Single Phase	*$330,884*	*$330,884*	*1,464*	*$226*	*$226*	
	Multi-Phase	*$128,326*	*$128,326*	*708*	*$181*	*$181*	
	<12.2 kV: Single-Phase	*$398,484*	*$398,484*	*1,713*	*$233*	*$233*	
	Multi-Phase	*$102,877*	*$102,877*	*559*	*$184*	*$184*	
	Hazard Removal (5yr)	$537,975	$537,975				
	Service Pruning	$670,000	$670,000				
Un-Scheduled	Hot-Spot	$3,500,000	$3,500,000				
Staff	Contract Work Planners (12)	$1,200,000	$1,200,000				
Total VM Program Costs:		**$68,182,762**	**$57,076,575**				

II. Reclamation Cycle 4yr w/ Mid-Cycle (34kV), 5yr (12.5-19.9 kV), 5yr (<12.5 kV):

Maint. Type	VM Activity	Budget Year 1-4	Budget Year 5	Miles	Cost/Mile Year 1-4	Cost/Mile Year 5	CI Avoided
Scheduled	Tree Pruning & Removal	$55,229,254	$46,899,614	6,371	$8,669	$7,361	82,987
	34 kV: All	*$16,563,913*	*$8,234,273*	*1,927*	*$8,598*	*$4,274*	
	12.2-19.9 kV: Single Phase	*$14,128,122*	*$14,128,122*	*1,464*	*$9,651*	*$9,651*	
	Multi-Phase	*$4,320,807*	*$4,320,807*	*708*	*$6,103*	*$6,103*	
	<12.2 kV: Single-Phase	*$16,794,910*	*$16,794,910*	*1,713*	*$9,806*	*$9,806*	
	Multi-Phase	*$3,421,502*	*$3,421,502*	*559*	*$6,118*	*$6,118*	
	Mid-Cycle (34 kV)	$330,401	$330,401	464	$712	$712	
	Brush	$1,383,315	$1,383,315				
	34 kV: All	*$422,743*	*$422,743*	*1,927*	*$219*	*$219*	
	12.2-19.9 kV: Single Phase	*$330,884*	*$330,884*	*1,464*	*$226*	*$226*	
	Multi-Phase	*$128,326*	*$128,326*	*708*	*$181*	*$181*	
	<12.2 kV: Single-Phase	*$398,484*	*$398,484*	*1,713*	*$233*	*$233*	
	Multi-Phase	*$102,877*	*$102,877*	*559*	*$184*	*$184*	
	Hazard Removal (5yr)	$537,975	$537,975				
	Service Pruning	$670,000	$670,000				
Un-Scheduled	Hot-Spot	$3,500,000	$3,500,000				
Staff	Contract Work Planners (12)	$1,200,000	$1,200,000				
Total VM Program Costs:		**$62,850,944**	**$54,521,304**				

[11] CI avoided cumulatively over 5 years was estimated based on the additional trees worked by voltage category, the historic interruption rate per 1,000 trees at NYSEG and benchmark interruption rates of other utilities per 1,000 trees.

Long-Term Budget Options (Following Reclamation)

III. Option 1 3yr (34kV), 4yr (12.5-19.9 kV), 5yr (<12.5 kV):

Maint. Type	VM Activity	Budget Year 6-10	Miles	Cost/Mile	CI Avoided
Scheduled	Tree Pruning & Removal	$34,989,062	7,556	$4,631	4,355
	34 kV: All	*$10,979,031*	*2,569*	*$4,274*	
	12.2-19.9 kV: Single Phase	*$9,324,196*	*1,830*	*$5,095*	
	Multi-Phase	*$3,558,486*	*885*	*$4,021*	
	<12.2 kV: Single-Phase	*$8,872,079*	*1,713*	*$5,180*	
	Multi-Phase	*$2,255,270*	*559*	*$4,033*	
	Mid-Cycle (34 kV)	$0	0	$0	
	Brush	$1,639,031			
	34 kV: All	*$563,657*	*2,569*	*$219*	
	12.2-19.9 kV: Single Phase	*$413,605*	*1,830*	*$226*	
	Multi-Phase	*$160,408*	*885*	*$181*	
	<12.2 kV: Single-Phase	*$398,484*	*1,713*	*$233*	
	Multi-Phase	*$102,877*	*559*	*$184*	
	Hazard Removal (5yr)	$430,380			
	Service Pruning	$670,000			
Un-Scheduled	Hot-Spot	$3,500,000			
Staff	Contract Work Planners (12)	$1,200,000			
Total VM Program Costs:		**$42,428,474**			

IV. Option 2 4yr + Mid-Cycle (34kV), 4yr Multi-Phase & 5yr Single-Phase (12.5-19.9 kV), 5yr (<12.5 kV):

Maint. Type	VM Activity	Budget Year 6-10	Miles	Cost/Mile	CI Avoided
Scheduled	Tree Pruning & Removal	$30,379,465	6,548	$4,640	4,073
	34 kV: All	*$8,234,273*	*1,927*	*$4,274*	
	12.2-19.9 kV: Single Phase	*$7,459,357*	*1,464*	*$5,095*	
	Multi-Phase	*$3,558,486*	*885*	*$4,021*	
	<12.2 kV: Single-Phase	*$8,872,079*	*1,713*	*$5,180*	
	Multi-Phase	*$2,255,270*	*559*	*$4,033*	
	Mid-Cycle (34 kV)	$330,401	464	$712	
	Brush	$1,415,396			
	34 kV: All	*$422,743*	*1,927*	*$219*	
	12.2-19.9 kV: Single Phase	*$330,884*	*1,464*	*$226*	
	Multi-Phase	*$160,408*	*885*	*$181*	
	<12.2 kV: Single-Phase	*$398,484*	*1,713*	*$233*	
	Multi-Phase	*$102,877*	*559*	*$184*	
	Hazard Removal (5yr)	$430,380			
	Service Pruning	$670,000			
Un-Scheduled	Hot-Spot	$3,500,000			
Staff	Contract Work Planners (12)	$1,200,000			
Total VM Program Costs:		**$37,925,643**			

V. Option 3 4yr (34kV), 5yr (12.5-19.9 kV), 6yr (<12.5 kV):

Maint. Type	VM Activity	Budget Year 6-11	Miles	Cost/Mile	CI Avoided
Scheduled	Tree Pruning & Removal	$27,813,210	5,992	$4,642	3,458
	34 kV: All	*$8,234,273*	*1,927*	*$4,274*	
	12.2-19.9 kV: Single Phase	*$7,459,357*	*1,464*	*$5,095*	
	Multi-Phase	*$2,846,789*	*708*	*$4,021*	
	<12.2 kV: Single-Phase	*$7,393,399*	*1,427*	*$5,180*	
	Multi-Phase	*$1,879,392*	*466*	*$4,033*	
	Mid-Cycle (34 kV)	$0	0	$0	
	Brush	$1,299,754			
	34 kV: All	*$422,743*	*1,927*	*$219*	
	12.2-19.9 kV: Single Phase	*$330,884*	*1,464*	*$226*	
	Multi-Phase	*$128,326*	*708*	*$181*	
	<12.2 kV: Single-Phase	*$332,070*	*1,427*	*$233*	
	Multi-Phase	*$85,731*	*466*	*$184*	
	Hazard Removal (5yr)	$430,380			
	Service Pruning	$670,000			
Un-Scheduled	Hot-Spot	$3,500,000			
Staff	Contract Work Planners (12)	$1,200,000			
Total VM Program Costs:		**$34,913,344**			

VI. Option 4 5yr (34kV), 5yr (12.5-19.9 kV), 5yr (<12.5 kV):

Maint. Type	VM Activity	Budget Year 6-10	Miles	Cost/Mile	CI Avoided
Scheduled	Tree Pruning & Removal	$28,020,914	5,985	$4,682	3,442
	34 kV: All	*$6,587,418*	*1,541*	*$4,274*	
	12.2-19.9 kV: Single Phase	*$7,459,357*	*1,464*	*$5,095*	
	Multi-Phase	*$2,846,789*	*708*	*$4,021*	
	<12.2 kV: Single-Phase	*$8,872,079*	*1,713*	*$5,180*	
	Multi-Phase	*$2,255,270*	*559*	*$4,033*	
	Mid-Cycle (34 kV)	$0	0	$0	
	Brush	$1,298,766			
	34 kV: All	*$338,194*	*1,541*	*$219*	
	12.2-19.9 kV: Single Phase	*$330,884*	*1,464*	*$226*	
	Multi-Phase	*$128,326*	*708*	*$181*	
	<12.2 kV: Single-Phase	*$398,484*	*1,713*	*$233*	
	Multi-Phase	*$102,877*	*559*	*$184*	
	Hazard Removal (5yr)	$430,380			
	Service Pruning	$670,000			
Un-Scheduled	Hot-Spot	$3,500,000			
Staff	Contract Work Planners (12)	$1,200,000			
Total VM Program Costs:		**$35,120,060**			

Appendix D

NYSEG VM Monthly Cash Flow - Reclamation Phase

NYSEG VM Monthly Cash Flow

Reclamation Cycle 4yr w/ Mid-Cycle (34kV), 5yr (12.5-19.9 kV), 5yr (<12.5 kV)

	Year 1 - 01	Year 1 - 02	Year 1 - 03	Year 1 - 04	Year 1 - 05	Year 1 - 06	Year 1 - 07	Year 1 - 08	Year 1 - 09	Year 1 - 10	Year 1 - 11	Year 1 - 12	Total
Scheduled Maintenance Dollars	$1,734,410	$1,968,202	$2,202,612	$2,437,640	$2,672,669	$2,906,460	$3,141,489	$3,376,518	$3,610,309	$3,845,957	$4,079,129	$4,312,921	$36,288,316
Total Crews:	85	96	107	119	130	142	153	165	176	188	199	210	148 avg
Contract Work Planners	$6,389	$12,760	$19,148	$25,553	$31,957	$38,328	$44,733	$51,138	$57,509	$63,931	$70,285	$76,655	$498,386
Total Planners:	0.8	1.5	2.3	3.1	3.8	4.6	5.4	6.1	6.9	7.7	8.4	9.2	5.0 avg
Total Budget:	**$1,740,799**	**$1,980,962**	**$2,221,760**	**$2,463,193**	**$2,704,626**	**$2,944,788**	**$3,186,222**	**$3,427,656**	**$3,667,818**	**$3,909,888**	**$4,149,414**	**$4,389,576**	**$36,786,702**
Circuit Miles:	**179**	**203**	**228**	**252**	**276**	**300**	**325**	**349**	**373**	**397**	**422**	**446**	**3,750**
Mid-Cycle Miles:	**13**	**15**	**17**	**18**	**20**	**22**	**24**	**25**	**27**	**29**	**31**	**32**	**273**
	Year 2 - 01	**Year 2 - 02**	**Year 2 - 03**	**Year 2 - 04**	**Year 2 - 05**	**Year 2 - 06**	**Year 2 - 07**	**Year 2 - 08**	**Year 2 - 09**	**Year 2 - 10**	**Year 2 - 11**	**Year 2 - 12**	**Total**
Scheduled Maintenance Dollars	$4,547,950	$4,781,741	$5,016,151	$5,251,180	$5,485,590	$5,720,000	$5,997,911	$5,725,279	$5,725,279	$6,270,543	$4,907,382	$5,725,278	$65,154,284
Total Crews:	222	233	245	256	268	279	279	279	279	279	279	279	265 avg
Contract Work Planners	$83,061	$89,432	$95,819	$102,224	$108,612	$115,000	$122,074	$116,525	$116,525	$127,622	$99,878	$116,525	$1,293,297
Total Planners:	10.0	10.7	11.5	12.3	13.0	13.8	14	14	14	14	14	14	12.9 avg
2014 Budget:	**$4,631,011**	**$4,871,173**	**$5,111,970**	**$5,353,404**	**$5,594,202**	**$5,835,000**	**$6,119,985**	**$5,841,804**	**$5,841,804**	**$6,398,165**	**$5,007,260**	**$5,841,803**	**$66,447,581**
Circuit Miles:	**470**	**494**	**518**	**543**	**567**	**591**	**620**	**592**	**592**	**648**	**507**	**591**	**6,733**
Mid-Cycle Miles:	**34**	**36**	**38**	**40**	**41**	**43**	**45**	**43**	**43**	**47**	**37**	**43**	**490**
	Year 3 - 01	**Year 3 - 02**	**Year 3 - 03**	**Year 3 - 04**	**Year 3 - 05**	**Year 3 - 06**	**Year 3 - 07**	**Year 3 - 08**	**Year 3 - 09**	**Year 3 - 10**	**Year 3 - 11**	**Year 3 - 12**	**Total**
Scheduled Maintenance Dollars	$5,471,986	$5,471,986	$6,019,185	$6,019,185	$5,471,986	$6,019,185	$6,019,185	$5,745,585	$5,745,585	$6,019,185	$5,198,387	$5,745,585	$68,947,025
Total Crews:	279	280	280	280	280	280	280	280	280	280	280	280	280 avg
Contract Work Planners	$111,352	$111,352	$122,488	$122,488	$111,352	$122,488	$122,488	$116,920	$116,920	$122,488	$105,785	$116,920	$1,403,041
Total Planners:	14	14	14	14	14	14	14	14	14	14	14	14	14 avg
2015 Budget:	**$5,583,338**	**$5,583,338**	**$6,141,673**	**$6,141,673**	**$5,583,338**	**$6,141,673**	**$6,141,673**	**$5,862,505**	**$5,862,505**	**$6,141,673**	**$5,304,172**	**$5,862,505**	**$70,350,066**
Circuit Miles:	**565**	**565**	**622**	**622**	**565**	**622**	**622**	**594**	**594**	**622**	**537**	**595**	**7,125**
Mid-Cycle Miles:	**41**	**41**	**45**	**45**	**41**	**45**	**45**	**43**	**43**	**45**	**39**	**46**	**519**
	Year 4 - 01	**Year 4 - 02**	**Year 4 - 03**	**Year 4 - 04**	**Year 4 - 05**	**Year 4 - 06**	**Year 4 - 07**	**Year 4 - 08**	**Year 4 - 09**	**Year 4 - 10**	**Year 4 - 11**	**Year 4 - 12**	**Total**
Scheduled Maintenance Dollars	$5,198,387	$5,745,585	$6,292,784	$5,745,585	$5,745,585	$6,019,185	$5,471,986	$6,292,784	$5,745,585	$5,745,585	$5,471,986	$5,471,987	$68,947,024
Total Crews:	280	280	280	280	280	280	280	280	280	280	280	280	280 avg
Contract Work Planners	$105,785	$116,920	$128,055	$116,920	$116,920	$122,488	$111,352	$128,055	$116,920	$116,920	$111,352	$111,354	$1,403,041
Total Planners:	14	14	14	14	14	14	14	14	14	14	14	14	14 avg
2016 Budget:	**$5,304,172**	**$5,862,505**	**$6,420,839**	**$5,862,505**	**$5,862,505**	**$6,141,673**	**$5,583,338**	**$6,420,839**	**$5,862,505**	**$5,862,505**	**$5,583,338**	**$5,583,341**	**$70,350,065**
Circuit Miles:	**537**	**594**	**650**	**594**	**594**	**622**	**565**	**650**	**594**	**594**	**565**	**566**	**7,125**
Mid-Cycle Miles:	**39**	**43**	**47**	**43**	**43**	**45**	**41**	**47**	**43**	**43**	**41**	**44**	**519**
	Year 5 - 01	**Year 5 - 02**	**Year 5 - 03**	**Year 5 - 04**	**Year 5 - 05**	**Year 5 - 06**	**Year 5 - 07**	**Year 5 - 08**	**Year 5 - 09**	**Year 5 - 10**	**Year 5 - 11**	**Year 5 - 12**	**Total**
Scheduled Maintenance Dollars	$4,827,763	$4,827,763	$5,551,928	$4,827,763	$5,310,540	$5,310,540	$4,827,763	$5,551,928	$4,827,763	$5,310,540	$4,827,763	$4,586,378	$60,588,432
Total Crews:	247	247	247	247	247	247	247	247	247	247	247	247	247 avg
Contract Work Planners	$111,732	$111,732	$128,492	$111,732	$122,905	$122,905	$111,732	$128,492	$111,732	$122,905	$111,732	$106,144	$1,402,235
Total Planners:	14	14	14	14	14	14	14	14	14	14	14	14	14 avg
2017 Budget:	**$4,939,495**	**$4,939,495**	**$5,680,420**	**$4,939,495**	**$5,433,445**	**$5,433,445**	**$4,939,495**	**$5,680,420**	**$4,939,495**	**$5,433,445**	**$4,939,495**	**$4,692,522**	**$61,990,667**
Circuit Miles:	**567**	**567**	**653**	**567**	**624**	**624**	**567**	**653**	**567**	**624**	**567**	**542**	**7,122**
Mid-Cycle Miles:	**41**	**41**	**48**	**41**	**45**	**45**	**41**	**48**	**41**	**45**	**41**	**42**	**519**
Total Cycle Budget:													**$305,925,081**
Total Cycle Circuit Miles:													**31,855**
Total Cycle Mid-Cycle Miles:													**2,320**

Average Annual Budget:	**$61,185,016**
Average Annual Circuit Miles:	**6,371**
Average Annual Mid-Cycle Miles:	**464**

Notes: All costs are in 2012 dollars. Cash flow is based on work days per month.
The average cost per year over five years for Contract Work Planners is $1,200,000.

Appendix E

NYSEG Vegetation Maintenance NPV Cycle Analysis

NPV Analysis using a discount rate of 4.10 percent

NYSEG Vegetation Maintenance Cycle Analysis

Assumptions:
- 34kV has been maintained on regular cycle and no savings result from second cycle maintenance.
- Non-storm interruption event increase from maintenance deferral = 100%
- Non-storm tree outage cost per N = $2,199 — Baseline Lateral Events per Year 4,050
- Storm tree outage cost per N = $6,378 — Baseline Storm Events per Year 3,660
- Estimated Customer valuation per N Avoided = $367 per 2004 Berkeley Nat'l Laboratory - LBNL-55718
- Non-storm tree restoration cost per N = $1,832 • Storm tree restoration cost per $6,011

35kV Main Cycle Cost per Mile $4,945 Year One **Midcycle cost per Mile** $712 Year Three
Non-35kV 3-phase Deferred Cost per Mile $6,103 Year One
Non-35kV 1-phase Deferred Cost per Mile $9,806 Year One — Maintenance cycle yr 6 budget = -$37.9 (2012 $M)

- Costs per mile expressed as negative cash flow, savings per mile expressed as positive cash flow.

Escalation Rate = 2.13% (US 10-yr CPI estimate by CBO in 2010)
interest rate = 4.10% (provided by NYSEG)

Cycle Options

NPV ($M) 15 yrs			Years 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Sum of Cash Flow
		Interruptions increased (storm)	366	748	1,121	1,495	1,869	2,243	2,617	2,991	3,364	3,738	3,818	3,899	3,982	4,067	4,154	
		Interruptions increased (non-storm)	405	827	1,241	1,655	2,068	2,482	2,895	3,309	3,723	4,136	4,224	4,314	4,406	4,500	4,596	
Current $20M		Flat cash flow $M	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$300.0
Storm Outage Impact		Outage Impact Δ $M	-$2.3	-$4.7	-$7.2	-$9.6	-$12.2	-$14.8	-$17.4	-$20.1	-$22.9	-$25.7	-$26.3	-$26.8	-$27.4	-$28.0	-$28.6	-$274.0
Non-storm Outage Impact		Outage Impact Δ $M	-$0.9	-$1.86	-$2.85	-$3.88	-$4.95	-$6.06	-$7.22	-$8.43	-$9.69	-$10.99	-$11.2	-$11.5	-$11.7	-$12.0	-$12.2	-$115.4
Typical Storm Restoration Cost			-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$375.0
Liability and Customer Relations*			-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$51.0
	($797)	**TOTAL**	-$52	-$55	-$58	-$62	-$66	-$69	-$73	-$77	-$81	-$85	-$86	-$87	-$88	-$88	-$89	-$1,115.4
		Interruptions avoided (non-storm)		166	454	758	1,062	1,366	1,366	1,366	1,366	1,366	1,366	1,366	1,366	1,366	1,366	
		Interruptions avoided (storm)		150	410	685	960	960	960	960	960	960	960	960	960	960	960	
35kV 4-yr w/Mid + Non-35kV 5-year		escalated cash flow $M	-$37	-$68	-$73	-$75	-$67	-$42	-$43	-$44	-$45	-$46	-$47	-$48	-$49	-$50	-$51	-$784.5
Typical Storm Restoration Cost			-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$375.0
Storm Outage Impact		Outage Impact Δ $M		$1.0	$2.7	$4.7	$6.7	$6.8	$6.9	$7.1	$7.2	$7.4	$7.6	$7.7	$7.9	$8.1	$8.2	$89.9
Non-storm Outage Impact		Outage Impact Δ $M		$0.4	$1.0	$1.7	$2.3	$3.0	$3.1	$3.1	$3.2	$3.3	$3.3	$3.4	$3.5	$3.6	$3.6	$38.4
Full Cycle	($774)	**TOTAL**	-$62.3	-$91.9	-$94.3	-$93.3	-$83.1	-$57.3	-$58.0	-$58.7	-$59.4	-$60.2	-$60.9	-$61.7	-$62.5	-$63.3	-$64.1	-$1,031.2

-2.8% Lower NPV for full cycle program compared to current $20 M per year program
Liability and customer relations costs associated with the Current $20M option, modeled at $3.4M, are difficult to quantify and could be higher.

*** Difficult to quantify risks associated with:**	**Current $20M Strategy Future Costs $M**		**Annual**
1. Liability related to utility worker and public safety	$4.5	Every 3 years	$1.5
2. Deterioration in customer satisfaction	$0.2	Annually	$0.2
3. Deterioration in governmental satisfaction	$0.3	Annually	$0.2
4. Major event mitigation	$30.0	Every 10 years	$3.0
	Estimated Annual Cost		$4.9

Example of Major Event Mitigation - CL&P Proposed Post-2011 Storm Mitigation Initiatives

Storm hardening: Estimated $2.2 Billion over 10 years
$13 per residential customer per month
Includes $366 million over ten years for additional tree trimming

NPV Analysis using a discount rate of 7.48 percent

NYSEG Vegetation Maintenance Cycle Analysis

Assumptions:
- 34kV has been maintained on regular cycle and no savings result from second cycle maintenance.
- Non-storm interruption event increase from maintenance deferral = 100%
- Non-storm tree outage cost per N = $2,199 — Baseline Lateral Events per Year 4,050
- Storm tree outage cost per N = $6,378 — Baseline Storm Events per Year 3,660
- Estimated Customer valuation per N Avoided = $367 per 2004 Berkeley Nat'l Laboratory - LBNL-55718
- Non-storm tree restoration cost per N = $1,832 ● Storm tree restoration cost per $6,011

35kV Main Cycle Cost per Mile $4,945 Year One **Midcycle cost per Mile** $712 Year Three
Non-35kV 3-phase Deferred Cost per Mile $6,103 Year One
Non-35kV 1-phase Deferred Cost per Mile $9,806 Year One — Maintenance cycle yr 6 budget = -$37.9 (2012 $M)
- Costs per mile expressed as negative cash flow, savings per mile expressed as positive cash flow.

Escalation Rate = 2.13% (US 10-yr CPI estimate by CBO in 2010)
interest rate = 7.48% (provided by NYSEG)

Cycle Options

NPV ($M) 15 yrs		Years 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Sum of Cash Flow
	Interruptions increased (storm)	366	748	1,121	1,495	1,869	2,243	2,617	2,991	3,364	3,738	3,818	3,899	3,982	4,067	4,154	
	Interruptions increased (non-storm)	405	827	1,241	1,655	2,068	2,482	2,895	3,309	3,723	4,136	4,224	4,314	4,406	4,500	4,596	
Current $20M	Flat cash flow $M	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$20.0	-$300.0
Storm Outage Impact	Outage Impact Δ $M	-$2.3	-$4.7	-$7.2	-$9.6	-$12.2	-$14.8	-$17.4	-$20.1	-$22.9	-$25.7	-$26.3	-$26.8	-$27.4	-$28.0	-$28.6	-$274.0
Non-storm Outage Impact	Outage Impact Δ $M	-$0.9	-$1.86	-$2.85	-$3.88	-$4.95	-$6.06	-$7.22	-$8.43	-$9.69	-$10.99	-$11.2	-$11.5	-$11.7	-$12.0	-$12.2	-$115.4
Typical Storm Restoration Cost		-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$375.0
Liability and Customer Relations*		-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$3.4	-$51.0
($623)	**TOTAL**	-$52	-$55	-$58	-$62	-$66	-$69	-$73	-$77	-$81	-$85	-$86	-$87	-$88	-$88	-$89	-$1,115.4
	Interruptions avoided (non-storm)		166	454	758	1,062	1,366	1,366	1,366	1,366	1,366	1,366	1,366	1,366	1,366	1,366	
	Interruptions avoided (storm)		150	410	685	960	960	960	960	960	960	960	960	960	960	960	
35kV 4-yr w/Mid + Non-35kV 5-year	escalated cash flow $M	-$37	-$68	-$73	-$75	-$67	-$42	-$43	-$44	-$45	-$46	-$47	-$48	-$49	-$50	-$51	-$784.5
Typical Storm Restoration Cost		-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$25	-$375.0
Storm Outage Impact	Outage Impact Δ $M		$1.0	$2.7	$4.7	$6.7	$6.8	$6.9	$7.1	$7.2	$7.4	$7.6	$7.7	$7.9	$8.1	$8.2	$89.9
Non-storm Outage Impact	Outage Impact Δ $M		$0.4	$1.0	$1.7	$2.3	$3.0	$3.1	$3.1	$3.2	$3.3	$3.3	$3.4	$3.5	$3.6	$3.6	$38.4
Full Cycle ($630)	**TOTAL**	-$62.3	-$91.9	-$94.3	-$93.3	-$83.1	-$57.3	-$58.0	-$58.7	-$59.4	-$60.2	-$60.9	-$61.7	-$62.5	-$63.3	-$64.1	-$1,031.2

1.1% Higher NPV for full cycle program compared to current $20 M per year program
Liability and customer relations costs associated with the Current $20M option, modeled at $3.4M, are difficult to quantify and could be higher.

*** Difficult to quantify risks associated with:**	**Current $20M Strategy Future Costs $M**		**Annual**
1. Liability related to utility worker and public safety	$4.5	Every 3 years	$1.5
2. Deterioration in customer satisfaction	$0.2	Annually	$0.2
3. Deterioration in governmental satisfaction	$0.3	Annually	$0.2
4. Major event mitigation	$30.0	Every 10 years	$3.0
	Estimated Annual Cost		$4.9

Example of Major Event Mitigation - CL&P Proposed Post-2011 Storm Mitigation Initiatives

Storm hardening: Estimated $2.2 Billion over 10 years
$13 per residential customer per month
Includes $366 million over ten years for additional tree trimming

Appendix F

National Electrical Safety Code (NESC)[12]

Part 2: Safety Rules for Overhead Lines

218. Vegetation management

A. General

1. Vegetation that may damage ungrounded supply conductors should be pruned or removed. Vegetation management should be performed as experience has shown to be necessary.

   NOTE 1: Factors to consider in determining the extent of vegetation management required include, but are not limited to: line voltage class, species' growth rates and failure characteristics, right-of-way limitations, the vegetation's location in relation to the conductors, the potential combined movement of vegetation and conductors during routine winds, and sagging of conductors due to elevated temperatures of icing.

   NOTE 2: It is not practical to prevent all tree-conductor contacts on overhead lines.

2. Where pruning or removal is not practical, the conductor should be separated from the tree with suitable materials or devices to avoid conductor damage by abrasion and grounding of the circuit through the tree.

B. At line crossings, railroad crossings and limited-access highway crossings, or navigable waterways requiring crossing permits

The crossing span and the adjoining span on each side of the crossing should be kept free from over-hanging or decayed trees or limbs that otherwise might fall into the line.

[12] The Institute of Electrical and Electronics Engineers, Inc. 3 park Avenue, New York, NY 10016-5997. 2012 Edition.

Appendix G

The Economic Impacts of Deferring Electric Utility Tree Maintenance

The Economic IMPACTS of Deferring Electric Utility Tree Maintenance

by D. Mark Browning, Project Manager,
Environmental Consultants, Inc.

Electric utility line clearance programs typically approach tree management through a program of maintenance cycles where trees are pruned at regularly scheduled intervals. The optimum maintenance cycle for a utility is one where pruning is scheduled just before the trees grow to the point where they have the potential for contacting the conductors. The optimum cycle minimizes the number of trees that have the potential to contact the conductors, which in turn helps to maintain the safety and reliability of the electric system.

Unfortunately, many utilities fund their line clearance programs in such a way that trees are not pruned at the optimum time and they begin to grow into and beyond the conductors. This results in a situation known as deferred maintenance.

The impact of deferring utility tree maintenance is generally evaluated in terms of service reliability. Anecdotal evidence suggests that deferred tree maintenance also impacts a utility's maintenance costs. Understanding the relationship between deferring maintenance and increasing costs would enable utility arborists to better identify and justify the optimum line clearance cycle in their service area.

The International Society of Arboriculture Research Trust provided funding in an effort to better understand and quantify the economic impacts of the widespread practice of deferring utility tree maintenance. The study was conducted on three utility properties in the United States by Environmental Consultants, Inc. (ECI). The three utilities that participated in the study are Northern States Power Company (MN), Puget Sound Power and Light Company, and West Penn Power Company.

STUDY METHODOLOGY

At each utility, 5 similar sites last pruned during the dormant season 2, 3, 4, 5, and 6 years prior to the study were selected. Pruning of the sites was completed in the spring of 1996 in a manner consistent with the utilities' normal line clearance operations. The maintenance crews collected data on time and equipment required to complete the work, type of work completed (top or side trim), tree diameter, and clearance prior to and following pruning for each tree. The weight of each load of chipped debris was also collected by study site.

IMPACT OF DEFERRED MAINTENANCE ON COST

Knowing the economic impact of deferring maintenance of a scheduling unit for a year or more would be an invaluable tool to utility vegetation managers. This information could be used to identify and justify the optimum maintenance schedule. It would also be useful for developing future maintenance budgets.

ECI used regression analysis to develop predictive models for worker-minutes of pruning time at each of the utilities involved in the study. These models can be used to project the economic impact of allowing trees at a specific site to grow longer than the optimum cycle. Since tree diameter, type of pruning, and clearance were each found to be significant factors affecting the time and cost of pruning trees, it is clear that the impact of deferred maintenance will vary for different site conditions.

Most trees, once pruned, begin to regrow towards the electric conductors and need to be maintained again in a few years. The period between prunings is known as the cycle. Traditionally, the optimum cycle has been considered to be one that allows no more than 10 to 15 percent of the trees at a given site to grow into or beyond the conductors.

One of the study sites which met this criteria, and therefore could be considered to be at the end of the optimum cycle, was chosen as a model site. This provided a specific set of conditions for comparing the cost of pruning at different points in time using the predictive model. The results obtained from modeling the data are the same for each utility and maintenance cycle; deferring maintenance beyond the optimum cycle length will have a substantial impact on maintenance costs.

Figure 1 shows the projected impact of deferred maintenance on the relative cost of pruning trees for the various cycle lengths that have been implemented by the participating utilities. Utilities B and C have established one cycle length systemwide, whereas Utility A has implemented 3 different cycle lengths in its service area. The results in Figure 1 are based upon the conditions found at the study sites, and are thus utility specific.

As shown in Figure 1, deferring maintenance beyond the optimum cycle length will have a substantial impact on maintenance costs at each utility, regardless of the established cycle length. Taking Utility B as an example shows that each dollar "saved" ►

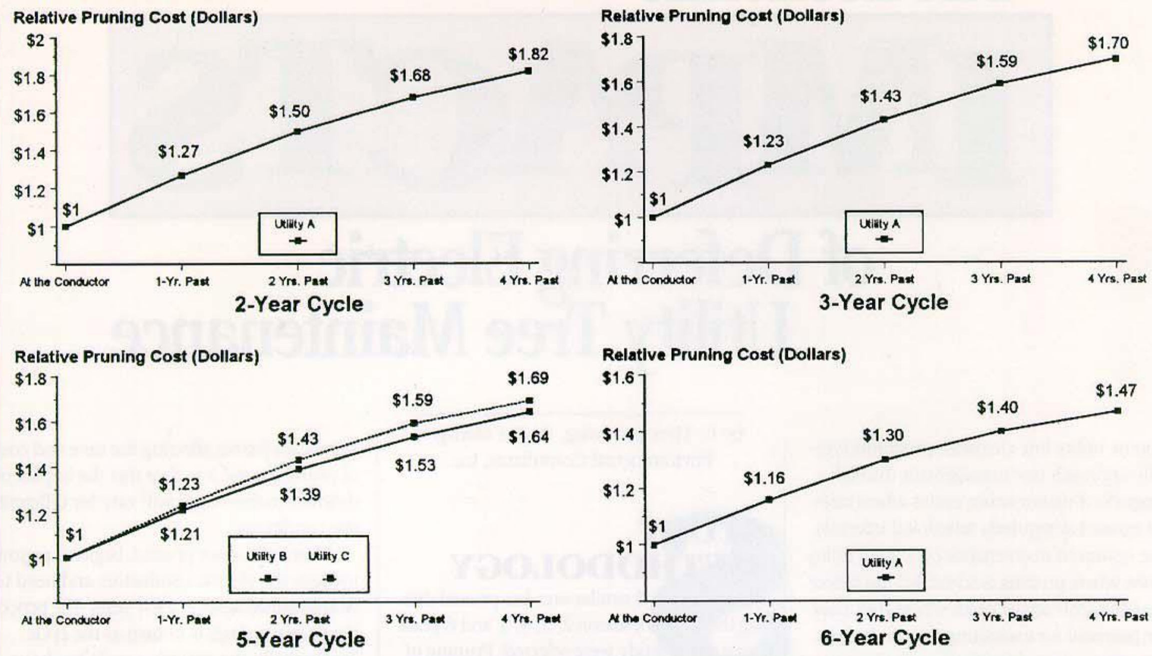

Figure 1. Projected impact of deferred maintenance on the average cost of pruning trees for line clearance.

by not pruning trees at the appropriate time (year 5) will have to be replaced with $1.21 (plus inflation adjustment) one-year later in order to get back on schedule. If trees are allowed to grow past the conductors for 2 years, it will cost $1.39 for every $1 of pruning deferred.

BIOMASS

Chipped debris generated as a result of tree pruning was collected to gain insight into the relationship between the age of branch regrowth and the amount of biomass removed from a tree. The weight of chipped debris was not obtained for individual trees. Rather, the total weight of chipped biomass was determined for each site and an average per-tree weight of biomass was calculated.

The data shows that the average per-tree weight of chipped biomass rises significantly with time. For example, the average weight of chipped debris increased from about 16 pounds per tree at a 2-year old site to over 285 pounds per tree at a 6-year old site. This data indicates that postponing maintenance will result in significant increases in debris disposal costs.

IMPACT OF BUDGET CUTS ON CYCLE LENGTH

Many utilities that reduce their line clearance budget do not replace the funds in subsequent years. Therefore, it is important to know the long-term impact of funding reductions. This can be also assessed using the predictive models.

In order to illustrate the long-term impact of funding reductions, assume that a utility with an adequately funded, optimum 5-year maintenance cycle undergoes a 20 percent reduction in its annual budget for tree pruning. Initially, it would appear that the cycle length would merely increase by 20 percent, from 5 years to 6.25 years. The impact, however, would actually be much larger. This is because the effectiveness of the funds available for pruning trees is reduced since maintenance has been deferred. Once maintenance has been deferred, trees cost significantly more to maintain than if they were being pruned on an optimum cycle.

The predictive model projects that one-year of reduced funding would allow 4 percent of the trees to grow beyond the optimum scheduled maintenance time (5 years). After 4 years of a reduced budget, over 21 percent of the trees will have grown longer than the optimum 5 years and some of the trees will have 7 years of regrowth. After 12 years, nearly one-half of all the trees on the system will have gone longer than 5 years without receiving maintenance, and some will not have been pruned in 9 years.

This example shows how a 20 percent reduction in annual funding would result in moving the utility from a 5-year cycle to a 9-year cycle (i.e., 4 years over cycle) in 12 years. In addition, this change is likely to be accelerated as service reliability declines and hotspotting and responses to customer requests becomes more common, further reducing the funds available for scheduled, cyclical maintenance.

The impact of hotspotting on a program can be significant. Hotspot maintenance carries a higher price tag due to the increased amount of nonproductive time spent traveling from worksite to worksite during the day. Hotspotting also reduces the time available for scheduled work, which further defers maintenance of the system.

A decline in system reliability also results in lost revenue while service is down and in an increase to the amount of time being spent on service restoration. Although service restoration is not a vegetation management cost, it can still be directly related to vegetation conditions and should therefore be considered when making decisions on deferring the maintenance of scheduling units.

Deferred maintenance can also alter the vegetation conditions of scheduling units beyond increasing the amount of regrowth on the trees. Longer maintenance intervals can allow hazardous trees and limbs to develop, further jeopardizing system reliability. In addition, deferring the maintenance of scheduling units gives brush the opportunity to mature. As brush matures it becomes a more expensive, and often permanent, part of the workload.

SUMMARY

In terms of service reliability and safety, it is imperative to maintain vegetation on a cycle that minimizes the number of trees that have the potential to contact the conductors. Deferring maintenance allows trees to grow into and beyond the conductors, which decreases the reliability and safety of the system and can significantly increase future maintenance costs. Deferring maintenance also increases the amount of biomass that must be removed, which in turn increases debris disposal costs.

Appendix H

How Trees Cause Outages

Understanding Tree Caused Outages: The Research

By Kenneth E Finch for Environmental Consultants, Inc.

Key Words: Electric distribution system, tree-caused interruptions, electric mode, carbon path, outage risk.

Background

Trees cause interruption of the electric system in one of two ways, an electric short circuit (electric mode) or through physical damage to the system (mechanical mode).

Prior to the early 1990's, "conventional line clearance wisdom" held that trees growing into overhead distribution lines were a significant outage risk (electric mode) that provided a fault pathway to ground. Considerable line clearance dollars have been spent over the years to complete hot spot pruning of distribution lines, especially following the unexplained operation of substation breakers, or line reclosures affecting critical customers or large numbers of customers.

In 1994, arborists for Baltimore Gas & Electric challenged these perceptions by presenting the results of five years of field research[i]. Their work developed and presented several theories, including:

- Incidental tree contact does not pose a significant outage risk.
- An electric fault did not occur until a carbon path was formed between conductors (phase-to-phase or phase-to-neutral).
- A fault does not occur instantaneously when two conductors are bridged. Time seems to be necessary, and water

Figure H1. Photo courtesy of Chad Devine, BG&E

and steam are expelled from the branch during the carbonization process.

- The impedance (resistance) of the tree must change before it will conduct enough current to fault.
- The distance between conductors seems to affect the time required to create the carbon path.

If correct, critical hot spot and cyclical pruning resources could be redirected to essential reliability improvement initiatives.

Objective

In this paper the author will summarize the research conducted by ECI to assist the reader in understanding and applying the results to field practice.

Testing the Concept

In 1996 Environmental Consultants, Incorporated, together with John Goodfellow, began to refine a conceptual model and develop the experimental protocols required to test the BG&E theories, and conduct preliminary high voltage experiments. They insisted that proof required rigid experimental design and structured analytical procedures. They envisioned testing large numbers of specimens in a controlled laboratory environment, with multiple replications and recorded time and current measurements.

The initial testing was made possible by funding from Allegheny Power Systems. The report presented in 1998 was entitled "Understanding the Way Trees Cause Power Outages."

Figure H2. Laboratory test setup

A high voltage test bench was assembled, with insulators positioned a fixed distance apart. Specimens were placed within saddles formed of aluminum wire, allowing consistent positioning for each test sequence. A variable output AC high potential transformer allowed for uniform testing at predetermined voltage levels.[ii]

Two hundred fifty six (256) living samples (4 species x 4 diameter classes x 2 origin conditions x 2 surface conditions x 4 voltage classes) and sixty four (64) dead branch samples (4 species x 2 diameter classes x 2 surface conditions x 4 voltage gradients) were tested.[2]

Protocols were further refined, and in 1999 a second report entitled "Understanding The Way Trees Cause Power Interruptions" was produced for Allegheny Power System, Niagara Mohawk Power Corp, and Portland General Electric. This round of testing examined eight species (seven additional species), studying up to eight different branch diameters and ten voltage gradients.

Combined, the two studies examined eleven species, testing more than eleven hundred specimens. The results of the studies are summarized below.

The Electric Mode of Failure

The ECI studies confirmed that *"the impedance (resistance) must change before it (the branch) will conduct enough current to fault,"* as suggested by BG&E.

Figure H3. Formation of the carbon pathway prior to flash over

When we take a moment to examine this, intuitively it makes sense. Wood has some higher level of resistance that must be overcome for a short circuit to occur. Most utility arborists have seen energized primaries on wooden cross arms and for years insulated line clearance tools were made of wood. The question was when do they become conductive? Quite simply the carbon path becomes the more conductive route for electricity across the wood.

In their discussion of the "Conceptual Model of the Electrical Mode of Failure" in the 1998 report ECI states; "The electrical stress at the point(s) of contact are due to unequal potential across the conductor surface, branch surface (outer bark), inner bark (cambium), and xylem (wood). The electrical stress causes arcing; a high energy point discharge. Heat energy generated from the arc is sufficient to cause breakdown of organic compounds (cellulose and lignin) into elemental carbon and charcoal. The carbon generated is relatively conductive as compared to branch tissue." [iii]

Figure H4. A completed carbon path, fault occurred

The pathway is largely evident as a "blackened area of charcoal" across the branch surface, between the two points of contact. When the pathway was not evident on the surface, branch dissection often revealed internal tracking. Once the pathway was complete, a fault was instantaneous each time the branch was re-energized.[iv]

Role of Voltage Gradient

The studies also confirmed that voltage gradient is the variable with the greatest effect on outage risk. Figure H5 shows the time in seconds for a carbon path to form and the fault to develop, decreases rapidly as voltage gradient increases. While BG&E suggested the fault is not instantaneous when two conductors are bridged, the time and current measurements showed it can be nearly instantaneous at higher gradients. At the same time, the steepness of the curve at lower voltage gradients clearly suggests a threshold exists below which a carbon path will not form.[v]

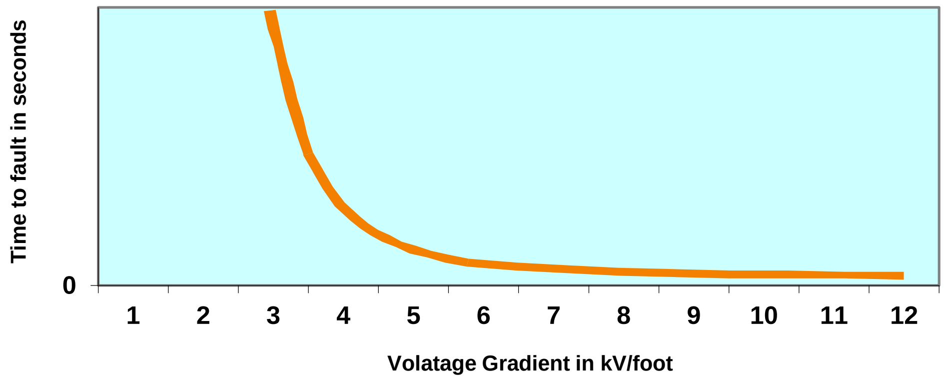

Figure H5. Influence of Voltage Gradient on Time to Fault

Figure H6 confirms the threshold theory. It examines the results from the first (1998) study, in which more than 300 specimens were tested at four pre-determined voltage gradients. There were no outages at the 1.2 kV/foot gradient, and 100 percent failure at 11.5 kV/foot. Variability in outage risk exists at the 3.32 and 5.16 kV/foot gradients, indicating there may be differences among species and related to other wood characteristics.[vi]

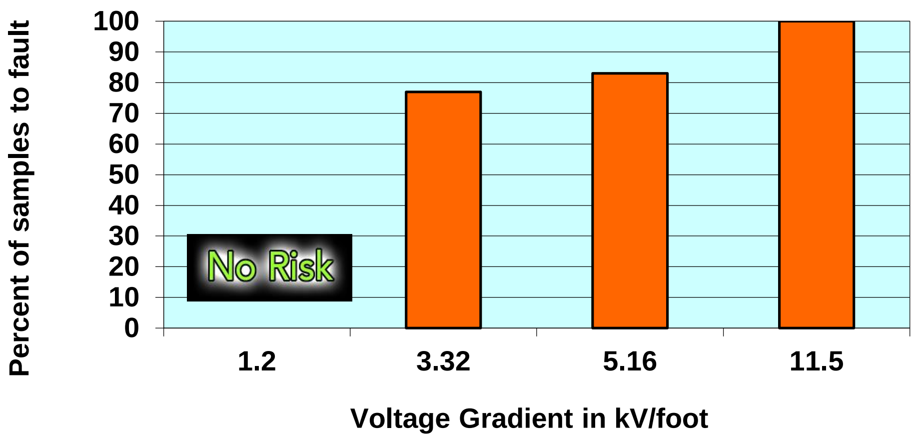

Figure H6. Influence of Voltage Gradient on Likelihood to Fault

While the 1998 study tested the samples at specific voltages and no outages occurred below 1.2 kV/ft., the 1999 study tested specimens at gradually declining voltage gradients until a no fault threshold was determined for each species. Significant variability was found between species.[vii] The studies also looked beyond voltage gradient to determine if differences existed between species, as well as several physiological factors such as branch diameter, branch origin, dead wood vs. live wood, and internal and surface moisture condition.

The studies were followed by two additional studies. In 2001 ECI completed “Assessing the Seasonal Variation in the Electrical Characteristics of Trees” for Allegheny Power. This was followed by “Species Specific Variation in Impedance as Related to Electrical Fault Potential” in 2004. The results of these studies are summarized as follows.

Species Variation

In the 2004 study, ten new species were investigated, and the results combined with the findings from previous work to bring the total number of species tested to twenty-one. Testing protocols were further refined to explore questions posed in the earlier testing. The combined results expanded our knowledge and identified key risk factors.

Voltage gradient remains the most significant risk factor. Voltage gradients above 5.5 kV/ft. are a high risk for fault, while gradients below 1.3 kV/ft. are low risk to no risk. Voltages gradients from 1.4 kV/ft. to 5.2 kV/ft. exhibited a moderate failure risk, with significant variability based on species and branch diameter. [viii]

Variation in species resistively, as measured by the average “Rho” for all specimens within a species, ranged from a low of 89 for weeping willow (most conductive), to a highs of 1,782 for paper birch and 1,903 for Ponderosa Pine (least conductive). The average “Rho” for all species was 614.[ix]

All three studies (1998, 1999 and 2004) found that large diameter branches are usually more conductive (higher risk) than small branches, and the carbon path developed more rapidly. Their findings are consistent with previous research which believes branch conductivity is related to cross sectional area. They also reported branches less than 0.5 inches in diameter were significantly lower risk than those in the 0.5 – 1 inch, 1 – 2 inch, or the 2 to 3 inch classes. [x]

Seasonal Variation

Seasonal variations in conductivity were examined in 2001. Red maple samples were tested during seven dormancy stages. The results were consistent with earlier research into seasonal changes in electrical resistance, finding that the samples taken during the active growing season (June, July) were significantly more conductive than samples taken during the dormant season (March, October). [xi]

Other Physiological Differences

The original studies found no significant difference in carbon path formation based on branch origin, e.g. from either normal growth or sprout growth. [xii]

They also found wetting the branch surface caused a "slight and non-significant difference in time to fault between wet and dry samples." It speculated that wetting may initially reduce resistance at the two points of contact. However, after overcoming the contact resistance the current must then overcome the resistance of the limb itself. As a result, the average time to fault for branches that were either surface wet or dry, were so similar that their failure curves overlay each other when plotted.[xiii]

Internal stem moisture content was not a significant variable between live branches, but it does play a role in fault development. In the 2004 report, ECI explains that most water within the plant is stored in the sapwood (xylem), and that the internal moisture levels of these tissues are consistently above fiber saturation. "Fully moistened fibers are at their most conductive" levels. Since all living tissue is well past fiber saturation, there is little variability between species. However, they suggest a strong indication that the xylem is a significant conductive pathway, since most moisture in the tree is stored in the sapwood. This would help explain the presence of steam and water coming from the samples when an electrical stress is applied. Below fiber saturation conductivity in the branch is limited by moisture. [xiv] The theory remains consistent with the "branch surface phenomenon" discussed earlier in this paper regarding carbon path formation. While the sapwood tissue just beneath the cambium may be the most conductive, the heat energy created by the electricity readily burns through the cambium and bark tissues, becoming evident on the surface.

Live limbs were found to be significantly *higher risk* of failure than dead limbs. This is believed to be related to the lack of internal moisture within the dead limb tissue. Small dead limbs (1-2 inch) were a much lower risk than larger limbs (3-4 inch), but even larger dead limbs were significantly lower risk than living limbs of the same size. [xv]

Bark texture, tissue morphology and biochemical composition of the branch tissues and the sap may also be conductivity and outage risk factors. For example, smooth bark appears to be more conductive than cork like, plated or rough bark, and differences in vascular tissues between coniferous and deciduous species may affect conductivity. [xvi]

Conclusions

This research is providing utilities with a better understanding of the electrical failure mode of failure, as well as the risk of outage when trees grow into energized overhead lines or fall onto them from above or beside the lines. The relationship between electric distribution systems and the natural environment surrounding them are far more complex than accepted ten years ago.

The design, construction and operation of the distribution system are a critical factor in tree outage performance and overall system reliability that is often overlooked. At the same time, effective vegetation management strategies are being re-written into dynamic, prescriptive applications that make long-term reliability improvements. Successful strategies go beyond a one size fits all model, requiring support from arborists, engineers, field operations personnel, reliability personnel, senior management, regulators, the public, etc. Opportunities exist for utilities to apply this knowledge on their systems, to refine historic vegetation management practices, identify areas of cost savings and those needing additional funding, and effectively focus their expenditures on cost effective system improvements.

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[i] W. R. Rees, T.C Birx, et al, Baltimore Gas & Electric, "Controlled Phase to Phase Tree Fault Test", Dec 3, 1992, and Exhibit F, "Commentary for Tree Fault Test Tape."

[ii] Environmental Consultants, Inc. for Allegheny Power Systems, 1998, "Understanding the Way Trees Cause Power Outages", pgs 3, 5.

[iii] Environmental Consultants, Inc. for Allegheny Power Systems, 1998, "Understanding the Way Trees Cause Power Outages", pg 10.

[iv] Environmental Consultants, Inc. for Allegheny Power Systems, Niagara Mohawk Power Corp, Portland General Electric, 1999, "Understanding the Way Trees Cause Power Interruptions," pg 12

[v] Environmental Consultants, Inc. for Allegheny Power Systems, 1998, "Understanding the Way Trees Cause Power Outages," pg 7.

[vi] Environmental Consultants, Inc. for Allegheny Power Systems, 1998, "Understanding the Way Trees Cause Power Outages," pg 6.

[vii] Environmental Consultants, Inc. for Allegheny Power Systems, Niagara Mohawk Power Corp, Portland General Electric, 1999, "Understanding the Way Trees Cause Power Interruptions," pg 12, 13.

[viii] Environmental Consultants, Inc., "Species-Specific Variation in Impedance as Related to Electrical Fault Potential", 2004, pg 6.

[ix] Environmental Consultants, Inc., "Species-Specific Variation in Impedance as Related to Electrical Fault Potential", 2004, pg 12, 67, 77, 111.

[x] Environmental Consultants, Inc., "Species-Specific Variation in Impedance as Related to Electrical Fault Potential", 2004, pg 12, 15.

[xi] Environmental Consultants, Inc. for Allegheny Power Systems, "Assessing the Seasonal Variation in Electrical Characteristics of Trees", Executive Summary, pg 1, 11.

[xii] Environmental Consultants, Inc. for Allegheny Power Systems, Niagara Mohawk Power Corp, Portland General Electric, 1999, "Understanding the Way Trees Cause Power Interruptions," pg 8.

[xiii] Environmental Consultants, Inc. for Allegheny Power Systems, Niagara Mohawk Power Corp, Portland General Electric, 1999, "Understanding the Way Trees Cause Power Interruptions," pg 10.

[xiv] Environmental Consultants, Inc., "Species-Specific Variation in Impedance as Related to Electrical Fault Potential", 2004, pg 18.

[xv] Environmental Consultants, Inc. for Allegheny Power Systems, Niagara Mohawk Power Corp, Portland General Electric, 1999, "Understanding the Way Trees Cause Power Interruptions," pg 9.

[xvi] Environmental Consultants, Inc., "Species-Specific Variation in Impedance as Related to Electrical Fault Potential", 2004, pg 19.

Appendix I

About Environmental Consultants, Inc.

ECI Profile

Environmental Consultants, Inc. has 40 years of consulting experience in the electric utility industry. We provide quality solutions for all aspects of vegetation management, including program development, crew productivity measurement, environmental assessment, contract foresters, program management, training, expert testimony, and research.

Environmental Consultants, Inc. (ECI) is an environmental, scientific, and vegetation management consulting firm with the operations office located in Stoughton, Wisconsin. ECI's administrative office is located in Southampton, Pennsylvania and has several other offices nationwide. ECI has successfully served companies throughout the United States, Canada, Australia and the United Kingdom by furnishing consulting services tailored to meet the specific needs of the client.

ECI avails itself of a professional, technical, and support staff, including a group of specialized scientists, engineers, and field technicians, to help clients solve complex environmental and operations problems, through cost-effective management practices and state-of-the-art quality control methods.

The cornerstone of ECI's consulting effectiveness is the demonstrated ability to assemble and manage multi-disciplinary project teams. These teams are developed for each assignment and focus on the specific requirements of each client. The interplay between the many phases of a project may involve scientific, engineering, economic, and regulatory aspects. These requirements are addressed through the wide range of expertise available in ECI and outside specialists as required. The ability to organize and complete complex research is employed in meeting the objectives of each assignment.

ECI has a staff of approximately 300 professionals with expertise in vegetation management, forestry, biology, wildlife management, and related fields. Many of these employees are engaged in assisting utility clients in vegetation management program implantation, including work planning, risk tree assessment, customer notification, customer inquiry response and work acceptance processes.

ADDITIONAL INFORMATION ABOUT ECI

ECI has helped over 170 utilities develop new or improved distribution and/or transmission vegetation management programs. We have a proven record of success in helping utilities for over 40 years.

ECI is consistently at the forefront in the development of reliability-focused, cost-effective line clearance programs. Clients implementing our programs and recommendations have realized dramatic improvements in reliability, significant cost savings, and overall improvements in operational effectiveness. In addition, ECI's programs enhance the public's perception of line clearance operations.

ECI's cutting-edge research efforts are consistently integrated with our consulting services, ensuring that the latest information is incorporated into program development. ECI has conducted and been involved in several competitive analyses and benchmarking studies, which provide a resource base for comparative statistics. Research into how trees cause outages continues to shed light on the interactions between electrical conductors and trees. The Economic Impacts of Deferring Electric Utility Tree Maintenance study completed by ECI continues to be widely used to assess the impact of line clearance program budget reductions.

ECI has also conducted numerous environmental studies, including a wetlands study, an herbicide use study, an EIS for ROW management in the Allegheny National Forest, an EIS for Tree Growth Regulator use, and buffer zone effectiveness study. ECI's Green Lane Research Demonstration Project in Pennsylvania, begun in 1987, is a long-term, continuous study that examines the impacts of various right-of-way vegetation management techniques. While many of these studies are proprietary to ECI's clients, several are available in the public domain. Some of ECI's more than 50 research studies include:

- *Herbicide Use on Rights-of-Way in Michigan. ECI. 1995.*
- *Effect of Tree Growth Regulators on Re-sprout Biomass and the Time to Trim Silver Maple. Study for NIPSCO. ECI. 1999.*
- *Herbicide Risk Assessment: A Report to National Grid. ECI. 2004.*
- *The Economic Impacts of Deferring Electric Utility Tree Maintenance. Arborist News. 6:2, 17-19. 1997.*
- *Deferred Tree Maintenance What Does It Really Cost. Utility Arborist Association Quarterly. 12:1, 6-7. 2003.*
- *Annual Reports to Cooperators 1989 – 2004. Green Lane Research Project on the Elroy to Hosensack 500 kV Line of the Philadelphia Electric Company. ECI. 1989-2004.*
- *Evaluation of the Ability of Natural Plant Communities to Inhibit/Resist Invasion of Tree Seedlings on New York Transmission Rights-of-Way. Study for Consolidated Edison Company of New York, Inc. ECI. 1994.*
- *Final Environmental Impact Statement, Vegetation Management on Electric Utility Rights-of-Way. Allegheny National Forest. ECI. 1997.*
- *Understanding the Way Trees Cause Power Interruptions, Allegheny Power System, Niagara Mohawk, Portland General Electric Report. ECI. 1999.*

- *Assessing the Seasonal Variation in the Electrical Characteristics of Trees: A Report to Allegheny Power. ECI. 2000.*
- *Assessing the Relationship Between Tree-Conductor Contact and Momentary Outages at Niagara Mohawk Power Corporation. ECI. 2000.*
- *Species-Specific Variation in Impedance as Related to Electrical Fault Potential. ECI. 2004.*

ECI is a major contributor of publications related to Vegetation Management in the United States. ECI's Electric Power Research Institute (EPRI) reports and CEATI International Inc. (CEATI) include:

- *Determination of the Effectiveness of Herbicide Buffer Zones in Protecting Water Quality. EPRI and ESEERCO. 1999. TR-113160.*
- *Use of the Registered Tree Growth Regulators Paclobutrazol (Profile ®2SC) and Flurprimidol (Cutless®) in the State of New York. Generic Environmental Impact Statement. EPRI and ESEERCO. 2000. 1000272.*
- *Right-of-Way Treatment Cycles: Update 2000. EPRI and ESEERCO. 2000. 1000525.*
- *Long-term Right-of-Way Effectiveness: Update 2000. EPRI and ESEERCO. 2000. 1000271.*
- *Cost Comparison of Right-of-Way Treatment Methods: Update 2000. EPRI and ESEERCO. 2000. 1000270*
- *Wildlife and Integrated Vegetation Management on Electric Transmission Line Rights-of-Way Technical Update. EPRI. 2002 1005366.*
- *Tree Growth Regulators for Management of Trees in Electric Utility Rights-of-Way, A Literature Review and Current Status. EPRI and ESEERCO. 2000. 1000317.*
- *Wildlife and Integrated Vegetation Management on Electric Transmission Line Rights-of-Way. Technical Update. EPRI. 2002. 1005366.*
- *Landscape Fragmentation and Electric Transmission Corridor Siting and Management. EPRI. 2003. 1005371.*
- *Electric Distribution Hazard Tree Risk Reduction Strategies. EPRI. 2004. 1008480.*
- *Electric Transmission Rights-of-Way Uses and Risks. EPRI. 2004. 1009479.*
- *Product Options for Herbicide Applications. EPRI. 2005. 1010125.*
- *New Equipment for Electric Utility Vegetation Management. EPRI. 2005. 1010126.*
- *Transmission Rights-of-Way Invasive Non-Native Woody Plant Species Control. EPRI. 2006. 1010127.*

- *Electric Transmission Right-of-Way Post-Blackout Vegetation Management Strategies. EPRI. 2007. 1012551.*
- *Assessment of Environmental Effects of Underground and Overhead Transmission Line Construction and Maintenance in the United States. EPRI. 2008. 1015597.*
- *EPRI Invasive Plant Species Workshop. EPRI. 2010. 1019877.*
- *Evolving Post-Blackout Right-of-Way Vegetation Management Standards and Practices: Update 2010. EPRI. 2010. 1019878.*
- *Technology Review on Best Practices for a Risk-Based Approach to Vegetation Management. CEATI. 2011. TLAM PI 10.01.*

ECI's Distribution Line Clearance Programs also meet with regulatory approval; our projections, studies and final reports have been successfully used in rate cases in several states. ECI has not only developed recommendations for vegetation management but also actively manages line clearance work and implements industry best practices.

ECI has literally written the book on electric utility industry best practices. ECI prepared the Vegetation Management Manual for the National Rural Electric Cooperative Association, completed a companion manual on tree growth regulators and prepared the Utility Specialist Certification Guide for the International Society of Arboriculture.

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PROFESSIONAL EXPERIENCE

ENVIRONMENTAL CONSULTANTS, INC., Stoughton, Wisconsin **1999 to Present**

President (September 2006 - Present)
Provides corporate leadership for ECI, including oversight of all field operations for the Consulting Services, Total Management Services, Field Services, and Information Management Services business units.

Vice President, Consulting Services (2003-2006)
Provides leadership of ECI's consulting services business unit. This business unit focuses on assisting utility management through diagnostic vegetation management program assessments, vegetation management program development, research-based reliability improvement strategies and outsourcing of line clearance program management. Other consulting services provided include: litigation support, wood pole and joint facilities management planning, transmission right-of-way studies, training services, practical research projects, special studies and information services (production monitoring software and record keeping services, and handheld data collection).

Director, Consulting Services (2000-2002)
Responsible for oversight and direction of the consulting services business unit including distribution line clearance studies, wood pole and joint facilities management plans, transmission ROW studies, turnkey vegetation management operations, training services, practical research projects, information services, litigation support and special studies.

Senior Project Manager (1999-2000)
Responsible for management of ECI's benchmarking programs and development of management planning services for utility wood pole maintenance/joint attachments, litigation related consulting services.

COMMONWEALTH EDISON COMPANY, Chicago, Illinois **1985 to 1999**

System Vegetation Management Superintendent (1993 to 1999)
Responsible for vegetation management including: line clearance, tree maintenance, landscape repair, landscape site maintenance as well as wood pole inspection and maintenance throughout the 44,000 mile transmission and distribution (T&D) system. Managed $40 million to $70 million in contracts annually.

- Supervised 27-member department, which directed activities for 1200 contract personnel.
- Led development and implementation of incentive based landscape repair contracts, which reduced completion times by over 50% while maintaining or increasing quality.
- Initiated studies resulting in efficiency improvements:
  - NPV analysis of tree removal/replacement versus periodic pruning.
  - Efficacy of wood pole supplemental preservative treatment.
  - Wood pole replacement versus reinforcement.

- Co-chaired teams which developed innovative approaches to tree maintenance and wood chip disposal contracting that aligned cost reduction objectives while improving effectiveness.
- Functioned as expert witness on serious claims litigation.
- Assisted in negotiations with regional telephone company regarding shared costs for pole maintenance and tree maintenance related to jointly owned facilities.
- Designed research based brochures addressing customer concerns about tree maintenance.
- Implemented pruning standards change together with a customer notification program based on a combination of personal contact and written materials; recognized by Chairman of the Illinois Commerce Commission for public relations initiative.
- Prepared company responses to inquiries from regulators including Illinois Commerce Commission.

System Line Clearance Coordinator (1988 to 1993)
Responsible for functional control of all line clearance activities and right-of-way vegetation management on the T&D system including contracts specification creation. Direct responsibility for administration and planning of wood pole maintenance contracts.

- Implemented first company electronic database for line clearance records.
- Initiated major review and analysis of distribution line clearance program achieving cost, customer service, reliability and safety objectives. Presented to company officers.

Foreman – Northwest Area (1985 to 1988)
Supervised seven contract line clearance crews and the right-of-way mowing contract in the area.

VILLAGE OF DOWNERS GROVE, Downers Grove, Illinois **1976 to 1985**

Village Forester
Responsible for general administration of forestry department programs including: parkway tree maintenance, Dutch elm disease and gypsy moth control, grounds maintenance, tree planting and leaf pick up. Additional responsibilities included: supervision of personnel, budget preparation, policy and program recommendation, contract management, technical arboricultural consultation to individual homeowners, tree appraisal, landscape planning, public relations and assistance with general administration of Public Works Department.

DAVEY TREE EXPERT COMPANY, Kent, Ohio **1975 to 1976**

Foreman
Progressive experience gained in all aspects of residential tree care including pruning, cabling and bracing, planting, spraying, fertilizing, systemic injection and utility line clearance.

CITY OF APPLETON, Appleton, Wisconsin **1975**

Forestry Technician
Responsible for Dutch elm disease surveillance and resident notification, cost analysis of wood disposal/utilization operation, arboricultural consultation to individual homeowners.

EDUCATION

B.S., Forestry, Michigan Technological University, Houghton, Michigan, 1975

PUBLICATIONS/PAPERS

Appelt, Paul. 1985. "A New Eradication Strategy for Small, Remote Gypsy Moth Infestations." Journal of Arboriculture, Vol. 11, No. 8, August 1985.

Appelt, Paul and Herbert Schroeder. 1985. "Public Attitudes Toward A Municipal Forestry Program." Journal of Arboricultural, Vol. 11, No. 1, January 1985.

Appelt, Paul and John Goodfellow. 2004. "Research on How Trees Cause Interruptions – Applications to Vegetation Management." IEEE Rural Electric Power Conference, May 2004.

Appelt, Paul. 2004. "Utility Vegetation Management – Use of Reliability Centered Maintenance Concepts to Improve Performance." EPRI Technical Update, Product ID #1008859, Palo Alto, CA, April 2004.

Appelt, Paul. 2004. "Electric Distribution Hazard Tree Risk Reduction Strategies." EPRI Technical Report, Product ID #1008480, Palo Alto, CA, November 2004.

Appelt, Paul and Anne Beard. 2006. "Components of an Effective Vegetation Management Program." IEEE Rural Electric Power Conference, April 2006.

Appelt, Paul. 2009. "Why a Strategic Plan for Vegetation Management Is a Critical Asset Management Decision Support Component". EPRI Fifth Power Delivery Asset Management Conference, November 4-6, 2009.

PROFESSIONAL AFFILIATIONS

International Society of Arboriculture
International Society of Arboriculture, Board of Directors, 1989 to 1995
Journal of Arboriculture Editorial Board, 1993 -1995
Illinois Urban Forestry Advisory Council, 1990-1995
Illinois Arborist Association, President, 1986 (Board member and officer previous years)
American Wood Preservers Association
Edison Electric Institute
Utility Arborist Association

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ecunnin@eci-consulting.com

PROFESSIONAL EXPERIENCE

ENVIRONMENTAL CONSULTANTS, INC., Stoughton, Wisconsin **2008 to Present**

Director, Consulting Services
Responsible for oversight and direction of the ECI's consulting services business unit including distribution line clearance studies, wood pole and joint facilities management plans, transmission ROW studies, gas pipeline assessment and mapping, training services, practical research projects, litigation support and special studies.

COMMONWEALTH EDISON COMPANY, Chicago, Illinois **1991 to 2008**

Transmission Project Lead (2004 to August, 2008)
Responsible for management of all transmission vegetation management programs. This position established short- and long-term goals, developed and managed the budget, provided oversight of all contract vegetation maintenance crews on the transmission system, and maintained monthly performance indicators of work completed against budget and performance goals. Recipient of Project Habitat award for "Best Right-of-Way Management Practices"

Manager Vegetation Maintenance (November 1999 to 2004)
Responsibilities included regional budgeting, scheduling and preparation of monthly performance indicators associated with the management of all cyclic distribution line clearance activities. System-wide responsibilities included substation bare-ground and grounds maintenance programs. The approximate budget for all programs managed was $15M. Responsible for rotational vegetation management lead within the System Emergency Response Organization, which included management of the vegetation storm emergency staff, tree crew callout, assignment, monitoring and coordination of emergency line clearance efforts with the various overhead line departments and management of vegetation related outage tickets.

Regional Vegetation Management Supervisor (1993-1999)
Responsible for regional distribution and transmission vegetation managements as well as the regional substation grounds maintenance, bare ground weed control and landscape repair programs. This included staff supervision, contract management, budgeting, scheduling and preparation of monthly progress reports associated with these activities.

Line Clearance Analyst (November 1991-1993)
Assisted the System Line Clearance Superintendent in line clearance performance auditing, program analysis, and RFP development. Mr. Cunningham was also responsible for quality assurance and data management for the wood pole maintenance program on the ComEd system.

JERSEY CENTRAL POWER & LIGHT, Morristown, New Jersey **1976 to 1991**

System Forester (1976 – 1991)
Mr. Cunningham directed all vegetation management programs for JCP&L serving in various capacities associated with vegetation management, environmental assessment, and wetland delineation. This included the budgeting, scheduling and preparation of monthly performance indicators associated with distribution and transmission vegetation management as well as management of system-wide grounds maintenance, substation bare-ground program and wood-pole inspection and maintenance.

Other (1985- 1991)

Independent Consulting Forester - prepared forest management plans and worked with landowner in the implementation of these plans.

U.S. Forest Service, Panhandle National Forest, Wallace, ID (1976)

EDUCATION

M.S.F. – Forest Management, West Virginia University
B.S. – Wood Industries, West Virginia University

PUBLICATIONS AND PRESENTATIONS

Cunningham, E.L. 1976. Thesis: Effects of Power Line Clearance and Maintenance on Vigor of Adjacent Stand and Composition of Bordering Understory's. West Virginia University, Morgantown, WV.147pp.

Cunningham, E.L. 1979. Computer Program for Utility Forestry Activities. Journal of Arboriculture 5(5):113-115.

Cunningham, E.L. 1987. Firm Price Tree Trimming at Jersey Central Power and Light. Journal of Arboriculture 13(12):299-303.

Cunningham, E.L. 1992. Work Measurement System. Journal of Arboriculture 18(1):43-44.

Cunningham, E.L. 2009. 30 Years of ECI's Vegetation Management Research: From the Well Know to the Unknown. 9th International Symposium on Environmental Concerns in Rights-of-Way Management, September 27-30, 2009, Portland, Oregon

Cunningham, E.L. 2010. The Impact of Vegetation on Restoration: Before, During and After the Storm. 5th Annual Summit on Emergency Preparedness and Service Restoration for Utilities. New Orleans, LA.

Cunningham, E.L. 2010. EPRI Invasive Plant Species Workshop Report. EPRI, Palo Alto, CA: EPRI (2010) 101987

Cunningham, E.L. 2011. Technology Review on Best Practices for a Risk-Based Approach to Vegetation Management. CEATI International, Montreal, Quebec, Canada (2011) TLAM PI10.01

Cunningham, E.L. 2012. Review of Best Practices for a Risk-Based Approach to Integrated Vegetation management on distribution Lines. CEATI International, Montreal, Quebec, Canada (2012) DALCM IFP11.06

PROFESSIONAL AFFILIATIONS

International Society of Arboriculture (ISA).
Utility Arborist Association (UAA), Illinois Chapter ISA
Keep Northern Illinois Beautiful, affiliate of Keep America Beautiful, former Board of Directors
Illinois Arborist Association, former Board of Directors
Utility Arborist Association Education and Training Committee
Steering Committee, 8^{th} and 9^{th} International Symposium for Environmental Concerns in Right-of-Way Management

CERTIFICATES

ISA Certified Arborist IL 0594A
ISA Certified Utility Specialists IL 0594U
Certified Tree Growth Regulator Applicator
Illinois Certified Pesticide Applicator (previous)
New Jersey Certified Tree Expert License (No. 209)
Project Management Advanced Training-Construction Industry Cooperative Alliance, Clemson University

NYSEG Reclamation Cycle Implementation Plan

Circuit Prioritization and Scheduling

1. Schedule maintenance of 34 kV main lines on 4-year cycle.
2. 1st 18 months – expand full circuit maintenance on 12.5 to 19.2kV circuits with prioritization based on maintenance history and recent tree-caused interruptions.
3. Final 42 months – expand full circuit maintenance to circuits operating at voltages below 12.5 kV. These circuits will also be prioritized on the basis of maintenance history and recent tree-caused interruptions.
4. All circuits will have received maintenance once within 60 months, in addition to approximately 25% of the 34kV backbone receiving maintenance twice.

PERSONNEL

NYSEG Internal Arborist Staff

NYSEG plans to add a sufficient number of internal staff to ensure that the distribution vegetation management program is effectively managed. Transmission vegetation management responsibilities will be separated from the responsibilities of distribution arborists. The distribution vegetation management program will require arborists that are dedicated to the program. The distribution arborists' key responsibilities will include: day-to-day management of the program; scheduling work; auditing work; approving invoicing; managing customer inquiries; monitoring local budgets; and assisting with restoration efforts. The distribution arborists will report to regional coordinators. Transmission arborists will be responsible for the transmission vegetation management program. An additional technician will be required to manage invoicing and data collection and reporting.

Contract Arborists

Contract arborists will be used to supplement the internal work force as crews are increased over the first 18 months and will be retained as needed over the reclamation period. Contract arborists will assist with conducting audits, customer inquiries and communications.

WORK ACCEPTANCE and AUDITING

Partial contractor payments for circuit clearing will be made upon completion of pre-established production milestones. Prior to acceptance and full payment to external contractors for vegetation maintenance work on a particular circuit, 100% of the work done will be audited to assure completion according to NYSEG specifications. The auditing will be conducted by NYSEG distribution arborists with assistance as necessary from the contract arborists. It is important to verify line clearance contractor adherence to clearance specifications so that NYSEG can achieve its reliability goals and future vegetation maintenance cost reductions.

CUSTOMER RELATIONS AND OUTREACH

Prior to beginning maintenance of vegetation on scheduled circuits, several steps will be taken to notify customers and municipal officials of any pending maintenance. The steps will include press releases regarding the general nature of the work, specific personal contact with municipal officials by distribution arborists and personal contacts with property owners by tree maintenance contractors who will be prepared to answer specific questions about the scope of work on particular properties. NYSEG distribution arborists and/or contract arborists will respond to additional inquiries from customers or municipal officials as work progresses.

TRACKING/RECORD KEEPING

A system of record keeping will be utilized that provides a timely, accurate accounting of work accomplished at the circuit level. The record keeping system will be a comprehensive program that collects work progress, work units and costs. NYSEG uses electronic tree crew time sheets to track daily work progress and to manage invoicing. The system will track progress on each circuit, including spans worked, trees worked, services pruned and all related costs. The arborists will use electronic handheld units to enter audit and other information and to track any required re-work by contractors.

NYSEG 2014 Vegetation Management Plan

December 2, 2013

Introduction

New York State Electric & Gas (NYSEG), a subsidiary of IBERDROLA USA Networks, received an October 1, 2013 Order from the NY PSC denying NYSEG's request for a temporary surcharge for recovery of costs required to implement a "full cycle" Vegetation Management (VM) program.

The Commission also ordered NYSEG to, within 60 days, file a plan for continuing progress during 2014 towards achieving a full cycle VM program. The Order directed that the plan address circumstances in its Brewster Division where implementation of full cycle VM may serve as an interim step towards system-wide full cycle VM, which could assist in controlling costs while experience in full cycle VM is gained.

NYSEG is submitting its 2014 Vegetation Management Plan to move towards a full VM cycle with a focus on the Brewster and Liberty Divisions.

I. 2013 Vegetation Management

The March 15, 2013 petition filed by NYSEG, and the Commission's related October 1, 2013 Order, recognize the benefits of a full cycle distribution system vegetation management program.

NYSEG's 2013 and 2014 amount included in rates for its distribution system VM is $20 million annually. In both 2013 and 2014, the Company is planning to spend in excess of the $20 million included in rates, with a particular focus on accelerating the implementation of a full cycle VM program in the Brewster Division. During 2013, NYSEG anticipates completing nearly 3,000 total miles of distribution VM work.[1]

NYSEG has set in motion a plan, beginning in late 2013 and continuing into 2014, to complete additional circuit clearance in the Brewster Division with a goal of having the Brewster Division on a full cycle trim basis by the end of 2015. Tables 1 and 2 summarize the anticipated 2013 expenditures.

[1] The NYSEG rate plan targeted miles for 2013 is 2,700 miles. NYSEG is planning to trim more than 100 additional miles than originally planned in the Brewster division during 2013.

Table 1 - 2013 NYSEG Distribution Vegetation Management Summary of Planned Expenditures

TABLE 1

2013	NYSEG Planned
Maintenance	$16,228,720
4th Quarter Incremental (Brewster)	REDACTED
Hot Spot	$3,771,280
Grand Total	REDACTED

Table 2 – 2013 NYSEG Distribution Vegetation Management Mileage Clearance Planned, Expenditures by Voltage Class

TABLE 2

NYSEG	NYSEG Distribution Miles Planned 2013	34.5 kV Miles	34.5 kV Cost	15 kV Miles	15 kV Cost	5 kV Miles	5 kV Cost	Total Planned Cost
Maintenance Program	2890	1009	$4,750,913	1135	$6,542,722	746	$4,935,085	$16,228,720
4th Quarter Incremental (Brewster)	109			98	REDACTED	11	REDACTED	REDACTED

II. 2014 Vegetation Management Plan

NYSEG's 2014 distribution VM plan is designed to continue progress toward achieving full cycle VM, focused on those Divisions with some of the most significant tree issues affecting customers.

Focus on Brewster and Liberty Divisions

Tree-caused SAIFI is higher in Brewster than other Divisions. Trees per mile within distribution rights-of-way are among the highest of all the Divisions and high levels of tree-to-conductor contact were documented in 2010 in the Brewster Division. Further, tree maintenance issues in the Brewster Division have been a significant source of dissatisfaction among customers.

Between 2011 and 2013, 68% of the Brewster Division miles will have undergone full circuit clearance. The remaining 528 miles, as part of this new plan, are now planned to be completed by the end of 2015. NYSEG intends to increase from the previous 2014 plan the total miles of VM in Brewster during 2014 to allow for completion of the first full cycle by the end of 2015. Completing the remaining miles in Brewster over two years provides a more levelized resource need (as compared to a more rapid one year completion) in future years as a long-term maintenance cycle is implemented. This approach also provides sustained presence of line clearance crews in the Division.

The Liberty Division tree-caused interruption statistics per mile generally rank second behind Brewster. The Liberty Division has the highest tree density of all Divisions at 175 trees per mile, even higher than the 162 trees per mile in the Brewster Division. Table 3 summarizes the full circuit miles completed in Brewster and Liberty since 2011 and the plan to accelerate completion of the first full cycle of circuit clearance in these divisions.

Approximately 70 percent of the distribution VM miles in the Liberty Division remain to be reclaimed. NYSEG's plan for 2014 is to accelerate the tree pruning and removal work in the Liberty Division on a pace to complete all remaining miles over the next four years. This acceleration will result in completion of approximately 244 more miles than originally planned (within the $20 million base spend) in each of 2014 and 2015.

Both the Brewster and Liberty increased mileage in 2014 would result in an incremental increase in spending of approximately [REDACTED] million above the $20 million currently included in rates.

Table 3. Brewster and Liberty Division Full Circuit Miles Completed 2011-2013, Planned for 2014 and Remaining After 2014

Division	Total Miles	2011 Miles	2012 Miles	2013 Miles[2]	2014 Plan Miles	Remaining Miles after 2014
Brewster	1,634	330	302	474	264[3]	264
Liberty	2,041	106	200	274	367[4]	1,094

Customer communication processes will continue and be enhanced, as appropriate, to both inform customers of pending VM work in their areas, provide specific information about work to be done in their yards and promote general information about the needs and benefits of tree maintenance on and adjacent to electric distribution lines. Website enhancements to better communicate maintenance schedules are among the customer communication enhancements.

[2] Includes for Brewster 109 miles planned to be completed in the 4th quarter of 2013 with an incremental [REDACTED] million above the $20 million base.
[3] 2014 miles include 134 plan miles and 130 incremental miles above those in the $20 million base.
[4] 2014 miles include 123 plan miles and 244 incremental miles above those in the $20 million base.

Deviation from March 2013 Petition

In its March 2013 petition, NYSEG was proposing to move toward full cycle VM in all Divisions if the Company was allowed to collect the incremental cost of such reclamation. The Commission's Order directs the Company to commence early implementation of full cycle vegetation management, with an emphasis on the Brewster Division, as an interim step towards system wide full cycle vegetation management. However, the Commission did not provide any additional rate recovery for such movement to full cycle VM, and instead asks the Company to identify sources of funding that might cover any incremental spending.

NYSEG's 2014 plan provides for the interim step of moving towards full cycle VM with a focus on both the Brewster and Liberty Divisions. NYSEG anticipates spending an additional [REDACTED] million (a [REDACTED] increase over the $20 million included in rates) in 2014 to accelerate moving the Brewster and Liberty Divisions to full cycle. The additional spending will allow the Company to complete 50 percent of the outstanding miles in the Brewster Division and to set the Liberty Division on a path to complete maintenance of all circuits within four years. This additional spending is beyond the Company's rate allowance of $20 million and reflects the Company's commitment to full cycle VM. The [REDACTED] million amount also reflects the direction in the Order to focus on Brewster and areas where tree density is especially high, and to control costs while experience in full cycle VM is gained. The original ECI report as filed with the Company's petition presumed an across the board ramp-up toward full cycle VM in all Divisions in the first year following approval of the petition by the Commission. As noted above, this current plan, consistent with the Order, commences early implementation of full cycle VM, as an interim step, in two Divisions where tree density is especially high. This will allow the Company to continue to gain experience in full cycle VM, while at the same time managing costs.

Table 4 summarizes the 2014 plan for Brewster and Liberty Division and continuation of the current program for VM in the remaining Divisions.

Table 4. Planned Expenditures and Miles by Division for 2014.

Division	Base Expenditure Estimate ($ million)	Base Planned Miles	Incremental Estimated Expenditure ($ million)	Incremental Planned Miles
Brewster	REDACTED	134	REDACTED	130
Liberty	REDACTED	123	REDACTED	244
All other Divisions and Hotspot	REDACTED	2,449		
TOTAL	$20.000	2,706	REDACTED	374

Estimated expenditures for incremental miles are based on the cost per mile included in base expenditures.

III. Opportunities for Process Improvements

Given the general guidance in the Order encouraging the Company to explore opportunities for cost effectiveness associated with VM activities, NYSEG requested ECI to conduct field reviews in its Brewster Division. Based on ECI's field reviews of circuits, and current contract pricing in the Brewster Division, several major contributors to costs have been identified. Some of these cost drivers are unique to the conditions in the Brewster Division and are not avoidable. Others are a function of various processes that may have potential for improvement over time. Following are the significant factors believed to be driving the costs per mile in the Brewster Division:

Cost drivers with limited opportunity for improvement

- The need for flagging crews on a majority of highways in the Brewster Division compared to other areas.
- Higher than typical need for customer notification and follow-up on complaint issues.
- Contractor crew parking and chip disposal result in crews driving significant distances in many cases.

Cost drivers with opportunities for process improvements

- The annual firm price contracting process identifies the lowest competitively bid price for each circuit, but it does not create a longer term stable, local workforce. This process is not unusual due to the variability in annual mileage by Division under the current rate plan. However, with the potential to create a more stable clearance program under full cycle VM, the Company can build into its bidding process the potential for a more local skilled workforce. By doing so, the Company may lower some of the daily per diem payments and overtime pay, that are likely included in the current lowest priced bid.
- A substantial portion of firm prices bid is for the cost of tree and brush removal. There are different considerations for residential work compared to wooded non-residential spans. The actual work that will be done becomes subject to judgment and cooperation of property owners and local officials. This creates uncertainty in the overall work scope and higher pricing than may be obtained if the work scope were less variable.

NYSEG intends to implement pilot projects in 2014 in an effort to reduce costs compared to existing competitively bid firm prices. Pilot projects may include prescriptive planning of specific work, use of herbicides to help control long-term costs, longer commitments to contractors and efforts related to building less reliance on non-local labor resources.

Processes and strategies implemented successfully by other utilities, to the extent they may be applicable to the conditions on the NYSEG distribution system, will also be examined through these pilot projects. It is anticipated that experience gained in the Brewster and Liberty Divisions and the process improvement pilots will be beneficial in moving toward a cost effective full cycle VM program for all Divisions.

IV. Source of Funding

The Commission's Order did not provide any additional funding for NYSEG's VM program. Nevertheless, the Company is committed to moving toward full cycle VM starting with the Brewster and Liberty Divisions as outlined above. NYSEG will manage its additional VM spending within the confines of its overall corporate budget during 2014. In addition, NYSEG intends to examine additional areas in its contracting efforts to continuously improve the effective management of its VM program. As noted in the Order, there may be several different approaches to fund the incremental VM costs within the confines of its overall budget for 2014, including reconfiguring other costs and achieving cost savings in other areas. To the extent that process improvements may result in reduced costs, there may be an opportunity to expand the number of full circuit miles worked.

The Company anticipates that further movement toward full cycle VM and the related cost recovery would be addressed in the Company's next electric rate filing.

NYSEG 2015 Vegetation Management Cycle Alternative Analysis

December 15, 2014

Introduction

This report is a supplemental to the two previous reports[1&2] prepared by Environmental Consultants, Inc. (ECI) for New York State Electric & Gas (NYSEG). This report addresses the steps taken by NYSEG as a result of the New York Public Service Commission's (NYPSC) order requesting that NYSEG address circumstances in its Brewster and Liberty Divisions where implementation of full cycle vegetation management (VM) may serve as an interim step towards system-wide full cycle VM. In addition, this report utilizes the results of that pilot project and other lessons learned to explore alternative cost-effective full cycle options and their impacts on system tree contact and reliability.

I. Brewster & Liberty Pilot Results

In its March 2013 petition, NYSEG proposed to move toward full cycle VM in all Divisions if the Company was allowed to collect the incremental cost of such reclamation. The Commission's Order directed the Company to commence early implementation of full cycle vegetation management, with an emphasis on the Brewster Division, as an interim step towards system wide full cycle vegetation management. However, the Commission did not provide any additional rate recovery for such movement to full cycle VM, and instead asked the Company to identify sources of funding that might cover any incremental spending.

In December 2013, NYSEG submitted its 2014 Vegetation Management Plan that provided for the interim step of moving towards full cycle VM with a focus on both the Brewster and Liberty Divisions. The plan included an additional spend of $4.3 million (a 21.5% increase over the $20 million in rates) in 2014 to accelerate moving the Brewster and Liberty Divisions to full cycle which included the completion of 130 and 244 additional miles, respectively.

The goal of the pilot project was to identify main cost drivers and cost per mile reduction opportunities that could be applied system wide to provide cost-effective full cycle vegetation maintenance. With the assistance of ECI, several operational and process opportunities were identified. These included:

- Prescriptive planning of specific work.
- Use of herbicides to help control long-term costs.

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[1] Environmental Consultants, Inc. "*NYSEG Distribution System Cycle Optimization Study*". March 1, 2013
[2] Environmental Consultants, Inc. "*NYSEG 2014 Vegetation Management Plan*". December 2, 2013

- Longer commitments to contractors and efforts related to building less reliance on non-local labor resources.

The latter two are long-term strategic goals that were outside the scope of this short-term project and were deemed unfeasible to review at this time. However, NYSEG recognizes the importance of both these potential cost drivers and the need to progress toward these goals in future operations.

Work Planning

One potential cost driver that was explored was the opportunity to reduce cost through proper work planning. NYSEG recognized the need to better define the total vegetation maintenance work scope on the selected circuits for this project. Defining work scope can help reduce cost by minimizing non-essential pruning and removals that have negligible impact on system reliability and safety. NYSEG used work planners to survey each circuit and identify the work to be performed. Subsequent vendor firm price bids were submitted based on these defined work plans.

Vendor submitted bid prices exceeded historical average cost per mile expenditures which was expected due to the increased work scope (reclamation). However, the pre-planning of these circuits along with the modified clearance specifications did result in substantial reductions in cost per mile.

Clearance Specification Modification

Despite the success of the work planning project, NYSEG recognized the need to further reduce the cost per mile spend in order to make it feasible for system wide implementation of a full cycle program. NYSEG proposed that since single-phase conductors pose the largest expenditure to reclaim the existing rights-of-way, reducing the required clearances may allow for additional cost savings while still allowing for improvements to overall system reliability and safety. The primary changes which applied only to single-phase line sections included:

- Reducing side clearance from 10 feet to 6 feet.
- Limiting overhang removal to 5 feet.
- Limiting removal to cost-effective removals less than or equal to 12 inches DBH.

Refer to Appendix C for full modified specification. Vendors were asked to re-submit firm price bids based on this revised clearance specification. The cost per mile savings due to the reduction of clearance specification and the defined work scope resulted in a 9 percent and 42 percent reduction over ECI estimates in Brewster and Liberty Division, respectively (see Table 1).

Table 1. Firm Price Bid Average Cost per Mile for the Pilot Project Based on the NYSEG Modified Clearance Specification.

	Brewster		Liberty	
	Avg. Cost/Mile	% Savings	Avg. Cost/Mile	% Savings
Work Planned @ Full Spec	$10,841		$13,767	
Work Planned @ Modified Spec	$9,815	9%	$8,019	42%

II. Full Cycle Alternatives

NYSEG is committed to moving toward full cycle VM starting with the Brewster and Liberty Divisions as outlined above. The lessons learned in 2014 were used to reanalyze system cost projections to determine the feasibility of extending the full cycle program to all remaining Divisions. Cost saving methodologies from the pilot program were used to project full cycle budget requirements under varying cycle scenarios. Each cycle scenario presents varying reliability benefits. NYSEG submits the following four program scenarios for consideration in Table 2 below. Note that the dollars presented represent the average inflation (CPI) adjusted annual expenditure requirements for both the reclamation cycle and the 2nd cycle assuming an April 2016 implementation. Detailed budget breakouts for each scenario are listed in Appendix A (without inflation and shown in 2015 dollars with no ramp-up) for alternative comparisons only. The cash flow for the ECI recommended strategy (Option 1) is presented in Appendix B (shown with and without inflation). These monthly cash flows show the calendar year (January through December) detailed cash flow as well as a rate year summary table. The cash flow in Appendix B recognizes that tree personnel are a limited commodity and NYSEG will need to build tree crew resources over an 18 month period. Therefore, the actual spend requirements as listed in Appendix B for each calendar or rate year will vary from the budget scenarios in Table 2 (which shows the average over multiple years) and Appendix A (which does not include inflation). The cash flow presented in Appendix B represents the annual "actual" dollars needed by NYSEG to fund and execute the recommended cycle option (Option 1).

Credit for reclamation miles completed to date is factored into the budget scenarios. Miles completed to date equate roughly to one year of completed reclamation. Therefore, the 2nd cycle benefits will be realized one year earlier which explains why the reclamation years extend for only four years.

Table 2. NYSEG Full Cycle Cost Estimates by Varying Cycle Options.

Option	Description	5 Year Estimate	End 1st Cycle Estimate	Reclamation Cycle Average Annual Cost Estimate (with Inflation)	2nd Cycle Average Annual Cost Estimate (with Inflation)	Total Cost End of 1st Cycle (with Inflation)
Option 1 **Full Spec** **Recommended**	**Circuit Cycle:** <12.5kV= 5 yr 12.5-19.9kV= 5 yr 34.5kV= 4 yr **Mid Cycle:** 34.5kV 3ø= 4 yr **Hazard Tree:** All= 5 yr	**CI Avoided:** <12.5kV= 8,791 12.5-19.9kV= 10,676 34.5kV= 14,142 Total= 33,609 %Tree SAIFI Redtn.= 11.53%	**CI Avoided:** <12.5kV= 8,791 12.5-19.9kV= 10,676 34.5kV= 14,142 Total= 33,609 %Tree SAIFI Redtn.= 11.53%	$62,512,255	$51,055,457	$250,049,020
Option 2 **Mod Spec**	**Circuit Cycle:** <12.5kV= 5 yr 12.5-19.9kV= 5 yr 34.5kV= 4 yr *w/ Modified Spec **Mid Cycle:** 34.5kV 3ø= 4 yr **Hazard Tree:** All= 5 yr	**CI Avoided:** <12.5kV= 4,641 12.5-19.9kV= 6,629 34.5kV= 7,202 Total= 18,471 %Tree SAIFI Redtn.= 6.34%	**CI Avoided:** <12.5kV= 4,641 12.5-19.9kV= 6,629 34.5kV= 7,202 Total= 18,471 %Tree SAIFI Redtn.= 6.34%	$57,470,096	$56,887,020	$229,880,384
Option 3 **Mod Spec**	**Circuit Cycle:** <12.5kV= 5 yr 12.5-19.9kV= 5 yr 34.5kV= 5 yr *w/ Modified Spec **Mid Cycle:** 34.5kV 3ø= 5 yr **Hazard Tree:** All= 5 yr	**CI Avoided:** <12.5kV= 4,012 12.5-19.9kV= 7,247 34.5kV= 6,430 Total= 17,689 %Tree SAIFI Redtn.= 6.08%	**CI Avoided:** <12.5kV= 4,012 12.5-19.9kV= 7,247 34.5kV= 6,430 Total= 17,689 %Tree SAIFI Redtn.= 6.08%	$54,377,997	$59,790,940	$217,511,987
Option 4 **Mod Spec**	**Circuit Cycle:** <12.5kV= 6 yr 12.5-19.9kV= 6 yr 34.5kV= 5 yr *w/ Modified Spec **Mid Cycle:** 34.5kV 3ø= 5 yr **Hazard Tree:** All= 6 yr	**CI Avoided:** <12.5kV= 3,238 12.5-19.9kV= 6,088 34.5kV= 4,823 Total= 14,148 %Tree SAIFI Redtn.= 4.85%	**CI Avoided:** <12.5kV= 3,885 12.5-19.9kV= 7,305 34.5kV= 5,787 Total= 16,978 %Tree SAIFI Redtn.= 5.82%	$49,716,253	$59,030,382	$193,196,612

III. Conclusion

Each of the four full-cycle budget scenarios presented offer varying levels of reliability improvement and speed to which those improvements can be realized. NYSEG recommends for approval, Option 1 which will yield the lowest overall annual budget but still provide for an 11.5 percent reduction in tree SAIFI from 0.31 (average 2013/2014 SAIFI) to 0.27 by the end of the first cycle. Assuming an April 2016 implementation date, Table 3 presents the annual budget Requirements including inflation and ramp-up.

Table 3. NYSEG Estimated Option 1 Budget Requirements by Rate Year.

Apr. 2016 – Mar. 2017	Apr. 2017 – Mar. 2018	Apr. 2018 – Mar. 2019	Apr. 2019 – Mar. 2020	Apr. 2020 – Mar. 2021	Apr. 2021 – Mar. 2022	Total
$39,948,046	$67,045,295	$74,985,399	$68,070,280	$49,204,642	$50,130,051	$349,383,713

Appendix A
Full Cycle Budget Scenarios
(Excludes Inflation)

Option 1. 4yr w/ Mid-Cycle (34kV), 5yr (12.5-19.9 kV), 5yr (<12.5 kV): 3-Phase 12.5-19.9 kV drops to 4 year cycle in 2nd cycle

Maint. Type	VM Activity	Reclamation Budget Year 1-4	Budget Year 5	Budget 2nd Cycle	Miles Year 1-4	Miles 2nd Cycle	Cost/Mile Year 1-4	Cost/Mile Year 5	Cost/Mile 2nd Cycle	Est. % CI Improv. Year 5	Est. % CI Improv. End 1st Cycle	System Contact %
Scheduled	Tree Pruning & Removal	$52,912,609	$45,222,701	$37,394,501	6,370	6,547	$8,306	$7,099	$5,711	11.5%	11.5%	18.0%
	34 kV: Single-Phase	*$13,536,269*	*$6,210,208*	*$9,247,759*	*1,462*	*1,462*	*$9,257*	*$4,247*	*$6,324*			
	Multi-Phase	*$2,296,088*	*$1,932,243*	*$1,836,871*	*464*	*464*	*$4,945*	*$4,161*	*$3,956*			
	12.2-19.9 kV: Single-Phase	*$13,404,712*	*$13,404,712*	*$9,159,421*	*1,464*	*1,464*	*$9,157*	*$9,157*	*$6,257*			
	Multi-Phase	*$4,320,807*	*$4,320,807*	*$3,835,561*	*708*	*885*	*$6,103*	*$6,103*	*$4,334*			
	<12.2 kV: Single-Phase	*$15,933,230*	*$15,933,230*	*$10,884,455*	*1,713*	*1,713*	*$9,303*	*$9,303*	*$6,355*			
	Multi-Phase	*$3,421,502*	*$3,421,502*	*$2,430,434*	*559*	*559*	*$6,118*	*$6,118*	*$4,346*			
	Mid-Cycle (34 kV)	$330,401	$330,401	$264,321	464	464	$712	$712	$569			
	Brush	$1,383,315	$1,383,315	$791,474								
	34 kV: Single-Phase	*$337,120*	*$337,120*	*$183,279*	*1,462*	*1,462*	*$231*	*$231*	*$125*			
	Multi-Phase	*$85,622*	*$85,622*	*$51,988*	*464*	*464*	*$184*	*$184*	*$112*			
	12.2-19.9 kV: Single-Phase	*$330,884*	*$330,884*	*$179,894*	*1,464*	*1,464*	*$226*	*$226*	*$123*			
	Multi-Phase	*$128,326*	*$128,326*	*$97,228*	*708*	*885*	*$181*	*$181*	*$110*			
	<12.2 kV: Single-Phase	*$398,484*	*$398,484*	*$216,636*	*1,713*	*1,713*	*$233*	*$233*	*$126*			
	Multi-Phase	*$102,877*	*$102,877*	*$62,449*	*559*	*559*	*$184*	*$184*	*$112*			
	Hazard Removal (5yr)	$493,402	$493,402	$246,701								
	Service Pruning	$670,000	$670,000	$670,000								
Un-Scheduled	Hot-Spot	$3,500,000	$3,500,000	$3,500,000								
Staff	Work Planner Resources	$1,200,000	$1,200,000	$1,200,000								
Total VM Program Costs (w/o CPI):		**$60,489,726**	**$52,799,819**	**$44,066,996**								

Option 2. 4yr w/ Mid-Cycle (34kV), 5yr (12.5-19.9 kV), 5yr (<12.5 kV) w/ Reduced Spec on Single-Phase: 3-Phase 12.5-19.9 kV drops to 4 year cycle in 2nd cycle and Return to Full Spec

Maint. Type	VM Activity	Reclamation Budget Year 1-4	Budget Year 5	Budget 2nd Cycle	Miles Year 1-4	Miles 2nd Cycle	Cost/Mile Year 1-4	Cost/Mile Year 5	Cost/Mile 2nd Cycle	Est. % CI Improv. Year 5	Est. % CI Improv. End 1st Cycle	System Contact %
Scheduled	Tree Pruning & Removal	$47,019,626	$46,626,307	$42,309,653	6,370	6,547	$7,381	$7,319	$6,462	6.3%	6.3%	43.0%
	34 kV: Single-Phase	*$11,689,998*	*$11,689,998*	*$10,734,369*	*1,462*	*1,462*	*$7,995*	*$7,995*	*$7,341*			
	Multi-Phase	*$2,251,874*	*$1,858,555*	*$1,846,537*	*464*	*464*	*$4,850*	*$4,003*	*$3,977*			
	12.2-19.9 kV: Single-Phase	*$11,574,171*	*$11,574,171*	*$10,627,131*	*1,464*	*1,464*	*$7,906*	*$7,906*	*$7,259*			
	Multi-Phase	*$4,320,807*	*$4,320,807*	*$3,957,547*	*708*	*885*	*$6,103*	*$6,103*	*$4,472*			
	<12.2 kV: Single-Phase	*$13,761,275*	*$13,761,275*	*$12,636,820*	*1,713*	*1,713*	*$8,035*	*$8,035*	*$7,378*			
	Multi-Phase	*$3,421,502*	*$3,421,502*	*$2,507,250*	*559*	*559*	*$6,118*	*$6,118*	*$4,483*			
	Mid-Cycle (34 kV)	$330,401	$330,401	$270,929	464	464	$712	$712	$583			
	Brush	$691,657	$1,037,486	$853,866								
	34 kV: Single-Phase	*$168,560*	*$252,840*	*$198,663*	*1,462*	*1,462*	*$115*	*$173*	*$136*			
	Multi-Phase	*$42,811*	*$64,217*	*$55,351*	*464*	*464*	*$92*	*$138*	*$119*			
	12.2-19.9 kV: Single-Phase	*$165,442*	*$248,163*	*$194,993*	*1,464*	*1,464*	*$113*	*$170*	*$133*			
	Multi-Phase	*$64,163*	*$96,245*	*$103,546*	*708*	*885*	*$91*	*$136*	*$117*			
	<12.2 kV: Single-Phase	*$199,242*	*$298,863*	*$234,821*	*1,713*	*1,713*	*$116*	*$175*	*$137*			
	Multi-Phase	*$51,439*	*$77,158*	*$66,492*	*559*	*559*	*$92*	*$138*	*$119*			
	Hazard Removal (5yr)	$421,383	$421,383	$295,886								
	Service Pruning	$670,000	$670,000	$670,000								
Un-Scheduled	Hot-Spot	$3,500,000	$3,500,000	$3,500,000								
Staff	Work Planner Resources	$1,200,000	$1,200,000	$1,200,000								
Total VM Program Costs (w/o CPI):		**$53,833,067**	**$53,785,577**	**$49,100,334**								

Option 3. Reduced Spec on Single-Phase and Adjusted Cycle (all voltages 5 Years + 5Yr Mid-Cycle on 34.5 kV Three-Phase) Return to Full Spec in 2nd Cycle

Maint. Type	VM Activity	Reclamation Budget Year 1-5	Budget 2nd Cycle	Miles Year 1-5	Miles 2nd Cycle	Cost/Mile Year 1-5	Cost/Mile 2nd Cycle	Est. % CI Improv. Year 5	Est. % CI Improv. End 1st Cycle	System Contact %
Scheduled	Tree Pruning & Removal	$44,231,252	$44,628,308	5,985	5,985	$7,390	$7,457	6.1%	6.1%	45.0%
	34 kV: Single-Phase	*$9,351,999*	*$9,853,515*	*1,170*	*1,170*	*$7,995*	*$8,423*			
	Multi-Phase	*$1,801,500*	*$1,603,335*	*371*	*371*	*$4,850*	*$4,316*			
	12.2-19.9 kV: Single-Phase	*$11,574,171*	*$12,193,596*	*1,464*	*1,464*	*$7,906*	*$8,329*			
	Multi-Phase	*$4,320,807*	*$3,615,114*	*708*	*708*	*$6,103*	*$5,106*			
	<12.2 kV: Single-Phase	*$13,761,275*	*$14,499,956*	*1,713*	*1,713*	*$8,035*	*$8,466*			
	Multi-Phase	*$3,421,502*	*$2,862,792*	*559*	*559*	*$6,118*	*$5,119*			
	Mid-Cycle (34 kV)	$264,321	$235,246	371	371	$712	$633			
	Brush	$649,383	$983,181							
	34 kV: Single-Phase	*$134,848*	*$202,006*	*1,170*	*1,170*	*$115*	*$173*			
	Multi-Phase	*$34,249*	*$53,699*	*371*	*371*	*$92*	*$145*			
	12.2-19.9 kV: Single-Phase	*$165,442*	*$247,840*	*1,464*	*1,464*	*$113*	*$169*			
	Multi-Phase	*$64,163*	*$100,527*	*708*	*708*	*$91*	*$142*			
	<12.2 kV: Single-Phase	*$199,242*	*$298,468*	*1,713*	*1,713*	*$116*	*$174*			
	Multi-Phase	*$51,439*	*$80,642*	*559*	*559*	*$92*	*$144*			
	Hazard Removal (5yr)	$421,383	$390,032							
	Service Pruning	$670,000	$670,000							
Un-Scheduled	Hot-Spot	$3,500,000	$3,500,000							
Staff	Work Planner Resources	$1,200,000	$1,200,000							
Total VM Program Costs (w/o CPI):		**$50,936,338**	**$51,606,767**							

Option 4. Reduced Spec on Single-Phase and Adjusted Cycle (5YR 34.5 kV, 6YR Other) + 5Yr Mid-Cycle on 34.5 kV Three-Phase Return to Full Spec in 2nd Cycle

Maint. Type	VM Activity	Reclamation Budget Year 1-5	Budget Year 6	Budget 2nd Cycle	Miles Year 1-5	Miles 2nd Cycle	Cost/Mile Year 1-5	Cost/Mile Year 6	Cost/Mile 2nd Cycle	Est. % CI Improv. Year 5	Est. % CI Improv. End 1st Cycle	System Contact %
Scheduled	Tree Pruning & Removal	$38,718,293	$38,403,637	$42,614,476	5,244	5,244	$7,383	$7,323	$8,126	4.9%	5.8%	49.0%
	34 kV: Single-Phase	*$9,351,999*	*$9,351,999*	*$10,757,815*	*1,170*	*1,170*	*$7,995*	*$7,995*	*$9,196*			
	Multi-Phase	*$1,801,500*	*$1,486,844*	*$1,693,410*	*371*	*371*	*$4,850*	*$4,003*	*$4,559*			
	12.2-19.9 kV: Single-Phase	*$9,645,142*	*$9,645,142*	*$11,093,749*	*1,220*	*1,220*	*$7,906*	*$7,906*	*$9,094*			
	Multi-Phase	*$3,600,672*	*$3,600,672*	*$3,279,903*	*590*	*590*	*$6,103*	*$6,103*	*$5,559*			
	<12.2 kV: Single-Phase	*$11,467,729*	*$11,467,729*	*$13,192,307*	*1,427*	*1,427*	*$8,035*	*$8,035*	*$9,243*			
	Multi-Phase	*$2,851,251*	*$2,851,251*	*$2,597,293*	*466*	*466*	*$6,118*	*$6,118*	*$5,573*			
	Mid-Cycle (34 kV)	$264,321	$264,321	$248,462	371	371	$712	$712	$669			
	Brush	$569,335	$854,003	$987,724								
	34 kV: Single-Phase	*$134,848*	*$202,272*	*$232,774*	*1,170*	*1,170*	*$115*	*$173*	*$199*			
	Multi-Phase	*$34,249*	*$51,373*	*$60,426*	*371*	*371*	*$92*	*$138*	*$163*			
	12.2-19.9 kV: Single-Phase	*$137,868*	*$206,802*	*$237,989*	*1,220*	*1,220*	*$113*	*$170*	*$195*			
	Multi-Phase	*$53,469*	*$80,204*	*$94,303*	*590*	*590*	*$91*	*$136*	*$160*			
	<12.2 kV: Single-Phase	*$166,035*	*$249,053*	*$286,608*	*1,427*	*1,427*	*$116*	*$175*	*$201*			
	Multi-Phase	*$42,865*	*$64,298*	*$75,624*	*466*	*466*	*$92*	*$138*	*$162*			
	Hazard Removal (5yr)	$351,152	$351,152	$381,066								
	Service Pruning	$670,000	$670,000	$670,000								
Un-Scheduled	Hot-Spot	$3,500,000	$3,500,000	$3,500,000								
Staff	Work Planner Resources	$1,200,000	$1,200,000	$1,200,000								
Total VM Program Costs (w/o CPI):		**$45,273,101**	**$45,243,114**	**$49,601,728**								

Appendix B
NYSEG Cash Flows for ECI Recommended Cycle

Rate Year Projection with Inflation (or CPI)

Option 1. Annual Cost Estimates by Rate Year with Inflation and 18-month Ramp-up.

	1st Cycle - Reclearing				2nd Cycle				
	Apr. 2016 – Mar. 2017	Apr. 2017 – Mar. 2018	Apr. 2018 – Mar. 2019	Apr. 2019 – Mar. 2020	Apr. 2020 – Mar. 2021	Apr. 2021 – Mar. 2022	Apr. 2022 – Mar. 2023	Apr. 2023 – Mar. 2024	Apr. 2024 – Mar. 2025
NYSEG Estimated Budget Requirement	$39,948,046	$67,045,295	$74,985,399	$68,070,280	$49,204,642	$50,130,051	$51,055,460	$51,980,866	$52,906,268
	Average Reclearing: $62,512,255				Average 2nd Cycle: $51,055,457				

Rate Year Projection without Inflation

Option 1. Annual Cost Estimates by Rate Year without Inflation.

	1st Cycle - Reclearing				2nd Cycle				
	Apr. 2016 – Mar. 2017	Apr. 2017 – Mar. 2018	Apr. 2018 – Mar. 2019	Apr. 2019 – Mar. 2020	Apr. 2020 – Mar. 2021	Apr. 2021 – Mar. 2022	Apr. 2022 – Mar. 2023	Apr. 2023 – Mar. 2024	Apr. 2024 – Mar. 2025
NYSEG Estimated Budget Requirement	$38,758,136	$63,602,448	$69,780,651	$62,127,761	$44,066,995	$44,066,995	$44,066,995	$44,066,995	$44,066,995
	Average Reclearing: $58,567,249				Average 2nd Cycle: $44,066,995				

NYSEG VM Monthly Cash Flow (Correction for CPI)

Reclamation Cycle 4yr w/ Mid-Cycle (34kV), 5yr (12.5-19.9 kV), 5yr (<12.5 kV); Second Cycle 4yr w/ Mid-Cycle (34kV), 4yr (12.5-19.9 kV) on 3-Phase, 5yr (12.5-19.9 kV) on 1-Phase, 5yr (<12.5 kV)

	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Total
Scheduled Maintenance Dollars	$1,612,903	$1,612,903	$1,774,194	$2,323,725	$2,458,243	$2,761,652	$2,679,107	$3,276,307	$3,168,820	$3,346,230	$3,187,205	$3,700,109	$31,901,398
Total Crews:	83	83	83	109	117	126	134	143	151	160	168	177	128 avg
Contract Work Planners	$0	$0	$0	$6,979	$13,699	$21,546	$26,093	$37,548	$41,132	$47,981	$49,576	$61,643	$306,197
Total Planners:	0.0	0.0	0.0	0.8	1.7	2.7	3.2	4.6	5.1	5.9	6.1	7.6	3.1 avg
Total Budget:	$1,612,903	$1,612,903	$1,774,194	$2,330,704	$2,471,942	$2,783,198	$2,705,200	$3,313,855	$3,209,952	$3,394,211	$3,236,781	$3,761,752	$32,207,595
Circuit Miles:	173	173	191	204	225	258	254	315	308	329	316	370	3,116
Mid-Cycle Miles:	0	0	0	2	5	7	9	12	14	16	16	20	101

	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Total
Scheduled Maintenance Dollars	$3,981,578	$3,766,329	$4,759,817	$4,095,971	$4,934,054	$5,125,404	$4,832,495	$5,757,945	$5,179,946	$6,321,406	$5,459,396	$5,746,732	$59,961,073
Total Crews:	185	194	202	211	219	228	236	245	253	281	281	281	235 avg
Contract Work Planners	$70,331	$69,962	$92,434	$82,688	$103,132	$110,519	$107,152	$130,969	$120,566	$135,498	$117,021	$123,180	$1,263,452
Total Planners:	8.5	8.4	11.1	9.9	12.4	13.3	13	14	14	15	15	15	12.4 avg
2014 Budget:	$4,051,909	$3,836,291	$4,852,251	$4,178,659	$5,037,186	$5,235,923	$4,939,647	$5,888,914	$5,300,512	$6,456,904	$5,576,417	$5,869,912	$61,224,525
Circuit Miles:	391	373	474	410	497	519	491	588	531	659	569	599	6,101
Mid-Cycle Miles:	23	22	30	27	33	35	34	42	39	52	45	47	429

	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Total
Scheduled Maintenance Dollars	$6,448,027	$5,568,751	$6,154,935	$6,112,327	$6,403,390	$6,112,327	$6,112,327	$6,694,453	$5,530,200	$6,694,453	$5,530,200	$5,821,264	$73,182,654
Total Crews:	280	281	281	279	279	279	279	279	279	279	279	279	279 avg
Contract Work Planners	$138,213	$119,365	$131,930	$131,068	$137,309	$131,068	$131,068	$143,550	$118,585	$143,550	$118,585	$124,826	$1,569,117
Total Planners:	15	15	15	15	15	15	15	15	15	15	15	15	14.7 avg
2015 Budget:	$6,586,240	$5,688,116	$6,286,865	$6,243,395	$6,540,699	$6,243,395	$6,243,395	$6,838,003	$5,648,785	$6,838,003	$5,648,785	$5,946,090	$74,751,771
Circuit Miles:	659	569	629	625	655	625	625	684	565	684	565	595	7,480
Mid-Cycle Miles:	52	45	50	49	52	49	49	54	45	54	45	47	591

	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Total
Scheduled Maintenance Dollars	$6,529,134	$5,638,798	$6,232,356	$5,512,135	$5,774,618	$5,249,653	$5,774,618	$5,774,618	$5,249,653	$6,037,101	$4,724,687	$5,512,135	$68,009,506
Total Crews:	279	279	279	247	247	247	247	247	247	247	247	247	255 avg
Contract Work Planners	$140,005	$120,914	$133,642	$133,207	$139,550	$126,864	$139,550	$139,550	$126,864	$145,894	$114,178	$133,207	$1,593,425
Total Planners:	15	15	15	15	15	15	15	15	15	15	15	15	14.7 avg
2016 Budget:	$6,669,139	$5,759,712	$6,365,998	$5,645,342	$5,914,168	$5,376,517	$5,914,168	$5,914,168	$5,376,517	$6,182,995	$4,838,865	$5,645,342	$69,602,931
Circuit Miles:	766	662	731	638	669	608	669	669	608	699	547	638	7,904
Mid-Cycle Miles:	52	45	49	49	52	47	52	52	47	54	42	49	590

	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Total
Scheduled Maintenance Dollars	$5,885,831	$5,083,218	$5,885,831	$3,986,016	$3,796,206	$4,175,826	$4,175,826	$3,986,016	$3,986,016	$4,175,826	$3,416,585	$4,175,824	$52,729,021
Total Crews:	247	247	247	175	175	175	175	175	175	175	175	175	193 avg
Contract Work Planners	$142,238	$122,842	$142,238	$111,583	$106,269	$116,896	$116,896	$111,583	$111,583	$116,896	$95,642	$116,896	$1,411,562
Total Planners:	15	15	15	12	12	12	12	12	12	12	12	12	12.7 avg
2017 Budget:	$6,028,069	$5,206,060	$6,028,069	$4,097,599	$3,902,475	$4,292,722	$4,292,722	$4,097,599	$4,097,599	$4,292,722	$3,512,227	$4,292,720	$54,140,583
Circuit Miles:	831	718	831	548	522	574	574	548	548	574	470	574	7,312
Mid-Cycle Miles:	64	56	64	39	37	41	41	39	39	41	33	41	535

	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Total
Scheduled Maintenance Dollars	$3,867,935	$3,674,538	$4,448,125	$4,061,332	$3,867,935	$4,254,729	$4,061,332	$4,254,729	$4,061,332	$4,061,332	$3,674,538	$4,254,727	$48,542,584
Total Crews:	175	175	175	175	175	175	175	175	175	175	175	175	175 avg
Contract Work Planners	$108,277	$102,863	$124,519	$113,691	$108,277	$119,105	$113,691	$119,105	$113,691	$113,691	$102,863	$119,105	$1,358,878
Total Planners:	12	12	12	12	12	12	12	12	12	12	12	12	12.0 avg
2017 Budget:	$3,976,212	$3,777,401	$4,572,644	$4,175,023	$3,976,212	$4,373,834	$4,175,023	$4,373,834	$4,175,023	$4,175,023	$3,777,401	$4,373,832	$49,901,462
Circuit Miles:	522	496	600	548	522	574	548	574	548	548	496	574	6,550
Mid-Cycle Miles:	37	35	43	39	37	41	39	41	39	39	35	41	466

	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Total
Scheduled Maintenance Dollars	$3,939,665	$3,742,682	$4,530,615										$12,212,962
Total Crews:	175	175	175										175 avg
Contract Work Planners	$110,285	$104,771	$126,828										$341,884
Total Planners:	12	12	12										12.0 avg
2017 Budget:	$4,049,950	$3,847,453	$4,657,443										$12,554,846
Circuit Miles:	522	496	600										1,618
Mid-Cycle Miles:	37	35	43										115
Total:													$354,383,713
Total Circuit Miles:													40,081
Total Mid-Cycle Miles:													2,827

Average Annual Budget:	$59,063,952
Average Annual Circuit Miles:	6,680
Average Annual Mid-Cycle Miles:	471

Notes: Cash flow is based on work days per month.
*2nd Cycle will begin 1 year earlier giving credit for miles completed to date.

NYSEG VM Monthly Cash Flow (Correction for CPI)

Reclamation Cycle 4yr w/ Mid-Cycle (34kV), 5yr (12.5-19.9 kV), 5yr (<12.5 kV); Second Cycle 4yr w/ Mid-Cycle (34kV), 4yr (12.5-19.9 kV) on 3-Phase, 5yr (12.5-19.9 kV) on 1-Phase, 5yr (<12.5 kV)

	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Total
Scheduled Maintenance Dollars	$1,612,903	$1,612,903	$1,774,194	$2,233,921	$2,407,682	$2,704,850	$2,624,003	$3,208,920	$3,103,644	$3,277,404	$3,121,651	$3,624,005	$31,306,080
Total Crews:	83	83	83	109	117	126	134	143	151	160	168	177	128 avg
Contract Work Planners	$0	$0	$0	$6,709	$13,418	$21,103	$25,556	$36,776	$40,286	$46,994	$48,556	$60,376	$299,774
Total Planners:	0.0	0.0	0.0	0.8	1.7	2.7	3.2	4.6	5.1	5.9	6.1	7.6	3.1 avg
Total Budget:	$1,612,903	$1,612,903	$1,774,194	$2,240,630	$2,421,100	$2,725,953	$2,649,559	$3,245,696	$3,143,930	$3,324,398	$3,170,207	$3,684,381	$31,605,854
Circuit Miles:	173	173	191	204	225	258	254	315	308	329	316	370	3,116
Mid-Cycle Miles:	0	0	0	2	5	7	9	12	14	16	16	20	101

	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Total
Scheduled Maintenance Dollars	$3,797,767	$3,592,455	$4,540,077	$3,906,878	$4,706,270	$4,888,787	$4,609,400	$5,492,126	$4,940,811	$6,029,575	$5,207,360	$5,481,431	$57,192,937
Total Crews:	185	194	202	211	219	228	236	245	253	281	281	281	235 avg
Contract Work Planners	$67,084	$66,732	$88,167	$78,871	$98,371	$105,417	$102,205	$124,922	$115,000	$129,243	$111,619	$117,494	$1,205,125
Total Planners:	8.5	8.4	11.1	9.9	12.4	13.3	13	14	14	15	15	15	12.4 avg
2014 Budget:	$3,864,851	$3,659,187	$4,628,244	$3,985,749	$4,804,641	$4,994,204	$4,711,605	$5,617,048	$5,055,811	$6,158,818	$5,318,979	$5,598,925	$58,398,062
Circuit Miles:	391	373	474	410	497	519	491	588	531	659	569	599	6,101
Mid-Cycle Miles:	23	22	30	27	33	35	34	42	39	52	45	47	429

	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Total
Scheduled Maintenance Dollars	$6,029,575	$5,207,360	$5,755,503	$5,715,660	$5,987,834	$5,715,660	$5,715,660	$6,260,008	$5,171,311	$6,260,008	$5,171,311	$5,443,487	$68,433,377
Total Crews:	280	281	281	279	279	279	279	279	279	279	279	279	279 avg
Contract Work Planners	$129,243	$111,619	$123,368	$122,562	$128,398	$122,562	$122,562	$134,235	$110,889	$134,235	$110,889	$116,726	$1,467,288
Total Planners:	15	15	15	15	15	15	15	15	15	15	15	15	14.7 avg
2015 Budget:	$6,158,818	$5,318,979	$5,878,871	$5,838,222	$6,116,232	$5,838,222	$5,838,222	$6,394,243	$5,282,200	$6,394,243	$5,282,200	$5,560,213	$69,900,665
Circuit Miles:	659	569	629	625	655	625	625	684	565	684	565	595	7,480
Mid-Cycle Miles:	52	45	50	49	52	49	49	54	45	54	45	47	591

	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Total
Scheduled Maintenance Dollars	$5,987,834	$5,171,311	$5,715,660	$5,055,150	$5,295,871	$4,814,428	$5,295,871	$5,295,871	$4,814,428	$5,536,593	$4,332,986	$5,055,150	$62,371,153
Total Crews:	279	279	279	247	247	247	247	247	247	247	247	247	255 avg
Contract Work Planners	$128,398	$110,889	$122,562	$122,164	$127,981	$116,346	$127,981	$127,981	$116,346	$133,798	$104,712	$122,164	$1,461,322
Total Planners:	15	15	15	15	15	15	15	15	15	15	15	15	14.7 avg
2016 Budget:	$6,116,232	$5,282,200	$5,838,222	$5,177,314	$5,423,852	$4,930,774	$5,423,852	$5,423,852	$4,930,774	$5,670,391	$4,437,698	$5,177,314	$63,832,475
Circuit Miles:	766	662	731	638	669	608	669	669	608	699	547	638	7,904
Mid-Cycle Miles:	52	45	49	49	52	47	52	52	47	54	42	49	590

	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Total
Scheduled Maintenance Dollars	$5,295,871	$4,573,707	$5,295,871	$3,586,482	$3,415,697	$3,757,267	$3,757,267	$3,586,482	$3,586,482	$3,757,267	$3,074,127	$3,757,265	$47,443,785
Total Crews:	247	247	247	175	175	175	175	175	175	175	175	175	193 avg
Contract Work Planners	$127,981	$110,529	$127,981	$100,398	$95,618	$105,179	$105,179	$100,398	$100,398	$105,179	$86,056	$105,179	$1,270,075
Total Planners:	15	15	15	12	12	12	12	12	12	12	12	12	12.7 avg
2017 Budget:	$5,423,852	$4,684,236	$5,423,852	$3,686,880	$3,511,315	$3,862,446	$3,862,446	$3,686,880	$3,686,880	$3,862,446	$3,160,183	$3,862,444	$48,713,860
Circuit Miles:	831	718	831	548	522	574	574	548	548	574	470	574	7,312
Mid-Cycle Miles:	64	56	64	39	37	41	41	39	39	41	33	41	535

	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Total
Scheduled Maintenance Dollars	$3,415,697	$3,244,912	$3,928,051	$3,586,482	$3,415,697	$3,757,267	$3,586,482	$3,757,267	$3,586,482	$3,586,482	$3,244,912	$3,757,265	$42,866,996
Total Crews:	175	175	175	175	175	175	175	175	175	175	175	175	175 avg
Contract Work Planners	$95,618	$90,837	$109,960	$100,398	$95,618	$105,179	$100,398	$105,179	$100,398	$100,398	$90,837	$105,179	$1,199,999
Total Planners:	12	12	12	12	12	12	12	12	12	12	12	12	12.0 avg
2017 Budget:	$3,511,315	$3,335,749	$4,038,011	$3,686,880	$3,511,315	$3,862,446	$3,686,880	$3,862,446	$3,686,880	$3,686,880	$3,335,749	$3,862,444	$44,066,995
Circuit Miles:	522	496	600	548	522	574	548	574	548	548	496	574	6,550
Mid-Cycle Miles:	37	35	43	39	37	41	39	41	39	39	35	41	466

	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Total
Scheduled Maintenance Dollars	$3,415,697	$3,244,912	$3,928,051										$10,588,660
Total Crews:	175	175	175										175 avg
Contract Work Planners	$95,618	$90,837	$109,960										$296,415
Total Planners:	12	12	12										12.0 avg
2017 Budget:	$3,511,315	$3,335,749	$4,038,011										$10,885,075
Circuit Miles:	522	496	600										1,618
Mid-Cycle Miles:	37	35	43										115
Total:													$327,402,986
Total Circuit Miles:													40,081
Total Mid-Cycle Miles:													2,827

Average Annual Budget:	$54,567,164
Average Annual Circuit Miles:	6,680
Average Annual Mid-Cycle Miles:	471

Notes: Cash flow is based on work days per month.
*2nd Cycle will begin 1 year earlier giving credit for miles completed to date.

Appendix C

Modified Clearance Specifications

2015 Modified Specifications for Single Phase Lines Only

(Only the changes in red are to be used for the modified specifications, all other work is to be performed to the original specifications)

1) **Primary and Neutral Wire - Pruning**
   a. A minimum of (6) six feet of side clearance or a minimum of (5) five years of clearance to the side of conductors, at time of pruning.

   b. Minimum of (5) feet or five (5) years of clearance for overhead clearing. Branches extending over conductors shall have enough clearance to swing/hinge if broken without touching conductors (i.e. under snow and ice load).

   c. Clearances do not change with different voltage or conductor type.

   d. Dead limbs, diseased, or structurally unsound limbs that could present a hazard to the line (overhanging or adjacent) will be removed even if they are outside of the zone to be cleared.

   e. The intent is not to allow encroachment of the existing Rights-of-Way (ROW) in situations where the ROW is wider than the current distribution specifications; Company specifications requires full ROW width to be maintained.

2) **Secondary Wire**
   a. The CONTRACTOR, with prior COMPANY approval, shall prune secondary and service drops if strain or abrasion is present from surrounding vegetation.
      i. Trimming of secondary wires will be paid by unit price separate from contract if not parallel or under built with primary wires

3) **Ground Cutting**
   a. COMPANY requires ground cutting of all capable tree species that will grow into the conductors within five (5) years within a minimum of (10) ten feet from center line.

   b. 100% of the capable vegetation species that must be removed shall be cut at ground level Stumps shall be cut as level with the ground as possible and not exceed 2-4 inches in height

4) **Removals**
   a. Company requires CONTRACTOR to remove or cut to safe height, on ROW hazard trees that pose a threat to overhead conductors.

   b. The CONTRACTOR shall remove identified Off ROW hazardous vegetation (overhanging dead limbs, brush) and/or cut to a safe height with prior COMPANY approval. CONTRACTOR shall notify COMPANY of hazardous trees identified while working immediately. The completed tree work will be paid using unit rates or T&M rates and should be completed during routine contract work

   c. When a tree is removed, the stump will not exceed (2-4) two to four inches in height

   d. Large, sturdy trees (greater than twelve (12) inches DBH) that do not pose a hazard or threat to reliability may remain within the ROW provided side and overhead limbs have been removed to obtain 5 years clearance or a minimum of five (5) feet over overhead and six (6) feet of side clearance and allow adequate maintenance.

i) Retention of such trees shall be kept at a minimum.

e. All trees within the right of way twelve (12) inches DBH and smaller shall be removed. Trees larger than twelve (12) inches DBH may be removed with COMPANY approval to be paid at T&M or unit rates.

f. Yard Tree Removals: Unit Rates shall apply for any actively maintained yard trees that due to species, location or pruning requirements, will interfere with the electrical facilities within a 5 year period from the date of pruning and with a DBH of 18” or greater located in the immediate yard locations of a residential dwelling only during the maintenance of lump sum circuits. Division Forester shall approve all removals prior to work commencing on property.

g. It is the responsibility of the CONTRACTOR to obtain written acknowledgement from the property owner for all removals

RG&E 2015 Vegetation Management Cycle Budget Requirements

January 5, 2015

Introduction

This report represents an analysis of the Rochester Gas & Electric (RG&E) cycle budget requirements prepared by Environmental Consultants, Inc. (ECI). It addresses the total miles for each of the RG&E divisions and identifies the budget requirements needed to sustain the current average five-year vegetation maintenance cycle.

I. RG&E Data

Rochester Gas & Electric is comprised of four divisions totaling approximately 5,208 miles. Table 1 presents the divisions with their associated miles.

Table 1. OH Line Miles for RG&E by Division and Voltage Class.

	Canandaigua	Genesee Valley	Lakeshore	Rochester	System
19.9 kV - 3-Ø Miles	0.00	122.95	0.00	0.07	123.02
19.9 kV 1-Ø Miles	0.00	469.34	0.00	0.00	469.34
11.0-19.9 kV 3-Ø Miles	410.90	22.96	374.66	712.29	1,520.81
11.0-19.9 kV 1-Ø Miles	271.93	74.51	526.93	463.52	1,336.89
<11.0 kV 3-Ø Miles	50.11	176.67	159.08	446.58	832.44
<11.0 kV 1-Ø Miles	18.42	229.94	90.86	586.63	925.85
Total Miles	**751.36**	**1,096.37**	**1,151.53**	**2,209.09**	**5,208.35**

Through the end of 2014, RG&E has completed four of the five-year equivalent cycle miles. RG&E has increased budgets over the last several years in order to meet the cycle requirements (see Table 2).

Table 2. RG&E Vegetation Management Expenditures.

Description	2011	2012	2013	2014	2015 Projected
Cycle work - Lump sum and incidental work not included in the bid	$3,581,737	$4,607,032	$5,347,304	$5,333,419	$5,785,998
Hot Spot	$3,436,405	$2,184,614	$1,404,618	$1,271,644	$814,002
Reliability project	$3,379,901				
TOTAL	**$10,398,044**	**$6,791,646**	**$6,751,922**	**$6,605,063**	**$6,600,000**

Due to cost increases however, the execution of the five-year cycle within the allotted budget has necessitated the deferral of some tree removals to control costs as well as a reduction in clearances at the time of pruning on some line sections. The cost increases limiting the long-term effectiveness of the cycle program include: inflation not accounted for in the original flat budget spread, vendor cost increases, and higher tree densities on 4.16 kV rear-lot single-phase laterals. Table 3 presents the 2015 miles and lump sum costs showing the contractor bid prices in 2015 far exceeds the $6.6 million in approved funding.

Table 3. RG&E 2015 Lump Sum Submitted Bid Prices.

	Miles	Lump Sum Cost	Cost/Mile
Canandaigua	89.15	$304,240	$3,413
Genesee Valley	219.75	$701,760	$3,193
Lakeshore	256.84	$635,995	$2,476
Rochester	609.96	$5,720,634	$9,379
Total	**1,175.70**	**$7,362,629**	**$6,262**

II. RG&E Budget Requirements

ECI has reviewed the 2015 bid submissions and historical expenditures and agrees that an additional $0.916 million (in 2015 dollars and does not include inflation) or $1.472 million (average five-year annual with inflation) over the base $6.6 million is required to complete the plan. Historical circuit expenditures using the last maintenance costs brought up to 2015 dollars along with the 2015 circuit bid costs suggest that an annual budget of $7.516 million (in 2015 dollars without inflation) or $8.072 million (five-year average with inflation) is required to complete the designated five-year cycle.

Tables 4 and 5 present the detailed ECI estimated annual budget breakout for RG&E in 2015 dollars with no inflation. Table 6 presents the annual and monthly cash flows without inflation. Table 7 presents the annual and monthly cash flows including inflation. Table 7 is the “actual” annual dollars required to maintain the 5-year cycle at RG&E assuming a funding implementation date of April 2016. Variations to the actual start date will require a re-calculation of the annual spend requirements due to inflation rates.

Table 4. ECI Estimated Annual Budget Requirements for RG&E Based on Maintenance History to Complete a Five-Year Cycle.

Maint. Type	VM Activity	Annual Budget	Miles	Cost/Mile
Scheduled	Tree Pruning, Removal, & Brush	$5,917,378	1,042	$5,449
	34 kV:	*$0*	*0*	*$0*
	12.2-19.9 kV:	*$3,095,796*	*688.50*	*$4,496*
	<12.2 kV:	*$2,821,582*	*353*	*$7,989*
	Mid-Cycle (34 kV)	$0	0	$0
Un-Scheduled	Hot-Spot	$1,598,325		
Total VM Program Costs:		**$7,515,702**		

Table 5. RG&E Annual Budget Estimate by Division.

VM Activity	Canandaigua	Genesee Valley	Lakeshore	Rochester	RGE Total
Tree Pruning, Removal, & Brush	$555,196	$1,185,701	$849,076	$3,327,405	$5,917,378
34 kV:	*$0*	*$0*	*$0*	*$0*	*$0*
12.2-19.9 kV:	*$490,456*	*$656,280*	*$678,346*	*$1,270,714*	*$3,095,796*
<12.2 kV:	*$64,741*	*$529,421*	*$170,730*	*$2,056,691*	*$2,821,582*
Mid-Cycle (34 kV)	$0	$0	$0	$0	$0
Hot-Spot	$230,575	$336,451	$353,379	$677,920	$1,598,325
	$785,772	**$1,522,152**	**$1,202,454**	**$4,005,325**	**$7,515,702**

Table 6. RG&E Monthly Cash Flows (in 2015 dollars with no inflation).

RGE VM Monthly Cash Flow without CPI

RGE 5-Year Cycle

	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Total
Scheduled Maintenance Dollars	$532,258	$532,258	$585,484	$626,309	$626,309	$656,133	$596,484	$685,957	$626,309	$626,309	$566,660	$626,310	$7,286,780
Total Crews:	20	20	20	22	22	22	22	22	22	22	22	22	22 avg
Contract Work Planners	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Planners:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 avg
Total Budget:	**$532,258**	**$532,258**	**$585,484**	**$626,309**	**$626,309**	**$656,133**	**$596,484**	**$685,957**	**$626,309**	**$626,309**	**$566,660**	**$626,310**	**$7,286,780**
Circuit Miles:	**79**	**79**	**87**	**90**	**90**	**95**	**86**	**99**	**90**	**90**	**82**	**90**	**1,057**
Mid-Cycle Miles:	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Total
Scheduled Maintenance Dollars	$626,309	$566,660	$685,957	$573,487	$664,038	$664,038	$603,671	$694,222	$603,671	$664,038	$573,487	$603,671	$7,523,249
Total Crews:	22	22	22	22	22	22	22	22	22	22	22	22	22 avg
Contract Work Planners	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Planners:	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0.0 avg
2014 Budget:	**$626,309**	**$566,660**	**$685,957**	**$573,487**	**$664,038**	**$664,038**	**$603,671**	**$694,222**	**$603,671**	**$664,038**	**$573,487**	**$603,671**	**$7,523,249**
Circuit Miles:	**90**	**82**	**99**	**83**	**96**	**96**	**87**	**100**	**87**	**96**	**83**	**87**	**1,086**
Mid-Cycle Miles:	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Total
Scheduled Maintenance Dollars	$664,038	$573,487	$633,854	$628,804	$658,747	$628,804	$628,804	$688,690	$568,918	$688,690	$568,918	$598,858	$7,530,612
Total Crews:	21	22	22	22	22	22	22	22	22	22	22	22	22 avg
Contract Work Planners	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Planners:	0	0	0	0	0	0	0	0	0	0	0	0	0.0 avg
2015 Budget:	**$664,038**	**$573,487**	**$633,854**	**$628,804**	**$658,747**	**$628,804**	**$628,804**	**$688,690**	**$568,918**	**$688,690**	**$568,918**	**$598,858**	**$7,530,612**
Circuit Miles:	**96**	**83**	**92**	**91**	**95**	**91**	**91**	**100**	**82**	**100**	**82**	**87**	**1,090**
Mid-Cycle Miles:	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Total
Scheduled Maintenance Dollars	$658,747	$568,918	$628,804	$626,309	$656,133	$596,484	$656,133	$656,133	$596,484	$685,957	$536,836	$626,307	$7,493,245
Total Crews:	22	22	22	22	22	22	22	22	22	22	22	22	22 avg
Contract Work Planners	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Planners:	0	0	0	0	0	0	0	0	0	0	0	0	0.0 avg
2016 Budget:	**$658,747**	**$568,918**	**$628,804**	**$626,309**	**$656,133**	**$596,484**	**$656,133**	**$656,133**	**$596,484**	**$685,957**	**$536,836**	**$626,307**	**$7,493,245**
Circuit Miles:	**95**	**82**	**91**	**90**	**95**	**86**	**95**	**95**	**86**	**99**	**78**	**90**	**1,082**
Mid-Cycle Miles:	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Total
Scheduled Maintenance Dollars	$656,133	$566,660	$656,133	$628,804	$598,861	$658,747	$658,747	$628,804	$628,804	$658,747	$538,975	$658,748	$7,538,163
Total Crews:	22	22	22	22	22	22	22	22	22	22	22	22	22 avg
Contract Work Planners	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Planners:	0	0	0	0	0	0	0	0	0	0	0	0	0.0 avg
2017 Budget:	**$656,133**	**$566,660**	**$656,133**	**$628,804**	**$598,861**	**$658,747**	**$658,747**	**$628,804**	**$628,804**	**$658,747**	**$538,975**	**$658,748**	**$7,538,163**
Circuit Miles:	**95**	**82**	**95**	**91**	**87**	**95**	**95**	**91**	**91**	**95**	**78**	**95**	**1,090**
Mid-Cycle Miles:	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Total
Scheduled Maintenance Dollars	$598,861	$568,918	$688,690	$628,804	$598,861	$658,747	$628,804	$658,747	$628,804	$628,804	$568,918	$658,747	$7,515,705
Total Crews:	22	22	22	22	22	22	22	22	22	22	22	22	22 avg
Contract Work Planners	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Planners:	0	0	0	0	0	0	0	0	0	0	0	0	0.0 avg
2017 Budget:	**$598,861**	**$568,918**	**$688,690**	**$628,804**	**$598,861**	**$658,747**	**$628,804**	**$658,747**	**$628,804**	**$628,804**	**$568,918**	**$658,747**	**$7,515,705**
Circuit Miles:	**87**	**82**	**100**	**91**	**87**	**95**	**91**	**95**	**91**	**91**	**82**	**95**	**1,087**
Mid-Cycle Miles:	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Total
Scheduled Maintenance Dollars	$598,861	$568,918	$688,690										$1,856,469
Total Crews:	22	22	22										22 avg
Contract Work Planners	$0	$0	$0										$0
Total Planners:	0	0	0										0.0 avg
2017 Budget:	**$598,861**	**$568,918**	**$688,690**										**$1,856,469**
Circuit Miles:	**87**	**82**	**100**										**269**
Mid-Cycle Miles:	**0**	**0**	**0**										**0**
Total Cycle Budget:													**$46,744,223**
Total Cycle Circuit Miles:													**6,761**
Total Cycle Mid-Cycle Miles:													**0**

Average Annual Budget:	**$7,790,704**
Average Annual Circuit Miles:	**1,127**
Average Annual Mid-Cycle Miles:	**0**

Notes: Cash flow is based on work days per month.
*2nd Cycle will begin 1 year earlier giving credit for miles completed to date.

Table 7. RG&E Monthly Cash Flows (with inflation, assuming April 2016 implementation).

RGE VM Monthly Cash Flow with CPI

RGE 5-Year Cycle

	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Total
Scheduled Maintenance Dollars	$532,258	$532,258	$585,484	$651,486	$639,461	$669,912	$609,011	$700,362	$639,461	$639,461	$578,560	$639,461	$7,417,175
Total Crews:	20	20	20	22	22	22	22	22	22	22	22	22	22 avg
Contract Work Planners	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Planners:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 avg
Total Budget:	$532,258	$532,258	$585,484	$651,486	$639,461	$669,912	$609,011	$700,362	$639,461	$639,461	$578,560	$639,461	$7,417,175
Circuit Miles:	79	79	87	90	90	95	86	99	90	90	82	90	1,057
Mid-Cycle Miles:	0	0	0	0	0	0	0	0	0	0	0	0	0

	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Total
Scheduled Maintenance Dollars	$656,622	$594,086	$719,157	$601,244	$696,177	$696,177	$632,889	$727,822	$632,889	$696,177	$601,244	$632,890	$7,887,374
Total Crews:	22	22	22	22	22	22	22	22	22	22	22	22	22 avg
Contract Work Planners	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Planners:	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0.0 avg
2014 Budget:	$656,622	$594,086	$719,157	$601,244	$696,177	$696,177	$632,889	$727,822	$632,889	$696,177	$601,244	$632,890	$7,887,374
Circuit Miles:	90	82	99	83	96	96	87	100	87	96	83	87	1,086
Mid-Cycle Miles:	0	0	0	0	0	0	0	0	0	0	0	0	0

	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Total
Scheduled Maintenance Dollars	$710,122	$613,287	$677,844	$672,443	$704,464	$672,443	$672,443	$736,485	$608,401	$736,485	$608,401	$640,421	$8,053,239
Total Crews:	21	22	22	22	22	22	22	22	22	22	22	22	22 avg
Contract Work Planners	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Planners:	0	0	0	0	0	0	0	0	0	0	0	0	0.0 avg
2015 Budget:	$710,122	$613,287	$677,844	$672,443	$704,464	$672,443	$672,443	$736,485	$608,401	$736,485	$608,401	$640,421	$8,053,239
Circuit Miles:	96	83	92	91	95	91	91	100	82	100	82	87	1,090
Mid-Cycle Miles:	0	0	0	0	0	0	0	0	0	0	0	0	0

	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Total
Scheduled Maintenance Dollars	$718,298	$620,348	$685,648	$682,927	$715,447	$650,407	$715,447	$715,447	$650,407	$747,968	$585,366	$682,925	$8,170,635
Total Crews:	22	22	22	22	22	22	22	22	22	22	22	22	22 avg
Contract Work Planners	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Planners:	0	0	0	0	0	0	0	0	0	0	0	0	0.0 avg
2016 Budget:	$718,298	$620,348	$685,648	$682,927	$715,447	$650,407	$715,447	$715,447	$650,407	$747,968	$585,366	$682,925	$8,170,635
Circuit Miles:	95	82	91	90	95	86	95	95	86	99	78	90	1,082
Mid-Cycle Miles:	0	0	0	0	0	0	0	0	0	0	0	0	0

	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Total
Scheduled Maintenance Dollars	$729,226	$629,786	$729,226	$698,853	$665,574	$732,131	$732,131	$698,853	$698,853	$732,131	$599,017	$732,130	$8,377,911
Total Crews:	22	22	22	22	22	22	22	22	22	22	22	22	22 avg
Contract Work Planners	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Planners:	0	0	0	0	0	0	0	0	0	0	0	0	0.0 avg
2017 Budget:	$729,226	$629,786	$729,226	$698,853	$665,574	$732,131	$732,131	$698,853	$698,853	$732,131	$599,017	$732,130	$8,377,911
Circuit Miles:	95	82	95	91	87	95	95	91	91	95	78	95	1,090
Mid-Cycle Miles:	0	0	0	0	0	0	0	0	0	0	0	0	0

	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Total
Scheduled Maintenance Dollars	$678,150	$644,242	$779,872	$712,057	$678,150	$745,965	$712,057	$745,965	$712,057	$712,057	$644,242	$745,968	$8,510,782
Total Crews:	22	22	22	22	22	22	22	22	22	22	22	22	22 avg
Contract Work Planners	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Planners:	0	0	0	0	0	0	0	0	0	0	0	0	0.0 avg
2017 Budget:	$678,150	$644,242	$779,872	$712,057	$678,150	$745,965	$712,057	$745,965	$712,057	$712,057	$644,242	$745,968	$8,510,782
Circuit Miles:	87	82	100	91	87	95	91	95	91	91	82	95	1,087
Mid-Cycle Miles:	0	0	0	0	0	0	0	0	0	0	0	0	0

	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Total
Scheduled Maintenance Dollars	$690,726	$656,190	$794,335										$2,141,251
Total Crews:	22	22	22										22 avg
Contract Work Planners	$0	$0	$0										$0
Total Planners:	0	0	0										0.0 avg
2017 Budget:	$690,726	$656,190	$794,335										$2,141,251
Circuit Miles:	87	82	100										269
Mid-Cycle Miles:	0	0	0										0
Total Cycle Budget:													$50,558,367
Total Cycle Circuit Miles:													6,761
Total Cycle Mid-Cycle Miles:													0

Average Annual Budget:	$8,426,395
Average Annual Circuit Miles:	1,127
Average Annual Mid-Cycle Miles:	0

Notes: Cash flow is based on work days per month.
*2nd Cycle will begin 1 year earlier giving credit for miles completed to date.

III. Conclusion

RG&E is committed to continual improvement as it moves toward the completion of its first five-year cycle. ECI recommends an annual budget for RG&E by calendar year as indicated in Table 7 and summarized here in Table 8 by rate year. Note that the budget requirements assume an April 2016 implementation date and variations will require a recalculation of the budget requirements due to inflation.

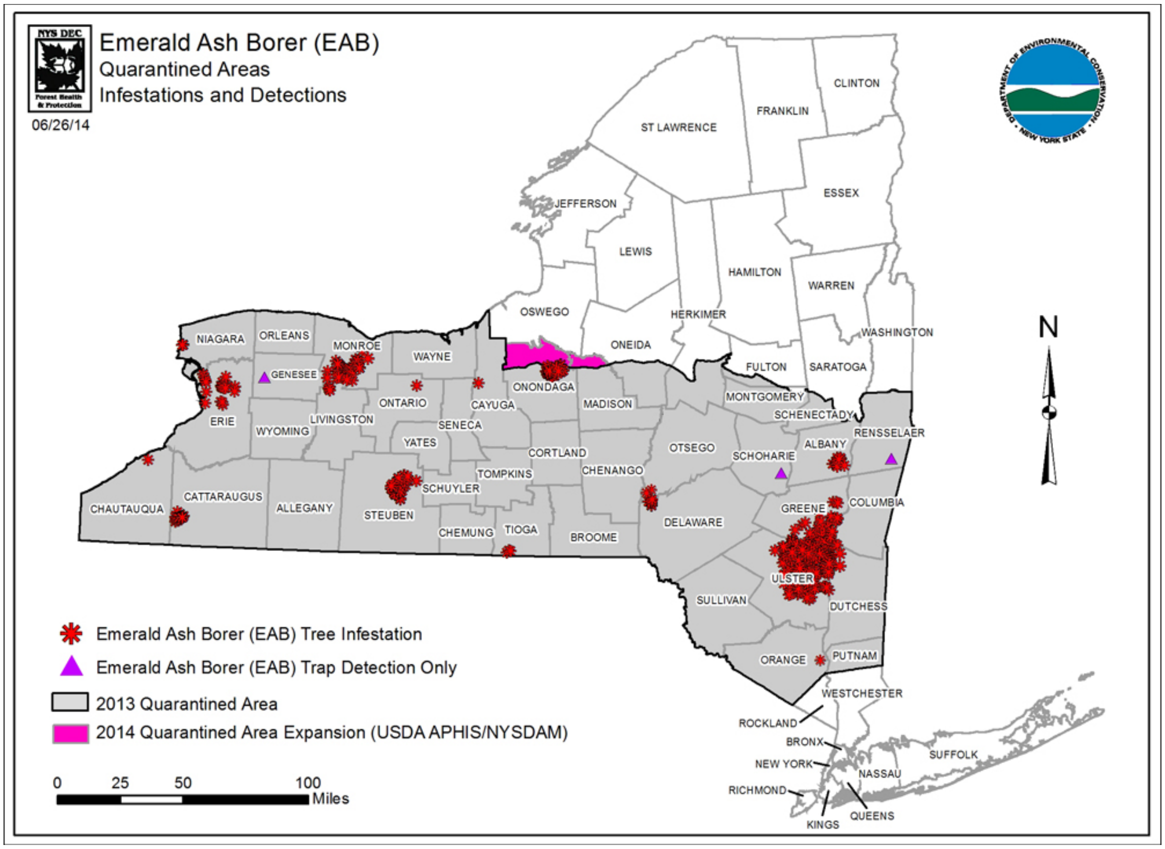
Table 8. RG&E Estimated Rate Year Budget Requirements to Maintain a 5-Year Cycle (includes inflation and assumes an April 2016 implementation date).

	Apr. 2016 – Mar. 2017	**Apr. 2017 – Mar. 2018**	**Apr. 2018 – Mar. 2019**	**Apr. 2019 – Mar. 2020**	**Apr. 2020 – Mar. 2021**	**Apr. 2021 – Mar. 2022**
NYSEG Estimated Budget Requirement	$7,737,040	$7,918,762	$8,076,280	$8,234,579	$8,391,937	$8,549,769

Emerald Ash Borer Mitigation Estimates for NYSEG and RG&E

It is estimated that in New York State's hardwood forests one in every ten trees is an ash (*fraxinus spp.*). Emerald Ash Borer (*Agrilus planipennis* Fairmaire) or EAB poses a significant risk to all of New York's estimated 900 million ash trees[1]. Cornell University estimates that approximately five percent of New York's ash trees are currently infested and urges the public to begin developing action plans now. Since EAB's discovery in July 2009, its existence has been confirmed in 11 counties, including: Cattaraugus, Steuben, Ulster, Monroe, Genesee, Livingston, Greene, Erie, Orange, Albany, Niagara, and Dutchess Counties. Estimating the rate of EAB spread across New York or more specifically the NYSEG and RG&E service territory is difficult. The rate of spread is dependent upon many factors; however, it is known that the largest contributor to the rate of spread is the transportation of infested trees (mainly in the form of firewood and millage) to non-infested areas. As such, EAB models designed to estimate the rate of spread utilize factors such as the number of major highways in and out of infested areas, the number of campgrounds and locations within a state, log mill locations within the state, ash population densities, and several other factors. While quarantines may help to slow the rate of spread, it is certain that these quarantines will not stop the spread.

[1] "History of EAB in New York." *New York State Department of Environmental Conservation*. New York State Department of Environmental Conservation, n.d. Web. 14 Feb. 2015. http://www.dec.ny.gov/animals/74604.html.



Consumers Energy in the state of Michigan has seen substantial increases in outages related to EAB damaged trees. In addition, outage minutes are also increasing due to the catastrophic nature of these outages. Consumers Energy estimates a 150 percent increase in total tree-caused outages due to EAB related tree outages over the next five to seven years. The customer outage impact is estimated to be approximately $18 million per year for the next 10-years in the form of outage restoration costs and lost revenues and effect approximately one million additional customers per year. Consumers Energy estimates that the cost to remove the ash tree threat to be approximately $6 million per year over the same timeframe.

Trees become infested when adult beetles lay eggs on the bark, which hatch into larvae that bore into the tree. The larvae tunnel in the phloem layer (between bark and wood) and disrupt the movement of water and nutrients, eventually killing the tree. Tree mortality can be swift, commonly occurring within one to three years. From an electric utility standpoint, this poses obvious risks to service reliability. Ash trees that succumb to EAB are often subject to mechanical failure at the root plate, resulting in the whole tree hinging over at the base. Mechanical failure of this magnitude can cause severe damage to the utility infrastructure, causing conductors to fail, broken poles, and other hardware damage.

Dead ash trees are extremely hazardous to remove since they cannot be safely climbed. Therefore, quick and decisive action must be taken to remove these trees prior to tree death.

Dead ash trees can also be much more expensive to remove since safety issues generally require higher levels of expertise and alternative removal techniques to effect their removal.

3.1 Estimated Cost

The vegetation workload study conducted by Environmental Consultants, Inc. (ECI) in 2010 estimated that approximately 10.5 percent of the total 2.427 million trees under and immediately adjacent to NYSEG's overhead distribution system were ash species. Approximately 10.9 percent of the total 400,000 trees on the RG&E system were ash species. Therefore, approximately 299,000 ash trees may pose a significant risk to the safety and reliability of the electrical infrastructure. Since the 2010 ECI study did not account for trees outside of the current line corridors, it is estimated that the total ash tree population that must be addressed could easily be double that amount.

With an estimated cost of removal of $450 per tree, initial estimates place the cost of mitigation (including patrol costs) at between $142.57 million and $285.13 million. Table 1 presents the minimum estimated expense by operating company.

Table 1. Minimum Pro-Active Ash Tree Removal Estimates by Operating Company.

OP Company	OH Primary Miles	Total All Species	Est. % Ash Trees	Est. # Ash Trees	Avg. Cost/ Removal	Est. Removal Cost	Patrol Cost/ Mile	Est. Patrol Cost	Total Cost (Removal + Patrol)
RG&E	5,208	400,000	10.9%	44,000	$450	$19,800,000	$228.14	$1,188,000	$20,988,000
NYSEG	29,926	2,427,000	10.5%	255,000	$450	$114,750,000	$228.14	$6,827,000	$121,577,000
Total:	**35,134**	**2,827,000**		**299,000**		**$134,550,000**		**$8,015,000**	**$142,565,000**

The cost of mitigation would be spread over a 10-year period. Removal efforts would initially focus on those areas with the highest concentrations of EAB and those areas with known infestations.

In studies performed recently by ECI, the cost of deferral (the "do nothing approach") in removing ash trees far exceeds the proactive removal costs due to increased removal costs (i.e. dead trees cannot be safely climbed), outages resulting in major equipment damage, and customer dissatisfaction.

INDEX OF WORKPAPERS SUPPORTING DIRECT TESTIMONY OF VEGETATION MANAGEMENT PANEL						
Exhibit Reference	**Description of Exhibit**	**No. of WP**	**Title of Workpaper (or WP) File**	**Content of Workpaper**	**WP Format**	**Trade Secret**
VMP-4	2015 ECI Analysis and Report for NYSEG	5	• NYSEG_OutageReduction_Proj_Rev6	• Worksheets calculate the estimated CI and N reduction associated with each budget scenario based on identified parameters.	.xlsx	Yes
			• NYSEG Ramp Up Table for Alternatives Rev6 - by Rate Period	• Methodology used for calculating inflation (CPI) and monthly cash flows by rate year for the panel recommended funding option.	.xlsx	Yes
			• NYSEG Ramp Up Table for Alternatives Rev6 - Option2	• Methodology used for calculating inflation (CPI) and monthly cash flows by rate year for funding Option 2.	.xlsx	Yes
			• NYSEG Ramp Up Table for Alternatives Rev6 - Option3	• Methodology used for calculating inflation (CPI) and monthly cash flows by rate year for funding Option 3.	.xlsx	Yes
			• NYSEG Ramp Up Table for Alternatives Rev6 - Option4	• Methodology used for calculating inflation (CPI) and monthly cash flows by rate year for funding Option 4.	.xlsx	Yes
VMP-5	2015 ECI Analysis and Report for RG&E	2	• RGE Budget Calculation Alternative	• Worksheet calculations for determining budget requirements.	.xlsx	Yes
			• RGE Ramp Up Table Rev6 - by Rate Period Alternative	• Methodology used for calculating inflation and monthly budget spread.	.xlsx	Yes

INDEX OF WORKPAPERS SUPPORTING DIRECT TESTIMONY OF VEGETATION MANAGEMENT PANEL						
Exhibit Reference	**Description of Exhibit**	**No. of WP**	**Title of Workpaper (or WP) File**	**Content of Workpaper**	**WP Format**	**Trade Secret**
VMP-6	EAB Mitigation Estimates	2	• Iberdrola_A-NYSEG & RGE only	• Tree counts from 2010 workload study by Operating Company.	.xlsx	Yes
			• Iberdrola_B-Total Company	• Species frequency percentages from 2010 workload study.	.xlsx	Yes