**BEFORE THE PUBLIC UTILITY COMMISSION**

**OF OREGON**

**AR 506**

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| In the Matter of a Rulemaking to Amend and Adopt Permanent Rules in OAR 860, Divisions 024 and 028, Regarding Pole Attachment Use and Safety | **THIRD ROUND COMMENTS OF PORTLAND GENERAL ELECTRIC COMPANY** |

## I. INTRODUCTION

Portland General Electric ("PGE") filed two previous rounds of comments in this docket which specifically addressed many aspects of Staff's proposed rules, including the proposed vegetation clearance requirements. Comments of Portland General Electric, AR 506 (May 1, 2006); Second Round of Comments of Portland General Electric, AR 506 (May 25, 2006) ("Second Round"). In those comments, we described the history of Staff's Tree to Power Line Clearance Policy and pointed out the specific ways in which the proposed rules differ from that policy and substantially raise standards for vegetation clearance. We also submitted evidence that the proposed vegetation management rules alone would cost PGE $4-5 million per year in additional costs and questioned the statement in the March 10 Notice of Proposed Rulemaking, AR 506 Phase I, that the proposed rules would have "little overall financial impact on…businesses, industry, and the public."

The July 13, 2006 Notice of Proposed Rulemaking, AR 506 Phase I (July 13 Notice) ignores the evidence provided by PGE and others that the proposed rules will have a substantial fiscal impact upon utilities and their customers. The new Notice states, "…those operators that have been in compliance with state safety statutes and rules, and have been following the Commission's related policies will likely experience minimal cost impacts from the proposed

rules…." This statement has no basis in fact. The proposed rules set a higher standard than the National Electric Safety Code (NESC) and a higher standard than the existing policy. It makes no sense to claim that the application of these heightened standards for vegetation management will result in no cost to those utilities in compliance with the existing rules. The July 13 Notice provides no rationale to explain this remarkable conclusion.

Because the proposed rules presented with the July 13 Notice include a minor modification in the proposed vegetation clearance requirements, we present in these comments a new budget estimate of the cost to PGE for complying with proposed OAR 860-024-0016. *See* Affidavit of David A. Johnson, PGE Senior Forester, attached as Exhibit A; Affidavit of David Van Bossuyt, PGE Manager of Operations Services and OPUC Liason, attached as Exhibit B. This cost will exceed $4.5 million per year. The overall impact of the rule, however, remains the same, as does our reason for opposing it: It imposes a much higher standard for vegetation clearance than previously existed, at a substantial cost to customers and businesses, without a demonstration of an incremental benefit to accompany that change.

## II. VEGETATION CLEARANCE REQUIREMENTS – OAR 860-024-0016

We do not reiterate here all of our previous comments. Instead, we describe the change Staff made from the previous proposed rule and the manner in which that change impacts our cost estimate for complying with Staff's proposed vegetation clearance requirements. We also provide a specific budget estimate of the cost of complying with the proposed rule.

### A. Proposed Rule Change from Eighteen to Six Inches

Staff's Tree to Power Line Clearance Policy has been in place for over twenty years. *See* Exhibit 6, Division 24 Comments of PUC Staff, AR 506 (May 1, 2006). PGE's compliance with this policy is further described in a Stipulation signed by Joe MacArthur on January 5, 1999. *See*

*id.*, Exhibit 11. This policy contains the following clause, which describes a general exception to the minimum clearance rule:

> Intrusion of limited small branches and new tree growth into this minimum clearance area can be tolerated so long as it does not contribute to a safety hazard to a person climbing the tree or cause interference with the conductors.

*Id.* at Exhibit 11 page 6.

Staff's new proposed rule sets a much higher standard than the Tree to Power Line Clearance Policy. Staff's proposed rule OAR 860-024-0016(5)(c)(B), as set forth in the July 13 Notice reads,

> Infrequent intrusion of small new vegetation growth into the minimum clearance area is acceptable provided the vegetation does not come closer than six inches to the conductor.

This proposed rule differs from Staff's previous rule proposal (Draft Rules issued by Staff on May 23, 2006) only in that it uses a standard of six-inches of clearance instead of eighteen-inches. While we appreciate Staff's willingness to compromise on this issue, the proposed rule still represents a much higher standard than Staff's original policy, without any showing of an incremental benefit.

We say it represents a higher standard for two reasons. First, the new policy changes from a "no contact" standard (per Staff's previous interpretation of "no interference," as described in PGE's Second Round Comments at 5-9) to a six-inch standard. Second, and more importantly, the policy changes from "limited small branches and new tree growth" to "infrequent intrusion of small new vegetation growth." In previous comments, we described why this seemingly minor wording change will have enormous financial repercussions. *See id.* at 8-10. We were clear that to maintain this new clearance requirement, PGE would have to move from a two/three year cycle of trimming to a one/two year cycle of trimming. *See id.* We also noted that the proposed change is not necessary to improve reliability, address any known safety

hazard, or protect the public. *See id.* Our conclusions in this respect have not changed based on the difference between the original 18-inch clearance proposal and the new 6-inch clearance proposal.

**B. Fiscal Impact of New Proposed Rule**

Mr. Johnson analyzed the cost of compliance with the new rule and provided budget estimates for PGE related to compliance with both the current policy and the new rule. *See* Exhibit A at ¶ 3-8; *see also* Exhibit B at ¶ 4-5. Mr. Johnson concluded that compliance with the proposed rule will cost PGE an estimated $4.5 million in 2007, over and above what the company would otherwise have spent to comply with the current policy. *See* Exhibit A at ¶ 7. The majority of this increased cost relates to the need to move from a two/three year trimming cycle to a one/two year cycle. *Id.* at ¶ 8-9. PGE will be required to make this cycle change in order to comply with the new, higher rule requirement, while not unduly damaging or risking the survival of the trees. *Id.* at ¶ 9-10.

The proposed policy requires all trees to have at least three-feet of clearance from PGE's distribution lines at all times, five-feet of clearance if the trees are climbable. Infrequently, a few branches on rare trees ("cycle-busters," or those exceptional trees that grow at a rate different from other trees) may intrude closer than three-feet but at no time can they get closer than six inches. This rule basically equates to a strict three-foot clearance rule, where the previous rule allowed limited intrusion into the clearance area, provided it did not cause "interference" (defined by Staff as "contact") with a conductor. *See* Exhibit A at ¶ 9-10. While the change from eighteen-inches to six-inches appears to modify the standard to make it more reasonable, in fact, when coupled with the refusal to return to the existing policy standard allowing "limited small branches and new tree growth," it makes little difference in the cost required for compliance. *Id.* at ¶ 11.

## III. THRESHOLD STANDARD FOR COMPLIANCE

In previous comments, we suggested that the Commission adopt a new rule to guide Staff's assessment of what constitutes an acceptable vegetation management program. Second Round at 11-12. Based on Staff's insistence on having a proposed clearance standard that allows only "infrequent" or "rare" intrusion of trees into the clearance area, the need for a threshold standard is even more important than before.

The proposed rigid standard for vegetation management presupposes that tree-trimming can be done in such a manner to achieve perfect compliance every year. The only exception given from the rule is for cycle-busters. This rule does not take into account the fact that growing seasons vary from year-to-year, as can temperature and water conditions. These factors all affect growth rates, and make it very difficult to assess within a matter of inches how far a tree will grow over a multi-year period. *See* Environmental Consultants, Inc. Report on Scientific Literature, attached as Exhibit C. As Exhibit C demonstrates, PGE will have to trim its trees to the "worst case" for growth—meaning the largest growth cycles—in order to comply with the new standard. A threshold standard for compliance could allow PGE to mitigate some of the harm to trees and the expense involved in achieving compliance with the proposed rules.

## IV. PHASING-IN RULES

Staff has proposed no phase-in process for the new vegetation clearance rules. This means that all utilities will be out of compliance as of the date the rules are enacted. We do not believe this is a reasonable result. We respectfully request that the proposed rules be modified to include a phase-in period to allow each utility's tree trimming program time to bring its service area into compliance with the new, higher standard. We propose that the rules become effective on January 1, 2009. This phase-in period is roughly equivalent to a two-year trimming cycle,

allowing utilities to gradually bring their service territory into compliance with the higher standard without having to double-back over areas that have recently been trimmed.

> **OAR 860-024-0016(8): This rule shall be effective no sooner than January 1, 2009. The effective date may be extended for an individual utility upon agreement by both Staff and the utility.**

We emphasize here that Staff's proposed heightened vegetation management standards are not necessary to rectify any existing safety hazard. A phase-in period would not prolong any dangerous or hazardous condition; it would simply help mitigate the financial burden to utilities and their customers of meeting the higher standard.

## V. CONCLUSION

We have demonstrated in these and other comments that compliance with the heightened vegetation management standards in Staff's proposed rules will cost PGE and its customers an additional $4.5 million per year. This is a significant fiscal impact on just one utility. We hope the Commission will carefully examine the record in this proceeding, and not adopt proposed rules that will impose such substantial costs without any incremental benefits. We also hope the Commission will seriously consider adopting a threshold standard for compliance. The threshold standard would enable Staff to administer the new rules consistently and evaluate utility tree-trimming programs using a fair and unbiased mechanism. Finally, we strongly urge the Commission to consider establishing a phase-in period for any new, higher standards it chooses to adopt.

We appreciate the opportunity to provide these additional comments and look forward to further participation in this rulemaking.

DATED this 22nd day of August, 2006.

Respectfully submitted,

/s/ INARA K. SCOTT

Inara K. Scott, OSB # 01013
Portland General Electric Company
121 SW Salmon Street, 1WTC1301
Portland, OR 97204
(503) 464-7831 (telephone)
(503) 464-2200 (telecopier)
inara.scott@pgn.com

## CERTIFICATE OF SERVICE

I certify that I have caused to be served the foregoing **THIRD ROUND COMMENTS OF PORTLAND GENERAL ELECTRIC** in OPUC Docket No AR 506, by electronic mail, and for the parties who have not waived paper service, by First Class US Mail, postage prepaid and properly addressed, upon each party on the attached service list, pursuant to Oregon Administrative Rule 860-013-0070.

DATED this 22ND day of August, 2006.

/S/ INARA K. SCOTT

Inara K. Scott

AR 506 Service List

MATT COONS
matt.coons@comspanusa.net

JIM DEASON
ATTORNEY AT LAW
521 SW CLAY ST STE 107
PORTLAND OR 97201-5407
jimdeason@comcast.net

SCOTT JOHNSON
CITY OF ASHLAND
90 NORTH MOUNTAIN AVE
ASHLAND OR 97520
johnsons@ashland.or.us

DENISE ESTEP
CENTRAL LINCOLN PUD
PO BOX 1126
NEWPORT OR 97365
destep@cencoast.com

MICHAEL L WILSON
INTERIM GENERAL MANAGER
CENTRAL LINCOLN PUD
2129 N COAST HWY
NEWPORT OR 97365-0090
mwilson@cencoast.com

DOUG COOLEY
CENTURYTEL OF OREGON INC
707 13TH ST STE 280
SALEM OR 97301
doug.cooley@centurytel.com

GARY LEE
CHARTER COMMUNICATIONS CORP
521 NE 136TH AV
VANCOUVER WA 98684
glee@chartercom.com

PHIL CHARLTON
ELECTRIC LIGHTWAVE
pcharlton@eli-consulting.com

BILL KIGGINS
OPERATIONS MANAGER
CLEAR CREEK MUTUAL TELEPHONE CO
18238 S FISCHERS MILL RD
OREGON CITY OR 970445-9696
bkiggins@clearcreek.coop

STEPHEN R CIESLEWICZ
PRESIDENT
CLEAR CREEK MUTUAL TELEPHONE CO
PO BOX 746
NOVATO CA 94948-0746
steve@cnutility.com

SCOTT THOMPSON
ATTORNEY
COLE RAYWID & BRAVERMAN LLP
1919 PENNSYLVANIA AVE NW STE 200
WASHINGTON DC 20006
sthompson@crblaw.com

SEBASTIAN MC CROHAN
COMSPANUSA
sebastian.mccrohan@comspanusa.net

STUART SLOAN
CONSUMER POWER INC
PO BOX 1180
PHILOMATH OR 97370
stuarts@cpi.coop

SARAH K WALLACE
ATTORNEY AT LAW
DAVIS WRIGHT TREMAINE
1300 SW FIFTH AVENUE
SUITE 2300
PORTLAND OR 97201
sarahwallace@dwt.com

MICHAEL T WEIRICH
ASSISTANT ATTORNEY GENERAL
DEPARTMENT OF JUSTICE
REGULATED UTILITY & BUSINESS SECTION
1162 COURT ST NE
SALEM OR 97301-4096
michael.weirich@state.or.us

CHARLES L BEST
ATTORNEY AT LAW
ELECTRIC LIGHTWAVE LLC
PO BOX 8905
VANCOUVER WA 98668-8905
charles_best@eli.net

CRAIG ANDRUS
CUSTOMER ENGINEERING SUPERVISOR
EMERALD PUD
33733 SEAVEY LOOP RD
EUGENE OR 97405-9614
craig.andrus@epud.org

CATHERINE A MURRAY
MGR - REGULATORY AFFAIRS
ESCHELON TELECOM OF OREGON INC
730 SECOND AVE S STE 900
MINNEAPOLIS MN 55402-2489
camurray@eschelon.com

CHRISTY MONSON
HAROLD LEAHY & KIERAN
223 A ST STE D
SPRINGFIELD OR 97477-4500
ckm@haroldleahy.com

JEANNETTE C BOWMAN
IDAHO POWER COMPANY
PO BOX 70
BOISE ID 83707
jbowman@idahopower.com

BRENT VAN PATTEN
IDAHO POWER COMPANY
PO BOX 70
BOISE ID 83707-0070
bvanpatten@idahopower.com

ANDREA FOGUE
SENIOR STAFF ASSOCIATE
LEAGUE OF OREGON CITIES
PO BOX 928
1201 COURT ST NE STE 200
SALEM OR 97308
afogue@orcities.org

SCOTT ROSENBALM
CITY OF MCMINNVILLE WATER & LIGHT
PO BOX 638
MCMINNVILLE OR 97128-0638
sgr@mc-power.com

EUGENE A FRY
MILLENNIUM DIGITAL MEDIA
3633 136TH PL SE #107
BELLEVUE WA 98006
gfry@mdm.net

BROOKS HARLOW
ATTORNEY
MILLER NASH LLP
601 UNION ST STE 4400
SEATTLE WA 98101-2352
brooks.harlow@millernash.com

J. WHITE
CITY OF MONMOUTH
151 W MAIN ST
MONMOUTH OR 97361
jwhite@ci.monmouth.or.us

DAVE WILDMAN
CITY OF MONMOUTH
401 N HOGAN RD
MONMOUTH OR 97361
dwildman@ci.monmouth.or.us

MICHAEL DEWEY
EXECUTIVE DIRECTOR
OREGON CABLE AND
TELECOMMUNICATIONS
ASSOCIATION
1249 COMMERCIAL ST SE
SALEM OR 97302
mdewey@oregoncable.com

GENOA INGRAM
OREGON JOINT USE ASSOCIATION
1286 COURT ST NE
SALEM OR 97301
genoa@westernadvocates.com

JOHN SULLIVAN
OREGON JOINT USE ASSOCIATION
2213 SW 153RD DR
BEAVERTON OR 97006
john.sullivan@pgn.com

WILLIAM C WOODS
OREGON JOINT USE ASSOCIATION
9605 SW NIMBUS AVE
BEAVERTON OR 97008
william_woods@cable.comcast.com

TOM O'CONNOR
EXECUTIVE DIRECTOR
OREGON MUNICIPAL ELECTRIC
UTILITIES ASSOC
PO BOX 928
SALEM OR 97308-0928
toconnor@teleport.com

DON GODARD
OREGON PUD ASSOCIATION
727 CENTER ST NE, STE 305
SALEM OR 97301
dgodard@opuda.org

HEIDI CASWELL
PACIFICORP
825 NE MULTNOMAH STE 1500
PORTLAND OR 97232
heide.caswell@pacificorp.com

SANDRA FLICKER
OREGON RURAL ELECTRIC
COOPERATIVE ASSN
707 13TH ST. SE STE 200
SALEM OR 97301-4005
sflicker@oreca.org

BRANT WOLF
EXECUTIVE VICE PRESIDENT
OREGON TELECOMMUNICATIONS
ASSN
707 13TH ST SE STE 280
SALEM OR 97301-4036
bwolf@ota-telecom.org

CECE L COLEMAN
PACIFIC POWER & LIGHT
825 NE MULTNOMAH STE 800
PORTLAND OR 97232
cece.coleman@pacificorp.com

WILLIAM EAQUINTO
VICE PRESIDENT OF OPERATIONS
PACIFIC POWER & LIGHT
825 NE MULTNOMAH STE 1700
PORTLAND OR 97232
bill.eaquinto@pacificorp.com

RANDY MILLER
PACIFIC POWER & LIGHT
1407 W N TEMPLE, STE 220
SALT LAKE CITY UT 84116
randy.miller@pacficorp.com

COREY FITZGERALD
PACIFIC POWER & LIGHT
825 NE MULTNOMAH STE 800
PORTLAND OR 97232
corey.fitz-gerald@pacificorp.com

BILL CUNNINGHAM
PACIFICORP
825 NE MULTNOMAH STE 1500
PORTLAND OR 97232
bill.cunningham@pacificorp.com

PETE CRAVEN
PACIFICORP
825 NE MULTNOMAH STE 1500
PORTLAND OR 97232
pete.craven@pacificorp.com

JIM MARQUIS
PACIFICORP
830 OLD SALEM ROAD
ALBANY, OR 97321
james_I.marquis@pacificorp.com

GENERAL MANAGER
PIONEER TELEPHONE COOPERATIVE
1304 MAIN ST PO BOX 631
PHILOMATH OR 97370

RICHARD GRAY
PORTLAND CITY OF - OFFICE OF TRANSPORTATION
1120 SW 5TH AVE RM 800
PORTLAND OR 97204
richard.gray@pdxtrans.org

PRIORITYONE
TELECOMMUNICATIONS INC
PO BOX 758
LA GRANDE OR 97850-6462
kmutch@p1tel.com

LINDA L SPURGEON
COOS CURRY ELECTRIC COOPERATIVE
PO BOX 1268
PORT ORFORD OR 97465
spurgeon@cooscurryelectric.com

KRISTIN L.JACOBSON
SPRINT NEXTEL
201 MISSION ST. STE 400
SAN FRANCISCO CA 94105
kristijn.l.jacobson@sprint.com

JERRY MURRAY
PUBLIC UTILITY COMMISSION
PO BOX 2148
SALEM OR 97308-2148
jerry.murray@state.or.us

JOHN WALLACE
PUBLIC UTILITY COMMISSION
PO BOX 2148
SALEM OR 97308-2148
john.wallace@state.or.us

JEFF KENT
QWEST
8021 SW CAPITOL HILL RD
ROOM 180
PORTLAND OR 97219
jeffrey.kent@qwest.com

ALEX M DUARTE
QWEST CORPORATION
421 SW OAK ST STE 810
PORTLAND OR 97204
alex.duarte@qwest.com

ROGER KUHLMAN
SALEM ELECTRIC
PO BOX 5588
SALEM OR 97304-0055
kuhlman@salemelectric.com

BARBARA YOUNG
SPRINT COMMUNICATIONS CO LP
902 WASCO ST - ORHDRA0412
HOOD RIVER OR 97031-3105
barbara.c.young@mail.sprint.com

MARK OBERLE, PROPERTY MANAGER
EWEB
PO BOX 10148
EUGENE OR 97440
Mark.oberle@eweb.eugene.or.us

BRIAN THOMAS
TIME WARNER TELECOM OF OREGON LLC
223 TAYLOR AVE N
SEATTLE WA 98109-5017
brian.thomas@twtelecom.com

STEVEN LINDSAY
VERIZON
PO BOX 1033
EVERETT WA 98206
steve.lindsay@verizon.com

RICHARD STEWART
VERIZON NORTHWEST INC
600 HIDDEN RIDGE
HQEO3J28
IRVING TX 75038
richard.stewart@verizon.com

RENEE WILLER
VERIZON NORTHWEST INC
20575 NW VON NEUMANN DR MC OR030156
HILLSBORO OR 97006
renee.willer@verizon.com

MARTY PATROVSKY
WANTEL INC
1016 SE OAK AVE
ROSEBURG OR 97470
marty.patrovsky@comspanusa.net

DAVID LUCHINI
CENTURYTEL OF OREGON, INC
PO BOX 327
AURORA OR 97002
dave.luchini@centurytel.com

RONALD W JONES
IBEW LOCAL 659
4480 ROGUE VALLEY HWY # 3
CENTRAL POINT OR 97502-1695
ronjones@ibew659.org

RICHARD W. RYAN, PRESIDENT
HUNTER COMMUNICATIONS, INC.
801 ENTERPRISE DR. STE 101
CENTRAL POINT OR 97502
rryan@coreds.net

CHRISTOPHER S. HUTHER
PRESTON GATES ELLIS RUVELAS & MEEDS
1735 NEW YORK AVE NW STE 500
WASHINGTON DC 2006-5209
chuther@prestongates.com

ANDREA L. KELLY, VICE PRESIDENT
REGULATION DEPARTMENT
PACIFICORP DBA PACIFIC POWER & LIGHT
825 NE MULTNOMAH ST STE 2000
PORTLAND OR 97232
andrea.kelly@pacificorp.com

KEVIN O'CONNOR
TIME WARNER TELECOM
520 SW 6TH AVE
PORTLAND OR 97031
kevin.oconnor@twtelecom.com

FRANK MCGOVERN
QUALITY TELEPHONE INC
PO BOX 141048
DALLAS TX 75214
fmcgovern@qtelephone.com

NANCY JUDY
SPRINT/UNITED TELEPHONE CO OF THE NORTHWEST
902 WASCO ST A0412
HOOD RIVER OR 97031
nancy.judy@sprint.com

TOM MCGOWAN
SPRINT/UNITED TELEPHONE CO OF THE NORTHWEST
902 WASCO ST
HOOD RIVER OR 97031
tom.a.mcgowan@sprint.com

CINDY MANHEIM
CINGULAR WIRELESS
PO BOX 97061
REDMOND, WA 98073
cindy.manheim@cingular.com

SCOTT WHEELER
COMCAST PHONE OF OREGON LLC
9605 SW NIMBUS AVE
BEAVERTON OR 97008
scott_wheeler2@cable.comcast.com

ANDREW MCBRIDE
COOS CURRY ELECTRIC
COOPERATIVE
PO BOX 1268
PORT ORFORD OR 97465
amcbride@cooscurryelectric.com

MARK P. TRINCHERO
DAVIS WRIGHT TERMAINE LLP
1300 SW 5TH AVENUE, SUITE 2300
PORTLAND OR 97201
marktrinchero@dwt.com

RICHARD J. BUSCH
GRAHAM & DUNN PC
PIER 70
2801 ALASKAN WAY STE 300
SEATTLE WA 98121-1128
rbusch@grahamdunn.com

THOMAS DIXON
VERIZON CORPORATE SERVICES
707 17TH STREET
DENVER CO 80202
thomas.f.fdixon@verizon.com

KEENE C. BASSO
LIN SUPERINTENDENT
CLATSKANIE PUD
PO BOX 216
CLATSKANIE, OR 97016
kbasso@clatskaniepud.com

THE HONORABLE ROBERT
ACKERMAN
OREGON HOUSE OF
REPRESENTATIVES
900 COURT ST NE RM H-389
SALEM OR 97310

GARY PUTNAM
PUBLIC UTILITY COMMISSION
PO BOX 2148
SALEM OR 97308-2148
gary.putnam@state.or.us

JOHN WALLACE
PUBLIC UTILITY COMMISSION
PO BOX 2148
SALEM OR 97308-2148
john.wallace@state.or.us

**BEFORE THE PUBLIC UTILITY COMMISSION**

**OF OREGON**

**AR 506**

| | |
|---|---|
| In the Matter of a Rulemaking to Amend and Adopt Permanent Rules in OAR 860, Divisions 024 and 028, Regarding Pole Attachment Use and Safety | **AFFIDAVIT OF DAVID A. JOHNSON** |

I, DAVID A. JOHNSON, declare under penalty of perjury under the laws of Oregon as follows:

1. My name is David A. Johnson. I am Senior Forester for PGE, a position I have held for twenty years. My current business address is: 9480 SW Boeckman Road, Wilsonville, OR 97070.

2. As Senior Forester, I supervise the vegetation management program for PGE. I am responsible for the vegetation maintenance of approximately 9,000 miles of overhead distribution lines and 2,000 miles of transmission lines throughout PGE's service territory.

3. In August 2006, I prepared a budget estimate for PGE's tree-trimming program for the 2007 calendar year based on the current OPUC Tree to Power Line Clearance Policy.

4. PGE maintains trees on a two-year or three-year cycle, depending on tree densities, specie and anticipated growing conditions. Accordingly, my budget estimate included the scheduled trimming of approximately 2,000 two-year line miles and 1,925 three-year line miles with an average of 40 tree crews working 180,848 man hours.

5. The total amount of this budget for 2007, based on the current OPUC Staff Policy, is $9,901,149

6. I prepared a similar budget for the 2007 calendar year based on the new rules proposed by Staff in Docket AR 506.

7. The budget based on the proposed rules is $14,403,701, an increase of $4,502,552.

8. The budget for the proposed rules reflects the cost of moving the two-year scheduled areas to a one-year cycle and the three-year trimming areas to a two-year cycle to meet the proposed standards. The budgeted amount includes an average of 56 tree crews working 262,128 man hours to complete the trimming on an estimated 3,200

miles in one-year areas and 2,875 miles in two-year areas. It also includes adding four additional foresters to our current staff to administer the increased workload.

9. The proposed rules require this change from a two/three year cycle to a one/two year cycle. Specifically, the new rules require maintaining minimum clearance areas in all cases except for rare instances of cycle-busters (an unusually fast-growing tree). In the past, we could allow limited small branches and new growth into the clearance area. In most of our urban areas, tree variety and growing conditions vary, so we will have to trim trees after only one growing season in an effort to achieve compliance with the higher standards.

10. In some cases, we could have maintained a two/three year trimming cycle, but in order to do so we would have had to cut more drastically on the trees to meet the higher standards. This would have not only damaged otherwise healthy trees, and created unsafe conditions by weakening the trees, but actually triggered more rampant regrowth because of a tree's natural response to drastic cutting or wounding. It is anticipated that many trees lining the streets in the communities we serve will likely die under the stress of the extreme trimming.

11. The proposed change from 18 inches to 6 inches does not have a significant financial impact on these calculations. As mentioned above, the vast majority of the trees we maintain will fall under the requirement of no new growth within three feet (five feet if climbable) from primary lines. The change from 18 to 6 inches only matters for those rare cycle-busters that would fall under the six-inch exception. For well over 98% of the trees that we maintain, the change from 18 inches to 6 inches would have no significant impact on the required trimming.

I hereby declare that the above statements are true to the best of my knowledge and belief. I understand that these statements are made for use as evidence in a Public Utility Commission proceeding and are subject to penalty for perjury.

DATED this 21st day of August, 2006.

DAVID A. JOHNSON
Senior Forester, Portland General Electric Company

STATE OF OREGON )
) ss.
County of Multnomah )

SUBSCRIBED AND SWORN to before me this 21ST day of August 2006.

NOTARY PUBLIC in and for the State of Oregon
My Commission Expires: 1/17/2010

OFFICIAL SEAL
SHEILA M COX
NOTARY PUBLIC-OREGON
COMMISSION NO. 401473
MY COMMISSION EXPIRES JANUARY 17, 2010

**BEFORE THE PUBLIC UTILITY COMMISSION**

**OF OREGON**

**AR 506**

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| In the Matter of a Rulemaking to Amend and Adopt Permanent Rules in OAR 860, Divisions 024 and 028, Regarding Pole Attachment Use and Safety | **AFFIDAVIT OF DAVID VAN BOSSUYT** |

I, DAVID VAN BOSSUYT, declare under penalty of perjury under the laws of Oregon as follows:

1. My name is David Van Bossuyt. I am Manager of Operation Services and Oregon Public Utility Commission (OPUC) Liaison for Portland General Electric. I have worked in this position since 1990. I have been employed by PGE for 25 years. I have had responsibility for the vegetation management program for 21 of those 25 years.

2. I worked with the original team that drafted the OPUC Tree to Power Line Clearance Policy, and have been involved in developing the vegetation management plans necessary to comply with that policy since its inception.

3. My current job duties include overall management of PGE's overhead and underground major preventative maintenance programs (FITNES), PGE & Northwest Natural combination service installation crews (UNITY), Underground Locating, street light relamping, landscape maintenance and restoration, Distribution contract management and the vegetation management program. I regularly review budgets for the vegetation management program.

4. I reviewed the two 2007 budget estimates prepared by David A. Johnson for purposes of this proceeding, one for the current policy and the other for the 2007 budget under the proposed rule.

5. I believe both budget estimates are accurate.

6. I concur with Mr. Johnson's conclusion that the proposed rule will require PGE to move from a two/three-year trimming cycle to a one/two-year trimming cycle.

7. In my experience, the amount of trimming that would need to be done to comply with the new, higher standard on a two/three year cycle would significantly damage and weaken many trees. Some would have to be removed all together.

8. I have seen no evidence that suggests moving to this higher standard will bring any measurable improvement in PGE's vegetation-related safety record.

I hereby declare that the above statements are true to the best of my knowledge and belief. I understand that these statements are made for use as evidence in a Public Utility Commission proceeding and are subject to penalty for perjury.

DATED this 21 day of August, 2006.

David Van Bossuyt

DAVID VAN BOSSUYT
Manager, Portland General Electric's Distribution Department

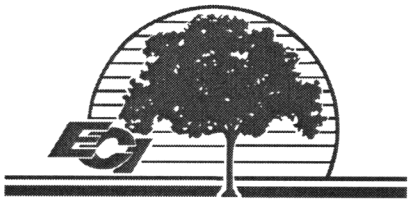
STATE OF OREGON )
) ss.
County of Multnomah )

SUBSCRIBED AND SWORN to before me this 21st day of August 2006.

Sheila M Cox

NOTARY PUBLIC in and for the State of Oregon
My Commission Expires: 1-17-10

OFFICIAL SEAL
SHEILA M COX
NOTARY PUBLIC-OREGON
COMMISSION NO. 401473
MY COMMISSION EXPIRES JANUARY 17, 2010



# Literature Review
# On Variability in Tree Height Growth
# Due to Seasonal Precipitation

Prepared for
Portland General Electric
Portland, Oregon

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

August 17, 2006

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## Executive Summary

In July 2006 Portland General Electric (PGE) requested that ECI conduct a review of scientific literature on the effects of variation in seasonal and annual precipitation on the growth of Pacific Northwest tree species. That research was conducted both on the Internet and at the libraries of two universities. This report presents the findings of that literature review as well as conclusions drawn from the literature pertaining to line clearance issues.

The growth of trees at different points in time and in different locations is characterized by variability. Sources of variability include climatic factors (precipitation, temperature, and growing season length), site factors (soil chemical and physical characteristics, elevation) tree species, individual tree genetics, and biotic influences such as fertilization and competition with other trees for resources. Within trees of the same species, water availability is the single most controlling factor in tree growth.

The climate/growth studies reviewed have identified seasonal, annual and longer-term effects of weather on tree growth. In general, any precipitation, which is timed to contribute to water availability during a tree's growing season, will promote tree growth. Geographic location, site elevation and summer temperatures are also related to tree growth. Examination of these other factors reveals that they are involved either in causing changes in precipitation or in limiting water availability. Further research has shown that trees of different species and even individual trees of the same species grow differently in response to changes in precipitation.

The OPUC staff has proposed rules that would require Oregon Utilities to maintain clearance between trees and distribution conductors of three or five feet, dependent on whether or not a tree is readily climbable. Only rarely would it be acceptable for trees to be closer than these distances, but never closer than six inches. Yet the studies cited in this paper indicate that sudden changes in growing season precipitation cause some tree species to grow substantially more than would be expected based on normal trends. These changes will affect trees throughout the service territory and cause more than "infrequent" intrusion of tree growth beyond the three or five-foot clearance standards in some years, if tree clearances at the time of maintenance are designed for normal growth trends.

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**Study Objective:** To find evidence in scientific literature of a relationship between growing season precipitation and tree height growth in the PGE service area around Portland, Oregon.

## Introduction

At the most basic level, the growth of a tree is governed by its genetics and environment. While genetics is a constant that does not change over time, environmental factors vary over both time and geographic location. As a result, changes in environment over time will produce corresponding changes in tree growth. With the issue of global climate change attracting greater attention in recent years, more studies are being conducted on the effects of changing climate on both tree species and entire ecosystems.

## Literature Review

The growth of a tree is regulated by a variety of factors. These factors include tree species, individual tree genetics, soil characteristics, temperature, light, competition, length of growing season, precipitation and others (Busgen and Thomson, 1929). According to Coder (1999), "More than eighty percent of the variation in tree growth is because of water supply." If a tree has access to adequate soil moisture during the growing season, it will continue to grow at the maximum rate allowed by other genetic and environmental factors. It does not matter whether the source of the water is root-accessible ground water, precipitation or irrigation. If there is too little water (drought), growth begins to shut down. Growth also is impaired by too much water (flooding). In urban areas, some landscape trees are watered during the growing season. Most trees, however, rely on natural precipitation for growth.

Finding research on relationships between monthly or seasonal precipitation and tree height growth proved to be difficult. According to a 2006 paper by Nakawatase and Peterson, "little is known about the spatial and temporal variability in tree growth-climate relationships" in Pacific Northwest forests. Much of the information that does exist on this subject comes from tree-ring studies, which is concerned primarily with annual weather data and tree diameter growth. However, since tree diameter growth is directly related to tree height growth, tree-ring and diameter growth studies are still useful tools for measuring growth response to climate.

The literature search discovered a number of papers showing annual and/or seasonal effects of precipitation on tree growth, both in the Pacific Northwest and elsewhere. One such study was published by Little et al in 1995, examining regional and seasonal climate on Douglas-fir in southwest Oregon. A relationship this study found was current year growth of Douglas-fir increased with current summer precipitation. Because summers in this area are warm and dry, summer rainfall can provide water needed at light and temperature conditions suitable to maximum photosynthesis.

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Case and Peterson (2005) also studied the relationship between climate and Douglas-fir growth, this time in the northern Cascade Range in Washington. They found that at about 2000-3000 foot elevations tree growth increased with growing season precipitation and decreased with growing season temperature. At higher elevations, tree growth increased with mean annual temperature. At high elevations, higher mean annual temperatures result in a longer growing season.

Another study, conducted in northern California from 1978 to 1991 (Wensel and Turnblom, 1998), modeled individual tree growth variation over time in relation to precipitation. The main premise for the work was that "Variation in growth rates of northern California conifers through time has been shown to be correlated with precipitation changes". The study compared tree growth over time with variation in precipitation in an attempt to better forecast long-term and short-term forest productivity. Douglas-fir was one of the species considered, as well as ponderosa pine, sugar pine, incense cedar, white fir and red fir. A second paper using the same dataset by Yeh and Wensel (2000) found that winter precipitation and summer temperatures influenced tree growth both in the current year and those following. They also discovered that, under the same climatic conditions, different tree species had different growth responses.

On a Tennessee site called the Throughfall Displacement Experiment, precipitation over one of three forest plots was intercepted and transported to another plot continuously over many years. This created a control plot, a wet plot with 1/3 more precipitation, and a dry plot with 1/3 less precipitation. On this experiment from 1994 to 1999 Hanson et al (2001) studied the growth response of six hardwood tree species to annual, seasonal and experiment-shifted precipitation. The species examined were red maple, dogwood, tulip tree, blackgum, white oak and chestnut oak. One finding of their study over the entire experiment was that diameter growth in wet years was 2-3 times greater than in dry years. Another finding was the discovery that annual and seasonal trends in precipitation had more of an effect on tree growth than the percentage shift in moisture between the wet and dry plots. While this experiment was conducted in the Midwest, some of the tree species examined can be found planted as ornamentals in the Pacific Northwest.

Looking at mountain hemlock in the southern Oregon Cascades, Peterson and Peterson (2001) found both annual and longer-scale responses in tree growth to seasonal precipitation and elevation. During dry summers, moisture limited tree growth. For species growing at high elevations, heavy winter and spring snowpack was also correlated with growth. Nakawatase and Peterson (2006), who found similar results in a study in the Olympic Mountains of Washington, concluded that winter and spring snowpack did not directly affect tree growth, but was more likely a measure of growing season length at high elevation.

Holman and Peterson (2006) studied variability in forest growth resulting from climatic variability in both wet and dry areas of the Olympic Mountains. They found that annual tree growth and growth variability were sensitive to changes in climate over large geographic areas. Tree species present on their study sites included western hemlock, western redcedar, Sitka spruce, red alder, bigleaf maple, Douglas-fir, silver fir, yellow-cedar, mountain hemlock, subalpine fir, grand fir and lodgepole pine.

It is important to remember, however, that water availability or temperature does not alone govern tree growth. Due to genetics, microsite differences and competition dynamic, multiple trees in the same stand may have differing rates of growth under the same climatic conditions. As an example, Binkley et al (2002) examined growth variation among individual Eucalyptus trees in two plantations in relation to light, water and nutrient usage. They concluded "our work demonstrates that individual trees may vary substantially in stem growth per unit of resource use". They concluded that competition among trees for the same resources could lead to dominant trees of the same age and species having a greater rate of growth than adjacent suppressed trees.

**Precipitation and Tree Growth – Portland, Oregon**

According to the Oregon Climate Service (OCS) website of Oregon State University (http://www.ocs.oregonstate.edu/index.html), the Willamette Valley receives about 50% of its annual precipitation from December through February. This precipitation is mainly rainfall. The amount of annual precipitation varies widely with elevation. Around Portland, annual precipitation can fall below 40 inches per year. In higher elevation locations in the foothills, there may be more than 80 inches annual precipitation. Growing season length also varies considerably with elevation, ranging from 73 to 244 days above 32° F. Portland is near the high end of the spectrum, with 237 days above 32° F and 306 days above 24° F. This results in a very long growing season. The implication of this precipitation and growing season variability is that trees of the same species growing in different parts of the Willamette Valley will also have widely variable annual growth. It should be noted that the data from the OCS is an average of data collected from the years 1971 to 2000.

Figure 1 shows total precipitation for the growing season in Portland, Oregon from 2000 to 2006, as reported by the National Weather Service.

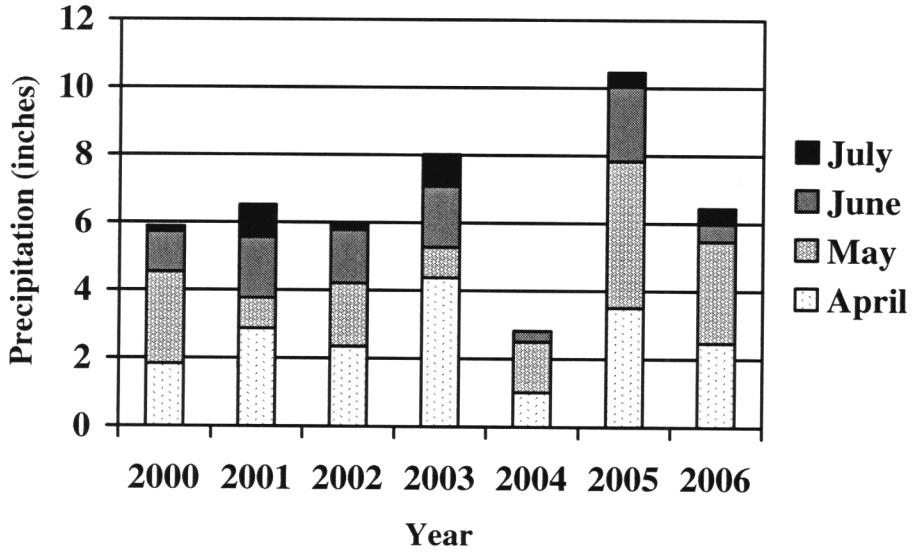


**Figure 1. Portland, Oregon Precipitation During April-July for the Years 2000-2006**

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Over the 7 years depicted in this chart, the mean growing season precipitation was 6.89 inches and mean July precipitation was 0.45 inches. In 2004, growing season precipitation was 2.81 inches and there was no measured precipitation in July. The following year, 2005, growing season precipitation was 10.45 inches and July precipitation was 0.41 inches. That means that 2005 growing season precipitation was 3.56 inches above the short-term average and 7.64 inches greater than the previous year. Based upon the findings of the studies cited in this report, that annual growing season precipitation is positively correlated with annual tree growth, tree growth should have been well above average in 2005. Also, since July is a warm, dry month at the end of the growing season, the studies suggest that water availability in July would be a limiting factor for tree growth. So, since there was no precipitation in July of 2004, tree growth that year would be limited. In 2005 however, there were 0.41 inches of precipitation, or just about average. As a result, tree growth would have been able to continue during July of 2005.

Complicating the issue of tree growth in relation to climate are differences in pruning regrowth between species. As an example, compare the growth rates of Douglas-fir, bigleaf maple and black cottonwood. According to Silvics of North America (Burns and Honkala, 1990), Douglas-fir on an average site at low elevation will grow 2 feet per year at age 30. At the same age, Thomas (1999) reports bigleaf maple growth rates of 1-2 feet/year. Similar growth (18+ inches/year) is reported for black cottonwood in the Michigan State University Ornamental Plants plus database. For younger trees, growth rates of 3-6 feet/year are possible. Across the three species however, growth rates are similar.

When examining top regrowth after pruning, however, species differences emerge. Internal ECI data from a study in the Pacific Northwest outside of Oregon provides a comparison between the growth response of Douglas-fir and bigleaf maple on two sites with low and high precipitation. The two sites compared had annual precipitation approximately equal to the lowest and highest precipitation that occurs across PGE's service territory. The percent increases in regrowth between the two sites are shown in Table 1. The main point to be drawn from this comparison is that regrowth at the site with greater annual precipitation was much higher. A second important point is that the two tree species, with different annual growth rates to begin with, responded differently to changes in precipitation in pruning regrowth.

**Table 1. Percent Increase in Regrowth from Low to High Precipitation Sites**

| Species | 1 Year % Increase | 6 Year Mean % Increase |
|---|---|---|
| Douglas-fir | 233 % | 256 % |
| Bigleaf maple | 136 % | 88 % |

## Conclusions

Scientific studies have found correlations between seasonal temperatures and precipitation and tree growth in the Pacific Northwest and elsewhere. Water availability

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during the growing season appears to be the greatest factor in limiting growth. As a result, the presence of sufficient water during the spring and especially into the normally dry summer months around Portland will increase tree growth.

An important consideration is the variability of annual precipitation with small elevation changes in the Willamette Valley. Increases of only a few hundred feet in elevation can result in much greater annual precipitation. Take the example of trees of the same species being pruned at the same time in two different locations in the Willamette Valley. Some trees are pruned in Portland and some in Estacada, which is 400 feet higher and averages up to 20 inches greater annual precipitation than in Portland. Two years after pruning, the trees in Estacada could be expected to have regrown more than those in Portland. If tree trimming line clearances were designed for Portland growth rates, the Estacada trees would have grown beyond acceptable clearances.

The variable rates of regrowth of different tree species after pruning also present a problem. Not only do species like Douglas-fir and bigleaf maple have different annual growth rates, but they also respond to changes in precipitation to differing degrees. So, in a year with above-normal summer rainfall, certain tree species can be expected to grow more as a result.

Finally, considering the precipitation / growth relationships discussed in this paper, the timing of the PGE line clearance review must be examined (Oregon Public Utility Commission Safety Report number E05-45). This review took place from August 15 to September 2, 2005. This began in the month following the largest growing season precipitation recorded in the past 7 years. It can be expected that tree growth just prior to the review was also well above average. This would result in an above-average number of trees encroaching on minimum required line clearances.

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## Appendix – Literature Search Methodology

A literature search was conducted for articles pertaining to tree growth response to monthly precipitation. The geographic location sought for these articles was the area of Portland, Oregon in particular and the coastal Pacific Northwest in general. Tree species looked for specifically were Douglas-fir, bigleaf maple, black cottonwood and black walnut. Attention was also paid during the search to any related articles pertaining to other tree species occurring in the target area. These included non-native maples and native trees such as grand fir and western red cedar.

Online searches of the Internet were conducted initially. Using the Yahoo and Google search engines, the following keywords were used in various combinations:

Douglas-fir
Pseudotsuga menziesii
Black cottonwood
Populus balsamifera (or trichocarpa)
Bigleaf maple
Acer macrophyllum
Black walnut
Juglans nigra
Aboveground
Climate
Climate change
Environment
Growth
Growth response
height
interannual
irrigation
monthly
Pacific Northwest
precipitation
production
rain
rainfall
regrowth
seasonal
site index
variation
water relations

These same keywords were then used to search three online journal article databases. These were the National Agricultural Library Article Citation Database (AGRICOLA, http://agricola.nal.usda.gov/), the journal article archive JSTOR (http://www.jstor.org/), and the Blackwell/Synergy online journal database (www.blackwell-synergy.com). Also searched was the University of Missouri online library catalog, MERLIN (Missouri Education and Research Libraries Information Network http://laurel.lso.missouri.edu/search~S1).

Using the online searches as a base, 15 refereed journal titles were physically browsed and their tables of contents inspected. Those journals and the years examined were:

American Nurseryman, 1998-2006
Arboriculture & Urban Forestry, 2006
Botanical Gazette, selected references
Canadian Journal of Forest Research, 2005-2006 and selected references
Ecological Monographs, selected references
Forest Ecology and Management, selected references
Forest Science, 2005-2006 and selected references
Journal of Arboriculture, 1975-2005

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Journal of Environmental Horticulture, 2004-2006 and selected references
Journal of Forestry, 1972-1986, 2004-2006 and selected references
Oregon State University current Extension Bulletins
Northern Journal of Applied Forestry, 1984-2006
Northwest Science, 2004-2006
USDA Forest Service Pacific Northwest Research Stations - selected General Technical Reports, Research Notes and Research Papers
Western Journal of Applied Forestry, 1986-2006

These manual searches took place either at the ECI office library or at the libraries of the University of Missouri-Columbia and the University of Wisconsin.

Following the online and manual literature searches, three tree nurseries in the Willamette Valley of Oregon were contacted. Each was asked whether their nursery had information on monthly tree growth related to precipitation or irrigation, or whether they were aware of a source of such information. The three nurseries were the J. F. Schmidt Nursery in Boring, the Oak Point Nursery near Independence, and the Weyerhaeuser Aurora Forest Nursery in Aurora. The Oak Point Nursery, while small in comparison to the others, was contacted because they are a grower of native Oregon tree species. None of the three nurseries had information on monthly tree growth or was aware of a source of that information.

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