BART Analysis for Centralia Power Plant

Prepared for

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Executive Summary

Background

In accordance with federal and state Best Available Retrofit Technology (BART) regulations and guidelines, CH2M HILL was requested to perform a BART analysis for TransAlta's Centralia Power Plant (CPP). This BART analysis has been conducted only for oxides of nitrogen (NOx). A BART analysis was not performed for other pollutants because the United States Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) have determined that CPP installed BART for sulfur dioxide (SO_2) from 2000 to 2002 and that CPP's controls meet BART for particulate matter (PM). The BART controls for SO_2 were installed to comply with Regulatory Order to Establish Reasonability Control Technology No. 97-2057 (herein referred to as the Order) issued by Southwest Air Pollution Control Agency (SWAPCA). CPP's position is that the NOx controls installed in the 2000 to 2002 period also meet applicable BART requirements, but it has voluntarily agreed to submit this BART analysis.

CPP has two coal-fired units, with each unit having a net generating capacity of 702.5 megawatts (MW). Under federal BART regulations, emission limits must be achieved within 5 years after the State Implementation Plan (SIP) is approved by EPA. A compliance date of 2014 was assumed for this analysis.

BART Engineering Analysis

The specific steps in a BART engineering analysis are identified in the Code of Federal Regulations (CFR) at 40 CFR 51 Appendix Y, Section IV and Ecology guidance, "Best Available Retrofit Technology Determinations Under the Federal Regional Haze Rule" (June 12, 2007). Based on the aforementioned documents, the analysis must include the following components:

1. The identification of available and technically feasible retrofit control options.
2. Consideration of pollution control equipment in use at the source (which affects the availability of options and their impacts).
3. The costs of compliance with the control options.
4. The remaining useful life of the facility.
5. The energy and non-air quality environmental impacts of compliance.
6. The degree of visibility improvement that may reasonably be anticipated from the use of BART.

The following steps guide and incorporate the aforementioned components of the BART analysis:

Step 1 – Identify All Available Retrofit Control Technologies

Step 2 – Eliminate Technically Infeasible Options

Step 3 – Evaluate Control Effectiveness of Remaining Control Technologies

Step 4 – Evaluate Energy and Non-Air Quality Impacts

Step 5 – Evaluate Visibility Impacts

As previously mentioned, this analysis has been conducted for NOx emissions. All costs included in the BART analyses are in 2007 dollars, and costs have not been escalated to the assumed 2014 BART implementation date.

Coal Characteristics

The main source of fuel burned at CPP is being transitioned to be exclusively western sub-bituminous coal from the Wyoming Powder River Basin (PRB) by 2013.

NOx Emission Control

In response to the Order, between 2000 and 2002, also CPP installed new low NOx burners (LNB), over-fire air (OFA), and other combustion controls. In completing the BART analysis, technology alternatives were investigated and potential reductions in NOx emission rates were identified. Listed below are the technology alternatives that were considered:

NOx emission controls:

- Rotating Opposed Fire Air (ROFA)
- Selective non-catalytic reduction system (SNCR)
- Selective catalytic reduction (SCR) system
- Neural Network Controls

The level of burner combustion controls that CPP installed is referred to as LNC3. In developing the BART guidelines for similar coal-fired units, EPA recognized LNC3 as the highest level of burner technology.

The ROFA vendor contacted for this analysis did not demonstrate that it has successfully installed the process on units of comparable size; hence, CPP does not consider ROFA to be available technology. Both SNCR and SCR have been demonstrated on comparable units and can reasonably be expected to achieve reductions of 25 percent and 75 percent, respectively; therefore, both were considered in this analysis. Neural Network Controls has not been able to guarantee a minimum level of reduction so therefore it was not considered available for this BART analysis; however, based on the potential NOx reductions and cost effectiveness, CPP is investigating this technology further.

None of the technologies considered above, which are technically feasible for CPP and would provide guaranteed reductions, would result in cost effectiveness of less than $3,500 per ton of NOx reduced. This is compared to the $281 per ton national average cost for BART Controls that EPA estimated for tangential-fired sub-bituminous coal units when it established presumptive BART.

BART Modeling Analysis

The Gaussian puff dispersion model, herein referred to as CALPUFF, was used by Geomatrics, a subcontractor of CPP, to assess the visibility impacts of NOx emissions from Centralia at Class I areas. The Class I areas potentially affected are located more than 50 kilometers (km), but less than 300 km, from CPP. Ecology guidance also requests the visibility analysis to include the Columbia River Gorge National Scenic Area, although it is not designated a Class I area. The Class I areas include the following national parks and wilderness areas:

- Alpine Lakes Wilderness
- Glacier Peak Wilderness
- Goat Rocks Wilderness
- Mount Adams Wilderness
- Mount Hood Wilderness
- Mount Jefferson Wilderness
- Mount Rainier National Park
- Mount Washington Wilderness
- North Cascades National Park
- Olympic National Park
- Pasayten Wilderness
- Three Sisters Wilderness

The following modeling cases were developed for NOx emission controls. The currently installed electrostatic precipitator and wet scrubber will continue to provide PM_{10} and SO_2 emission control, respectively, with no upgrades or modifications assumed.

- **Case 0:** Pre-NOx Control (1997) – 0.43 pounds per million British thermal units (lb/MMBtu)
- **Case 1:** Baseline - 2008-2009 PRB Flex Fuel Project Improvements with existing Low NOx burners – 0.264 lb/MMBtu;
- **Case 2:** SNCR – 0.198 lb/MMBtu;
- **Case 3:** Presumptive BART – 0.150 lb/MMBtu; and
- **Case 4:** SCR – 0.070 lb/MMBtu

Visibility improvements for all emission control cases were analyzed and the results were compared using a Least-Cost Envelope, as outlined in the draft EPA (1990) *New Source Review Workshop Manual*.

To evaluate the impacts of the modeled control cases on the twelve Class I areas and the Columbia Gorge National Scenic Area, the total annualized cost, cost per deciview (dv) reduction, and cost per reduction in number of days above 0.5 delta-deciview (Δdv) were analyzed. This report provides a comparison of the average incremental costs between

relevant cases for the twelve Class I areas; the total annualized cost versus number of days above 0.5 Δdv; and the total annualized cost versus 98th percentile Δdv reduction.

The modeling results indicate that Mount Rainier National Park is the Class I area most impacted by CPP. In Mount Rainier National Park, on an annualized basis it would cost at least $1,370,000 for each day to reduce the number of days that CPP has a impact greater than 0.5 dv from 148 days per year to 137 days per year. In addition, the average annualized cost per dv improvement would be at least $21.8 million to $42.3 million per dv per year. For comparison, the Order resulted in visibility improvements at an annualized cost of about $3.8 million per dv. In addition, the modeling results indicate that the greatest potential improvement would be in the Mount Rainier National Park of about 2 dv, a level that might not be perceptible by humans.

Conclusion

CPP's recently installed LNC3 technology is the type of technology that was the primary basis for EPA's adoption of the presumptive BART standard. None of the options evaluated are cost effective when compared to the estimated national average cost of $281 per ton for tangential-fired sub-bituminous coal units that EPA used in establishing presumptive BART. At a minimum, additional controls would be over ten times that much per ton. Furthermore, further reductions in NOx emissions from CPP will not likely noticeably improve visibility for two reasons: not only are the modeled deciview impacts small, but CPP's NOx emissions contribute less than one percent to the total visibility extinction in Mount Rainier National Park, the Class I area most impacted by CPP. Based on these considerations and the technologies considered, CPP's current LNC3 technology should be determined to be BART.

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Acronyms and Abbreviations

BACT	Best Available Control Technology
BART	Best Available Retrofit Technology
Btu	British thermal unit
CCOFA	Close-Coupled over-fire air
CDM	Collaborative Decisionmaking
CFR	Code of Federal Regulations
CO	carbon monoxide
CPP	Centralia Power Plant
Δdv	delta deciview, change in deciview
dv	deciview
DEQ	Department of Environmental Quality
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
FLM	Federal Land Manager
Fuel NOx	oxidation of fuel bound nitrogen
Km	Kilometer
kW	Kilowatt
kW-Hr	Kilowatt-hour
lb/MMBtu	pounds per million British thermal unit
LAER	lowest achievable emission rate
LNB	low-NOx burner
MMBtu	million British thermal unit
MW	Megawatt
Mt.	Mount
N_2	Nitrogen
NO	nitric oxide
NO_2	nitrogen dioxide
NOx	oxides of nitrogen
OFA	over-fire air
PM	Particulate Matter
PRB	Powder River Basin
RACT	Reasonability Control Technology
ROFA	Rotating Opposed Fire Air
SCR	Selective catalytic reduction
SIP	State Implementation Plan
SNCR	Selective non-catalytic reduction
SO_2	sulfur dioxide
SOFA	Separated over-fire air
SWCAA	Southwest Clean Air Agency

1.0 Introduction

1.1 Purpose

Best Available Retrofit Technology (BART) guidelines were established by the United States Environmental Protection Agency (EPA) to reduce the occurrence of regional haze in national parks and other Class I protected air quality areas in the United States[1]. These guidelines provide instruction for states when determining which major stationary sources must install additional controls; and more specifically, the type of controls that must be used. Facilities eligible for BART installation were built between 1962 and 1977 and have the potential to emit more than 250 tons per year of visibility-impairing pollutants.

Once facilities are identified, there are five basic elements related to BART that are considered when setting emission limits:

- Existing pollution control technology in use at the source
- The cost of the controls
- The remaining useful life of the source
- The energy and non-air environmental impacts of compliance
- The degree of improvement in visibility that may reasonably be anticipated from the use of such technology

This report documents the BART analysis that was performed on the Centralia Power Plant's (CPP) two coal-fired boilers, Unit 1 and Unit 2, by CH2M HILL for TransAlta Centralia Generation, LLC. The analysis was performed for oxides of nitrogen (NOx).

1.2 Report Organization

Section 2.0 of this report provides a description of the present unit operation, including a discussion of coal sources and characteristics. The BART Engineering Analysis is provided in Section 3.0. Section 4.0 provides the methodology and results of the BART Modeling Analysis, followed by recommendations in Section 5.0. References are provided in Section 6.0. and appendices provide more detail on the Economic Analysis and the BART Modeling Analysis.

[1] 40 Code of Federal Regulations (CFR) Part 51: Regional Haze Regulations and Guidelines for Best Available Retrofit Technology (BART) Determinations; Final Rule. 70 Federal Register, 39103-39172, July 6, 2005.

2.0 Present Unit Operation

CPP includes two BART-eligible coal-fired units, each with a net capacity of 702.5 megawatts (MW). The units were commissioned in 1971 and 1972 and are located near Centralia, Washington. Both units are currently equipped with a tangentially-fired pulverized coal boiler manufactured by Combustion Engineering. New low-NOx burners (LNB) and over-fire air (OFA) were installed between 2000 and 2002. This system is an Alstom LNC3 system which includes separated OFA.

Although not part of this BART analysis, both units utilize dual electrostatic precipitators for particulate emissions reduction and wet forced oxidation scrubbers for SO_2 control.

This analysis is based on both units operating at least until 2025. Therefore, a 10 year useful life as recommended by Ecology Guidance[2] was used. This report does not attempt to quantify any additional life extension costs needed to allow the units and these control devices to operate beyond 2025.

The BART regulations and Ecology guidance state that the baseline emissions utilized for visibility modeling be established by identifying the highest 24-hour average actual emission rate for the period modeled. The period modeled was 2003-2005 and the highest 24-hour actual NOx emission rate during that period was 0.302 (pounds per million British thermal unit (lb/MMBtu) for Unit 1 and 0.306 lb/MMBtu for Unit 2. These rates were used by Geomatrix for the visibility modeling.

CPP is currently implementing a Flex Fuel Project which includes modifying both units to efficiently utilize Powder River Basin (PRB) and possibly other coal sources. At the completion of the Flex Fuel Project, the expected average NOx emission rate will be no more than 0.264 lb/MMBtu (based on the worst case PRB coal). Hence, for the cost-effectiveness analysis 0.264 lb/MMBtu was used as the emission baseline rate instead of the highest 24-hour average actual emission rate during the 24-month period prior to the analysis. This will result in a more representative and realistic cost analysis.

In December 1996 the National Park Service, EPA, the U.S. Forest Service, Ecology, the Southwest Clean Air Agency (SWCAA), and the Puget Sound Clean Air Agency reached consensus though the Collaborative Decisionmaking (CDM) Process on emission reductions at CPP to meet state NOx and federal and state BART requirements. As a result of the CDM Process, from 2000 to 2002 CPP installed sulfur dioxide scrubbers, low NOx burners, and other combustion controls.

The CDM Process culminated in SWCAA (then referred to as the Southwest Air Pollution Control Agency [SWAPCA]) issuing a Regulatory Order to Establish Reasonability Control Technology (RACT), SWAPCA 97-2057 (the Order), for CPP. At the time the Order was issued, the CDM agencies agreed that the Order also met BART requirements for SO_2, NOx, and particulate matter (PM). The Order required CPP to limit SO_2 emissions to less than

[2] Washington Department of Ecology, "Guidelines for Best Available Retrofit Technology (BART) Determinations under the Regional Haze Rule", June 12, 2007.

10,000 tons per year after 2002 and limit NOx emissions to an annual average 0.30 lb/MMBtu when the units are operating at 360 MW or greater. According to the RACT Order Technical Support Document, the estimated reduction of SO_2 was about 79,000 tons per year, at an annualized cost of about $300 per ton of SO_2 removed, expressed in 2000 dollars. The Order also resulted in CPP installing new LNB and OFA controls. The installation of the NOx controls at a capital cost of about $14 million resulted in a reduction of about 12,000 tons of NOx per year at a cost of about $230 per ton, based on information in the Order Technical Support Document.

Table 2-1 lists additional unit information and study assumptions for this analysis. Coal sources are listed in Table 2-2.

TABLE 2-1
Unit Operation and Study Assumptions

Measure	Data
Site Elevation (feet above MSL)	250
Stack Height (feet)	470
Stack Exit ID (feet) /Exit Area (square feet))	42.06 /1389
Stack Exit Temperature (°F)	137
Stack Exit Velocity (feet/second)	57
Stack Flow (actual cubic feet per minute)	4,752,000
Annual Unit Capacity Factor (percent)	93
Net Unit Output (MW)	702.5 each (1,405 total)
Boiler Heat Input (MMBtu/Hour)(100% load)	7,049 each
Type of Boiler	Tangentially-fired
Boiler Fuel	Sub-Bituminous Coal Fuel Oil (Startup, Shutdown, Flame Stabilization)
Current NOx Controls	LNBs with OFA
Pre-1997 NOx Emission Rate (lb/MMBtu)	0.545
Maximum 24-Hr. NOx Emission Rate (lb/MMBtu) (2003 – 2005) for visibility modeling analysis	0.302/0.306
2006-2007 NO_x Annual Average Emission Rate (lb/MMBtu)	0.28
Projected 2009 Average Emission Rate (lb/MMBtu)	0.264

The EPA BART regulations set "presumptive BART limits" for electric power plants greater than 750 MW, which are rebuttable based on a balancing of the five factors described in Section 1.1. Because CPP has a generating capacity greater than 750 MW, the presumptive BART limits apply, subject to a balancing of the five factors. Therefore, this analysis includes a comparison of the presumptive BART limit against the level of emissions that each control technology would achieve.

The BART presumptive NOx limit for tangentially-fired boilers burning sub-bituminous coal is 0.15 lb/MMBtu. The source of fuel burned at CPP is anticipated to be western sub-bituminous PRB coal, with probable coal sources and characteristics summarized in Table 2-2**.** For evaluation purposes within this report, coal characteristics from Jacobs Ranch were used since highest NO_x emissions are anticipated when burning this coal.

TABLE 2-2
Coal Sources and Characteristics

Coal Quality Data	Units	Buckskin	Caballo 8500	Cordero Rojo	Jacobs Ranch Upper Wyodak	Rawhide	Special K Fuel	Belle Ayr	Eagle Butte
Proximate Analysis (As-Received Basis)									
Higher Heating Value	Btu/lb	8400.00	8500.00	8456.00	8800.00	8300.00	7907.00	8500.00	8400.00
Moisture	%	29.95	29.90	29.61	26.45	30.50	25.74	30.50	30.50
Volatile Matter	%	30.25	31.40	30.71	32.50	30.40	28.76	30.40	31.92
Fixed Carbon	%	34.65	33.80	34.22	34.35	34.20	32.46	34.20	32.93
Ash	%	5.15	4.90	5.46	6.70	4.90	13.04	4.90	4.65
Fixed Carbon to Volatile Matter (Fuel) Ratio		1.15	1.08	1.11	1.06	1.13	1.13	1.12	1.03
Ultimate Analysis (As-Received Basis)									
Carbon	%	49.00	49.91	49.16	51.26	48.58	45.82	50.01	49.17
Hydrogen	%	3.24	3.56	3.43	3.89	3.34	3.07	3.43	3.42
Nitrogen	%	0.63	0.71	0.71	0.80	0.63	0.56	0.67	0.67
Sulfur	%	0.35	0.36	0.32	0.88	0.37	0.28	0.26	0.38
Ash	%	5.15	4.90	5.46	6.70	4.90	13.04	4.90	4.65
Moisture	%	29.95	29.90	29.61	26.45	30.50	25.74	30.50	30.50
Chlorine	%	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01
Oxygen	%	11.68	10.66	11.31	10.01	11.68	11.49	11.12	11.20

Note: Special K Fuel is blend of Spring Creek coal and Kaolin clay

3.0 BART Engineering Analysis

3.1 Applicability

The Regional Haze Program requirements of the federal Clean Air Act and State of Washington regulations require compliance with BART emission limits for BART eligible units within 5 years after EPA's approval of the SIP. While voluntarily submitting the BART Analysis, CPP has reserved the issue of whether it has previously met BART requirements.

3.2 BART Process

The specific steps in a BART engineering analysis are identified in the Code of Federal Regulations (CFR) at 40 CFR 51 Appendix Y, Section IV and Ecology's BART guidance. The evaluation must include the following:

1. The identification of available and technically feasible retrofit control options
2. Consideration of any pollution control equipment in use at the source (which affects the availability of options and their impacts)
3. The costs of compliance with the control options
4. The remaining useful life of the facility
5. The energy and non-air quality environmental impacts of compliance
6. The degree of visibility improvement that may reasonably be anticipated from the use of BART

These aforementioned requirements are incorporated into the BART analysis in the following steps:

Step 1 – Identify All Available Retrofit Control Technologies

Step 2 – Eliminate Technically Infeasible Options

- The identification of available and technically feasible, retrofit control options
- Consideration of any pollution control equipment in use at the source (which affects the applicability of options and their impacts)

Step 3 – Evaluate Control Effectiveness of Remaining Control Technologies

Step 4 – Evaluate Energy and Non-Air Quality Impacts

- The costs of compliance with the control options
- The remaining useful life of the facility
- The energy and non-air quality environmental impacts of compliance

Step 5 – Evaluate Visibility Impacts

- The degree of visibility improvement that may reasonably be anticipated from BART use

In addition to evaluation of new control equipment, the analysis includes evaluation of any pollution control equipment in use at the source, the costs of compliance associated with the existing controls, and the energy and non-air quality environmental impacts of compliance using these existing control devices.

All costs included in the BART analysis are in 2007 dollars, and costs have not been escalated for inflation to the assumed 2014 BART implementation date.

NOx formation in coal-fired boilers is a complex process that is dependent on a number of variables, including operating conditions, equipment design, and coal characteristics.

During coal combustion, NOx is formed in three different ways. The dominant source of NOx formation is the oxidation of fuel-bound nitrogen (fuel NOx). During combustion, part of the fuel-bound nitrogen is released from the coal with the volatile matter, while the other part is retained in the solid portion (char). The nitrogen chemically bound in the coal is partially oxidized to nitrogen oxides (nitric oxide [NO] and nitrogen dioxide [NO_2]) and partially reduced to molecular nitrogen (N_2). A smaller part of NOx formation is due to high temperature fixation of atmospheric nitrogen in the combustion air (thermal NOx). A very small amount of NOx is called "prompt" NOx. Prompt NOx results from an interaction of hydrocarbon radicals, nitrogen, and oxygen.

In a conventional pulverized coal burner, air is introduced with turbulence to promote the efficient mixing of fuel and air, which provides stable combustion. However, not all of the oxygen in the air is used for combustion. Some of the oxygen combines with the fuel nitrogen to form NOx.

Coal characteristics directly and significantly affect NOx emissions from coal combustion. Coal ranking is a means of classifying coals according to their degree of metamorphism in the natural series, from lignite to sub-bituminous to bituminous to anthracite. Lower rank coals, such as the sub-bituminous coals from the PRB, produce lower NOx emissions than higher ranked bituminous coals due to their higher reactivity and lower nitrogen content. The fixed carbon to volatile matter ratio (fuel ratio), coal oxygen content, and rank are good relative indices of the reactivity of a coal type. Lower rank coals release more organically bound nitrogen earlier in the combustion process than do higher rank bituminous coals. When used with LNBs, sub-bituminous coals require relatively longer time for the kinetics to promote more stable molecular nitrogen; hence resulting in lower NOx emissions.

All coal sources which are planned to be burned in Centralia are classified as sub-bituminous.

3.2.1 Step 1: Identify All Available Retrofit Control Technologies

The first step of the BART process is to evaluate NOx control technologies with practical potential for application to Centralia. A broad range of information sources has been reviewed in an effort to identify potentially applicable emission control technologies.

Both units at CPP are tangentially-fired. NOx emissions are currently controlled through the use of Alstom LNBs; which were installed between 2000 and 2002; close-coupled over fire air (CCOFA), and separated over fire air (SOFA) configuration for the units are identified by Alstom (referred to as "LNC3"). Information regarding current and anticipated LNC3 NOx emission levels was obtained from TransAlta and EPA acid rain database. In spite of the recent installation of the LNC3 system, a proposal was requested from Mobotec for their ROFA and Rotamix systems.

The following potential NOx control technology options were considered:

- Mobotec Rotating Opposed Fire Air (ROFA) and Rotamix systems
- Selective non-catalytic reduction (SNCR) system
- Selective catalytic reduction system (SCR)
- Neural Net Boiler Controls

3.2.2 Step 2: Eliminate Technically Infeasible Options

For CPP, with tangentially-fired units burning sub-bituminous coal, technical feasibility will primarily be determined by physical constraints and boiler configuration. CPP's emissions rate during the most recent eight calendar quarters reported to the EPA Clean Air Markets Division is approximately 0.28 lb/MMBtu. The expected average emissions after completion of the Flex Fuel Project will be 0.264 lb/MMBtu for the coal with the highest nitrogen content. The cost-effectiveness analysis is based on 0.264 lb/MMBtu.

For this BART analysis, emission and cost information pertaining to the post Flex Fuel Project, SNCR, and SCR was based on a combination of CPP data, vendor information, internal CH2M HILL information, and the EPA Air Pollution Cost Control Manual. Sources of cost estimates for CPP are listed in Table 3-1, which also summarizes the control technology options evaluated in this BART analysis, along with projected NOx emission rates.

Projected post Flex Fuel Project NOx emission rates were provided by TransAlta, and derived from data developed by Alstom and Black & Veatch. Mobotec also provided preliminary NOx emission rates and budgetary cost information for their ROFA and Rotamix technologies. After further discussions with Mobotec, CPP does not consider Mobotec ROFA and Rotamix technologies technically feasible. This conclusion was reached primarily on the basis that these technologies have not been previously demonstrated on utility units similar in configuration or capacity to the Centralia units. In the "Technical Support Document for BART NOx Limits for Electric Generating Units Excel Spreadsheet" (EPA-HQ-OAR-0002-0067-0446) ("EPA TSD") EPA estimated the cost of adding ROFA to CPP's units to be $749 per ton for Unit 1 and $809 per ton for Unit 2. However, EPA presumably did not perform a feasibility analysis. Therefore, Mobotec ROFA and Rotamix were eliminated from further consideration within this BART analysis.

TABLE 3-1
NOx Control Technology Emission Rate Ranking

Technology	Source of Estimated Emissions	Expected Emission Rate (lb/MMBtu)
Presumptive BART Limit		0.15
Flex Fuel Project (baseline)	CPP/Alstom/B&V	0.264
SNCR	CH2M HILL	0.198
Presumptive BART Limit	CH2M HILL	0.15 (average of both units)
SCR	CH2M HILL	0.07

3.2.3 Step 3: Evaluate Control Effectiveness of Remaining Control Technologies

Preliminary vendor proposals, such as those used to support portions of this BART analysis, include inherent uncertainties. These proposals are usually prepared in a limited time frame, may be based on incomplete information, may contain over-optimistic conclusions, and are non-binding. Therefore, emission rate values obtained in such preliminary proposals must be qualified, and it must be recognized that contractual guarantees are established only after more detailed analysis has been completed.

Level of Confidence for Vendor Post-Control Emissions Estimates. To determine the level of NOx emissions needed to achieve compliance consistently with an established goal, a review of typical NOx emissions from coal-fired generating units was completed. As a result of this review, it was noted that NOx emissions can vary significantly around an average emissions level. This variance can be attributed to many reasons, including coal characteristics, unit load, boiler operation including excess air, boiler slagging, burner equipment condition, coal mill fineness, and so forth.

The steps used to determine a level of confidence for a vendor-expected value are as follows:

1. Establish expected NOx emissions value from vendor.
2. Evaluate vendor experience and historical basis for meeting expected values.
3. Review and evaluate unit physical and operational characteristics and restrictions. The fewer variations there are in operations, coal supply, etc., the more predictable and less variable the NOx emissions are.
4. Make adjustments to the expected value. For each technology expected value, there is a corresponding potential for actual NOx emissions to vary from this expected value. From the vendor information presented, along with anticipated unit operational data, an adjustment to the expected value can be made.

As an integral part of the BART analysis process, cost and expected emission information was developed for NOx. This information is assembled from various sources including

emission reduction equipment vendors, CPP operating and engineering data, and internal CH2M HILL historical information.

The level of accuracy of the cost estimate can be broadly classified as "Order of Magnitude", which can be categorized as -30/+50 percent. There are several reasons for the wide range of cost estimates included in a BART analysis; however, they are primarily caused by the difficulty in receiving detailed and accurate information from equipment vendors. Due to the extremely active power industry marketplace, obtaining engineering and construction information is severely restricted due to vendor workload. Material and construction labor costs are also widely fluctuating in today's active economy.

The accuracy of expected emissions may also be questionable, and is also attributable to the inability to gain timely and accurate information. This is exemplified by the difficulty in obtaining background information, and the vendor time required to develop accurate emission projections for study purposes as opposed to their response to actual project request for proposals. Also, variance in expected emissions can be dependent upon the pollutant under consideration (i.e., particulate emissions can generally be more accurately predicted than NOx emissions).

Therefore, when selecting emissions control technologies and establishing emission permitting levels, consideration of variability in cost and expected emissions information must be considered.

The following subsections describe the control technologies and the control effectiveness evaluated in this BART analysis.

Existing LNBs with OFA System. The mechanism used to lower NOx with LNBs is to stage the combustion process and to initially provide a fuel-rich condition; thus, oxygen is needed for combustion and is not diverted to combine with nitrogen to form NOx. Fuel-rich conditions favor the conversion of fuel nitrogen to N_2 instead of NOx. Additional air (or OFA) is then introduced downstream in a lower temperature zone to burn out the char.

CPP installed LNBs and made overfire air improvements between 2000 and 2002 as a result of the Order. Information provided to CH2M HILL by CPP related to the Flex Fuel Project indicates that an emission rate of 0.264 lb/MMBtu would be expected. This emission rate represents a reduction from the current NOx emission rate.

SNCR. Selective non-catalytic reduction is generally used to achieve modest NOx reductions generally on smaller units. With SNCR, an amine-based reagent such as ammonia or urea is injected into the furnace within a temperature range of 1,600 degrees Fahrenheit (°F) to 2,100°F, where it reduces NOx to nitrogen and water. NOx reductions of up to 60 percent have been achieved, although 20 to 40 percent is more realistic for most applications.

Reagent utilization, which is a measure of the efficiency with which the reagent reduces NOx, can range from 20 to 60 percent, depending on the amount of reduction, unit size, operating conditions, and allowable ammonia slip. With low-reagent utilization, low temperatures, or inadequate mixing, ammonia slip occurs, allowing unreacted ammonia to create problems downstream. The ammonia may render fly ash unsaleable, react with sulfur to foul heat exchange surfaces, and/or create a visible stack plume. Reagent utilization can

have a significant impact on economics, with higher levels of NOx reduction generally requiring more reagent and higher operating cost. Reductions from high baseline concentrations (inlet NOx) are lower in cost per ton, but result in higher operating costs, due to greater reagent consumption.

A budgetary estimate for a urea-based SNCR system, which provides nominally a 25 percent reduction from baseline NOx levels, was estimated utilizing the CH2M HILL project database. Due to an extremely tight boiler outlet configuration and limited available space for new equipment, a 50 percent adjustment was used for SNCR cost estimates.

SCR. SCR works on the same chemical principle as SNCR, but SCR uses a catalyst to promote the chemical reaction. Ammonia or urea is injected into the flue-gas stream, where it reduces NOx to nitrogen and water. Unlike the high temperatures required for SNCR, the SCR reaction takes place on the surface of a vanadium/titanium-based catalyst at a temperature range between 580°F and 750°F. Due to the catalyst, the SCR process is more efficient than SNCR and results in lower NOx emissions. The most common type of SCR is the high-dust configuration, where the catalyst is located downstream from the boiler economizer and upstream of the air heater and any particulate control equipment. In this location, the SCR is exposed to the full concentration of fly ash in the flue gas that is leaving the boiler. The high-dust configuration is assumed for CPP. In a full-scale SCR, the flue ducts are routed to a separate large reactor containing the catalyst. With an in-duct SCR, the catalyst is located in the existing gas duct, which may be expanded in the area of the catalyst to reduce flue gas flow velocity and increase flue gas residence time. Due to the higher removal rate, a full-scale SCR was used as the basis for analysis at CPP.

Due to an extremely tight boiler outlet ductwork configuration, and limited available space for new equipment, a 50 percent adjustment was used for SCR cost estimates. As with SNCR, it is generally more cost effective to reduce NOx emission levels as much as possible through combustion modifications than to increase the catalyst surface area and ammonia requirements of the SCR.

Neural Net Boiler Controls. Information regarding neural net controls for boilers was previously received from NeuCo, Inc. While NeuCo offers several neural net optimization products, CombustionOpt and SootOpt provide the potential for NOx reduction at some facilities. Both CombustionOpt and SootOpt are control system based products offered by NeuCo. CombustionOpt provides for optimized control of fuel and air to reduce NO_x and improve fuel efficiency. SootOpt improves boiler sootblowing by proportioning heat transfer and reducing "hot spots" resulting from ineffective cleaning. NeuCo stated these products can be used on most boiler control systems and can be effective even in conjunction with other NOx reduction technologies.

NeuCo predicts that generally CombustionOpt can reduce NOx by 15 percent, and SootOpt can provide an additional 5 to 10 percent. Expected NOx reduction is very unit specific, and actual results may vary greatly. Previously received budgetary prices for CombustionOpt and SootOpt were $150,000 and $175,000, respectively, with an additional $200,000 cost for a process link to the unit control system.

Because NeuCo does not guarantee NOx reduction, the estimated emission reduction levels provided cannot be considered as reliable projections. Therefore, neural net should be

considered as a potential supplementary or polishing technology, but not as a NO_x technology for this BART analysis. Due to the potential NOx reductions and cost effectiveness, CPP is investigating this technology further.

Presumptive BART. EPA's presumptive BART standard for tangential-fired units burning sub-bituminous coal is 0.15 pounds of NOx per MMBtu. In the preamble of the July 6, 2005 BART rule, EPA specifically stated that the expected national average cost of tangential-fired sub-bituminous coal units would be $281 per ton, although in situations in which LNC3 is not technically feasible, that the expected cost effectiveness of installing ROFA as BART for NOx would be less than $1,500 per ton..

The EPA TSD acknowledges that CPP currently utilizes the highest level of burner based combustion controls, LNC3, upon which the presumptive standard is based. CPP has already installed a higher level of combustion control technology than almost all of the other units that EPA considered in determining the applicable presumptive BART. In addition, of the 48 tangentially-fired units burning sub-bituminous coal that EPA expected would need controls to meet presumptive BART, only 6 had a lower NOx emission rate in 2004, the base year that EPA used for cost effectiveness. Finally, as described above, in Section 3.2.2, CPP has determined that installing ROFA, contrary to EPA's assumption, is technically infeasible at the two Centralia units.

For purposes of this analysis, it was assumed that CPP could achieve the presumptive BART level of 0.15 lb/MMBtu by completing the Flex Fuel Project, installing SCR on one of the two units, and averaging the emissions of the two units. Hence, for the purposes of this analysis, presumptive BART (0.15 lb/MMBtu) is based on installing SCR on one of the two units at CPP.

Table 3-2 shows the total capital costs and the annualized costs for each available and feasible control option considered. For comparison, the table also shows the same information for the Order. The average cost per ton of NOx removed as a result of the Order was $230 per ton, while the average cost of the SNCR is about $4,000 per ton of NOx removed and the average cost for SCR is about $7,900 per ton. The table also shows the amount removed compared to the Flex Fuel Project. For example SNCR installed after completion of the Flex Fuel Project would remove an additional 3,762 ton of NOx per year and SCR would remove 11,112 tons of NOx per year after the completion of the Flex Fuel Project.

In addition to the total cost per ton, both EPA and Ecology guidance requires identification of the incremental cost of control. For example the annualized incremental cost of SCR over SNCR is $72.6 million per year (87.7 – 15.5). As compared to SNCR, SCR would remove an additional 7,351 tons per year (11,112 – 3,761). Thus, the incremental cost effectiveness of SCR over SNCR is approximately $9,878 per ton.

TABLE 3-2
NOx Control Cost Comparison

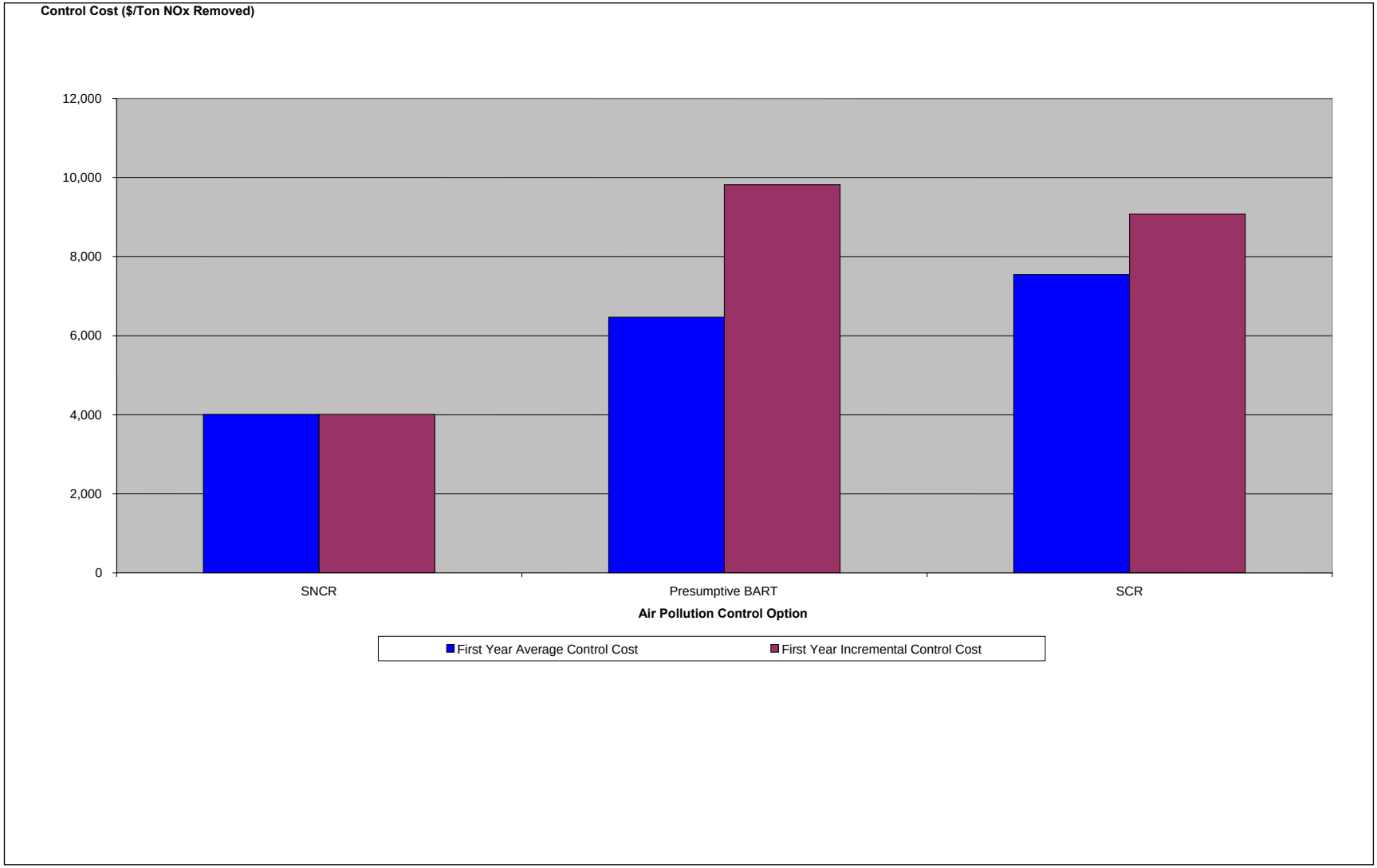
Factor	RACT/BART - SO_2	RACT/BART – NOx	Flex Fuel Project	SNCR	Presumptive BART	SCR
Major Materials and Design Costs				$33.0 Million	$102 Million	$204.0 Million
Total Installed Capital Costs	$236.6 Million	$14.1 Million		$85.1 Million	$276.7 Million	$553.3 Million
Total First Year Fixed & Variable Operation & Maintenance Costs				$2.9 Million	$4.7 Million	$8.9 Million
Total First Year Annualized Cost	$24.7 Million	$1.6 Million		$15.1 Million	$44.1 Million	$87.7 Million
Power Consumption (MW)				1.41	3.51	7.03
Annual Power Usage (1000 MW-Hr/Yr)				11.4	28.6	57.2
NOx Design Control Efficiency	80.00%	36%		25%	43.1%	75%
NOx Removed per Year (Tons)	79,812[1]	6,883	5,169	3,761[2]	6,518[2]	11,112[2]
First Year Average Control Cost ($/Ton of NOx Removed)	310	232		4,007	6,760	7,890
Incremental Control Cost over SNCR ($/Ton of NOx Removed)					10,516	9,878
Incremental Control Cost over Presumptive ($/Ton of NOx Removed)						9,495

[1] Tons of SO_2 removed
[2] Tons removed after Flex Fuel Project

Notes:

SNCR capital cost based on ~$40/kilowatt with a 50 percent complexity factor therefore making the cost ~$60/kilowatt
SCR capital cost based on ~$250/kilowatt with a 50 percent complexity factor therefore making the cost ~$375/kilowatt
The tons removed for three scenarios are based upon the control efficiency factor applied to the Flex Fuel NOx value of 0.264 lb/MMBtu.

FIGURE 3-1
First-Year Control Cost for NO_X Air Pollution Control Options



In EPA's New Source Review Workshop Manual (1990), EPA states that,

> *Incremental cost-effectiveness comparisons should focus on annualized cost and emission reduction differences between dominant alternatives. Dominant set of control alternatives are determined by generating what is called the envelope of least-cost alternatives. This is a graphical plot of total annualized costs for a total emissions reductions for all control alternatives identified in the BACT analysis...*

An analysis of incremental cost effectiveness has been conducted. Figures 3-2 and 3-3 show the annualized costs for each type of technology and the annualized cost per ton for each option.

FIGURE 3-2
Least-Cost Envelope Control Options Annualized Cost

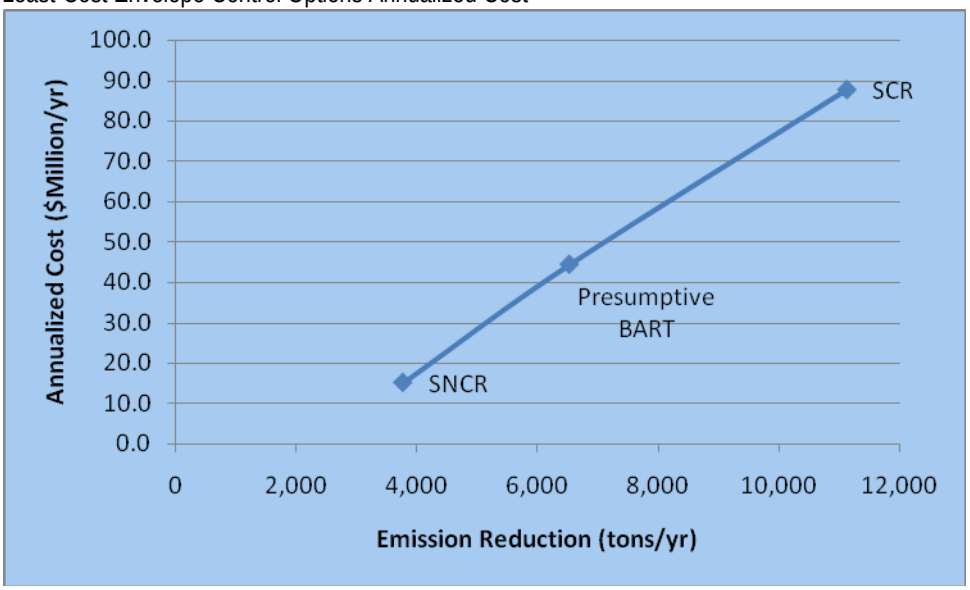
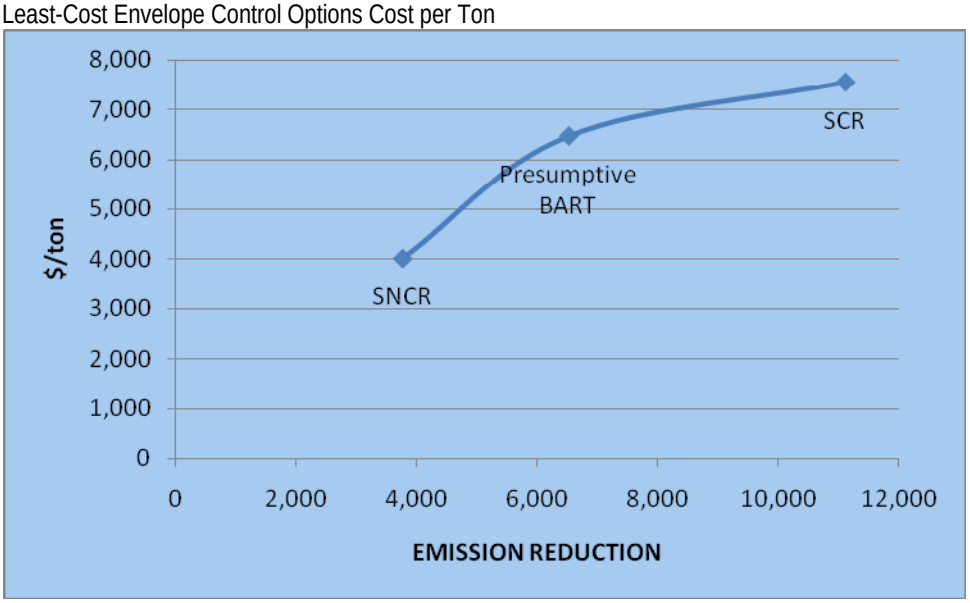


Figure 3-3
Least-Cost Envelope Control Options Cost per Ton



3.2.3 Step 4: Evaluate Energy and Non-Air Quality Impacts

This step involves the consideration of energy, environmental, and economic impacts associated with each control technology. The remaining useful life of the plant is also considered during the evaluation.

Energy Impacts. The auxiliary power requirement for an SNCR system for a 702 MW unit is estimated at 702 kilowatts (kW).

SCR retrofit impacts the existing flue gas fan systems due to the additional pressure drop associated with the catalyst, which is typically a 6- to 8-inch water gage increase. In addition to resulting in higher operating costs, additional capital costs may be required if additional fan capacity is necessary. The extent of additional capital cost improvements would be determined during the design phase of an SCR installation.

Other Air Quality Impacts. SNCR and SCR installation could impact the salability and disposal of fly ash due to ammonia levels and could potentially create a visible local stack plume, which may offset other visibility improvements. Other environmental impacts involve the safety hazards and potential for releases of ammonia, especially if anhydrous ammonia is used, and the transportation of the ammonia to the power plant site.

Both SNCR and SCR result in emissions of ammonia which is a Washington State Toxic Air Pollutant (TAP). Ammonia may also cause an odor around the facility.

Non-air Quality Impacts. The existing scrubber may collect some ammonia or urea from an SNCR or SCR system. The additional ammonia in the ash may affect waste water and solid waste at CPP. Much of the coal combustion by-products produced by CPP is currently sold as a concrete additive or other useful by-product. Any coal combustion by-products not managed in this manner, will be required to be landfilled in a regulated solid waste facility. Although unlikely because of expected low ammonia slip levels, under some conditions the coal combustion by-products could contain enough ammonia for the ash to be designated as a dangerous waste or a hazardous waste**.** Because of possible odor problems, the addition of ammonia may cause the coal ash to be less desirable for recycling in cement or other construction projects.

Economic Impacts. Costs for SNCR and SCR were estimated through vendor-obtained price and performance quotations and utilization of the CH2M HILL database. A comparison of the technologies on the basis of costs, design control efficiencies, and tons of NOx removed is summarized in Table 3-2, and the first year control costs are presented in Figure 3-1. The complete Economic Analysis is contained in Appendix A.

3.2.4 Step 5: Evaluate Visibility Impacts

The visibility impacts are presented in Section 4.0, BART Modeling Analysis.

4.0 BART Modeling Analysis

4.1 Introduction

This section presents the dispersion modeling methods and results for estimating the degree of visibility improvement from BART control technology options for CPP.

The modeling followed the methodology outlined in the *Modeling Protocol for Washington , Oregon, and Idaho* (Idaho Department of Environmental Quality [DEQ], Oregon DEQ, and Ecology, 2006) and was utilized by Geomatrix Consultants, Inc. under contract to TransAlta. Additional details on this modeling analysis can be found in Appendix B.

Visibility improvements for all emission control cases were analyzed, and the results are compared below, using a least-cost envelope, as outlined in the BART Guidelines and the draft EPA New Source Review Workshop Manual (1990).

4.2 Analysis Baseline and Cases

Table 4-1 compares the five emission control cases with expected emission levels for the two combined units. The Baseline is the maximum 24-hour NOx, SO_2, and PM10 emission rate during 2003 – 2005. The modeling examined four cases with lower NOx emissions than the Baseline case.

TABLE 4-1
Emission Control Cases

Control Description	Expected NOx Emission (lb/MMBtu)	Expected SO_2 Emissions (lb/MMBtu)	Expected PM_{10} Emissions (lb/MMBtu)
Pre NO_X Controls	0.545	2.300	0.023
Modeling Baseline	0.302/0.306	0.321	0.017
Flex Fuel	0.264	0.100	0.010
SNCR	0.198	0.100	0.010
Presumptive BART (SCR on Unit 1)	0.150 Average both units	0.100	0.010
SCR	0.070	0.100	0.010

Table 4-2 shows the average number of days per year that each case would result in a modeled impact greater than 0.5 ΔdV. For example, after completion of the Flex Fuel Project, the maximum number of days per that CPP would result in greater than 0.5 ΔdV impact in Mount Rainier National Park would be 148 or about 41 percent of the clear days. The

addition of SNCR would reduce the number of impacted days per year by approximately 11 days or 3 percent. For comparison, prior to 2000 CPP modeled impacted at Mount Rainier about 204 days per year or about 56 percent of the days.

TABLE 4-2
Average Number of Days per Year with Maximum Delta dv Greater Than 0.5 dv

Analysis Area	Pre-NOx Controls	Modeling Baseline	Flex Fuel	SNCR	Presumptive BART	SCR
Alpine Lakes Wilderness	190	144	114	100	85	55
Glacier Peak Wilderness	156	92	61	50	38	18
Goat Rocks Wilderness	170	138	112	99	88	56
Mt. Adams Wilderness	148	110	86	75	68	39
Mt. Hood Wilderness	115	75	53	43	37	18
Mt. Jefferson Wilderness	89	43	26	21	16	7
Mt. Rainier National Park	204	168	148	137	122	94
Mt. Washington Wilderness	77	34	19	14	9	4
N. Cascades National Park	136	69	41	32	25	10
Olympic National Park	113	85	69	62	55	36
Pasayten Wilderness	111	47	24	14	10	4
Three Sisters Wilderness	78	35	20	14	10	5
Columbia River Gorge National Scenic Area	132	82	52	38	30	12

Table 4-3 shows the 98th percentile daily Δdv for each control case and for pre-NOx emissions. After completion of the Flex Fuel Project, CPP is expected to have a 3.92 Δdv impact on the 98th percentile most impacted day. The addition of SNCR would lower that impact to 3.23 dv, or a 0.691 dv improvement. Before the installation of NOx and SO_2 controls, CPP had a 98th percentile impact of 11.999 Δdv.

TABLE 4-3
98th Percentile Daily Delta dv[1]

Analysis Area	Pre-NOx Controls	Modeling Baseline	Flex Fuel	SNCR	Presumptive BART	SCR
Alpine Lakes Wilderness	10.458	4.342	2.742	2.271	1.959	1.309
Glacier Peak Wilderness	7.357	2.618	1.754	1.414	1.144	0.744
Goat Rocks Wilderness	9.886	4.281	2.901	2.406	1.983	1.28
Mt. Adams Wilderness	8.683	3.623	2.357	1.952	1.615	1.042
Mt. Hood Wilderness	7.659	2.827	1.821	1.481	1.244	0.777
Mt. Jefferson Wilderness	5.531	1.886	1.138	0.929	0.781	0.505
Mt. Rainier National Park	11.999	5.483	3.922	3.231	2.711	1.798
Mt. Washington Wilderness	4.743	1.411	0.783	0.64	0.546	0.385
N. Cascades National Park	6.395	2.208	1.335	1.086	0.904	0.579
Olympic National Park	9.813	4.019	2.670	2.273	1.874	1.270
Pasayten Wilderness	4.912	1.479	0.902	0.731	0.607	0.397
Three Sisters Wilderness	4.789	1.535	0.901	0.724	0.609	0.405
Columbia River Gorge National Scenic Area	6.027	2.351	1.496	1.228	1.030	0.624

[1] Based on the 22nd highest results for each Class I area for the modeling period of 2003 through 2005

To provide perspective on the visibility modeling results, studies have been conducted that demonstrate only dv differences of approximately 1.5 to 2.0 dv or more are perceptible by the human eye. (Henry 2002, see Section 6.0) Deciview changes of less than 1.5 dv cannot be distinguished by the average person. Therefore, the modeling analysis results indicate that only minimal, if any, observable visibility improvements at the Class I areas studied would be expected under any of the cases.

Finally, it should be noted that none of the data were corrected for natural obscuration, where water in various forms (fog, clouds, snow, or rain) or other naturally caused aerosols

obscure the atmosphere. For example, there are often foggy days in Mount Rainier National Park where visibility degradation from manmade sources is not an issue.

4.3 Visibility Cost Analysis

Of the 12 federal Class I areas included in this analysis, cost and incremental cost analyses for six Class I areas are presented in this section. Five of these areas were selected because they represented the maximum baseline impacts in the State of Washington. Mt. Hood Wilderness has also been included because this area represents the maximum impacts in the State of Oregon.

As these analyses show, the relative results are consistent between the Class I areas. The six selected Class I areas are:

- Alpine Lakes Wilderness
- Goat Rocks Wilderness
- Mount Adams Wilderness
- Mount Hood Wilderness
- Mount Rainier National Park
- Olympic National Park

The total annualized cost, 98th percentile ΔdV reduction from Pre-NOx impact levels, cost per ΔdV reduction relative to Flex Fuel Project impact levels, and cost per reduction in number of days above 0.5 ΔdV for each of the NOx emission control cases are listed in Tables 4-4 through 4-9.

TABLE 4-4
NOx Control Case Cost Results for Mount Rainier National Park

Controls	Average Number of Days Above 0.5 ΔdV (Days/yr)	98th Percentile Δdv Reduction	Total Annualized Cost (Million$)	Cost per Reduction in No. of Days Above 0.5 Δdv (Million$/Day Reduced)	Cost per Δdv Reduction (Million$/dv Reduced)
Pre-NOx Controls	204				
Flex Fuel	148	8.077			
SNCR	137	8.768	15.072	1.370	21.812
Presumptive BART	122	9.288	44.058	1.695	36.382
SCR	94	10.201	87.679	1.624	41.280

TABLE 4-5
NOx Control Case Cost Results for Alpine Lakes Wilderness

Controls	Average Number of Days Above 0.5 ΔdV (Days/yr)	98th Percentile ΔdV Reduction	Total Annualized Cost (Million$)	Cost per Reduction in No. of Days Above 0.5 ΔdV (Million$/Day Reduced)	Cost per ΔdV Reduction (Million$/dV Reduced)
Pre-NOx Controls	190				
Flex Fuel	114	7.716			
SNCR	100	8.187	15.072	1.077	32.000
Presumptive BART	85	8.499	44.058	1.519	56.268
SCR	55	9.149	87.679	1.486	61.186

TABLE 4-6
NOx Control Case Cost Results for Goat Rocks Wilderness

Controls	Average Number of Days Above 0.5 ΔdV (Days/yr)	98th Percentile ΔdV Reduction	Total Annualized Cost (Million$)	Cost per Reduction in No. of Days Above 0.5 ΔdV (Million$/Day Reduced)	Cost per ΔdV Reduction (Million$/dV Reduced)
Pre-NOx Controls	170				
Flex Fuel	112	6.985			
SNCR	99	7.480	15.072	1.159	30.448
Presumptive BART	88	7.903	44.058	1.836	47.994
SCR	56	8.606	87.679	1.566	54.090

TABLE 4-7
NOx Control Case Cost Results for Olympic National Park

Controls	Average Number of Days Above 0.5 ΔdV (Days/yr)	98th Percentile ΔdV Reduction	Total Annualized Cost (Million$)	Cost per Reduction in No. of Days Above 0.5 ΔdV (Million$/Day Reduced)	Cost per ΔdV Reduction (Million$/dV Reduced)
Pre-NOx Controls	113				
Flex Fuel	69	7.143			
SNCR	62	7.540	15.072	2.153	37.965
Presumptive BART	55	7.939	44.058	3.147	55.349
SCR	36	8.543	87.679	2.657	62.628

TABLE 4-8
NOx Control Case Cost Results for Mount Hood Wilderness

Controls	Average Number of Days Above 0.5 ΔdV (Days/yr)	98th Percentile ΔdV Reduction	Total Annualized Cost (Million$)	Cost per Reduction in No. of Days Above 0.5 ΔdV (Million$/Day Reduced)	Cost per ΔdV Reduction (Million$/dV Reduced)
Pre-NOx Controls	115	0.000			
Flex Fuel	53	5.838			
SNCR	43	6.178	15.072	1.507	44.329
Presumptive BART	37	6.415	44.058	2.754	76.357
SCR	18	6.882	87.679	2.505	83.984

TABLE 4-9
NOx Control Case Cost Results for Mount Adams Wilderness

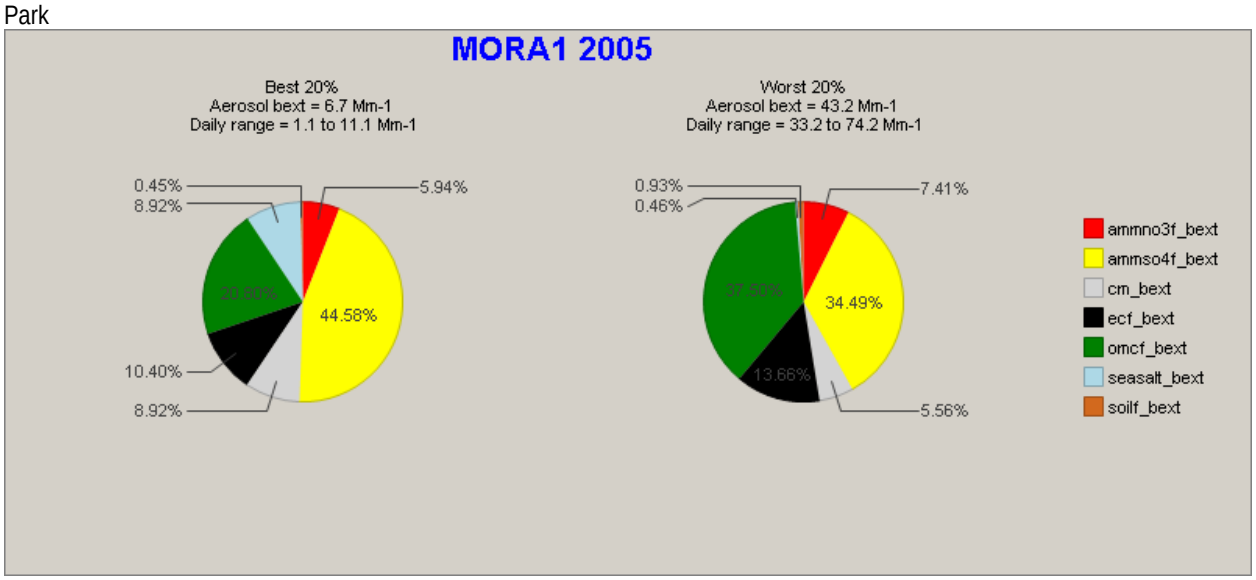
Controls	Average Number of Days Above 0.5 ΔdV (Days/yr)	98th Percentile ΔdV Reduction	Total Annualized Cost (Million$)	Cost per Reduction in No. of Days Above 0.5 ΔdV (Million$/Day Reduced)	Cost per ΔdV Reduction (Million$/dV Reduced)
Pre-NOx Controls	148				
Flex Fuel	110	5.06			
SNCR	86	6.326	15.072	0.628	11.905
Presumptive BART	75	6.731	44.058	1.259	26.366
SCR	68	7.068	87.679	2.088	43.665

4.4 Evaluate Visibility Impacts

The above analysis indicates the maximum possible visibility improvements that reductions in NOx emissions from CPP could have on Class I areas. CPP's share of impact on visibility compared with other sources should also be considered. As shown in Figure 4-1, nitrates formed by NOx emissions typically contribute less than 10 percent of the observed extinction in Mount Rainier National Park on both the best and worst days in 2005. Other years show similar small contributions from NOx emissions.

As shown in Figure 4-2, from a source apportionment study conducted by the Western Regional Air Partnership (WRAP) about 11 percent of the nitrate in Mt. Rainier National Park can be attributable to all industrial point sources. CPP is only a portion of the industrial point sources. Therefore, on the best and worst visibility days, NOx emissions from CPP can only contribute less than one percent of the total extinction budget. Further reductions in CPP's NOx emissions would not likely have a significant effect on visibility in the Park or other Class I areas.

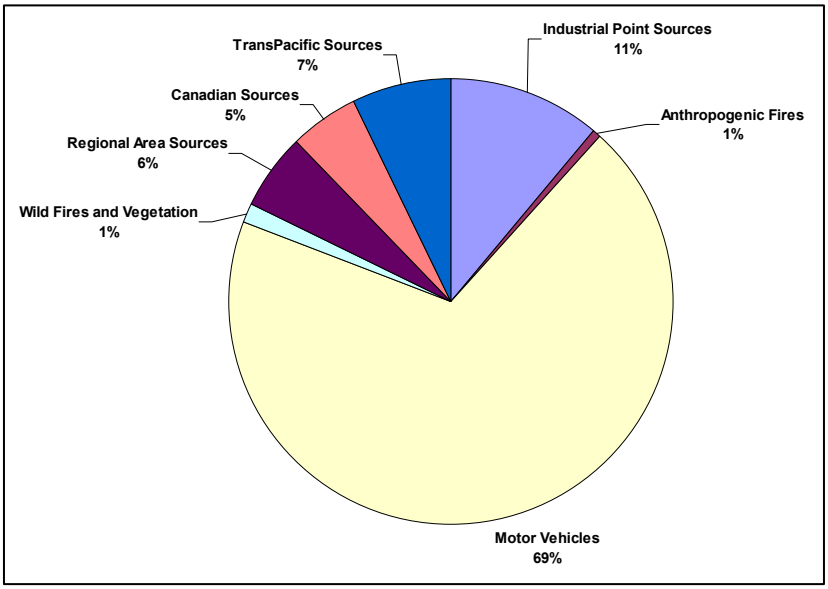
Figure 4-1
Extinction Budget for Mount Rainier National Park



ammNO3f – ammonium nitrate
CM – Coarse particles (usually soil)
OMCf – organic carbon,
Source: (http://vista.cira.colostate.edu/views/)

ammSO4f – ammonium sulfate
ECf – elemental carbon (soot)
Soilf – fine particle (usually soil)

FIGURE 4-2
Nitrate Source Contributions for 2002, Mount Rainier National Park Based on Source Apportionment Simulations Conducted by WRAP
Source (http://www.coha.dri.edu/)



5.0 Conclusion

Costs, visibility improvement, and other environmental impacts were considered for four cases: the projected emissions after completion of the Flex Fuel Project, installation of SNCR, presumptive BART (installation of SCR on one unit), and installation of SCR on both units. The emissions after completion of the Flex Fuel Project were assumed to be the base case because the project is expected to result in a reduction in emissions when compared with the recent past emissions. Although the cost of the Flex Fuel Project is considerable, because it is the base case its costs were not incorporated in the analysis.

The implementation of NOx and SO_2 BART controls from 2000 to 2002 resulted in about 86,000 tons of emission reductions at an average cost of about $300 per ton. Those controls resulted in improving visibility in 10 percent of the days (35/365) and improving visibility by 6.5 dv on the 98th percentile worst day.

The visibility improvements of the Flex Fuel Project over the Pre-NOx Controls impacts are demonstrated clearly in Tables 4-4 through 4-9. For Mt. Rainier National Park, there are 56 fewer days of impacts greater than 0.5 ΔdV for the Flex Fuel Project.

SNCR would result in reducing NOx emissions by about 25 percent or 3,800 tons per year at a cost of about $4,000 per ton. In Mt. Rainier National Park, which is the most impacted Class I area by CPP, the implementation of SNCR would improve CPP's visibility impacts below 0.5 dV on 3 percent of the days (at most 11 days per year) at an annualized cost of at least $1.3 million per day. The expected visibility improvement on the 98th percentile worst day would be an imperceptible 0.69 dv relative to the Flex Fuel Project, at a cost of about $22 million per dv.

Implementing presumptive BART (SCR on one unit) and installing SCR on both units would cost about $6,760per ton and $7,890 per ton, respectively. Although the EPA BART Guidelines do not set a firm cost-effectiveness value, in establishing presumptive BART for tangential-fired unit burning sub-bituminous coal, EPA estimated a national average cost of $281 per ton of NOx removed for units similar to CPP to comply with the presumptive standard.

EPA's background document for establishing BART for electric generating facilities correctly identified CPP as having the level of combustion control burners, LNC3, that were the basis for setting the presumptive standard.

All of the additional technologies that are considered to be technically available by the Centralia Power Plant are at least ten times more expensive than the cost levels that EPA considered for similar units when EPA established the presumptive BART level of 0.15 pounds of NOx MMBtu. CPP has already incurred the costs for NOx controls anticipated in the EPA BART Guidelines.

Further, reduction of CPP's NOx emissions is not likely to have a significant effect on visibility in the Mount Rainier National Park because studies have shown that nitrates only contribute a small portion of the visibility loss. Furthermore, stationary industrial sources,

such as CPP, contribute a small portion of the total NOx, while transportation sources contribute most of the NOx.

The key factors in the BART analysis are cost-effectiveness of available controls and visibility improvement. Based on these considerations and the technologies considered, CPP's current LNC3 technology should be determined to be BART.

6.0 References

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APPENDIX A

Economic Analysis

TransAlta BART Analysis Report Tables

CPP

TABLE 3-1

NO_x Control Technology Emission Rate Ranking

CPP

Technology	Projected Emission Rate
SNCR	0.20
Presumptive BART	0.15
SCR	0.07

TABLE 3-2

NO_x Control Cost Comparison

CPP

Factor	SNCR	Presumptive BART	SCR
Major Materials Design Costs	$ 33.0 Million	$ 102.0 Million	$ 204.0 Million
Total Installed Capital Costs	$ 85.1 Million	$ 276.7 Million	$ 553.3 Million
Total First Year Fixed & Variable O&M Costs	$ 2.9 Million	$ 4.7 Million	$ 8.9 Million
Total First Year Annualized Cost	$ 15.1 Million	$ 44.1 Million	$ 87.7 Million
Power Consumption (MW)	1.41	3.51	7.03
Annual Power Usage (kW-Hr/Yr)	11.4	28.6	57.2
NO_x Design Control Efficiency	24.9%	43.1%	73.4%
Tons NO_x Removed per Year	3,761	6,518	11,112
First Year Average Control Cost ($/Ton of NO_x Removed)	4,007	6,760	7,890
Incremental Control Cost ($/Ton of NO_x Removed)	4,007	10,516	18,696
			9,495

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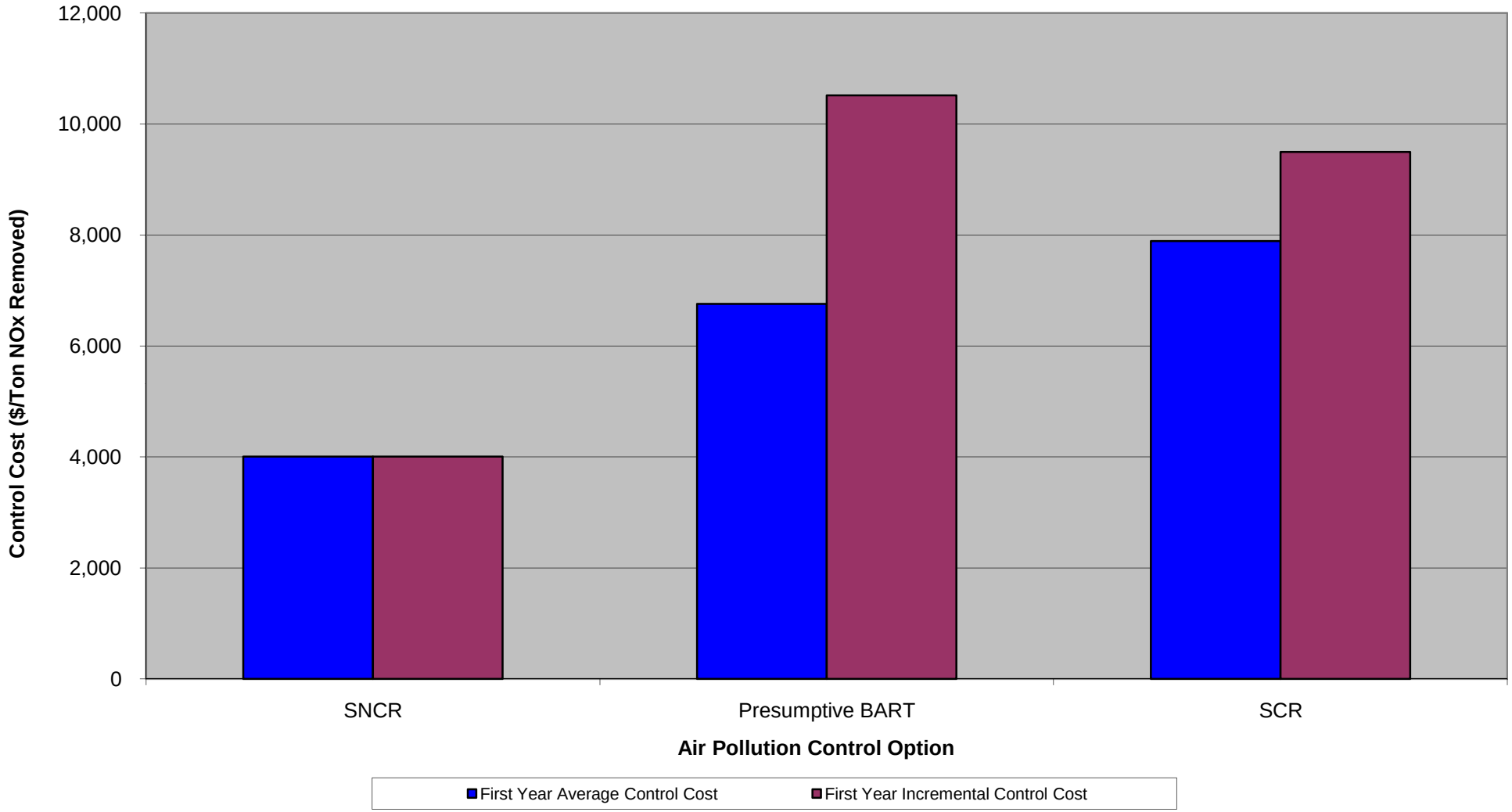
12,000
10,000
8,000
6,000
4,000
2,000
0
Control Cost ($/Ton NOx Removed)
SNCR
Presumptive BART
SCR
Air Pollution Control Option
First Year Average Control Cost
First Year Incremental Control Cost

APS BART Analysis Scenarios

Select Unit:	1	CPP

Index No.	Name of Unit
1	CPP

TransAlta

CPP		
Scenario		**First Year Cost**
Baseline - PRB Flex Fuel Project, Exiting SO2 and PM control		
Scenario 1 - SNCR on both units, Existing SO2 and PM control	**$**	**15,071,941**
	$	15,071,941
Scenario 2 - Unit 1 - SCR, Unit 2 - PRB Flex Fuel Project, Existing SO2 and PM control	**$**	**44,058,078**
	$	44,058,078
Scenario 3 - SCR on both units, Existing SO2 and PM control	**$**	**87,679,369**
	$	87,679,369

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ECONOMIC ANALYSIS SUMMARY

CPP **Boiler Desigr Tangentially Fired**

Parameter	Post-Flex Fuel Project	NOx Control		
		SNCR	Presumptive BART	SCR
NOx Emission Control System	PRB Flex Fuel Project	SNCR	Presumptive BART	SCR
	Forced Oxidation	Forced Oxidation	Forced Oxidation	Forced Oxidation
SO2 Emission Control System	Limestone	Limestone Scrubber	Limestone Scrubber	Limestone Scrubber
PM Emission Control System	Dual ESPs	Dual ESPs	Dual ESPs	Dual ESPs
TOTAL INSTALLED CAPITAL COST ($)	**0**	**85,140,000**	**276,667,200**	**553,334,400**
FIRST YEAR O&M COST ($)				
Operating Labor ($)	0	281,000	175,625	351,250
Maintenance Material ($)	0	562,000	351,250	702,500
Maintenance Labor ($)	0	281,000	175,625	351,250
Administrative Labor ($)	0	0	0	0
TOTAL FIXED O&M COST	**0**	**1,124,000**	**702,500**	**1,405,000**
Reagent Cost	0	1,253,608	1,479,861	2,522,936
SCR Catalyst	0	0	1,053,750	2,107,500
Electric Power Cost	0	572,313	1,430,782	2,861,564
TOTAL VARIABLE O&M COST	**0**	**1,825,921**	**3,964,393**	**7,491,999**
TOTAL FIRST YEAR O&M COST	**0**	**2,949,921**	**4,666,893**	**8,896,999**
FIRST YEAR DEBT SERVICE ($)	0	12,122,021	39,391,185	78,782,370
TOTAL FIRST YEAR COST ($)	**0**	**15,071,941**	**44,058,078**	**87,679,369**
Power Consumption (MW)	**0.0**	**1.4**	**3.5**	**7.0**
Annual Power Usage (kW-Hr/Yr)	**0.0**	**11.4**	**28.6**	**57.2**
CONTROL COST ($/Ton Removed)				
NOx Removal Rate (%)	**0.0%**	**24.9%**	**43.1%**	**73.4%**
NOx Removed (Tons/Yr)	**0**	**3,761**	**6,518**	**11,112**
First Year Average Control Cost ($/Ton NOx Rem.)	**0**	**4,007**	**6,760**	**7,890**
Incremental Control Cost ($/Ton NOx Removed)	**0**	**4,007**	**10,516**	**9,495**
		2-0	2-1	3-2
PRESENT WORTH COST ($)	**0**	**164,764,056**	**474,807,176**	**944,233,106**

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INPUT CALCULATIONS

CPP **Boiler Design** **Tangentially Fired**

Parameter	Post-Flex Fuel Project	NOx Control			Comments
		SNCR	Presumptive BART	SCR	
NOx Emission Control System	PRB Flex Fuel Project	SNCR	Presumptive BART	SCR	
SO2 Emission Control System	Forced Oxidation Limestone Scrubber	Forced Oxidation Limestone Scrubber	Forced Oxidation Limestone Scrubber	Forced Oxidation Limestone Scrubber	
PM Emission Control System	Dual ESPs	Dual ESPs	Dual ESPs	Dual ESPs	
Unit Design and Coal Characteristics					
Type of Unit	PC	PC	PC	PC	
Net Power Output (kW)	702,500	702,500	702,500	702,500	
Net Plant Heat Rate (Btu/kW-Hr)	10,034	10,034	10,034	10,034	
Boiler Fuel	Jacobs Ranch Upper Wyodak	Jacobs Ranch Upper Wyodak	Jacobs Ranch Upper Wyodak	Jacobs Ranch Upper Wyodak	
Coal Heating Value (Btu/Lb)	8,800	8,800	8,800	8,800	
Coal Sulfur Content (wt.%)	0.88%	0.88%	0.88%	0.88%	
Coal Ash Content (wt.%)	6.70%	6.70%	6.70%	6.70%	
Boiler Heat Input, each (MMBtu/Hr)	7,049	14,098	14,098	14,098	
Coal Flow Rate (Lb/Hr)	801,023	1,602,045	1,602,045	1,602,045	
(Ton/Yr)	3,262,886	6,525,772	6,525,772	6,525,772	
(MMBtu/Yr)	57,426,793	114,853,586	114,853,586	114,853,586	
Emissions					
Uncontrolled NOx (Lb/Hr)	1,857	3,715	3,715	3,715	
(Lb/MMBtu)	0.26	0.26	0.26	0.26	
(Lb Moles/Hr)	61.89	123.79	123.79	123.79	
(Tons/Yr)	7,566	15,132	15,132	15,132	
NOx Removal Rate (%)	0.0%	24.9%	43.1%	73.4%	
(Lb/Hr)	0	923	1,600	2,728	
(Lb Moles/Hr)	0.00	30.77	53.32	90.90	
(Ton/Yr)	0	3,761	6,518	11,112	
NOx Emission Rate (Lb/Hr)	1,857	2,791	2,115	987	
(Lb/MMBtu)	0.26	0.20	0.15	0.07	
(Ton/Yr)	7,566	11,371	8,614	4,020	
General Plant Data					
Annual Operation (Hours/Year)	8,147	8,147	8,147	8,147	
Annual On-Site Power Plant Capacity Factor	0.93	0.93	0.93	0.93	
Economic Factors					
Interest Rate (%)	7.00%	7.00%	7.00%	7.00%	
Discount Rate (%)	7.00%	7.00%	7.00%	7.00%	
Plant Economic Life (Years)	10	10	10	10	
Installed Capital Costs					
NOx Emission Control System ($2008)	0	85,140,000	276,667,200	553,334,400	
Total Emission Control Systems ($2008)	0	85,140,000	276,667,200	553,334,400	
NOx Emission Control System ($/kW)	0	121	394	788	
Total Emission Control Systems ($/kW)	0	121	394	788	
Total Fixed Operating & Maintenance Costs					
Operating Labor ($)	0	281,000	175,625	351,250	
Maintenance Material ($)	0	562,000	351,250	702,500	
Maintenance Labor ($)	0	281,000	175,625	351,250	
Administrative Labor ($)	0	0	0	0	
Total Fixed O&M Cost ($)	0	1,124,000	702,500	1,405,000	
Annual Fixed O&M Cost Escalation Rate (%)	2.00%	2.00%	2.00%	2.00%	
Reagent Cost	None	Urea	Anhydrous NH3	Anhydrous NH3	
Unit Cost ($/Ton)	0.00	370	400	400	
($/Lb)	0.000	0.185	0.200	0.200	
Molar Stoichiometry	0.00	0.45	1.00	1.00	
Reagent Purity (Wt.%)	100%	100%	100%	100%	
Reagent Usage (Lb/Hr)	0	832	908	1,548	
First Year Reagent Cost ($)	0	1,253,608	1,479,861	2,522,936	
Annual Reagent Cost Escalation Rate (%)	2.00%	2.00%	2.00%	2.00%	
SCR Catalyst / FF Bag Replacement Cost			SCR Catalyst	SCR Catalyst	
Annual SCR Catalyst (m3)	0	0	351	703	
SCR Catalyst ($/m3)	3,000	3,000	3,000	3,000	
First Year SCR Catalyst	0	0	1,053,750	2,107,500	
Annual SCR Catalyst	2.00%	2.00%	2.00%	2.00%	
Auxiliary Power Cost					
Auxiliary Power Requirement (% of Plant Output)	0.00%	0.20%	0.50%	1.00%	
(MW)	0.00	1.41	3.51	7.03	
Unit Cost ($2008/MW-Hr)	50.00	50.00	50.00	50.00	
First Year Auxiliary Power Cost ($)	0	572,313	1,430,782	2,861,564	
Annual Power Cost Escalation Rate (%)	2.00%	2.00%	2.00%	2.00%	

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Input Tables

Table 1 - Cases

Index No.	Name of Unit | Case --->	Existing	NOx Control 1	2	3
1	CPP	Post-Flex Fuel Project	SNCR	Presumptive BART	SCR

Presumptive BART is where one unit has SCR and one has the flex fuel option

Table 2 - Unit Design and Coal Characteristics

		Current Emission Control Systems			Unit Design				Coal Quality			
Index No.	Name of Unit	NOx	SO2	PM	Boiler Design	Net Power Output (kW)	Net Plant Heat Rate (Btu/kW-Hr)	Capacity Factor (%)	Coal	Heating Value, HHV (Btu/Lb)	Sulfur Content (Wt.%)	Ash Content (Wt.%)
1	CPP	PRB Flex Fuel Project	Forced Oxidation Limestone Scrubber	Dual ESPs	Tangentially Fired	702,500	10,034	93%	Jacobs Ranch Upper Wyodak	8,800	0.880%	6.700%

Fuel quality data are averages from the coal data table within the report

Table 3 - Emissions

		Current Emission Rates (Lb/MMBtu)[1]			NOx Control		
Index No.	Name of Unit	SO2	NOx	PM	1	2	3
1	CPP		0.264		0.20	0.15	0.07

Table 4 - Case 1 O&M Costs (Current Operation)

		Annual Fixed O&M Costs				Variable Operating Requirements			
Index No.	Name of Unit	Oper. Labor	Maint. Materials	Maint. Labor	Admin. Labor	Makeup Water Use (Gpm)	Reagent	Reagent Molar Stoich.	Aux. Power Usage (MW)
1	CPP	$ -	$ -	$ -	$ -	-	None	-	-

Table 6 - Case 3 O&M Costs (SNCR)

		Annual Fixed O&M Costs				Variable Operating Requirements			
Index No.	Name of Unit	Oper. Labor	Maint. Materials	Maint. Labor	Admin. Labor	Makeup Water Use (Gpm)	Reagent	Reagent Molar Stoich.	Aux. Power Usage (MW)
1	CPP	$ 281,000	$ 562,000	$ 281,000	$ -	-	Urea	0.45	1.41

Table 8 - Case 5 O&M Costs (Unit 1 - SCR/Unit 2 - No change)

		Annual Fixed O&M Costs				Variable Operating Requirements				
Index No.	Name of Unit	Oper. Labor	Maint. Materials	Maint. Labor	Admin. Labor	Makeup Water Use (Gpm)	Reagent	Reagent Molar Stoich.	Annual SCR Catalyst Replace. (m3)	Aux. Power Usage (MW)
1	CPP	$ 175,625	$ 351,250	$ 175,625	$ -	-	Anhydrous NH3	1.00	351	3.51

Table 9 - Case 6 O&M Costs (SCR)

		Annual Fixed O&M Costs				Variable Operating Requirements				
Index No.	Name of Unit	Oper. Labor	Maint. Materials	Maint. Labor	Admin. Labor	Makeup Water Use (Gpm)	Reagent	Reagent Molar Stoich.	Annual SCR Catalyst Replace. (m3)	Aux. Power Usage (MW)
1	CPP	$ 351,250	$ 702,500	$ 351,250	$ -	-	Anhydrous NH3	1.00	703	7.03

Table 12 - Major Materials Design and Supply Costs

		NOx Control		
Index No.	Name of Unit | Case --->	1	2	3
1	CPP	$ 33,000,000	$ 102,000,000	$ 204,000,000
		2 - SNCR	1 - SCR	2 - SCR

Notes

Economic spreadsheet costs are based on two units

Baseline based on the future emission rate of 0.264 lb/MMBtu

SNCR capitol cost based on ~$40/kW/unit with 50% complexity factor therefore ~$60/kW/unit

SCR capitol cost based on ~$250/kW/unit with 50% complexity factor therefore ~$375/kW/unit

SNCR and SCR cost has additional 50% complexity factor

Case 2 emission rate of 0.15 lb/MMBtu is an average of both units.

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CAPITAL COST

CPP

Parameter	NOx Control					
	SNCR		Presumptive BART		SCR	
NOx Emission Control System	SNCR		Presumptive BART		SCR	
SO2 Emission Control System	Forced Oxidation Limestone Scrubber		Forced Oxidation Limestone Scrubber		Forced Oxidation Limestone Scrubber	
PM Emission Control System	Dual ESPs		Dual ESPs		Dual ESPs	
CAPITAL COST COMPONENT	**Factor/Source**	**Cost**	**Factor/Source**	**Cost**	**Factor/Source**	**Cost**
SNCR or SCR		**SNCR**		**SCR**		**SCR**
Major Materials Design and Supply	**Vendor**	**$33,000,000**	**Vendor**	**$102,000,000**	**Vendor**	**$204,000,000**
Construction	**50.0%**	$16,500,000	**50.0%**	$51,000,000	**50.0%**	$102,000,000
Balance of Plant	**50.0%**	$16,500,000	**50.0%**	$51,000,000	**50.0%**	$102,000,000
Electrical (Allowance)	**5.0%**	$1,650,000	**5.0%**	$5,100,000	**5.0%**	$10,200,000
Owner's Costs	**10.0%**	$3,300,000	**10.0%**	$10,200,000	**10.0%**	$20,400,000
Surcharge	**16.0%**	$5,280,000	**16.0%**	$16,320,000	**16.0%**	$32,640,000
AFUDC	**12.0%**	$3,960,000	**12.0%**	$12,240,000	**12.0%**	$24,480,000
Subtotal		**$80,190,000**		**$247,860,000**		**$495,720,000**
Lost Generation at $20.00/MWhr and 42 days[1]				$13,507,200		$27,014,400
Contingency	**15.0%**	$4,950,000	**15.0%**	$15,300,000	**15.0%**	$30,600,000
Total Capital Cost for SNCR or SCR		**$85,140,000**		**$276,667,200**		**$553,334,400**

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APPENDIX B

Modeling Analysis

BART Determination Modeling Analysis
TransAlta Centralia Generation Power Plant

Centralia, Washington

Prepared for:

TransAlta Centralia Generation

913 Big Hanaford Road
Centralia, Washington 98531

January 2008

Project No. 12530.002

Geomatrix

BART Determination Modeling Analysis

TransAlta Centralia Generation Power Plant

Centralia, Washington

Prepared for:

TransAlta Centralia Generation
913 Big Hanaford Road
Centralia, Washington 98531

Prepared by:

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January 2008

Project No. 12530.002

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BART DETERMINATION MODELING ANALYSIS

TransAlta Centralia Generation Power Plant
Centralia, Washington

1.0 INTRODUCTION

Geomatrix conducted a regional air quality modeling study to support a Best Available Retrofit Technology (BART) determination analysis for TransAlta's Centralia Generation Power Plant (CPP). Under Washington State Department of Ecology (Ecology) and Environmental Protection Agency (EPA) rules and guidance, sources subject to BART must conduct modeling analyses to assess the relative merits of different control strategies to improve visibility in Class I areas.[1]

CPP has two coal-fired units with a total generating capacity of 1,405 MW that are subject to BART. The control strategies assessed in this study are for emissions of oxides of nitrogen (NOx) from these two coal-fired units. Ecology and EPA have determined that controls installed during 2000-2002 at CPP meet BART requirements for sulfur dioxide (SO_2) and PM_{10} (particles with aerodynamic diameters less than 10 µm) emissions. TransAlta's position is BART for NOx was also installed in the 2000 to 2002 period, but it has voluntarily agreed to submit a BART determination analysis.

Geomatrix applied the CALPUFF modeling system to assess NOx controls at CPP. The CALPUFF system is recommended by the *BART Guidelines*[1] for such assessments. Idaho Department of Environmental Quality (IDEQ), Oregon Department of Environmental Quality (ODEQ), and Ecology developed a CALPUFF modeling protocol for BART exemption and BART determination analyses ("*BART Modeling Protocol*").[2] The *BART Modeling Protocol* is designed to be conservative and will likely overstate both the impacts of CPP NOx emissions on regional haze and the likely benefits of NOx controls to improve visibility in Class I areas.

The remainder of this report describes a BART determination modeling analysis for NOx emissions from CPP BART-eligible units following the *BART Modeling Protocol*. We will

[1] 40 CFR Part 51. Regional Haze Regulations and Guidelines for Best Available Retrofit Technology Determinations; Final Rule. pg 39129. July 6, 2005. Appendix Y, "Guideline for Best Available Retrofit Technology Determination" (*BART Guidelines*) details EPA's requirements and guidance for states for conducting BART analyses.

[2] *Modeling Protocol for Washington, Oregon, and Idaho: Protocol for the Application of the CALPUFF Modeling System Pursuant to the Best Available Retrofit Technology (BART) Regulation*. Final Version October 11, 2006.

describe the modeling domain and identify any changes to the protocol used in our study. The report includes a discussion of the baseline emission rates used in simulations for the CPP units, how the various NOx controls affected these emission rates, and the manner that sources were characterized in the simulations. The report concludes with a presentation of the dispersion model results.

2.0 BART DETERMINATION ANALYSIS EMISSION RATES

The BART determination analysis compares the benefits of additional NOx controls towards reducing regional haze in Class I areas against the results from a simulation of baseline conditions. While the analysis evaluates only NOx control alternatives, SO_2 and PM_{10} emissions are also included in the simulations to characterize plume chemistry and for the calculation of the total visual extinction attributable to the two units. In this analysis simulations of emissions from the two CPP units are performed for the following six cases:

- Baseline – Maximum 24-hour NOx, SO_2, and PM_{10} emissions during 2003-2005
- Flex Fuel – Projected maximum daily NOx, SO_2, and PM_{10} emissions after the Powder River Basin (PRB) Flex Fuel Project
- SNCR – NOx controlled by selective non-catalytic reduction; SO_2 and PM_{10} emissions as in Flex Fuel
- Presumptive – NOx emissions at the EPA presumptive limit of 0.15 lb/MMBtu; SO_2 and PM_{10} emissions as in Flex Fuel
- SCR - NOx controlled by selective catalytic reduction; SO_2 and PM_{10} emissions as in Flex Fuel
- Pre-NOx Control – Maximum daily NOx, SO_2, and PM_{10} emissions prior to 2000

The *BART Modeling Protocol* requires that the highest daily NOx, PM_{10}, and SO_2 emission rates during 2003-2005 be used for the Baseline case. The period for the baseline emissions matches the timeframe of the meteorological dataset (2003-2005) described in the *BART Modeling Protocol*. The PRB Flex Fuel Project scheduled for 2008 and 2009 will alter the emission rates of CPP and is included in the simulations to assess future conditions without additional NOx controls. The NOx control cases are based on the BART technology assessment results applied to the estimated emission rates following the PRB Flex Fuel Project. TransAlta also asked Geomatrix to characterize the visibility impacts of a Pre-NOx Control (pre-2000) case and

compare the results to the post-NOx control emission cases. The methods used to estimate emission rates for each of the six cases are described in the remainder of this section.

2.1 BASELINE EMISSION RATES

Table 2-1 shows the maximum calendar day NOx, SO_2, and PM_{10} emission rates (daily average pound per hour) for each boiler unit used for the Baseline simulations. Geomatrix constructed the Baseline case from the maximum 24-hour NOx, SO_2, and PM_{10} emissions rates during 2003-2005. We estimated the maximum daily emission rates using historic Continuous Emission Monitoring Systems (CEMS) data for NOx and SO_2. The CEMS database includes hourly NOx and SO_2 emission rates and hourly heat input rates for each boiler unit. Maximum emissions were calculated for each unit and pollutant independently. The highest NOx and SO_2 emissions were not required to occur on the same day, and emissions from the two units were evaluated separately.

Particulate matter emission factors (lb/MMBtu) were calculated from annual unit-specific source tests. PM_{10} emission factors were estimated by summing (1) the measured filterable component (Method 5) multiplied by 0.67 (per AP-42 Table 1.1-6) and (2) the measured condensable fraction (Method 202). Geomatrix calculated the maximum PM_{10} emission rates by multiplying the maximum calendar day boiler heat demands for each year by the corresponding annual unit-specific PM_{10} emission factors. Further details and a description of the source tests can be found in the PRB Flex Fuel Project report.[3]

2.2 PRB FLEX FUEL PROJECT EMISSIONS

Since the closure of its local mine in 2006, TransAlta has been evaluating various sources of coal from the Powder River Basin (PRB) of Wyoming and Montana for use in the CPP boilers. CPP burned blends of local and PRB coal in the past, but is now likely to burn 100 percent PRB coal. The PRB Flex Fuel Project includes several safety and boiler efficiency projects associated with the specific characteristics of PRB coal. The boiler projects will be implemented during outages in the first quarters of 2008 and 2009. Future NOx, SO_2, and PM_{10} emissions will be lower than the Baseline case. SO_2 and NOx emission rates for the Flex Fuel case are based on the maximum sustained demand from the coal with the highest nitrogen and sulfur contents (Jacobs Ranch Upper River Wyodak coal). PM_{10} emission rates were calculated from source tests in 2005/2006 using Eagle Butte coal with a maximum sustained load of 7,059 MMBtu/hr.

[3] Geomatrix, 2007. *Air Quality Permit Applicability Assessment, Boiler Efficiency Project.* Prepared for TransAlta, 913 Big Hanaford Road, Centralia, WA 98531. Geomatrix Project No.12530.001, September 2007.

2.3 NOx Control cases

The BART determination analysis examined four cases with lower NOx emissions than the Baseline case. NOx emissions for these cases are compared in Table 2-3. Maximum daily NOx emissions for the Flex Fuel case are described above. In addition to the switch to PRB coal, the control technology review identified two NOx control strategies for the BART determination analysis: SNCR and SCR. A third case was added where the NOx emission factor was set at the EPA BART presumptive limit of 0.15 lb/MMBtu for dry-bottom tangential fired units burning sub-bituminous coal. The presumptive limit for NOx could be attained with SCR installed on only one of the two units and/or SCR on both units using less catalyst. In all instances, it was assumed the two CPP units would burn the PRB coal with the highest NOx potential and the units would be operating at the maximum sustainable heat demand associated with that coal.

Table 2-4 summarizes the NOx, SO_2 and PM_{10} emission rates used for the BART determination analysis simulations. Our assessment assumes maximum daily SO_2 and PM_{10} emissions can be characterized by the estimates for the Flex Fuel case. SO_2 and PM_{10} emissions are considerably lower than the Baseline because of the switch to PRB coal.

2.4 Pre-NOx Control Emissions

Geomatrix also included CALPUFF simulations of maximum daily emissions for the CPP coal-fired boilers prior to NOx controls. The Pre-NOx Control emissions are compared to the NOx, SO_2, and PM_{10} emissions from the other five cases in Table 2-4. The Pre-NOx Control CPP emission rates are based on a combination of data from the RACT Order Technical Support Document and sources tests conducted in 1996. Assumptions used for the derivation are listed in the footnotes to Table 2-4.

2.5 Stack Parameters

Stack parameters for the BART determination analysis CALPUFF simulations are shown in Table 3-3. Stack parameters prior to the NOx controls were taken from a modeling analysis conducted by the National Park Service (NPS).[4] As in the NPS analysis, we assumed the emissions from both CPP units could be simulated as a release from a single stack. Since the actual stacks of the two boilers were separated from one another, the flow rates were not combined.

[4] Vimont, J.C., 1996. *Modeling Analysis of the Centralia Power Plant*. National Park Service, Air Resources Division, PO Box 25287, Denver, CO 80225, September 1996.

Stack parameters for the Baseline and NOx control cases were based on the CEMS database from 2003-2005. The exit velocities and temperatures are the averages from the three-year period. The exit temperature is lower than the Pre-NOx Control case due to the installation of the wet-scrubber. The two boiler stacks are now next to one another, encased is a large common structure, and the plumes combine on exit. In order to consider the enhanced plume rise of the combined release, emissions from the two units were simulated as a single stack with double the cross-sectional area.

3.0 CALPUFF MODELING PROCEDURES

Geomatrix applied the CALPUFF modeling system to assess potential decreased regional haze in Class I areas caused by the SO_2, NOx, and PM_{10} emissions in the BART determination cases described in the previous section. Features of the CALPUFF modeling system include the ability to consider: secondary aerosol formation; gaseous and particle deposition; wet and dry deposition processes; complex three-dimensional wind regimes; and the effects of humidity on regional visibility.

Geomatrix used Version 6.112 of the CALPUFF modeling system for the simulations per the recommendations of the *BART Modeling Protocol* for Washington, Oregon, and Idaho.[5] The simulations were performed using a 2003-2005 meteorological database prepared by Geomatrix for BART related analyses in the three states. With the exception of the ozone data discussed in Section 3.2, the CALPUFF modeling procedures follow the *BART Modeling Protocol*.

3.1 CALPUFF DOMAIN AND RECEPTORS

Figure 3-1 displays the CALPUFF modeling domain within the larger CALMET domain used for BART simulations in Washington, Oregon and Idaho. The CALPUFF computation domain was selected using a circle with a 300 kilometer (km) radius surrounding CPP. All Class I areas located inside of the circle are included in the BART exemption modeling. The CALPUFF computation domain includes a buffer of approximately 50 km from any Class I area touched by the 300-km circle.

Figure 3-2 shows the CALPUFF domain and the Class I areas considered in the analysis. The 12 Class I areas included in the visibility impact analysis include: Alpine Lakes Wilderness, Glacier

[5] Although a later version of the modeling system is now available, Ecology requests Version 6.112 be applied for consistency with previously submitted BART exemption analyses from other sources. This version of the CALPUFF modeling system is also compatible with a large meteorological database prepared on Ecology's behalf by Geomatrix for BART simulations.

Peak Wilderness, Goat Rocks Wilderness, Mt. Adams Wilderness, Mt. Hood Wilderness, Mt. Jefferson Wilderness, Mt. Rainier National Park, Mt. Washington Wilderness, North Cascades National Park, Olympic National Park, Pasayten Wilderness, and the Three Sisters Wilderness. At Ecology's request, the Columbia River Gorge National Scenic Area (CRGNSA) was also included in the visibility impact analysis to provide information to interested parties.

Receptor locations and elevations for the Class I areas were obtained from a database available from the NPS.[6] Receptor locations and elevations for the Columbia River Gorge National Scenic Area were provided by Ecology. In addition to the Class I area receptors, CALPUFF predictions were also obtained at each grid point within the 4-km mesh size computational domain. These receptors were used only for diagnostic purposes.

3.3 OZONE DATA

The *BART Modeling Protocol* recommends a constant ozone background concentration of 60 ppb for BART simulations. However, it has become common practice for both BART analyses and New Source Review assessments of Class I areas to use actual ozone observations within Washington, Oregon, and Idaho for background. ODEQ prepared such a database that is available for BART sources to use in their assessments.

The ODEQ database does not contain Canadian monitoring data and the modeling domain shown in Figure 3-3 extends into British Columbia. Geomatrix supplemented the ODEQ ozone database for 2003-2005 by adding data from seven monitoring stations in southern British Columbia. The database was submitted by Geomatrix and subsequently approved by Ecology for BART and New Source Review analyses.[7]

3.4 CALPUFF EMISSION DATA

Section 2 of this report presented the highest daily NOx, PM_{10}, and SO_2 emission rates used for the simulations for each CPP BART determination case. Prior to the simulations, PM_{10} emissions must be divided into one to six species, including: soot or elemental carbon (EC), fine soil particles (PMF), coarse particles (PMC), organic carbon (OC), sulfate (SO_4), and nitrate (NO_3). These species have different scattering efficiencies that when combined with relative humidity adjustment factors and predicted aerosol concentrations are used to calculate visual extinction.

[6] Receptor locations, elevations, and boundaries for each Class I area can be obtained from the NPS at: http://www2.nature.nps.gov/air/maps/Receptors/index.cfm.

[7] Email from Clint Bowman, Ecology to Ken Richmond, Geomatrix, Subj: *Addition of BC Ozone Observations to Ozone.dat.* December 20, 2007.

Table 3-1 shows the PM_{10} speciation assumed for the simulations. Geomatrix used two of the PM_{10} profiles provided by the NPS for BART and New Source Review Class I assessments.[8] For the Pre-NOx Control case we used the NPS profile for a dry-bottom boiler burning pulverized coal controlled with an electrostatic precipitator (ESP). The Baseline and four NOx control cases use the speciation profile for a dry-bottom boiler burning pulverized coal controlled with ESP and flue-gas desulfurization. The NPS profiles depend on the sulfur and ash content of the coal. The qualities of the coal assumed by Geomatrix are listed in the footnotes for Table 3-1.

A summary of the CALPUFF simulation emission rates is shown Table 3-2. The NPS profile spreadsheets divide PM_{10} emissions into PMC, PMF, EC, OC, ammonium nitrate, and ammonium sulfate. SO_4 and NO_3 emissions in the CALPUFF input files were calculated based on the respective ammonium sulfate and ammonium nitrate in the NPS profile after accounting for the change in molecular weight. To avoid double counting of the sulfur emitted by the units, SO_2 emissions were reduced slightly to account for the sulfur assumed to be formed in the condensable PM_{10} fraction.

3.5 CALPOST POST-PROCESSING

Geomatrix applied CALPOST to post-process the CALPUFF output files and calculate the change to the Haze Index (HI) predicted by aerosols emitted and formed from the CPP units. Background HIs for each Class I area were calculated using CALPOST Method 6 and the monthly average relative humidity adjustment factors and aerosol concentrations listed in Appendix B of the *BART Modeling Protocol*. The background extinction in the protocol represents the hypothetical "natural" background on the 20 percent best visibility days of the year.

As recommended by the *BART Guidelines*, Geomatrix used the 98th percentile change to the daily Haze Index (ΔHI), in units of deciviews (dv), as a visibility metric to assess the significance of results from the six emission cases. The 98th percentiles within each Class I area were estimated from the 8th highest ΔHI of each year and the 22nd highest in three-years. The time-series lists in the CALPOST output files that show the maximum daily ΔHI within each Class I area were sorted to obtain the required 98th percentiles.

Geomatrix also summarized the simulations of each BART determination case by comparing the number of days where the predicted ΔH exceeds 0.5 dv within each Class I area. This is the

[8] The NPS speciation profiles were downloaded from http://www2.nature.nps.gov/air/permits/ect/index.cfm

screening criterion for BART exemption. According to *BART Guidelines*, a ΔHI of less than 0.5 dv when compared to natural conditions does not cause or contribute to impairment of visibility.

4.0 BART DETERMINATION MODELING RESULTS

Table 4-1 displays the number of days in three years predicted by the CALPUFF modeling system where the ΔHI significance criterion of 0.5 dv was exceeded for each Class I area and emission case. The number of days in three years exceeding the screening criterion range in the Pre-NOx Control case from 611 days in Mt. Rainier National Park to 232 days in the Mt. Washington Wilderness. In areas of interest, the mean number of days exceeding 0.5 dv is reduced by about 50 percent overall in the Flex Fuel case compared with the Pre-NOx Control case, and by 80 percent in the SCR case.

The reduction in the number of days at Mt. Rainier National Park from the Pre-NOx Control to Flex Fuel case is somewhat less (27 percent) than predicted for the other Class I areas. The screening criterion is assessed using extremely low hypothetical "natural" background extinction. For the cases with higher CPP emissions, it only takes a few hours of the CPP plume brushing the edge of the Park for the criterion to be exceeded. In these instances, the number of days exceeding the 0.5 dv ΔHI significance level tends to be more a function of the meteorology than the magnitude of the SO_2, NOx, and PM_{10} emissions.

Table 4-2 presents the three-year 98th percentile ΔHI predicted for each Class I area and emission case. This metric is related both to the frequency and magnitude of the predicted change to the haze index. The highest potential decreases to regional haze are predicted in Mt. Rainier National Park followed by the Alpine Lakes Wilderness, Goat Rocks Wilderness, and the Olympic National Park. The mean 98th percentile ΔHI for all areas of interest under the Flex Fuel case is about 25 percent of the prediction for Pre-NOx Control emissions. For Mt. Rainier National Park, the 98th percentile ΔHI predicted by the Flex Fuel simulation is 33 percent of the same value predicted with Pre-NOx Control emissions.

The yearly 98th percentile ΔHI for each of three years is shown in Table 4-3. In almost all instances the higher visibility impacts are predicted during 2004 and the lowest occur during 2005. For some of the Class I areas and emission cases, there is about a factor-of-two difference with the 98th percentile ΔHI predicted for 2004 versus 2005.

The highest predicted extinction for all cases and years occurs within Mt. Rainier National Park. Figure 4-1 and Figure 4-2 show time-series of the predicted maximum daily ΔHI in Mt. Rainier National Park for the six emission cases. The highest potential changes to the HI occur during the summer for most of the emission cases due to favorable meteorology and conditions conducive to sulfate formation. Although the CALPUFF chemistry algorithms favor nitrate formation during wintertime stagnation episodes, plumes from CPP tend to be transported away from Mt. Rainier National Park under such conditions.

Appendix A lists the CPP aerosol related extinction budgets on the design days for each Class I area, period and emission scenario.[9] The CPP extinction budgets for design days are dominated by the sulfate fraction in the Pre-NOx Control case and the nitrate fraction in the Flex Fuel case. Typically in the Pre-NOx Control simulations, over 72 percent of the extinction on the design days is cased by sulfate. For the Flex Fuel case, the design day extinction budgets from CPP are caused primarily by nitrate aerosols. The non-hygroscopic components of the PM_{10} emissions do not contribute significantly to the overall visibility impairment on the worst days.

Figure 4-3 shows the average extinction budget for the top 22 days with the highest ΔHI predicted for Mt. Rainier National Park. The extinction budgets for Mt. Rainier National Park are similar to those predicted for the other areas of interest. Prior to the NOx controls, the CPP related contribution to regional haze consisted primarily of sulfate. As SO_2 emissions are reduced nitrate aerosols tend to dominate the budgets. Under the SCR case, the increased extinction due to CPP emissions within Mt. Rainier National Park is predicted to be an even mixture of both nitrate and sulfate aerosols.

[9] The "design days" are the dates with the corresponding 8th highest ΔHI of each year and the 22nd highest in three-years within each Class I area

TABLES

TABLE 2-1

BASELINE (2003-2005) 24-HOUR MAXIMUM EMISSION RATES

Year	NOx (lb/hr)		SO_2 (lb/hr)		PM_{10} (lb/hr)	
	Unit 1	Unit 2	Unit 1	Unit 2	Unit 1	Unit 2
2003	2,474	2,293	1,898	1,783	91	57
2004	2,440	2,510	2,062	2,460	91	90
2005	2,415	2,496	740	1,135	98	144
Max Rate Used	2,474	2,510	2,062	2,460	98	144
Date of Max	02/28/03	06/17/04	10/13/04	10/13/04	12/16/05	7/12/05
MMBtu/hr on Max day	8,201	8,198	7,516	7,295	8,175	8,461
lb/MMBtu on Max Day	0.302	0.306	0.274	0.337	0.012	0.017

TABLE 2-2

PRB FLEX FUEL PROJECT EMISSION RATES

	NOx [1]		SO_2 [1]		PM_{10}	
	Unit 1	Unit 2	Unit 1	Unit 2	Unit 1	Unit 2
Emission Rate (lb/hr)	1,859	1,859	704	704	61	78
lb/MMBtu	0.264	0.264	0.100	0.100	0.0086	0.011

1. NOx and SO_2 emission rates are based on Jacobs Ranch Upper River Wyodak coal and a maximum sustainable heat domain of 7,049 MMBtu/hr.
2. PM_{10} emission rates based on 2005/2006 source tests with Eagle Butte coal and with a maximum sustainable heat demand of 7,059 MMBtu/hr.

TABLE 2-3

BART NOX EMISSION RATES

Case	Emission Factor (lb/MMBtu)	Heat Demand (MMBtu/hr)	Unit 1 NOx (lb/hr)	Unit 2 NOx (lb/hr)
Flex Fuel	0.264	7,049	1,859	1,859
SNCR	0.200	7,049	1,394	1,394
Presumptive	0.150	7,049	1,057	1,057
SCR	0.070	7,049	493	493

1. NOx emission rates are based on Jacobs River Upper River Wyodak coal.

TABLE 2-4

BART EMISSION RATES BY CASE, TOTAL FOR BOTH UNITS

Case	NOx (lb/hr)	SO_2 (lb/hr)	PM_{10} (lb/hr)
Pre-NOx Control [1]	7,683	32,425	321
Baseline [2]	4,984	4,522	242
Flex Fuel [3]	3,718	1,408	139
SNCR [4]	2,789	1,408	139
Presumptive [5]	2,115	1,408	139
SCR [6]	987	1,408	139

1. Pre-NOx Control emission rates are based on data from the RACT Technical Support Document. NOx emissions use 0.545 lb/MMBtu and 7,049 MMBtu/hr. SO_2 emissions are based on the 1000 ppm emission limit and a combined flow of 5,469,000 acfm. PM_{10} emissions are based on the same flow rate and maximum grain loading from 1996 source tests.
2. Maximum actual 24-hour emissions during 2003-2005
3. PRB Flex Fuel Project
4. NOx emissions controlled by SNCR; SO_2 and PM_{10} are from PRB Flex Fuel Project.
5. NOx based on EPA Presumptive BART emission limit, SO_2 and PM_{10} from PRB Flex Fuel Project
6. NOx emissions controlled by SCR; SO_2 and PM_{10} from PRB Flex Fuel Project.

TABLE 3-3
STACK PARAMETERS

Case	Stack Location xlcc (km)[1]	Stack Location ylcc (km)[1]	Base Elevation (m)[3]	Stack Height (m)	Diameter (m)	Velocity (m/s)	Temperature (K)
Pre-NOx Control [2]	-136.702	-239.551	108.6	143.3	7.32 [4]	29.2	449.8
All Others	-136.702	-239.551	108.6	143.3	12.82 [5]	15.0	332.3

1 Lambert Conic Conformal (LCC) coordinates with reference Latitude 49 North and reference Longitude 121 West.

2 Stack parameters from: Vimont, J.C., 1996. *Modeling Analysis of the Centralia Power Plant*. National Park Service, Air Resources Division, PO Box 25287, Denver, CO 80225, September 1996

3 Source elevation based on bilinear interpolation of the 4-km mesh size terrain used by CALMET

4 The units were simulated as a release from a single stack. The flows were not combined as the actual stacks were separated by more than one stack diameter.

5 The units were simulated as a release from a single stack. The two stacks are next to one another and the flows were combined using an equivalent diameter calculated from the combined area of the two stacks

TABLE 3-1

PM10 SPECIATION

Case	$(NH_4)_2SO_4$	NH_4NO_3	OC	PMC	PMF	EC
Pre-NOx Control [1]	43.96%	0.00%	10.99%	25.03%	19.28%	0.74%
Baseline [2]	22.68%	0.00%	5.67%	39.81%	30.67%	`1.18%
Flex Fuel [3]	39.45%	0.00%	9.86%	28.16%	21.69%	0.83%
SNCR [3]	39.45%	0.00%	9.86%	28.16%	21.69%	0.83%
Presumptive [3]	39.45%	0.00%	9.86%	28.16%	21.69%	0.83%
SCR [3]	39.45%	0.00%	9.86%	28.16%	21.69%	0.83%

1. NPS PM_{10} profile for Dry Bottom Boiler burning pulverized coal with ESP assuming a sulfur content of 0.92%, an ash content of 14.9%, and a heat content of 7,961 Btu/lb

2. NPS PM_{10} profile for Dry Bottom Boiler burning pulverized coal with FGD and ESP assuming a sulfur content of 0.92%, an ash content of 14.9%, and a heat content of 7,961 Btu/lb

3. NPS PM_{10} profile for Dry Bottom Boiler burning pulverized coal with FGD and ESP assuming a sulfur content of 0.9%, an ash content of 6.7%, and a heat content of 8,800 Btu/lb

TABLE 3-2

CALPUFF EMISSION RATES, TOTAL FOR BOTH UNITS

	Maximum 24-hour Emission Rates (lb/hr)								
Case	**SO_2 [1]**	**SO_4**	**NOx**	**HNO_3**	**NO_3**	**OC [2]**	**PMC**	**PMF**	**EC**
Pre-NOx Control	32,375.2	102.6	7,683.0	0.0	0.0	35.3	80.3	61.9	2.4
Baseline	4,502.6	40.0	4,984.0	0.0	0.0	13.7	96.4	74.3	2.9
Flex Fuel	1,388.7	39.9	3,718.0	0.0	0.0	13.7	39.1	30.2	1.2
SNCR	1,388.7	39.9	2,788.5	0.0	0.0	13.7	39.1	30.2	1.2
Presumptive	1,388.7	39.9	2,114.7	0.0	0.0	13.7	39.1	30.2	1.2
SCR	1,388.7	39.9	986.9	0.0	0.0	13.7	39.1	30.2	1.2

1. SO_2 emissions have been reduced by the amount of SO_4 formed in the condensable PM_{10} fraction.
2. OC emissions were actually labeled secondary organic aerosols (SOA) in the CALPUFF input files to facilitate post-processing with CALPOST. This assumes all OC emitted forms SOA with the same molecular weight.

TABLE 4-1

NUMBER OF DAYS WITH PREDICTED CHANGE TO THE HAZE INDEX GREATER THAN 0.5 DECIVIEWS

		Number of Days in 2003-2005 with Delta HI > 0.5 dv					
Area of Interest	**Period**	**Pre-NOx Control**	**Baseline**	**Flex Fuel**	**SNCR**	**Pre-sumptive**	**SCR**
Alpine Lakes Wilderness	2003-2005	569	432	341	300	256	164
Glacier Peak Wilderness	2003-2005	467	275	182	150	113	54
Goat Rocks Wilderness	2003-2005	509	414	335	298	263	169
Mt. Adams Wilderness	2003-2005	443	329	259	224	203	116
Mt. Hood Wilderness	2003-2005	344	224	158	129	112	55
Mt. Jefferson Wilderness	2003-2005	268	130	79	62	47	22
Mt. Rainier National Park	2003-2005	611	505	444	411	367	283
Mt. Washington Wilderness	2003-2005	232	101	58	42	27	13
N. Cascades National Park	2003-2005	407	206	123	96	75	31
Olympic National Park	2003-2005	340	254	208	185	164	109
Pasayten Wilderness	2003-2005	332	141	71	42	31	13
Three Sisters Wilderness	2003-2005	235	105	60	41	30	14
CRGNSA	2003-2005	397	245	156	114	89	36
Overall	Min	232	101	58	41	27	13
	Mean	396	259	190	161	137	83
	Max	611	505	444	411	367	283

TABLE 4-2

PREDICTED CHANGE TO THE 98TH PERCENTILE DAILY HAZE INDEX FOR 2003-2005

		98th Percentile Daily Delta HI (dv) [1]					
Area of Interest	**Period**	**Pre-NOx Control**	**Baseline**	**Flex Fuel**	**SNCR**	**Pre-sumptive**	**SCR**
Alpine Lakes Wilderness	2003-2005	10.458	4.342	2.742	2.271	1.959	1.309
Glacier Peak Wilderness	2003-2005	7.357	2.618	1.754	1.414	1.144	0.744
Goat Rocks Wilderness	2003-2005	9.886	4.281	2.901	2.406	1.983	1.280
Mt. Adams Wilderness	2003-2005	8.683	3.623	2.357	1.952	1.615	1.042
Mt. Hood Wilderness	2003-2005	7.659	2.827	1.821	1.481	1.244	0.777
Mt. Jefferson Wilderness	2003-2005	5.531	1.886	1.138	0.929	0.781	0.505
Mt. Rainier National Park	2003-2005	11.999	5.483	3.922	3.231	2.711	1.798
Mt. Washington Wilderness	2003-2005	4.743	1.411	0.783	0.640	0.546	0.385
N. Cascades National Park	2003-2005	6.395	2.208	1.335	1.086	0.904	0.579
Olympic National Park	2003-2005	9.813	4.019	2.670	2.273	1.874	1.270
Pasayten Wilderness	2003-2005	4.912	1.479	0.902	0.731	0.607	0.397
Three Sisters Wilderness	2003-2005	4.789	1.535	0.901	0.724	0.609	0.405
CRGNSA	2003-2005	6.027	2.351	1.496	1.228	1.030	0.624
Overall	Min	4.743	1.411	0.783	0.640	0.546	0.385
	Mean	7.558	2.928	1.902	1.567	1.308	0.855
	Max	11.999	5.483	3.922	3.231	2.711	1.798

1. Based on the 22nd highest on a Class I area basis

TABLE 4-3

YEARLY PREDICTED CHANGE TO THE 98TH PERCENTILE DAILY HAZE INDEX

		98th Percentile Delta HI (dv) [1]					
Area of Interest	**Year**	**Pre-NOx Control**	**Baseline**	**Flex Fuel**	**SNCR**	**Pre-sumptive**	**SCR**
Alpine Lakes Wilderness	2003	8.664	3.595	2.274	1.868	1.577	1.053
	2004	12.374	4.863	3.283	2.687	2.233	1.532
	2005	8.631	3.852	2.653	2.138	1.748	1.087
Glacier Peak Wilderness	2003	5.875	2.067	1.262	1.027	0.856	0.565
	2004	9.397	3.609	2.154	1.812	1.556	1.058
	2005	6.040	2.550	1.685	1.374	1.143	0.698
Goat Rocks Wilderness	2003	8.749	4.201	2.769	2.228	1.823	1.225
	2004	11.059	4.987	3.350	2.788	2.331	1.548
	2005	9.096	3.821	2.617	2.129	1.757	1.132
Mt. Adams Wilderness	2003	8.858	3.663	2.433	1.989	1.651	1.084
	2004	9.560	3.623	2.350	1.925	1.596	1.073
	2005	8.081	3.376	2.286	1.919	1.593	1.025
Mt. Hood Wilderness	2003	6.963	2.770	1.752	1.433	1.187	0.777
	2004	8.836	3.466	2.111	1.755	1.491	1.029
	2005	6.015	2.156	1.327	1.092	0.918	0.582
Mt. Jefferson Wilderness	2003	5.076	1.568	0.958	0.775	0.642	0.411
	2004	6.274	2.077	1.259	1.021	0.848	0.565
	2005	4.269	1.181	0.745	0.588	0.479	0.293
Mt. Rainier National Park	2003	11.999	5.548	4.027	3.334	2.775	1.807
	2004	13.157	5.445	3.917	3.280	2.750	1.839
	2005	11.129	5.369	3.754	3.130	2.660	1.678
Mt. Washington Wilderness	2003	4.622	1.372	0.836	0.675	0.556	0.355
	2004	6.014	2.024	1.159	0.972	0.820	0.553
	2005	3.012	0.943	0.536	0.432	0.357	0.266
N. Cascades National Park	2003	4.654	1.556	1.056	0.861	0.695	0.410
	2004	8.333	2.816	1.657	1.385	1.184	0.831
	2005	5.448	1.807	1.264	1.005	0.801	0.486
Olympic National Park	2003	8.376	3.846	2.529	2.147	1.859	1.270
	2004	10.557	4.639	2.867	2.401	2.025	1.439
	2005	9.167	3.627	2.542	2.042	1.664	1.012

1. Based on the 8th highest on a Class I area basis

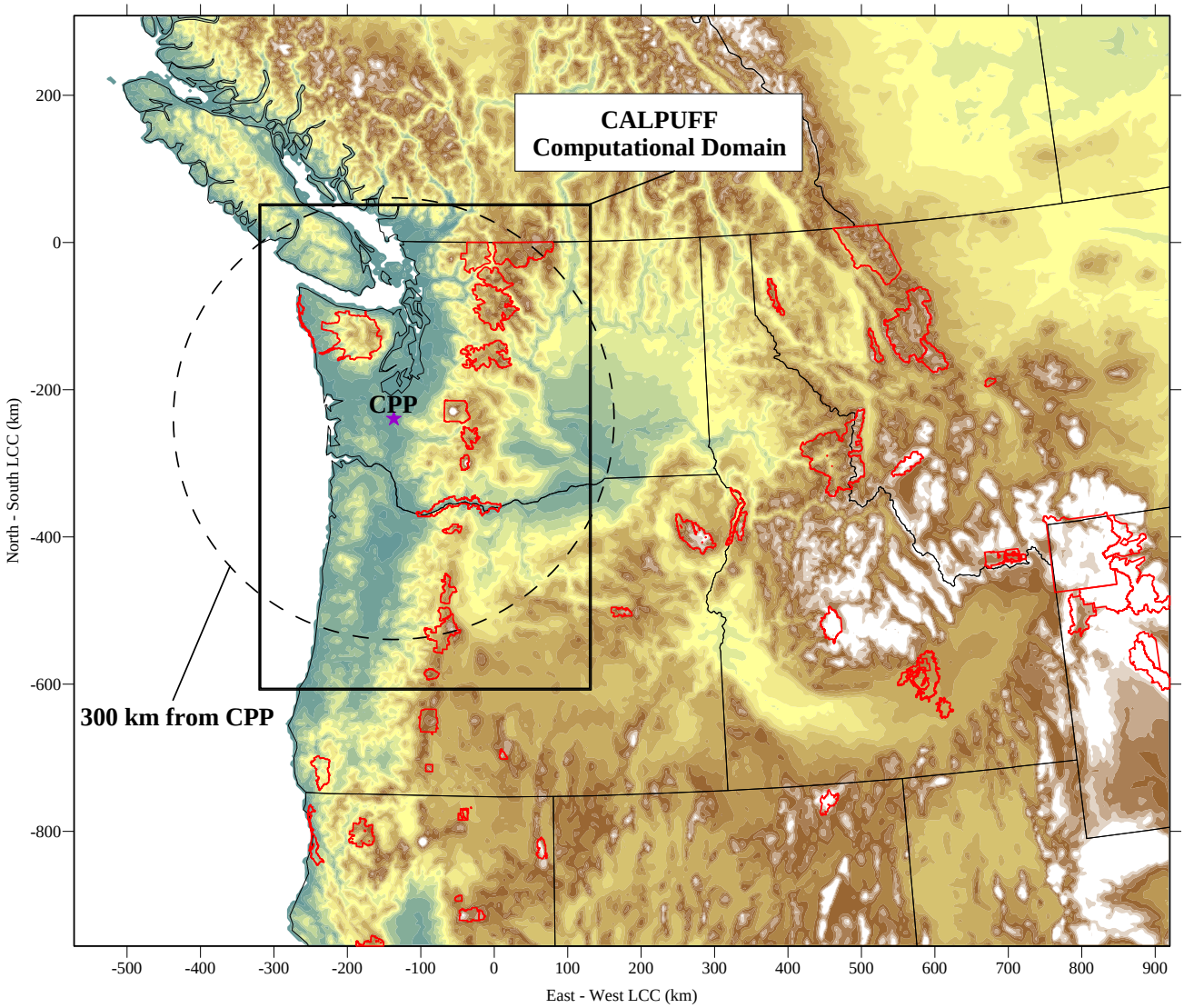
TABLE 4-3 (Continued)

YEARLY PREDICTED CHANGE TO THE 98TH PERCENTILE DAILY HAZE INDEX

	98th Percentile Delta HI (dv) [1]						
Area of Interest	**Year**	**Pre-NOx Control**	**Baseline**	**Flex Fuel**	**SNCR**	**Pre-sumptive**	**SCR**
Pasayten Wilderness	2003	4.291	1.128	0.694	0.552	0.450	0.296
	2004	5.740	1.951	1.154	0.951	0.802	0.535
	2005	4.045	1.170	0.713	0.555	0.457	0.312
Three Sisters Wilderness	2003	4.730	1.535	0.901	0.724	0.594	0.391
	2004	6.101	2.167	1.166	0.980	0.847	0.588
	2005	3.218	1.069	0.574	0.477	0.410	0.270
CRGNSA	2003	5.995	2.429	1.538	1.261	1.056	0.659
	2004	6.795	2.541	1.573	1.307	1.076	0.693
	2005	5.206	1.713	1.168	0.926	0.757	0.442
Overall	Min	3.012	0.943	0.536	0.432	0.357	0.266
	Mean	7.344	2.875	1.869	1.537	1.283	0.843
	Max	13.157	5.548	4.027	3.334	2.775	1.839

1. Based on the 8th highest on a Class I area basis

FIGURES

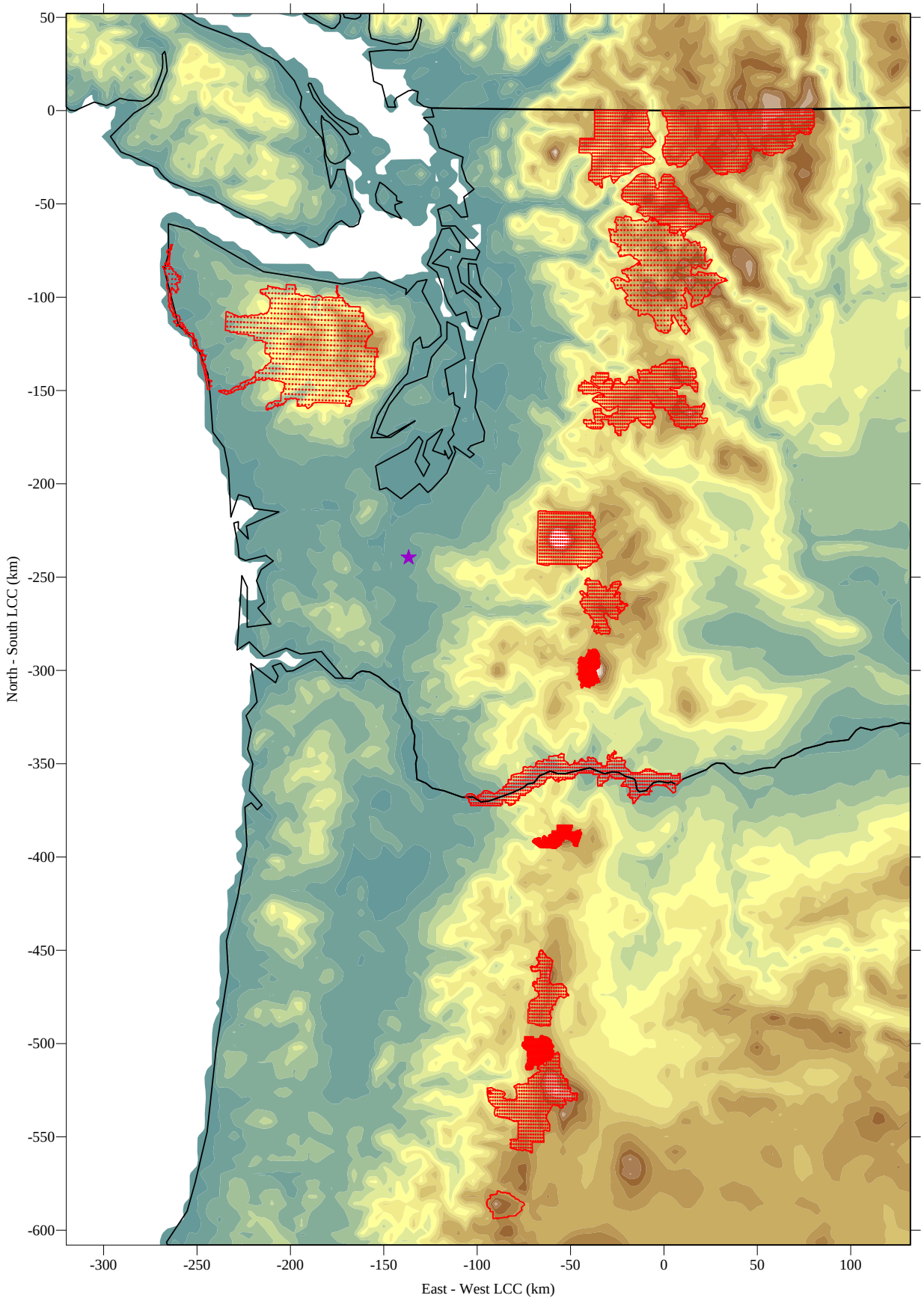


GEOMATRIX

CALMET AND CALPUFF MODELING DOMAINS
TransAlta BART Determination Modeling
Centralia, Washington

Project No.
12530.002.0

Figure
3-1

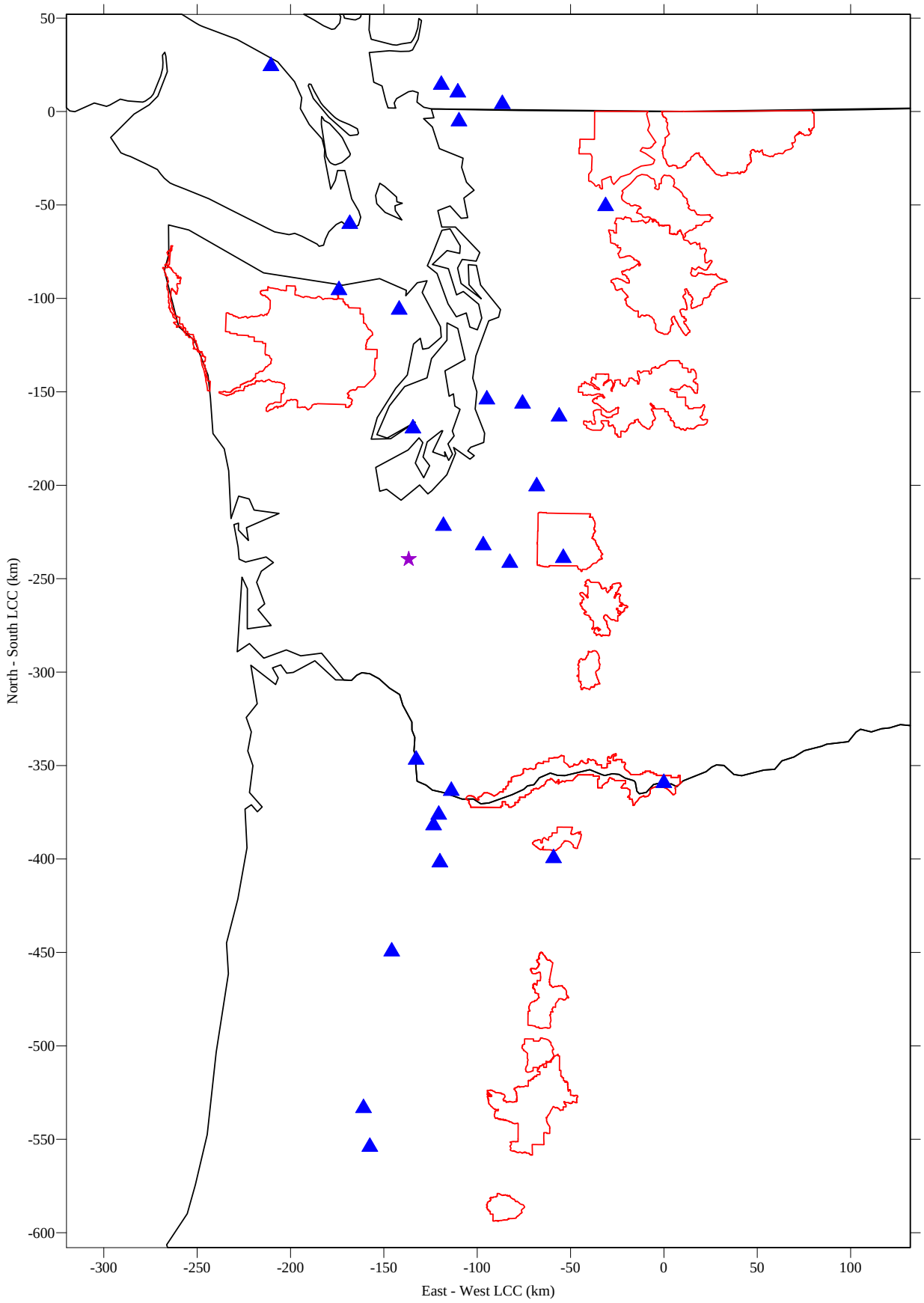


GEOMATRIX

CALPUFF MODELING DOMAIN WITH CLASS I RECEPTORS
TransAlta BART Determination Modeling
Centralia, Washington

Project No.
12530.002.0

Figure
3-2

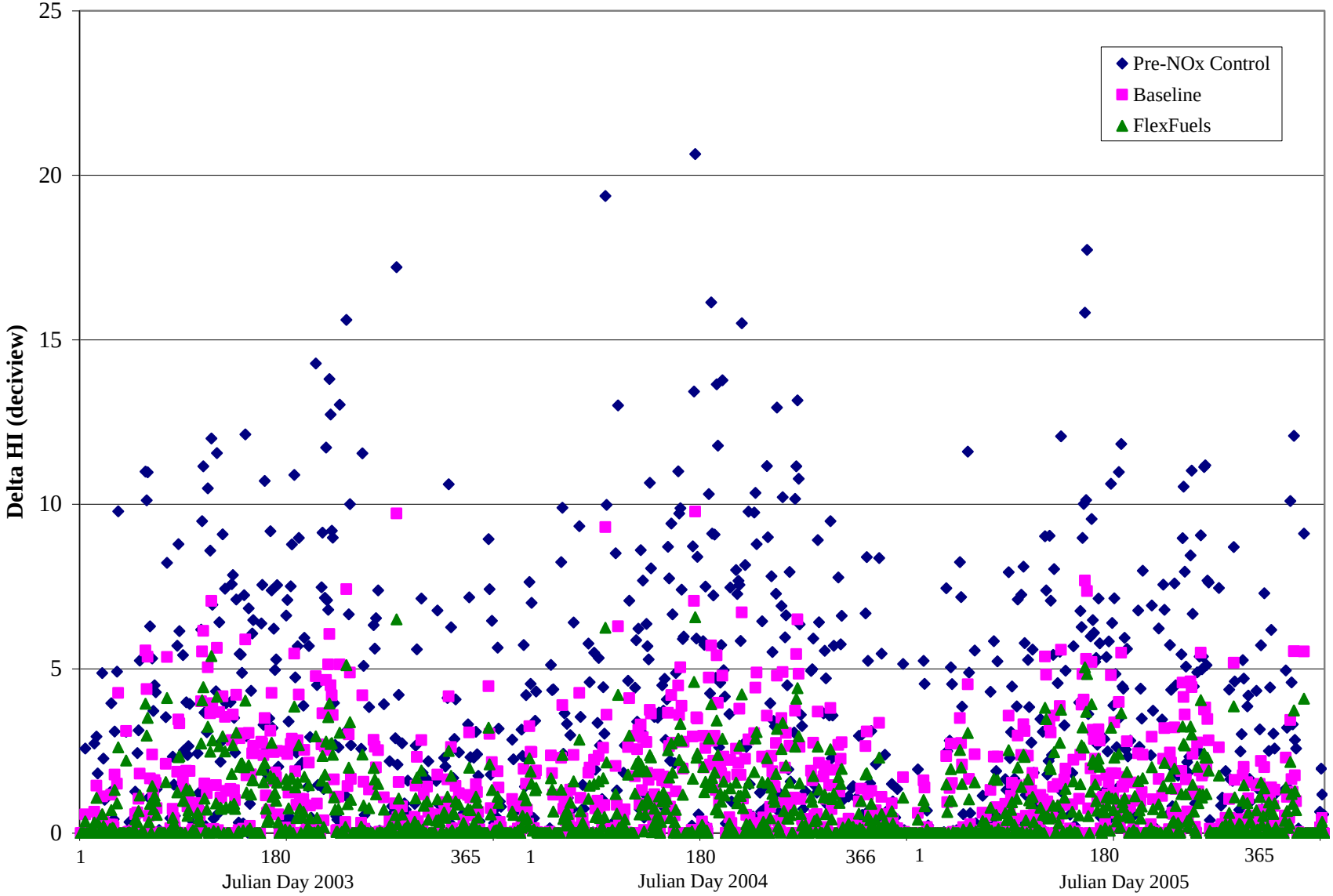


GEOMATRIX

OZONE STATIONS WITHIN DOMAIN
TransAlta BART Determination Modeling
Centralia, Washington

Project No.
12530.002.0

Figure
3-3

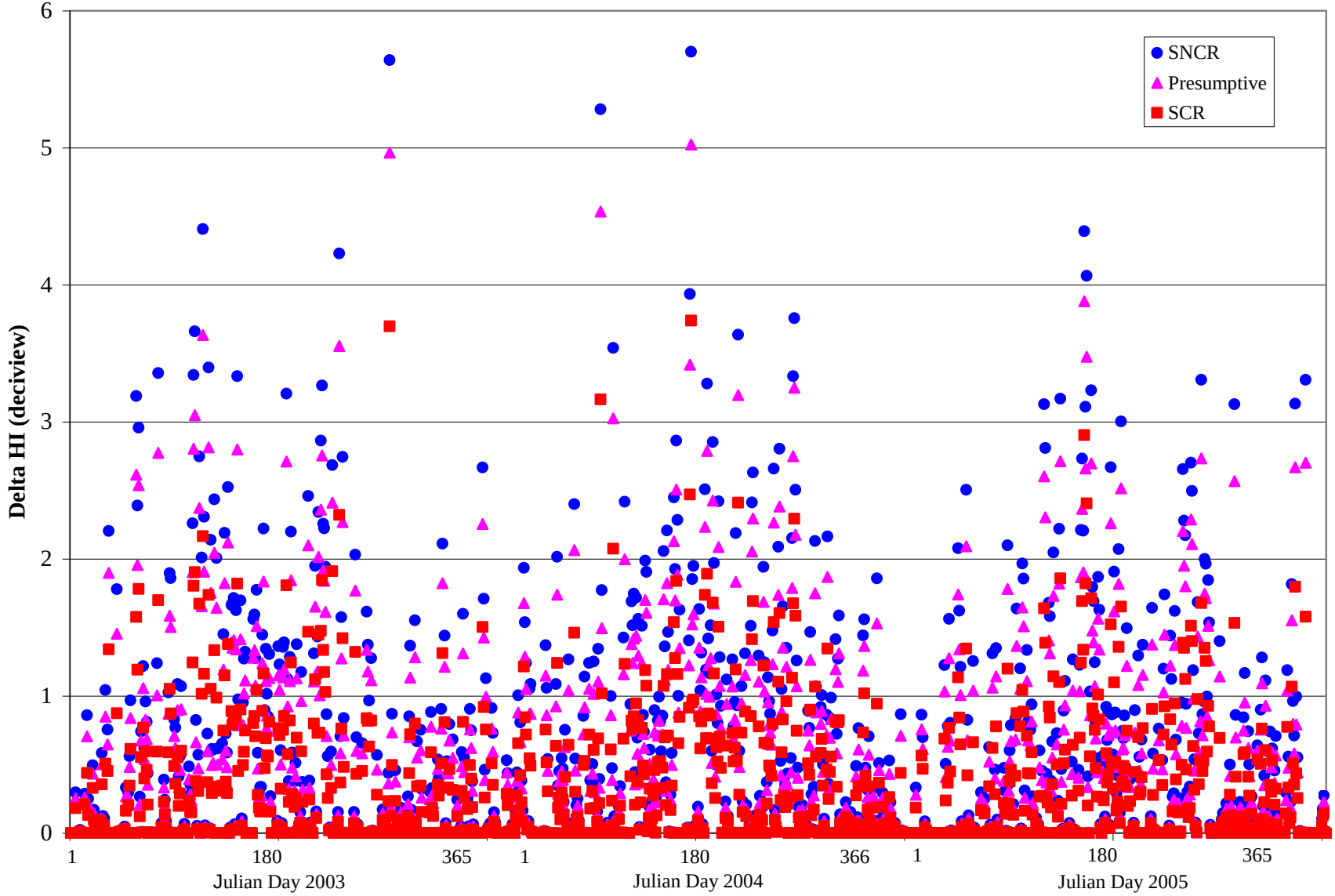


GEOMATRIX

TIME SERIES OF MAXIMUM DAILY DELTA HAZE INDEX FOR MOUNT RAINIER NATIONAL PARK
PRE-NOX CONTROL, BASELINE AND FLEX FUEL CASES
TransAlta BART Determination Modeling
Centralia, Washington

Project No.
12530.002.0

Figure
4-1

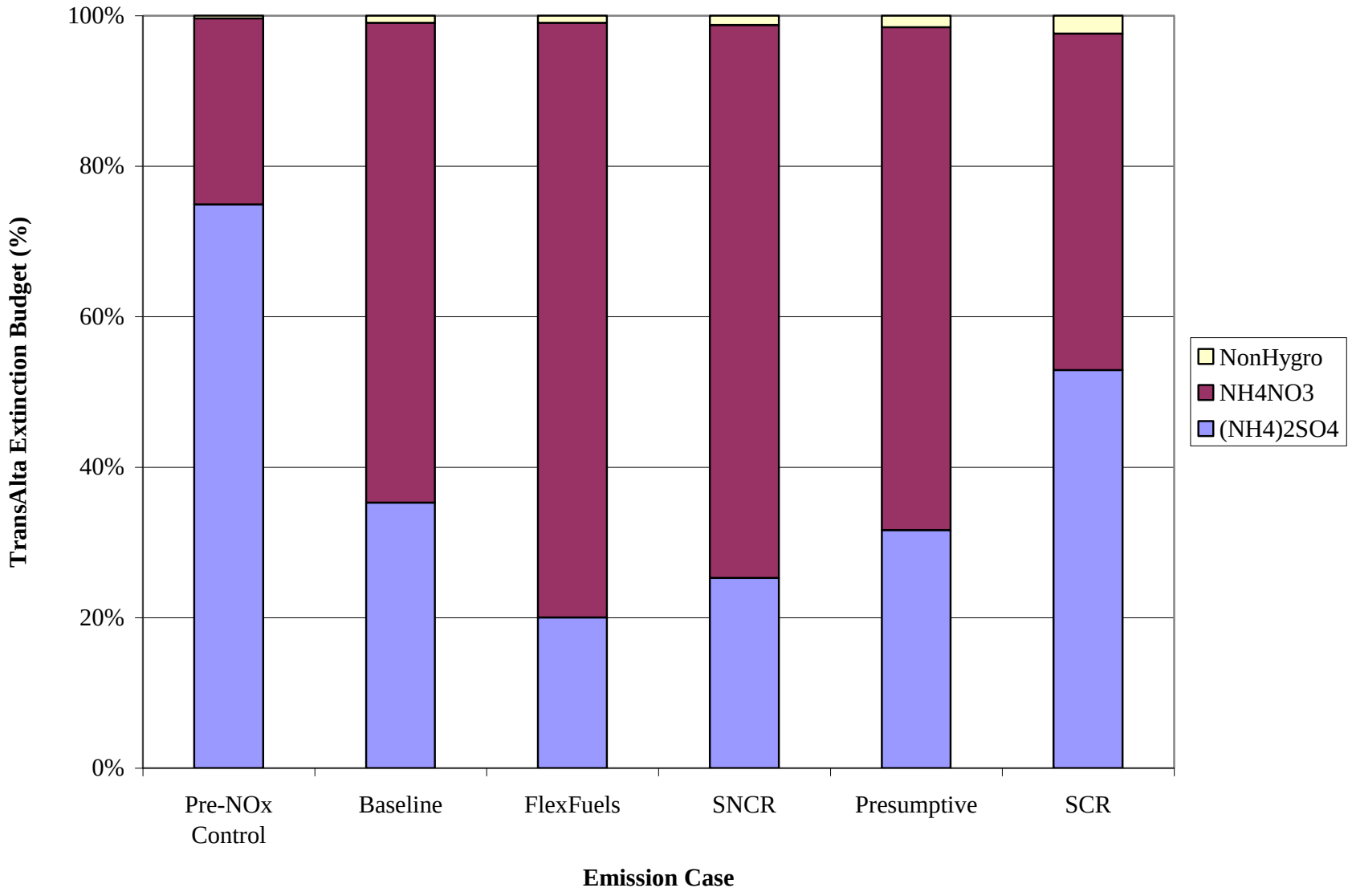


GEOMATRIX

TIME SERIES OF MAXIMUM DAILY DELTA HAZE INDEX FOR MOUNT RAINIER NATIONAL PARK
SNCR, PRESUMPTIVE, AND SCR CASES
TransAlta BART Determination Modeling
Centralia, Washington

Project No.
12530.002.0

Figure
4-2



GEOMATRIX

AVERAGE EXTINCTION BUDGET FOR TOP 22 DAYS IN MOUNT RAINIER NATIONAL PARK (2003-2005)
TransAlta BART Determination Modeling
Centralia, Washington

Project No.
12530.002.0

Figure
4-3

APPENDIX A

BART Determination Analysis Results, Extinction Budgets for Design Days
TransAlta Pre-NOx Control Case

		98th Percentile Paired By Class I Area		Contribution by Species (%)					
Area of Interest	**Year**	**Delta HI (dv)**	**Date**	**SO4**	**NO3**	**OC**	**EC**	**PMC**	**PMF**
Alpine Lakes Wilderness	2003	8.664	8/26/2003	67.6	31.8	0.3	0.1	0.1	0.1
	2004	12.374	5/12/2004	77.3	22.4	0.2	0.0	0.1	0.1
	2005	8.631	10/8/2005	55.6	44.0	0.2	0.0	0.1	0.1
	2003-2005	10.458	3/18/2005	57.1	42.4	0.3	0.1	0.1	0.1
Glacier Peak Wilderness	2003	5.875	8/15/2003	74.0	25.7	0.2	0.0	0.0	0.1
	2004	9.397	9/24/2004	80.7	19.2	0.1	0.0	0.0	0.0
	2005	6.040	10/12/2005	62.2	37.5	0.2	0.0	0.0	0.1
	2003-2005	7.357	8/16/2004	81.9	17.9	0.1	0.0	0.0	0.1
Goat Rocks Wilderness	2003	8.749	3/4/2003	79.7	19.7	0.3	0.1	0.1	0.1
	2004	11.059	6/1/2004	67.4	32.4	0.2	0.0	0.0	0.1
	2005	9.096	12/3/2005	71.5	28.2	0.2	0.0	0.0	0.1
	2003-2005	9.886	9/21/2004	50.5	48.7	0.4	0.1	0.1	0.2
Mt. Adams Wilderness	2003	8.858	4/18/2003	60.7	39.0	0.1	0.0	0.0	0.1
	2004	9.560	8/16/2004	78.3	21.4	0.2	0.0	0.0	0.1
	2005	8.081	7/1/2005	61.3	38.0	0.4	0.1	0.1	0.2
	2003-2005	8.683	6/16/2003	83.8	16.0	0.1	0.0	0.0	0.0
Mt. Hood Wilderness	2003	6.963	2/9/2003	67.3	32.5	0.1	0.0	0.0	0.0
	2004	8.836	9/26/2004	77.1	22.6	0.1	0.0	0.0	0.1
	2005	6.015	5/24/2005	67.1	32.6	0.2	0.0	0.0	0.1
	2003-2005	7.659	6/24/2003	76.1	23.6	0.2	0.0	0.0	0.1
Mt. Jefferson Wilderness	2003	5.076	6/17/2003	82.2	17.6	0.1	0.0	0.0	0.1
	2004	6.274	7/27/2004	81.9	17.9	0.1	0.0	0.0	0.1
	2005	4.269	8/15/2005	84.6	15.1	0.2	0.0	0.0	0.1
	2003-2005	5.531	6/23/2004	83.4	16.5	0.1	0.0	0.0	0.0
Mt. Rainier National Park	2003	11.999	4/25/2003	42.7	56.8	0.2	0.0	0.1	0.1
	2004	13.157	9/22/2004	74.5	25.0	0.3	0.1	0.1	0.1
	2005	11.129	9/15/2005	82.5	16.8	0.4	0.1	0.1	0.2
	2003-2005	11.999	4/25/2003	42.7	56.8	0.2	0.0	0.1	0.1
Mt. Washington Wilderness	2003	4.622	10/14/2003	71.9	27.9	0.1	0.0	0.0	0.0
	2004	6.014	6/28/2004	83.3	16.5	0.1	0.0	0.0	0.1
	2005	3.012	4/27/2005	69.3	30.5	0.1	0.0	0.0	0.1
	2003-2005	4.743	5/15/2004	83.7	16.2	0.1	0.0	0.0	0.0
N. Cascades National Park	2003	4.654	4/14/2003	71.4	28.4	0.1	0.0	0.0	0.1
	2004	8.333	1/3/2004	74.7	25.2	0.1	0.0	0.0	0.0
	2005	5.448	10/12/2005	66.5	33.2	0.2	0.0	0.0	0.1
	2003-2005	6.395	11/5/2004	70.2	29.5	0.2	0.0	0.0	0.1
Olympic National Park	2003	8.376	2/26/2003	57.4	42.4	0.1	0.0	0.0	0.1
	2004	10.557	3/8/2004	77.6	22.1	0.1	0.0	0.0	0.1
	2005	9.167	3/11/2005	68.6	31.2	0.1	0.0	0.0	0.1
	2003-2005	9.813	11/12/2004	46.5	53.1	0.3	0.0	0.1	0.1
Pasayten Wilderness	2003	4.291	2/14/2003	77.9	21.9	0.1	0.0	0.0	0.1
	2004	5.740	4/13/2004	70.2	29.6	0.1	0.0	0.0	0.1
	2005	4.045	7/10/2005	78.3	21.5	0.1	0.0	0.0	0.1
	2003-2005	4.912	11/13/2004	77.6	22.3	0.1	0.0	0.0	0.0
Three Sisters Wilderness	2003	4.730	6/18/2003	82.9	17.0	0.1	0.0	0.0	0.0
	2004	6.101	6/23/2004	81.2	18.7	0.1	0.0	0.0	0.0
	2005	3.218	8/5/2005	89.6	10.1	0.2	0.0	0.0	0.1
	2003-2005	4.789	7/18/2003	87.6	12.2	0.2	0.0	0.0	0.1
CRGNSA	2003	5.995	8/5/2003	81.5	18.1	0.2	0.0	0.1	0.1
	2004	6.795	4/6/2004	66.3	33.4	0.2	0.0	0.0	0.1
	2005	5.206	4/26/2005	77.0	22.6	0.3	0.0	0.1	0.1
	2003-2005	6.027	12/12/2005	66.4	33.4	0.1	0.0	0.0	0.1
Overall	Min	3.012		42.7	10.1	0.1	0.0	0.0	0.0
	Mean	7.397		72.1	27.6	0.2	0.0	0.0	0.1
	Max	13.157		89.6	56.8	0.4	0.1	0.1	0.2

BART Determination Analysis Results, Extinction Budgets for Design Days
TransAlta Baseline Case

		98th Percentile Paired By Class I Area		Contribution by Species (%)					
Area of Interest	**Year**	**Delta HI (dv)**	**Date**	**SO4**	**NO3**	**OC**	**EC**	**PMC**	**PMF**
Alpine Lakes Wilderness	2003	3.595	5/22/2003	31.7	67.2	0.3	0.2	0.2	0.4
	2004	4.863	7/18/2004	52.8	46.3	0.3	0.1	0.1	0.3
	2005	3.852	5/4/2005	29.0	70.3	0.2	0.1	0.1	0.3
	2003-2005	4.342	9/28/2005	30.2	68.9	0.3	0.1	0.2	0.4
Glacier Peak Wilderness	2003	2.067	8/15/2003	39.0	60.1	0.3	0.2	0.1	0.4
	2004	3.609	12/24/2004	47.9	51.5	0.2	0.1	0.1	0.3
	2005	2.550	5/4/2005	37.0	62.4	0.2	0.1	0.1	0.2
	2003-2005	2.618	6/10/2003	42.4	56.9	0.2	0.1	0.1	0.3
Goat Rocks Wilderness	2003	4.201	8/7/2003	44.3	55.1	0.2	0.1	0.1	0.2
	2004	4.987	6/11/2004	42.5	55.8	0.5	0.3	0.3	0.6
	2005	3.821	12/3/2005	34.8	64.6	0.2	0.1	0.1	0.3
	2003-2005	4.281	6/25/2005	34.3	64.7	0.3	0.2	0.2	0.4
Mt. Adams Wilderness	2003	3.663	7/5/2003	33.5	65.3	0.4	0.2	0.2	0.5
	2004	3.623	7/3/2004	41.9	57.1	0.3	0.2	0.2	0.4
	2005	3.376	9/2/2005	26.7	71.6	0.5	0.3	0.4	0.6
	2003-2005	3.623	7/3/2004	41.9	57.1	0.3	0.2	0.2	0.4
Mt. Hood Wilderness	2003	2.770	10/4/2003	37.5	61.9	0.2	0.1	0.1	0.3
	2004	3.466	9/25/2004	43.8	55.3	0.3	0.1	0.1	0.4
	2005	2.156	6/29/2005	40.2	58.8	0.3	0.2	0.1	0.4
	2003-2005	2.827	9/23/2004	26.1	72.9	0.3	0.1	0.2	0.4
Mt. Jefferson Wilderness	2003	1.568	10/14/2003	37.0	62.6	0.1	0.1	0.0	0.2
	2004	2.077	8/18/2004	30.6	68.5	0.3	0.2	0.1	0.4
	2005	1.181	4/25/2005	31.5	68.1	0.2	0.1	0.1	0.2
	2003-2005	1.886	7/5/2004	32.6	66.4	0.3	0.2	0.2	0.4
Mt. Rainier National Park	2003	5.548	2/26/2003	23.5	75.9	0.2	0.1	0.1	0.2
	2004	5.445	9/21/2004	17.9	80.5	0.5	0.2	0.3	0.6
	2005	5.369	4/28/2005	26.3	72.8	0.2	0.1	0.2	0.3
	2003-2005	5.483	7/4/2005	34.9	64.2	0.3	0.1	0.2	0.4
Mt. Washington Wilderness	2003	1.372	10/14/2003	36.5	63.0	0.1	0.1	0.0	0.2
	2004	2.024	6/22/2004	43.2	56.1	0.2	0.1	0.1	0.3
	2005	0.943	8/15/2005	57.1	42.1	0.3	0.1	0.1	0.4
	2003-2005	1.411	5/15/2004	51.6	48.1	0.1	0.1	0.1	0.2
N. Cascades National Park	2003	1.556	3/30/2003	22.2	76.6	0.4	0.2	0.2	0.5
	2004	2.816	12/24/2004	47.3	52.1	0.2	0.1	0.1	0.2
	2005	1.807	5/14/2005	45.4	53.7	0.3	0.1	0.1	0.4
	2003-2005	2.208	6/5/2004	40.2	59.2	0.2	0.1	0.1	0.3
Olympic National Park	2003	3.846	12/22/2003	24.4	73.3	0.6	0.3	0.6	0.8
	2004	4.639	10/4/2004	39.2	60.3	0.2	0.1	0.1	0.2
	2005	3.627	11/20/2005	22.3	77.1	0.2	0.1	0.1	0.2
	2003-2005	4.019	3/8/2004	43.9	55.4	0.2	0.1	0.2	0.3
Pasayten Wilderness	2003	1.128	5/24/2003	48.8	50.6	0.2	0.1	0.1	0.2
	2004	1.951	12/24/2004	43.5	56.0	0.1	0.1	0.1	0.2
	2005	1.170	7/5/2005	44.9	54.2	0.3	0.1	0.1	0.4
	2003-2005	1.479	6/25/2004	56.6	42.8	0.2	0.1	0.1	0.3
Three Sisters Wilderness	2003	1.535	5/12/2003	45.6	54.0	0.1	0.1	0.1	0.2
	2004	2.167	7/27/2004	55.2	44.1	0.2	0.1	0.1	0.3
	2005	1.069	9/28/2005	53.7	45.7	0.2	0.1	0.1	0.3
	2003-2005	1.535	5/12/2003	45.6	54.0	0.1	0.1	0.1	0.2
CRGNSA	2003	2.429	9/25/2003	29.7	68.9	0.4	0.2	0.2	0.6
	2004	2.541	5/15/2004	39.1	60.2	0.2	0.1	0.1	0.3
	2005	1.713	12/13/2005	17.4	81.9	0.2	0.1	0.2	0.3
	2003-2005	2.351	1/13/2005	29.7	69.5	0.2	0.1	0.2	0.3
Overall	Min	0.943		17.4	42.1	0.1	0.1	0.0	0.2
	Mean	2.888		38.0	61.2	0.2	0.1	0.1	0.3
	Max	5.548		57.1	81.9	0.6	0.3	0.6	0.8

BART Determination Analysis Results, Extinction Budgets for Design Days
TransAlta FlexFuels Case

		98th Percentile Paired By Class I Area		Contribution by Species (%)					
Area of Interest	**Year**	**Delta HI (dv)**	**Date**	**SO4**	**NO3**	**OC**	**EC**	**PMC**	**PMF**
Alpine Lakes Wilderness	2003	2.274	3/17/2003	15.7	83.6	0.3	0.1	0.1	0.2
	2004	3.283	4/17/2004	18.2	81.1	0.3	0.1	0.1	0.2
	2005	2.653	10/16/2005	12.6	86.3	0.5	0.1	0.2	0.3
	2003-2005	2.742	2/26/2003	12.7	86.9	0.2	0.1	0.1	0.1
Glacier Peak Wilderness	2003	1.262	8/15/2003	23.7	75.5	0.5	0.1	0.0	0.3
	2004	2.154	12/24/2004	29.8	69.5	0.3	0.1	0.1	0.2
	2005	1.685	7/9/2005	21.2	78.0	0.4	0.1	0.1	0.2
	2003-2005	1.754	10/12/2005	16.3	83.0	0.4	0.1	0.1	0.2
Goat Rocks Wilderness	2003	2.769	2/27/2003	15.5	84.1	0.2	0.1	0.1	0.1
	2004	3.350	8/16/2004	22.7	76.5	0.4	0.1	0.1	0.2
	2005	2.617	9/15/2005	14.8	83.5	0.8	0.2	0.3	0.4
	2003-2005	2.901	12/12/2005	15.1	84.4	0.3	0.1	0.1	0.1
Mt. Adams Wilderness	2003	2.433	6/19/2003	16.4	82.4	0.6	0.1	0.2	0.3
	2004	2.350	4/6/2004	23.0	76.6	0.2	0.0	0.0	0.1
	2005	2.286	6/27/2005	35.1	64.1	0.4	0.1	0.1	0.2
	2003-2005	2.357	9/5/2005	20.3	79.0	0.3	0.1	0.1	0.2
Mt. Hood Wilderness	2003	1.752	8/5/2003	30.3	68.8	0.4	0.1	0.1	0.2
	2004	2.111	9/25/2004	26.8	72.3	0.5	0.1	0.1	0.3
	2005	1.327	6/29/2005	24.5	74.5	0.5	0.1	0.1	0.3
	2003-2005	1.821	6/24/2003	24.9	74.3	0.4	0.1	0.1	0.2
Mt. Jefferson Wilderness	2003	0.958	4/21/2003	18.7	81.1	0.1	0.0	0.0	0.1
	2004	1.259	7/29/2004	23.8	75.4	0.5	0.1	0.1	0.3
	2005	0.745	9/27/2005	17.7	81.6	0.4	0.1	0.1	0.2
	2003-2005	1.138	4/21/2005	15.4	84.1	0.3	0.1	0.1	0.2
Mt. Rainier National Park	2003	4.027	5/25/2003	18.8	80.3	0.4	0.1	0.2	0.2
	2004	3.917	7/8/2004	22.0	76.6	0.7	0.2	0.2	0.4
	2005	3.754	5/12/2005	22.9	75.8	0.6	0.1	0.2	0.3
	2003-2005	3.922	6/8/2005	15.4	82.7	0.9	0.2	0.3	0.5
Mt. Washington Wilderness	2003	0.836	10/14/2003	20.7	78.9	0.2	0.1	0.0	0.1
	2004	1.159	7/27/2004	35.4	63.8	0.5	0.1	0.1	0.3
	2005	0.536	9/20/2005	21.0	78.5	0.3	0.1	0.0	0.2
	2003-2005	0.783	7/13/2005	23.4	75.7	0.5	0.1	0.1	0.3
N. Cascades National Park	2003	1.056	5/24/2003	28.5	70.8	0.3	0.1	0.1	0.2
	2004	1.657	12/24/2004	29.2	70.2	0.3	0.1	0.1	0.2
	2005	1.264	10/12/2005	17.8	81.6	0.3	0.1	0.1	0.2
	2003-2005	1.335	5/4/2005	24.7	74.8	0.3	0.1	0.1	0.2
Olympic National Park	2003	2.529	12/10/2003	31.3	68.0	0.3	0.1	0.1	0.2
	2004	2.867	2/29/2004	28.4	71.2	0.2	0.1	0.1	0.1
	2005	2.542	11/20/2005	12.6	86.9	0.2	0.1	0.1	0.1
	2003-2005	2.670	7/30/2004	32.2	66.8	0.5	0.1	0.2	0.3
Pasayten Wilderness	2003	0.694	5/27/2003	19.4	80.0	0.3	0.1	0.1	0.2
	2004	1.154	12/24/2004	25.9	73.6	0.3	0.1	0.0	0.1
	2005	0.713	1/6/2005	10.5	88.9	0.3	0.1	0.0	0.2
	2003-2005	0.902	10/9/2005	23.4	76.2	0.2	0.0	0.0	0.1
Three Sisters Wilderness	2003	0.901	10/14/2003	19.4	80.2	0.2	0.1	0.0	0.1
	2004	1.166	7/27/2004	36.1	63.0	0.5	0.1	0.1	0.3
	2005	0.574	9/14/2005	19.2	80.1	0.3	0.1	0.1	0.2
	2003-2005	0.901	10/14/2003	19.4	80.2	0.2	0.1	0.0	0.1
CRGNSA	2003	1.538	10/4/2003	23.2	76.0	0.4	0.1	0.1	0.2
	2004	1.573	12/20/2004	27.0	72.3	0.3	0.1	0.1	0.2
	2005	1.168	9/18/2005	12.4	86.8	0.4	0.1	0.1	0.2
	2003-2005	1.496	7/5/2004	23.0	75.4	0.8	0.2	0.2	0.4
Overall	Min	0.536		10.5	63.0	0.1	0.0	0.0	0.1
	Mean	1.877		21.9	77.3	0.4	0.1	0.1	0.2
	Max	4.027		36.1	88.9	0.9	0.2	0.3	0.5

BART Determination Analysis Results, Extinction Budgets for Design Days
TransAlta SNCR Case

		98th Percentile Paired By Class I Area		Contribution by Species (%)					
Area of Interest	**Year**	**Delta HI (dv)**	**Date**	**SO4**	**NO3**	**OC**	**EC**	**PMC**	**PMF**
Alpine Lakes Wilderness	2003	1.868	8/6/2003	32.3	66.3	0.7	0.2	0.2	0.4
	2004	2.687	4/17/2004	22.9	76.2	0.4	0.1	0.1	0.2
	2005	2.138	10/16/2005	16.1	82.6	0.6	0.1	0.2	0.4
	2003-2005	2.271	6/24/2004	41.4	57.5	0.5	0.1	0.1	0.3
Glacier Peak Wilderness	2003	1.027	8/15/2003	29.4	69.5	0.6	0.1	0.1	0.3
	2004	1.812	12/24/2004	36.1	63.1	0.4	0.1	0.1	0.2
	2005	1.374	7/9/2005	26.4	72.5	0.5	0.1	0.1	0.3
	2003-2005	1.414	10/12/2005	20.5	78.6	0.5	0.1	0.1	0.3
Goat Rocks Wilderness	2003	2.228	2/27/2003	19.8	79.7	0.3	0.1	0.1	0.2
	2004	2.788	6/11/2004	33.0	65.1	0.9	0.2	0.3	0.5
	2005	2.129	9/15/2005	18.7	79.2	1.0	0.2	0.4	0.6
	2003-2005	2.406	8/23/2003	19.2	79.4	0.7	0.2	0.2	0.4
Mt. Adams Wilderness	2003	1.989	6/19/2003	20.6	77.9	0.7	0.2	0.2	0.4
	2004	1.925	4/6/2004	28.6	70.9	0.2	0.1	0.1	0.1
	2005	1.919	9/2/2005	21.4	76.7	0.9	0.2	0.3	0.5
	2003-2005	1.952	6/12/2004	14.6	84.2	0.6	0.1	0.2	0.3
Mt. Hood Wilderness	2003	1.433	5/11/2003	19.5	79.4	0.6	0.1	0.2	0.3
	2004	1.755	9/25/2004	32.8	66.1	0.6	0.1	0.1	0.3
	2005	1.092	6/29/2005	30.1	68.6	0.7	0.2	0.1	0.4
	2003-2005	1.481	9/5/2004	23.3	75.8	0.5	0.1	0.1	0.3
Mt. Jefferson Wilderness	2003	0.775	10/14/2003	26.2	73.3	0.3	0.1	0.0	0.2
	2004	1.021	7/29/2004	29.7	69.3	0.6	0.1	0.1	0.3
	2005	0.588	7/25/2005	17.8	81.1	0.6	0.1	0.1	0.3
	2003-2005	0.929	7/27/2004	41.2	57.8	0.6	0.1	0.1	0.3
Mt. Rainier National Park	2003	3.334	5/25/2003	23.6	75.3	0.5	0.1	0.2	0.3
	2004	3.280	7/8/2004	27.1	71.1	0.9	0.2	0.2	0.5
	2005	3.130	4/28/2005	20.2	78.9	0.5	0.1	0.1	0.3
	2003-2005	3.231	6/8/2005	19.4	78.3	1.1	0.2	0.4	0.6
Mt. Washington Wilderness	2003	0.675	10/14/2003	25.9	73.6	0.3	0.1	0.0	0.2
	2004	0.972	7/27/2004	42.6	56.4	0.5	0.1	0.1	0.3
	2005	0.432	9/20/2005	26.2	73.2	0.4	0.1	0.0	0.2
	2003-2005	0.640	7/13/2005	28.8	70.0	0.6	0.1	0.1	0.3
N. Cascades National Park	2003	0.861	11/1/2003	22.1	77.2	0.4	0.1	0.0	0.2
	2004	1.385	12/24/2004	35.4	63.9	0.4	0.1	0.1	0.2
	2005	1.005	1/6/2005	13.3	85.8	0.5	0.1	0.1	0.3
	2003-2005	1.086	5/4/2005	30.7	68.6	0.4	0.1	0.1	0.2
Olympic National Park	2003	2.147	12/10/2003	37.7	61.6	0.4	0.1	0.1	0.2
	2004	2.401	2/29/2004	34.7	64.8	0.3	0.1	0.1	0.1
	2005	2.042	11/20/2005	16.1	83.3	0.3	0.1	0.1	0.2
	2003-2005	2.273	7/30/2004	38.7	60.1	0.6	0.1	0.2	0.3
Pasayten Wilderness	2003	0.552	5/27/2003	24.6	74.7	0.4	0.1	0.1	0.2
	2004	0.951	12/24/2004	31.8	67.7	0.3	0.1	0.1	0.2
	2005	0.555	1/6/2005	13.6	85.7	0.4	0.1	0.1	0.2
	2003-2005	0.731	10/9/2005	29.3	70.3	0.2	0.1	0.0	0.1
Three Sisters Wilderness	2003	0.724	10/14/2003	24.3	75.2	0.3	0.1	0.0	0.2
	2004	0.980	7/27/2004	43.4	55.6	0.5	0.1	0.1	0.3
	2005	0.477	9/28/2005	41.1	58.0	0.4	0.1	0.1	0.2
	2003-2005	0.724	10/14/2003	24.3	75.2	0.3	0.1	0.0	0.2
CRGNSA	2003	1.261	10/4/2003	28.6	70.4	0.5	0.1	0.1	0.3
	2004	1.307	12/20/2004	32.9	66.2	0.4	0.1	0.1	0.2
	2005	0.926	9/18/2005	15.9	83.1	0.5	0.1	0.1	0.3
	2003-2005	1.228	7/5/2004	28.4	69.6	1.0	0.2	0.3	0.5
Overall	Min	0.432		13.3	55.6	0.2	0.1	0.0	0.1
	Mean	1.544		27.0	72.0	0.5	0.1	0.1	0.3
	Max	3.334		43.4	85.8	1.1	0.2	0.4	0.6

BART Determination Analysis Results, Extinction Budgets for Design Days
TransAlta Presumptive Case

		98th Percentile Paired By Class I Area		Contribution by Species (%)					
Area of Interest	**Year**	**Delta HI (dv)**	**Date**	**SO4**	**NO3**	**OC**	**EC**	**PMC**	**PMF**
Alpine Lakes Wilderness	2003	1.577	5/24/2003	37.5	61.1	0.7	0.1	0.2	0.4
	2004	2.233	4/17/2004	28.2	70.7	0.5	0.1	0.2	0.3
	2005	1.748	10/16/2005	20.1	78.3	0.8	0.2	0.3	0.4
	2003-2005	1.959	9/28/2005	27.9	70.8	0.7	0.1	0.2	0.4
Glacier Peak Wilderness	2003	0.856	8/15/2003	35.6	63.1	0.7	0.2	0.1	0.4
	2004	1.556	12/24/2004	42.6	56.5	0.5	0.1	0.1	0.3
	2005	1.143	2/3/2005	17.0	81.6	0.8	0.2	0.1	0.4
	2003-2005	1.144	7/9/2005	32.1	66.6	0.7	0.1	0.2	0.4
Goat Rocks Wilderness	2003	1.823	2/27/2003	24.6	74.7	0.4	0.1	0.1	0.2
	2004	2.331	6/12/2004	19.5	78.4	1.0	0.2	0.3	0.6
	2005	1.757	9/15/2005	23.1	74.3	1.2	0.3	0.4	0.7
	2003-2005	1.983	12/8/2003	21.4	78.1	0.3	0.1	0.1	0.1
Mt. Adams Wilderness	2003	1.651	6/1/2003	22.0	76.5	0.8	0.2	0.2	0.4
	2004	1.596	7/3/2004	37.1	61.4	0.7	0.2	0.2	0.4
	2005	1.593	9/2/2005	26.3	71.4	1.1	0.2	0.4	0.6
	2003-2005	1.615	4/6/2004	34.6	64.8	0.3	0.1	0.1	0.2
Mt. Hood Wilderness	2003	1.187	10/4/2003	33.2	65.8	0.5	0.1	0.1	0.3
	2004	1.491	9/25/2004	39.1	59.6	0.7	0.2	0.1	0.4
	2005	0.918	6/29/2005	36.1	62.4	0.8	0.2	0.1	0.4
	2003-2005	1.244	8/5/2003	43.8	54.9	0.6	0.1	0.1	0.4
Mt. Jefferson Wilderness	2003	0.642	10/14/2003	31.9	67.5	0.4	0.1	0.0	0.2
	2004	0.848	7/29/2004	36.0	62.7	0.7	0.2	0.1	0.4
	2005	0.479	9/27/2005	27.9	70.9	0.6	0.1	0.1	0.3
	2003-2005	0.781	9/23/2004	28.5	70.5	0.5	0.1	0.1	0.3
Mt. Rainier National Park	2003	2.775	3/17/2003	19.7	77.6	1.2	0.3	0.5	0.7
	2004	2.750	9/21/2004	20.0	77.9	1.1	0.2	0.3	0.6
	2005	2.660	6/3/2005	32.7	65.0	1.1	0.3	0.3	0.6
	2003-2005	2.711	7/7/2003	30.4	67.0	1.2	0.3	0.4	0.7
Mt. Washington Wilderness	2003	0.556	10/14/2003	31.6	67.8	0.3	0.1	0.0	0.2
	2004	0.820	6/22/2004	38.8	60.1	0.6	0.1	0.1	0.3
	2005	0.357	9/20/2005	31.8	67.4	0.4	0.1	0.1	0.2
	2003-2005	0.546	5/15/2004	45.1	54.3	0.3	0.1	0.1	0.2
N. Cascades National Park	2003	0.695	3/30/2003	19.6	78.8	0.8	0.2	0.2	0.4
	2004	1.184	12/24/2004	41.8	57.3	0.5	0.1	0.1	0.3
	2005	0.801	1/6/2005	16.8	82.1	0.6	0.1	0.1	0.3
	2003-2005	0.904	5/4/2005	37.2	62.0	0.4	0.1	0.1	0.2
Olympic National Park	2003	1.859	12/10/2003	44.1	55.0	0.4	0.1	0.1	0.2
	2004	2.025	10/4/2004	35.4	63.8	0.4	0.1	0.1	0.2
	2005	1.664	11/20/2005	20.2	79.1	0.4	0.1	0.1	0.2
	2003-2005	1.874	5/27/2003	22.4	76.2	0.7	0.1	0.3	0.4
Pasayten Wilderness	2003	0.450	5/27/2003	30.4	68.8	0.5	0.1	0.1	0.3
	2004	0.802	12/24/2004	38.0	61.3	0.4	0.1	0.1	0.2
	2005	0.457	7/5/2005	41.1	57.5	0.7	0.2	0.1	0.4
	2003-2005	0.607	10/12/2005	25.7	73.6	0.4	0.1	0.0	0.2
Three Sisters Wilderness	2003	0.594	10/14/2003	29.8	69.6	0.3	0.1	0.1	0.2
	2004	0.847	7/27/2004	50.5	48.3	0.6	0.1	0.1	0.4
	2005	0.410	9/28/2005	48.0	51.0	0.5	0.1	0.1	0.3
	2003-2005	0.609	8/14/2004	58.2	40.5	0.7	0.2	0.1	0.4
CRGNSA	2003	1.056	10/4/2003	34.6	64.3	0.6	0.1	0.1	0.3
	2004	1.076	4/1/2004	18.4	79.6	0.9	0.2	0.3	0.5
	2005	0.757	4/26/2005	30.6	67.3	1.0	0.2	0.3	0.6
	2003-2005	1.030	7/5/2004	34.2	63.4	1.2	0.3	0.3	0.7
Overall	Min	0.357		16.8	40.5	0.3	0.1	0.0	0.1
	Mean	1.289		31.8	66.9	0.7	0.1	0.2	0.4
	Max	2.775		58.2	82.1	1.2	0.3	0.5	0.7

BART Determination Analysis Results, Extinction Budgets for Design Days
TransAlta SCR Case

		98th Percentile Paired By Class I Area		Contribution by Species (%)					
Area of Interest	**Year**	**Delta HI (dv)**	**Date**	**SO4**	**NO3**	**OC**	**EC**	**PMC**	**PMF**
Alpine Lakes Wilderness	2003	1.053	2/26/2003	36.0	62.7	0.6	0.1	0.2	0.4
	2004	1.532	2/19/2004	61.2	37.6	0.6	0.1	0.2	0.3
	2005	1.087	8/17/2005	65.6	32.5	1.0	0.2	0.2	0.5
	2003-2005	1.309	9/23/2004	60.9	37.2	0.9	0.2	0.3	0.5
Glacier Peak Wilderness	2003	0.565	8/15/2003	54.7	43.3	1.1	0.2	0.1	0.6
	2004	1.058	4/12/2004	48.9	49.6	0.7	0.2	0.2	0.4
	2005	0.698	10/1/2005	39.2	58.9	0.9	0.2	0.3	0.5
	2003-2005	0.744	7/9/2005	50.4	47.6	1.0	0.2	0.3	0.6
Goat Rocks Wilderness	2003	1.225	8/23/2003	40.0	57.0	1.4	0.3	0.5	0.8
	2004	1.548	8/4/2004	63.0	34.7	1.1	0.3	0.4	0.6
	2005	1.132	12/3/2005	48.7	49.8	0.7	0.2	0.2	0.4
	2003-2005	1.280	6/18/2003	41.7	54.1	2.0	0.5	0.6	1.1
Mt. Adams Wilderness	2003	1.084	7/5/2003	48.6	48.7	1.4	0.3	0.4	0.7
	2004	1.073	4/6/2004	53.7	45.5	0.4	0.1	0.1	0.2
	2005	1.025	9/5/2005	50.1	48.3	0.8	0.2	0.2	0.5
	2003-2005	1.042	5/30/2005	50.4	46.5	1.6	0.4	0.2	0.9
Mt. Hood Wilderness	2003	0.777	10/4/2003	51.9	46.6	0.8	0.2	0.1	0.4
	2004	1.029	9/25/2004	58.1	40.0	1.0	0.2	0.1	0.6
	2005	0.582	9/14/2005	47.2	51.2	0.9	0.2	0.1	0.5
	2003-2005	0.777	10/4/2003	51.9	46.6	0.8	0.2	0.1	0.4
Mt. Jefferson Wilderness	2003	0.411	10/14/2003	50.4	48.6	0.6	0.1	0.1	0.3
	2004	0.565	9/25/2004	59.7	38.7	0.9	0.2	0.1	0.5
	2005	0.293	4/27/2005	42.3	56.0	0.9	0.2	0.1	0.5
	2003-2005	0.505	12/2/2004	51.8	47.9	0.2	0.0	0.0	0.1
Mt. Rainier National Park	2003	1.807	7/7/2003	47.8	48.1	2.0	0.4	0.6	1.1
	2004	1.839	6/11/2004	57.7	38.6	1.8	0.4	0.6	1.0
	2005	1.678	9/12/2005	35.8	61.1	1.5	0.3	0.4	0.8
	2003-2005	1.798	12/3/2005	49.8	48.6	0.8	0.2	0.3	0.4
Mt. Washington Wilderness	2003	0.355	10/14/2003	50.1	48.9	0.5	0.1	0.1	0.3
	2004	0.553	6/22/2004	58.3	40.1	0.9	0.2	0.1	0.5
	2005	0.266	8/15/2005	70.6	27.5	1.0	0.2	0.1	0.5
	2003-2005	0.385	6/23/2004	66.0	32.8	0.6	0.1	0.1	0.4
N. Cascades National Park	2003	0.410	3/30/2003	37.4	59.8	1.4	0.3	0.3	0.8
	2004	0.831	12/24/2004	60.7	38.1	0.7	0.1	0.1	0.4
	2005	0.486	12/12/2005	34.7	64.0	0.6	0.1	0.1	0.4
	2003-2005	0.579	4/13/2004	50.5	48.4	0.6	0.1	0.1	0.3
Olympic National Park	2003	1.270	12/17/2003	63.4	34.2	1.2	0.3	0.3	0.7
	2004	1.439	2/29/2004	60.8	38.2	0.5	0.1	0.2	0.3
	2005	1.012	6/6/2005	54.4	43.8	0.9	0.2	0.3	0.5
	2003-2005	1.270	12/17/2003	63.4	34.2	1.2	0.3	0.3	0.7
Pasayten Wilderness	2003	0.296	6/12/2003	49.6	48.5	1.0	0.2	0.1	0.6
	2004	0.535	9/24/2004	62.3	36.6	0.6	0.1	0.1	0.3
	2005	0.312	7/5/2005	60.7	37.2	1.1	0.2	0.2	0.6
	2003-2005	0.397	1/20/2004	41.9	58.1	0.0	0.0	0.0	0.0
Three Sisters Wilderness	2003	0.391	5/12/2003	61.5	37.6	0.5	0.1	0.1	0.3
	2004	0.588	4/1/2004	40.7	58.1	0.6	0.1	0.2	0.3
	2005	0.270	7/25/2005	44.2	53.5	1.2	0.3	0.2	0.7
	2003-2005	0.405	8/18/2004	50.1	47.5	1.3	0.3	0.2	0.7
CRGNSA	2003	0.659	2/9/2003	46.2	53.0	0.4	0.1	0.1	0.2
	2004	0.693	5/15/2004	53.2	45.1	0.9	0.2	0.2	0.5
	2005	0.442	4/25/2005	63.0	35.2	0.9	0.2	0.2	0.5
	2003-2005	0.624	9/5/2004	48.3	49.7	1.0	0.2	0.3	0.6
Overall	Min	0.266		34.7	27.5	0.0	0.0	0.0	0.0
	Mean	0.846		52.1	46.1	0.9	0.2	0.2	0.5
	Max	1.839		70.6	64.0	2.0	0.5	0.6	1.1