

2005 Inventory of Greenhouse Gas Emissions Ascribable to the University of Washington

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Institutional Framework

Partnership with the City of Seattle

The City of Seattle has been working toward setting and meeting a greenhouse gas (GHG) reduction goal since 2001, when the city council adopted Resolution 30316 committing the City to meet or exceed the targets set by the international GHG treaty, the Kyoto Protocol. In 2005, Mayor Greg Nickels placed Seattle in a leadership position by launching the Mayors Climate Protection Agreement, unanimously passed by the U.S. Conference of Mayors and committing all signatory cities to GHG reduction targets. There are now over 330 signatory cities, of which Seattle was one of the first.

Mayor Nickels also appointed a Green Ribbon Commission on Climate Protection to develop recommendations for achieving Seattle's GHG target. The Commission's recommendations were released in March of 2006, and one of those recommendations was to form the Seattle Climate Partnership, a voluntary pact among Seattle's largest employers to reduce emissions and work together toward the city-wide goal.

A partnership agreement was drawn up by ten Seattle employers that are the Seattle Climate Partnership's founding partners. The University of Washington (the University; UW) is one of these ten founding partners, and is also the largest single employer in the City of Seattle.

Authority from the University

Anticipating the recommendations of the partnership agreement, in January 2006 Executive Vice President Weldon Ihrig asked the UW Environmental Stewardship Advisory Committee (ESAC) to oversee an initial quantitative estimate of the University's GHG emissions profile. This document is the result.

The University of Washington Greenhouse Gas Inventory (the Inventory) provides a policy background, identifies GHG data sources, and addresses methodological issues that underlie a sound GHG emissions baseline. Such a baseline will enable the University to make more informed decisions regarding GHG reduction strategies.

The Inventory was compiled by Evans School of Public Affairs MPA candidate Roel Hammerschlag, from February through December 2006. Oversight was provided by an inventory advisory committee consisting of:

John Chapman	Acting Associate Vice President, Facilities Services
Alison Cullen	Associate Professor, Evans School of Public Affairs
Richard Fenske	Professor, Environmental and Occupational Health Sciences
Richard Gammon	Professor, Oceanography and Chemistry
Stephanie Harrington	Executive Director, UW Earth Initiative
Terry Nyman	Compliance Analyst, EH&S
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Evans School of Public Affairs MPA candidate Matthew Van Sickle provided research and writing assistance.

Methodology

Corporate vs. Geographic Inventories

Greenhouse gas inventories are of two fundamental types: geographic and corporate.

Geographic inventories are the type required by the well-known Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC). Geographic inventories tabulate the emissions that originate physically from within a defined geographic boundary, usually a country though sometimes states, provinces, counties or other government entities conduct geographic inventories as well.

Non-government entities typically conduct corporate inventories. Corporate inventories differ from the methodologically simpler geographic inventories in two important ways: (1) the inventory boundary is drawn organizationally rather than geographically, and (2) corporate inventories may account indirect emissions induced outside the organizational boundary by the entity's operation. The organizational boundary is usually drawn with a rule that relates most intuitively to traditional boundaries drawn around corporate entities, such as facility ownership or facility control. Indirect emissions ascribed to corporate operations almost always include emissions induced by the entity's electricity and steam purchases, and less frequently might include emissions due to employee commuting and travel, outsourced activities, waste disposal, or any number of other activities. Corporate inventories typically account indirect emissions because this brings into focus the entire reach of an entity's capacity for affecting GHG emissions.

Since the University is not a geographically-defined entity, and since the University has a genuine interest in reducing GHG emissions generally, it chooses to account a corporate inventory.

Inventory Protocol

Most corporate inventories worldwide are guided by the *GHG Protocol*. The *GHG Protocol* was developed with a multi-stakeholder, consensus-based process by the World Business Council for Sustainable Development and World Resources Institute. This Inventory follows the *GHG Protocol, Revised Edition*, released in March 2004.

The *GHG Protocol* does not prescribe quantitative methods for estimating emissions from specific sources, but rather provides high-level guidance for the definition, scope, organization and verification of the inventory. For technical methodologies, this Inventory duplicates the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2004* (U.S. Inventory) wherever appropriate. The U.S. Inventory is the geographic inventory of the United States that is submitted annually to the United Nations under rules set by the UNFCCC. Since corporate and geographic inventories do not, in principle, differ in the underlying scientific assumptions that define greenhouse gas emissions, this is appropriate.

The U.S. Inventory follows methodologies prescribed by the UNFCCC Kyoto Protocol; specifically these are methodologies developed during the early to mid-1990s by the Intergovernmental Panel on Climate Change (IPCC) and published as the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC Guidelines). Since the

Kyoto Protocol requires comparable inventories from 1990 through 2012, the IPCC Guidelines are scheduled to remain unchanged until that time to provide a sound and stable basis for the U.S. Inventory and therefore the University Inventory as well.

Unlike the GHG Protocol, the IPCC Protocol provides technical methodologies appropriate for determining national, geographic inventories. Though usually sufficient to guide the Inventory, in a few cases methodologies appropriate for the University's unique spectrum of sources and available data are not available. In these cases, the University surveys published literature for the best available science, and follows a methodology consistent with the literature.

In summary, the Inventory follows the *GHG Protocol*. For methodologies not specified by the *GHG Protocol*, the University Inventory emulates the U.S. Inventory. If the U.S. Inventory fails to provide clear guidance for any methodology, the IPCC Guidelines are consulted for clarification. Finally, if the IPCC Guidelines fail to provide an appropriate methodology, the University Inventory adopts the best available science available from the published literature.

GHG Gases Inventoried

The Inventory surveys all six greenhouse gases identified in the IPCC Guidelines; these are listed in Table 1.

The table lists the global warming potential (GWP) of each gas. The GWP indicates the mass units of carbon dioxide (CO₂) that effect the same amount of global warming as one mass unit of the gas. For instance, the GWP of methane is 21, so it requires 21

kilograms of carbon dioxide to produce the same global warming as just one kilogram of methane. The higher the GWP, the more potent the greenhouse gas.

gas	chemical formula	GWP
carbon dioxide	CO ₂	1
methane	CH ₄	21
nitrous oxide	N ₂ O	310
hydrofluorocarbons	C _x H _y F _z	various
perfluorocarbons	C _x F _y	various
sulfur hexafluoride	SF ₆	23,900

Table 1 – greenhouse gases inventoried

The Inventory uses the GWPs printed in the IPCC's Second Assessment Report, released in 1996. IPCC released a Third Assessment Report in 2001 that includes slightly modified GWPs of 23 for methane and 296 for nitrous oxide. The Inventory continues to use the Second Assessment values for consistency with countries under the UNFCCC (of which the U.S. is one), and with the U.S. Inventory. The UNFCCC countries do not plan to change the GWPs used for GHG accounting until after 2012, since the national baselines and corresponding Kyoto Protocol commitments through 2012 were created before the Third Assessment was published.

Of the six gases listed, CO₂ dominates both the U.S. Inventory and the University Inventory. It is the principal combustion product of fossil fuels, which provide the vast majority of energy and energy products in the United States. Methane (CH₄) and nitrous oxide (N₂O) are both associated principally (but not only) with agricultural processes and play a very small role in the Inventory. Hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) are usually used as refrigerants and have various, very high GWPs ranging from the low 100s to over 10,000. Sulfur hexafluoride (SF₆) is a gaseous insulator used in electrical switchgear; though used in small quantities it is also inventoried due to its abnormally high GWP of 23,900.

Units

Because greenhouse gas emissions are of international concern, common practice is to account their quantities in metric units. In this document, all values of GHG emissions and sequestration are reported in metric tons of greenhouse gas equivalent, or MgCO₂e. “Mg” is shorthand for “megagram” or one million grams, the definition of a metric ton. “CO₂e” is shorthand for CO₂-equivalent, or carbon dioxide-equivalent. The “equivalent” means that any non-CO₂ gases included in the total were weighted by their GWPs, as described in section *GHG Gases Inventoried* above. A metric ton weighs 2,205 U.S. pounds.

Most energy values – quantities of fuel or electricity – are reported in the metric unit TJ. “TJ” is shorthand for “terajoule,” a unit of 10¹² joules. One TJ equal to about 278 MWh, 9,490 therms, 949 mmBtu or 7,330 gallons of gasoline equivalent. For some liquid fuels, quantities are reported in L or ML. “L” means liters; one liter is equal to 0.264 gallons. “ML” means megaliters, or units of one million liters.

All numbers reported in this document are rounded to three significant digits.¹ For example, the number 21.2748 is printed as 21.3, and the number 832,491 is printed as 832,000. Four or more significant digits would misleadingly imply accuracies beyond those achievable in a GHG inventory. The spreadsheets that support this document carry out their calculations with unlimited precision; the rounding is carried out as a final step prior to printing in this document. As a result, sums of line items in the printed tables may differ slightly from the printed totals.

Organizational Boundaries

The *GHG Protocol* offers a choice to define an entity’s organizational boundaries with an equity share approach or a control approach. In the equity share approach, an entity accounts emissions from facilities in which it has a financial stake; in the cases where facility ownership is shared the entity prorates emissions according to its equity share in the facility. In the control approach, the entity accounts for all emissions from facilities over which it exerts either financial or organizational control.

The equity share and financial control approaches are identical when all facilities are wholly owned by the entity. The Inventory follows an ownership approach that is designed to be similar to the equity share/financial control approaches described by the *GHG Protocol*. The ownership-based organizational boundary used for this inventory means that:

This inventory accounts for all GHG emissions originating from, or induced by (1) real estate to which the University of Washington holds the title or a capital lease; (2) equipment housed in such real estate; and (3) mobile equipment owned by the University of Washington.

The University manages dozens of research facilities, minor housing units and office annexes, some in foreign countries, which pose a significant data collection challenge while adding little to the inventory on a quantitative level. Most of these minor facilities are rented or leased, and following an ownership approach permits their omission and

¹ Except for emissions factors reported in the source notes.

makes for a more cost-effective inventory.² The ownership approach also simplifies the inventory because it is simpler to evaluate: determining organizational control over a facility's operations is sometimes significantly more complex than determining who holds the title.

Operational Boundaries

Even with the organizational boundary of the UW, well-defined, operational boundaries still need to be set. Toward this end, the inventory is divided into three scopes defined by the *GHG Protocol*:

Scope 1 – direct emissions includes emissions that originate from the University's organizational boundary, that is real estate and equipment owned by the University. On-site natural gas heating and vehicle fleets are examples.

Scope 2 – energy imports includes emissions from facilities that generate electricity purchased by University-owned facilities. The emissions do not originate from University-owned facilities, but the University induces them through its purchases of electricity.

Scope 3 – other emissions include any sources of emissions that are not included in Scope 1 or 2, for which the University wishes to take responsibility. An example is emissions from vehicles used by commuting students, faculty and staff.

Scope 1 emissions are perfectly defined by the inventory's organizational boundary. Scope 2 emissions are well defined by the organizational boundary, but parties may disagree on which generators are responsible for the specific electricity consumed by the University, and therefore on the exact values of Scope 2 emissions. Scope 3 emissions are not well defined by the organizational boundary; this scope must be defined by the inventory's directorate, in this case by the UW administration.

The *GHG Protocol* also offers a fourth category for the emissions inventory:

Optional Information includes notes regarding emissions from special sources not included in the three formal scopes, estimates of effects of special projects on the inventory, background operating data for the University, and other data.

The Inventory uses the Optional Information category to report emissions reductions attributable to forestry operations and waste disposal operations.

Audit Trail

The formal inventory is a dataset consisting of approximately 150 electronic files and several dozen paper files. An archival copy of the data files is held at the Office of the Executive Vice President. There are four basic categories of file:

² The *GHG Protocol* prescribes completeness without the *de minimis* thresholds that some other protocols allow. A *de minimis* threshold describes a maximum level of emissions below which a source may be omitted from an inventory. The *GHG Protocol* does not allow a *de minimis* threshold because completeness was highly valued by the authoring stakeholders, and because the need to estimate emissions from potential, *de minimis* sources begged the question of why such estimates weren't simply included in the inventory in the first place.

Index file – A single index file, <dataset index.xls>, lists names and sources of all other files, electronic and paper alike, in the inventory.

Source files – These files are numbered 05-001 through 05-152. Most are internal, UW reports of energy or chemical usage that serve as the basis for greenhouse gas emissions estimates documented in the calculation files. Some source files originate from outside the UW; these are clearly marked as such in the index file. Electronic source files may have any one of extensions:

.doc	Microsoft Word document
.htm	HTML page
.pdf	Adobe Portable Document Format
.txt	Unformatted text document (used most often for emails)
.xls	Microsoft Excel workbook

Reference files – These files are numbered 05-801 through 05-814. Each is a copy of a formally published work that is used as a reference source for universal emissions factors or other constants. Filename extensions may be any one of the same set allowed for source files.

Calculation files – These files are numbered 05-901 through 05-923. All calculation files are Microsoft Excel workbooks. The calculation files document the translation of source and reference data found in files 05-001 through 05-900 into the final GHG emissions estimates published in this document. File <05-901.xls> is the master calculation file, and includes at least the highest-level calculations for every datum reported in this document. Every table in this document is duplicated from <05-901.xls.> Calculation file numbers 05-902 and higher document detailed calculations necessary to process some of the more complex data sources, with the results summarized in 05-901.

Every single datum in the calculation files is traceable to one of the source files through the 05-*nnn* number provided in the “call no.” column of most of the calculation files, or in a few rare instances to a note above a table of calculations.

Throughout this inventory, grey boxes with the heading *source notes* report technical notes on the data sources used to generate the inventory, and in some cases on methods used for calculating emissions. The *source notes* will be of little interest to most readers, but they will assist future GHG accountants assembling subsequent inventories, and provide convenient entryways for inventory auditors.

The first *source notes* box appears here:

source notes

Data sources

Data sources cited in the *source notes* boxes appear as boldface, five-digit call numbers, e.g. **05-086**. Such citations are simply shorthand for the corresponding file in the dataset; for example the citation above refers to file <03-086.xls>.

Emission factors

Emission factors associated with fossil fuel consumption are used throughout the inventory, and are summarized here:

fuel	emission factor
gasoline	2,318 gCO ₂ /L
diesel	2,651 gCO ₂ /L
natural gas	50.0 gCO ₂ /MJ
LPG	59.5 gCO ₂ /MJ
jet fuel	66.5 gCO ₂ /MJ

Only CO₂ emissions directly due to combustion of the fuels are included; higher-order emissions from fuel extraction, processing and transportation are excluded. These emission factors are derived from the U.S. Inventory **05-803** and are documented in the master spreadsheet **05-901**.

Emission factors required for sources other than fossil fuel combustion are documented in the respective inventory chapters and sections.

Inventory Overview

Organizational Boundary

The University is usually thought of as encompassing three campuses: Seattle, Tacoma and Bothell. However, the University also owns facilities in several other locations. Table 2 summarizes the locations and populations of all real estate owned by the University.

location	2005 headcounts			total
	students	faculty	staff	
Seattle	38,400	7,350	17,600	63,300
Tacoma	2,110	141	200	2,450
Bothell	1,600	108	169	1,880
outlying facilities				
Friday Harbor Laboratories	45	18	42	105
Pack Forest	-	4	8	12
Olympic Nat. Resources Ctr.	-	3	7	10
Big Beef Creek	-	-	1	1
minor outlying facilities	-	-	-	-
university-wide	42,100	7,630	18,100	67,800

Table 2 – University of Washington locations in 2005 and their student, faculty and staff populations.

For the purposes of the inventory, all real estate in the City of Seattle is included in the definition of “Seattle.” This is distinct from the traditional understanding of the Seattle campus as formally defined by the Major Institutions Overlay (MIO) boundary shown in Figure 1.

There are two reasons for dispensing with the customary MIO boundary. The first is that the Inventory is motivated in part by potential, future cooperation with the City of Seattle toward meeting the city’s own regulatory GHG emissions target – which is correspondingly defined by the city limits. The second is that the facilities outside the MIO boundary would otherwise be classified as “outlying facilities” in the inventory, adding unnecessary complexity to this document and other emissions reporting.

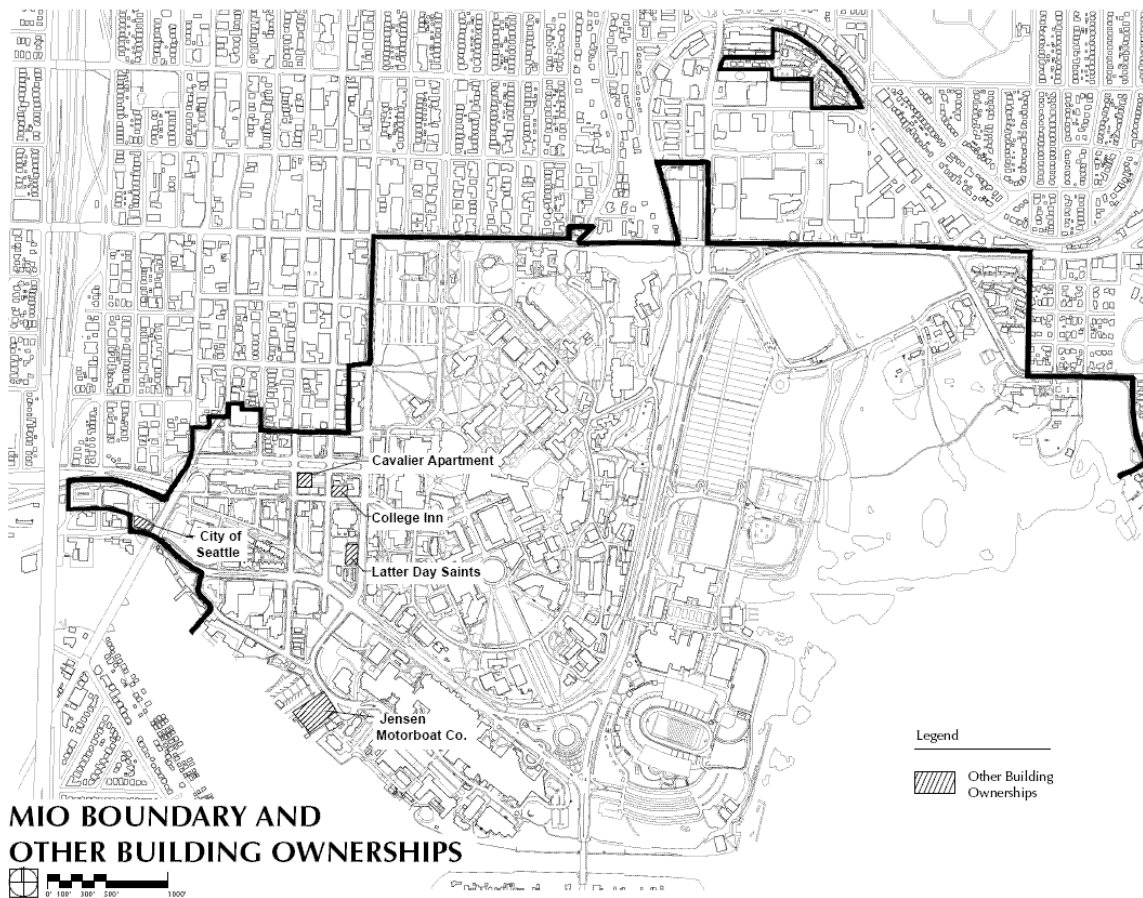


Figure 1 – The UW Seattle Campus MIO boundary, from Figure V-1 in the University of Washington’s January, 2003 Seattle Campus Master Plan. UW students and employees will recognize it as the familiar green area on the campus map. The enclave to the north is Nordheim Court and Blakeley Village family housing.

Though the MIO boundary is not used in this inventory, it does loosely circumscribe those facilities that receive electricity, steam and chilled water from the Seattle campus’ central power plant. The power plant is operated by Facilities Services. Facilities Services also receives and pays utility bills for a number of buildings that lie outside of the central power plant’s service area; hence it provides this inventory with centralized accounting of the vast majority of energy consumption in the University’s Seattle buildings. The complete list of buildings which are either served by or paid for by Central Facilities appears in Appendix E.

Facilities Services is only tasked with paying utility bills for buildings supported by state funds. A number of buildings owned by the University are associated with non-state-funded budgets and are financially invisible to Facilities Services. These non-centrally accounted buildings appear in Table 3. Many of the facilities listed in the table consist of multiple buildings in turn.

facility	location	payor
Paid by UW (but not Facilities Services):		
4038 12th Ave NE commons	4038 12th Ave NE	Housing & Food Services
4225 Roosevelt*	4225 Roosevelt Way NE	various departments
4245 Roosevelt*	4245 Roosevelt Way NE	Medical Center
4545 garage	4545 15th Ave NE	Parking Services
Applied Physics Laboratory	3737 Pacific Lane	Applied Physics Laboratory
Blakeley Village commons	4747 30th Ave NE	Housing & Food Services
Consolidated Laundry Buildings	2901 27TH AVE S	Medical Center
Harborview Research & Training	300 Ninth Ave.	Medical Center
Laurel Village commons	4200 Mary Gates Drive	Housing & Food Services
Russian House	2104 NE 45th St.	Housing & Food Services
Sand Point facilities	multiple addresses	various departments
Stevens Court	3801 Brooklyn Ave E	Housing & Food Services
Paid by non-UW entities:		
4038 12th Ave NE apartments	4038 12th Ave NE	occupants
Agua Verde	1303 NE BOAT ST	Agua Verde
Arboretum Buildings	2300 Arboretum Dr E	City of Seattle (Parks)
Blakeley Village apartments	multiple addresses	occupants
Commodore Duchess apartments	4005-4009 15th Ave NE	Commodore Duchess
Laurel Village apartments	multiple addresses	occupants
Metropolitan Tract buildings	multiple addresses	Unico Properties + occupants
Nordheim Court Apartments	multiple addresses	Nordheim Court + occupants
private houseboats (6)	1409 NE BOAT ST	occupants
Radford Court	multiple addresses	Radford Court + occupants

* indicates capital lease rather than title ownership

Table 3 – Non-state-funded facilities that are owned by the University. Those for which utilities are paid by the University are used for research, teaching or administrative services related to the UW, while those paid by non-University entities are occupied by other parties, or by UW-affiliated residential occupants.

Beyond the city of Seattle and the Tacoma and Bothell campuses, there are four substantive outlying facilities. Friday Harbor Laboratories is located on a 484-acre site on San Juan Island and is administered by the Office of Research. Pack Forest encompasses 4,250 acres near Eatonville, WA, and is operated by the College of Forest Resources. Olympic Natural Resources Center is located in Forks, WA, and occupies 40 acres; it is also operated by the College of Forest Resources. Finally, Big Beef Creek, covering 400 acres on the eastern shore of Hood Canal, is operated by the School of Aquatic & Fisheries Sciences.

Populations of the primary and outlying facilities in 2000 were as shown in Table 4:

location	students	2000 headcounts		total
		faculty	staff	
Seattle	36,100	6,550	16,300	59,000
Tacoma	1,550	135	169	1,850
Bothell	1,340	100	196	1,640
outlying facilities	42	23	54	118
university-wide	39,000	6,810	16,800	62,600

Table 4 – Campus populations in 2000.

Due to a lack of available data, populations of the outlying facilities were estimated only in aggregate for 2000.

Four tracts of real estate owned by the University support no permanent student, staff or faculty populations and are classified as “minor outlying facilities” in Table 2. These four tracts are Lee Forest, a 160 acre research forest in Snohomish County, WA; Manashtash Ridge Observatory near Yakima, WA; Wellington Hills in Bothell, WA, currently leased to a golf & country club; and a 1,260 acre biological preserve spanning Shaw and San Juan islands in the Puget Sound. The biological preserve is adjacent to Friday Harbor Laboratories.

source notes

Real estate under UW ownership is tracked by the Real Estate Office; Jeanette Henderson provided the office’s inventory in **05-050**. The Real Estate records provide little detail on the multiple buildings occupying each site, so this source was augmented with **05-054**, a report of active, owned buildings automatically generated by the Office of Planning and Budgeting’s (OPB) on-line Space Inventory Management System. The Real Estate and OPB records were reconciled in worksheet **05-909**, the master list of facilities targeted for the Inventory.

The student populations reported for the Seattle, Tacoma and Bothell campuses in Tables 3 and 4 are drawn from **05-133**, an automated report generated by the Office of Institutional Studies’ (OIS) electronic factbook. City of Seattle faculty and staff populations are from **05-132**, a population study compiled by Peter Dewey of the Transportation Services office. Tacoma and Bothell faculty and staff 2005 populations are from **05-093**, a static document obtained from the OIS electronic factbook. Tacoma and Bothell faculty and staff 2000 populations are drawn from **05-134**, a static document obtained from the OIS electronic factbook that documents 2002 populations; the 2000 factbook is unavailable and 2002 data were used as the best available proxy.

2005 populations of the outlying facilities were obtained from interviews with staff at the facilities: **05-119** documents Scott Schwinge’s estimate of FHL population; **05-121** documents Debi Pitzl’s estimate of Pack Forest population; **05-120** documents Kathy Heuring’s estimate of ONRC population; and **05-125** is a record of Big Beef Creek’s solitary staffperson Gordy George confirming that he is, indeed, Big Beef Creek’s solitary staffperson. All four estimates of the outlying facilities’ employee populations did not differentiate between staff and faculty, so in Table 2 employees are distributed between the two categories according to the university-wide ratio of staff to faculty. Finally, the OIS and Transportation Services data for the Seattle campus, which include staff and students at the outlying facilities, were adjusted downward in **05-901** by subtracting the populations of the combined outlying facilities.

2000 populations of the aggregated outlying facilities were estimated by aggregating the 2005 populations and then multiplying by the 2000:2005 university-wide, gross population ratio (62,592/67,805).

UW contacts

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OPB Space Inventory Management System

<<http://pelee.opb.washington.edu/pnbdb/sims2>>

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OIS electronic factbook (also includes links to UW Annual Reports)

<<http://www.washington.edu/admin/factbook>>

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Summary of emissions

An overview of the entire inventory appears in Table 5.

	gross emissions MgCO ₂ e		emission intensity kgCO ₂ e/capita	
	2000	2005	2000	2005
Scope 1 - direct emissions				
Seattle				
power plant	90,500	82,700	1,530	1,310
buildings	5,080	6,440	86	102
vehicles	3,030	3,040	51	48
landfill	17,000	12,800	287	201
fugitive gases	1,820	136	31	2
total	117,000	105,000	1,990	1,660
Tacoma				
buildings	341	699	184	285
vehicles	10	12	6	5
fugitive gases	n.d.	n.d.	n.d.	n.d.
total	351	710	190	289
Bothell				
buildings	258	622	158	332
vehicles	133	61	81	32
fugitive gases	n.d.	n.d.	n.d.	n.d.
total	392	683	239	364
outlying facilities	221	239	1,870	1,870
university-wide	118,000	107,000	1,890	1,570
Scope 2 - electricity				
Seattle				
central loop	16,100	-	274	-
other	8,390	4,670	142	74
total	24,500	4,670	416	74
Tacoma	629	343	340	140
Bothell	664	2,730	406	1,460
outlying facilities	46	144	390	1,130
university-wide	25,900	7,890	413	116
Scope 3 - other emissions				
Seattle				
student commuting	19,100	21,800	324	345
faculty & staff commuting	27,000	32,700	459	517
professional travel	16,700	18,700	283	295
off-campus medical	16,700	12,600	282	198
total	79,500	85,800	1,350	1,350
Tacoma	2,150	2,340	1,160	955
Bothell	1,390	1,570	849	837
outlying facilities	55	62	469	485
university-wide	83,100	89,800	1,330	1,320
Grand totals				
Seattle	221,000	196,000	3,750	3,090
Tacoma	3,130	3,400	1,690	1,380
Bothell	2,450	4,980	1,490	2,660
outlying facilities	322	445	2,730	3,480
university-wide	227,000	204,000	3,630	3,010
Optional Information				
NSF research vessels	4,380	6,640		
Seattle campus waste	(7,790)	(6,240)		
forest carbon sequestration	(12,200)	(16,400)		
university-wide total w/ O.I.	212,000	188,000		

Table 5 – Overview of the Inventory. Emission intensities are calculated per gross headcount: students, faculty and staff combined.

In Table 5 and all following tables, non-numeric symbols may be interpreted as follows:

symbol	interpretation
0	emissions less than 1 significant digit
-	no known sources
n.d.	no data
**	backcast datum
	not applicable (blank cell)

Briefly ignoring scope, the 2005 emissions can be summarized as a pie chart as shown in Figure 2.

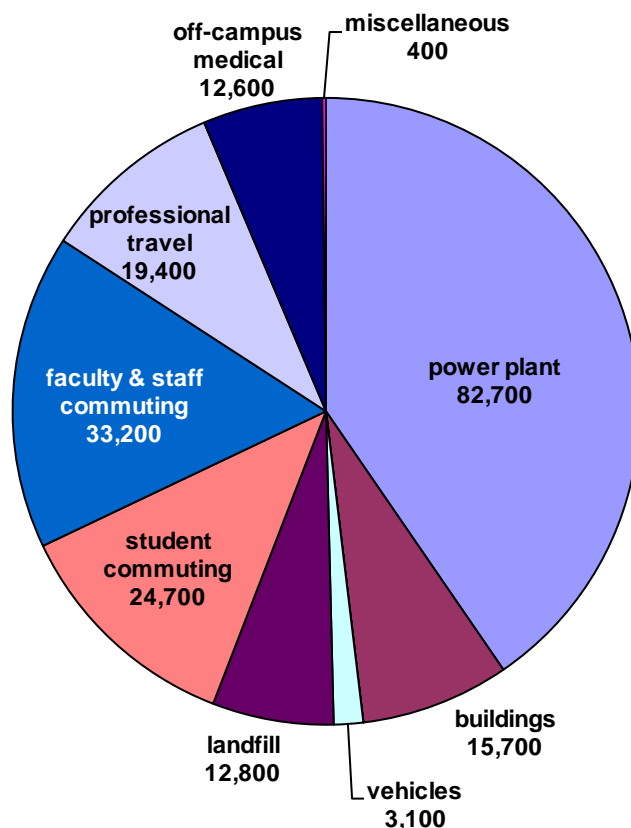


Figure 2 – Summary of gross, university-wide emissions in 2005. All values are in metric tons CO₂-equivalent (MgCO₂e).

The largest single contributor to the Inventory is the Scope 1 steam plant, which serves most facilities in the MIO boundary. This includes two major facilities that serve populations in addition to students and employees: the University of Washington Medical Center, and the sports facilities.

The second- through fourth-ranked contributors are all in Scope 3: student commuting, faculty & staff commuting, and professional air travel. Because the main campus is located in the service area of Seattle City Light, which had a zero GHG emissions factor as of 2005, Scope 2 emissions are minor (entirely encompassed within the “buildings” wedge of Figure 2).

The gross inventory is heavily dominated by the Seattle campus, which accounted for 96% of the inventory in 2005. In order to better characterize and compare the smaller campuses, Figure 3 presents emission intensities for each of the three campuses. Emission intensities are calculated on a per-capita basis, where capita include the full-time equivalent populations of students, faculty and staff combined. This definition of the university population was chosen to reflect the UW's strong focus on research, as well as student education.

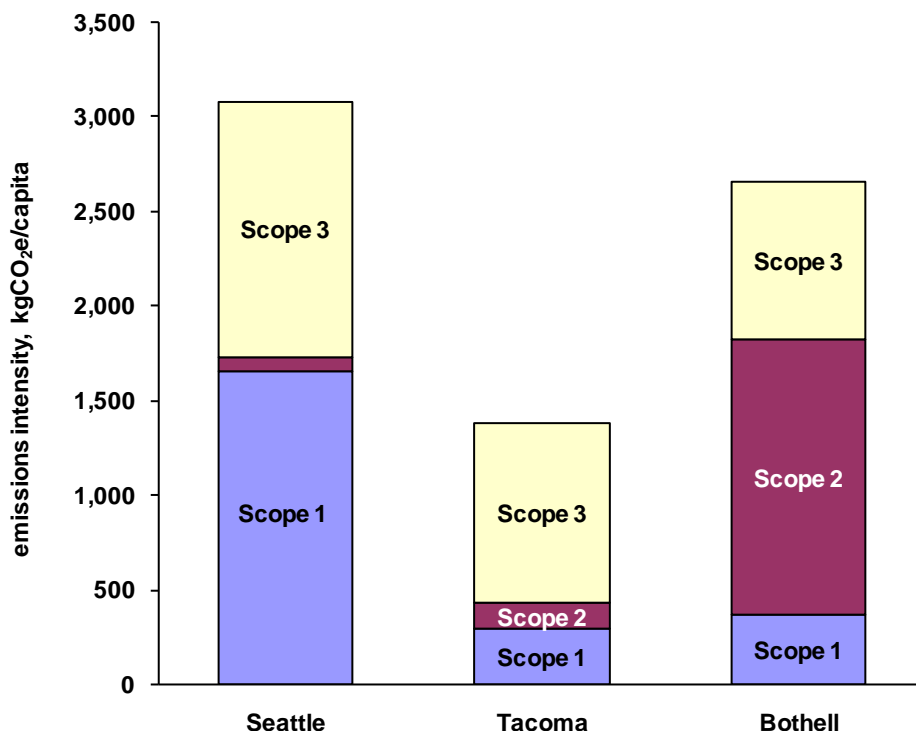


Figure 3 – Emissions intensity at each campus.

The Seattle campus' Scope 1 emissions are dominated by the campus power plant, while at the other two campuses the Scope 1 emissions are generated principally by burning natural gas in building heating systems. Seattle exhibits zero Scope 2 emissions due to Seattle City Light's GHG-neutral electricity (see the explanation in *Scope 2* below.) Bothell employees and students experience a very large Scope 2 contribution because the utility serving this campus relies heavily on coal for electric generation. The Scope 3 contributions at all three campuses are similar, consisting mostly of student commuting, employee commuting, and professional travel. The Seattle per-capita, Scope 3 emissions are the largest, as they also include off-campus medical facilities.

Scope 1 – Direct Emissions

Scope 1 emissions, or direct emissions, originate from *equipment and facilities owned by the University of Washington*. Scope 1 emissions in calendar years 2000 and 2005 are summarized in Figure 4.

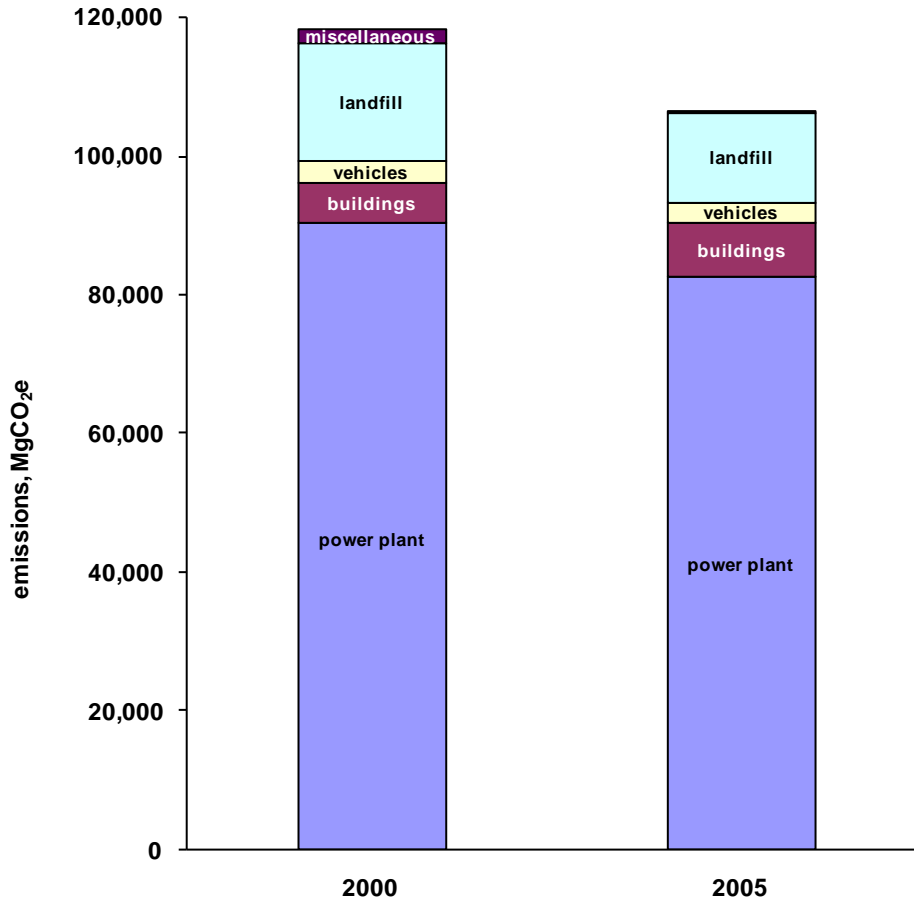


Figure 4 – Scope 1 emissions in calendar years 2000 and 2005. The “miscellaneous” category includes fugitive gases and all Scope 1 emissions from outlying facilities.

The substantive decrease in direct emissions can be attributed principally to energy conservation efforts on the Seattle campus that decrease demand on the steam plant. The Seattle campus conservation efforts benefited most strongly from three initiatives:

- Reduction in nominal winter heating temperature from 72 °F to 68 °F;
- Installation of a new boiler with a high energy conversion efficiency; and
- Turning off selected heating and ventilation equipment on nights and weekends.

The decrease in emissions occurred despite a simultaneous increase in campus population.

The following five sections detail Scope 1 emissions originating from the Seattle campus power plant, buildings, vehicles, the Montlake landfill and fugitive gases, respectively.

Power Plant

On the Seattle campus, an on-site power plant generates steam, electricity, chilled water and compressed air for most facilities inside the MIO boundary (Figure 1 on p. 11). Seven boilers consume principally natural gas, but can switch to low-sulfur, number 2 fuel oil. The UW has an interruptible supply contract with natural gas provider Puget Sound Energy (PSE), so substantial fuel oil can be consumed in a given year, depending on the weather and resulting load on PSE's gas system. Oil is delivered by truck to an underground storage tank located near the power plant..

	2000		2005	
	TJ	MgCO ₂ e	TJ	MgCO ₂ e
natural gas	1,750	87,600	1,570	78,300
oil	42	2,890	63	4,350
totals		90,500		82,700

Table 6 – Fuel consumption at and GHG emissions from the Seattle campus power plant.

Table 6 shows fuel consumption and GHG emissions at the power plant in 2000 and 2005. All emissions are CO₂ emitted from the plant stack, a direct product of the natural gas and fuel oil combustion in the boiler.

source notes

Fuel consumption by the steam plant is tracked by the Finance and Administration office of Facilities Services. Consumption figures are from spreadsheet **05-013** provided by Lori Natsume.

UW contacts

Lori Natsume
Facilities Services / Finance and Administration
206-221-4366, natsume@u.washington.edu

Buildings

There are no direct emissions associated with buildings on the Seattle campus that receive steam from the steam plant. However, a number of other buildings on the Seattle campus, and in the City of Seattle, consume natural gas for building heating, cooking and a few other uses. In Seattle, Tacoma and Bothell virtually all building emissions are due to the combustion of natural gas. However, in the outlying facilities most building emissions are due to the combustion of LPG (liquefied petroleum gas, or "propane") and fuel oil.

	2000		2005	
	TJ	MgCO ₂ e	TJ	MgCO ₂ e
Seattle, state-funded facilities	43	2,160	52	2,600
Seattle, non-state-funded		**2,300		2,490
Tacoma	7	341	14	699
Bothell	5	258	12	622
outlying facilities	**4	**24	4	26
Totals	105	5,080	133	6,440

Table 7 – Fuel consumption and GHG emissions at UW buildings.

Table 7 shows fuel consumption and GHG emissions arising directly from UW buildings in 2000 and 2005. Two separate line items for the Seattle campus distinguish between the state-funded facilities that are centrally accounted by Facilities Services, and the non-state-funded facilities.³

Of the 2,490 MgCO₂e emissions from burning natural gas in non-state-funded facilities in 2005, the vast majority is generated at the consolidated laundry buildings located in south Seattle, which serve the two hospital facilities.

source notes

Fuel consumption by state-funded facilities is tracked by the Finance and Administration office of Facilities Services. Consumption figure are from spreadsheet **05-013** provided by Lori Natsume. For non-state-funded facilities paid by the University (except Housing and Food Services), Sean Eamon Kennedy extracted 2005 records for natural gas purchases from Puget Sound Energy into worksheet **05-108**; those purchases were converted to energy usage using PSE rate table **05-112** (schedule 31, commercial/industrial general service). Rob Lubin of Housing and Food Services provided direct accounting of academic year '05-'06 gas use in **05-139**. None of the facilities paid for by other entities consume significant natural gas. David Gault did provide 2005 gas usage data for the Fairmont Olympic Hotel in **05-147**, however.

Fuel consumption at the Tacoma, Bothell and outlying campuses are each tracked by a local facilities manager or facilities department. Figures for Tacoma are taken directly from email communication **05-033** from Oliver Dunagan. Figures for Bothell are computed in **05-905** from raw data supplied by Trina Darakjy in spreadsheet **05-053**. Figures for the outlying facilities are from the following sources:

FHL, **05-067** and **05-122** provided by Scott Schwinge;
Pack Forest, **05-090** provided by Debi Pitzl;
ONRC, estimated with headcounts in **05-120** provided by Kathy Huering.

Big Beef Creek is powered entirely by electricity so has zero Scope 1 building emissions. A propane backup generator is owned and fueled by the National Marine Fisheries Service.

UW contacts

Lori Natsume (Seattle state-funded) – see *Power Plant* source notes

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Trina Darakjy (Bothell)
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Anthony Guerrero (Bothell, alternate)
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³ The state-funded facilities served or paid by Facilities Services includes one leased building, the 4545 Building which houses a computing center. This is a minor exception to the ownership-based organizational boundary described on p. 6 in *Methodology*, but serves the dual benefit of simplifying inventory accounting while including a vital part of the University's infrastructure in the core (Scope 1/Scope 2) inventory.

Scott Schwinge (FHL) – see Inventory Overview: *Organizational Boundary* source notes
Debi Pitzl (Pack Forest) – see Inventory Overview: *Organizational Boundary* source notes
Kathy Huering (ONRC) – see Inventory Overview: *Organizational Boundary* source notes

vendor contacts

David Gault (Fairmont Olympic Hotel gas usage)
 Director of Engineering, Fairmont Olympic Hotel
 206-287-4010

Vehicles

The University manages the majority of its vehicles through the UW Motor Pool. The Motor Pool serves mainly the Seattle campus; other campuses own and maintain their own, smaller fleets.

As of February 2006, the Motor Pool consisted of 628 cars and light trucks, 54 heavy trucks, and 5 buses. Most motor pool vehicles are assigned to specific University programs, for example the Health Sciences Express buses. Approximately 120 of the vehicles are available University-wide for rental on an as-needed basis.

The Motor Pool tracks all fuel purchases for its vehicles, and these are used to estimate GHG emissions as shown in Table 8.

	2000		2005	
	L	MgCO ₂	L	MgCO ₂
gasoline vehicles				
Seattle Motor Pool	946,000	2,190	910,000	2,110
Seattle other	n.d.	n.d.	n.d.	n.d.
Tacoma Motor Pool	**4,490	**10	4,870	11
Bothell Motor Pool	57,400	133	26,200	61
outlying facilities	**32,400	**131	35,100	142
gasoline subtotals	1,040,000	2,470	977,000	2,320
diesel vehicles				
Seattle Motor Pool	163,000	433	218,000	577
Seattle other	n.d.	n.d.	n.d.	n.d.
Tacoma Motor Pool	-	-	114	-
Bothell Motor Pool	-	-	-	-
outlying facilities	**24,500	**65	26,600	71
diesel subtotals	188,000	498	244,000	648
marine equipment				
Seattle Marine Pool (gasoline)	681	2	681	2
R/V Centennial (diesel)	**23,000	**61	23,000	61
marine subtotals	23,700	63	23,700	63
Totals	1,250,000	3,030	1,240,000	3,040

Table 8 – Fuel consumption and GHG emissions from University-owned vehicles.

Though there are exceptions, for the most part diesel vehicles are off-road equipment and large on-road vehicles (e.g., buses).

The University also owns one research vessel moored at Friday Harbor Laboratories (the R/V Centennial) and some small marine equipment managed on the Seattle campus; these are also tabulated in Table 8. Two additional research vessels moored in

Seattle are owned by the National Science Foundation and discussed further in *Optional Information*.

source notes

UW Motor Pool fuel consumption was provided by David Carr in **05-004** and **05-146**.

Fuel consumption at the Tacoma, Bothell and outlying campuses are each tracked by a local fleet manager. Figures for Tacoma are taken directly from email communication **05-033** from Oliver Dunagan. Figures for Bothell are computed in **05-908** from gasoline vendor invoices **05-036** supplied by Diana Graham. Figures for the outlying facilities are from the following sources:

FHL, **05-067** provided by Scott Schwinge;
Pack Forest, **05-090** provided by Debi Pitzl;
ONRC, **05-120** provided by Kathy Huering.
Big Beef Creek, **05-125** by Gordy George.

Scott Schwinge of FHL also provided fuel consumption for the R/V Centennial in **05-142**; fuel consumption for the Seattle marine equipment was provided by Floyd McCroskey in **05-143**.

UW contacts

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Oliver Dunagan (Tacoma) – see Scope 1 *Buildings* source notes

Diana Graham (Bothell)

Physical Plant Services – Bothell
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Scott Schwinge (FHL) – see Inventory Overview: *Organizational Boundary* source notes

Debi Pitzl (Pack Forest) – see Inventory Overview: *Organizational Boundary* source notes

Kathy Huering (ONRC) – see Inventory Overview: *Organizational Boundary* source notes

Gordy George (Big Beef Creek) – see Inventory Overview: *Organizational Boundary* source notes

Floyd McCroskey (Seattle marine equipment)

School of Oceanography
206-543-5186, floydg@ocean.washington.edu

Montlake Landfill

The northeastern portion of the University parking lot E1, the athletic fields and the Union Bay Natural Area, lie atop the Montlake Landfill, which operated from 1925 to 1966. The landfill contains approximately 5.4 million cubic yards of municipal solid waste. A fair portion of the landfill has sunk below the water table so the wet, anaerobic conditions conducive to methane generation are well met. Estimated methane generation in the inventory years are presented in Table 9.

	2000		2005	
	m ³	MgCO ₂ e	m ³	MgCO ₂ e
CH ₄ emissions	1,190,000	17,000	895,000	12,800

Table 9 – Methane generated by the closed Montlake Landfill, 1990-2005.

Methane emissions decay exponentially after waste is placed in the landfill, so emissions have dwindled greatly since the first few years after closure, when the landfill was capable of sustaining several flares. As of 2005, the landfill's 12,800 MgCO₂e of methane emissions make up about 5% of the university-wide inventory. A detailed discussion of the landfill and its emissions can be found in Appendix B.

source notes

Landfill volume was calculated as 4,118,399 m³ in **05-919**. (See Appendix B for detailed discussion and sources.) Landfill mass was estimated to be 1,805,665 Mg using U.S. average landfill density 438 kg/m³ published in **05-809**. Methane emissions in each year were calculated with the methane kinetics equation from IPCC Guidelines **05-812**, $Q = L_0 R (e^{-kc} - e^{-kt})$. Emissions Q are in m³/yr, annual waste placement R is in Mg/yr, c is the years since landfill closure and t the years since landfill opening. We set the two constants $L_0 = 100$ m³/Mg and $k = .057$ yr⁻¹ to match the U.S. inventory **05-803**. Assuming constant (equal mass per year) operation from 1925 to 1966 implies $R = 44,041$ Mg/yr. Each calculated value for Q in m³/yr was converted to MgCO₂e/yr using methane's density at ISO standard temperature and pressure (0.68 g/L) and the Second Assessment Report GWP of methane (21.) The kinetics calculations were carried out in **05-901**.

UW contacts

Erin McKeown (historical documents on Montlake Landfill)
Environmental Health & Safety
206-616-0585, mstoxic@u.washington.edu

vendor contacts

Jeff Neuner (City of Seattle historical landfill info)
City of Seattle / Seattle Public Utilities
206-684-7693, jeff.neuner@seattle.gov

Scott Gaulke (borehole studies & current methane monitoring at Montlake Landfill)
Shannon & Wilson, Inc.
206-695-6893

Fugitive Gases

Fugitive gases are gases with high GWPs that escape to the atmosphere through leakage or other unintentional loss – in contrast to, for instance, CO₂ emissions which are typically concentrated in exhaust streams from a stack or tailpipe. The Inventory presumes that all such high-GWP gases consumed by the UW are eventually lost to the atmosphere, unless they are specifically reported as recycled. Fugitive gases fall into three categories: HFCs, PFCs and SF₆.

Hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) are gases used principally as refrigerants, though they have a few other applications as well. HFC and PFC sales increased dramatically in the 1990s when they gained popularity as substitutes for chlorofluorocarbons (CFCs) banned by the Montreal Protocol. HFCs and PFCs are not significant threats to stratospheric ozone, but they do have significant GWPs and are therefore recorded under the Kyoto Protocol. The University tracks the consumption of refrigerants carefully, and Table 10 shows presumed fugitive emissions of HFCs, PFCs and SF₆ in 2000 and 2005, after discounting for any recycling.

	2000		2005	
	kg	MgCO ₂ e	kg	MgCO ₂ e
HFCs	27	35	104	136
PFCs	-	-	-	-
SF ₆	75	1,790	-	-
Totals	102	1,820	104	136

Table 10 – Presumed fugitive emissions from HFC, PFC and SF₆ use.

Sulfur hexafluoride (SF₆) is principally used as a gaseous insulator in electrical switching equipment. It is inventoried separately because it is a different class of chemical than the refrigerants, and because it has an abnormally high GWP (23,900). The time periods between service of electric switchgear can be quite long, and the time periods between purchases of SF₆ to support that service even longer. The large drop in total emissions reported in Table 10 is due more to the happenstance of SF₆ purchase patterns, rather than to an identifiable downward trend in its use.

source notes

2000 releases of refrigerants and SF₆ were estimated from same-year purchases. These were obtained from Stores records provided by Joe Sabo. **05-052** reports 27 kg of HFC-134a, and 75 kg of SF₆ purchased in 2000. GWPs from the Second Assessment Report **05-814** are 1,300 for HFC-134a and 23,900 for SF₆; these were used to convert the entire purchase mass to fugitive CO₂-equivalents.

2005 releases were estimated from same-year work requests. **05-074** provided by Rick Cheney indicates 103 kg of work requests for HFC-134a in 2005 for Seattle’s non-medical facilities. There were no known purchases or uses of SF₆ in 2005 (see note in **05-052**.) The medical facilities report 2 kg of work requests for HFC-134a in 2005, according to **05-152** provided by Ken Feilen.

UW contacts

Rick Cheney (refrigerant work requests, 2005)
Facilities Services / Maintenance & Alterations
206-685-1468, rcheney@u.washington.edu

Joe Sabo (historical refrigerant purchases)
University Stores / Upper Campus
206-685-3565, jpsabo@u.washington.edu

Ken Feilen (UWMC refrigerant work requests, 2005)
UWMC Operations & Maintenance
206-598-4691, feilen@u.washington.edu

Scope 2 – Energy imports

Scope 2 emissions originate from facilities neither owned nor controlled by the University, but which produce electricity or steam consumed by the University. Scope 2 emissions are summarized by campus in Figure 5. Unlike Scope 1 and Scope 3, the Seattle campus does not necessarily dominate the inventory in Scope 2, especially in and after 2005 when Seattle City Light began delivering GHG-neutral electricity (discussed in more detail below).

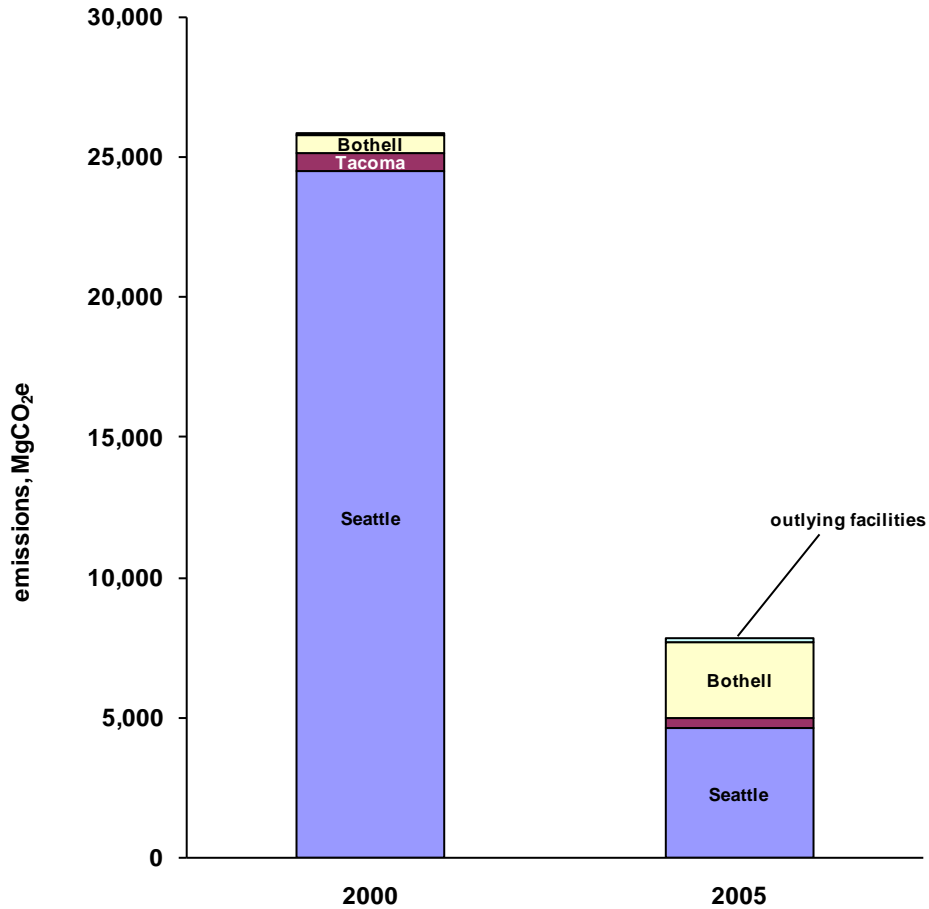


Figure 5 – Scope 2 emissions in calendar years 2000 and 2005.

Each campus receives electricity from a different utility. Table 11 lists the principal fuels used by each utility as of 2005.

campus	electric utility	nominal fuel mix
Seattle	Seattle City Light	hydro 91%, nuclear 4%
Tacoma	Tacoma Power	hydro 87%, nuclear 9%
Bothell	Puget Sound Energy	hydro 42%, coal 36%, cogen 14%, natural gas 6%
outlying facilities		
Friday Harbor Labs	Orcas Power & Light Co.	hydro 82%, nuclear 12%, coal 4%
Pack Forest	Town of Eatonville	hydro 82%, nuclear 12%, coal 4%
ORNL	Clallam County PUD #1	hydro 81%, nuclear 12%, coal 4%
Big Beef Laboratory	Puget Sound Energy	see Bothell, above

Table 11 – Utilities serving each campus. Nominal fuel mix includes fuels contributing 4% or more of the energy delivered in 2004.

The table lists only the significant contributors to the fuel mix. Because most utilities purchase some power on the wholesale market, their final fuel mixes typically include very small amounts of nearly all types of fuel. Coal is the most GHG-intensive fuel for electric generation, followed by petroleum (oil) and natural gas. Hydroelectric and nuclear electricity are largely GHG-free.

On the Seattle campus, Seattle City Light (SCL) provides electricity through one connection to the *central loop*, an electric circuit that includes most of the buildings in the MIO boundary. The power plant also supplies electricity to the central loop, such that in a typical year SCL supplies a little more than 90% of the electric load and the power plant a little less than 10%. Seattle facilities that are not on the central loop are served through independent connections with SCL.

Unless there is evidence to merit an exception, electricity consumption is generally ascribed to the buildings source category, since the majority is typically used for building HVAC systems and lighting. Table 12 lists the electricity consumption and related emissions for the various campuses.

	2000		2005	
	MWh	MgCO ₂ e	MWh	MgCO ₂ e
Seattle				
central loop	252,000	16,100	263,000	-
other state-funded facilities	15,400	986	15,500	-
non-state-funded facilities		**7,410		4,670
Tacoma	3,550	629	9,020	343
Bothell	2,220	664	7,070	2,730
outlying facilities	1,730	46	2,240	144
Totals		25,900		7,890

Table 12 – Electricity consumption and related upstream greenhouse gas emissions. Buildings included in Seattle’s central loop and other state-funded facilities are detailed in Appendix E. Seattle’s non-state-funded facilities are listed in Table 3 on p. 12. Energy consumption for Seattle’s non-state-funded facilities are not listed because they are a mixture of electricity and steam.

Pursuant to City of Seattle resolution 30144, Seattle City Light (SCL) began delivering electricity with zero net greenhouse gas emissions in 2005. SCL achieves the goal

principally by generating electricity with zero-GHG resources like hydroelectric and wind power, but also offsets the GHGs of some natural gas-fired generation and market electricity by purchasing GHG offsets. GHG offsets are tradable certificates representing GHG reductions, that are traded in an open market. In most cases they were originally generated by financial investments in projects that sequester GHGs or reduce GHG emissions.

SCL reported 2005 fuel data to the state Energy Policy office, and corresponding 2005 emissions data directly to the University, that do not discount the GHG offsets. However, SCL electricity is marketed as GHG-free (see, e.g., City of Seattle press release of November 9, 2005 “City Light First in Nation to Reach Zero Net Emissions Goal.”)⁴ Accordingly, the Inventory accounts zero GHG emissions from SCL electricity purchased in 2005.

In Table 12, the non-state-funded facilities category is dominated by steam- and electricity-related emissions from the Metropolitan Tract. The Metropolitan Tract is the former site of the University of Washington, and the University still owns the property and seven large buildings on it. Unico leases six of the buildings: the Cobb Building, Financial Center, IBM Building, Puget Sound Plaza, Rainier Tower and the Skinner Building. Legacy Hotels leases the Fairmont Olympic Hotel.

Scope 2 emissions in the Inventory are very low relative to other corporate inventories due to Seattle City Light’s low-GHG electricity (even in 2000, prior to the zero-GHG mandate). However, the Bothell campus inventory is dominated by Scope 2 emissions because the campus is served by Puget Sound Energy, which relies on coal for some 36% of its electric generation.

source notes

Electric consumption on the central loop and by other state-funded facilities is tracked by the Finance and Administration office of Facilities Services. The central loop consumption figures are from spreadsheet **05-013** provided by Lori Natsume; figures for the other state-funded facilities are derived from **05-013** data in spreadsheet **05-903**. For non-state-funded facilities paid by the University (except Housing and Food Services), Sean Eamon Kennedy extracted 2005 records for electricity purchases from SCL into worksheet **05-107**; those purchases were converted to energy usage using SCL rate table **05-111** (Medium General Service, City.) The dollars-to-energy conversions are carried out in **05-901**. Rob Lubin of Housing and Food Services provided direct accounting of academic year '05-'06 electric consumption in **05-139**.

For non-state-funded facilities paid by other entities, Chuck Peterson of SCL supplied 2005 consumption data in **05-103**, which was aggregated for the inventory in spreadsheet **05-922**. David Gault provided steam consumption data for the Fairmont Olympic Hotel in **05-147**. Clarence Clipper of Unico Properties supplied steam consumption data for the remainder of the Metropolitan Tract in **05-151**, which was aggregated for the inventory in spreadsheet **05-923**. 2000 consumption for non-state-funded facilities was backcast as equal to 2005 for buildings occupied by businesses, or prorated by University population for entities affiliated with the University.

Electricity consumption at the Tacoma, Bothell and outlying campuses are each tracked by a local facilities manager or facilities department. Figures for Tacoma are taken directly from email communication **05-033** from Oliver Dunagan. Figures for Bothell are computed in **05-905** from raw data supplied by Trina Darakjy in spreadsheet **05-053**. Figures for the outlying facilities are from the following sources:

FHL, **05-915** incorporating data from **05-100** and **05-109** supplied by Marilyn Goff at Orcas Power and Light Cooperative and **05-066** provided by Scott Schwinge;
Pack Forest, **05-090** provided by Debi Pitzl;

⁴ <<http://www.seattle.gov/news/detail.asp?id=5656&dept=40>>, accessed 7 June 2006.

ONRC, estimated from headcounts in **05-120** provided by Kathy Huering;
Big Beef Creek, **05-013** provided by Lori Natsume.

UW contacts

Lori Natsume (Seattle state-funded) – see Scope 1 *Power Plant* source notes

Sean Eamon Kennedy (Seattle non-state-funded) – see Scope 1 *Buildings* source notes

Rob Lubin (Housing & Food Services) – see Scope 1 *Buildings* source notes

Oliver Dunagan (Tacoma) – see Scope 1 *Buildings* source notes

Trina Darakjy (Bothell) – see Scope 1 *Buildings* source notes

Scott Schwinge (FHL) – see Inventory Overview: *Organizational Boundary* source notes

Debi Pitzl (Pack Forest) – see Inventory Overview: *Organizational Boundary* source notes

Kathy Huering (ONRC) – see Inventory Overview: *Organizational Boundary* source notes

vendor contacts

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David Gault (Fairmont Olympic Hotel) – see Scope 1 *Buildings* source notes

Clarence Clipper (Metropolitan Tract steam consumption)
Unico Properties
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Marilyn Goff (FHL electric service)
Orcas Power and Light Cooperative
360-376-3551

Scope 3 – Other

Scope 3 emissions originate from sources not classifiable as either Scope 1 or Scope 2. The University includes student, faculty and staff commuting; professional travel; and off-campus medical facilities among its Scope 3 sources. Their emissions in calendar years 2000 and 2005 are shown in Figure 6, and detailed in the three sections that follow.

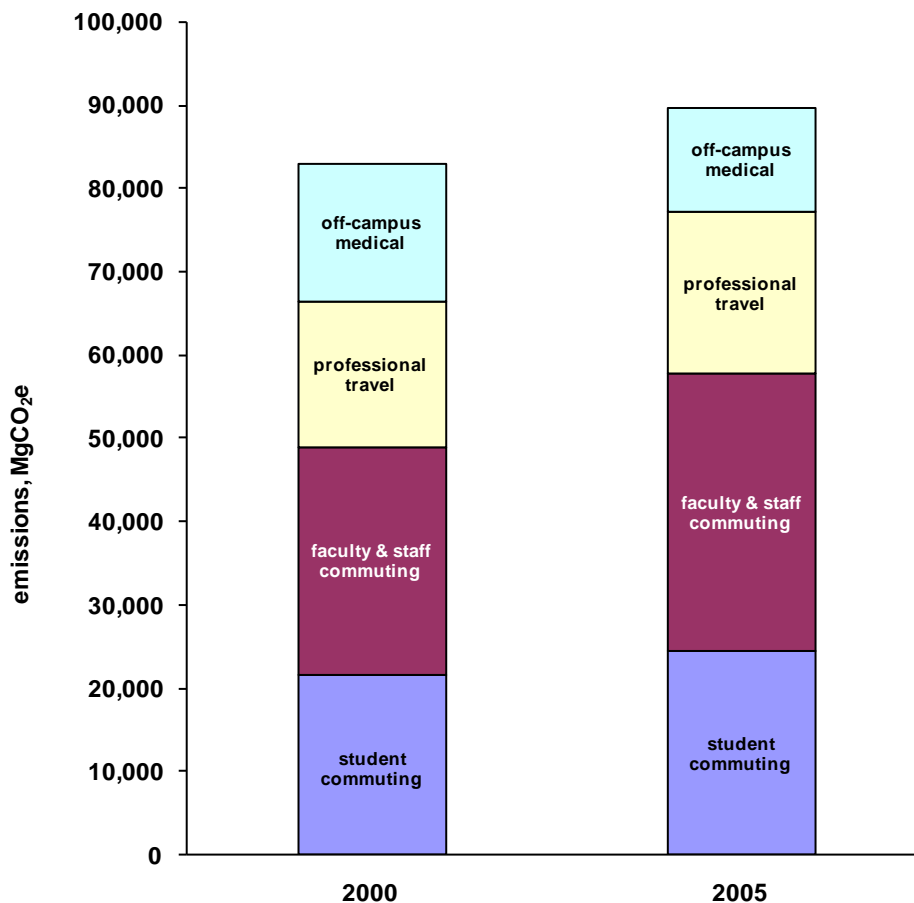


Figure 6 – Scope 3 emissions in calendar years 2000 and 2005.

Student, Faculty and Staff Commuting

Washington State’s Commute Trip Reduction (CTR) law requires employers with facilities housing 100 or more employees to survey commuting behavior biannually. The UW’s survey results are reported to the Washington State Department of Transportation (WSDOT) which then processes the survey data to provide the University with commuting travel statistics for each qualifying facility.

The CTR law applies only to employees so it does not require that students be surveyed. However, on the Seattle campus the U-Pass program conducts an extended survey that meets the CTR requirements but also goes beyond them, adding additional questions and, importantly for the Inventory, including students. Table 13 shows GHG emissions in 2000 and 2005 associated with commuting at the three campuses. (There is no data for commuting at the outlying facilities since they all fall below the CTR size threshold.)

	2000		2005	
	10 ⁶ pm	MgCO ₂ e	10 ⁶ pm	MgCO ₂ e
Seattle				
SOVs	67.2	26,900	79.7	31,600
carpools & vanpools	38.0	6,760	33.0	5,970
transit	67.7	12,500	91.5	17,000
Seattle totals	173.0	46,200	204.0	54,600
Tacoma				
SOVs	n.d.	**1,200	n.d.	1,310
carpools & vanpools	n.d.	**136	n.d.	147
transit	n.d.	**492	n.d.	534
Tacoma totals		1,830		1,990
Bothell				
SOVs	n.d.	757	n.d.	812
carpools & vanpools	n.d.	95	n.d.	94
transit	n.d.	292	n.d.	390
Bothell totals		1,140		1,300
outlying facilities	n.d.	n.d.	n.d.	n.d.
Grand totals		49,100		57,800

Table 13 – Commuting emissions by campus and mode in MgCO₂e. “10⁶ pm” are millions of passenger miles. Passenger mile data are not available for the Tacoma and Bothell campuses because the state CTR program provided vehicle miles traveled data.

In 2000, the Tacoma campus had not yet surpassed the CTR threshold yet so survey data is unavailable and we backcast from 2005 emissions using campus-wide population data. The student portion of commuting emissions at Tacoma and Bothell are both estimated by scaling Seattle campus emissions according to student populations.

In Seattle transit emissions are mostly from the King County Metro system, which operates a combination of diesel coaches and electric trolley buses. At the main campus, a breakdown of commuting between students, staff and faculty is possible thanks to the more sophisticated U-Pass survey, and the results of analyzing the data this way are shown in Table 14.

The growth of emissions from 2000 to 2005 is principally an artifact of the burgeoning campus populations documented in the *Inventory Overview*. Nevertheless, emissions intensities per capita are also increasing, as documented in Table 15.

	2000			2005		
	kgCO ₂ e/pm	kgCO ₂ e/cap	pm/cap	kgCO ₂ e/pm	kgCO ₂ e/cap	pm/cap
students	0.244	530	2,170	0.250	569	2,280
faculty	0.322	809	2,510	0.320	1,100	3,430
staff	0.278	1,330	4,780	0.269	1,400	5,190

Table 15 – Per-capita commuting emissions intensities for the Seattle campus by population. “pm” means passenger miles and “cap” means capita.

The table demonstrates that emissions per passenger mile are essentially stable from 2000 to 2005, and that the brunt of the per-capita increase in emissions intensity is due to increased annual passenger miles per capita. This increase is most likely due to a lengthening average home-to-work distance: the increase is most pronounced among

	2000	2005
students	19,100	21,800
faculty	5,300	8,070
staff	21,800	24,700

Table 14 – Commuting emissions for the Seattle campus by population, in MgCO₂e.

faculty, secondarily among staff, and only very slightly among students.

source notes

Data for 2005 commuting on the Seattle campus were deduced from the autumn, 2004 U-PASS survey cross-tabulation reports (“crosstabs”). There is one crosstab each for students, faculty and staff: **05-040**, **05-041** and **05-042**, respectively; all U-PASS survey data were supplied by Paul Roybal of UW Transportation Services. Each respondent’s data reflects one representative week of commuting, so data are weighted by student, staff and faculty populations, and extrapolated to cover an entire calendar year.

For each population, the emissions are calculated separately for each mode of commuting (single-occupancy vehicle, bus, etc.) and then the emissions from all modes are combined at the end of the calculation chain. Each respondent could specify up to five different modes for the five different days in the week, but the inventory sums only the primary and secondary modes used by each respondent. Respondents using more than two modes in one week were rare.

For each population the average, per-capita distance traveled in one week for a given primary mode is calculated as:

$$\text{mean mode distance per week} = 2 \times \text{mean commute distance} \times \text{mean mode days per week}, \quad (1)$$

where “mean” refers to the average person in that population (either students, staff or faculty). *mean commute distance* and *mean mode days per week* are extracted directly from the cross-tabs. The total, annual distance traveled by the population is:

$$\text{mode distance per year} = \frac{\text{mean mode distance per week} \times \text{population size}}{\text{population fraction using mode} \times \text{commute weeks per year}}. \quad (2)$$

population size is drawn from the sources described in the source notes to *Organizational Boundary* in the *Inventory Overview* above. *population fraction using mode* is calculated in **05-901** from crosstab data. *commute weeks per year* is assumed to be 48 weeks per year for staff and faculty, 30 weeks for academic-year students, and 10 weeks for summer students.

The same pair of equations is used to derive the secondary mode distances per year, and each pair of matching results (e.g. primary bus distance and secondary bus distance) is summed to create a gross distance in passenger-kilometers for that mode, for that population. Emissions are then calculated from 2005 emission factors as follows:

mode	emission factor
SOV	247 gCO ₂ /pkm
carpool/vanpool	247 gCO ₂ /pkm / <i>mean carpool size</i>
Metro Transit	121 gCO ₂ /pkm
Sound Transit	121 gCO ₂ /pkm
Community Transit	100 gCO ₂ /pkm

pkm means passenger-kilometers. *mean carpool size* differs for each population, and is drawn directly from the crosstabs. The SOV emission factor is derived from 2002 U.S. average fuel efficiency documented in **05-802** (the most recent available), combined with the 2003 gasoline emissions factor derived from the U.S. GHG inventory **05-803** (the most recent available). Metro Transit and Community Transit emission factors are calculated from fuel consumption reported in the Federal Transit Administration’s (FTA) National Transit Database **05-082**, and passenger mile data in FTA profile reports **05-078** and **05-079**. The Sound Transit emission factor is set equal to the Metro Transit emission factor because Sound Transit buses are operated by Metro Transit so Sound Transit does not report fuel consumption to the FTA.

Data for 2000 commuting on the Seattle campus were deduced from the autumn, 2000 U-PASS survey crosstabs **05-043**, **05-044** and **05-045** for students, faculty and staff, respectively. Methodology is identical

to that described above for the 2004 U-PASS survey, except the modes and corresponding emission factors differ slightly as follows:

mode	emission factor
SOV	249 gCO ₂ /pkm
carpool/vanpool	249 gCO ₂ /pkm / <i>mean carpool size</i>
transit	115 gCO ₂ /pkm

Metro Transit was used to represent the emission factor for the undifferentiated “transit” mode reported in the 2000 survey crosstabs. Metro Transit fuel consumption came from the FTA National Transit Database **05-081** and passenger mile data from FTA profile report **05-075**.

Employees located in Northgate, Seattle (leased buildings that are not otherwise included in the inventory) are surveyed under the CTR program but not the U-PASS program. Ed Hillsman of the Washington State Department of Transportation supplied summary data from CTR surveys for this facility in spreadsheet **05-106**. The Northgate campus surveys on odd-numbered years so 2005 was represented by 2005 survey data, and 2000 by 1999 survey data. **05-106** reports vehicle miles traveled rather than passenger miles traveled for each mode, so these values were converted to emissions with the following emission factors:

vehicle	emission factor
car (2005)	247 gCO ₂ /km
car (2000)	249 gCO ₂ /km
van (2005)	310 gCO ₂ /km
van (2000)	313 gCO ₂ /km
bus	1,384 gCO ₂ /km

Emissions from employee commuting at the Tacoma and Bothell campuses were derived from the state data **05-106** using the same methodology as used for the Northgate properties. For 2000, no survey data were available for the Tacoma campus, so the emissions were backcast from 2005 using 2000-to-2005 growth in Tacoma employee population. Emissions from student commuting at the Tacoma and Bothell campuses were estimated in **05-901** by scaling the Seattle campus emissions by the ratios of student populations at the two campuses, respectively, to the student population at the Seattle campus.

UW contacts

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vendor contacts

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Research Travel and Other Professional Travel

University of Washington faculty, and to a lesser extent staff and students, make frequent use of air travel in the processes of performing research, conducting fieldwork, and attending research meetings and conferences. The UW does not track air miles traveled, but it was possible to deduce airfare expenses from 2005 fiscal data. Miles traveled were estimated from the expenses using an average cost of 25¢/passenger-

mile, consistently with the American College and University Presidents Climate Commitment.⁵ The results are shown in Table 16.

In 2005 University faculty, staff and students traveled some 110 million air miles, inducing about 31,700 MgCO₂e in the process. On average, about 3,900 miles were flown per full time-equivalent employee. Emissions were calculated from air miles using national average, commercial aircraft energy intensity reported by the U.S. Department of Energy, and the jet fuel emissions factor available from the U.S. GHG inventory. The fiscal data did not allow distinction between campuses, so the university totals were apportioned among campuses according to faculty population, as shown in Table 17.

	air miles (000s)	MgCO ₂ e
university-wide		
state-funded	3,680	956
other	71,000	18,400
Totals	74,700	19,400

Table 16 – University-wide professional travel and associated emissions in 2005.

	2000		2005	
	air miles (000s)	MgCO ₂ e	air miles (000s)	MgCO ₂ e
Seattle	**64,300	**16,700	72,000	18,700
Tacoma	**1,230	**320	1,380	359
Bothell	**944	**245	1,060	275
outlying facilities	**214	**55	239	62
Totals	66,700	17,300	74,700	19,400

Table 17 – Air miles traveled and induced emissions associated with each campus.

Similar, 2000 fiscal data are unavailable so 2000 emissions from professional air travel are backcast using faculty population figures.

source notes

2005 fiscal travel data was provided by Thomas Phillips in **05-089**. Travel types were grouped by account number (to identify the type of travel) and budget number (to identify the travel funder) and summed in **05-912**. Fiscal totals were transferred to **05-901** where the remainder of the emissions calculations are documented. The 25¢ value for cost per passenger mile used here is documented in **05-153**. Passenger miles were converted to energy consumption using the 2002 commercial aircraft energy intensity of 3.9 MJ/passenger-mile documented in the Transportation Energy Data Book **05-802**, and energy consumption converted to CO₂ emissions using jet fuel emission factor 66.5 gCO₂/MJ derived from the U.S. GHG Inventory **05-803**.

2000 fiscal data were unavailable so the 2000 passenger miles and emissions are backcast proportional to growth in faculty population.

UW contacts

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⁵ American College and University Presidents Climate Commitment, *Implementation Guide*, v. 1.0, September 2007, p. 15 (**05-153**). The U.S. Bureau of Transportation Statistics maintains a national average revenue per passenger-mile, which was 12.22¢/passenger-mile in 2003, the most recent year available (see **05-098**). However, the national figure is strongly influenced by budget and recreational travel that is atypical of the professional travel induced by a university.

Off-Campus Medical Facilities

In choosing the ownership approach to defining the organizational boundary, two substantive emissions sources that would likely be included in a control approach are excluded from Scopes 1 and 2, despite being closely tied to the core functions of the University. This section compiles emissions from Harborview Medical Center, and the Regional Primate Research Center's AIDS research facility.

The Harborview Medical Center building is owned by King County, but is operated by University employees.

	2000		2005	
	energy	MgCO ₂ e	energy	MgCO ₂ e
direct emissions				
buildings	n.d.	**73	1.0 TJ	73
vehicles		**5		5
misc. equipment		**3		3
total		<u>81</u>		<u>81</u>
electricity & steam				
buildings				
electricity	27,600 MWh	1,770	35,700 MWh	-
steam	143,000 klb	13,200	121,000 klb	11,200
total		<u>15,000</u>		<u>11,200</u>
total emissions		<u><u>15,100</u></u>		<u><u>11,300</u></u>

Table 18 – Emissions at the Harborview Medical Center. Scope 1 building emissions are all from natural gas combustion. Scope 1 energy values for vehicles and miscellaneous equipment are not given due to multiple fuels.

Table 18 details Harborview emissions in the two inventory years. Harborview is the only University-operated facility purchasing steam energy; the Scope 2 emissions from generating the steam are the dominant component of Harborview's inventory. The steam is generated by Seattle Steam, located in downtown Seattle, and delivered by pipeline. Seattle Steam combusts natural gas in a boiler, with approximately 57% of the natural gas heating value embodied in steam heating value at the plant gate.

Harborview's security department utilizes several vehicles but these are leased from the main campus Motor Pool; their fuel consumption is captured in the Seattle segment of the main Scope 1 inventory above.

The Regional Primate Research Center (RPRC's) AIDS research facility is located in a 40,000 square foot, rented building in the City of Seattle. It is a substantive contributor to the GHG inventory because climate control and ventilation requirements produce high electricity and natural gas demands. Emissions are listed in Table 19.

	2000		2005	
	energy	MgCO ₂ e	energy	MgCO ₂ e
natural gas	n.d.	1,300	26.0 TJ	1,300
electricity	n.d.	**258	4,030 MWh	-
total emissions		<u>1,560</u>		<u>1,300</u>

Table 19 – Direct emissions from natural gas, and indirect emissions from electricity consumption, at the RPRC AIDS research facility.

source notes

All source files regarding Harborview were supplied by Peter Rackers of Harborview Medical Center Facilities and Engineering Services. 2005 natural gas consumption was calculated in **05-916** from Puget Sound Energy utility bills in **05-101**, and the final conversion to emissions was calculated in **05-901**. Fuel consumption by vehicles and miscellaneous equipment in 2005 was reported in emails **05-123** and **05-124**. There were no 2000 data available for Scope 1 sources, so all of these were backcast to be equal to 2005.

Electricity consumption in 2005 was computed in **05-920** from Seattle City Light bills contained in **05-101**, and steam consumption was computed in **05-921** from Seattle Steam bills in **05-101**. Fiscal year 2000 electricity consumption (July 1, 1999 – June 30, 2000) was provided as a proxy for calendar year 2000 electricity consumption, in spreadsheet **05-105**. Calendar year 2000 steam consumption was calculated in **05-921** from utility bill data in spreadsheet **05-104**.

The CO₂ emission factor for Seattle Steam is duplicated from the 2003 Inventory of King County Air Emissions, **05-811**, which reports a steam enthalpy of 10 therms/klb and a boiler heat rate of 1.75 therms natural gas per therm steam.

2005 electricity and natural gas consumption at the RPRC was calculated from utility billing records **05-107** and **05-108**, respectively, supplied by Sean Eamon Kennedy of Business Services. The financial data obtained from Business Services is converted to consumption using utility rate schedules in **05-901**.

UW contacts

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Sean Eamon Kennedy – see Scope 1 *Buildings* source notes

Optional Information

Optional information is an inventory section formally defined by the *GHG Protocol*. It may include estimates of GHG emissions that are alternative to (*i.e.* they duplicate) estimates presented in Scopes 1, 2 or 3; estimates of GHG sequestration; values of GHG offsets purchased, sold or otherwise traded; or other, ancillary information that does not indicate a specific quantity of GHGs. *Optional Information* in this inventory includes the following items:

1. Emissions from National Science Foundation research vessels operated by the University;
2. Emissions and sequestration associated with solid waste management;
3. Sequestration associated with Pack Forest; and
4. A brief discussion of unaccounted emissions associated with travel by medical patients and sports fans.

NSF Research Vessels

The UW stewards two research vessels owned by the National Science Foundation and moored at the School of Oceanography pier on Portage Bay. One of these, R/V Thomas G. Thompson, accommodates major research cruises in international waters and consumes substantial quantities of diesel fuel each year. Fuel consumption and related emissions for both ships appear in Table 20.

	2000		2005	
	L	MgCO ₂ e	L	MgCO ₂ e
R/V Thomas G. Thompson	1,610,000	4,280	2,480,000	6,570
R/V Clifford A. Barnes	37,800	100	27,300	73
Totals	1,650,000	4,380	2,510,000	6,640

Table 20 – Fuel consumption and GHG emissions by NSF research vessels operated by the University of Washington.

The R/V Thompson supports researchers from many other institutions besides the University of Washington.

source notes

All fuel consumption data were supplied by Daniel Schwartz in **05-141** and **05-144**.

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Emissions and Reductions Associated with Solid Waste

The U.S. EPA stewards the Waste Reduction Model (WARM), which is designed to estimate GHG emissions and reductions associated with various waste management strategies. The model divides waste into multiple categories depending on waste type, and allows the user to designate landfill disposal, incineration, recycling or composting as the fate of each category. When recycling is the assigned fate for a given category, the model often reports greenhouse gas reductions rather than emissions for the waste management strategy, because recycling is modeled in part as an avoidance of manufacturing from virgin materials. In most cases, the avoided manufacturing is more GHG-intensive than the recycling so a net GHG reduction results.

Though landfilled waste emits methane when it decays in the anaerobic landfill environment, some of the organic waste remains in the landfill undecayed, so the sequestered organic material sequesters a certain amount of carbon and therefore CO₂. At the main campus, waste that is disposed of (rather than recycled) is handled by Waste Management, Inc. and landfilled in the Arlington landfill in eastern Oregon. For this Inventory, we instructed the WARM model to emulate Arlington disposal with a 258-mile rail transport followed by landfilling in a dry environment with 75% capture and flaring of the generated methane.

UW Property & Transport Services	U.S. EPA WARM
garbage	Mixed MSW
office paper	Mixed Paper (primarily from offices)
UWMC paper	Mixed Paper (general)
WM paper	Mixed Paper (general)
concrete	Aggregate
TAG	Glass
wood debris	Dimensional Lumber
pallets	Dimensional Lumber
landscape waste	Yard Trimmings
baled cardboard	Corrugated Cardboard
UWMC cardboard	Corrugated Cardboard
books	Mixed Paper (general)
ferrous metal	Steel Cans
food waste	Food Scraps
food	Food Scraps
fluor tube	Mixed MSW
monitors/CPUs	Personal Computers
refrigs	Mixed MSW
aluminum	Aluminum Cans
other	Mixed Recyclables

Table 21 – UW-to-EPA waste category crosswalk. UW Property & Transport Services classifies all listed categories except “garbage” as “recycling.” However, “fluor tube” and “refrigs” are modeled in EPA WARM as unrecycled because WARM provides no capacity for recycling these types of materials.

UW Property & Transport Services tracks waste in approximately 20 different categories. In Table 21 we describe how each of the Property & Transport Services categories is mapped into an EPA WARM category. When main campus waste is recategorized this way, we can run the WARM model to produce the results shown in Table 22.

	2000		2005	
	tons	MgCO ₂ e	tons	MgCO ₂ e
landfilled				
mixed MSW	7,530	1,400	6,310	1,170
composted				
yard trimmings	679	(136)	988	(198)
food & food scraps	7	(1)	92	(18)
recycled				
mixed recyclables	124	(357)	-	-
aluminum	14	(213)	n.d.	n.d.
steel	298	(535)	373	(668)
glass	493	(139)	179	(50)
corrugated cardboard	824	(2,260)	574	(1,580)
dimensional lumber	110	(269)	143	(351)
mixed paper	381	(1,210)	274	(870)
office paper	1,320	(4,050)	1,120	(3,430)
personal computers	5	(13)	96	(238)
concrete	83	(1)	499	(5)
Totals	11,900	(7,790)	10,700	(6,240)

Table 22 – Emissions and reductions from main campus waste, divided among the EPA WARM categories. “MSW” is municipal solid waste, i.e. garbage.

WARM reports net emissions only from the landfilled waste; recycled materials (almost 41% of the waste stream in 2005) all result in reductions of GHG emissions via displacement of manufacturing from virgin materials. In 2005, the recycled materials displaced some 7,410 MgCO₂e, more than offsetting the 1,170 MgCO₂e generated from landfilling MSW that year.

source notes

Anne Eskridge of Property & Transport Services supplied spreadsheet **05-055** detailing waste and recycling tonnages in the “UW Property & Transport Services” categories listed in the Table 21. **05-055** contains data for both inventory years. Using the Table 21 crosswalk, these data were entered into two WARM runs **05-918** and **05-917** for calendar years 2000 and 2005, respectively. Where multiple UW categories fill a single EPA category, the multiple UW data can be audited by examining the formula in the relevant WARM input cell, which will contain the sum in a fully disaggregated form.

The WARM runs are programmed to assume 75% methane capture and flaring at the landfill, and 258 miles of MSW transport to the landfill (the rail distance from Seattle to Arlington, Oregon.)

The calculations were performed in WARM version 7 (August 2005); each of the two saved runs includes the entire Microsoft Excel model so they are self-documenting.

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vendor contacts

U.S. EPA Waste Reduction Model website

<<http://yosemite.epa.gov/oar/globalwarming.nsf/content/ActionsWasteWARM.html>>

Forest Sequestration

The University owns five tracts that are mostly forested, listed in Table 23. Pack Forest, the largest, is also the only one that is systematically surveyed with sufficient detail to estimate carbon stocks. In fact, surveys have been conducted every five years since the 1970s. None of the other four tracts are surveyed, so their sequestration value could not be calculated for the Inventory.

The College of Forest Resources Silviculture Lab used their in-house carbon modeling software, Landscape Management System (LMS), to calculate the GHG sequestration value of Pack Forest as shown in Table 24.

Site	acres
Pack Forest	4,250
Friday Harbor Laboratories	1,744
Big Beef Creek	400
Lee Forest	160
Olympic Natural Resources Center	40

Table 23 – Forested land owned by the University. Acreages are totals for the sites; not all acres include forest cover. Friday Harbor Laboratories includes Shaw Island tracts.

	1995	2000	2005
Pack Forest			
forest carbon, MgC	169,000	185,000	208,000
embodied GHGs, MgCO ₂ e	618,000	678,000	760,000
sequestration, MgCO ₂ e/yr	n.d.	12,200	16,400

Table 24 – Forest carbon in Pack Forest, 1995-2005.

For each of the two Inventory years, GHG sequestration is calculated from the average annual increase in carbon stock over the prior, five-year period. The average annual carbon increase is then converted to CO₂-equivalents, representing the trees' removal of CO₂ from the air during their growth. In the five-year period leading up to 2005, CO₂ sequestration at Pack Forest accelerated markedly to 16,400 MgCO₂e/yr, up 35% from the 12,200 MgCO₂e/yr achieved in the five-year period leading up to 2000. The acceleration of carbon storage is due to a relatively young but aging tree stock: as young trees become larger, they photosynthesize more mass each year. The carbon storage rate increases until the forest is old enough that GHG sources associated with dead and decaying matter equal the sink associated with photosynthesis, but reaching this steady state can take hundreds of years for northern forests like Pack Forest.

source notes

Site acreages are from the UW Office of Research Field Stations website, except Friday Harbor Laboratories, which was supplied by Mary Hoverson of the UW Real Estate Office in **05-135**.

James McCarter of the College of Forest Resources Silviculture Lab provided Landscape Management Systems (LMS) output **05-096** containing carbon storage estimates in Pack Forest for calendar years 1995, 2000 and 2005. The values reported in the Inventory are the total forest carbon, regardless of form (crown, stem, litter, etc.) Second-order terms associated with harvest for forest products, etc. are not included. The forest survey data supporting the LMS runs were provided by Duane Emmons at Pack Forest.

UW contacts

Office of Research Field Stations website
<<http://www.washington.edu/research/field>>

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Customer Travel

The University of Washington induces substantive quantities of travel among two populations that are neither employees nor students of the university. These two populations are sports fans attending events at Husky Stadium and its neighboring athletic facilities, and patients being treated at the UW Medical Center or Harborview.

The UW is not reporting emissions estimates for these two GHG sources because sufficiently accurate estimation methods do not exist at this time.

Appendix A: Standard Factors Used in GHG Calculations

molecular mass ratios

CO ₂ /C	3.664	[unitless]
CO ₂ /CH ₄	2.743	[unitless]

100-year global warming potentials (from Second Assessment Report)

CO ₂	1	[unitless]
CH ₄	21	[unitless]
N ₂ O	310	[unitless]

higher heating values of fuels

gasoline	34.8	MJ/L	
diesel	38.6	MJ/L	
natural gas	0.0382	MJ/L	at 1 atmosphere, 15 degC
propane	25.4	MJ/L	

carbon content of fuels

gasoline	18.3	g/MJ
diesel	18.9	g/MJ
natural gas	13.7	g/MJ
propane	16.3	g/MJ

energy equivalents

gallon gasoline equivalent	137	MJ
kWh	3.60	MJ
mmBtu	1,054	MJ
therm	105	MJ

Appendix B: History and Assessment of the Montlake Landfill

History of the Site¹

At the turn of the century, Union Bay was a shallow arm of Lake Washington with a deep peat bottom slowly filling up with the sediments from Ravenna Creek. The completion, in 1916, of the Hiram M. Chittenden Locks at Ballard dropped the water level in Lake Washington eleven feet (at high water), producing a vast cattail marsh that stretched from the University Campus eastward to the edge of Laurelhurst. Rubbish filling began in the northeastern corner of the marsh in 1925 and moved intermittently south and east following the solid ground.

By 1949, University temporary housing covered this filled land, and an open burning dump was in operation on the western edge of the marsh. Internal canals were dredged for drainage. In 1956 modern sanitary landfill methods were instituted which required nightly covering of the day's fill with a layer of earth. This change in landfill policy and practices, coupled with an expanding amount of refuse from Seattle's growing population, quickly increased the rate of marsh reclamation by landfill. By late 1956 the western portion of the interior perimeter-loop channel had been covered over by refuse and the first Montlake parking lot was completed. New dredging the same year established the first south channel, separating a large marsh island from the body of the main marshland.

The rate of filling accelerated even more from the late fifties until 1965 when the landfill began closing procedures. A new technique for filling was instituted during this time at the advice of University of Washington Professor Walter Dunn. In order to keep peat from squeezing out from under the landfill edge and into the bay, dikes of timber and rubble were placed to form large "cells" or compartments to contain the fill and stabilize the underlying edges of peat. Filling spread rapidly into the marsh and reached its greatest extent in 1964. A new canal was placed along the western dike to accommodate runoff from the urban area to the north. Landfill operations ceased entirely in 1966, but a series of surface cover filling, grading, and seeding operations altered the landscape until 1971, when all but minimal maintenance activities ceased.

History of Methane²

Aerobic decomposition of the biodegradable garbage occurred on initial placement of the garbage and debris, while oxygen was still available. Once the oxygen was used up, anaerobic microbes began to decompose the garbage and debris. Anaerobic decomposition's primary by-products are methane, carbon dioxide, water, organic acids, nitrogen, ammonia, ferrous and manganous salts, and hydrogen sulfide. Tests

¹ History adapted from: *The Draft Environmental Impact Statement: Center for Urban Horticulture at Union Bay*. Prepared by University of Washington Department of Facilities Planning and Construction, 1980, Pages 29-30. (05-061) Available upon request from Shannon & Wilson, Incorporated.

² Methane history adapted from *The Montlake Landfill Information Summary*. Prepared by Seattle/King County Department of Health; Washington State Department of Ecology; Washington State Department of Health; and University of Washington, 1999, Pages 21-22. (05-011) Available upon request from the University of Washington Environmental Health and Safety.

performed in 1980 showed that biological decomposition of the garbage and debris was anaerobic.

While the Montlake Landfill still generates methane as decomposition continues to occur, the quantity of methane released is now small enough that flares are no longer used to burn off any excess gas at the site. The methane collection system is still in place, but most of the flares were extinguished in the late 1970s.

In 1997, the University measured the concentration of methane generated in the landfill area, using a method similar to that used in *The Seattle/King County Abandoned Landfill Study in the City of Seattle* of 1984.³ The concentrations of methane are available in Table 6 of *The Montlake Landfill Information Summary*.⁴ Concentrations of methane measured in 1997 were below the combustion limit and significantly below the levels measured in 1984.

Since decomposition of the underlying peat also produces methane gas, methane will continue to be produced even when the garbage is depleted. Due to the potential for methane to pool under impermeable layers, such as asphalt or concrete, long-term measurements are generally done around such landfill areas, even after long-term closure. Accordingly, the University is monitoring methane levels around the landfill perimeter, under the E-1 parking lot, and in buildings near the landfill on a quarterly basis.⁵

Research Process

Calculating the amount of garbage and rubbish in the Montlake Landfill required compiling the past reports and impact statements on the site. This process began with two reports in particular, *The Montlake Landfill Information Summary (1999)* and *The Draft Environmental Impact Statement (1980)*. These two informational sources proved invaluable as they contained bibliographies dating back to the 1950s. Using these sources, the two documents uncovered were *The Master Plan Union Bay Teaching/Research Arboretum (1976)* and *The Seattle/King County Abandoned Landfill Study in the City of Seattle (1984)*. From these sources, the final and most complete document was discovered: *The Proposed Reclamation and Utilization of Union Bay Swamp (1959)*.

Contributions from the Literature

The above-cited documents provided the essential information needed to estimate the amount of garbage and rubbish in the Montlake Landfill. The following summarizes their contributions:

³ Bishop, Greg and Wayne Turnberg. *The Seattle/King County Abandoned Landfill Study in the City of Seattle*. Seattle/King County Department of Health, 1984. Call # TD 795.7 S47 1984. (05-807)

⁴ *The Montlake Landfill Information Summary*. Prepared by Seattle/King County Department of Health; Washington State Department of Ecology; Washington State Department of Health; and University of Washington, 1999. (05-011)

⁵ As of this inventory, the most recent monitoring event was conducted in early August, 2006 by Shannon & Wilson, Inc. (05-138).

- *The Montlake Landfill Information Summary (1999)* Description of primary operations (110 18m³ truckloads of refuse, 5 days a week, from the late 1950s until closure) and the maximum rubbish and debris thickness (12.2 meters).⁶
- *The Draft Environmental Impact Statement (1980)* Average depth of refuse (20 feet). Maximum and minimum refuse thickness (Less than 10 feet at the northeastern portion of the site to nearly 40 feet at the southwest corner).⁷
- *The Master Plan Union Bay Teaching/Research Arboretum (1976)*⁸ Historical information and two cross sections.
- *The Seattle/King County Abandoned Landfill Study in the City of Seattle (1984)* Size of the landfill (200 acres).
- *The Proposed Reclamation and Utilization of Union Bay Swamp (1959)*⁹ Estimated garbage and rubbish disposal available at the landfill during 1960-1969 (6,400,000 y³).

Amount of Refuse Calculation Methods¹⁰

Due to the significance of the number, three separate calculations were undertaken to determine the amount of refuse in the Montlake Landfill. These calculations can be located in document **05-919**.

- Calculation A: Total Refuse = Size of the landfill as noted by Turnberg and Bishop (1984) (200 acres) * Average depth of refuse (20 feet) as noted by The Draft Environmental Impact Statement (1980)
Total Refuse = 968,000 square yards * 6.67 yards
Total Refuse = 6,456,560 yd³
- Calculation B: Estimation from Dunn (1959) of the total capacity of the landfill at the year which filling ceased, 1966
Total Refuse = 4,400,000 yd³
- Calculation C: Total Refuse = Total Primary Operations¹¹ (110 18m³ truckloads of refuse, 5 days a week for an estimated 8 years¹²)
Total Refuse = 110 (truckloads) * 18m³ * 5 (days a week) * 52 (weeks a year) * 8 (years)

⁶ Based on 1984 borings associated with *The Seattle/King County Abandoned Landfill Study in the City of Seattle*. Cited from *The Draft Environmental Impact Statement*, Page 10. (05-061)

⁷ Based on borings conducted by Shannon and Wilson in 1975 as cited in *The Montlake Landfill Information Summary*, Page 50. (05-011)

⁸ Jones and Jones. *The Master Plan Union Bay Teaching/Research Arboretum*. Seattle: University of Washington, 1976. Call# HT 168 S6 J675 1976. (05-806)

⁹ Dunn, Walter. *The Proposed Reclamation and Utilization of Union Bay Swamp*. Seattle: University of Washington, Office of the University Architect, 1959. Call # F899.S46 U55 1959. (05-808)

¹⁰ For a spreadsheet of these calculations, please see 05-919.

¹¹ From: *The Montlake Landfill Information Summary*. Prepared by Seattle/King County Department of Health; Washington State Department of Ecology; Washington State Department of Health; and University of Washington, 1999. (05-011) Available upon request from the University of Washington Environmental Health and Safety. While the landfill did have a secondary operation, the primary operations constituted the majority of the refuse.

¹² 8 years is an estimate from the "late 1950s" until closure in 1966.

Total Refuse = 4,118,400 m³
Total Refuse = 5,386,663 yd³

Reconciling the Calculations

While the three separate calculations have a variation of approximately 2,000,000 yd³, Dunn's final estimate (Calculation B) of the total amount of refuse that could be disposed at the Montlake Landfill was 6,400,000 cubic yards, placing Calculation A and B very close together. Conservatively, Calculation B was halted at the year which the landfill closed. There is also a disparity between the size of landfill in Calculations A and B. Dunn puts the size of the landfill at 97 acres, but Turnberg and Bishop have it at 200 acres. One possibility for this difference between these two size estimations is that from 1962-1964, Dunn's successful implementation of the diking method allowed for the expansion of the landfill beyond his original calculation. In light of these difficulties, the recommended number for this report is Calculation C as it is most closely based on reported observations. Since Calculation C includes only the "Primary Operations" of the landfill, it can be assured that this is not an over-estimate of the volume of the site.

Appendix C: Dataset Index

05-xxx source files

call#	ext.	document title and/or <filename as received>	source (person or URL)	received
05-001	.txt	telecom: Terry Nyman	Roel Hammerschlag	02/03/06
05-002	.htm	University Slough	http://en.wikipedia.org/wiki/University_Slough	02/03/06
05-003	.txt	telecom: Erin McKeown	Roel Hammerschlag	02/03/06
05-004	.txt	fuel use for UW inventory	David Carr	02/07/06
05-005	--	Revised Landfill Gas Monitoring Plan: University of Washington Montlake Landfill	Erin McKeown	02/08/06
05-006	--	RE: UNIVERSITY OF WASHINGTON, MONTLAKE LANDFILL, METHANE MONITORING RESULTS, OCTOBER 2005	Erin McKeown	02/08/06
05-007	.txt	telecom: Lori Natsume	Roel Hammerschlag	02/09/06
05-008	.xls	<DEPTOWNED2006.xls>	David Carr	02/07/06
05-009	.txt	telecom: Oliver Dunagan	Roel Hammerschlag	02/15/06
05-010	.txt	telecom: Sean Kennedy	Roel Hammerschlag	02/15/06
05-011	--	Montlake Landfill Information Summary	Erin McKeown	02/21/06
05-012	.xls	<2006 VEHICLE COMPOSITION.xls>	Joles Tahara	02/21/06
05-013	.xls	<Energy consumption data for RoelH.xls calendar year.xls>	Lori Natsume	03/06/06
05-014	--	University of Washington Field Stations	http://www.washington.edu/research/field/	02/28/06
05-015	.xls	<SCL's GHG Inventory for UW - Feb 2006.xls>	Corinne Grande, Seattle City Light	04/06/06
05-016	.txt	telecom: Oliver Dunagan	Roel Hammerschlag	03/01/06
05-017	--	Class Code List	Heidi Gustafson	03/02/06
05-018	--	Ad Hoc Reports	Heidi Gustafson	03/02/06
05-019	.txt	telecom: Lori Natsume	Roel Hammerschlag	03/06/06
05-020	.pdf	<telephonesurvey2004.pdf>	Paul Roybal	03/06/06
05-021	.txt	telecom: Diana Graham	Roel Hammerschlag	03/06/06
05-022	.txt	telecom: John Calhoun	Roel Hammerschlag	03/07/06
05-023	.txt	telecom: Duane Emmons	Roel Hammerschlag	03/07/06
05-024	.txt	<Roel-FuelChemHotspots.txt>	Heidi Gustafson	03/07/06
05-025	.txt	<Roel-LgFuelBurningEquip-All.txt>	Heidi Gustafson	03/07/06
05-026	.txt	<Roel-Vehicles.txt>	Heidi Gustafson	03/07/06
05-027	.txt	<Roel-Buildings.txt>	Heidi Gustafson	03/07/06
05-028	.xls	<Roel-FacNumList.xls>	Heidi Gustafson	03/08/06

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05-029	--	2004 U-Pass Survey (Cross-tabulations: Weighted Total Banner)	Paul Roybal	03/10/06
05-030	--	U-Pass Telephone Survey 2000 (Cross-tabulations: Weighted Total Banner)	Paul Roybal	03/10/06
05-031	--	The U-Pass Telephone Survey 2000	Paul Roybal	03/10/06
05-032	--	Documentation of the University of Washington's Campus Transportation Surveys (1988, 1989, & 1991)	Paul Roybal	03/10/06
05-033	.doc	<GHG.doc>	Oliver Dunagan	03/08/06
05-034	--	<i>multiple documents</i>	Oliver Dunagan	03/14/06
05-035	.xls	<Vehicle Mileage Stats.xls>	Diana Graham	03/14/06
05-036	--	<i>multiple documents</i>	Diana Graham	03/14/06
05-037	--	University of Washington Changes in Population 1989-2004	Paul Roybal	03/16/06
05-038	.pdf	University of Washington Quarterly Enrollment Profile Summer Quarter 2005	http://depts.washington.edu/reptreq/reports/qep/qep-sum-2005.pdf	03/15/06
05-039	.doc	<i>telecom</i> : Bob Stimmel & Lori Natsume	Roel Hammerschlag	03/16/06
05-040	--	2004 U-Pass Survey (Student Banner)	Paul Roybal	03/16/06
05-041	--	2004 U-Pass Survey (Faculty Banner)	Paul Roybal	03/16/06
05-042	--	2004 U-Pass Survey (Staff Banner)	Paul Roybal	03/16/06
05-043	--	U-Pass Telephone Survey 2000 (Cross-tabulations: Weighted Students Banner)	Paul Roybal	03/16/06
05-044	--	U-Pass Telephone Survey 2000 (Cross-tabulations: Faculty Banner)	Paul Roybal	03/16/06
05-045	--	U-Pass Telephone Survey 2000 (Cross-tabulations: Staff Banner)	Paul Roybal	03/16/06
05-046	--	1996 U-Pass Survey Results: Students	Paul Roybal	03/16/06
05-047	--	1996 U-Pass Survey Results: Faculty	Paul Roybal	03/16/06
05-048	--	1996 U-Pass Survey Results: Staff	Paul Roybal	03/16/06
05-049	.htm	Interesting UW Real Estate Facts	http://www.washington.edu/admin/reo/facts.html	03/17/06
05-050	.xls	<owned buildings.xls>	Jeanette Henderson	03/17/06
05-051	--	Green Up! Order Confirmation	John Chapman	03/17/06
05-052	.txt	[no subject]	Joe Sabo	03/23/06
05-053	.xls	<Electric-Gas Consumption.xls>	Trina Darakjy	03/28/06
05-054	.xls	<report.xls>	https://pelee.opb.washington.edu/pnbdb/sims2/reports/facility_filter.cfm	04/07/06

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05-055	--	Waste & Recycle Tons	Anne Eskridge	03/28/06
05-056	--	University of Washington Comprehensive Solid Waste Management Plan, Phase I	Anne Eskridge	03/28/06
05-057	--	University of Washington Comprehensive Solid Waste Management Plan, Phase II	Anne Eskridge	03/28/06
05-060	--	University of Washington Waste Characterization Study	Anne Eskridge	03/28/06
05-061	--	Center for Urban Horticulture @ Union Bay - Draft Environmental Impact Statement	Cody Johnson, Shannon & Wilson, Inc.	04/11/06
05-062	.xls	<04.10 diesel use for UW study.xls>	Jim Boon, King County Metro	04/12/06
05-063	.xls	<report.xls>	https://pelee.opb.washington.edu/pnbdb/sims2/reports/facility_filter.cfm	04/14/06
05-064	--	CTR Survey Report	Amy Tuliao	04/12/06
05-065	.doc	telecom: Debi Pitzl	Roel Hammerschlag	04/17/06
05-066	.xls	<FHLElectricBills.xls>	Scott Schwinge	04/13/06
05-067	.txt	Re: utility	Scott Schwinge	04/13/06
05-068	.doc	telecom: Anne Eskridge	Roel Hammerschlag	04/18/06
05-069	.xls	<Bldgs on central system_RoelH.xls>	Lori Natsume	04/20/06
05-070	.xls	<dVMT and dEmissions for UW campuses 04 19 06.xls>	Ed Hillsman, WA DOT	04/19/06
05-071	.txt	Re: greenhouse gas data	Kathy Heuring	04/19/06
05-072	.xls	<fuel mix stats for 2000.xls>	Carolee Sharp, WA CTED	04/17/06
05-073	.txt	Re: fuel use for UW inventory	David Carr	04/21/06
05-074	.pdf	<refrig usage by refrig type cy2005 20060410.pdf>	Rick Cheney	04/10/06
05-075	.pdf	National Transit Database Metro Transit Profile 2000	http://www.ntdprogram.com/NTD/ntdhome.nsf/Docs/NTDPublications?OpenDocument	04/21/06
05-076	.pdf	National Transit Database Snohomish County Transportation Benefit Area Corporation Profile 2000	http://www.ntdprogram.com/NTD/ntdhome.nsf/Docs/NTDPublications?OpenDocument	04/21/06
05-077	.pdf	National Transit Database Seattle-Sound Transit Profile 2000	http://www.ntdprogram.com/NTD/ntdhome.nsf/Docs/NTDPublications?OpenDocument	04/21/06
05-078	.pdf	National Transit Database Metro Transit Profile 2004	http://www.ntdprogram.com/NTD/ntdhome.nsf/Docs/NTDPublications?OpenDocument	04/21/06
05-079	.pdf	National Transit Database Snohomish County Transportation Benefit Area Corporation Profile 2004	http://www.ntdprogram.com/NTD/ntdhome.nsf/Docs/NTDPublications?OpenDocument	04/21/06
05-080	.pdf	National Transit Database Central Puget Sound Regional Transit Authority Profile 2004	http://www.ntdprogram.com/NTD/ntdhome.nsf/Docs/NTDPublications?OpenDocument	04/21/06
05-081	.pdf	Table 17:Energy Consumption: Details by Transit Agency (2000)	http://www.ntdprogram.com/NTD/NTDData.nsf/DataTableInformation?OpenForm&2000	04/21/06
05-082	.pdf	Table 17:Energy Consumption	http://www.ntdprogram.com/NTD/NTDData	04/21/06

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		: Details by Transit Agency (2004)	nsf/DataTableInformation?OpenForm&2004	
05-083	.txt	Re: central account numbers	Lori Natsume	04/24/06
05-084	.xls	<greenjhn.xls>	Jeff Neuner, City of Seattle	04/21/06
05-085	.doc	telecom: Jeff Neuner; Phil Woodhouse	Roel Hammerschlag	04/24/06
05-086	.xls	<Bldgs on central system_RoelH.xls>	Lori Natsume	04/24/06
05-087	.pdf	Table 15: Energy Consumption: Detail by Transit Agency Directly Operated Service (1996)	http://www.ntdprogram.com/NTD/NTDData.nsf/DataTableInformation?OpenForm&1996	04/24/06
05-088	.pdf	Table 26: Transit Operating Statistics: Service Supplied and Service Consumed: Details by Transit Agency DO and PT Service (1996)	http://www.ntdprogram.com/NTD/NTDData.nsf/DataTableInformation?OpenForm&1996	04/24/06
05-089	.xls	Roeland.xls	Tom Phillips	04/27/06
05-090	.xls	<GreenhouseRpt2.xls>	Debi Pitzl	04/28/06
05-091	--	1994 University Profile	Phil Hoffman	04/29/06
05-092	--	University Factbook Online	http://erebor.opb.washington.edu:7778/pls/portal/FB_BUILD.RPT_ST_HCOUNTS_BY_CAMPUS_TERM.show	05/01/06
05-093	.pdf	Total Appointments by Type and Employment Status	http://www.washington.edu/admin/factbook/tablef2_2005.pdf	05/01/06
05-094	.txt	Re: Corrected Report	Debi Pitzl	05/02/06
05-095	.txt	Re: Pack Forest inventories, update on numbers...	James McCarter	05/04/06
05-096	.xls	<packforest_1995_CarbonLC.xls>	James McCarter	05/04/06
05-097	.doc	<LANDFILL EMISSIONS.doc>	Jeff Neuner, City of Seattle	04/27/06
05-098	.xls	Air Carrier Profile	<http://www.bts.gov/publications/national_transportation_statistics/2006/excel/table_air_carrier_profile.xls>	05/08/06
05-099	.pdf	2005 Utility Fuel Mix Reports	<http://qa.cted.wa.gov/_CTED/documents/ID_2061_Publications.pdf>	05/09/06
05-100	--	Service Location: U OF W FRIDAY HBR LABS	Marilyn, Orcas Power & Light Co.	05/09/06
05-101	--		Peter Rackers	05/11/06
05-102	.txt	Fw:	Peter Rackers	05/12/06
05-103	.xls	<UW Facilities.xls>	Chuck Peterson, Seattle City Light	05/10/06
05-104	.xls	<Steam Consumption.xls>	Peter Rackers	05/10/06
05-105	.xls	<Usage and cost.xls>	Peter Rackers	05/10/06
05-106	.xls	<VMT for UW 05 08 06.xls>	Ed Hillsman, WA DOT	05/09/06
05-107	.xls	<SeattleCityLight.xls>	Sean Eamon Kennedy	05/15/06
05-108	.xls	<PugetEnergy.xls>	Sean Eamon Kennedy	05/15/06
05-109	.doc	telecom: Marilyn (Orcas Power & Light Co.)	Roel Hammerschlag	05/19/06
05-110	.txt	RE:{BTSTL#472-758}\$}/mile	U.S. Bureau of Transportation Statistics	05/26/06
05-111	.htm	Rates - detail tables	<http://www.ci.seattle.wa.us/light/accounts/	06/05/06

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			rates/ac5_rt2k11.htm>	
05-112	.pdf	Puget Sound Energy Gas Summary Sheet No. S-1	<http://www.pse.com/InsidePSE/ratesDocs/summ_gas_prices_2005_04_01.pdf>	06/05/06
05-113	.txt	Re: real estate energy bills	Jeanette Henderson	06/06/06
05-114	.xls	<RPT_MV_SFTE_CAT.xls>	<http://erebor.opb.washington.edu:7778/pls/portal/FB_BUILD.RPT_MV_SFTE_CAT.SHOW_PARMS>	06/07/06
05-115	.pdf	University of Washington Annual Report 2005	<http://www.washington.edu/admin/finacct/office/annualreport2005.pdf>	06/07/06
05-116	.pdf	University of Washington Annual Report 2000	<http://www.washington.edu/admin/finmgmt/annrpt/AnnReport.pdf>	06/07/06
05-117	.doc	telecom: Teresa Seyfried	Roel Hammerschlag	06/08/06
05-118	.txt	Re: PBI	Chris Malins	06/08/06
05-119	.doc	telecom: Scott Schwinge	Roel Hammerschlag	06/08/06
05-120	.doc	telecom: Kathy Heuring	Roel Hammerschlag	06/08/06
05-121	.txt	Re: headcount	Debi Pitzl	06/08/06
05-122	.txt	Re: oil use	Scott Schwinge	06/08/06
05-123	.txt	Fw: Vehicle question (fwd)	Peter Rackers	05/19/06
05-124	.txt	Fw: Harborview (fwd)	Peter Rackers	05/19/06
05-125	.doc	telecom: Gordy George	Roel Hammerschlag	06/08/06
05-126	.txt	RE: [Fwd: RE: energy bills]	Rob Lubin	06/08/06
05-127	.doc	telecom: Sheila Lockwood	Roel Hammerschlag	04/12/06
05-128	.htm	The University of Texas System: Travel Services	<http://www.utsystem.edu/travel/>	06/20/06
05-129	.doc	BUDGET NUMBERS <Budget Number identifier.doc>	<www.artsci.washington.edu/services/Meetings/Administrators/March06/Budget%20Number%20identifier.doc>	06/23/06
05-130	FLD	University of Washington Master Plan: Seattle Campus	<http://www.washington.edu/community/cmp_site/final_cmp.html>	06/23/06
05-131	.doc	<Notes on Greenhouse Gas Inventory.doc>	Peter Dewey	08/09/06
05-132	.xls	<population.xls>	Peter Dewey	11/03/06
05-133	.xls	<RPT_ST_HCOUNTS_BY_CAMPUS_TERM.xls>	<http://erebor.opb.washington.edu:7778/pls/portal/FB_BUILD.RPT_ST_HCOUNTS_BY_CAMPUS_TERM.SHOW_PARMS>	11/03/06
05-134	.pdf	<tablf2_2002.pdf>	<http://www.washington.edu/admin/factbook/tablf2_2002.pdf>	11/04/06
05-135	.txt	Re: UW draft GHG inventory - please comment (fwd)	Mary Hoverson	08/17/06
05-136	.txt	Re: UW draft GHG inventory - please comment	Jeanette Henderson	08/16/06
05-137	.txt	Fwd: RE : energy bills	Rob Lubin	11/09/06
05-138	FLD	RE: METHANE MONITORING RESULTS, SECOND QUARTER 2006, UNIVERSITY OF WASHINGTON, MONTLAKE LANDFILL	Erin McKeown	11/15/06
05-139	.xls	<Utility '05-'06.xls>	Rob Lubin	11/16/06
05-140	.doc	telecom: Rob Lubin	Roel Hammerschlag	11/20/06

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05-142	.txt	Re: [Fwd: Re: ship fuel use]	Scott Schwinge	11/16/06
05-143	.txt	Re: Re: ship fuel use]	Floyd McCroskey	11/27/06
05-144	.txt	Re: ship fuel use	Daniel Schwartz	11/27/06
05-145	.pdf	<Propane properties.pdf>	< http://www.propanegas.ca/files/Propane%20properties.pdf >	11/27/06
05-146	.txt	Re: Diesel fuel 2000 to 2005	David Carr	12/06/06
05-147	.pdf	<Energy Statistics_UW.pdf>	David Gault, Fairmont Olympic Hotel	12/08/06
05-148	.xls	<ICA IMA UMC for Roel Hammerschlag.xls>	Lori Natsume	12/11/06
05-149	.txt	Re: RPPL energy records	Alan Hoffman	12/12/06
05-150	.pdf	Electricity Rates for Commercial, Industrial and Lighting Customers	< http://www.pse.com/InsidePSE/ratesDocs/summ_elec_1216_comm_ind_2005_03_04.pdf >	12/12/06
05-151	.xls	<2005 usage.xls>	Clarence Clipper, Unico Properties	12/18/06
05-152	.txt	Re:CY 2000 & CY 2005 HFC/PFC/SF6 use	Ken Feilen	12/22/06
05-153	.pdf	Implementation Guide	< http://www.presidentsclimatecommitment.org/pdf/ACUPCC_IG_Final.pdf >	09/14/07

05-8xx reference files

call#	ext.	title	author	publisher or journal	year
05-801	.pdf	Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2003.	U.S. EPA	U.S. EPA	2005
05-802	--	Transportation Energy Data Book: Edition 24	Davis, Stacey & Diegel, Susan	U.S. DOE Oak Ridge National Laboratory	2004
05-803	FLD	Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2004.	U.S. EPA	U.S. EPA	2006
05-804	.pdf	Guidelines for College-Level Greenhouse Gas Emissions Inventories	Dautremont-Smith, Julian	Lewis & Clark College	2002
05-805	.pdf	Carbon Dioxide Emissions from the Generation of Electric Power in the United States	U.S. DOE	U.S. DOE Energy Information Administration	2000
05-806	--	The Proposed Reclamation and Utilization of Union Bay Swamp	Jones and Jones	University of Washington	1959
05-807	--	The Seattle/King County Abandoned Landfill Study in the City of Seattle	Wayne Turnberg and Greg Bishop	Seattle/King County Department of Health	1984
05-808	--	The Proposed Reclamation and Utilization of Union Bay Swamp	Walter Dunn	University of Washington	1956
05-809	.pdf	Characterization of Municipal Solid Waste in the United States: 1998 Update	Franklin Associates	U.S. EPA	1999
05-810	.pdf	The Greenhouse Gas Protocol - Revised Edition	World Resources Institute		2004
05-811	--	2003 Inventory of King County Air Emissions	King County	King County	2004
05-812	--	Revised 1996 IPCC Guidelines for	IPCC	IPCC	1996

call#	ext.	title	author	publisher or journal	year
		National Greenhouse Gas Inventories			
05-813	--	Master Plan: Union Bay Teaching/Research Arboretum	Jones and Jones	Jones & Jones	1976
05-814	--	IPCC Second Assessment Report: Climate Change 1995	IPCC	IPCC	1996

05-9xx workbooks

call#	description	source files
05-901	master workbook	many
05-902	OASIS dumps from the Equipment Inventory Office	05-024, 05-025, 05-026, 05-027
05-903	Facilities utility data	05-013
05-904	FACNUM database.	05-028
05-905	UW Bothell utility data	05-053
05-906	U-Pass data analysis	05-046, 05-047, 05-048
05-907	Student Transportation Analysis 1990 (Using 1989 Data)	05-032
05-908	UW Bothell gasoline data	05-036
05-909	reconciled buildings list	05-050, 05-054
05-910	Electric & gas accounts not paid by Facilities.	05-013, 05-083
05-911	Motor Pool vehicles sorted by type	05-012
05-912	travel reimbursements sorted by type	05-089
05-913	City of Seattle helper spreadsheet	05-910
05-914	electric emission factors	05-015, 05-072, 05-099, 05-805
05-915	Friday Harbor Electrical Usage	05-066, 05-100, 05-109
05-916	Harborview Natural Gas Usage	05-101
05-917	WARM run on 2005 data	05-055
05-918	WARM run on 2000 data	05-055
05-919	Montlake Refuse Calculations	05-806, 05-807, 05-808, 05-011, 05-061
05-920	Harborview Electricity Usage	05-101
05-921	Harborview Steam Usage	05-101, 05-104
05-922	SCL accounts	05-103
05-923	Metropolitan Tract steam usage	05-151

Appendix D: Audit and Responses

Envirometrics, Inc. delivered an informal audit of Inventory revision D on August 22, 2006. Selected highlights from the audit are quoted below in *italics*, followed by the page number and paragraph at which the passage occurs in the August 22 document. Responses are in roman type following each quotation. A reference copy of the original audit document follows the quotations and responses.

The Inventory is described as following the equity share approach within its organizational boundaries. We do not believe it does, nor is its description of this approach correct. (p. 1 ¶3 et seq.)

The organizational boundary definition has been refined and further explained beginning on p. 6 of the Methodology section.

Rather than delaying some of the discussion of operational boundaries to the section on Buildings under the Scope 1 section, it would be useful to provide this discussion when the Operational Boundaries are initially defined. It would be beneficial to move up Table 8 and place it in this discussion. (p. 2 ¶4)

This has been done.

It is unclear that all the facilities listed there under “Paid by non-UW entities:” should be included in the UW inventory because of the lack of control the University has over decisions that influence GHG emissions or their future reduction (e.g., the Olympic Hotel). Including some of these as Optional Information might be more appropriate. (p. 2 ¶4)

These facilities are all owned by the UW and therefore must be included in the core (Scope 1/Scope 2) inventory in order to maintain integrity of the ownership-based organizational boundary. No change.

The University Bookstore, KUOW and KCTS present interesting issues, because their management is one-step removed from the University but they are perceived by the public as University operations. (p. 2 ¶4)

The KCTS transmitter is owned by the University and therefore already included in the Inventory. Time does not allow pursuing utility records for the University Bookstore and KUOW for this Inventory, but they should be considered for the Optional Information category of future inventories.

...the internet hub in 4545 15th NE... (p.3 ¶1)

Energy consumption by this building is paid by Facilities Services and is therefore already included in Scope 1 and Scope 2 emissions calculations. Footnote 3 has been added to clarify.

...the Regional Primate Center and portions of Harborview are functionally indistinguishable from similar facilities on South Campus. At least this discussion should point to the Harborview Medical Center information being included in Optional Information. (p.3 ¶1)

We agree that the RPRC and Harborview are functionally similar to operations within the UW Medical Center. Both have been moved to Scope 3 so that they can be included in any future, reduction target-related inventories along with the UW Medical Center, which is captured in Scopes 1 and 2 by virtue of its ownership status.

There are a number of large buildings on campus, in particular some of the newer buildings on South Campus, that are not receiving steam and chilled water from the power plant. It might be useful to enumerate these buildings in order to reassure the reader that they have been included in the inventory. Similarly, it would be useful for the report (not just an appendix) to include a complete list of the buildings served by the power plant. (p.3 ¶2)

Appendix E has been added, supplying this information. The list of buildings is too long to reasonably be included in the body of the document.

...the Montlake Landfill emissions should not be attributed to the University. Although it apparently owns the land, the waste did not preferentially come from the University but from the north end of the city generally and was not placed there by the University. Its continued emissions are not due to any action or inaction on the part of the University and there is no action the University can take now to reduce the emissions. It might be more appropriate to put these emissions into the Optional Information category. (p. 3 ¶4)

The ownership criterion used to define the organizational boundary requires inclusion of the landfill. Even if a control criterion was used to define the organizational boundary, the landfill would still qualify for inclusion because the UW, as the land owner, has the unique ability to control and mitigate emissions from the landfill to the extent that this is possible. No change.

The GHG emissions associated with new building construction do not seem to have been included anywhere. Arguments could be made for including them in either Scope 1 or Scope 3. However, a good argument can also be made for excluding them entirely because of the difficulty in developing decent inventory data and the dramatic differences that will occur from year to year. These activities could legitimately be the subject of an entirely separate report. They should at least be acknowledged as a major source and a discussion of the disposition of this source should be included here. (p.3 ¶6)

Inventorying construction emissions is extraordinarily difficult, and the annual variation is sufficiently large to make target-setting even more difficult. To keep the inventory as straightforward as possible, they remain omitted. However, a note reiterating the reviewers' points was added to the inventory delivery memo, so that construction emissions may be added as Optional Information in future inventories.

We would argue that waste disposal properly should be a Scope 3 activity and not Optional Information. (p.3 ¶7)

The figures reported under waste disposal represent life-cycle emissions differentials associated with substitution of recycled stock for virgin manufacturing materials, avoided landfill emissions, and other sources and sinks far removed from the University's direct control. Hence the character of these figures is very different from the relatively direct accounting of other sources included in Scope 3. Furthermore, the waste disposal figures account for greenhouse gas sinks as well as sources, and the GHG Protocol makes it clear that sinks should be tabulated in Optional Information. No change.

Calculations and estimates were made for 2000 as a Base Year. Because the City of Seattle has chosen a future target of reductions from a 1990 Base Year, it would be useful to provide an explanation as to why 1990 was not selected as the Base Year for this inventory. Without the 1990 Base Year, the University cannot contribute data to determine if the City is able to meet its announced goal. (It is evident from some of the communications and many of the calculation tables in the appendix that an effort was made to collect and compute 1990 data. It would be useful to identify the barriers to the full use of these data.) (p.4 ¶1)

This issue is addressed in the delivery memo.

What is not included, and would be very useful, is any estimate of the uncertainties in the inventory data or the calculations. (p. 4 ¶5)

This issue is addressed in the delivery memo.

By limiting the presentation in Figure 3 to Scopes 1, 2 and 3 emissions, it does not illustrate the magnitude of the "negative" emissions associated with the recycling activities and the forest sequestration at Pack Forest, which are presented as Optional Information. It might be very useful for those activities to be displayed "below the line" so their comparative magnitude can be seen. (p. 4 ¶7)

We agree, but the software being used to supply graphics for the inventory report (Microsoft Excel 2002) cannot accommodate simultaneous above-the-line and below-the-line bars in charts.

Figure 4 presents the emissions intensity at each campus. It would be helpful to also have this in tabular form so the precise values are available for comparison to other institutions. (p. 4 ¶8)

These values are already tabulated in the two right-hand columns of Table 5. No change.

Table 24 would be more valuable with an additional calculation row showing the annual sequestration per acre. (p. 4 ¶8)

The calculation of sequestration at Pack Forest is performed with a relatively sophisticated model that accounts for different growth rates in different stands of the forest, and also discounts emissions from forest products removed from the site. A per-acre value for sequestration at Pack Forest would not be a physically meaningful value. No change.

Some changes in values from 2000 to 2005 noted in tables would benefit by some comment as to their source. For example, a large increase in diesel fuel purchases is seen in Table 9... (p. 5 ¶3)

This apparent increase was due to an error in the value for calendar year 2000. The error has been corrected.

...the elimination of SF₆ use is seen in Table 11... (p. 5 ¶3)

An explanation has been added following the table.

...an increase in annual sequestration rate is seen in Table 24. Why? (p. 5 ¶3)

An explanation has been added below the table.

The Seattle commuting emissions reported in Scope 3 were found to be in error. The emissions from the "Northgate" campus apparently were left out of the totals in Table 5. (p. 6 ¶1)

This has been corrected.

We would have expected to see recommendations for ways that data collection and recording by various University operations and entities could be modified that would ease future GHG emissions inventories. These observations should not be lost by an excess of diplomacy. (p. 6 ¶5)

Recommendations for inventory process improvements are in the delivery memo.

Appendix E: Sites Served or Paid by Facilities Services

The following four tables are reprinted verbatim from source file 05-086.

Buildings with Central Electricity

Type	Facnum	Building	GSF	Owned or Leased
Central	1093	1001 BROADWAY	4,572	Leased
Central	1060	1401 NE BOAT ST	3,210	Owned
Central	1030	3710 BROOKLYN AVE NE 1969	3,897	Owned
Central	1031	3716 BROOKLYN AVE NE 1969	3,371	Owned
Central	4075	3900/3902 U WAY	1,248	Owned
Central	4073	4038 12TH AVE NE	1,200	Owned
Central	4074	4046 12TH AVE NE	1,840	Owned
Central	1062	5020 25TH AVE. NE	2,939	Owned
Central	1119	ACADEMIC COMPUTER CENTER	30,468	Owned
Central	1185	AERODYNAMICS LAB -1917	1,871	Owned
Central	1131	AEROSPACE ENG & RES LAB	58,779	Owned
Central	3991	ALLEN CENTER FOR CSE	168,954	Owned
Central	1317	ALLEN CNTR VIS ART	49,646	Owned
Central	1107	ALLEN LIBRARY	221,635	Owned
Central	1351	ANDERSON HALL	33,543	Owned
Central	1268	ARCHITECT MOBILE CONST OF	260	Owned
Central	1024	ARCHITECT SOUTH CAMPUS	1,070	Owned
Central	1180	ARCHITECTURE HALL	47,485	Owned
Central	1298	ART BUILDING	124,082	Owned
Central	1044	ATHLETIC MAINTENANCE BLDG	4,210	Owned
Central	1294	ATMOSPHERIC SCI-GEOPHYSIC	77,709	Owned
Central	1206	BAGLEY HALL	223,700	Owned
Central	1157	BALMER HALL	78,677	Owned
Central	1277	BENSON HALL	76,271	Owned
Central	1132	BLOEDEL HALL	77,316	Owned
Central	1326	BOTANY GREENHOUSE	14,539	Owned
Central	1269	BOTANY GREENHOUSE ANNEX	600	Owned
Central	3951	BOTANY QUONSET	300	Owned
Central	1059	BRYANT ANNEX	321	Owned
Central	1278	BURKE MEMORIAL WASHINGTON STATE MUSEUM	68,916	Owned
Central	1187	CANOEHOUSE	13,267	Owned
Central	1219	CHDD CLINIC	70,345	Owned
Central	1354	CHDD SCHOOL	45,598	Owned
Central	1220	CHDD SOUTH	12,378	Owned

Central	1108	CHEMISTRY BUILDING	130,227	Owned
Central	1279	CHEMISTRY LIBRARY BUILDING	39,363	Owned
Central	1178	CLARK HALL	30,568	Owned
Central	1152	COMMODORE-DUCHESS APT	97,849	Owned
Central	1161	COMMUNICATIONS BUILDING	106,465	Owned
Central	1124	CONDON HALL	132,533	Owned
Central	1166	CONIBEAR SHELLHOUSE	45,643	Owned
Central	1183	CUNNINGHAM HALL	5,104	Owned
Central	1181	DENNY HALL	89,745	Owned
Central	1195	EDMUNDSON PAVILION	229,479	Owned
Central	1008	EE/CSE	237,794	Owned
Central	3963	EH&S TRAILER	-	Owned
Central	1182	ENGINEERING ANNEX	28,128	Owned
Central	1325	ENGINEERING LIBRARY	40,549	Owned
Central	1017	ENVIRONMENTAL SFTY OFFICE BLDG	2,989	Owned
Central	1357	FISHERIES BUILDING	130,307	Owned
Central	1163	FISHERIES CENTER	99,870	Owned
Central	1104	FISHERIES TEACHING/RESEARCH	34,788	Owned
Central	1111	FLUKE HALL	73,086	Owned
Central	4523	GATE HOUSES	631	Owned
Central	1164	GERBERDING HALL	82,405	Owned
Central	1139	GOLF DRIVING RANGE BLDG.	15,094	Owned
Central	1135	GOULD HALL	115,038	Owned
Central	1201	GOWEN HALL	68,925	Owned
Central	1275	GRAVES ANNEX BUILDING	32,098	Owned
Central	1149	GRAVES HALL	29,313	Owned
Central	1344	GUGGENHEIM ANNEX	3,945	Owned
Central	1198	GUGGENHEIM HALL	56,207	Owned
Central	1202	GUTHRIE ANNEX I -1917	6,301	Owned
Central	1280	GUTHRIE ANNEX II	7,672	Owned
Central	1169	GUTHRIE ANNEX III	5,337	Owned
Central	1319	GUTHRIE ANNEX IV	3,426	Owned
Central	1134	GUTHRIE HALL	74,241	Owned
Central	1147	HAGGETT HALL	206,114	Owned
Central	1203	HALL HEALTH CENTER	57,794	Owned
Central	1204	HANSEE HALL	111,364	Owned
Central	1186	HARRIS HYDRAULICS LAB	22,933	Owned
Central	1154	HENDERSON HALL	106,340	Owned
Central	1194	HENRY ART GALLERY	12,539	Owned
Central	1324	HITCHCOCK HALL	116,416	Owned
Central	1209	HUGHES PENTHOUSE	15,354	Owned
Central	1302	HUTCHINSON HALL	55,164	Owned
Central	3950	INDOOR PRACTICE FACILITY	95,000	Owned
Central	1323	INSTRUCTIONAL CENTER/THEATER	12,176	Owned
Central	1137	INTRAMURAL ACTIVITIES	266,309	Owned

Central	1190	JOHNSON ANNEX A	14,758	Owned
Central	1200	JOHNSON HALL	121,573	Owned
Central	1276	KANE HALL	153,375	Owned
Central	1130	KINCAID HALL	84,459	Owned
Central	1205	KIRSTEN AERONAUTICAL LAB	23,963	Owned
Central	1160	LANDER-TERRY HALLS	339,678	Owned
Central	1177	LEWIS HALL	23,220	Owned
Central	1346	LOEW HALL	58,747	Owned
Central	1156	MACKENZIE HALL	43,099	Owned
Central	1222	MAGNUSON HS CTR AA	58,820	Owned
Central	1016	MAGNUSON HS CTR ANNEX 4	6,846	Owned
Central	1223	MAGNUSON HS CTR BB	248,765	Owned
Central	1221	MAGNUSON HS CTR WING A	53,201	Owned
Central	1304	MAGNUSON HS CTR WING B	117,619	Owned
Central	1224	MAGNUSON HS CTR WING C	48,288	Owned
Central	1328	MAGNUSON HS CTR WING D	183,975	Owned
Central	1225	MAGNUSON HS CTR WING E	56,540	Owned
Central	1226	MAGNUSON HS CTR WING F	122,767	Owned
Central	1227	MAGNUSON HS CTR WING G	64,594	Owned
Central	1228	MAGNUSON HS CTR WING H	211,284	Owned
Central	1300	MAGNUSON HS CTR WING I	151,026	Owned
Central	1174	MAGNUSON HS CTR WING J	170,719	Owned
Central	1173	MAGNUSON HS CTR WING K	227,640	Owned
Central	1175	MAGNUSON HS CTR WING RR	140,512	Owned
Central	1168	MAGNUSON HS CTR WING T	493,496	Owned
Central	1138	MARINE SCIENCES BUILDING	59,570	Owned
Central	1122	MARINE STUDIES BLDG	31,290	Owned
Central	3744	MARINE VESSEL	-	Owned
Central	1197	MARY GATES HALL	183,435	Owned
Central	1158	MC CARTY HALL	170,241	Owned
Central	1143	MC MAHON HALL	288,352	Owned
Central	1126	MEANY HALL	124,491	Owned
Central	1347	MECHANICAL ENGINEERING	97,768	Owned
Central	1142	MERCER HALL	89,392	Owned
Central	1192	MILLER HALL	72,655	Owned
Central	1171	MORE HALL	81,173	Owned
Central	1145	MORE HALL ANNEX	6,677	Owned
Central	1109	MUELLER HALL	16,687	Owned
Central	1299	MUSIC BUILDING	73,482	Owned
Central	1105	NORDSTROM TENNIS CENTER	51,439	Owned
Central	1348	NPL CYCLTRON SHOP	6,914	Owned
Central	1167	NUCLEAR PHYSICS CYCLOTRON	13,399	Owned
Central	1349	OBSERVATORY	2,147	Owned
Central	1037	OCEAN RECH BLDG 2	3,999	Owned
Central	1314	OCEAN SCIENCES BLDG	111,276	Owned

Central	1352	OCEANOGRAPHY BUILDING	25,066	Owned
Central	1049	OCEANOGRAPHY DOCK BLDG	1,330	Owned
Central	1189	OCEANOGRAPHY ST SHED 1920	2,446	Owned
Central	1141	OCEANOGRAPHY TEACHING	51,552	Owned
Central	1125	ODEGAARD UNDERGRAD LIBR.	165,973	Owned
Central	1136	PADELFOORD HALL	138,555	Owned
Central	1179	PARRINGTON HALL	53,963	Owned
Central	1196	PAVILION POOL	27,045	Owned
Central	1176	PHYSICAL PLANT OFFICE	10,303	Owned
Central	1306	PHYSICS-ASTRONOMY ADTRM	59,181	Owned
Central	1242	PHYSICS-ASTRONOMY BAR	175,930	Owned
Central	1243	PHYSICS-ASTRONOMY TOWER	44,010	Owned
Central	3952	PLANT LAB SHED	450	Owned
Central	1207	PLANT LABORATORY	6,234	Owned
Central	1036	PLANT LABORATORY ANNEX 1	430	Owned
Central	1050	PLANT LABORATORY ANNEX 2	309	Owned
Central	1038	PLANT OPERATIONS ANNEX 2	546	Owned
Central	1039	PLANT OPERATIONS ANNEX 3	1,745	Owned
Central	1184	PLANT OPERATIONS ANNEX 4	8,525	Owned
Central	1040	PLANT OPERATIONS ANNEX 5	485	Owned
Central	1026	PLANT OPERATIONS ANNEX 6	4,199	Owned
Central	1046	PLANT OPERATIONS ANNEX 7	3,999	Owned
Central	1199	PLANT OPERATIONS BUILDING	9,131	Owned
Central	1350	POWER PLANT	174,767	Owned
Central	1301	RAITT HALL	48,148	Owned
Central	1047	ROBERTS ANNEX	1,680	Owned
Central	1191	ROBERTS HALL	32,471	Owned
Central	1327	SAVERY HALL	102,105	Owned
Central	1127	SCHMITZ HALL	99,691	Owned
Central	1316	SEAFIRST EXECU ED CENTER	65,566	Owned
Central	1045	SHELLHOUSE ANNEX	3,324	Owned
Central	1332	SIEG HALL	57,180	Owned
Central	1208	SMITH HALL	92,757	Owned
Central	1308	SOUTH CAMPUS CENTER	69,852	Owned
Central	1188	STADIUM	137,591	Owned
Central	1570	STADIUM CONCESSION 2	3,330	Owned
Central	1571	STADIUM CONCESSION 3	1,736	Owned
Central	1572	STADIUM CONCESSION 4	1,747	Owned
Central	1573	STADIUM CONCESSION 6	1,747	Owned
Central	1574	STADIUM CONCESSION 9	868	Owned
Central	1153	STUDENT UNION	259,938	Owned
Central	1193	SUZZALLO LIBRARY	317,942	Owned
Central	1356	THOMSON HALL	62,687	Owned
Central	3964	TRANS SERV ANNEX	320	Owned
Central	1253	U W MED CTR/CC	56,744	Owned

Central	1254	U W MED CTR/EA	159,235	Owned
Central	1255	U W MED CTR/EB	66,173	Owned
Central	1256	U W MED CTR/EC	51,530	Owned
Central	1241	U W MED CTR/EE	80,408	Owned
Central	1257	U W MED CTR/NE	40,442	Owned
Central	1258	U W MED CTR/NN	122,217	Owned
Central	1259	U W MED CTR/NW	88,465	Owned
Central	1260	U W MED CTR/SE	52,439	Owned
Central	3958	U W MED CTR/SP	160,000	Owned
Central	1261	U W MED CTR/SS	73,825	Owned
Central	1262	U W MED CTR/SW	65,415	Owned
Central	1027	UNIVERSITY FACILITIES ANNEX	3,482	Owned
Central	4250	UNIVERSITY FACILITIES ANNEX 2	3,360	Owned
Central	1331	UNIVERSITY FACILITIES BLDG	6,340	Owned
Central	1144	UW CLUB	13,455	Owned
Central	1150	VAN DE GRAAFF ACCL	37,148	Owned
Central	1297	VISITORS INFORMATION CENT	3,075	Owned
Central	4057	W. H. FOEGE BIOENGINEERING	146,854	Owned
Central	4058	W. H. FOEGE GENOME	146,854	Owned
Central	1120	WATERFRONT ACTIV. CNTR	20,904	Owned
Central	1117	WEST RECEIVING STATION	2,000	Owned
Central	1345	WILCOX HALL	41,265	Owned
Central	1420	WILLIAM H. GATES LAW SCHOOL	210,117	Owned
Central	1022	WILSON ANNEX	4,154	Owned
Central	1170	WILSON CERAMIC LABORATORY	4,909	Owned
Central	1054	WINKENWERDER ANNEX	267	Owned
Central	1151	WINKENWERDER FOREST LAB	26,231	Owned
Central	1315	WOMEN'S FASTPITCH SOFTBALL BUILDING	16,161	Owned

Buildings with Central Steam

Type	Facnum	Building	GSF	Owned or Leased
Central	1060	1401 NE BOAT ST	3,210	Owned
Central	4075	3900/3902 U WAY	1,248	Owned
Central	4073	4038 12TH AVE NE	1,200	Owned
Central	4074	4046 12TH AVE NE	1,840	Owned
Central	1062	5020 25TH AVE. NE	2,939	Owned
Central	1185	AERODYNAMICS LAB -1917	1,871	Owned
Central	1131	AEROSPACE ENG & RES LAB	58,779	Owned
Central	3991	ALLEN CENTER FOR CSE	168,954	Owned
Central	1317	ALLEN CNTR VIS ART	49,646	Owned
Central	1107	ALLEN LIBRARY	221,635	Owned
Central	1351	ANDERSON HALL	33,543	Owned
Central	1268	ARCHITECT MOBILE CONST OF	260	Owned
Central	1024	ARCHITECT SOUTH CAMPUS	1,070	Owned

Central	1180	ARCHITECTURE HALL	47,485	Owned
Central	1298	ART BUILDING	124,082	Owned
Central	1044	ATHLETIC MAINTENANCE BLDG	4,210	Owned
Central	1294	ATMOSPHERIC SCI-GEOPHYSIC	77,709	Owned
Central	1206	BAGLEY HALL	223,700	Owned
Central	1157	BALMER HALL	78,677	Owned
Central	1277	BENSON HALL	76,271	Owned
Central	1132	BLOEDEL HALL	77,316	Owned
Central	1326	BOTANY GREENHOUSE	14,539	Owned
Central	1269	BOTANY GREENHOUSE ANNEX	600	Owned
Central	3951	BOTANY QUONSET	300	Owned
Central	1059	BRYANT ANNEX	321	Owned
Central	1278	BURKE MEMORIAL WASHINGTON STATE MUSEUM	68,916	Owned
Central	1187	CANOEHOUSE	13,267	Owned
Central	1219	CHDD CLINIC	70,345	Owned
Central	1354	CHDD SCHOOL	45,598	Owned
Central	1220	CHDD SOUTH	12,378	Owned
Central	1108	CHEMISTRY BUILDING	130,227	Owned
Central	1279	CHEMISTRY LIBRARY BUILDING	39,363	Owned
Central	1178	CLARK HALL	30,568	Owned
Central	1152	COMMODORE-DUCHESS APT	97,849	Owned
Central	1161	COMMUNICATIONS BUILDING	106,465	Owned
Central	1124	CONDON HALL	132,533	Owned
Central	1166	CONIBEAR SHELLHOUSE	45,643	Owned
Central	1183	CUNNINGHAM HALL	5,104	Owned
Central	1181	DENNY HALL	89,745	Owned
Central	1140	EAGLESON HALL	18,966	Owned
Central	1195	EDMUNDSON PAVILION	229,479	Owned
Central	1008	EE/CSE	237,794	Owned
Central	3963	EH&S TRAILER	-	Owned
Central	1182	ENGINEERING ANNEX	28,128	Owned
Central	1325	ENGINEERING LIBRARY	40,549	Owned
Central	1017	ENVIRONMENTAL SFTY OFFICE BLDG	2,989	Owned
Central	1100	ENVIRONMENTAL STG BLDG	4,454	Owned
Central	1357	FISHERIES BUILDING	130,307	Owned
Central	1163	FISHERIES CENTER	99,870	Owned
Central	1111	FLUKE HALL	73,086	Owned
Central	1164	GERBERDING HALL	82,405	Owned
Central	1139	GOLF DRIVING RANGE BLDG.	15,094	Owned
Central	1135	GOULD HALL	115,038	Owned
Central	1201	GOWEN HALL	68,925	Owned
Central	1275	GRAVES ANNEX BUILDING	32,098	Owned
Central	1149	GRAVES HALL	29,313	Owned
Central	1344	GUGGENHEIM ANNEX	3,945	Owned

Central	1198	GUGGENHEIM HALL	56,207	Owned
Central	1202	GUTHRIE ANNEX I -1917	6,301	Owned
Central	1280	GUTHRIE ANNEX II	7,672	Owned
Central	1319	GUTHRIE ANNEX IV	3,426	Owned
Central	1134	GUTHRIE HALL	74,241	Owned
Central	1147	HAGGETT HALL	206,114	Owned
Central	1203	HALL HEALTH CENTER	57,794	Owned
Central	1204	HANSEE HALL	111,364	Owned
Central	1186	HARRIS HYDRAULICS LAB	22,933	Owned
Central	1154	HENDERSON HALL	106,340	Owned
Central	1194	HENRY ART GALLERY	12,539	Owned
Central	1324	HITCHCOCK HALL	116,416	Owned
Central	1209	HUGHES PENTHOUSE	15,354	Owned
Central	1302	HUTCHINSON HALL	55,164	Owned
Central	1137	INTRAMURAL ACTIVITIES	266,309	Owned
Central	1190	JOHNSON ANNEX A	14,758	Owned
Central	1200	JOHNSON HALL	121,573	Owned
Central	1276	KANE HALL	153,375	Owned
Central	1130	KINCAID HALL	84,459	Owned
Central	1205	KIRSTEN AERONAUTICAL LAB	23,963	Owned
Central	1160	LANDER-TERRY HALLS	339,678	Owned
Central	1177	LEWIS HALL	23,220	Owned
Central	1346	LOEW HALL	58,747	Owned
Central	1156	MACKENZIE HALL	43,099	Owned
Central	1222	MAGNUSON HS CTR AA	58,820	Owned
Central	1016	MAGNUSON HS CTR ANNEX 4	6,846	Owned
Central	1223	MAGNUSON HS CTR BB	248,765	Owned
Central	1221	MAGNUSON HS CTR WING A	53,201	Owned
Central	1304	MAGNUSON HS CTR WING B	117,619	Owned
Central	1224	MAGNUSON HS CTR WING C	48,288	Owned
Central	1328	MAGNUSON HS CTR WING D	183,975	Owned
Central	1225	MAGNUSON HS CTR WING E	56,540	Owned
Central	1226	MAGNUSON HS CTR WING F	122,767	Owned
Central	1227	MAGNUSON HS CTR WING G	64,594	Owned
Central	1228	MAGNUSON HS CTR WING H	211,284	Owned
Central	1300	MAGNUSON HS CTR WING I	151,026	Owned
Central	1174	MAGNUSON HS CTR WING J	170,719	Owned
Central	1173	MAGNUSON HS CTR WING K	227,640	Owned
Central	1175	MAGNUSON HS CTR WING RR	140,512	Owned
Central	1168	MAGNUSON HS CTR WING T	493,496	Owned
Central	1138	MARINE SCIENCES BUILDING	59,570	Owned
Central	3744	MARINE VESSEL	-	Owned
Central	1197	MARY GATES HALL	183,435	Owned
Central	1158	MC CARTY HALL	170,241	Owned
Central	1143	MC MAHON HALL	288,352	Owned

Central	1126	MEANY HALL	124,491	Owned
Central	1347	MECHANICAL ENGINEERING	97,768	Owned
Central	1142	MERCER HALL	89,392	Owned
Central	1192	MILLER HALL	72,655	Owned
Central	1171	MORE HALL	81,173	Owned
Central	1145	MORE HALL ANNEX	6,677	Owned
Central	1109	MUELLER HALL	16,687	Owned
Central	1299	MUSIC BUILDING	73,482	Owned
Central	1348	NPL CYCLTRON SHOP	6,914	Owned
Central	1167	NUCLEAR PHYSICS CYCLOTRON	13,399	Owned
Central	1349	OBSERVATORY	2,147	Owned
Central	1314	OCEAN SCIENCES BLDG	111,276	Owned
Central	1352	OCEANOGRAPHY BUILDING	25,066	Owned
Central	1049	OCEANOGRAPHY DOCK BLDG	1,330	Owned
Central	1189	OCEANOGRAPHY ST SHED 1920	2,446	Owned
Central	1141	OCEANOGRAPHY TEACHING	51,552	Owned
Central	1125	ODEGAARD UNDERGRAD LIBR.	165,973	Owned
Central	1136	PADEFORD HALL	138,555	Owned
Central	1179	PARRINGTON HALL	53,963	Owned
Central	1196	PAVILION POOL	27,045	Owned
Central	1176	PHYSICAL PLANT OFFICE	10,303	Owned
Central	1306	PHYSICS-ASTRONOMY ADTRM	59,181	Owned
Central	1242	PHYSICS-ASTRONOMY BAR	175,930	Owned
Central	1243	PHYSICS-ASTRONOMY TOWER	44,010	Owned
Central	3952	PLANT LAB SHED	450	Owned
Central	1207	PLANT LABORATORY	6,234	Owned
Central	1036	PLANT LABORATORY ANNEX 1	430	Owned
Central	1050	PLANT LABORATORY ANNEX 2	309	Owned
Central	1038	PLANT OPERATIONS ANNEX 2	546	Owned
Central	1039	PLANT OPERATIONS ANNEX 3	1,745	Owned
Central	1184	PLANT OPERATIONS ANNEX 4	8,525	Owned
Central	1040	PLANT OPERATIONS ANNEX 5	485	Owned
Central	1026	PLANT OPERATIONS ANNEX 6	4,199	Owned
Central	1199	PLANT OPERATIONS BUILDING	9,131	Owned
Central	1350	POWER PLANT	174,767	Owned
Central	1301	RAITT HALL	48,148	Owned
Central	1047	ROBERTS ANNEX	1,680	Owned
Central	1191	ROBERTS HALL	32,471	Owned
Central	1327	SAVERY HALL	102,105	Owned
Central	1127	SCHMITZ HALL	99,691	Owned
Central	1316	SEAFIRST EXECU ED CENTER	65,566	Owned
Central	1332	SIEG HALL	57,180	Owned
Central	1208	SMITH HALL	92,757	Owned
Central	1121	SOCIAL WORK/SPEECH&HEARIN	99,566	Owned
Central	1308	SOUTH CAMPUS CENTER	69,852	Owned

Central	1153	STUDENT UNION	259,938	Owned
Central	1193	SUZZALLO LIBRARY	317,942	Owned
Central	1356	THOMSON HALL	62,687	Owned
Central	3964	TRANS SERV ANNEX	320	Owned
Central	1253	U W MED CTR/CC	56,744	Owned
Central	1254	U W MED CTR/EA	159,235	Owned
Central	1255	U W MED CTR/EB	66,173	Owned
Central	1256	U W MED CTR/EC	51,530	Owned
Central	1241	U W MED CTR/EE	80,408	Owned
Central	1257	U W MED CTR/NE	40,442	Owned
Central	1258	U W MED CTR/NN	122,217	Owned
Central	1259	U W MED CTR/NW	88,465	Owned
Central	1260	U W MED CTR/SE	52,439	Owned
Central	3958	U W MED CTR/SP	160,000	Owned
Central	1261	U W MED CTR/SS	73,825	Owned
Central	1262	U W MED CTR/SW	65,415	Owned
Central	4250	UNIVERSITY FACILITIES ANNEX 2	3,360	Owned
Central	1331	UNIVERSITY FACILITIES BLDG	6,340	Owned
Central	1144	UW CLUB	13,455	Owned
Central	1150	VAN DE GRAAFF ACCL	37,148	Owned
Central	4057	W. H. FOEGE BIOENGINEERING	146,854	Owned
Central	4058	W. H. FOEGE GENOME	146,854	Owned
Central	1120	WATERFRONT ACTIV. CNTR	20,904	Owned
Central	1117	WEST RECEIVING STATION	2,000	Owned
Central	1345	WILCOX HALL	41,265	Owned
Central	1420	WILLIAM H. GATES LAW SCHOOL	210,117	Owned
Central	1022	WILSON ANNEX	4,154	Owned
Central	1170	WILSON CERAMIC LABORATORY	4,909	Owned
Central	1054	WINKENWERDER ANNEX	267	Owned
Central	1151	WINKENWERDER FOREST LAB	26,231	Owned

Buildings with Non-Central Electricity

Type	Facnum	Building	GSF	Owned or Leased
Non-Central	1025	1209 NE 41ST STREET	1,552	Owned
Non-Central	1286	1429 NE BOAT STREET -1963	5,935	Owned
Non-Central	1029	3930 BROOKLYN NE	3,108	Owned
Non-Central	1042	3935 UNIVERSITY WAY N.E.	5,363	Owned
Non-Central	1015	3937 15TH AVENUE NE	3,613	Owned
Non-Central	1041	3939 UNIVERSITY WAY NE	4,748	Owned
Non-Central	1019	3941 UNIVERSITY WAY NE	7,576	Owned
Non-Central	1033	3945 15TH AVENUE NE	2,198	Owned
Non-Central	1285	3947 UNIV WAY NE	3,136	Owned
Non-Central	1032	4001-7 UNIVERSITY WAY NE	2,815	Owned

Non-Central	1034	4034 12TH NE	1,986	Owned
Non-Central	1035	4042 12TH NE	1,681	Owned
Non-Central	1080	4545 15TH NE ADM DATA SVC	64,762	Leased
Non-Central	4522	BIG BEEF LABORATORY	12,260	Owned
Non-Central	1293	BROOKLYN BUILDING	23,497	Owned
Non-Central	1028	BRYANT BUILDING	86,782	Owned
Non-Central	1129	CERAMIC & METAL ARTS FAC	16,946	Owned
Non-Central	1023	CHILD CARE CENTER	3,681	Owned
Non-Central	1355	CORPORATION YARD BUILDING	2,772	Owned
Non-Central	1103	DOUGLAS RESEARCH CONSERVATORY	12,894	Owned
Non-Central	1140	EAGLESON HALL	18,966	Owned
Non-Central	1100	ENVIRONMENTAL STG BLDG	4,454	Owned
Non-Central	1292	ETHNIC CULTURAL CENTER	9,000	Owned
Non-Central	1051	GILMAN BUILDING	8,271	Owned
Non-Central	1053	HILL-CREST	14,853	Owned
Non-Central	1102	ISAACSON HALL	2,983	Owned
Non-Central	1284	KCTS-TV TRANSMITTER BLDG.	2,492	Owned
Non-Central	4436	MERRILL HALL	19,670	Owned
Non-Central	1116	NORTHLAKE BUILDING	22,077	Owned
Non-Central	1291	NW HORT SOC HALL	3,932	Owned
Non-Central	1018	OAKTREE BUILDING	30,347	Owned
Non-Central	1148	PLANT SERVICES BUILDING	144,198	Owned
Non-Central	1159	PLAYHOUSE THEATER	10,137	Owned
Non-Central	1106	PUBLICATIONS SERVICES 3900 7TH	60,003	Owned
Non-Central	1112	PURCHASING AND ACCOUNTING	39,576	Owned
Non-Central	1121	SOCIAL WORK/SPEECH&HEARIN	99,566	Owned
Non-Central	1113	SOUTHWEST MAINTENANCE BUILDING	7,464	Owned
Non-Central	1155	STAFF EMPLOYMENT BLDG	10,831	Owned
Non-Central	1115	STAFF SERVICES BUILDING	12,352	Owned
Non-Central	1101	TRANSPORTATION SERVICES	5,459	Owned
Non-Central	1172	URBAN HORT. FIELD HOUSE	1,920	Owned

Buildings with Non-Central Gas

Type	Facnum	Building	GSF	Owned or Leased
Non-Central	1093	1001 BROADWAY	4,572	Leased
Non-Central	1025	1209 NE 41ST STREET	1,552	Owned
Non-Central	1286	1429 NE BOAT STREET -1963	5,935	Owned
Non-Central	1030	3710 BROOKLYN AVE NE 1969	3,897	Owned
Non-Central	1031	3716 BROOKLYN AVE NE 1969	3,371	Owned
Non-Central	1042	3935 UNIVERSITY WAY N.E.	5,363	Owned
Non-Central	1015	3937 15TH AVENUE NE	3,613	Owned
Non-Central	1041	3939 UNIVERSITY WAY NE	4,748	Owned
Non-Central	1019	3941 UNIVERSITY WAY NE	7,576	Owned

Non-Central	1033	3945 15TH AVENUE NE	2,198	Owned
Non-Central	1285	3947 UNIV WAY NE	3,136	Owned
Non-Central	1032	4001-7 UNIVERSITY WAY NE	2,815	Owned
Non-Central	1034	4034 12TH NE	1,986	Owned
Non-Central	1035	4042 12TH NE	1,681	Owned
Non-Central	1119	ACADEMIC COMPUTER CENTER	30,468	Owned
Non-Central	1293	BROOKLYN BUILDING	23,497	Owned
Non-Central	1028	BRYANT BUILDING	86,782	Owned
Non-Central	1129	CERAMIC & METAL ARTS FAC	16,946	Owned
Non-Central	1023	CHILD CARE CENTER	3,681	Owned
Non-Central	1103	DOUGLAS RESEARCH CONSERVATORY	12,894	Owned
Non-Central	1292	ETHNIC CULTURAL CENTER	9,000	Owned
Non-Central	1104	FISHERIES TEACHING/RESEARCH	34,788	Owned
Non-Central	1169	GUTHRIE ANNEX III	5,337	Owned
Non-Central	1053	HILL-CREST	14,853	Owned
Non-Central	3950	INDOOR PRACTICE FACILITY	95,000	Owned
Non-Central	1102	ISAACSON HALL	2,983	Owned
Non-Central	1122	MARINE STUDIES BLDG	31,290	Owned
Non-Central	4436	MERRILL HALL	19,670	Owned
Non-Central	1116	NORTHLAKE BUILDING	22,077	Owned
Non-Central	1291	NW HORT SOC HALL	3,932	Owned
Non-Central	1018	OAKTREE BUILDING	30,347	Owned
Non-Central	1046	PLANT OPERATIONS ANNEX 7	3,999	Owned
Non-Central	1148	PLANT SERVICES BUILDING	144,198	Owned
Non-Central	1159	PLAYHOUSE THEATER	10,137	Owned
Non-Central	1106	PUBLICATIONS SERVICES 3900 7TH	60,003	Owned
Non-Central	1112	PURCHASING AND ACCOUNTING	39,576	Owned
Non-Central	1113	SOUTHWEST MAINTENANCE BUILDING	7,464	Owned
Non-Central	1155	STAFF EMPLOYMENT BLDG	10,831	Owned
Non-Central	1172	URBAN HORT. FIELD HOUSE	1,920	Owned
Non-Central	1297	VISITORS INFORMATION CENT	3,075	Owned