CITY OF LACEY
ENVIRONMENTAL ELEMENT
OF THE LACEY COMPREHENSIVE PLAN
2016

ENVIRONMENTAL

Community Vision - To preserve and enhance the natural environment to reflect the quality of life associated with the Pacific Northwest.

A. Introduction

The quality of life in the Pacific Northwest is often equated with the quality and richness of our natural environment. Protecting the environment depends on the community taking coordinated actions to minimize harmful impacts and enhancing the environment. Protecting the environmental resources in our community not only promotes a high quality of life but also encourages private investment in the community.

As the City matures and additional growth occurs, available green-field areas will become limited and available land supplies will increasingly contain environmentally sensitive areas. Urban environmental concerns will continue to be a priority for the community. Public investment in the urban environment, efficient use of land supply and resources, enhancement of the urban ecosystem, and minimizing adverse environmental impacts will assist in nurturing a healthy, sustainable environment.

The city of Lacey has been a leader in supporting efforts to protect and improve the environment while balancing the numerous goals and policies adopted by the City to help achieve its vision for the future. Environmental stewardship is an integrated part of the City's philosophy. Through policy, incentives, and regulations, Lacey seeks to maintain a healthy, sustainable urban environment, one that meets the needs of today without conceding the needs of future generations. Over time, the City's environmental strategy is anticipated to produce incremental and cumulative improvements to the functions and values of critical areas and promote sustainable ecosystems within the context of urban development constraints. Lacey weighs the relationships of the various elements of the urban environment in its decision making process.

The Environmental Protection and Resource Conservation Element provides the policy framework that guides implementation measures for protecting and improving Lacey's natural environment. The topics discussed in this element include: Natural Resources Conservation, Critical Areas, Habitat Conservation Areas, Shoreline Master Program, and Environmental Policy.

B. Natural Resources Conservation

The Growth Management Act (GMA) (Act) requires jurisdictions to prevent urban conversion of agricultural, timber, and mineral resource lands of long-term commercial significance. In general, the guidelines for the classification and designation of natural resource lands of long-term

significance indicate that these resource lands should be located beyond the boundaries of urban growth areas (UGA). Local jurisdictions are instructed to avoid including resource lands in UGA's because the designated purposes of these lands are incompatible with urban densities. However, local jurisdictions have been given guidelines to allow for existing and ongoing resource management operations of long-term significance to continue.

State law requires that notices be listed on all plats, short plats, development permits and building permits issued for development on, or within 500 feet of designated resource lands.

AGRICULTURAL LANDS

The conservation and protection of agricultural lands has been a long standing priority in Washington State due to the economic significance it plays in our economy as a whole and the ability to provide healthy food choices as an important public health issue. As such, the designation of agricultural lands within an UGA poses significant conflicts due to the proximity of urban development and development pressure because of higher land values. The primary intent of these urban areas is to provide for urban densities with urban services and to allow for the transitioning of properties to urban use.

Agricultural Lands of Long-Term Commercial Significance

The GMA recognizes the importance of agricultural lands to the state and nation and the conflicts that can arise between urban and agricultural uses with unplanned growth. The Act requires local jurisdictions to identify and conserve agricultural lands of long term significance as part of the comprehensive planning process. The Act also recognizes that agricultural lands of long term commercial significance should not be designated within UGA's unless a transfer or purchase of development rights has been enacted by the county and other designation guidelines could be met.

There are no properties designated as agricultural lands of long-term commercial significance in the current city limits or UGA. An analysis was completed that concluded that there was no property which should be classified as long term prime farm land. The criteria used to formulate this conclusion included: the availability of public facilities and services, tax status, relationship to urban growth boundary, predominant parcel size, intensity and land use settlement patterns, land values under alternative uses, and prime agricultural soils.

Local Regulatory Framework

There are four properties in the unincorporated portion of the growth area that are designated as Agricultural. The Agricultural (A) District designation is intended to serve as a place holder for existing agricultural properties located in the UGA pending the need for transition to other urban uses. This designation provides for the production of crops and livestock on areas of agricultural land with greater than twenty contiguous acres. These designated Agricultural lands should be re-examined for compatibility and intensity of nearby land uses; land values; and availability of public facilities to determine if more appropriate zoning should be put in place.

The city of Lacey works in conjunction with Thurston County to implement a Transfer of

Development Rights (TDR) program for agricultural lands. In 1995, the first TDR program in the state was established in Thurston County to allow owners of property designated Long-Term Agriculture (LTA) in rural areas to gain credit for unused development rights. These development rights can be sold and transferred to properties in an urban area to allow increased densities in specific areas. The goal of the program is to preserve farmland while allowing owners to realize the economic value of their land's development potential.

In the city of Lacey and its unincorporated UGA there are four zones that are receiving areas for TDR credits; they are the Mixed Use Moderate Density Corridor (MMDC), Mixed Use High Density Corridor (MHDC), Moderate Density Residential (MD) and the High Density Residential (HD). This program has not been utilized in Lacey's UGA since the establishment of the TDR program due to unfavorable market conditions, including the desire for increased densities. The program has been employed in other areas of the county, primarily transferring rights from south Thurston County to the city of Tumwater.

In 2011, the City adopted regulations to accommodate urban agricultural activities. The intent of the Urban Agriculture zone is to develop opportunities for a range of agricultural activities at a level and intensity that is compatible with Lacey's neighborhoods. The range of activities and use are dependent on lot size and design standards and range from personal use on individual single-family lots or common property for community agricultural use. Small commercial urban farms are provided for as well. Urban agricultural activities managed in a responsible way, with thoughtful consideration to compatibility and urban density can provide many benefits. These benefits include providing fresh produce, additional food choices, economic opportunities, a more sustainable life-style, and rich and varied neighborhoods.

URBAN FOREST RESOURCES

Forest lands are an important resource for Washington State both in terms of economics and in terms of environmental protection. From an environmental perspective, proper management of forested areas is important to protect wildlife habitat, provide open space, reduce the potential for erosion, storm and flood damage, protect water quality and produce oxygen from carbon dioxide.

Commercial Forest Lands

The GMA requires cities and counties to classify and conserve resource lands, including forest lands. Guidelines to designate forest lands of long-term commercial significance recognize that these lands are located outside urban areas, suburban areas, and rural settlements. Long-term forest lands are lands primarily devoted to growing trees for long-term commercial timber production on land that can be economically and practically managed for production. Historically, there have been conflicts between harvesting of trees for commercial purposes and preservation of trees for other benefits. Commercial timber harvesting considerations and urban development patterns tend to conflict. Based on the designation guidelines, there are no designated forest lands of long-term commercial significance in Lacey's UGA.

Urban Forest Management Plan

Lacey has been regulating the protection of trees and vegetation since the mid 1970's. Policy direction for protecting trees, vegetation, and landscape were subsequently directed by the adoption in 1985 of City of Lacey Urban Beautification Project and the Environmental Protection and Resource Conservation Plan in 1994.

During the early 2000's, an accelerated rate of private property development began to occur in areas with second growth forest species on site and appeared heavily forested. Since the intensity of development was causing nearly all the trees to be removed from development sites, the City started receiving more complaints from citizens about removal of trees. In 2006, the Lacey Urban Forestry Plan was adopted consistent with the vision Council had for balancing intense urban development with maintaining a forested character the City currently possesses.

An update to the Lacey Urban Forestry Plan was recently adopted by the Council with the goal of updating the plan every five years for needed revisions to technical data as well as addressing design and administration issues associated with implementation of the plan. The overall goal is to manage City trees to improve canopy cover and the aesthetic and physical benefits of trees to a community, while protecting infrastructure from tree damage. The management plan provides detailed goals and policies and makes recommendations for preservation, protection, restoration, species selection, design, planting, and citizen involvement.

MINERAL RESOURCE LANDS

The GMA recognizes the importance of mineral resource lands that contain gravel, sand, and other valuable metallic resources. The GMA requires local jurisdictions to designate mineral resource lands that are not already characterized by urban growth and that have long-term commercial significance for extraction of minerals. Mineral resources are in fixed supply and occur in very specific areas. Maintaining the ability to extract these materials for a variety of uses such as construction of roadways, the production of other materials, landscaping materials, and water filtration is a necessity. The recovering and processing of these resources can be costly depending on the location and environmental and land use protections put in place.

The consideration of designating mineral resource lands in the UGA is an exception to natural resource lands typically being located outside of the boundary. However, mineral extraction activities are typically associated with numerous nuisance characteristics that can have impacts on activities normally associated with urbanized areas. Residential, commercial, and other light industrial activities can have significant land use conflicts with mineral extraction activities. Any designation of new mineral resource lands in the UGA would be required to go through a thorough analysis to determine if significant cost savings can be obtained from using minerals close to their source; the potential for reusing the mined land for other purposes once mining is complete; potential conflicts and impacts to adjacent urbanized areas; and impacts to designated critical areas. Designating new mineral resource sites within the Lacey UGA would be difficult based on the existing urban development pattern in place.

Designation of Mineral Resource Lands

The Department of Natural Resource (DNR) maintains maps and records of all existing surface mining permits. Local governments must approve mine sites and the subsequent use of the site. The DNR is responsible for ensuring that reclamation follows completion of surface and underground mining. The DNR has the exclusive authority to regulate mine reclamation and approve reclamation plans. All permitted sites are required to have reclamation plans. Based on records in the DNR database, there are currently four active surface mining sites within Lacey and Lacey's UGA. Table 1 lists these known sites.

TABLE 1

MINERAL RESOURCE SITES				
10958 - Torden Thomsen	Steilacoom Mine	S18, T18, R01E (In UGA)	13 acres	Sand/Gravel
12168 - Miles Sand & Gravel	South Pit	S10, T18, R01W (Inside City)	72.5 acres	Sand/Gravel
10385 - Miles Sand & Gravel	North Pit	S10, T18, R01W (Inside City)	65 acres	Sand/Gravel
10938 - Lakeside Industries	Lacey Pit	S9&10, T18, R01W (Inside City)	12 acres	Sand/Gravel

Three of the surface mining sites are located within city limits and one is located in the unincorporated portion of the UGA. The mineral resource permitted to be extracted from all sites is sand and gravel.

The lifetime of a mine is variable and dependent on market conditions; mining activity may increase or decrease at any given time. The DNR inspects mining sites every one to two years to ensure that the site's activities have remained within the area and depth allowed by the permit and to oversee reclamation of mined areas.

Development Standards

Development regulations have been put in place in the Lacey Municipal Code to acknowledge the existence of existing mineral extraction activities and provide for the future use of these sites once these sites are no longer mined. These provisions are also intended to protect adjacent areas from adverse effects of extraction activities as well as protect the resource site from conflicting uses. The Steilacoom Mine and the Lacey Pit are located in the Mineral Extraction (ME) zone which allows for activities related to mineral extraction. This designation will remain in place until such time as these properties are ready to transition from mineral resource use. The Miles Sand and Gravel North Pit is designated as Hawks Prairie Business District-Business Commercial (HPBD-C); and the Miles Sand and Gravel South Pit is designated as Central Business District 6 (CBD-6).

Any notices specific to mineral resource lands must state the possibility of an application being made for mining related activities, like blasting, crushing, recycling, stockpiling, transporting, and washing of minerals.

C. Critical Areas

The GMA requires cities and counties to adopt regulations for the protection of environmentally critical areas, which include wetlands, aquifer recharge areas, fish and wildlife habitat conservation areas, frequently flooded areas, and geologically hazardous areas. These regulations are required to be periodically reviewed every eight years and brought up to date with any changes in the GMA and other relevant changes. Goals and policies contained in the plan are used to inform the content of development regulations in order to reduce the potential for impacts on the environment from changes in land use and development. Detailed analysis on impacts of future development is evaluated on a project basis through implementation of the Wetland Protection regulations and the State Environmental Policy Act (SEPA) during the development review process.

BEST AVAILABLE SCIENCE

GMA requires jurisdictions to use Best Available Science (BAS) in revising or adopting policies and regulations related to critical areas to protect the functions and values of these areas. State agencies have published suggested guidance materials to assist in identifying BAS for critical areas protection. In addition, other scientific information that is directly applicable to the community is used. Utilization of BAS is also central to recovery efforts required under the Endangered Species Act (ESA). The process to ascertain and identify pertinent BAS for the community assists in policy and regulatory decision-making.

Lacey's natural environment is composed of a variety of soils, waterways, vegetation, and geologic features. Some areas of the City have physical features that are compatible with development of variable intensities while other areas have challenges or are incompatible. The City regulates land use and development activities to protect certain critical areas as well as protect the public health, safety, and welfare.

WETLANDS

Wetlands are designated critical areas that are an integral feature of the City's urban landscape and local hydrologic cycle. In their natural state, wetlands provide many valuable social and ecological services such as controlling flooding and stormwater runoff; protecting water resources; providing areas for ground water recharge; preventing shoreline erosion; providing habitat areas for many species of fish, wildlife, and vegetation; and providing open space areas.

Wetlands and their buffer areas are valuable natural resources with development constraints due to flooding, erosion, soil liquefaction potential, and septic disposal limitations. Buffer areas surrounding wetlands are essential to maintain and protect wetland functions and values. Urbanization in the watershed diminishes the function of individual wetlands. Considerable acreage of these natural resources has been lost or degraded by draining, filling, excavating, building, or other acts incompatible with the stewardship of such areas.

Each wetland provides various beneficial purposes dependent on the wetland type functions. Larger wetlands and those hydrologically associated with lakes and streams have comparatively more important function in the watershed than smaller, isolated wetlands.

Wetland Protection Measures

To ensure the protection of these areas, the City has adopted regulations to avoid or minimize damage to wetland areas. These protections require activities not dependent upon a wetland location to be located away from wetlands and their associated buffer areas. The stated purpose of the Wetlands Protection Ordinance is to achieve no net loss of wetlands by requiring restoration or enhancement of degraded wetlands or creation of new wetlands to offset losses that are unavoidable. The long-term goal of the City is to increase the quantity and quality of Washington's wetland resource base. The provisions for wetlands are reviewed and updated as required as relevant data and information becomes available.

Three mapping sources are utilized to show the appropriate delineations of wetland areas within the city of Lacey. The Lacey Land Use and Zoning Map has an overlay zone showing environmentally sensitive areas; the National Wetlands Inventory maps; and the Department of Natural Resources Water Typing maps. These maps are used as indicators of possible wetland sites. Precise designation and delineation of wetlands must rely on field surveys at the time of review of individual sites initiated by development proposals.

Woodland Creek Basin

Woodland Creek serves as the primary natural drainage way through Lacey that is the culmination of a chain of connected lakes that flow from one to the other through wetlands. The Woodland Creek drainage system discharges into Puget Sound at Henderson Inlet. Woodland Creek is a major freshwater stream draining into Henderson Inlet and has a total length of approximately eleven miles. Several springs and smaller creeks feed into Woodland Creek.

The creek does not meet water quality standards due largely to issues with fecal coliform bacteria. Sources of these bacteria are from septic systems, animal waste, and other pollutants such as fertilizer. The creek is on the Department of Ecology's 303d list of impaired waters for water quality standards for fecal coliform, dissolved oxygen, and temperature. A TMDL (Total Maximum Daily Load) has been adopted to address fecal coliform in the creek. The TMDL's identify appropriate control actions to meet water quality standards. As such, the City cannot add to the amount of fecal coliform in the stormwater system. To address water quality treatment and flow control of stormwater runoff, Lacey has constructed nine regional stormwater facilities since 1991. Three of these regional facilities address stormwater from Woodland Creek. Ongoing measures are being implemented to continue to improve the water quality of the creek.

In 2006, Lacey joined with Thurston County and LOTT Wastewater Alliance to commission a study to estimate the amount of fecal coliform bacteria and nitrate pollution coming from various sources in an area along Woodland Creek and to identify feasible options for reducing the pollution. The City and Thurston County have been pursuing projects based on this recommendation including Woodland Creek Estates sanitary sewer project, Tanglewilde stormwater project, and the Aquifer Recharge Enhancement Area project in Woodland Creek Community Park.

City of Lacey Comprehensive Plan
Wetland Indicators and Open Space Institutional

OS-I Open Space Institutional
Wetland Indicators
City Limits
Urban Growth Area Boundary

0 0.25 0.5 1 Miles

N

LIBBY RD NE
58TH AVE NE
56TH AVE NE
HILL ST NE
HIGHLANDS DR NE
FOXTRAIL DR NE
47TH AVE NE
44TH AVE NE
LEGACY DR NE
41ST AVE NE
CAMPUS PARK DR NE
CAMPUS GLEN DR NE
36TH AVE NE
SLEATER KINNEY RD NE
HOLLYWOOD DR NE
HAWKS PRAIRIE RD NE
MARVIN RD NE
32ND AVE NE
31ST AVE NE
ORION DR NE
WILLAMETTE DR NE
BRITTON PKWY NE
QUINAULT DR NE
SKOKOMISH WAY NE
26TH AVE NE
SOUTH BAY RD NE
LILLY RD NE
ABERNETHY RD NE
JUDD ST NE
CARPENTER RD NE
HOGUM BAY RD NE
14TH AVE NE
13TH AVE NE
3RD WAY SE
6TH AVE NE
ENSIGN RD NE
MARTIN WAY E
I-5
I-5 TRAIL SE
3RD AVE SE
STEILACOOM RD SE
DUTTERROW RD SE
RIDGEVIEW DR SE
WOODLAND TRL SE
6TH AVE SE
4TH AVE SE
RANGER DR SE
FITZ HUGH DR SE
PACIFIC AVE SE
UNION MILLS RD SE
MARVIN RD SE
18TH AVE SE
16TH AVE SE
LACEY BLVD SE
GOLF CLUB RD SE
HOGUM DR SE
14TH AVE SE
15TH AVE SE
PIPERHILL DR SE
21ST AVE SE
22ND AVE SE
23RD AVE SE
20TH AVE SE
19TH AVE SE
25TH AVE SE
SHADY LANE RD SE
MAYES RD SE
BEDINGTON DR SE
30TH AVE SE
27TH AVE SE
28TH WAY SE
MORSE MERRYMAN RD SE
37TH AVE SE
39TH AVE SE
33RD AVE SE
39TH DR SE
41ST AVE SE
45TH AVE SE
KYRO RD SE
INDIAN SUMMER DR SE
WILDERNESS DR SE
DONNELLY DR SE
54TH AVE SE
58TH AVE SE
62ND AVE SE
74TH AVE SE
75TH AVE SE
YELM HWY SE
CATE FARM DR SE
PRESTWICK LN SE
RICH RD SE
RIXIE ST SE

Provisions have been included in the Lacey Historical Neighborhood zoning district that requires development and uses bordering Woodland Creek maintain a two-hundred foot natural buffer from the ordinary high water mark on both sides of the creek. Uses in the buffer area are limited to natural open spaces, trails, passive recreational activities, streets, and utility services. Pretreatment of stormwater runoff directed to the creek is also required to mitigate water quality impacts. Due to the high level of concern with water quality issues in the Woodland Creek Basin, this buffer area requirement should be extended to other zones bordering the creek.

FLOOD HAZARD PROTECTION

Flood plains and other areas subject to flooding perform important hydrologic functions and may present a risk to persons or property. Lacey's streams and lakes are subject to flooding during periods of heavy rainfall. Protection of life and property during flood events is a critical part of the City's duty to the public's safety.

The GMA recognizes the impact flooding can have on jurisdictions and requires the classification of such areas and the provision of standards to protect the public safety. Local jurisdictions are required to classify, at a minimum, the 100-year flood plain designations of the Federal Emergency Management Agency and the National Flood Insurance Program.

Flood Control Regulations

Flood control and floodplain management regulations seek to identify floodplains, develop local controls over land uses in flood prone areas, prepare plans to eliminate or mitigate human health risks and property damage from future floods, and manage flood events as they occur. Many state regulations are based on federal regulations, and many local regulations are based on state and federal regulations. State statutes are periodically amended to strengthen and coordinate flood hazard management activities.

Three principal state statutes address flood hazard management activities:

1) Flood Control by Counties (RCW 86.12) – Originally enacted in 1907, this statute authorized the levy of taxes and eminent domain to control or prevent flood damage. The bill expanded the role of counties in developing and adopting comprehensive flood hazard management plans. While counties are responsible for basin plan management, a participatory process with cities is required.
2) Floodplain Management (RCW 86.16) – This statute integrates local and state regulatory programs to reduce flood damage and protect human health and safety. The state program requires that local flood-prone jurisdictions adopt a flood damage prevention ordinance based on standards in the National Flood Insurance Program (NFIP). State regulations go beyond federal standards by prohibiting new or substantially improved residential construction in designated floodways.
3) State Participation in Flood Control Maintenance (RCW 86.26) Program (NFIP) – This statute is administered by the state Department of Ecology through the Flood Control Assistance Program (FCAAP). Local governments participating in the NFIP and meeting state requirements are eligible for matching funds for certain facilities and to develop comprehensive flood control management plans.

Lacey has been participating in the flood insurance program since 1980. The City has a flood protection ordinance as a chapter in the Lacey Municipal Code based on the federal NFIP. The basis for establishing areas of special flood hazard are those that are identified by the Federal Insurance Administration in a scientific and engineering report entitled The Flood Insurance Study for Thurston County, Washington and Incorporated Areas, Oct. 16, 2012. This report, with accompanying flood insurance rate maps (FIRM), is used as the best available information for flood hazard identification. As new data and information become available, the City works to update these regulations.

CRITICAL AQUIFER RECHARGE AREAS

Lacey and the Thurston region have done extensive study on identification and protection of underground aquifers located in northern Thurston County due to these aquifers being the sole source of drinking water for over 100,000 people. Groundwater protection is a particular concern in Thurston County as nearly 100% of the County's domestic, industrial, and agricultural water supplies rely on groundwater. Lacey is a member of the Northern Thurston County Groundwater Advisory Committee, which reports to the Department of Ecology. The committee oversees the development of technical data, the Northern Thurston County Groundwater Management Plan, and citizen involvement in ground water protection.

The hydrology of northern Thurston County indicates it is susceptible to contamination. Many of the surface deposits are sands and gravels that water and contaminates can move through easily. The water table is also close to the surface in places. The area of northern Thurston County has been designated as a groundwater management area and includes a total of 232 square miles. The groundwater management area boundaries were set with the goal of protecting the entire groundwater system within the hydrogeological boundaries of the northern Thurston County region.

According to studies, the groundwater management area contains a fairly distinct and hydraulically isolated mass of groundwater that does not receive water from the Cascade or Olympic Mountains or other distant locations. While streams and lakes provide a significant amount of groundwater recharge, rainfall is by far the primary source of water for the replenishment of the aquifer system.

In some areas there are a few soils and subsurface particles that contaminates can bind to easily. In many areas there are no confining layers between higher and lower aquifers so they are considered vulnerable. The degree of susceptibility varies throughout the groundwater area depending on the geologic characteristics of the subarea. A contaminate source must be present to pollute groundwater. Once groundwater is contaminated, it is difficult to clean up and the cost may be prohibitive.

Aquifer Recharge Areas Classified

The GMA requires the classification of recharge areas for aquifers according to the vulnerability of the aquifer. Vulnerability is the combined effect of hydrogeological susceptibility to contamination and the contamination loading potential. High vulnerability is indicated by land uses that contribute contamination that may degrade groundwater and hydrogeological conditions that facilitate degradation. Low vulnerability is indicated by land uses that do not contribute contaminants that degrade ground water and those conditions that do not facilitate digression.

Aquifer Recharge Regulations

Chapter 14.36, Critical Aquifer Recharge Areas Protection, contained in the Lacey Municipal Code outlines provisions for the protection of critical aquifer recharge areas and wellhead protection areas. The provisions contained in this chapter will be reviewed and updated based on best available science and technical guidance provided by the Washington State Department of Ecology that has become available since it was last reviewed and amended in 1999.

Critical aquifer recharge areas are rated by category based on the soil series listed in the Thurston County Soil Survey. The regulations contained in the code apply to aquifer sensitive areas listed as Category I or II, wellhead areas, or those areas that meet the stated criteria set forth in the protection measures. Interagency coordination with the Thurston County health officer is completed when an application is submitted requesting authorization of activities within an aquifer sensitive or wellhead protection area.

GEOLOGICALLY SENSITIVE AREAS

Geologically sensitive areas are those which are susceptible to erosion, landslides, earthquake and other geological events which pose a threat to public safety. At issue is the proper location and design of commercial, residential and industrial development to remove or reduce incompatibility with underlying geology.

Some geological hazards can be mitigated by proper engineering design or modified construction so that risks to health and safety are acceptable. However, when technology cannot reduce risk to acceptable levels, building in geologically sensitive areas shall be avoided.

Classification of Geologically Sensitive Areas

The GMA recognizes the significant hazard to the public health and safety from geologically hazardous areas. The Act requires jurisdictions to classify and designate geologically hazardous areas, including erosion hazard, landslide hazard, seismic hazard, and areas subject to other geological events.

Chapter 14.37 of the Lacey Municipal Code outlines provisions for Geologically Sensitive Areas Protection. Areas in Lacey that are prone to one or more of the following hazards are defined as geologically sensitive:

- **Erosion Hazard Areas**
- **Landslides Hazard Areas**
- **Seismic Hazard Areas**
- **Other geologically hazardous areas not mapped but meet the criteria of geologically sensitive areas, such as hillside areas having slopes of fifteen percent or greater.**

The City utilizes mapping as a guide to the general location and extent of geologically sensitive areas including Geologically Sensitive Areas Map; the Lacey Urban Growth Area Zoning Map; and the Soil Survey of Thurston County Washington. A qualified professional geotechnical engineer is

required to perform geologically sensitive area determinations. Coordination with other agencies, such as the U.S. Department of Agriculture Soil Conservation Service and other state and local agencies having jurisdiction or expertise in geologically sensitive areas, provides them the opportunity to comment on applicable development proposals.

In conjunction with the Thurston County Department of Emergency Management and twenty six area jurisdictions, the city of Lacey participated in the preparation of the Natural Hazards Mitigation Plan, September, 2009. Risk assessments for major natural hazards that threaten the Thurston Region and effective mitigation strategies are contained in the plan. Local governments are required to adopt a federally approved hazard mitigation plan in order to be eligible to apply for, and to receive, federal mitigation assistance program grants. These plans must be updated every five years. Each entity is responsible for implementation of their individual mitigation initiatives based on funding availability and entity priorities.

The Thurston region frequently experiences damage from natural hazard events such as earthquakes, landslides, severe storms, flooding, wildfires, and to a lesser extent volcanic eruptions. Natural disasters occur when people, property, and infrastructure are vulnerable or directly exposed to the effects of natural hazards.

As available developable land becomes more costly and difficult to locate in the urban growth area, properties that are encumbered with development limitations experience increased development pressures. Verifying the location and extent of environmentally sensitive areas prevents adverse impacts and protects public health and safety. Since the current development regulations for geologic sensitive areas were established for the City, additional knowledge and protection measures have been developed. The current development regulations and mapping resources for these areas should be reviewed and refined as necessary.

McAllister Springs Geologically Sensitive Area

The McAllister Springs area has been designated as a geologically sensitive area. Chapter 16.10 of the Lacey Municipal Code contains measures to protect the McAllister Springs Sensitive Area by provision of sewer and the application of strong water quality standards for residential uses. Residential densities are determined based on sewer availability. Additional environmental performance standards are also required to minimize surface water runoff and diversion, prevent soil erosion, and promote the aesthetic character of the community.

D. Habitat Conservation Areas

Preservation of fish and wildlife habitat is critical to the protection of suitable environments for animal species and in providing a desired quality of life for the community. The conservation of habitat entails active land management for maintaining species within their preferred habitats and accustomed geographic distribution. Isolation of sub-populations creates susceptibility to predation, dislocation, and inadequate food supplies. Habitat protection does not require the protection of all individuals of all species but it does require that land use planning be sensitive to the priority of saving and protecting animal-rich environments.

As salmonid fish species have been deemed to play an extremely important role in the ecosystem and are important cultural resources, jurisdictions must give special consideration to conservation and protection measures necessary to preserve or enhance anadromous fisheries[1].

CLASSIFIED FISH AND WILDLIFE HABITAT

The GMA requires the classification of seasonal ranges and habitats which are critical to the survival of endangered, threatened, and sensitive species. Habitats and species of local importance must be classified, including areas designated as priority habitats or priority species by the Washington Department of Fish and Wildlife (WDFW).

A listing of fish and wildlife habitat conservation areas to be protected by the state and the Lacey Municipal Code include:

- **Areas with which state or federally designated endangered, threatened, and sensitive species have a primary association;**
- **Habitats and species of local importance**
- **Commercial and recreational shellfish areas;**
- **Kelp and eelgrass beds, herring and smelt spawning areas;**
- **Naturally occurring ponds under twenty acres and their submerged aquatic beds that provide fish or wildlife habitat, including those artificial ponds intentionally created from dry areas in order to mitigate impacts to ponds;**
- **Waters of the state, including lakes, rivers, ponds, streams, island waters, underground waters, salt waters and all other surface waters and watercourses within the jurisdiction of the state of Washington;**
- **Lakes, ponds, streams, and rivers planted with game fish by a governmental or tribal entity;**
- **State natural areas preserves and natural resource conservation areas; and**
- **Land essential for preserving connections between habitat blocks and open spaces.**

There are currently 20 habitat types, 155 vertebrate species, 41 invertebrate species, and 11 species groups currently in the Priority Habitats and Species (PHS) List. These constitute approximately 17% of Washington's vertebrate species and fauna. Mapping of these priority areas was initiated in 1990 and is updated as information becomes available. These species and habitats may occur in areas not presently known due to lack of information or mobility. Site-specific surveys may be necessary in some cases. Species and habitats are mapped by county. Species distribution maps depict where each priority species is known to occur as well as where habitat primarily associated with the species exists.

Priority habitats are identified based on attributes that are unique or have significant value to many species. Priority species are identified and mapped based on three separate criteria: state listed and candidate species; vulnerable aggregations; and species of recreational, commercial, and/or tribal importance. Species are often considered a priority only within limited habitats such as

1 RCW 36.70A.172(1)

breeding areas or within areas that support a relatively high number of individuals. If species are so rare that any occurrence is important in land use decisions, then the priority area would be determined to be any occurrence.

DETERMINATION OF HABITAT CONSERVATION AREAS

All areas of Lacey meeting one or more of the designated fish and wildlife habitat conservation areas are subject to the development regulations contained in Chapter 14.33, Habitat Conservation Areas Protection, in the Lacey Municipal Code. Several mapping sources can be utilized to determine the approximate location and extent of habitat conservation areas in the City, including the Environmental Protection and Resource maps and zoning maps; the Department of Fish and Wildlife Priority Habitat and Species maps; the Department of Natural Resources Official Water Type Reference maps; and Anadromous and Resident Salmonid Distribution maps contained in the Habitat Limiting Factors.

The exact location of habitat conservation areas is required to be determined during the review of development proposals by the performance of a field investigation applying specific habitat or species recommendations of the WDFW for the completion of a management plan. A critical areas report and the recommendations provided by the Department of Fish and Wildlife in its publication, "Management Recommendations of Washington Priority Habitats and Species," should be followed.

ENDANGERED SPECIES ACT

The primary goal of the Endangered Species Act (ESA) is the recovery of listed species to levels where protection under the ESA is no longer necessary. Through a listing program, the U.S. Fish & Wildlife Service (USFWS) determines whether to add a species to the Federal list of endangered and threatened wildlife and plants. Listing affords a species the full range of protections available under the ESA, including prohibitions on killing, harming or otherwise "taking" a species.

Listings for state or federal threatened or endangered species identified in Thurston County include: bull trout, chum salmon, steelhead, Marbled Murrelet, Oregon spotted frog, spotted owl, streaked horned lark, orca, Mazama pocket gopher (four subspecies), and the Taylor's Checkerspot butterfly. Some of these species, such as the Oregon spotted frog have no known occurrence in the Lacey UGA.

As part of a broader effort to preserve the native prairie ecosystem of the South Puget Sound area, the USFWS recently listed several species as threatened or endangered under the ESA. These listings include the four subspecies of the Mazama pocket gopher, the Taylor's Checkerspot butterfly, and the streaked horned lark.

There are no known areas in the UGA where the Taylor's Checkerspot butterfly has been identified. At present, there has been a sighting of a single streaked horned lark in the Hawk's Prairie area and areas in the unincorporated portion of the UGA where field surveys have confirmed the existence of the pocket gopher. In the unincorporated portions of the UGA, Thurston County has conducted

field surveys with the USFWS during the permitting process and is completing a Habitat Conservation Plan (HCP) for prairie habitat and species. The HCP will outline a series of methods that will be used to regulate activities listed under the ESA. Due to the limited occurrence of these species within the incorporated portions of the City, each development proposal will be evaluated on a case by case basis.

PERFORMANCE STANDARDS

The code outlines minimum performance standards for alterations to conservation areas and provides for conditional approvals of activities allowed within or adjacent to a habitat conservation area or its buffers to minimize or mitigate any potential adverse impacts.

Additional performance standards for specific habitats such as endangered, threatened, and sensitive species; anadromous fish; wetland habitats; and riparian habitat areas are also identified. A variety of standards are employed for protecting habitats and species including: erosion and storm-water controls, setbacks and buffers around streams, wetlands and shorelines, and best management practices.

E. Shoreline Master Program

The foundation for shoreline management in Washington State is the Shoreline Management Act (SMA) (RCW 90.58) which was ratified by voters in 1972 based on a citizen initiative submitted to the legislature. The standards for local policies and regulations are embodied in the Shoreline Master Program Guidelines for managing, accessing and protecting shorelines. The SMA has three broad policies outlined in state law which includes

- **Protect the environmental resources of state shorelines**
- **Promote public access and enjoyment opportunities**
- **Give priority uses that require a shoreline location**

Local SMP's are required to be reviewed by the state Department of Ecology to insure compliance with state law.

LOCAL REGULATORY FRAMEWORK

The City of Lacey Shoreline Master Program (SMP), adopted on September 8, 2011 is the local mechanism for carrying out Shoreline Management Act. The SMP includes goals, polices, and regulations based on shoreline types and uses that is crafted to meet the needs of the City and also meet state laws and rules. State law has designed a partnership between local jurisdictions and the Department of Ecology as co-regulators of designated shorelines of the state. Lacey's SMP is required to be reviewed at a minimum of every eight years, and if necessary revised for compliance with applicable laws and regulations and the comprehensive plan.

The City has authority over shorelines within its municipal boundaries. Those shorelines within the city of Lacey and its UGA have been inventoried and found to meet criteria for lands within the jurisdiction of the SMP. These shoreline areas are as follows:

Marine Waters:

- **Nisqually Reach**

Lakes:

- **Chambers Lake**
- **Hicks Lake**
- **Long Lake**
- **Pattison Lake**
- **Southwick Lake**

Streams and Floodplains:

- **Woodland Creek**

The jurisdiction of the master program is defined as lands which extend landward two-hundred feet from the ordinary high water mark of "shorelines of the state," which includes all "shorelines" and "shorelines of statewide significance" as defined by state law. These areas are defined as having special economic and environmental value. These areas include marine waters; lakes larger than twenty acres in size; streams where the mean annual flow is twenty cubic feet per second; all of the 100 year flood plain within the associated shorelands; those wetlands which are in proximity to either influence or are influenced by the stream; and lands within a river delta flood plain not protected from flood waters by flood control devices.

The approximate shoreline jurisdiction and shoreline environment designations are delineated on the city of Lacey Shoreline Master Program Map. For the purposes of coordination of shoreline requirements with general land use regulations and the Comprehensive Plan, the shoreline designations are also shown as an overlay on the Comprehensive Land Use and Zoning Map.

The SMP contains four different shoreline environment designations: aquatic, natural, urban conservancy, and shoreline residential. These designations are used to differentiate between areas whose features imply differing objectives regarding their use and future development. Each of these designations has a stated purpose, designation criteria, and management policies that are intended to protect and manage the unique characteristics and resources of the different areas.

Goals & Policies (From SMP)

The goals and policies of an approved SMP are considered to be an element of the City's Comprehensive Plan. In 2003, the state legislature linked updates to local shoreline plans with the GMA. The goals and policies contained in the city of Lacey SMP are incorporated by reference into this Comprehensive Plan.

F. Environmental Policy

CARBON REDUCTION AND RESILIENCY (CR_2)

The Carbon Reduction and Resiliency Plan provides a road map for Lacey's energy policy and is a progressive program that will be applied in work towards sustainability. The plan sets benchmarks for carbon reduction and looks at sustainability issues. In 2008, the city of Lacey joined Local Governments for Sustainability to reduce greenhouse gas (carbon) emissions and work toward sustainable practices and policies. Lacey began implementing measures to protect air quality and the environment in 2009 based on the plan. Selecting and prioritizing future measures are intended to take place during the second phase of the Envision Lacey process.

TACOMA SMELTER PLUME

The Tacoma Smelter Plume is a 1,000 square mile area contaminated with arsenic and lead. Asarco's former copper smelter in north Tacoma released arsenic, lead and other heavy metals into the air for over 100 years. The wind carried these pollutants and they settled on surface soils across parts of King, Pierce, and Thurston Counties including northeast Lacey. Arsenic and lead are toxic metals and exposure can increase the risk of certain health problems. Arsenic and lead are not easily absorbed through the skin; however, working in the soil can increase the risk of accidentally swallowing soil and breathing dust. In 1983, the smelter site itself became a superfund site and cleanup of the surrounding area began.

In northeast Lacey, within areas identified by the Washington State Department of Ecology as areas being potentially over safe levels for arsenic, development projects are required to conduct soil sampling and remedy any contamination above safe levels (above 20 parts per million). The cleanup of these development sites are conducted through the Department of Ecology's Voluntary Cleanup Program (VCP). Through the VCP, cleanup options for contaminated sites may include:

- **Excavation and removal of contaminated soil.**
- **Mixing or tilling.**
- **Capping in place with soil or pavement.**
- **Consolidation and capping where soil is moved to one spot for capping.**

City of Lacey Comprehensive Plan
Tacoma Smelter Plume Map

Tacoma Smelter Plume Footprint (Scale Under 1:290,000)

Arsenic in ppm (parts per million)

- Limited Data
- Under 20 ppm
- 20 ppm to 40 ppm
- 40.1 ppm to 100 ppm
- Over 100 ppm
- City Limits
- Urban Growth Area Boundary

0 0.25 0.5 1 Miles

N

GOALS & POLICIES

Resource Lands and Critical Areas

Goal 1: Development shall protect, conserve and complement natural resources and environmentally sensitive areas and promote sustainability.

Policy A: Development shall be consistent with the Environmental Element, the provisions contained in the Lacey Municipal Code and sustainability goals and objectives contained in the Comprehensive Plan.

Resource Lands

Goal 1: Accommodate designated natural resource lands within the urban growth area in compliance with the stated intent of goals, policies and land use designations contained in the Comprehensive Plan.

Policy A: Allow for the continued use of designated agricultural and mineral lands in areas that currently provide for such products until such time these properties are ready to transition to urban uses.

Policy B: Ensure that land uses proposed adjacent to designated resource lands are compatible with such activities and appropriate buffers and regulations are in place.

Policy C: Accommodate appropriate urban densities within the urban growth area that comply with identified goals, policies and development standards to help ease development pressure on areas outside the growth boundary.

Agricultural Lands

Goal 1: Accommodate existing designated agricultural uses within the urban growth area over the short term and support the preservation of agricultural areas of long-term significance outside the urban growth area.

Policy A: Accommodate urban agricultural activities with sensitivity to urban density and land use compatibility issues.

Policy B: Support urban agricultural activities to provide fresh produce to encourage a healthy lifestyle; additional food choices; economic development opportunities; a more sustainable lifestyle; and urban neighborhoods with variety and interest.

Policy C: Periodically review the established design standards for urban agricultural activities to ensure that they do not compromise the livability of neighborhoods nuisance levels that could degrade the quality of life for surrounding residents.

Forest Lands

Goal 1: Recognize and protect suitably located non-commercial urban forest resources within the urban growth boundary and support the protection of commercial forestry activities of long-term

commercial significance outside the urban growth boundary.

Policy A: Implement and refine, when needed, the provisions contained in the Urban Forest Management Plan and Chapter 14.32 LMC, Tree and Vegetation Protection and Preservation.

Goal 2: Achieve and maintain a vibrant, healthy, and diverse urban forest in Lacey and Lacey's urban growth area consisting of both native and non-native landscape components to improve canopy cover and the aesthetic and physical benefits of trees while protecting infrastructure from tree damage.

Policy A: Base decisions on the preservation of trees and revegetation upon the requirements for individual development sites. Ensure that zoning classification considers criteria necessary for maintaining healthy, safe tree stands.

Policy B: Create and maintain a street tree program that takes advantage of indigenous trees, provides a coordinated and deliberative approach on preferred deciduous street tree species, and provides diversity of species, interest, and aesthetic quality. Promote the use of indigenous and drought-tolerant species, where appropriate.

Mineral Lands

Goal 1: Recognize Lacey's existing designated mineral resource lands while minimizing nuisance to adjacent urban uses.

Policy A: Existing mineral extraction sites in Lacey's urban growth area should be designated as such upon annexation if the site is being used for mineral extraction.

Policy B: Require a land use analysis for the designation of new mineral resource lands in the UGA that considers costs savings, urban reuse of the property, impacts to adjacent areas, and impacts to designated critical areas.

Critical Areas

Goal 1: Incorporate a systems perspective into policy, regulatory, and service decisions, recognizing the interrelationship of people, nature, and the economy.

Policy A: Recognize that Lacey's quality of life is one of its competitive advantages and promote economic growth that maintains and enhances this quality of life.

Policy B: Continue to recognize the requirement for, and substantial benefit of, incorporating the use of "best available science" in the overall management of critical areas and natural resource protection.

Policy C: Continue to preserve and protect significant environmental features including unique wetlands, shorelines, hillsides, and habitat areas to support wildlife and protect surface and groundwater resources.

Wetlands

Goal 1: Work to achieve no net loss of wetland resources and increase the quality and quantity of these resources.

Policy A: Utilize and amend, when necessary, Lacey's wetland protection measures to ensure protection of Lacey's wetland resources.

Flood Hazard Protection

Goal 1: Protect Lacey's citizens and property from flood hazards.

Policy A: Utilize and amend, when necessary, Lacey's flood hazard protection measures to minimize flood hazard impacts to life and property.

Policy B: Continue to participate in the National Flood Insurance Program to minimize risk of flood hazard.

Policy C: Utilize drainage and erosion control standards to respond and mitigate drainage problems.

Critical Aquifer Recharge Areas

Goal 1: Protect the quality and manage the quantity of groundwater resources.

Policy A: Seek to prevent groundwater contamination by protecting groundwater resources through various implementation measures.

Policy B: Strive to assure that proactive measures are taken to protect water quality from degradation and promote corrective actions in areas where degradation has occurred so that the net effect is an improvement of ground and surface water quality.

Policy C: Continue to implement adopted standards to regulate land uses within sensitive aquifer areas and well head protection areas.

Geologically Sensitive Areas

Goal 1: Protect the health and safety of the community and property to avoid the adverse impacts of erosion, landslide, and other geologic hazards.

Policy A: Mitigate geological hazards by proper engineering design and modified construction techniques when risk to health and safety are deemed acceptable. When technology cannot reduce risk to acceptable levels, development in geologically sensitive areas shall be avoided.

Policy B: Review and refine development regulations and mapping resources for geological sensitive areas as additional resource information becomes available.

Policy C: Continue to recognize the McAllister Springs area as geographically sensitive and require environmental performance standards to protect water quality, prevent soil erosion, and minimize surface water runoff and diversion.

Habitat Conservation Areas

Goal 1: Provide consideration, protection, and effective management of Lacey's habitat conservation areas.

Policy A: Utilize information and recommendations from the Department of Wildlife in classifying and designating priority habitats and species.

Policy B: Provide habitat for wildlife by maintaining a system of interconnected stream and trail corridors, shorelines, open spaces, vegetated LID facilities, and parks in areas of high habitat value.

Policy C: Continue to work with area resource partners to identify priority projects for habitat restoration projects.

Policy D: Continue to work with the U.S. Department of Fish & Wildlife to provide adequate mitigation, when required, for listed threatened and endangered species and habitat within the urban growth area.

Carbon Reduction and Resiliency (CR2)

Goal 1: Work to reduce greenhouse gas (carbon) emissions and work toward sustainable practices and policies.

Policy A: Work to conduct City operations in a manner that provides quality municipal services to the community while encouraging resource conservation and reducing adverse environment impacts.

IMPLEMENTATION STRATEGIES

1) Amend the provisions in Chapter 14.32 LMC, Tree and Vegetation Protection and Preservation and other applicable development standards as necessary to reflect updated goals and policies contained in the Lacey Urban Forest Management Plan.

2) Amend the development code to require a two-hundred foot buffer on all properties abutting Woodland Creek.

3) Begin implementation of Phase II of the Carbon Reduction and Resiliency Plan.

4) Add review criteria to Chapter 16.45, Mineral Extraction District, to require an analysis of designating new mineral resource lands in the UGA in order to determine if significant cost savings can be obtained from using minerals close to their source; the potential for reusing the mined land for other purposes once mining is complete; potential conflicts and impacts to adjacent urbanized areas; and impacts to designated critical areas.

5) Re-examine designated agricultural lands for compatibility and intensity of nearby land uses, land values, and availability of public facilities to determine if more appropriate zoning should be put in place.

CITY OF LACEY

CR_2

Strategy for
Carbon Reduction
and Resiliency

DRAFT

Planning Commission
June 19, 2012

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Introducing a Community Engagement Campaign:

energy
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4 ever green in lacey

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EXECUTIVE SUMMARY

For more than two decades, policy makers at all levels of government debated the need to address incremental climate change. A recent report by the U.S. Global Change Research Program attributes greenhouse gas (GHG) emissions as the number one contributor to global warming and climate change, already affecting communities around the world. These changes in climate are predicted to have far-reaching effects on air quality, human health, natural resources, land characteristics, and local economies —nearly every facet of our daily lives—over the next century. The good news is that we can make a difference.

The CR_2—Strategy for Carbon Reduction and Resiliency serves to accomplish three key objectives for the Lacey community:

- Identify potential risks to the community from projected changes in climate
- Refine efforts to build community resiliency through preparedness
- Outline actions to mitigate the impacts through strategic carbon (greenhouse gas) emissions reductions

In addition to protecting the community from the potential impacts of change to local climate, the CR_2—Strategy for Carbon Reduction and Resiliency meets the intent of state law to reduce greenhouse gas emissions in Washington. The plan validates and quantifies key efforts already underway in city government operations and the Lacey community which reduce emissions— through investments in energy efficiency, renewable energy, urban forestry, and open space policies, to name a few. Advancing policy for carbon reduction will serve to leverage funding for future infrastructure and capital development projects and provide a base for anticipated federal and state reporting and emissions reduction mandates.

The Lacey City Council passed Resolution 950, to join ICLEI -Local Governments for Sustainability and committed to a series of steps to manage air pollution and greenhouse gas emissions. An accounting of baseline emissions found that Lacey government operations generated approximately 6,879 tons of carbon dioxide equivalent (CO_2e)—a standard unit of measure which incorporates carbon dioxide (CO_2) and other potent greenhouses gases—and the Lacey community generated approximately 380,520 tons of CO_2e in 2005. Emissions are expected to grow at a steady rate, unless coordinated efforts are undertaken. Four main areas were identified to focus carbon reduction efforts:

- Transportation produces more than 50% of local greenhouse gas emissions. Changing the way people and goods move around our community—reducing reliance on driving alone, enhancing transportation choices, and using clean fuels will lower carbon emissions.
- Energy consumption is the second highest source of local emissions. Conservation efforts and development of clean, green energy sources to meet the demand of a growing population can serve to reduce emissions and enhance energy independence.
- Rooftops and Trees—land use which encourages integrated planning (high density, transit-oriented, and mixed-use development) and sustainable building practices, combined with a rich urban forest and open space inventory will maximize carbon reduction efforts into the future and keep our community green.
- Waste reduction, from local sourcing through disposal practices, can reduce emissions and environmental impacts to land, water, and air.

The CR2—Strategy for Carbon Reduction and Resiliency builds on Lacey's strong commitment to environmental stewardship and quality of life. Most of all, the plan is forward-thinking and optimistic. The plan outlines a variety of policies, goals, and measures that demonstrate leadership in sustainable actions to promote energy efficiency, local renewable energy, transportation options, healthy neighborhoods, and waste practices to reduce emissions. Further, it serves as a basis to build proactive community response to the impacts of climate conditions. For each goal, implementation strategy, partnerships, and funding mechanisms have been identified. A full list of measures is outlined in a matrix format to serve as a reference for selecting and prioritizing future implementation.

This plan incorporates a goal of reducing carbon emissions in the Lacey community to a level of 15% below 2005, by 2020, for both Lacey's municipal government operations, and the community as a whole. The city is already on track to meet the proposed 2020 reduction target in its municipal operations, but significant efforts will be necessary to meet the community's target. Coordinated efforts by local, regional, state and federal partners and participation by residents and businesses will be critical to reduce community level emissions.

This plan introduces a campaign—**4 Ever Green in Lacey—**to engage the community in selecting strategies to reduce carbon emissions and identify priorities in energy, transportation, rooftops and trees (land use, green building, and green spaces), and waste reduction. Outcomes from this public participation element will provide the foundation for Lacey's bridge to significant greenhouse gas emissions reduction.

Principles used in developing the CR_2—Strategy for Carbon Reduction and Resiliency:

- Work with other jurisdictions and stakeholders to coordinate and streamline community preparedness.
- Adapt infrastructure and services to emerging changes in climate.
- Look for opportunities to increase efficiency in services, buildings, and facilities.
- Identify partnerships to leverage funding.
- Continue incremental investments in current programs with direct and indirect benefits to carbon emissions.
- Engage and mobilize the community to achieve goals.

The CR_2—Strategy for Carbon Reduction and Resiliency affirms a commitment to protect the quality of life for future generations.

INTRODUCTION AND PURPOSE

INTRODUCTION AND PURPOSE

For the past two decades, policy makers at all levels of government debated the need to address incremental climate change. Support to address climate change reached a milestone in the mid-1990s when the international community gathered at a conference in Kyoto, Japan, to establish reduction goals for greenhouse gases. Known as the Kyoto Protocol , this international treaty prescribed greenhouse gas emissions reductions below 1990 levels by 2012.

Nationally, the U.S. Conference of Mayors, led by Seattle Mayor Greg Nickels, initiated the U.S. Mayors Climate Protection Agreement in 2005. The agreement encouraged cities to adopt standards equal or greater than the Kyoto Protocol. Since that time, over 1,000 mayors have pledged their support for the agreement.

The Washington State Legislature passed Senate Bill 6001 citing extreme weather, a warming Pacific Northwest, reduced snow pack, and sea level rise as four major ways that climate change is disrupting Washington's economy, environment, and communities. The legislation attributes greenhouse gas (GHG) emissions as the number one contributor to global warming and climate change. Greenhouse gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs).

Note: The terms greenhouse gas emissions and carbon emissions are used interchangeably in this report.

Washington State has been a leader in studying impacts of climate change, taken steps to protect and prepare for impacts, and set carbon reduction policy to mitigate emissions. Washington State's primary emissions sources include fuel use in transportation and electricity energy production for the residential, commercial, and industrial sectors. In response to global concerns of climate change, Washington State legislature mandated preparation of a comprehensive assessment of the impacts of climate change to the state in HB 1303. The "Washington Climate Change Impacts Assessment" report, published in 2009, by the Climate Impacts Group, University of Washington, was used extensively to analyze potential impacts to the Lacey community in the "Local Risks" section of this plan.

CLIMATE CONCERNS AND GREENHOUSE GASES

Since the last quarter of the twentieth century, scientists have been reporting changes in the composition of the atmosphere. According to the U.S. EPA, several types of gases known to trap heat near the Earth's surface — a process known as "the greenhouse effect"— are causing average global temperatures to rise, setting off a chain reaction of climate conditions around the world. These heat-trapping gases include water vapor, carbon dioxide (CO2), methane (CH_4), nitrous oxide (N2O), and several others—commonly referred to as greenhouse gases (see Figure 1). Human activities such as industrialization, deforestation, fossil fuel based transportation, energy production and consumption, and changing land use patterns increase the rate of greenhouse gases released into the atmosphere. Though the climate of the earth has changed over time from natural causes such as volcanic eruptions, the rate at which human-generated (anthropomorphic) greenhouse gases are being released has accelerated warming trends on a global level.

Across the United States and throughout the world, reports of how changes, or variables, in climate are already affecting communities, livelihoods, and the environment are becoming common-place. Rising

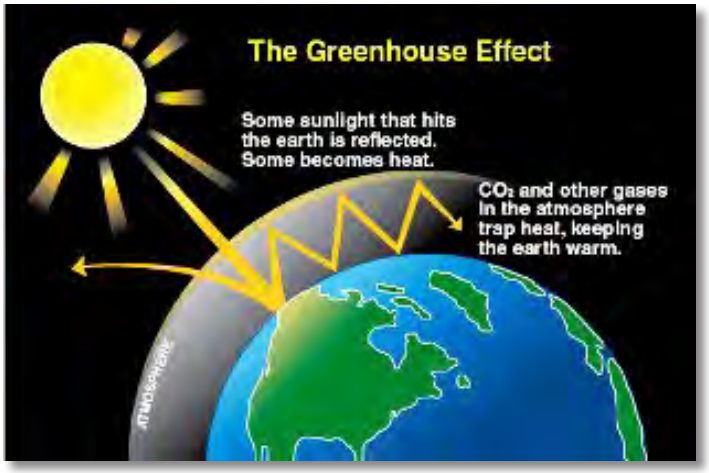
sea levels, drought, extreme weather events, loss of land and sea ice, and other climate-related impacts threaten communities, ecosystems, and public services and assets. The U.S. and many other nations are taking action to prepare for the effects of climate change and to mitigate the impacts by curbing greenhouse gas emissions.

The North Cascade glaciers have undergone significant loss in the last century. From 1950 to 2005, all 47 glaciers—of nearly 700 in the range being monitored—have undergone a significant retreat and four have disappeared. This decline has occurred in spite of a slight increase in winter precipitation. The North Cascades National Park has lost half of its ice area in the past century according to an article published in Northwest Science, November 2008. Mount Rainier's glaciers have shrunk by more than a quarter, according to a National Park Service geologist (Seattle Times, 2010).

Climate change refers to global, regional, and local level shifts in climate patterns. It can also refer to any significant change in measures of climate—temperature, precipitation, wind, etc.—lasting for an extended period of time. According to the U.S. Environmental Protection Agency (EPA), the experience of climate change due to warming global temperature trends is expected to vary by region. Further, if warming trends continue to accelerate at the same rate as the past few decades, impacts from climate change over the next century are predicted to have far-reaching effects on air quality, human health, natural resources, land characteristics, and local economies, to name a few.

Advances in climate modeling simulations, combined with data on observed changes in climate, have led to increased confidence in projections of future temperatures. In its 2007 assessment, the Intergovernmental Panel on Climate Change (IPCC 2007) provided best estimates and likely ranges for average global warming, given differing emissions scenarios. How much and how quickly the Earth's temperature will increase remains unknown—given the uncertainty of future greenhouse gases, aerosol emissions, and the Earth's response to changing conditions. In addition, natural influences, such as changes in the sun and volcanic activity, may affect future temperature—although the extent is unknown as timing and intensity of natural influences cannot be predicted. Given these uncertainties, the IPCC 2007, concluded:

Figure 1. The Greenhouse Effect



Source: Washington State Department of Ecology

> The average surface temperature of the Earth is likely to increase by 2 to 11.5°F (1.1-6.4°C) by the end of the 21st century, relative to 1980-1990, with a best estimate of 3.2 to 7.2°F (1.8-4.0°C). The average rate of warming over each inhabited continent is very likely to be at least twice as large as that experienced during the 20th century. Warming will not be evenly distributed around the globe. The warming will differ by season, with winters warming more than summers in most areas.

As a result of predicted temperature changes, sea levels are expected to rise from 7-23 inches by the end of the 21st century; air quality is also expected to deteriorate, according to the U.S. EPA.

LOCAL RISKS

LOCAL RISKS

Projections for changes to western Washington climate include milder, wetter winters and drier, hotter summers, and for sea level rise along coastal areas. These changes may not seem to be a significant concern for Lacey—with minimal coastline property and a marine west coast climate (moderate and wet). At first, warming temperatures could even seem appealing. So why should we be concerned?

To explore the consequences of potential changes in climate to Lacey and the South Puget Sound region, results of state and local impact studies were evaluated and applied to the Lacey community. Most, relevant was the "Washington Climate Change Impacts Assessment" report, published in 2009, by the Climate Impacts Group, University of Washington. The impacts assessment used climate modeling science to provide a comprehensive illustration of the consequences of a warming planet to Washington State (Appendix B). The report addressed potential impacts to hydrology and water resources, energy, agriculture, salmon, forests, coasts, urban stormwater infrastructure, and human health in the State of Washington. Other resources used to identify potential local risks included "Economic Impacts of Climate Change," by the Climate Leadership Initiative, University of Oregon, 2009, and Thurston County Public Health and Social Services, "Planning for Health Consequences of Climate Change," published in 2011 (Appendix C).

Key to this process is Lacey's future population. According to Thurston Regional Planning Council, The Profile 2010, Lacey's population is expected to increase to 51,650 people by the year 2030—a 56% increase from Lacey's 2005 population of 33,180. Growth will certainly add pressure on existing housing, tree cover, transportation, energy, water, and other resources.

Note: The following impacts should be considered general assumptions—projected from climate modeling studies and applied to the Lacey community.

WATER SYSTEM

The Washington State Climate Impacts Assessment found that future projections of change in precipitation and temperature would affect snow pack, soil moisture, and stream flow. Western Washington snow packs are among the most sensitive to changes in temperature because of the relative low elevation. Water basins that receive both rain and snow, like many Puget Sound watersheds, are highly sensitive to changes in climate.

Changes to seasonal weather patterns could have adverse effects on water availability and quality.

Reduced snow packs, shifts in timing of peak river flow, and reduced levels of summer and fall water storage would reduce the availability of drinking water to many Washington communities. Since Lacey's municipal water system has a diverse source of supply—consisting of nineteen wells that draw from three different groundwater aquifers, recharged mostly by precipitation—it is not dependent on snowpack and snowmelt.

A trend toward hotter summers would serve to increase summer water demand for irrigation and other outdoor uses, which will be addressed in long-term water system planning for assuring sufficient supply and storage. Source of supply planning will also consider that wells that draw from shallow aquifers are heavily influenced by annual precipitation patterns, and will likely experience greater fluctuation in

groundwater levels in response to change in recharge and increased peak summer demand. In addition, a significant sea level rise could have an impact on Lacey's two wells in the Nisqually Valley and could increase the risk of seawater intrusion for Lacey's wells in the Hawks Prairie area. However, Lacey's diverse sources of groundwater supply should allow the water system to adapt to changing precipitation patterns.

Regulatory response to summer stream flows could make it even more challenging in the future to secure groundwater rights for new wells. Lacey's Water Comprehensive Plan incorporates goals and objectives to identify and address water system vulnerabilities and to adapt policies and practices to hydraulic changes as data becomes available.

ENERGY

The Pacific Northwest depends on hydropower for nearly 70% of the region's electrical energy production. Although annual reductions in stream flow from climate-related changes are predicted to have a minor impact on hydropower production, seasonal changes were found to be significant by the Washington State Climate Impacts Study. Heating and cooling demands will increase with population growth. Cooling demand increases, coupled with predicted decreases in regional hydropower energy production, will put pressure on other sources of energy.

Hydropower is a significant source of electic energy in the Pacific Northwest.

Puget Sound Energy (PSE) provides electric and natural gas utility services to customers in Lacey. The utility's service territory spans from Whatcom County to Lewis County, with one million electric and 750,000 natural gas customers in Western Washington. PSE owns and operates the transmission and distribution grid for electric and natural gas in their service territory.

Approximately 46% of PSE's electric supply comes from utility owned resources. The remainder is purchased through several contracts. In 2010, PSE's electric supply portfolio included 36% coal, 33% hydroelectric, 29% natural gas, 1% nuclear, and 1% biomass, landfill gas, etc. All of PSE's natural gas is purchased from Canada and the Rocky Mountain states.

Washington State voters passed Initiative 937 in 2006, setting standards for utilities serving over 25,000 customers to increase renewable energy sources to 15% of their portfolio by 2020, with a milestone of 3% by 2012. Puget Sound Energy is in a position of meeting the requirements of I-937 through its Green Power Program, providing optional renewable energy investments for customers. The program is voluntary and funds invested are used to purchase renewable energy credits from regional renewable energy facilities , including PSE's three winds farms at Wildhorse, Hopkins Ridge, and Lower Snake River. PSE also operates a solar array at Wildhorse. In addition, PSE provides an array of energy efficiency and conservation programs for its residential, commercial and industrial customers.

Future electric energy demand and supply graphs were provided by Puget Sound Energy (Figure 2 and 3). Demand for electric energy correlates with future population growth. Puget Sound Energy's forecasted demand (Figure 2) is greater than the supply of electric energy production. PSE's forecasted supply portfolio shows a downward trend in current supply resources (Figure 3). This is due to expiration of power purchase contracts.

Puget Sound Energy's strategy to meet future electric demand uses a combination of measures. Natural gas production of electricity is the utility's primary approach. Natural gas prices have fallen in recent years as new technologies have opened up substantial reserves in the U.S. and Canada. Energy efficiency is the next significant push, along with expansion of biomass and wind production. Although the strategy may be effective, it will likely be costly and difficult.

Not only is energy supply vulnerable to changes in climate, but cost and availability are subject to world and regional market conditions and grid failure. Extraction and distribution of fossil fuels can harm the environment. Local sources and distribution systems for energy would offer independence, resource diversity, and reduce vulnerability to market cost fluctuations.

Figure 2. Puget Sound Energy Forecasted Electric Energy Demand Forecast (2010)

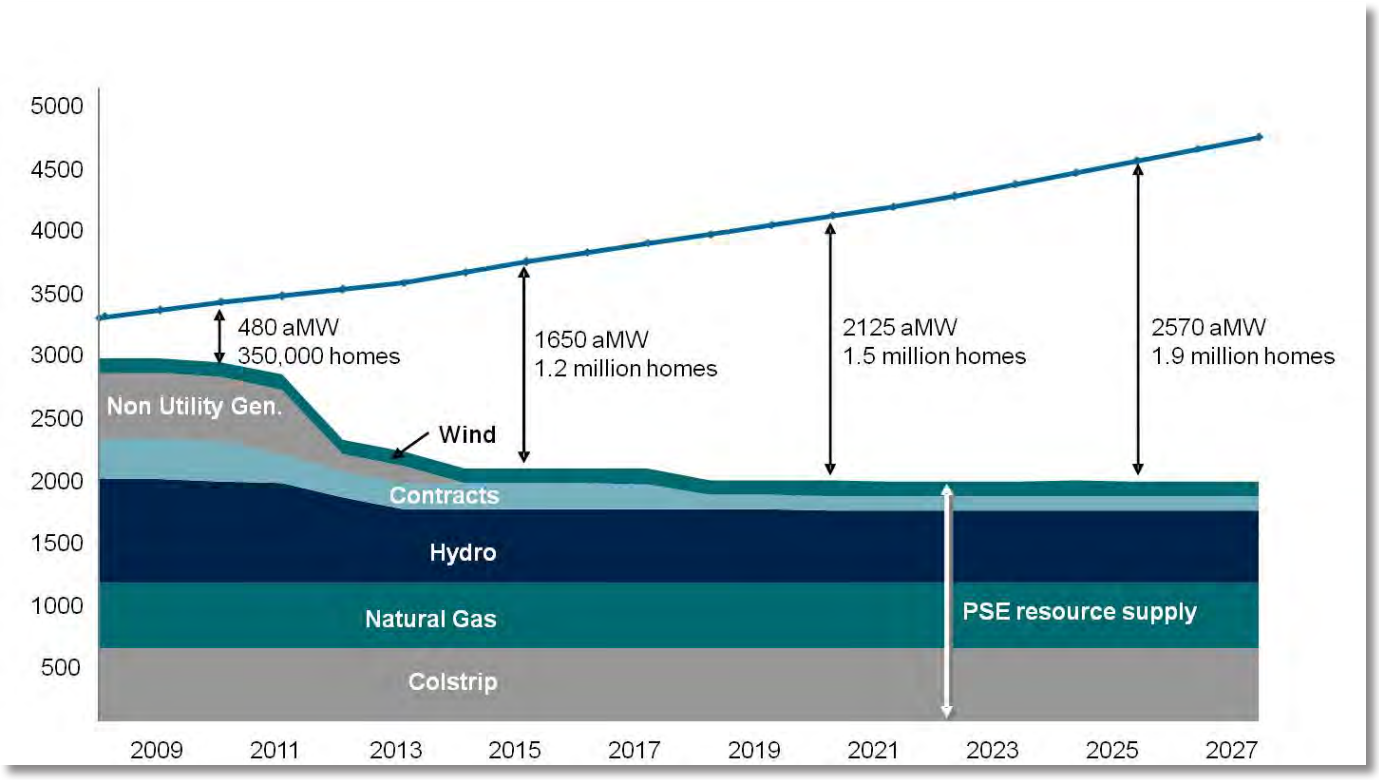
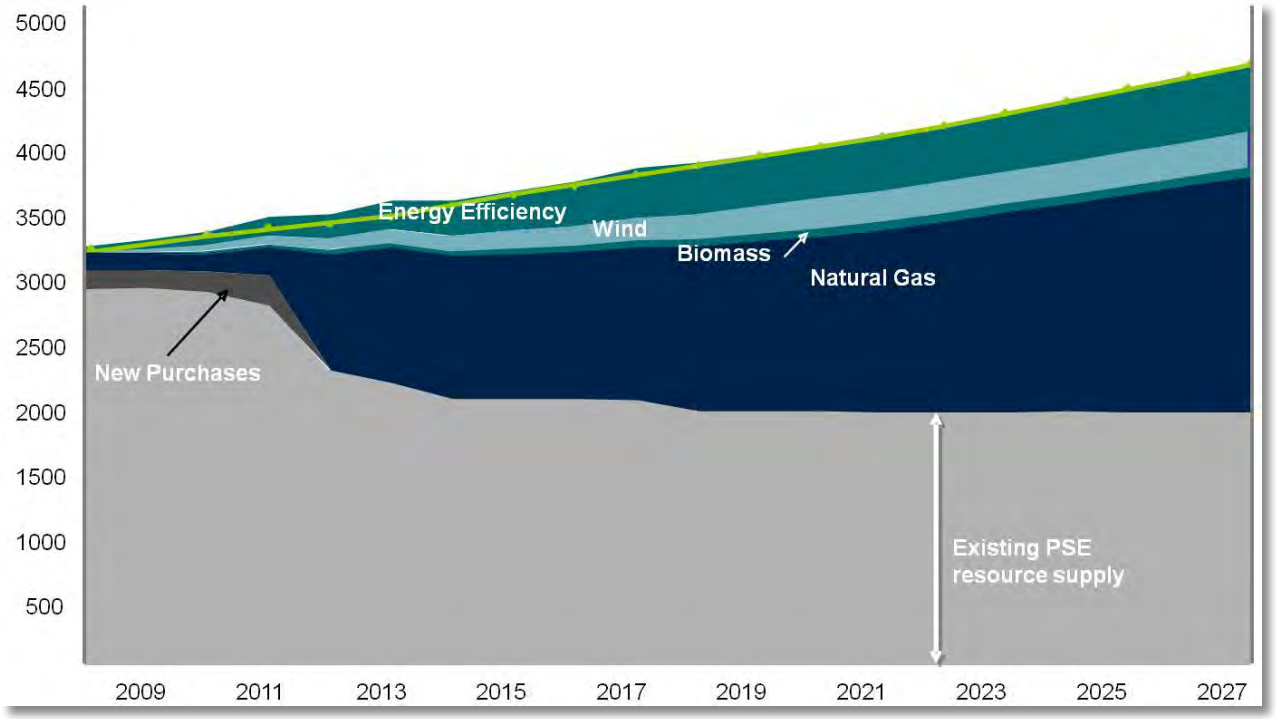


Figure 3. Puget Sound Energy – Forecasted Electric Supply Resources (2010)



SALMON HABITAT

Climate plays a crucial role in salmon ecology at every stage of their lifecycle. Warming trends, changes in stream flow, and increased flooding are predicted climate change impacts that would affect the quality and quantity of fresh water habitat.

Improving salmon habitat along Woodland Creek, which runs through the center of Lacey, has been a top priority—with nearly 90 percent of the creek's corridor now protected in the city. Projects have included fish weirs, habitat restoration, stormwater treatment, and property acquisitions to preserve pristine tracts of land along the creek. Continued efforts to provide and preserve shady buffers to reduce stream temperatures and maintain water quality will need to be emphasized. Lacey's Water and Stormwater Elements of the Comprehensive Plan provide protection for aquaculture, salmon, and shellfish habitat and health.

Warming stream temperatures disrupt aquatic habitat.

SHORELINES

Because Washington's nearly 3,000 miles of coastline is used for economic development such as ports, homes, recreation, wildlife and shellfish aquaculture, the physical effects of climate change, primarily sea level rise, will pose significant challenges. Sea level rise will shift coastal beaches inland and increase erosion and endanger building sites. Protecting port lands and transportation networks will be a challenge for many port jurisdictions in Washington State.

With a significant amount of shoreline and downtown infrastructure vulnerable to sea level rise, the City of Olympia commissioned a study in 2010, to identify risks to infrastructure. Lacey's Shoreline Master Program includes goals and objectives to protect public interest in shoreline development and preserve the natural character and ecology of Lacey's shorelines. The plan includes elements to prevent and minimize flood damage to property and infrastructure.

Sea level rise challenges shorelines and decreases freshwater supply due to saltwater intrusion.

URBAN FORESTRY

Trees enhance the beauty and character of Lacey's northwest landscape, as well as provide many other ecosystem benefits to our community. Trees absorb carbon dioxide (the most common greenhouse gas) from the air and store carbon (sinks). Preserving tree cover reduces run-off, cools streams, reduces the urban heat island effect, provides habitat, and buffers noise. Forest ecosystems are highly dependent on climate, and Lacey's urban forest is no exception.

Forest system health is adversely impacted by drought, disease, and fires.

According to the Washington State Climate Impacts report, changes in climate are predicted to impact the fundamental nature of the forests in Washington—affecting growth patterns, regeneration, and incidence of fire and insects, especially where water deficits are greatest.

A strong foundation of tree protection and an emphasis on native landscape plantings can build resiliency into Lacey's present and future urban forest canopy. Continuing to assess and adapt to changes in climate conditions through planning tools such as Lacey's Urban Forest Management Plan and the city's Development Guidelines will serve to protect and preserve our urban forest resources.

FOOD SUPPLY

Although climate change predictions include an increase in favorable conditions for some food crops in the next few decades, long-term effects of warming regional temperatures are less encouraging. The Washington State Climate Impact Study found that major commodity crop yields are projected to decrease at a relatively slow rate with more significant reductions as the end of the century nears. Temperature increases and resulting changes in the timing and quantity of snowmelt and runoff are predicted to reduce production of some Washington crops, especially in Eastern Washington.

Long-term effects of warming temperatures will decrease production for some Washington crops.

Although longer growing seasons would be beneficial to overall production, the irrigation season will likely be shorter and water rights more difficult to maintain. The net effect is a decline in several crop yields and crop values. Unknown factors such as changes in pests, weeds, and invasive species could further impair crop production. Seasonal droughts and limited water availability during growing seasons could impact local food production.

STORMWATER

Extreme weather events compromise infrastructure.

Lacey averages more than four feet of annual rainfall—most of which is received during mild wet winters, while summers are relatively dry. Climate projections indicate this pattern could become more extreme in future years. Stormwater management facilities are built according to historic precipitation patterns. Increased peak rainfall magnitudes and changes in rainfall patterns could overwhelm outdated stormwater management systems, and increase the risk of flooding and degraded surface water quality.

Sea-level rise would have minimal impact on stormwater and degrading surface waters in Lacey, but temperature changes could. The climate modeling for western Washington lowlands projects increased annual temperatures, with an enhanced seasonal cycle of drier summers but wetter autumns and winters, and a rise in Puget Sound water level. Surface water levels would be correspondingly higher during the "wet season" (October through April) and lower in summer. More creeks and wetlands may dry out completely by late summer. But during the wet season, water levels in wetlands and near-surface groundwater (often "perched" on poorly-draining glacial till) will be higher, and in some places the ground surface could become saturated.

Projected increases in peak rainfall coupled with higher overall winter rainfall could overwhelm drainage systems designed for less-intense storm peaks. Conveyance systems such as storm drain pipes and culverts that were designed for historical peak discharges may be undersized for projected higher peak discharges, and the expected result would be a greater chance for flooding of streets and properties as excess water backs-up in drainage systems. Most at risk would be areas that currently experience minor flooding, locations with inadequate drainage systems, and areas with high groundwater. Additional runoff volume would cause wet ponds and detention ponds to discharge for longer durations, adding more volume downstream.

Projections generally indicate increases in extreme high rainfall magnitudes throughout the coming decades, particularly around Puget Sound, which will in turn contribute to increases in peak annual discharges to creeks in the Puget Sound region. Higher discharge flows could impact downstream water quality, as more pollutants are washed off roads, parking lots and yards, into the drainage system and carried downstream. In addition, sudden large pulses of storm runoff water to creeks would put them at risk for increased erosion and sediment transport. Lacey's Stormwater Comprehensive Plan outlines responsive goals and strategies to manage stormwater system design standards and adjust as necessary.

HUMAN HEALTH

Rising public health concerns due to extreme heat conditions and worsening air quality are anticipated impacts of the warming temperatures predicted with climate change, more so in urban areas. According to a recent report by Thurston County Public Health and Social Services (Appendix C), the incidence of heat-related deaths in Thurston County is expected to increase. Although better controls on air pollution have resulted in improvements to air quality in recent years, the impact of warmer temperatures compromise those gains.

Thurston County Public Health and Social Services released a white paper on the impacts of climate change in Thurston County, 2011 (Appendix C). This report noted several adverse health concerns which coincide with changes in temperature, precipitation, and extreme weather events.

Heat and extreme weather events compromise human health.

- Short, intense heat waves are associated with increased deaths. The elderly, young, and chronically ill are most vulnerable.
- Poor air quality is associated with higher temperatures because of increased ground-level ozone, particulates, especially PM2.5, and pollen/fungal spores. Respiratory and cardiac functions, both acute and chronic heart and lung diseases are sensitive to air quality.
- Communicable disease rates can climb when disease reservoirs are increased due to high temperatures and flooding. Surface and groundwater supplies could be contaminated as well.
- Socially and economically vulnerable groups tend to live in conditions that are most susceptible to climate change and tend to suffer disproportionately.

ECONOMIC IMPACTS

A study completed at the University of Oregon by the Climate Leadership Initiative quantified economic impacts of Climate Change to Washington State. The study found that a reduction in available resources combined with accelerated health risks drive cost of living increases for residents. The report identified increased energy costs, reduced salmon populations, coastal and storm damage, reduced food production, increased wildland fire costs, increased public health costs, and lost recreation opportunities as economic impacts of climate change. Table 1 highlights some of the potential economic impacts of climate change from this study.

Table 1. Potential Economic Costs to Washington State for a Business-As-Usual Approach to Climate Change, 2020, 2040, and 2080 (dollars per year)

Figure 1. Potential Economic Costs in Washington Under a Business-as-Usual Approach to Climate Change, 2020, 2040, and 2080 (dollars per year)

Potential Cost	2020	2040	2080
Costs of Climate Change			
Increased Energy-Related Costs	$222 million	$623 million	$1.5 million
Reduced Salmon Populations	$531 million	$1.4 billion	$3.0 billion
Increased Coastal and Storm Damage	$72 million	$150 million	$352 million
Reduced Food Production	$35 million	$64 million	$364 million
Increased Wildland Fire Costs	$102 million	$208 million	$462 million
Increased Health-Related Costs	$1.3 billion	$2.2 billion	$4.4 billion
Lost Recreation Opportunities	$75 million	$210 million	$612 million
Subtotal for Costs of Climate Change	*$2.3 billion*	*$4.9 billion*	*$10.7 billion*
Additional Costs from Business-as-Usual (BAU) Activities that Contribute to Climate Change			
Inefficient Consumption of Energy	$1.4 billion	$1.6 billion	$2.2 billion
Increased Health Costs from Coal-Fired Emissions	$19 million	$23 million	$31 million
Subtotal for Costs from BAU Activities	*$1.4 billion*	*$1.6 billion*	*$2.2 billion*
TOTAL	**$3.8 billion**	**$6.5 billion**	**$12.9 billion**
Average Cost per Household per Year	$1,250	$1,800	$2,750

Source: ECONorthwest

Notes: These numbers illustrate different types of annual costs Washingtonians potentially would incur if society were to continue with a business-as-usual approach to climate change. There may be overlap between the values for some of the different types of costs. Nonetheless, adding the different types of costs probably seriously understates the total potential cost of climate change because the table excludes many additional types of climate-related costs that Washingtonians would incur under a business-as-usual approach. The numbers do not indicate the net effect of climate change, as they do not represent a forecast of how the economy will respond to the different effects of climate change, or account for potential economic benefits that might materialize from moderate warming and other changes in climate.

ECONorthwest, An Overview of Potential Economic Costs to Washington of a Business-As-Usual Approach to Climate Change

CLIMATE POLICY

CLIMATE POLICY

Internationally, nationally, and locally, jurisdictions have acted to mitigate the impacts of increased levels of greenhouse gases with a variety of policy and planning mechanisms, initiatives, and legislation. Climate protection activities are being formally implemented in virtually every one of America's 50 states. Many jurisdictions have adopted greenhouse gas (GHG) reduction targets to curb emissions— reduce their carbon footprint—and develop strategies to adapt to changes in sea levels, drought, extreme weather events, and loss of land due to climate change. The landmark international agreement to reduce greenhouse gas emissions—the Kyoto Protocol—recommended a goal of reducing greenhouse gas emissions by 7% below 1990 levels by 2012.

The Federal government is implementing policies to address climate change through voluntary and incentive-based programs. The U.S. EPA actively participates in international activities by establishing partnerships and providing leadership and technical expertise. The United States is a contributor to activities under the United Nations Framework Convention on Climate Change (UNFCCC) and the International Panel on Climate Change (IPCC). The Federal government is engaged in activities to provide accurate climate information, enhancing coordination and capacity for disaster risk reduction, and preparedness and response support.

WESTERN CLIMATE INITIATIVE (WCI)

Dozens of states and several Canadian provinces have entered into a regional collaboration to jointly reduce emissions. Washington State is currently a partner in the Western Climate Initiative (WCI). The WCI is a partnership between several states and Canadian provinces to develop a regional greenhouse gas inventory and reduction strategy focused on market-based cap and trade of emissions. Accordingly, all partners have agreed to a greenhouse gas emissions reduction of 15% below 2005, by 2020.

WASHINGTON STATE

Washington State has greenhouse gas emissions regulations under the Revised Code of Washington (RCW) Chapter 70.235, mandating greenhouse gas emissions limits. Under this RCW, the state has set greenhouse gas reduction target:
By 2020, reduce overall emissions of greenhouse gases in the state to 1990 levels;
By 2035, reduce overall emissions of greenhouse gases in the state to 25% below 1990 levels;
By 2050, the state will do its part to reach global climate stabilization levels by reducing overall emissions to 50% below 1990 levels, or 70% below the state's expected emissions that year.

The state implemented a number of low carbon policies including creation of climate action plan, mandatory GHG reporting for some industries, vehicle emissions guidelines, renewable energy portfolio standards, energy efficiency initiatives, vehicle mile traveled (VMT) standards, waste management, and State Environmental Policy Act (SEPA) guidance. Additionally, when selecting recipients for infrastructure and capital project funds, RCW 70.235.050 allows state agencies to consider whether a local jurisdiction has adopted a climate change plan or policy and if future projects will contribute to greenhouse gas emissions.

LOCAL GOVERNMENT ACTIONS

Local governments guide land use and zoning decisions, building codes and permits, infrastructure investments, deliver municipal services, and manage parks, open space, and recreation areas. Local govern-

ments identify and mitigate risks to their communities—they have an important role to play to ensure the health, safety, and quality of life. Many cities and counties have developed and implemented strategies to address climate change—reduce energy consumption and greenhouse gas emissions, and to prepare for potential risks, both in municipal operations and their communities at large. Strategies vary in development and implementation across jurisdictions.

LACEY INITIATIVES

The City of Lacey is a signatory city on the U.S. Mayors Climate Protection Agreement. Launched by Seattle Mayor Greg Nickels in 2005, participating cities commit to strive to meet or beat the Kyoto Protocol targets in their own communities; urge their state and federal government to enact policies and programs to meet or beat the greenhouse gas emission reduction target, and; to urge the U.S. Congress to pass greenhouse gas reduction legislation.

In 2008, the City of Lacey joined ICLEI-Local Governments for Sustainability (ICLEI), Cities for Climate Protection Campaign. ICLEI's mission is to help local governments reduce greenhouse gas emissions and work toward sustainable practices to protect the climate and physical environment. Lacey committed to undertake five milestones:

1. Conduct a baseline emissions inventory and forecast,
2. Adopt an emissions reduction target,
3. Develop a Local Climate Action Plan,
4. Implement policies and measures, and
5. Monitor and verify results.

ICLEI designed software tools and provided guidance for Lacey's actions to measure baseline greenhouse gas emissions, create forecasts, and quantify impacts of current and potential greenhouse gas emissions reduction measures.

LACEY'S CARBON FOOTPRINT

A carbon footprint is considered the total set of greenhouse gas emissions caused by an entity—in this case, an organization and an entire community. Local governments typically measure greenhouse gas emissions from municipal operations—including only those activities that are directly under financial or operational control of the jurisdiction—and for the community as a whole.

Generally, municipal operations emissions are reported by sector: Buildings & Facilities, Vehicle Fleet, Streetlights & Traffic Signals, Water and Wastewater Operations, Solid Waste, Employee Commute, and Refrigerants. Greenhouse gas emissions are calculated from the best data available on energy use, fuel use, vehicle types, solid waste, employee commute, and other measures of government activities. Using the Clean Air & Climate Protection (CACP 2009) software tool designed by ICLEI, greenhouse gas emissions were calculated for Lacey's municipal government operations.

The Lacey community's carbon footprint was measured in a similar manner, with inputs provided by Puget Sound Energy for electric and natural gas used by the residential, commercial, and the industrial sectors. Transportation modeling from Thurston Regional Planning Council generated vehicle miles traveled (VMT) for Lacey roads and streets. Solid waste data was provided by Thurston County Solid Waste.

CARBON EQUIVALENTS (CO_2E)

Greenhouse gas emissions are generally reported as carbon dioxide equivalents, or CO_2e—which is the concentration of carbon dioxide (CO_2) that would cause the same level of damage to the atmosphere as a given type and concentration of greenhouse gas. Examples of such greenhouse gases are methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), perfluorocarbons (PFCs), and hydrofluorocarbons (HFCs).

EMISSIONS INVENTORY AND FORECAST

Greenhouse gas emissions were calculated for a base year 2005, and for a year in the future – forecast year 2030. The inventory included emissions from all government operations (e.g., city owned and/or operated buildings, streetlights, water and wastewater utilities) and from all community-related activities (e.g., residential and commercial buildings energy use, motor vehicles, waste, and industry). This inventory and forecast provide a benchmark for planning and monitoring progress in government operations and the Lacey community.

In 2005, the City of Lacey's government operations generated approximately 6,879 tons of CO_2e, and the Lacey community generated approximately 380,520 tons of CO_2e. Government operations comprise 1.8% of the community's total emissions.

In 2030, the city's municipal operations are forecasted to generate approximately 17,899 tons of CO_2e, and the community of Lacey is forecasted to emit approximately 712,789 tons of CO_2e. Emissions forecasts are for a business-as-usual scenario (if no mitigation efforts were undertaken). The resulting increases to emissions are attributed, primarily, to the significant increase in population projected for the Lacey community.

Note: Municipal Operations emissions forecasting growth rates were based on average growth from 2005-2009 for city services, which may trend high. No adjustment was made for the subsequent recessionary period.

LACEY GOVERNMENT OPERATIONS INVENTORY – BASE YEAR 2005 SUMMARY

In 2005 the City of Lacey's municipal operations generated approximately 6,879 tons of CO_2e. Figure 4 displays a summary CO_2e emissions for Lacey municipal operations.

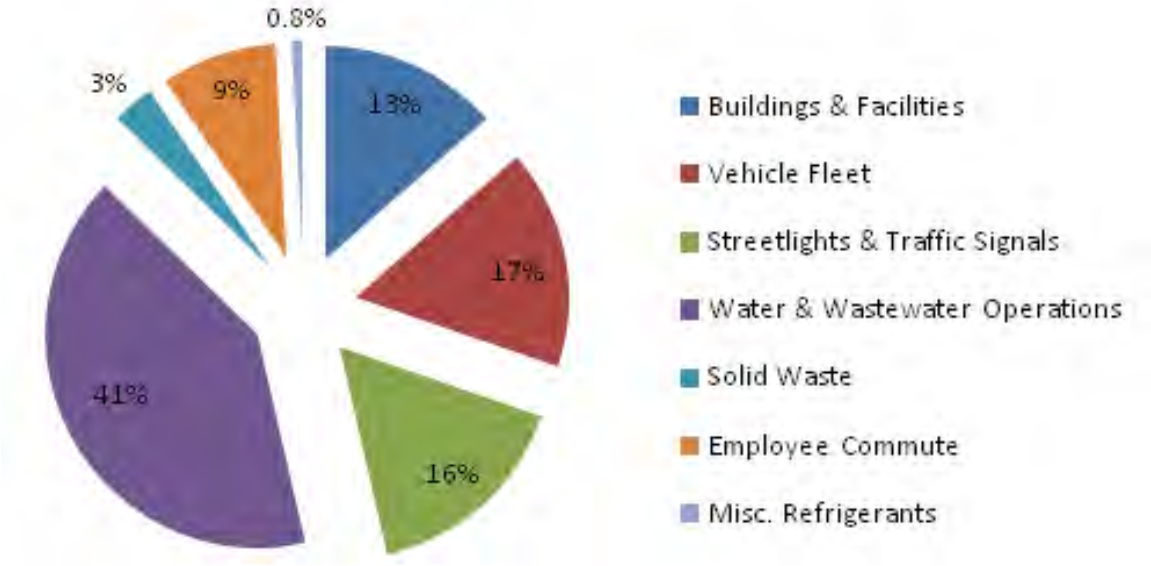
- Water and wastewater production and distribution contributed nearly 41% of the CO_2e emissions in 2005. Of the 2,811 tons of CO_2e produced from Water and Wastewater Operations, 2,640 tons of CO_2e is generated from power consumed to produce and distribute water to Lacey utility customers—38% of total emissions. Energy associated with Lacey's wastewater utility is used to pump waste to main sewer conveyance lines to be treated by LOTT Clean Water Alliance (LOTT).
- The city's vehicle fleet was the second highest source of greenhouse emissions—contributing nearly 17% in the form of direct emissions, or 1,144 tons CO_2e.
- Over 3,000 streetlights and nearly 26 traffic signals contributed to 1,111 tons CO_2e or 16% of Lacey municipal operation emissions.
- Buildings and facilities provided for 13.6% of emissions, 936 tons CO_2e, including electric and natural gas energy used for lighting, heating, ventilating, and cooling city-owned buildings.
- City employees contributed nearly 8.8% or 603 tons CO_2e for commuting purposes.
- Greenhouse gas emissions from solid waste are related to the amount of methane (CH_4) generated. Because

the community's solid waste is decomposed in a landfill which has a methane recovery system—a mitigation measure to capture an estimated 75% (minimum) of the methane gas—the emissions associated with this sector total 216 tons CO_2e or 3.1% of emissions.

- Emissions from refrigerants, less than 0.8%, were calculated from the maintenance of HVAC systems and fleet air conditioning.

Figure 4. City of Lacey Municipal Emissions Summary by Sector (2005)

Lacey Municipal Operations
Total 2005 Emissions: 6,879 tons of CO_2e

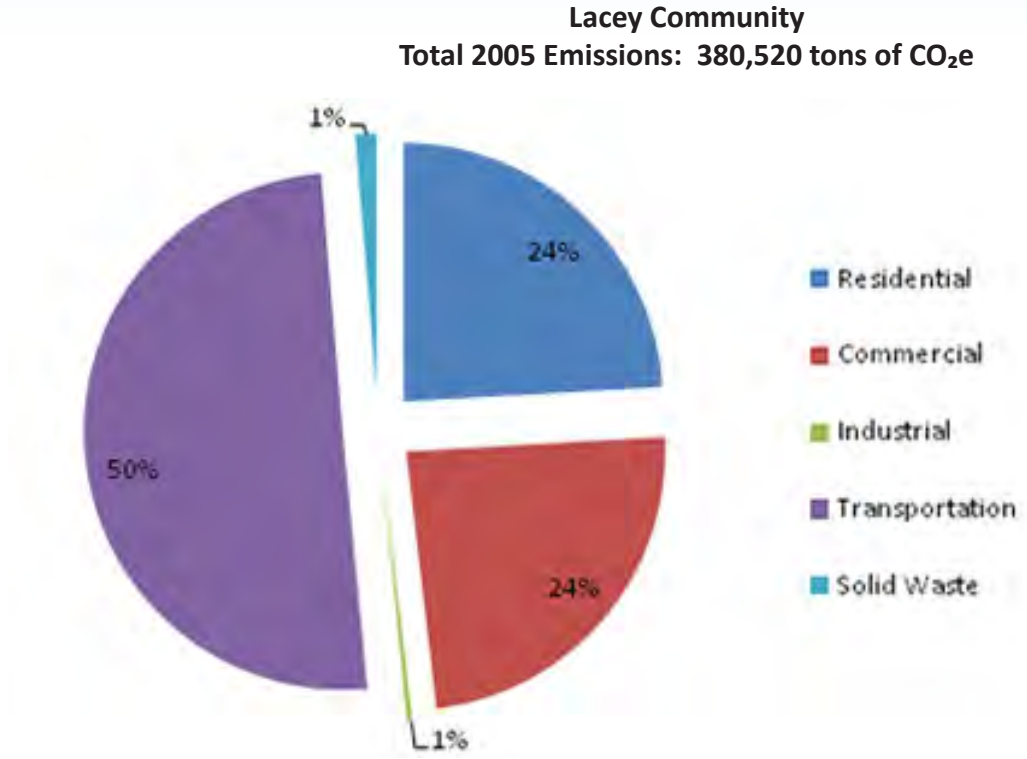


Source: Lacey CACP inventory

LACEY COMMUNITY INVENTORY – BASE YEAR 2005

In 2005, the Lacey community generated approximately 380,520 tons of CO_2e. Consistent with many local jurisdictions, transportation contributes nearly 50% of total CO_2e emissions. According to the Federal Transit Administration, U.S. Department of Transportation, most emissions from transportation are single occupancy vehicles or persons driving alone. Residential, commercial, and industrial sector (RCI) emissions are primarily from energy used for lighting, heating, and cooling. Combined, RCI accounts for nearly 49% of the community's CO_2e emissions. Because the community's solid waste is decomposed in a landfill which has a methane recovery system—estimated to capture more than 75% of the methane gas—the emissions associated with this sector are significantly reduced to nearly 1% of total emissions. Figure 5 provides a summary of CO_2e emissions for the community of Lacey.

Figure 5. Lacey Community Greenhouse Gas Emissions by Sector (2005)



Source: Lacey CACP inventory

EMISSIONS FORECAST

Lacey's population is expected to grow to more than 51,650 by the year 2030, accouding to forecasts by Thurston Regional Planning Council (2009), an increase of nearly 56% from 2005. In the absence of changes in policy or practice in curbing greenhouse gas emissions, an increase in population will result in increased emissions. A general outlook for Lacey's future carbon footprint was developed, based on growth rate predictions, utility data, and a variety of city growth indicators. If no carbon reduction measures are undertaken, the city's municipal operations carbon footprint could grow to approximately 17,899 tons of CO_2e (Figure 6), and the Lacey community is forecasted to generate approximately 712,789 tons of CO_2e per year by 2030 (Figure 7).

Note: Municipal Operations growth rates were based on average growth from 2005-2009, which may trend high. No adjustment was made for the subsequent recessionary period.

Figure 6. Lacey Municipal Operations Forecasted Greenhouse Gas Emissions

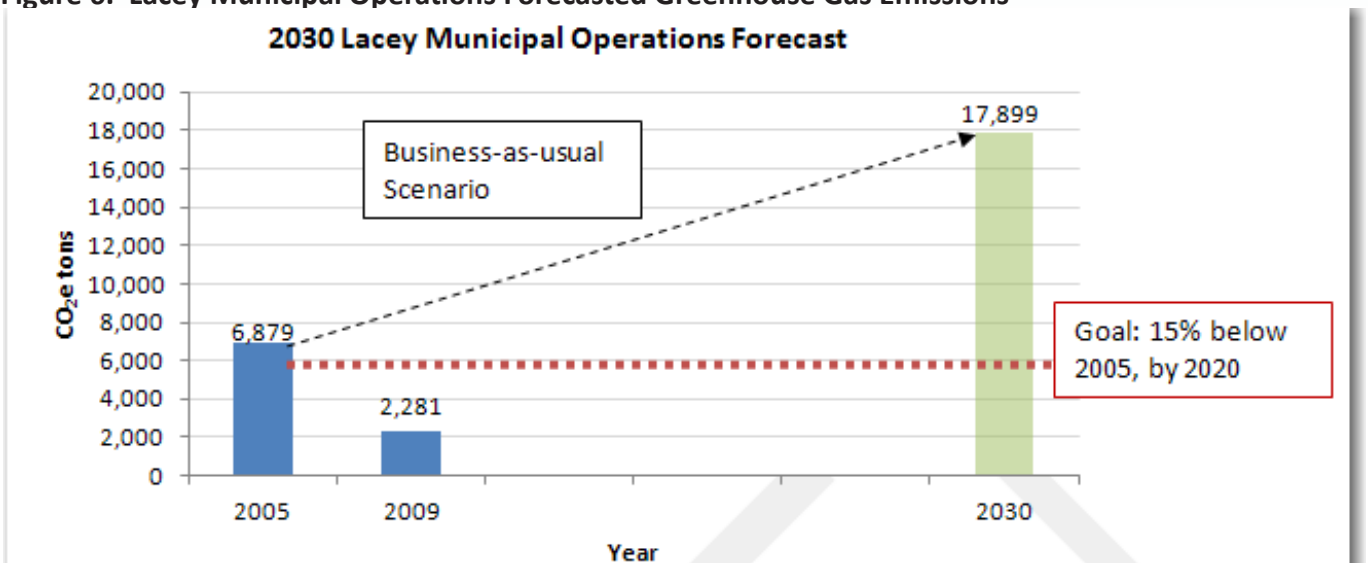
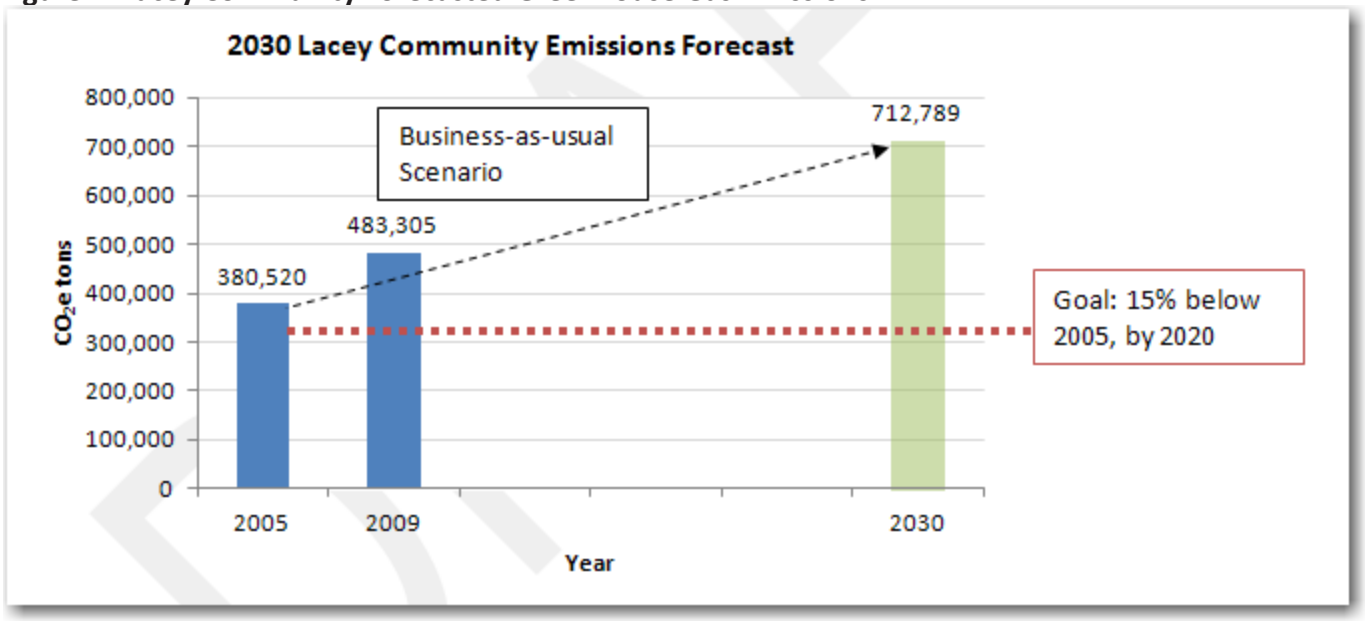


Figure 7. Lacey Community Forecasted Greenhouse Gas Emissions



GREENHOUSE GAS EMISSIONS REDUCTION TARGETS

Setting a reduction target is essential to create a framework that guides the planning and implementation of mitigation measures. The Lacey City Council Land Use Committee provided guidance for setting greenhouse gas reduction targets—15% below 2005 levels by 2020 (Appendix D). This target is consistent with the Western Climate Initiative greenhouse gas reduction target. It was selected because of its regional consistency, base year, and attainability.

Lacey's Municipal Operations have effectively reduced emissions to a level well-below the goal of 15% below 2005 emissions.

In determining the target, the Committee reviewed some key accomplishments in carbon reduction efforts that were undertaken in years subsequent to the baseline inventory. To account for these efforts, an emissions inventory was completed for the year 2009. Lacey's 2009 municipal operations emissions were 2,281 tons of CO_2e—nearly 67% reduction from 2005—to a level well below the proposed goal of 15% below 2005.

The City of Lacey's decision to purchase 100% renewable green power for all municipal operations (2007) made a significant impact to municipal operations emissions. Although this achievement is remarkable, the renewable energy purchase alone will not be sufficient to meet the goal, if city services continue to grow at the projected rate. Furthermore, given recessionary budget constraints, the premium cost of renewable energy may not be sustainable. Additional measures will need to be undertaken to reduce Lacey's municipal operations carbon footprint to meet the reduction goal in the target year.

There is no single action that will effectively reduce emissions. Efforts will involve both short term and long term measures.

The Land Use Committee also considered a goal of reducing carbon emissions in the Lacey community to a level of 15% below 2005, by 2020. There is no single action that will effectively reduce carbon emissions to the reduction target level (See Current and Potential Carbon Reduction Measures, Appendix D). Community efforts will require both short term and long term measures in order to achieve the emissions reduction target. Participation from the Lacey community will be critical to achieve success.

Although significant policy measures would be required to meet this goal, the Lacey City Council's Land Use Committee supported this reduction target for planning purposes to curb emissions for Lacey municipal operations and the Lacey community. The target goal can be altered after the effectiveness and support for the community's strategy is verified through future carbon inventory.

GOALS AND POLICIES

GOALS AND POLICIES

Goals and policies outline broad principles to guide decision-making at all levels of government. Policies translate into a framework for action. The goals and policies included in the CR_2—Strategy for Carbon Reduction and Resiliency serve to enhance the health, safety, and quality of life in the Lacey community. The goals in this plan serve to accomplish one of two objectives, 1) to build community resiliency through proactive preparedness measures, and 2) to mitigate the impacts to air quality, climate and the environment through strategic carbon emissions reductions.

Means for implementation of the following goals and policies include integration into transportation and land use planning, development guidelines, municipal services, city budget and council priorities, and capital facilities plan. Policy mechanisms to advance measures include direct service provision, legislation, planning and zoning, financial incentives, education, regulation, and advocacy.

Municipal and community strategies will require funding—from local, state, and federal sources, local and regional partners, general and utility funds, including personnel costs for administration— depending on the level of implementation. Some measures may fall outside the scope of city services. Project and program implementation will depend on city priorities, community partnerships, citizen involvement, and availability of funds and resources.

Each goal in the following section includes supporting policies, current and potential measures, implementation strategy, partnerships, and potential funding mechanisms. An overview of measures is included in the "Matrix of Measures" section.

COMMUNITY RESILIENCY

» COMMUNITY RESILIENCY

Planning plays in important role in building community resiliency. Preparedness involves outlining and implementing plans to reduce Lacey's vulnerability to conditions brought about by potential and emerging changes in climate. This strategy works to identify risks, manage impacts, and use tools and resources to build responsiveness into public services, infrastructure, and assets. Disaster response and recovery planning will protect lives, property, utilities, infrastructure, and safeguard the natural resources of our community.

» **Goal:** Build community resiliency through planning and preparedness.

- Emergency Management
- Stormwater
- Water system
- Stream quality
- Air quality

Policies:

a. Maintain comprehensive emergency preparedness, response, and recovery plans to include actions to protect lives, property, environment, and services from impacts of changing climate and related natural and technological disasters that can be reasonably anticipated.

b. Review stormwater utility design criteria periodically to assure drainage facilities keep pace with trends in hydrology as risks emerge. Provide for adequate maintenance and improvement to existing utility infrastructure to accommodate potentially higher storm flow rates and volumes, to reduce the potential for flooding, erosion and water quality impacts to receiving waters. Implement mitigation strategies such as upstream flow control and flow dispersion at discharges to creeks and other surface waters where applicable.

c. Protect water quality through stormwater programs and development standards to treat runoff and limit impact of site development on streams, surface, and groundwater. Encourage xeriscaping—environmental designs that minimize water use.

d. Protect and enhance stream quality, salmon habitat, and riparian buffers. Monitor stream health — provide and preserve shady and riparian buffers to improve and protect natural habitat of salmon, aquatic life, and wildlife in the community.

e. Adapt water pumping, treatment, and delivery system through demand-side and supply-side strategies to protect water quality and availability for community. Review changing trends in weather patterns, sea level rise, and local climate to protect water supply and water delivery infrastructure.

f. Continue conservation efforts, the use of reclaimed water for non-potable uses, and infrastructure improvements that provide additional storage.

g. Develop and implement responsive mitigation strategies for the rivers and streams that are in hydraulic connection with the groundwater systems pumped by Lacey's wells.

h. Collaborate with state and federal agencies and community partners to monitor air quality and respond to potential public health concerns. Support community partners such as Olympic Region Clean Air Agency (ORCAA), and Thurston County Public Health and Social Services to improve and air quality, monitor greenhouse gas emissions, and adapt services to emerging health concerns.

i. Encourage low impact development (LID), with standards required in sensitive areas to reduce conversion of forest cover to impervious surfaces.

j. Provide information to the community as evidence of change to local climate conditions emerge, to expand preparedness of residents and businesses.

k. Encourage local food production.

MEASURES

Current and potential implementation measures are included for municipal operations and the Lacey community. Measures with a ✓ have been implemented to some level.

MUNICIPAL OPERATIONS:

- ✓ Update flooding maps
- ✓ Monitor and protect water quality
- ✓ Expand reclaimed water utility
- ✓ Emergency preparedness training
- ✓ Monitor air quality
- ✓ Salmon habitat protection
- ✓ Prepare for extreme heat events
- ✓ Urban stormwater programs
- ✓ Low-impact development

COMMUNITY OPTIONS:

- ✓ Water conservation
- ✓ Expand reclaimed water utility
- ✓ Emergency preparedness training
- ✓ Stormwater treatment
- ✓ Low-impact development
- ✓ Urban agriculture programs

STRATEGY IMPLEMENTATION

Awareness and responsiveness are the keys to building a resilient community. The Lacey community has an established safety network that provides structure for planning and responding to natural disasters. The city works closely with Thurston County Emergency Management to coordinate local efforts with those of the state and federal emergency management agencies in disaster response, recovery, and community preparedness. The city also employs planning tools (elements) that work together to build the Lacey's Comprehensive Plan. Water, Wastewater, Stormwater, Shoreline management, and other elements help guide future investment and infrastructure development in the community.

Since changes in climate could alter long-term dynamics of the community's natural resources, trends in weather patterns, precipitation, utility indicators, water and stream quality, stormwater, and other environmental impacts should be monitored. Proactive and responsive measures should be taken to protect emerging concerns for health, safety, infrastructure, and environmental assets. City service delivery

should also adapt to emerging changes in climate and environmental conditions. And Lacey's Comprehensive Plan elements should be updated as necessary.

PARTNERSHIPS

The city has existing network partnerships that provide shared resources and help to coordinate and streamline community preparedness and emergency response activities. State and federal resources provide information, planning, funding, and services as well. Additional opportunities to engage in partnerships for planning, transportation, energy, air quality, water resources, waste, and emergency services may include:

- Local, regional, state and federal stakeholders
- Thurston County Emergency Management
- Federal Emergency Management Act (FEMA)
- Olympic Region Clean Air Agency (ORCAA)
- Thurston County Public Health and Social Services
- Stream Team
- Puget Sound Energy
- Thurston County Solid Waste and Recovery
- Lacey Fire District #3
- LOTT Clean Water Alliance

FUNDING

Community preparedness plans currently exist for the Lacey community. Changes in climate may require alteration of those plans. Infrastructure projects should incorporate emerging concerns into project costs. Measures to protect the community from climate risks can be prioritized through annual budget process. Partnership opportunities should be explored to leverage grant funding from state and federal resources and to continue to coordinate services.

CARBON REDUCTION

CARBON REDUCTION

Carbon reduction goals fall into the following categories: energy, transportation, rooftops & green spaces (land use, green building, and trees), and waste reduction. The overarching carbon reduction goal:

Goal: Reduce greenhouse gas emissions to 15% below 2005, by 2020, for Lacey municipal operations and the community.

- Energy
- Transportation
- Rooftops & Green Spaces
- Waste

Policies:

a. Conduct a greenhouse gas emissions inventory and forecast.

b. Set emissions reduction target and develop a strategy to meet target. Adjust target as necessary to meet mandated emissions reduction statutes or changes in policy strategy.

c. Implement the strategy—develop an action plan to be used as a steering tool for operational and policy decisions to meet reduction targets.

d. Where appropriate, develop performance measures for actions that are efficient to administer, effective to assess, and meaningful to the public. Measure, verify, and report performance. Assess impact of actions on emissions reduction and report progress every three to five years.

e. Identify opportunities to engage and inform citizens, develop partnerships, and secure funding for priority implementation of measures. Convene ongoing community discussions and public input into planning and decision-making processes to create awareness and develop solutions for carbon reduction and climate change mitigation.

f. Provide broad-based, early, and continuing public involvement in all aspects of the planning process. Ensure equal access to participation. Explore innovative participation techniques to increase overall public involvement.

g. Ensure that minority populations and people with low incomes do not incur disproportionately high and adverse human health or environmental effects from programs, policies, and investments.

h. Align policies for greenhouse gas (carbon) emissions reductions and clean air standards with federal, regional, state, and local partner jurisdictions, where appropriate.

i. Participate in regional discussions to address carbon reduction and sustainability and ensure Lacey is represented in regional planning efforts such as the Regional Plan for Sustainable Development through Thurston Regional Planning Council.

ENERGY

Energy Efficiency and Conservation

Green Renewable Energy

ENERGY

Residential, commercial, and industrial energy use contributed to nearly 49% of the Lacey community carbon footprint in 2005. Steps to reduce carbon emissions related to energy production must also ensure that reliable and sufficient energy is available to meet future demand. Future population growth in Lacey will increase demand for energy resources. Energy efficiency and conservation efforts can reduce that demand and maximize energy use. Building support for clean, green renewable energy production to help meet future demand also provides benefits beyond carbon reduction. These efforts can diversify the community's energy resources and reduce vulnerability to cost volatility from the world market and fossil fuel dependence.

Partners will play a significant role in reducing emissions from energy use. Puget Sound Energy's strategy to meet future electric demand uses a combination of measures. Increasing use of natural gas in electricity production is the utility's primary approach. Energy efficiency is secondary, along with expansion of biomass and wind production. The Department of Commerce released the 2012 Washington State Energy Strategy, identifying energy efficiency performance in buildings one of the top three energy priorities for the state. Goals to reduce carbon emissions from energy include energy efficiency and conservation and expanding renewable energy production and use.

ENERGY EFFICIENCY AND CONSERVATION

Energy efficiency is the first step to reducing energy use. Each kilowatt hour (kWh) of energy that can be saved, reduces the need for the equivalent unit from being produced. Reducing heat loss (or cooling during the summer) in a building structure through weatherization is an effective action with measurable bottom-line savings. Ensuring peak efficiency in mechanical systems and lighting performance in buildings, facilities, and services reduces waste, energy use, and carbon emissions.

- **Goal:** Maximize energy efficiency and conservation in heating, cooling, and lighting buildings and services.

- Alternate: Reduce per capita energy use by 15%

Policies:

a. Implement best practices in energy efficiency and conservation for public building and facility operation to maximize energy use. Consider public facility operation policy for energy conservation.

b. Consider interior and exterior public lighting installations with energy efficient fixtures, units, and controls, such as light emitting diode (LED) or compact fluorescent (CFL) bulbs, occupancy sensors, and incorporate energy-efficient lighting into facility and road construction projects where reasonable.

c. Retrofit heating, cooling, ventilation, and heat recovery systems and equipment to maximize energy efficiency. Utilize funding strategies such as investment grade audits, performance contracting, utility incentives and rebates, and cost-recovery programs to finance capital investments.

d. Purchase certified energy efficient equipment and appliances such as ENERGY STAR or equivalent where possible. Examples include computers and monitors, appliances, water system pump motor efficiency, etc.

e. Use water conservation devices such as low-flow faucets, toilets, and irrigation timers. Invest in water conveyance pumps and equipment with high efficiency ratings. Invest in water pumping, treatment and distribution equipment with maximum efficiency to optimize energy consumption for service delivery where possible.

f. Incorporate energy efficiency and conservation features into Lacey's Development Guidelines and city projects, such as LED street lighting, and low maintenance landscaping.

g. Promote energy efficiency through local Green Business Program.

h. Build efficiency measures into city services. Consider reducing street light operation.

i. Consider implementation of energy codes and/or building codes to provide standards for energy efficiency in new construction and remodeling in residential, commercial, and industrial sectors.

j. Consider education for residents and businesses on energy efficiency or launch an "energy efficiency challenge" campaign for community residents.

MEASURES

Current and potential measures for municipal operations and the Lacey community are listed below. Measures with a ✓ have been implemented to some level. See Matrix of Measures for more.

MUNICIPAL OPERATIONS:

- ✓ Resource Conservation Manager (RCM)
- ✓ Conservation Team (city staff)
- ✓ Energy audits
- ✓ Weatherization
- ✓ Utility Management software
- ✓ LED/efficient lighting retrofits, interior
- ✓ LED/efficient lighting retrofits, exterior
- ✓ LED traffic signals
- ✓ LED/Efficient street lights
- ✓ HVAC retrofits
- ✓ ENERGY STAR certified equipment
- ✓ Incorporate energy efficiency into Development Guidelines
- ✓ Occupancy Sensors/Controls
- ☐ Computer shut-down software

COMMUNITY OPTIONS:

- ✓ Energy audits
- ✓ Subsidize energy audits
- ☐ "Smart" utility meters
- ✓ LED/efficient lighting
- ✓ Water conservation programs
- ✓ Water conservation ordinance
- ✓ Energy code
- ✓ Rebates for retrofits
- ✓ Energy audits
- ✓ Weatherization programs
- ☐ Energy efficiency education
- ☐ Energy efficiency challenge
- ✓ Lighting retrofits
- ✓ Green business program
- ☐ Promote passive homes

- ✓ Water conservation equipment
- ☐ Building retro-commissioning
- ☐ Cool paving
- ✓ Low maintenance landscaping
- ☐ Green roofs or reflective roofs
- ✓ Water conservation program
- ☐ Standards for public buildings
- ✓ Efficient motors in water service equipment
- ☐ Decrease daily streetlight operation
- ☐ Weatherize public buildings
- ✓ Retrofit lighting with CFL/LED

- ☐ Energy performance rating system
- ☐ Building performance disclosure
- ☐ Meter-based financing
- ☐ Tax credits for efficiency upgrades
- ☐ District heating and cooling
- ☐ Peak demand energy pricing
- ☐ Promote ENERGY STAR appliances

IMPLEMENTATION STRATEGY

The City of Lacey is currently engaged in a number of energy efficiency measures that serve to reduce carbon emissions within municipal operations and the Lacey community. Additional capacity exists in a number of these measures to gain greater efficiencies and energy savings.

The city participates in PSE's Resource Conservation Manager Program to achieve utility savings through operational improvements, facility maintenance, cost accounting, and behavioral changes. PSE provided training, utility management software, grants, and support. City municipal operations achieved $23,000 in savings during the first year of the program through preliminary auditing and operational refinements. City buildings were audited and ranked for energy performance. Equipment, lighting retrofit and weatherization projects were identified.

Streetlights and Traffic Signals contributed to 16% of the city's municipal operations carbon emissions. Our city was one of the first jurisdictions to install light-emitting diode (LED) traffic signals (2002), saving energy and maintenance costs. Currently, all city-owned traffic signals have LED signal heads.

Lacey has the first LED streetlights in the county installed on Mullen Road Extension (West) in 2010. These fixtures can save long-term maintenance and energy costs, but the technology comes at a premium. Energy efficient lighting technology has only recently become available to meet the stringent lighting standards for multi-lane roadways. Retrofitting streetlights is costly. Energy savings does equate to operational cost savings, but the payback can be 20 to 30 years for a project. Standards were added to Lacey's Development Guidelines in 2011, which require LED streetlights for new construction projects.

Providing clean, potable water to customers requires a great deal of energy. Over 38% of municipal emissions (2,640 tons of CO_2e) in 2005, were from energy consumed to produce and distribute water to Lacey utility customers. Lacey employs a number of strategies to conserve water, including a water ordinance, tiered water rates, odd-even watering, indoor-outdoor water-saving kits, education programs and incentives.

Achieving efficiency in the residential and commercial sector can be difficult. Lacey contributed federal stimulus dollars through a sub-grant to the Thurston Energy program to provide enhanced services to Lacey residents and businesses. Education and outreach, subsidized energy audits, rebates for efficiency

and weatherization implementations, and community mobilization were provided. The federal grant funding expires in July 2012. Thurston Energy was developed through a partnership between the Thurston Economic Development Council and the Thurston Climate Action Team. The program facilitates energy audits for homeowners and businesses, energy efficiency education and advocacy, financing strategies for efficiency retrofits, and renewable energy resources. Puget Sound Energy also provides energy audit services for homeowners.

The city has sponsored the Thurston County Chamber's Green Business program, along with a number of community partners, since 2008. The business recognition program serves to promote a number of green business practices, including energy efficiency, renewable energy, low-carbon transportation, employee commute programs, green building, and waste reduction.

Recommendations:

- A performance contract is underway to retrofit Lacey City Hall. Other public facilities may benefit from HVAC retrofits and system commissioning to maximize efficiencies.
- Facility plans can be implemented to maximize energy efficiency in all public buildings and facilities.
- The city should explore options to adjust the number and hours of streetlight operation to reduce energy consumption.
- Consider pump and equipment efficiencies for water systems. Rather than retrofitting pumps, overhauls could be more cost-effective.
- Continue to support energy efficiency programs in Lacey through partnerships with Puget Sound Energy.
- Thurston Energy provides energy efficiency services to residents and businesses. Partnership opportunities should be explored to continue education and outreach to homes and businesses in Lacey. The program helps to create jobs and foster economic development through clean energy.
- Advocate for enabling legislation for residential and business financing programs for energy efficiency retrofits or renewable energy applications such as Property Assessed Clean Energy (PACE) programs, where investments can be paid through property tax assessments. Or meter-based financing programs which repay energy efficiency retrofits through utility payments.

PARTNERSHIPS

Energy efficiency partnership opportunities can enhance efforts to reduce overall energy consumption and thereby reduce emissions. Puget Sound Energy offers energy efficiency services to residents, businesses and municipalities. In 2010 and 2011, the utility offered rebates for energy efficient insulation, space and water heating equipment, new windows and appliances. Businesses received grants and rebates for new efficient lighting and controls, HVAC upgrades, and refrigeration equipment. The city partnered with PSE to provided outreach opportunities for some of these efforts.

Thurston Energy program received state funding for ongoing activities in the community. The program provides education, energy audits, PSE rebates, incentives, and helped to establish financing programs for energy efficiency measures for residents and businesses.

Consider external stakeholders to expand energy efficiency and conservation efforts:

- Puget Sound Energy (PSE)

- Washington State University Energy Program
- U.S. Environmental Protection Agency (EPA)
- U.S. Department of Energy (DOE)
- Washington State Department of Commerce
- Washington State Department of Ecology
- Washington State Department of Enterprise Services
- Cities of Olympia, Tumwater, Yelm and Thurston County
- Thurston Energy Program
- Local Chambers, Thurston Green Business
- Private Foundations
- Local Service Clubs and Faith Communities
- Neighborhood Associations
- Community members

FUNDING

Often, energy efficiency measures require premium up-front capital, but pay for themselves over time through energy savings. Many have a short pay-back period of a few months to a few years. Some efficiency measures will require more time. Financing up-front costs of energy efficiency is often the factor that will determine which features will be included in a project. For municipal projects, the city should explore options beyond the general fund:

- Consider incorporating HVAC equipment, lighting, landscaping, exit signs, with premium efficiencies into all new facilities. Project budgets should be developed to include practical applications of energy efficiency measures and consider maintenance and operational savings to determine cost-effectiveness.
- Utility rebates, grants, and incentives should be captured for all available weatherization, equipment, and lighting retrofits.
- Monitor federal and state grant availability to leverage public dollars for funding energy efficiency activities.
- Create an energy fund to provide initial capital for new projects with revenues from a percentage of projected annual energy savings from each installed project.
- Advocate for enabling legislation for residential and business financing programs for energy efficiency retrofits or renewable energy applications such as Property Assessed Clean Energy (PACE) programs, where investments can be paid through property tax assessments. On-bill or meter-based financing programs repay energy efficiency retrofits through utility payments.
- Explore partnerships opportunities to combine funding resources, leverage dollars for region.
- Consider performance contracting for public projects— financing energy efficiency retrofits from energy savings.
- Maximize investments through education, promotional campaigns, incentives, tax credits, and rebates.
- Utility-specific projects can be funded through utility enterprise funds.
- Conduct full cost benefit analysis for all public projects—include sustainability of funding, construction, maintenance and operation cost, net energy or resource saving, simultaneous goal achieved, etc.

GREEN RENEWABLE ENERGY

Electricity that is generated from renewable energy sources is referred to as "green" power. Unlike fossil fuel-based power, these sources of energy emit no or low carbon emissions. Purchasing green power, or electricity generated from renewable resources such as solar, wind, geothermal, low-impact biomass, and hydro resources, provides our community with an easy and effective way to reduce its carbon footprint. Using green power also helps to accelerate the development of new, domestic renewable energy sources, while playing an important role in the security of our region's energy supply.

Lacey has been a leader in supporting renewable energy development by purchasing 100% of municipal operations electric energy through Puget Sound Energy's (PSE) green power program since 2007. The city was designated a Green Power Community by the US Environmental Protection Agency in 2008. Purchasing green power demonstrates civic leadership and can spur local residents and businesses to follow suit. More than 6% of Lacey's electricity comes from green power.

Local renewable energy projects can have benefits beyond carbon reduction. On-site renewable energy installations, such as photovoltaic (PV) solar panels, solar water heaters, and other renewable technologies help to diversify energy resources and protect against the volatility of fossil fuel prices in the world market, and reduce dependence on fossil fuels.

The 2012 Washington State Energy Strategy identified distributed energy, in the form of district energy and combined heat and power, as primary opportunities to develop alternative and renewable energy. District heating applications provides shared energy to a business district or neighborhood. Combined heat and power applications provide efficient use of process by-products such as thermal energy captured to heat a facility, from the combustion for creating electricity. Economic development opportunities exist for the community and the state with local renewable energy projects and clean tech jobs.

» **Goal:** Support development of local, clean, renewable energy resources in the city and region.
- Solar
- Wind
- Biogas
- Biomass
- District or Distributed Energy
- Combined Heat and Power (Cogeneration)

» Alternate: 10% of Lacey energy derived from local, low-carbon, renewable resources.

Policies:

a. Purchase green (renewable) energy through investments in utility green power program, renewable energy credits (REC), or direct purchase of renewable energy such as solar, wind, biogas, biomass, or other energy technology.

b. Incorporate renewable energy technology applications in public buildings, facilities, and services, such as solar hot water heaters, and natural gas appliances, geothermal heat pumps, etc. where feasible.

c. Consider photovoltaic (PV) solar panel investment project(s) on city facilities or public land – community solar or public-owned installation.

d. Identify and remove barriers to permitting for renewable energy installations in residential, commercial, and industrial scale applications.

e. Encourage residential and commercial investment in green power or renewable energy sources. Consider programs to promote local renewable energy projects through education, tax incentives, utility-based financing, etc.

f. Where appropriate in public projects, consider installation of co-generation power production (capture generated steam and industrial by-products to produce energy), supporting development of a local improvement district (LID) for district heating and cooling applications, capture of methane on wastewater treatment, biomass, etc.

MEASURES

Current and potential measures for municipal operations and the Lacey community are listed below. Measures with a ✓ have been implemented to some level. See Matrix of Measures for more.

Municipal Operations:

- ✓ 100% Green power for operations
- ☐ Photovoltaic (PV) on public site(s)
- ☐ Solar hot water in buildings
- ☐ Geothermal heat pump
- ☐ Combined heat/power system
- ☐ Community solar project(s)
- ☐ Solar demonstration project

COMMUNITY OPTIONS:

- ✓ Community green power challenge
- ☐ Promote renewable energy
- ☐ Local tax incentives
- ☐ Solar or renewable challenge
- ☐ Expand financing options
- ☐ Promote natural gas
- ☐ One block off the grid campaign
- ☐ Co-generation power production
- ☐ LID for district heating

IMPLEMENTATION STRATEGY

Washington State requires utilities to build incremental energy portfolios with a minimum of 15% renewable energy sources by 2020. Puget Sound Energy's (PSE) green power program offers customers the option to match their electricity with renewable energy resources generated in the region. Since 2007, the City of Lacey has invested in PSE's green power program for 100% of electricity for municipal operations. And nearly 6% of Lacey's total community energy is green power, earning an annual "Green Power Community" designation from the US Environmental Protection Agency since 2008. The city sponsored two community green power challenges and one neighborhood challenge, earning a $10,000 solar demonstration grant from PSE in 2011.

Although investment in PSE's green power program helped to reduce municipal operations carbon emissions to a level well below the proposed goal of 15% in 2009, the city should continue to explore for public-owned renewable energy sources or local direct purchased power agreements. Local renewable projects help to model civic responsibility, support environmental stewardship, reduce demand on the electric grid, and generate clean tech jobs.

Community solar project(s) on public rooftops or ground installations are private, investor-owned systems with many economic benefits. Community solar projects can engage private energy investment and expand the use of Washington-produced solar products, in addition to reducing carbon emissions. Energy efficiency should be maximized in facilities to benefit from renewable energy. Incentives for community solar projects in Washington State will sunset on July 1, 2020.

Recommendations:

- The city should explore options to transfer the investment in green power offsets to city-owned renewable project(s) with long-term benefits.
- The city should consider community solar project(s). 1) Perform public facility solar feasibility assessment and rank potential sites. 2) Consider building life span, roof replacement schedule, structural integrity, solar access, security, and abatement issues. 3) Explore external funding options through RFP/bid proposals.
- New community buildings should consider incorporating renewable energy technologies into designs such as geothermal heat pumps, solar hot water, etc.
- Advocate for enabling legislation for residential and business financing programs for renewable energy applications such as Property Assessed Clean Energy (PACE) programs, where investments can be paid through property tax assessments, or meter-based (on-bill) financing programs to repay renewable energy projects through utility payments.

PARTNERSHIPS

External partners for green renewable energy projects could include:

- Puget Sound Energy (PSE)
- U.S. Environmental Protection Agency (EPA)
- U.S. Department of Energy (DOE), National Renewable Energy Laboratory, Energy Efficiency and Renewable Energy, Solar America Communities
- Washington State Department of Commerce
- Washington State University Energy Program
- Neighboring cities of Olympia, Tumwater, Yelm and Thurston County
- Joint Base Lewis McChord
- Thurston Energy Program
- Local Chambers
- Private Investors
- Local Service Clubs and Faith Communities
- Neighborhood Associations
- ICLEI—Local Governments for Sustainability
- Community members
- Local colleges and universities

FUNDING

Green renewable project implementation depends heavily on city priorities, business partnerships, citizen involvement, and availability of funds and resources.

- Monitor grants opportunities to leverage federal and state dollars for funding renewable projects.
- Maximize use of grants, rebates, and incentives from PSE in all public projects.
- Consider private-public partnerships such as community solar project(s). Third-party financing (Power Purchase Agreements) of solar or renewable projects (tax credits and incentives available to owner).
- Create a municipal energy fund to provide initial capital for new projects, funded by annual energy savings from each installed project. Consider selling Renewable Energy Credits (RECs) from renewable projects to other jurisdictions and/or charge department for energy benefits.
- Fund renewable utility projects through utility service fees.
- Explore partnerships opportunities to combine funding resources, leverage dollars for region.
- Maximize investments through education, promotional campaigns, incentives, tax credits, and rebates.
- Conduct cost benefit analysis for projects —consider sustainability of funding, implementation and maintenance cost, net energy or resource saving, simultaneous goal achieved, etc.
- Consider CREBs– Clean Renewable Energy Bonds for interest free financing of solar or renewable energy projects. Repaid through utility rebates or charging customers for electricity at utility rates.
- Use resources such as Department of Energy or WSU Energy Extension program for technical assistance to reduce project cost.
- Capture production tax credits, renewable energy production incentive, accelerated depreciation for renewable projects.
- Explore partnerships with educational institutions to reduce cost and expand training opportunities.
- Support development of Utility Local Improvement District (ULID) to fund local district heating projects.

TRANSPORTATION

TRANSPORTATION

Automobiles are the leading contributor to carbon emissions. Each gallon of gasoline emits 20 lbs of carbon dioxide, the primary greenhouse gas pollutant. Transportation contributes more than 50% of Lacey's greenhouse gas emissions. Nationally, transportation is one of the largest sources of emissions.

Expanding fuel efficiency and using clean, low-carbon, alternative fuels and providing transportation options are common actions by local governments to reduce emissions in the short run. Changing the way people and goods move around the community can make a significant long-term impact on emissions. Expanding transportation options such as walking, bicycling, and public transit—reducing vehicle miles traveled (VMT) in the community—are keys to low-carbon transportation system design.

Transportation and land use planning go hand-in-hand. Communities designed with mixed-use and transit oriented development advocate for services to be constructed in close proximity to homes—bringing people closer to where they live, work, and play—to reduce the need for travel. These efforts will require a long-term coordinated approach to be effective in reducing carbon emissions.

Goal: Reduce carbon emissions and vehicle miles traveled in the transportation sector.

- System designs for low-carbon transportation system
- Designs consistent with land use plans to reduce the overall need to travel.
- Expand transportation choices for walking, biking, public transit, and low-carbon options.
- Enhance multimodal system
- Reduce single occupancy vehicle commute trips
- Support clean, alternative fuels
- Optimize fuel efficiency

Alternate: Reduce vehicle miles traveled (VMT) in community by 10%
Reduce transportation sector emissions by 15% below 2005, by 2020.

Policies:

a. Develop transportation system consistent with land use plans, development patterns, and design standards that encourage non-motorized travel, encourage use of mass transit, and reduce vehicle miles traveled (VMT). Locate facilities to support mixed-use development policies: location of jobs, housing, industry, and other activities as called for in adopted land use plans to increase energy efficiency, reduce environmental impacts, and minimizing greenhouse gas emissions.

b. Coordinate with other jurisdictions on new regional connections for cross-town or cross-region travel that provide more direct routes and reduce VMT, where those connections do not promote sprawl or undermine adopted land use plans.

c. Work toward an integrated multimodal transportation system that supports adopted land use plans, increases travel options—walking, biking, mass-transit, rideshare, etc.—and reduces overall need to drive alone.

d. Provide for quality transportation choices appropriate to existing and future land uses, including walking, biking, public transportation, and motor vehicles. Ensure development of transit transfer centers, activity centers, employment centers, and schools that accommodates multiple modes of travel and safe, efficient connections among those modes of travel.

e. Improve access to public transportation, ridesharing, bicycling, and walking.

f. Increase options for walking. Encourage designs that provide direct, safe, and interconnected pedestrian network, consistent with land uses, sidewalks and street crossings near schools, and encourage pedestrian-friendly building design in areas where foot travel is likely, such as city centers and activity centers. In addition, provide street lighting, trees, benches, and other elements that make walking safe, desirable, and pleasant.

g. Increase options for bicycling. Develop a continuous, safe, and convenient bicycle network that functions as an integral part of the overall transportation system.

h. Support investments in a regional network of contiguous and connected north-south and east-west dedicated corridors to serve as the backbone of the non-motorized system.

i. Encourage the provision of bicycle parking facilities, transit centers park-and-ride locations, and other multimodal facilities, near schools, employment sites, and major activity centers.

j. Continue efforts of Lacey's Commute Trip Reduction Plan, LMC 10.46. Encourage use of commute trip reduction programs for Lacey municipal employees to reduce single occupancy vehicle (SOV) commuting.

k. Promote private sector transportation demand management programs and services that encourage employees to commute to work by means other than driving alone, or to change commuting patterns through teleworking, flex-time, or compressed work weeks.

l. Encourage the use of technologies that enable people to participate in activities or meet their needs without having to travel.

m. Consider incentives for use of alternative forms, (non-single occupancy vehicle) for commuting.

n. Collaborate with Intercity Transit to develop and maintain public transportation routes in Lacey. Encourage Intercity Transit to provide effective public transportation options, including development of partnerships for long-distance commute trips destinations outside Thurston County, vanpool program, and park-and-ride lots through the region.

o. Encourage public transportation use within the city, including commuter programs, vanpool program, and support Intercity Transit in increasing awareness of public transportation and how to use it through expanded education and public information tailored for various age groups and interests.

p. Encourage regional projects which examine a broad range of public transportation programs and services, including but not limited to local street trolleys, bus rapid transit, flex car programs, commuter rail, and high speed passenger rail to ensure a full mix of options to meet evolving transportation needs.

q. Support national and state efforts to promote clean, alternative fuels and technologies that reduce air pollution and greenhouse gas emissions from motorized vehicles, and reduce dependence on fossil fuels.

r. Encourage development of electric vehicle infrastructure through installation of electric vehicle charging stations in public locations.

s. Where reasonable and affordable, invest in fleet vehicles and equipment with high fuel efficiency, smallest possible size, alternative and renewable fuel options, or hybrids.

t. Consider fuel conservation programs such as anti-idling policy for city vehicles, engine maintenance program, and fleet tire pressure program.

u. Consider anti-idling ordinance.

v. Promote infrastructure investments through incentives to provide infrastructure for emerging or "alternative" clean fuels.

w. Support Washington State goals to decrease annual per capita vehicle miles traveled (VMT) in the region to 1990 levels by 2020, to 30% below 1990 levels by 2035, and to 50% below 1990 levels by 2050.

MEASURES

Current and potential measures for municipal operations and the Lacey community are listed below. Measures with a ✓ have been implemented to some level. See Matrix of Measures for more.

MUNICIPAL OPERATIONS:

- ✓ Employee Commute Trip Reduction (CTR)
- ✓ Electric vehicle charging stations
- ✓ Hybrid fleet vehicles
- ✓ Electric fleet vehicles
- ✓ Economy fleet
- ✓ Bicycles for employees
- ☐ Bicycle patrols
- ☐ Alternative fuels for fleet (B20, B50, B99)
- ☐ Tire pressure program
- ✓ Lacey Alternative Energy Fair
- ☐ Public-owned alternative fuel stations

COMMUNITY OPTIONS:

- ✓ Traffic signal synchronization
- ✓ Bicycle and Pedestrian infrastructure
- ✓ Traffic calming measures
- ✓ Institute Safe Routes to School
- ☐ Provide commuting incentives
- ☐ Anti-idling ordinance
- ☐ Restrict idling at public facilities
- ☐ Enhance trail system
- ☐ Alternative fueling stations
- ☐ Expand fiber-optic network
- ✓ Transportation Master Plan
- ☐ Car sharing program
- ☐ Pay-as-you-drive car insurance

IMPLEMENTATION STRATEGY

Employee Commute Trips
Lacey adopted a Commute Trip Reduction Plan (Ordinance 1328), prepared by the Thurston Regional Planning Council in 2009. The city participates in state-sponsored and funding CTR program for large employers in the region. Additional capacity exists in this program for reducing single occupancy commute trips for city employees and other business commuters in the community.

City Fleet
All new municipal fleet vehicles capable of alternative fuel use. Lacey has three hybrid vehicles and five fully electric TORO Workman vehicles for use in Lacey parks. All new city fleet vehicles are flex-fuel capable.

Alternative Fuels
Electric vehicle charging stations are provided at Lacey City Hall and the Lacey Library. The city adopted an ordinance to allow for charging stations in residential, public lots, and freeway locations.

Education
Lacey's award-winning Alternative Energy Fair, MPG Challenge, and electric car Grand Prix race promote alternative fuels and renewable energy.

Transportation System
Lacey's 2030 Transportation Plan element of the Comprehensive Plan employs goals and policies that are consistent with the low-carbon transportation system designs and implementation, included in this section. The 2030 Transportation Plan is developed in partnership with Thurston Regional Planning Council and is consistent with state, regional and local transportation plans. It guides transportation system improvements to meet existing and future needs in Lacey and its Urban Growth Area (UGA). Lacey Woodland Trail enhancements support multi-modal transportation options and assist in addressing the major contributor to carbon emissions—fossil fuels use in transportation.

Recommendations:

- Expand participation in Commute Trip Reduction program for city employees and in community.
- Consider expansion of fiber-optic network to facilitate telecommute options.
- Develop city fleet vehicle purchasing policy or practices to include smallest practical size, maximum fuel efficiency, and hybrid or alternative fuel when practical.
- Consider tire pressure program to maximize fleet fuel efficiency.
- Continue to seek opportunities to expand electric vehicle and/or alternative vehicle infrastructure.
- Support development of public alternative fuel station(s).
- Transportation projects and system designs should continue to incorporate elements of low carbon designs that support reduction of vehicle miles traveled and in the community.
- Continue to enhance trail system, and network of sidewalks and bike lanes in the city.
- Continue Safe Routes to Schools program.
- Continue traffic signal synchronization, incorporate smart corridor technology, and traffic management to maximize fuel efficiencies.

PARTNERSHIPS

The city works closely with Thurston Regional Planning Council and its state, regional, and local partners to coordinate transportation system design and construction.

- State and federal agencies, US EPA, US DOT, FHWA, etc.
- Washington State Department of Transportation
- Washington State Commute Trip Reduction Board
- Intercity Transit
- Local and regional
- Thurston Regional Planning Council
- Employers – commute trip reduction programs
- Schools
- Olympic Region Clean Air Agency (ORCAA)
- Puget Sound Clean Air Agency
- Clean Cities Coalition
- Climate advocacy groups

FUNDING

It is difficult to quantify investments in low-carbon transportation initiatives because measures can be broad and comprehensive. Policies can span a number of platforms into the purview of several planning elements. For instance, trail system improvements could be included in Capital Facilities, Transportation Plan, Land Use Plans, Commute Trip Reduction, and Parks & Open Space plans. Transportation system design is a basic city service, supported through general fund dollars. Transportation projects require extensive capital investments.

Funding for low-carbon transportation measures should seek to:

- Maximize investments through education, promotional campaigns, incentives, tax credits, and rebates.
- Coordinate efforts with regional partners to combine funding resources, leverage dollars for region.
- Explore opportunities for low-carbon projects through Local Improvement Districts, Urban Corridor and Sidewalk Programs, Safe Routes to Schools, etc.
- Capitalize on federal and state sustainability grant sources.

ROOFTOPS & TREES

Land Use

Green Building

Trees & Open Spaces

ROOFTOPS & TREES—Land Use, Green Building, Trees & Green Spaces

Community designs where residents live far away from places of work, school, and services, foster increasing dependence on motor vehicles. Urban "sprawl" translates into higher emissions and pollution for the community. Land use management and community design provide an important long-range opportunity to reduce emissions by increasing density and reducing sprawl. The placement of residential and business "rooftops" is important in low-carbon, mixed-use community designs. Green building practices—how those roofs are constructed—can achieve energy efficiency and reduce other negative impacts to the environment.

Trees and vegetation store carbon (carbon sinks) and provide "cooling" benefits. Although precise carbon benefits are difficult to quantify, street trees, parks, and green spaces provide beauty, recreation opportunities, food, environmental, and quality of life benefits—all important features in community design.

LAND USE

Goal: Incorporate compact, mixed-use community designs to bringing people closer to where they live, play, shop, and do business.

Policies:

a. Implement concepts consistent with Washington State Growth Management Act (GMA) that promote healthy, compact, mixed-use urban community designs. Provide a full range of options to encourage high-density, mixed-use development and infill that supports the development of quality neighborhoods and GMA strategies.

b. Promote high-density and support urban in-fill development through zoning within the city and designated urban growth area (UGA) where urban facilities and services exist or can be reasonably made available.

c. Look for opportunities to encourage development in Lacey's core areas that will promote livable/healthy city concepts—place making, walkability, affordable housing, a range of transportation options (multimodal), and opportunities for social interaction. Consider incentives and bonuses for development in existing high density areas and near public transit.

MEASURES

Current and potential measures for municipal operations and the Lacey community are listed below. Measures with a ✓ have been implemented to some level. See Matrix of Measures for more.

MUNICIPAL OPERATIONS:

- ✓ Maximize public facility use
- ☐ Co-locate facilities and services
- ✓ Protect existing wetlands
- ✓ Prepare a land use master plan

COMMUNITY OPTIONS:

- ✓ Encourage mixed-use development
- ☐ Develop new neighborhoods around transit hubs
- ☐ Development incentives for transit-oriented development
- ☐ Development incentives for downtown
- ✓ Promote high-density and infill development through zoning policies
- ☐ Discourage sprawl through impact fees
- ✓ Prepare a land use master plan

IMPLEMENTATION STRATEGY

Lacey has incorporated mixed use and transit-oriented planning principles into the community's urban design strategy—bringing people closer to where they live, work, shop and play. These principles help reduce the need for motor vehicle travel within the community by my making other forms, such as walking, biking, and public transportation, feasible and accessible.

Recommendations:

- Seek partnerships with residents and businesses to devise strategies to meet the intent of low-carbon, mixed-use community design and the State Growth Management Act where possible.
- Ensure land use and transportation plans are consistent.
- Involve residents and businesses in the process of policy development and zoning.

PARTNERSHIPS

Explore collaborative opportunities to share resources:

- Thurston Regional Planning Council and other regional planning agencies.
- Cities of Olympia, Tumwater, Yelm and Thurston County
- Lacey residents
- Neighborhood Associations
- Businesses (commercial development)

FUNDING

Land Use planning is a basic service provided by the city with activities supported by the city's general fund. It is the role of the city to guide land use and transportation systems through zoning policy to protect public interest, safety, and quality of life.

GREEN BUILDING

Most of the energy used in the commercial and residential sectors has to do with heating, cooling, and powering buildings. When developing carbon reduction strategy, it is important to consider not only the existing buildings, but future building construction as well. With the right planning, the negative energy impacts of the construction process itself can be greatly reduced, and building an energy-sound building from the start is the easiest way to reduce long-term operating costs and the environmental footprint for the owners and occupants.

Many communities have adopted policies to ensure that new municipal buildings meet green building standards. One of the most commonly cited, Leadership in Energy and Environmental Design (LEED) program of the U.S. Green Building Council and the U.S. EPA/Department of Energy's ENERGY STAR program.

Green building incorporates design and construction practices that significantly reduce or eliminate the negative impact of buildings on people and the environment through sustainable site planning, water efficiency, energy efficiency, conservation of materials and resources, and indoor environmental quality. Green building programs for new and existing buildings provide a framework for energy efficiency and green building techniques that save operational costs and avert carbon emissions.

» **Goal:** Encourage green building practices to reduce carbon emissions.

Policies:

a. Consider policy for Leadership in Energy and Environmental Design (LEED) certification for new construction and remodel of public buildings.

b. Encourage building practices that incorporate energy conservation measures, including cool roofs, green roofs, use of cool paving for pathways, parking and other roadway surfaces, passive homes, etc. Use "cool" materials or energy-saving designs where possible such as of such as green roof or reflective roof materials.

c. Incorporate energy efficiency and conservation features into Lacey's Development Guidelines and city projects, such as efficient street lighting, low maintenance landscaping, use of recycled materials, cool paving for pathways, parking and other roadway surfaces. Encourage construction material selection with maximum cost-effectiveness and consideration for heat gains, recycled content, and local sourcing.

d. Consider salvaging materials for places like Habitat for Humanity ReStore and recycling materials during remodeling and demolition to preserve resources and prevent carbon emitted from transportation and landfilling processes. (They also earn points toward LEED certification when you demo a structure to build a new one.)

MEASURES

Current and potential measures for municipal operations and the Lacey community are listed below. Measures with a ✓ have been implemented to some level. See Matrix of Measures for more.

MUNICIPAL OPERATIONS:

- ✓ Built Green Codes
- ☐ LEED certification training for city staff
- ☐ Require all new public projects to be LEED or ENERGYSTAR certified
- ☐ Require all public remodel projects to be LEED or ENERGYSTAR certified
- ☐ All new projects have LEED Accredited professional on design team
- ☐ ENERGYSTAR Portfolio Manager
- ☐ Provide technical assistance to developers on green building
- ☐ Green roofs on public buildings
- ☐ Salvage building materials from remodels and demolition

COMMUNITY OPTIONS:

- ✓ Education programs for green building
- ☐ Adopt building codes that exceed current guidelines
- ☐ Reward system for green buildings
- ☐ Adopt or encourage LEED building standards for commercial and/or residential projects
- ☐ Loan rates or financial incentives
- ☐ Encourage use of sustainable building materials
- ☐ Expand opportunities for green remodeling
- ☐ Promote ENERGYSTAR commercial buildings
- ☐ Green roofs

IMPLEMENTATION STRATEGY

New construction provides a unique opportunity to get it right the first time- preventing the cost, inconvenience, and effort required to retrofit buildings to improve the environment. While “affordable housing” is often built at the lowest possible upfront cost, poorly constructed and inefficient homes are not affordable. Energy costs and building repairs are substantial factors in housing affordability, and are contributors to mortgage defaults and evictions.

Green building practices can add an up-front cost to construction. Some measures may directly decrease building operation during occupancy, but some may be less tangible—like the health and environmental benefits of green building. Consideration should be given to the financial impacts of policy for “strict” green building standards.

Lacey’s current building codes meet minimum Built Green standards. Built Green programs encourage environmentally responsible building and construction by certifying homes that meet specific criteria. The program is administered by Olympia Master Builders. Various levels of certification are possible, using a checklist system. Higher levels require inspections by a certified third-party verifier.

The Leadership in Energy and Environmental Design (LEED) program provides a point system for meeting certain metrics in construction and design. Some green building programs, like LEED, provide standards that can be used as a framework for implementing efficiencies and green building features into new and existing construction.

Recommendations:

- Consider promotion or adoption of enhanced green building standards such as U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) certification, U.S. EPA's ENERGYSTAR Portfolio Manager, expanded Built Green program, or related standards for public and/or commercial buildings. Work with stakeholders for guidance and public support for policy and code changes, if any.

- Policies to encourage green roofs and other low impact development (LID) measures have been incorporated into the 2013-2018 National Pollutant Discharge Elimination System (NPDES) Phase II Municipal Stormwater Permit document.

- Consider salvaging materials for places like Habitat for Humanity ReStore and recycling materials during remodels/demolition to preserve resources and prevent carbon emitted from transportation and landfilling processes. Green demolition practices earn points toward LEED certification for new construction projects.

PARTNERSHIPS

- U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED)
- U.S. Environmental Protection Agency's (EPA) ENERGYSTAR Portfolio Manager
- Olympia Master Builders
- Northwest Eco Building Guild
- Community weatherization programs such as the Community Action Council
- U.S. Department of Housing and Urban Development, Rural Housing and Economic Development
- Habitat for Humanity Restore
- Thurston County Solid Waste
- Building trades and architects

FUNDING

New public construction projects can have a large range of funding sources.

- Utility, weatherization programs, and other energy-focused funding sources should be accessed during the early stages of planning public buildings.
- Private financing is the major funder for commercial building. Rolling green building measures into traditional projects during early construction could provide justification when looking for capital.
- In addition, funding may be available from private foundation sources for incremental costs of green building.
- Explore economic development partnerships and grant opportunities to expand affordable housing constructed with green building standards.

TREES AND GREEN SPACES

Lacey's strong urban forestry program, parkland acquisition, and open space practices provide many quality of life benefits to the community. Trees and vegetation serve to absorb carbon dioxide, clean the air, store (sequester) carbon, provide shade for buildings, recreation opportunities, and enhance the appearance of our community.

» **Goal:** Maintain healthy urban forest and green spaces to enhance carbon sinks, air quality, shading, economic vitality, and quality of life in the community.

Policies:

a. Enhance urban forest canopy through continued practices of tree preservation, tree densities, native and adaptable vegetation for landscapes, and tree tract requirements in developments. Implement and adapt practices to maximize urban forest and open spaces in the city.

b. Promote tree planting and species selection through education, development guidelines, and incentives such as seedling give-away programs.

c. Preserve open spaces within the city and urban growth area.

MEASURES

Current and potential measures for municipal operations and the Lacey community are listed below. Measures with a ✓ have been implemented to some level. See Matrix of Measures for more.

MUNICIPAL OPERATIONS:

- ✓ Urban Forestry Plan
- ✓ Tree City USA designation
- ✓ Maintain native landscape
- ✓ Develop parks
- ✓ Expand open space inventory

COMMUNITY OPTIONS:

- ✓ Tree protection ordinance
- ✓ Expand tree tracts
- ✓ Street trees
- ✓ Encourage native trees and landscapes
- ✓ Require tree permits
- ✓ Expand community gardens
- ✓ Distribute tree seedlings

IMPLEMENTATION STRATEGY

Lacey has established, forward-thinking urban forestry policy and tradition. Lacey's Urban Forest Management Plan recognizes the many environmental, economic and quality of life benefits that trees bring to the community. A diverse, healthy urban forest is enhanced through the city's Tree and Vegetation Protection and Preservation Ordinance (LMC 14.32). Tree evaluations, tree tract requirements for new development, replanting standards, and tree removal permits protect Lacey's urban forest resources.

Lacey received its twentieth consecutive Tree City USA designation in 2011, from the National Arbor Day Foundation for ongoing efforts to preserve and promote our community's quality urban forest practices. Since initially receiving the title in the early 1990s, the community has invested more than $3 million on tree planting and care, and distributed more than 23,000 free seedlings to residents, and provides care for more than 4,000 street trees.

Lacey's parks and open space inventory has grown to 29 locations encompassing more than 1,000 acres. The most recent park addition—407 pristine acres in the Northeast Area featuring two miles of frontage on Woodland, Fox and Eagle Creeks—was added in 2011. Lacey now boasts the largest city park, as well as the most extensive municipal park system in the county.

Recommendations:

- Continue programs to build a strong urban forest and open space program in the city.
- Encourage diverse, native, and draught-resistant tree and landscaping species in parks, public spaces, and right-of-ways.

PARTNERSHIPS

- Arbor Day Foundation
- Stream Team
- Local service groups

FUNDING

Look for funding opportunities for new programs through partnerships with other public, private, and nonprofit groups.

- Seek grant funding for education programs and services and leverage funds with partnerships.

WASTE REDUCTION

WASTE REDUCTION

Materials management strategies reduce carbon emissions associated with waste, materials and products. Using a system-based approach to measure greenhouse gas emissions, the U.S. EPA determined that 42% of America's carbon emissions (2006) were due to the materials management for the provision of food and goods—creating, transporting, and landfilling products for our consumption. Waste prevention, recycling, repurposing, and reuse can reduce pollution and carbon emissions. Decomposition of waste creates methane, a potent greenhouse gas. Waste reduction can also decrease transportation-related emissions. Product reuse and green purchasing practices can reduce energy consumption.

Lacey does not own and operate waste collection and disposal services. Waste Connections, Inc. (also known as LeMay, Inc. and Pacific Disposal) collects residential and commercial refuse and recycling in the city, which are transported to the Thurston County transfer station, also known as the Waste and Recycling Center (WARC), operated by Thurston County Solid Waste. All municipal solid waste (MSW), which includes waste generated by residential, business, industrial, and institutional locations in Thurston County are sorted and dispensed through this facility. This includes moderate risk waste from households and small quantity generators. Residents have the option to self-haul recyclables to the WARC's recycle center which is leased by LeMay. LeMay is responsible for transporting recycling materials to other locations for sorting and dispensing.

Commercial and residential recyclables are shipped to separate locations for further sorting and processing. Compostable materials are transported to Silver Springs Organics in Rainier, WA. LeMay takes the yard waste that residents or landscapers self-haul to the WARC and create hog fuel. The remaining refuse is then transported by truck and rail car to Roosevelt Landfill near Roosevelt, WA (approx. 240 miles away). Although the landfill's methane recapture offsets a significant portion of generated emissions of the actual waste, there is a significant amount of transportation involved in the disposal and dispensation of materials. Waste reduction will help to reduce carbon emissions.

Goal: Decrease solid waste through source reduction, green purchasing, reuse/repurposing practices, and recycling activities.

Policies:

a. Consider "green" or environmentally preferable purchasing policy for municipal operations, prioritizing recycled content, local sourcing, reduced toxins, etc.

b. Enhance recycling programs in city facilities and at city-sponsored events.

c. Consider lifecycle of materials in operations and management policies and practices. Demonstrate and promote wise consumption of materials.

MEASURES

Current and potential measures for municipal operations and the Lacey community are listed below. Measures with a ✓ have been implemented to some level. See Matrix of Measures for more.

MUNICIPAL OPERATIONS:

- ✓ Expand recycling at city facilities and events
- ✓ Expand organics recycling to city events
- ✓ Reduce paper use in municipal services
- ✓ Education programs for city employees
- ☐ Implement green purchasing program
- ☐ Materials lifecycle consideration in projects and procurement
- ☐ Implement local sourcing policy

COMMUNITY OPTIONS:

- ✓ Expand curbside recycling
- ✓ Methane recapture for waste
- ✓ Offer yard debris/composting services
- ☐ Ban recyclables from garbage
- ☐ Expand education programs
- ☐ Promote green purchasing
- ☐ Promote commercial recycling
- ☐ Promote residential recycling
- ✓ Loan event recycling containers

IMPLEMENTATION STRATEGY

Because waste collection and disposal are not direct services provided by the City of Lacey, partnerships will be important to achieve goals in this sector.

Recommendations:

- The best way to reduce waste—is not to produce it; therefore, the city should consider purchasing policies that supporting local sourcing, minimum packaging, and reuse.
- Look for opportunities to expand recycling at city events and facilities.
- Education programs for city employees about waste issues? Circulating waste sort results and implementing a "Get Caught Green Handed" program are great examples of this.

PARTNERSHIPS

Collaborate with community partners for waste initiatives to prevent solid waste and lower emissions from waste and associated transportation:

- Solid Waste Advisory Committee (SWAC)
- Thurston County Solid Waste
- Washington State Department of Ecology
- Waste Connections, Inc. (Pacific Disposal, LeMay, Inc.)
- Thurston Green Business

FUNDING

Look for funding opportunities for new programs through partnerships with other public, private, and nonprofit groups.

- Seek grant funding for education programs and services and leverage funds with partnerships.

MATRIX OF MEASURES

MATRIX OF MEASURES

*****REFER TO INSERT—MATRIX OF MEASURES***

Lacey has many forward-thinking policies and traditions. Numerous activities undertaken in the name of environmental stewardship, have also served to reduce Lacey's carbon emissions. Actions to save energy, preserve and protect natural resources, invest in renewable energy, and conserve water resources, build resiliency into city services and infrastructure, and provide carbon reduction benefits. Many of these policies and programs are in-process and ongoing. They continue to benefit municipal operations and the Lacey community.

To assist in evaluating future actions, current and potential carbon reduction measures from each goal section are compiled in the following matrix of measures. There is no single action that will effectively reduce emissions to meet the target of 15% below 2005, by 2020. Effective strategy will need to address the varied sources of carbon emissions. This matrix should be considered a menu, or playbook, of options for policy implementation to build community resiliency and to reduce carbon emissions. This matrix should be used as a guide. Measures can be added, altered, implemented and removed as feasibility and support are determined.

Sector:
Measures were divided by Government, Business, and Community (residential) sectors. The primary sector to initiate or lead a measure is identified by "A" and the primary benefactor of each measure is designated by "B". Not all measures have an identified leader.

Policy Area:
Measures are also categorized by the policy area of benefit: Adaptation, Energy Efficiency, Green Renewable Energy, Transportation, Land Use, Green Building, Trees & Open Spaces, and Waste Reduction.

Policy Mechanism:
The apparatus through which policy could be implemented is the Policy Mechanism. Depending on the strategy selected, some measures could be implemented through multiple mechanisms.

- **Government Operations/Direct Service**—Measures that will require municipal operations policy change or direct service provision to the public. This would include outsourcing and contracting activities. In this case, government is identified as the mechanism when Lacey municipal government would be the lead policy implementation.
- **Legislative/Zoning/Regulation**—Changes to local, state, or federal laws, regulations, zoning, or policy as the means to achieve results.
- **Financial Incentives/Awards**—Rewards, financial incentives, rebates, tax credits, or other incentives to increase implement policy.
- **Education/Information/Facilitation**—Promotional campaigns, education and outreach to enact policy.
- **Other**—requires action from external partner or third-party agency, business, or service provider.

Current Measures:
Measures that have been implemented to some level were identified with a "✓."

Capacity:
Additional capacity remains to expand the program, through the same or additional policy mechanisms have been identified with a "✓" in this column.

Implementation/Partners:
Lacey acts in partnership with a variety of stakeholders to accomplish goals. Current partnerships include the following agencies, jurisdictions, and service providers:

Cities—Refers to municipalities, especially Olympia, Tumwater, and Yelm
County—Thurston County
CTR – Washington State Commute Trip Reduction Program
DOE—Department of Energy
Ecology—Washington State Department of Ecology
EECBE—Energy Efficiency and Conservation Block Grant
IT—Intercity Transit
Landfill —Roosevelt Landfill
LeMay—a.k.a. Waste Connections, Inc. and Pacific Disposal
LOTT—LOTT Cleanwater Alliance
Pacific Disposal — Waste Connections, Inc owns LeMay, Inc. and Pacific Disposal
PSE—Puget Sound Energy
State—State of Washington
Thurston Green Business
TE—Thurston Energy
TRPC—Thurston Regional Planning Council

*****REFER TO INSERT—MATRIX OF MEASURES***

MATRIX OF MEASURES

	Sector A=Primary Actor, B=Primary Benefit			*Policy Area*								*Policy Mechanism*						*Implementation*		
Strategy	Government	Business	Community	Adaptation/Resiliency	Energy Efficiency	Green Renewable Energy	Transportation	Land Use	Green Building	Trees & Open Space	Waste	Government Operations/ Direct Services	Legislation/Zoning/ Regulation	Financial Incentives/ Awards	Education/Information/ Facilitation	Other/Private Action/Investment	Current Measure	Capacity Available	Partners
Community Resiliency																			
Update flooding maps	A,B	B	B	x								x					✓	✓	
Monitor and protect water quality	A,B	B	B	x								x					✓	✓	
Expand reclaimed water utility	A,B	B	B	x								x					✓	✓	
Emergency preparedness training	A,B	B	B	x								x					✓	✓	County
Monitor air quality	A,B	B	B	x								x	x				✓	✓	
Salmon habitat protection	A,B	B	B	x								x	x				✓	✓	
Prepare for extreme heat events	A,B	B	B	x								x					✓	✓	
Urban stormwater programs	A,B	B	B	x									x		x		✓	✓	
Low-impact development	A	B	B	x								x	x		x		✓	✓	
Urban agriculture	A,B		B	x									x		x	x	✓	✓	
Water conservation																			
Carbon Reduction																			
Resource Conservation Manager (RCM)	A,B				x					x		x					✓	✓	PSE, DOE
Resource Conservation Team (RCT)	A,B				x					x		x					✓	✓	PSE, DOE
Energy audits for municipal buildings	A,B				x							x					✓	✓	PSE, DOE
Energy audits for homes and businesses		B	B													x	✓	✓	DOE,PSE, Thurston Energy
Weatherize public buildings	A,B				x							x						✓	
Weatherization for homes and businesses		A,B	A,B		x										x	x	✓	✓	CAC, DOE, PSE, Thurston Energy
Utility management software	A,B				x							x					✓		PSE
LED/efficient lighting retrofits, interior	A,B	A,B	A,B		x							x			x	x	✓	✓	PSE, Thurston Energy
LED/efficient lighting retrofits, exterior	A,B	A,B	A,B		x							x			x	x	✓	✓	
LED traffic signals	A,B				x							x					✓		
LED/efficient street lights	A,B				x							x	x				✓	✓	PSE
HVAC retrofits	A,B	A,B	A,B		x							x				x	✓	✓	
ENERGY STAR certified equipment	A,B	A,B	A,B		x							x			x	x	✓	✓	
Energy efficiency measures in Development Guidelines	A,B				x								x				✓	✓	
Occupancy sensors/controls	A,B	A,B	A,B		x							x			x		✓	✓	PSE, DOE
Computer shut-down software	A,B				x							x						✓	PSE
Building retro-commissioning	A,B	A,B			x							x			x		✓	✓	
Cool paving	A,B	A,B			x							x	x					✓	

Measure	Sector A=Primary Actor, B=Primary Benefit			Policy Area								Policy Mechanism					Implementation		
Strategy	Government	Business	Community	Adaptation/Resiliency	Energy Efficiency	Green Renewable Energy	Transportation	Land Use	Green Building	Trees & Open Space	Waste	Government Operations/ Direct Services	Legislation/Zoning/ Regulation	Financial Incentives/ Awards	Education/Information/ Facilitation	Other/Private Action/Investment	Current Measure	Capacity Available	Partners
Low maintenance landscaping	A,B	A,B	A,B		x							x	x		x		✓	✓	
Green roofs or reflective roofs	A,B	A,B	A,B		x				x			x	x		x		✓	✓	
Decrease daily streetlight operation	A,B				x							x						✓	
Standards for public buildings	A,B				x				x			x						✓	
Weatherize public buildings	A,B				x							x						✓	
Subsidize energy audits		B	B		x									x			✓	✓	EECBG, Thurston Energy, PSE
"Smart" utility meters		A,B	B		x										x	x		✓	PSE
Water conservation ordinance	A,B	**B**	B		x								x				✓		
Water conservation program	A	B	B	x	x										x		✓	✓	LOTT
Water conservation equipment	A,B	B	B		x							x					✓	✓	LOTT
Tiered water rates	A,B	B	B		x								x	x			✓		
Energy efficient motors in water service equipment	A,B				x							x					✓	✓	
Energy code	A	B	B		x				x				x				✓	✓	State
Rebates for retrofits		B	B		x									x			✓	✓	PSE
Energy efficiency education		B	B		x										x		✓	✓	PSE, Thurston Energy
Energy efficiency challenge		B	B		x										x			✓	
Green business program	A	B			x	x	x		x		x				x		✓	✓	Thurston Chamber
Promote passive homes			B		x										x			✓	
Energy performance rating system		B	B		x								x		x			✓	
Building performance disclosure		B	B		x								x					✓	
Meter-based financing		B	B		x									x		x		✓	
Tax credits for efficiency upgrades	A	B	B		x									x				✓	
District heating and cooling		B	B		x											x		✓	
Peak demand energy pricing		A,B			x											x	✓		
Promote ENERGY STAR appliances	B	B	B		x										x	x	✓	✓	
Green power purchase	A,B	A,B	A,B			x						x				x	✓	✓	PSE
Green power challenge	A	B	B			x						x			x	x	✓		PSE, Olympia, IT, Thurston Energy
Photovoltaic (PV) solar on public site(s)	A,B					x						x						✓	
Solar hot water in buildings	A,B					x						x						✓	
Geothermal heat pump	B	B	B			x						x				x		✓	
Combined heat/power system	A,B	B	B			x						x				x		✓	
Co-generation power production	A,B	B	B			x						x				x		✓	
LID for district heating		B	B	x		x						x				x		✓	
Promote renewable energy	A	B	B			x									x		✓	✓	
Local tax incentives for renewables	A	B	B			x								x				✓	
Solar or renewable challenge	A	B	B			x									x	x		✓	Thurston Energy

Measure	Sector A=Primary Actor, B=Primary Benefit			Policy Area								Policy Mechanism					Implementation		
Strategy	Government	Business	Community	Adaptation/Resiliency	Energy Efficiency	Green Renewable Energy	Transportation	Land Use	Green Building	Trees & Open Space	Waste	Government Operations/ Direct Services	Legislation/Zoning/ Regulation	Financial Incentives/ Awards	Education/Information/ Facilitation	Other/Private Action/Investment	Current Measure	Capacity Available	Partners
Community solar	A,B	B				x						x				x		✓	
Expand financing options		A,B	B			x								x				✓	
Promote natural gas		A				x									x	x		✓	
One block off the grid campaign		B	B			x									x	x			
Employee Commute Trip Reduction	A,B	B					x					x		x	x		✓	✓	State CTR, TRPC
Encourage pay-as-you-drive car insurance			B				x									x		✓	
Electric Vehicle Charging Stations	A	A,B	B				x						x			x	✓	✓	
Hybrid Fleet Vehicles	A,B						x					x					✓	✓	
Electric Fleet Vehicles	A,B						x					x					✓	✓	
Economy fleet	A,B						x					x					✓	✓	
Bicycles for employees	A,B						x					x					✓	✓	
Bicycle patrols	A,B						x					x						✓	
Alternative Fuels for fleet (B20, B50, B99)	A,B						x					x					✓	✓	
Tire pressure program	A,B						x					x						✓	
Alternative Energy Fair	A				x	x	x		x						x		✓		
Promote Commute Trip Reduction		B					x								x		✓	✓	
Electric vehicle charging ordinance	A												x				✓		
Traffic signal synchronization	A	B	B				x										✓	✓	
Bicycle and pedestrian infrastructure	A	A	B				x					x				x	✓	✓	
Traffic calming measures	A						x										✓	✓	
Institute Safe Routes to School	A		B				x									x	✓	✓	
Provide commuting incentives		B					x							x				✓	
Anti-idling ordinance	A		B				x						x					✓	
Restrict idling at public facilities	A,B						x						x					✓	
Enhance trail system	A		B				x					x					✓	✓	
Public-owned alternative fueling stations	A		B				x									x		✓	
Promote community purchase of hybrid, fuel efficient, and alternative fuel vehicles		B	B				x								x			✓	
Car sharing program		B	B				x									x		✓	
Expand fiber-optic network																	✓	✓	
Prepare a transportation master plan	A						x					x					✓		TRPC
Develop new neighborhoods around transit hubs	A		B					x					x				✓	✓	
Maximize public facility use	A,B							x				x					✓	✓	
Co-locate facilities and services	A,B							x				x					✓	✓	
Encourage mixed-use development	A	A,B	B					x					x				✓	✓	
Development incentives for transit-oriented development		B	B					x						x				✓	

Measure	Sector A=Primary Actor, B=Primary Benefit			Policy Area								Policy Mechanism						Implementation		
Strategy	Government	Business	Community	Adaptation/Resiliency	Energy Efficiency	Green Renewable Energy	Transportation	Land Use	Green Building	Trees & Open Space	Waste	Government Operations/ Direct Services	Legislation/Zoning/ Regulation	Financial Incentives/ Awards	Education/Information/ Facilitation	Other/Private Action/Investment	Current Measure	Capacity Available	Partners
Development incentives for downtown		B						x						x				✓	
Promote high-density and infill development through zoning	A	B	B					x					x				✓	✓	
Discourage sprawl through impact fees	A							x					x					✓	
Prepare land use master plan	A							x				x					✓		TRPC
Protect existing wetlands	A							x					x				✓	✓	
Built Green Codes	A	A,B	B		x				x				x				✓	✓	
LEED Certification Training for City Staff	A,B	B			x				x						x			✓	
Require all new public projects to be LEED or ENERGYSTAR certified.	A,B				x				x				x					✓	
Require all public remodel projects to be LEED or ENERGYSTAR certified.	A,B				x				x				x					✓	
All new projects have LEED Accredited professional on design team		A,B	B		x				x				x			x		✓	
Education programs for green building	A		B		x				x						x			✓	
Adopt building codes that exceed minimum guidelines	A	A,B	B		x				x				x				✓	✓	
Reward system for green buildings	A	B			x				x									✓	
Adopt or encourage LEED building standards for commercial and/or residential projects	A	B	B						x				x					✓	
Loan rates or financial incentives for green building	A	A,B			x				x					x				✓	
Encourage use of sustainable building materials	A	B	B											x				✓	
Expand opportunities for green remodeling																		✓	
ENERGYSTAR Portfolio Manager for public buildings	A,B				x				x			x						✓	
Promote ENERGYSTAR Portfolio Manager for Commercial Buildings	A	B			x				x						x			✓	
Provide technical assistance to developers on green building	A								x			x						✓	
Salvage building materials from remodels and demolition	A,B	B	B						x		x	x				x		✓	
Urban Forestry Plan								x									✓		
Tree City USA Designation	A		B					x				x					✓	✓	
Incorporate native plants and trees into landscape	A,B	B	B					x				x		x			✓	✓	
Develop parks	A	B	B					x				x					✓	✓	

Measure	*Sector A=Primary Actor, B=Primary Benefit*			*Policy Area*								*Policy Mechanism*					*Implementation*		
Strategy	Government	Business	Community	Adaptation/Resiliency	Energy Efficiency	Green Renewable Energy	Transportation	Land Use	Green Building	Trees & Open Space	Waste	Government Operations/ Direct Services	Legislation/Zoning/ Regulation	Financial Incentives/ Awards	Education/Information/ Facilitation	Other/Private Action/Investment	Current Measure	Capacity Available	Partners
Tree Protection Ordinance	A									x			x				✓		
Expand Tree Tracts	A									x			x				✓	✓	
Require street trees	A									x			x				✓	✓	
Encourage native trees and landscapes	A									x			x				✓	✓	
Require Tree Permits	A		A,B							x							✓	✓	
Expand community gardens			A,B							x						x	✓	✓	GRuB
Distribute tree seedlings	A		B							x		x					✓	✓	
Expand open space inventory	A		B							x		x					✓	✓	
Expand recycling at city facilities & events	A,B										x	x					✓	✓	
Expand organics recycling											x					x	✓	✓	Pacific Disposal
Reduce paper use in municipal services	A,B										x	x					✓	✓	
Consider paperless policy	A,B										x	x						✓	
Implement municipal green purchasing program	A,B										x	x						✓	Ecology
Implement local sourcing policy	A,B	B									x	x						✓	County
Materials lifecycle consideration in projects and procurement	A,B										x	x						✓	County, Ecology
Expand curbside recycling		A,B	B								x					x	✓	✓	Pacific Disposal
Methane recapture for waste	B	B	B								x					x	✓		Roosevelt Landfill
Offer yard debris/composting services	B	B	B								x					x	✓		Pacific Disposal
Ban recyclables from garbage	A										x		x					✓	
Expand education programs		B	B								x				x	x	✓	✓	County
Promote green purchasing		B	B								x				x	x	✓	✓	County, Ecology
Adopt a "buy local" policy	A,B										x	x						✓	
Promote commercial recycling		B									x				x	x	✓	✓	County
Promote residential recycling			B								x				x	x	✓	✓	County
Expand reuse network	B	B	B								x					x	✓	✓	County
Loan event recycling containers	A	B	B								x	x				x	✓	✓	County

CITY OF LACEY

CR2

Strategy for Carbon Reduction and Resiliency

RESOURCES

Recommendations

Performance Measurement

Strategy Resources

Glossary of Terms

RECOMMENDATIONS

Lacey is on-track to meet the 2020 goal of 15% below 2005 emissions for its municipal operations. This accomplishment is due largely to the 100% renewable energy purchase through Puget Sound Energy's Green Power program. Many current environmental initiatives directly, or indirectly, benefit the emissions reduction goal as well. By continuing to use renewable energy and other current measures and seek other low-carbon initiatives—in energy, transportation, rooftops & green spaces, and waste reduction, the city will meet or exceed its goal.

The Lacey community will have greater challenges to overcome in reducing carbon emissions. Measures An inventory for the Lacey community was completed for the year 2009, to measure effectiveness of current measures to reduce Lacey's carbon footprint. In 2009, Lacey community emissions were 483,305 tons of CO_2e, an increase of 102,785 tons of CO_2e from 2005, or 27%. Despite efforts, the community's emissions increased. Population growth from 2005 (33,180) to 2009 (39,250) was 18.3%. Emissions generally follow population, but transportation modeling software upgrades at Thurston Regional Planning Council (TRPC) provided increased detail for VMT, which drove per capita emissions rate higher, from 11.47 tons CO_2e per capita in 2005, to 12.31 tons CO_2e per capita in 2009.

In order to reach the reduction target of 15% below 2005 by 2020, citizens and businesses will need to engage in an aggressive array of measures. Participation will be critical to meet the goal. This plan introduces a campaign—**4 Ever Green in Lacey—**a community engagement program. The Lacey community will be asked to provide input on selecting measures to direct carbon reduction efforts and identify priorities in energy, transportation, rooftops and trees (land use, green building, and green spaces), and waste reduction. Recommendations from the community on priority measures should be incorporated into this strategy, partnership opportunities explored, and priority measures undertaken as funding sources are identified.

The municipal, community, and regional strategies identified in this plan will require additional funding—from local, state, and federal sources, local and regional partners, the city's general and utility funds— depending on the level of implementation and the measures selected. Project and program implementation will depend on city priorities, community partnerships, citizen involvement, and availability of funds and resources. In general, the strategy should:

- Look for opportunities to increase efficiency in services, buildings and facilities.
- Identify partnerships to leverage funding for low-carbon activities.
- Continue incremental investments in current programs with direct and indirect benefits to carbon emissions.
- Work with other jurisdictions to coordinate and streamline community preparedness.
- Adapt infrastructure and services to emerging changes in climate.
- Engage the community to achieve goals.

PERFORMANCE MEASUREMENT

Monitoring and verifying progress on the implementation of measures is an ongoing process. Continuous monitoring provides important feedback that can be used to improve measures over time and demonstrate overall progress toward established emissions reduction targets. To measure progress, a greenhouse gas emissions inventory is suggested every three to five years.

Indicator	2005	2009
Population	33,180	39,250
FTE employees	212.4	251.7
Carbon Emissions (Municipal)	6,879 tons CO_2e	2, 281 tons CO_2e
Carbon Emissions (Lacey Community)	380,520 tons CO_2e	483,305 tons CO_2e
Energy:		
Total Energy—Municipal	59,926 MMBtu	72,761 MMBtu
Energy Use per FTE employee	282.14 MMBtu/FTE	289.08 MMBtu/FTE
Energy Use per 1,000 residents	1,806 MMBtu/1,000	1,854 MMBtu/1,000
Total Energy—Community	4,243,230 MMBtu	5,551,269 MMBtu
Energy Use per capita	127.86	141.43
Per capita carbon emissions	11.47 tons CO_2e	12.31 tons CO_2e
Renewable energy purchases (kWh) (Community)	N/A	16,184,577 kWh
Total Solar Installations (kW)	N/A	
Transportation:		
Average daily VMT (TRPC)	788,230/day	1,089,677/day
Rooftops & Green Spaces:		
Mixed-use developments		
Open Space/Parkland inventory		
Waste Reduction:		
Waste per capita	1,671 lbs/capita[1]	1,303 lbs/capita[2]

[1]The Profile, November 2008, Thurston Regional Planning Commission, Table VIII-13 Solid Waste, Thurston County 1996-2007

[2]Source: Thurston County Solid Waste Assessment. Waste projection (Table 3-1). November 2007.

Note: MMBtu —million British thermal units of energy

STRATEGY RESOURCES

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GLOSSARY OF TERMS

Adapt—to change or modify to suit new environmental conditions or needs.

Carbon dioxide—CO_2—gas naturally present in the Earth's atmosphere, also formed during the decomposition and combustion of organic compounds, respiration, and in the reaction of acids with carbonates.

Carbon dioxide equivalent (CO_2e)—Or equivalent CO_2 (CO_2e) is the concentration of carbon dioxide (CO_2) that would cause the same level of environmental damage as a given type and concentration of greenhouse gas. Examples of such greenhouse gases are methane and nirrous oxide, sulfur hexafluoride (SF_6), hydrofluorcarbons (HFCs), and perfluorcarbons (PFCs).

Carbon emissions—used interchangeably with the term greenhouse gas emissions in this report,

Carbon footprint—the total set of greenhouse gas emissions caused by an entity, at the level of a single organization, a community, state, nation, or globally.

Climate action—taking action to protect our community against predicted changes in climate and to lessen the effects of those potential changes.

Climate Change—refers to global, regional, and local level shifts in climate patterns. It can also refer to any significant change in measures of climate—temperature, precipitation, or wind, etc.—lasting for an extended period of time. Climate change due to warming global temperature trends is expected to vary by region.

Global warming—an increase in the Earth's average surface temperature that causes corresponding changes in climate that may result from the greenhouse effect. The effects of global warming include sea level rise, changes in precipitation patterns, extreme weather events (heat waves and flooding), retreat of glaciers and sea ice, species extinctions and crop yields.

Greenhouse effect—a process by which heat from solar radiation is reflected back toward the Earth's surface, due to gases which are trapped the atmosphere.

Greenhouse gases—several types of gases known to trap heat near the Earth's surface through a process called the greenhouse effect. Greenhouse gases occur in the natural environment and some, called anthropomorphic, are produced by human activities. Water vapor, carbon dioxide (CO_2), methane (CH_4), ozone, and nitrous oxide (N_2O) are the most prevalent. Sulfur hexafluoride (SF), hydrofluorocarbons (HFCs), and perfluorocarbons are also considered potent greenhouse gases.

Mixed Use—combining commercial and residential development in neighborhoods to co-locate jobs, housing, services and recreation to increase feasibility of low-carbon transportation options.

Mitigation – the act of making consequences less severe

Municipal solid waste (MSW)—MSW is all wastes that are generated by residential, business, industrial, and institutional locations. This includes moderate risk waste from households and small quantity generators.

Resiliency—the ability to recover readily from adversity

Sustainability—the capacity to endure (Wikipedia, 2/3/2012); the ability to meet immediate needs without causing harm to the supply of resources; ability to maintain an action or a process —with respect to quality of life.

Xeriscaping—environmental design principles used for residential property and parks that minimize water use.

APPENDICES

Appendix A

Resolution 950

RESOLUTION NO. 950
CITY OF LACEY

A RESOLUTION OF THE CITY OF LACEY, WASHINGTON, regarding membership in ICLEI—Local Governments for Sustainability and working toward sustainable practices to protect the climate and physical environment.

WHEREAS; scientific consensus has developed that carbon dioxide and other greenhouse gases released into the atmosphere have a negative effect on air quality and the Earth's climate; and

WHEREAS; energy consumption, specifically the burning of fossil fuels, reduces air and water quality, and accounts for more than 80% of U.S. greenhouse gas emissions; and

WHEREAS; local government actions to reduce greenhouse gas emissions and increase energy efficiency provide multiple benefits, specifically: (1) save taxpayer dollars through energy efficiency; (2) contribute to the local economy and create jobs; (3) improve air and water quality and public health; (4) invest in long-term community livability; and (5) helps promote the development of alternative energy resources; and

WHEREAS; the Cities for Climate Protection Campaign sponsored by ICLEI—Local Governments for Sustainability has invited the City of Lacey to join ICLEI and become a partner in the Cities and Counties Climate Protection Program; and

WHEREAS; the City of Lacey will undertake ICLEI's five milestones to reduce both air pollution and greenhouse gas emissions in its government operations throughout the community, and specifically: (1) conduct a greenhouse gas emissions inventory and forecast to determine the source and quantity of greenhouse gas emission in the jurisdiction; (2) establish a greenhouse gas emission reduction target; (3) develop an action plan with both existing and future actions that when implemented will meet the local greenhouse gas emissions; (4) implement the action plan; and (5) monitor and report progress; and

WHEREAS; that the City of Lacey requests assistance from ICLEI's Cities for Climate Protection Campaign as it progresses through the milestones.

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF LACEY AS FOLLOWS:

SECTION 1: MEMBERSHIP: City of Lacey will join ICLEI as a Full Member and pledges to take a leadership role in promoting sustainable practices that protect the climate and the physical environment.

ADOPTED BY THE CITY COUNCIL OF THE CITY OF LACEY, WASHINGTON, this 23rd day of July, 2009.

CITY COUNCIL

By _____
Mayor

Attest:

_____
City Clerk

Approved as to form:

_____
City Attorney

Appendix B

Washington Climate Change Impacts Assessment
Evaluating Washington's Future in a Changing Climate, Executive Summary
A report by The Climate Impacts Group, University of Washington, June 2009

The Washington Climate Change Impacts Assessment

Evaluating Washington's Future in a Changing Climate

Executive Summary

A report by

The Climate Impacts Group
University of Washington

June 2009

CLIMATE IMPACTS GROUP

Climate Science
in the Public Interest

Recommended citation:
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In The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, Climate Impacts Group, University of Washington, Seattle, Washington.
Available at: www.cses.washington.edu/db/pdf/wacciaexecsummary638.pdf

June 2009 addendum *Minor edits to the average temperature and precipitation projections summarized on pages 1, 6, and 7 were made in June 2009 to reflect updates made to the analysis after the March release of the Executive Summary. Additionally, the reference period in the caption for Figure 5 was corrected to provide the correct reference period (1916-2006) for changes in April 1 snowpack.*

Front cover satellite image credit:

http://visibleearth.nasa.gov/view_rec.php?vev1id=4786
NASA - National Aeronautics and Space Administration
Visible Earth: A catalog of NASA images and animations of our home planet

Provided by the SeaWiFS Project, NASA/Goddard Space Flight Center, and ORBIMAGE

The Pacific Northwest is cloud-free in this SeaWiFS image. Multihued phytoplankton blooms are visible off of Washington's Olympic coast. Also visible in this image are: Fraser River outflow, snowcapped peaks of Mt. Olympus, Mt. Rainier, Mt. Adams, Mt. Hood, Mt. Jefferson, the Three Sisters, the North Cascades, and the Columbia and Snake River watersheds.

Metadata
** Sensor OrbView-2/SeaWiFS*
** Visualization Date 2000-09-26*
** The Visible Earth is part of the EOS Project Science Office located at NASA Goddard Space Flight Center.*

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Report design: Beth Tully, Edit-Design Center, University of Washington

Washington Climate Change Impacts Assessment

Evaluating Washington's Future in a Changing Climate

Executive Summary

Temperature records indicate that Pacific Northwest temperatures increased 1.5°F since 1920. Climate models used in the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report simulate the same historical warming by including both human and natural causes, and point to much greater warming for the next century. **These models project[1] increases in annual temperature of, on average, 2.0°F by the 2020s, 3.2°F by the 2040s, and 5.3°F by the 2080s (compared to 1970 to 1999[2]), averaged across all climate models[3].** Projected changes in annual precipitation, averaged over all models, are small (+1 to +2%), but some models project an enhanced seasonal precipitation cycle with changes toward wetter autumns and winters and drier summers. Increases in extreme high precipitation in western Washington and reductions in Cascades snowpack are key projections that are consistent among different projections of a high-resolution regional climate model.

Probable impacts associated with projected 21st century changes in Northwest climate include the following:

- **April 1 snowpack is projected to decrease by 28% across the state by the 2020s, 40% by the 2040s, and 59% by the 2080s compared with the 1916 - 2006 historical average.** As a result, seasonal streamflow timing will likely shift significantly in sensitive watersheds.
- **The Yakima basin reservoir system will likely be less able (compared to 1970 to 2005) to supply water to all users, especially those with junior water rights.** Historically (1916-2006), detrimental water shortages in the Yakima basin occurred in 14% of years. Without adaptation, shortages would likely occur more frequently: 32% of years in the 2020s, 36% of years in the 2040s, and 77% of years in the 2080s. Due to lack of irrigation water and more frequent and severe prorating, the average production of apples and cherries could decline by approximately $23 million (about 5%) in the 2020s and by $70 million (about 16%) in the 2080s.
- **Rising stream temperatures will likely reduce the quality and extent of freshwater salmon habitat.** The duration of periods that cause thermal stress and migration barriers to salmon is projected to at least double (low emissions scenario, B1) and perhaps quadruple (medium emissions scenario, A1B) by the 2080s for most analyzed streams and lakes. The greatest increases in thermal stress would occur in the Interior Columbia River Basin and the Lake Washington Ship Canal.

[1] All changes are benchmarked to 1970 to 1999 unless otherwise stated.

[2] 20 different global climate models for greenhouse gas emissions under a "medium" emissions scenario (A1B) and 19 models for a "low" scenario (B1) - see Box 3 for more information. All statements in this document are for the "medium" scenario (A1B) unless otherwise stated.

[3] We use the term "projections" throughout to minimize confusion with "forecasts" and "predictions", both of which convey levels of certainty inappropriate for future climate. We use "likely" to convey relatively high certainty and "possibly" to convey less certainty.

- **Due to increased summer temperature and decreased summer precipitation, the area burned by fire regionally is projected to double by the 2040s and triple by the 2080s[4].** The probability that more than two million acres will burn in a given year is projected to increase from 5% (observed) to 33% by the 2080s. Primarily east of the Cascades, mountain pine beetles will likely reach higher elevations and pine trees will likely be more vulnerable to attack by beetles.
- **Although few statistically significant changes in extreme precipitation have been observed to date in the Puget Sound, the Spokane area, or Vancouver/ Portland, regional climate model simulations generally predict increases in extreme high precipitation over the next half-century, particularly around Puget Sound.** In that region, existing drainage infrastructure designed using mid-20th century rainfall records may be subject to rainfall regimes that differ from current design standards.
- **Climate change in Washington will likely lead to significantly more heat- and air pollution-related deaths throughout this century.** Projected warming would likely result in 101 additional deaths among persons aged 45 and above during heat events in 2025 and 156 additional deaths in 2045 in the greater Seattle area alone[5]. By mid-century, King County will likely experience 132 additional deaths between May and September annually due to worsened air quality caused by climate change.

The significance of these regional consequences of climate change underscore the fact that historical resource management strategies will not be sufficient to meet the challenges of future changes in climate. Rather, these changes demand new strategies. Options for adapting to climate change vary between sectors (e.g., between water resources and forest ecosystems) and even within sectors (e.g., between watersheds) depending on the unique characteristics of the systems being considered. This assessment highlights some of the likely impacts of future changes in climate in Washington. There is more work yet to be done, however, including (1) continuing work to identify and quantify impacts in these and other sectors, and (2) analyzing the adaptation options appropriate to specific impacts, specific locations, management goals, and jurisdictions. Additionally, the range of projected climates from different global climate models (or regional climate models) could be explored more fully in future work to develop a range of impacts scenarios useful for making decisions under different levels of risk tolerance. Integration between the sectors is also very important because the nature of some impacts is synergistic within and between sectors.

[4] Relative to 1916 - 2006.

[5] Relative to 1980 - 2006.

Box 1: Climate Change, Climate Variability, and Weather

In this assessment, it is necessary to distinguish between climate change (the long term trend), climate variability (year-to-year or decade-to-decade variations), and weather (the daily to seasonal changes with which we are all familiar). Pacific Northwest events – storms, floods, winters that seem colder and summers that seem hotter - need to be put in an appropriate context and time frame. Such events can be associated with climate, but only over many years – a single flood, back-to-back snowy winters, or an extended drought don't necessarily signal a change in climate over longer time frames. Some common questions and their answers help distinguish these sometimes confusing terms.

Q. The last two winters have been cool in the Pacific Northwest. Has global warming stopped?

A. No. Rising greenhouse gases (carbon dioxide, methane, and others) continue to produce increasingly warmer temperatures. Additional upward or downward detours come from other important sources of climate variability. For example, an extremely strong tropical El Niño event helped make 1998 a record warm year, not to be matched until 2005, a year with a mild El Niño event. The 2008 La Niña event produced temporary global cooling, but even so, the National Climatic Data Center still ranked 2008 as the 8th warmest year globally on record. Local cold weather, or heat waves, tell us nothing about global factors in climate like the effects of rising greenhouse gases.

Q. Isn't the climate record dominated by natural variability?

A. Yes, but natural causes and natural variability cannot explain the rapid increase in global temperatures in the last 50 years. Scientists have searched for other explanations – heat from the ocean, solar variability, cosmic rays, instrumental error – and have used sophisticated statistical techniques, and nearly every study concludes that the rising temperature is a result of rising greenhouse gases. Laboratory tests, ground-based instruments, and satellite instruments show that adding greenhouse gases to the atmosphere warms the surface – a simple physical fact.

1. Introduction

The 2007 Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) states that 20th century warming of our climate is unequivocal and that human activities have contributed to increasing atmospheric greenhouse gas concentrations and therefore warming of the atmosphere and oceans. The IPCC expects global climate to continue warming in the 21st century, with the rate of warming somewhat dependent on the rate of human greenhouse gas emissions.

What are the consequences of a warming climate for the regional systems we rely upon for our livelihood? Certainly, we may no longer rely solely on past events, measurements, and management approaches to understand our natural and human resources. To help answer this question, the Washington State legislature passed House Bill 1303, which mandated the preparation of a comprehensive assessment of the impacts of climate change on the State of Washington. Passed in April 2007, HB 1303 specifically requested that the Departments of Community, Trade, and Economic Development and Ecology work with the University of Washington Climate Impacts Group (in collaboration with Washington State University and Pacific Northwest National Laboratory) to produce this comprehensive assessment.

To assess the future impacts of climate change, we integrate climate model projections into our understanding of the physical, biological, and human responses to climate that will shape Washington's future. This assessment presents the most complete and up to date look yet at the future climate of the Pacific Northwest (PNW) and the potential impacts of projected climate change on important ecological and economic sectors in Washington State, and provides Washington State decision makers and resource managers with information critical to planning for climate change.

This executive summary describes the key findings and conclusions of the Climate Impacts Group's Washington Climate Change Impacts Assessment. The Assessment addresses the impacts of global climate change over the next 50 years or more on eight sectors: Hydrology and Water Resources, Energy, Agriculture, Salmon, Forests, Coasts, Urban Stormwater Infrastructure, and Human Health (Box 2). In addition, the Washington Assessment addresses the need for adaptive planning and adaptation options within each sector. Full technical details are provided in a series of papers that together comprise the Washington Assessment.

Figure 1. Washington State and surrounding Pacific Northwest region. This assessment is focused on impacts of climate change on resources in the state of Washington, but the region as a whole has been considered because the climatic and hydrologic impacts require regional analyses. For example, Columbia River flow is related to conditions across an area much greater than Washington alone, the purple line outlines the Columbia River Basin.

Box 2: Impacts Assessment Sectors Covered in this Summary and Their Main Areas of Focus

- **Climate Scenarios:** changes in future temperature and precipitation for the Pacific Northwest and assessment of sub-regional climate change using regional climate models
- **Hydrology and Water Resources:** changes in the hydrology (streamflow, snowpack, soil moisture) and the water resources (water storage, irrigated agriculture) of Washington
- **Energy:** changes in the demand for and production of hydropower in Washington
- **Agriculture:** changes in the expected production of high-value crops in Washington
- **Salmon:** changes in the quality and quantity of salmon freshwater habitat in Washington
- **Forests:** changes in the productivity, distribution and disturbance of forest ecosystems in Washington
- **Coasts:** impacts in coastal areas of Washington
- **Urban Stormwater Infrastructure:** changes in storms and demands on urban stormwater infrastructure in Washington
- **Human Health:** impacts of heat waves and climate-related air pollution on health in Washington
- **Adaptation:** fundamental concepts for planning for climate change and options for adapting to the impacts identified in the above sectors

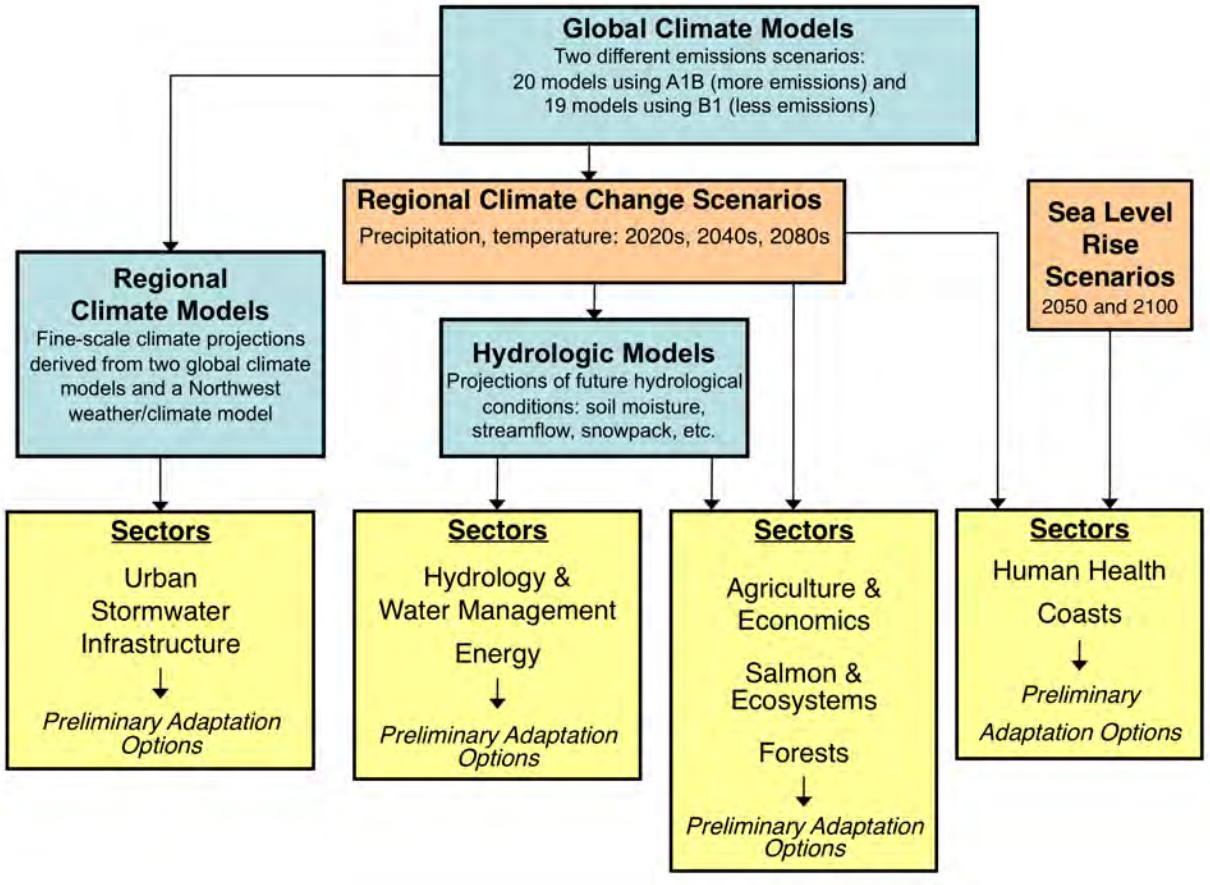

Figure 2. Summary of overall assessment approach. Sectors use one or more pathways in the flowchart above. Global and regional climate change information is related to sector impacts using hydrologic and regional climate models. This allows quantification of impacts at scales more useful for decision making. Adaptation options are developed based on the downscaled impacts.

1.1 Assessment Approach

The climate of the 21st century in Washington State will very likely be quite different from the climate we have witnessed in the past. The changes will in many cases be large, and the ultimate consequences will depend on how well we plan for and manage these changes. Effective planning requires sectorally and geographically specific information on which to base decisions. This assessment provides that information by using global climate model projections from the IPCC Fourth Assessment to develop regionally-specific climate change scenarios and then assessing some of the consequences for eight important sectors (Box 2) in Washington (Figure 1). Figure 2 illustrates the overall approach taken in this study. The sections that follow present the main conclusions for each sector. The Washington Assessment focuses on three 30-year windows in the 21st century, that is, the thirty years centered on the 2020s (2010 to 2039), 2040s (2030 to 2059), and 2080s (2070 to 2099)[6]. Projections for the 2080s are least certain of those presented here[7], because climate, human population growth, and energy use patterns are more difficult to estimate farther into the future.

1.2 Modeling Approach

Translating from projections of global climate change to impacts in Washington State requires making the climate projections more regionally specific and, in many cases, using those climate projections to develop other important information such as hydrologic projections (Figure 2). The process begins with 20 climate models from research groups around the world (models that were used in the 2007 IPCC Fourth Assessment). For each of these global climate models, two IPCC greenhouse gas emissions scenarios were used to represent different assumptions about future global development (see Box 3 for description of the emissions scenarios).

Six average climate change scenarios (called "composites") were created for the Pacific Northwest by averaging the model output for the region for each of the model runs during each time period of interest, i.e., 2020s medium emissions scenario (A1B), 2020s low emissions scenario (B1), 2040s medium emissions scenario (A1B), 2040s low emissions scenario (B1), and so on for the 2080s. In order to make the composite climate scenarios suitable for locally-specific climate impacts analysis, they were "downscaled" to create higher resolution climate projections in the Pacific Northwest. Each downscaled climate change scenario was used as input into a hydrologic model (Hydrology chapter) that uses climate and other information to develop projections of future hydrologic conditions, soil moisture and streamflow. In addition, a regional

Box 3: Future Emissions Scenarios: Low (B1) and Medium (A1B)

Greenhouse gasses are the main cause of 21st century climate change, and they stem from human choices in many arenas. They are by no means the only influence on climate, nor are they the only forcings considered by the IPCC. This assessment uses two future scenarios that differ in their assumptions about future greenhouse gas emissions and other factors influencing climate. The two scenarios are called "B1" and "A1B" – these letters refer to emissions scenario "families" developed for the IPCC, and described fully in the IPCC Special Report on Emissions Scenarios (SRES). A1B refers to a future where global population peaks mid-century and there is very rapid economic growth and a balanced portfolio of energy technologies including both fossil fuels and high efficiency technology that is adopted rapidly. B1 refers to a future where population is the same as A1B, but there are rapid economic shifts toward a service/information economy, the introduction of clean and resource-efficient technologies and emphasis on global solutions to economic, social, and environmental sustainability. A1B results in warmer future climates by the end of the century and can be considered a "medium" scenario in terms of warming, (it is not the warmest of all the IPCC scenarios). B1 has less warming (see section 2, Future scenarios), and could be considered the "low" warming scenario. The emissions scenarios were used by the IPCC as input into global climate models to project climate changes for 20 (scenario A1B) or 19 (scenario B1) climate models (Figure 2).

[6] The overlap between the 2020s and 2040s is due to the focus on time frames most useful for decision-making (first half of the 21st century) and also the need to have sufficient numbers of years (~30) for projection purposes.

[7] Uncertainty about future projections is dealt with in several ways in the climate modeling and impacts sectors. Uncertainty about future climate is addressed by using many (20) climate models, two emissions scenarios, and two approaches for "downscaling" climate projections specifically for the Pacific Northwest. This allows a range of possible futures, i.e., different climates, different rates of change, and different levels of detail to be considered in the impacts assessments. The models are also "weighted" by their ability to track observed changes, with better models receiving higher importance when calculating the average changes ("composite delta") projected by the climate models. Uncertainty about future impacts is addressed in the individual chapters when necessary.

climate model (Regional Climate chapter) was used to better understand the influence of sub-regional geographic variability (such as mountains) on future climate. Both downscaling and regional climate models provide increased resolution for future projections by accounting for the influence of smaller features than can be resolved in a global climate model. Detailed descriptions of how the future climate scenarios were used to generate sector-specific results are available in each sector chapter (Box 2).

This assessment is the first to combine such a diverse set of climate models, fine spatial resolution, and hydrologic modeling into an integrated climate impacts assessment. It is also the first to examine impacts on human health, agriculture, and urban stormwater infrastructure in the Northwest. In each of the following sections, the most important projections of future impacts are presented for each sector. Further details are in the sector chapters that follow this summary.

2. Future Climate Scenarios

Using 20 different climate models (see Scenarios chapter) to explore the consequences of two different greenhouse gas emissions scenarios results in a wide range of possible future climates for the Pacific Northwest. All of the models indicate that this future climate will be warmer than the past and together, they suggest that Pacific Northwest **warming rates will be greater in the 21st century than those observed in the 20th century**. All changes below are relative to the period 1970-1999 unless noted, and all are regionally averaged changes that apply to the Pacific Northwest including the state of Washington.

- **Climate models project increases in annual average temperature** of 2.0°F (range of projections from all models: +1.1°F to +3.3°F) by the 2020s; 3.2°F (range: +1.5°F to +5.2°F) by the 2040s; and 5.3°F (range: +2.8°F to +9.7°F) by the 2080s (Table 1).
- Climate models are able to match the observed 20th century warming (+1.5°F since 1920, or +0.2°F per decade for 1920 to 2000) in the Northwest, and foresee a warming rate of roughly +0.5°F per decade of warming in the 21st century (Figure 3).
- **Projected changes in annual precipitation vary considerably between models, but averaged over all models are small (+1 to +2%).** Changes early in the 21st century may not be noticeable given the large natural variations between wetter and drier years. Some models show large seasonal changes, especially toward wetter autumns and winters and drier summers. Regional modeling additionally points out areas and seasons that get drier even as the region gets wetter (Figure 4).
- **Warming is expected to occur during all seasons** with most models projecting the largest temperature increases in summer. The models with the most warming also produce the most summer drying.
- **Medium projections of sea level rise for 2100 are 2 inches to 13 inches (depending on location) in Washington State.** Substantial variability within the region exists due to coastal winds and vertical land movement[8]. The small possibility of substantial sea level rise from the melting of the Greenland ice cap lead to projections as high as 35 inches to 50 inches for 2100 (depending on location).
- **Regional climate models project some changes that are similar across global models, namely increases in extreme high precipitation in western Washinton and reductions in Cascade snowpack.** Regional climate models project a larger increase in extreme daily heat and precipitation events in some locations than the global climate models suggest.
- **Regional climate models suggest that some local changes in temperature and precipitation may be quite different than average regional changes projected by the global models.** For example, the two global models examined suggest winter precipitation will increase in many parts of the Pacific Northwest, but potentially decrease in the Cascades. Future research is required to understand if this is a trend consistent across many global models.

[8] Sea level rise projections for specific coastal areas can be found in: Mote et al. 2008. Sea-level rise in the coastal waters of Washington: A report by the Climate Impacts Group, University of Washington, and the Washington Department of Ecology.

	Temperature Change (F°)	Precipitation Change (%)
2020s	+2.0 (+1.1 to +3.3)	+1.3 (-9 to +12)
2040s	+3.2 (+1.5 to +5.2)	+2.3 (-11 to +12)
2080s	+5.3 (+2.8 to +9.7)	+3.8 (-10 to +20)

Table 1. Average and range of projected changes in temperature and precipitation for the Pacific Northwest. Reported averages are changes relative to 1970-1999, for both medium (A1B) and low (B1) scenarios and all models (39 combinations averaged for each cell in the table). The ranges for the lowest to highest projected change are in parentheses.

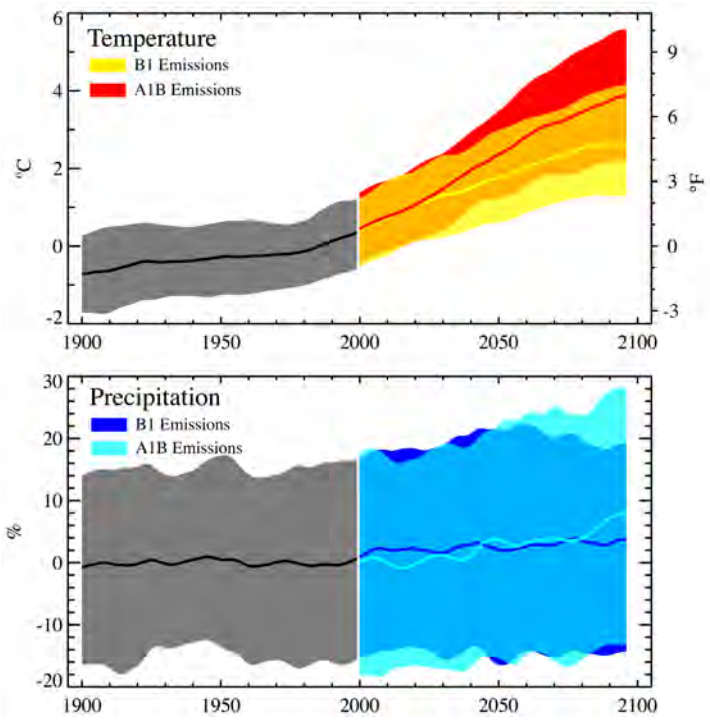

Figure 3. Simulated temperature change (top panel) and percent precipitation change (bottom panel) for the 20th and 21st century global climate model simulations. The black curve for each panel is the weighted average[9] of all models during the 20th century. The colored curves are the weighted average of all models in that emissions scenario ("low" or B1, and "medium" or A1B) for the 21st century. The colored areas indicate the range (5th to 95th percentile) for each year in the 21st century. All changes are relative to 1970-1999 averages.

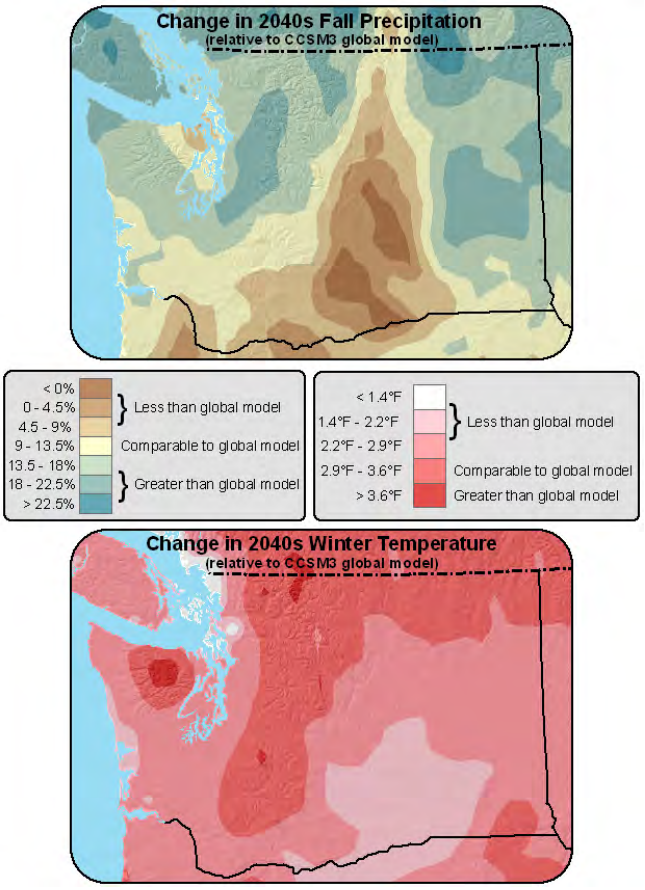

Figure 4. Differences between a regional climate model (WRF) and a global climate model (CCSM3) for projected changes in fall precipitation (September to November top) and winter temperature (December to February, bottom) for the 2040s. The global model produces a regionally averaged 11.7% increase in precipitation, but the regional model provides more detail (top), projecting some areas of increase (green) and some of decrease (brown) compared to the global model. Note that large increases are seen on windward (west and southwest) slopes and smaller increases on leeward (east and northeast) slopes. The global model produces a 3.6°F statewide averaged increase in winter temperature, while the regional model produces a statewide average 2.6°F warming. There are greater increases (darker red) at higher elevations and windward slopes, particularly the Olympic Mountains, North Cascades, and central Cascades. These differences illustrate the value of regional climate models for identifying sub-regional patterns and differences. The patterns of climate change differ depending on the global model being downscaled (we present only one here); nevertheless, the local terrain has a consistent influence on the results.

[9] The global climate models used by the IPCC were weighted by their ability to model observed regional Pacific Northwest data, with better performing models weighted more highly than those that had significant bias for the last half of the 20th century. See Scenarios chapter for more detail.

3. Hydrology and Water Resources

Projected hydrologic changes across the state are closely linked with future projections of precipitation and temperature. This assessment evaluated the hydrologic implications of climate change over the State of Washington as a whole, and in addition focused on several watersheds that are of particular importance from a water resources management standpoint. Impacts of climate change on Washington's water resources are herein divided into three parts: regional hydrology (snowpack, soil moisture, streamflow); water management in the Yakima River basin; and water management in the Puget Sound region.

Washington snowpacks are among the most sensitive to warming in the West because of their relatively low elevation. The impact of warming temperature on snowpack will differ with the type of river basin. There are three important types: *rain dominant* (precipitation falls primarily as rain, usually in low elevations, such as the Chehalis River), *snowmelt dominant* (precipitation falls primarily as snow and is released as snowmelt, usually in higher elevation basins or large river systems with mountainous headwaters like the Columbia River, and *transient* (mixed rain and snowmelt dominant, usually in mid elevations, such as the Yakima River). Especially in transient basins, a relatively small increase in temperature can significantly increase the fraction of winter precipitation falling as rain and decrease the amount of water stored in snowpack.

3.1 Regional Hydrologic Impacts

- **April 1[10] snow water equivalent (snow water content) is projected to decrease** by an average of 28% to 29% across the state by the 2020s, 37% to 44% by the 2040s and 53% to 65% by the 2080s compared with the 1916 – 2006 historical mean (Figure 5).
- **By the 2080s, seasonal streamflow timing in snowmelt-dominated and transient rain-snow watersheds would shift significantly due to the decrease in snowpack and earlier melt (Figure 6).** Snowmelt-dominated watersheds will likely become transient, resulting in reduced peak spring streamflow, increased winter streamflow and reduced late summer flow. Transient basins will likely experience significant shifts, becoming rain dominant as winter precipitation falls more as rain and less as snow. Watersheds that are rain dominated will likely experience higher winter streamflow because of increases in average winter precipitation, but overall will experience relatively little change with respect to streamflow timing. These changes are important because they determine when water is available and how it must be stored.
- **For Washington State as a whole, projected changes in runoff depend strongly on season.**

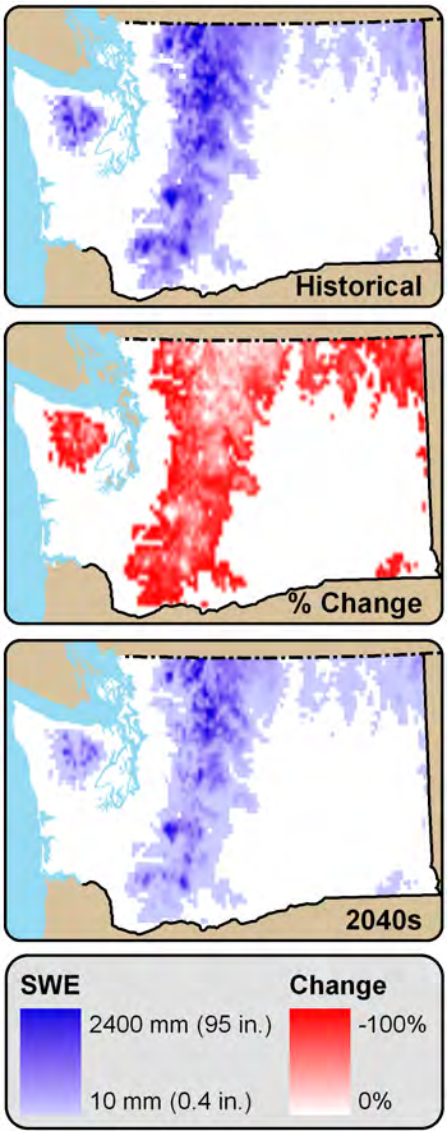

Figure 5. Summary of projected April 1 snow pack (measured as snow water equivalent, or SWE) and changes in April 1 snow pack for the 2040s, medium emissions scenario (A1B). Projected statewide decline relative to 1916-2006 is 37% to 44%. Snow water equivalent is simply the amount of water the snowpack would yield if it were melted.

[10] In watersheds that accumulate significant snowpack, SWE on April 1 is a common indicator of summer water supply.

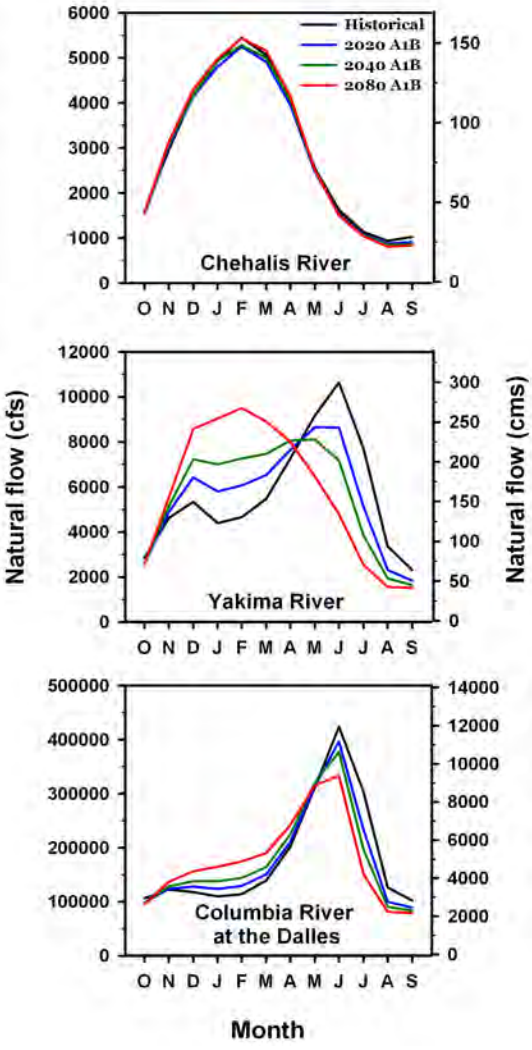

Figure 6. Historical and projected future hydrographs for three rivers under the medium emissions scenario (A1B). The Chehalis River represents a rain-dominated watershed, the Yakima River represents a transient watershed (mixed rain and snow), and the Columbia River represents a snowmelt-dominated watershed. Projected climate changes will influence the timing of peak streamflow differently in different types of hydrologic basins. The timing of peak streamflow does not change in rain-dominated basins because most of the precipitation falls as rain, both currently and in the future, and is therefore available for runoff as it falls. Timing of peak flow shifts earlier as climate warms in the transient and snowmelt-dominated basins because precipitation that historically fell as snow later falls as rain – snowpack melting ceases to dominate the timing of peak flow as the snowpack declines.

- Average cool season (October to March) runoff is projected to increase 10% to 13% by the 2020s, 16% to 21% by the 2040s, and 26% to 35% by the 2080s, corresponding with reduced snowpack and increased precipitation falling as rain.
- Average warm season (April to September) runoff is projected to decrease 16% to 19% by the 2020s, 22% to 28% by the 2040s, and 34% to 43% by the 2080s, although warm season runoff is historically about half of cool season runoff so the magnitude of these changes is smaller.
- Annual runoff (water into streams) across the state is projected to increase 0% to 2% by the 2020s, 2% to 3% by the 2040s, and 4% to 6% by the 2080s. These changes are mainly driven by projected increases in winter precipitation.

3.2 Water Management - Puget Sound

According to the 2000 census, the Puget Sound region contains almost 70% of Washington State's population. The water supply that is required to sustain the regional environment and more than 4 million people depends heavily on both natural and artificial means of storage. Puget Sound watersheds, like other basins that receive both rain and snow, are highly sensitive to changes in climate. Key findings on the implications of climate change for water management in the Puget Sound include the following:

- **The primary impact of climate change on Puget Sound natural water supply will be a shift in the timing of peak river flow from late spring (driven by snowmelt) to winter (driven by precipitation).** Puget Sound water supply systems will generally be able to accommodate changes through the 2020s in the absence of any significant demand increases. Projected changes in system reliability are small for the Everett, Seattle, and Tacoma systems in the 2020s. Even with future increases in demand, only the Tacoma system is projected to experience substantial reductions in reliability by the 2040s, primarily because water allocations within that system are closer to current system capacity.
- **Other aspects of system performance, such as reduced levels of summer and fall storage, occur as early as the 2020s.** Seasonal patterns of reservoir storage will be affected to varying degrees in all three systems. The amount of water stored in reservoirs will be lower from late spring through early fall, affecting water supply for municipal use and other

operating objectives such as hydropower production and the ability of the systems to augment seasonal low flows for fish protection. For example, in the Seattle system, October storage levels below 50% active capacity occurred historically 34% of the time, but are projected to increase to 58% in the 2020s, 67% in the 2040s, and 71% in the 2080s (scenario A1B).

3.3 Water Management and Irrigated Agriculture – Yakima

Crops in the Yakima Valley, most of which are irrigated, represent about a quarter of the value of all crops grown in Washington. The watershed's reservoirs hold 30% of streamflow annually and rely heavily on additional water storage in winter snowpack to meet water demand for agriculture. As in other watersheds across Washington, climate change is projected to cause decreases in snowpack and changes in streamflow patterns, making active management of water supply critical for minimizing negative impacts. Agricultural production increases caused by warming temperatures will likely be undermined by lack of water for irrigation.

- **The Yakima basin reservoir system will be less able (compared to 1970-2005) to supply water to all users, especially those with junior water rights.** Historically (1916-2006)[11], the Yakima basin has been significantly water short[12] 14% of the time. Without adaptations, current projections of the medium (A1B) emissions scenario estimate this value will increase to 32% (15% to 54% range) in the 2020s and will increase further to 36% in the 2040s and 77% in the 2080s.
- **Due to increases in temperature and changes in the timing and quantity of snowmelt and runoff, the irrigation season will likely be shorter, the growing season will likely be earlier by about two weeks, and crop maturity will likely be earlier by two to four weeks by the 2080s.**
- **Under the medium (A1B) emissions scenario, average apple and cherry yields are likely to decline by 20% to 25% (2020s) and by 40% to 50% (2080s) for junior water rights holders.** These declines are due to lack of irrigation water and more frequent and severe prorating, even though the direct effect of warming and CO_2 (carbon dioxide) would be to increase production (see Agriculture chapter).
- **The value of apple and cherry production in the Yakima basin is likely to decline by approximately $23 million (about 5%) in the 2020s and by $70 million (about 16%) in the 2080s.** These declines are buffered by senior irrigators and by price responses to smaller production. Overall, the risk of net operating losses for junior irrigators is likely to increase substantially.

[11] Simulation models for the historical period 1916-2006 were used to determine the frequency of water short years – see chapter 3, Hydrology and Water Resources, for details. Prorating began on the Yakima system in 1970.

[12] "Water short" is defined as 75% prorating (effectively, a legal loss of 25% of water rights during drought) for junior water rights holders.

4. Energy Supply and Demand

Hydropower accounts for roughly 70% of the electrical energy production in the Pacific Northwest and is strongly affected by climate-related changes in annual streamflow amounts and seasonal streamflow timing. Heating and cooling energy demand in Washington will be affected by both population growth and warming temperatures. Other factors influence energy supply and demand, but this assessment focuses on (1) the effects of projected warming and precipitation change on regional hydropower production, and (2) the effects of warming on energy demand, expressed in terms of heating energy demand (population times heating degree days, or the demand for energy for heating structures) and residential cooling energy demand (population times cooling degree days times the amount of air conditioning use, or the demand for energy for cooling structures).

- **Annual hydropower production (assuming constant installed capacity) is projected to decline by a few percent due to small changes in annual stream flow, but seasonal changes will be *substantial* (Figure 7).** Winter hydropower production is projected to increase by about 0.5% to 4.0% by the 2020s, 4.0% to 4.2% by the 2040s, and 7% to 10% by the 2080s (compared to water year 1917-2006) under the medium (A1B) emissions scenario. The largest and most likely changes in hydropower production are projected to occur from June to September, during the peak air conditioning season. Summer (JJA) energy production is projected to decline by 9% to11% by the 2020s, 13% to 16% by the 2040s, and 18% to 21% by the 2080s
- **Despite decreasing heating degree days with projected warming, annual heating energy demand**

is projected to increase due to population growth[13] (Figure 8). In the absence of warming, population growth would increase heating energy demand in WA by 38% by the 2020s, 68% by the 2040s, and 129% by the 2080s. For fixed 2000 population, projected warming would reduce heating energy demand by 11% to 12% for the 2020s, 15-19% for the 2040s, and 24% to 32% for the 2080s due to decreased heating degree days. Combining the effects of warming with population growth, heating energy demand for WA is projected to increase by 22% to 23% for the 2020s, 35% to 42% for the 2040s, and 56% to 74% for the 2080s. Increases in annual heating energy demand will affect both fossil fuel use for heating and demand for electrical power.

- **Residential cooling energy demand is projected to increase rapidly due to increasing population, increasing cooling degree days, and increasing use of air conditioning (Figure 8).** In the absence of warming, population growth would increase cooling energy demand in WA by 38% by the 2020s, 69% by the 2040s, and 131% by the 2080s. For fixed 2000 population, warming would increase cooling energy demand by 92% to 118% for the 2020s, 174-289% for the 2040s, and 371% to 749% by the 2080s due to the combined effects of increased cooling degree days, and increased use of air conditioning. Combining the effects of warming with population growth, cooling energy demand would increase by 165% to 201% (a factor of 2.6-3.0) for the 2020s, 363-555% (a factor of 4.6-6.5) for the 2040s, and 981-1845% (a factor of 10.8-19.5) by the 2080s. Increases in cooling energy demand are expected to translate directly to higher average and peak electrical demands in summer.
- **Taken together the changes in energy demand and regional hydropower production suggest that adaptation to climate change in cool season will be easier than in warm season.** Increases in hydropower production in winter will at least partially offset projected increases in heating energy demand due to population growth. Adapting to projected increases in cooling energy demand (which would result in increased electrical energy demand) will be more difficult because of reductions in hydropower production in the peak air conditioning season. These effects in summer will put additional pressure on other sources of energy.

[13] Population estimates in this study used information from both the Washington Growth Management Act estimates and global estimates. See Energy chapter for details.

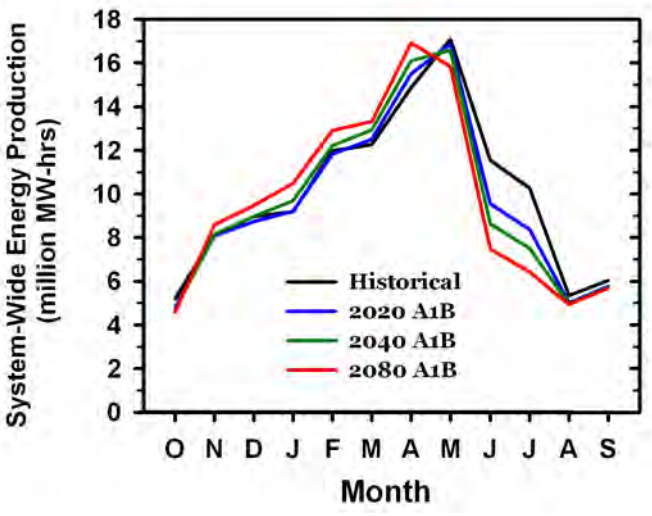

Figure 7. Long-term average system-wide energy production from the Columbia River hydro system for historical 20th century climate (1917-2006) by month, compared to future scenarios for the 2020s, 2040s, and 2080s for the medium (A1B) emissions scenario.

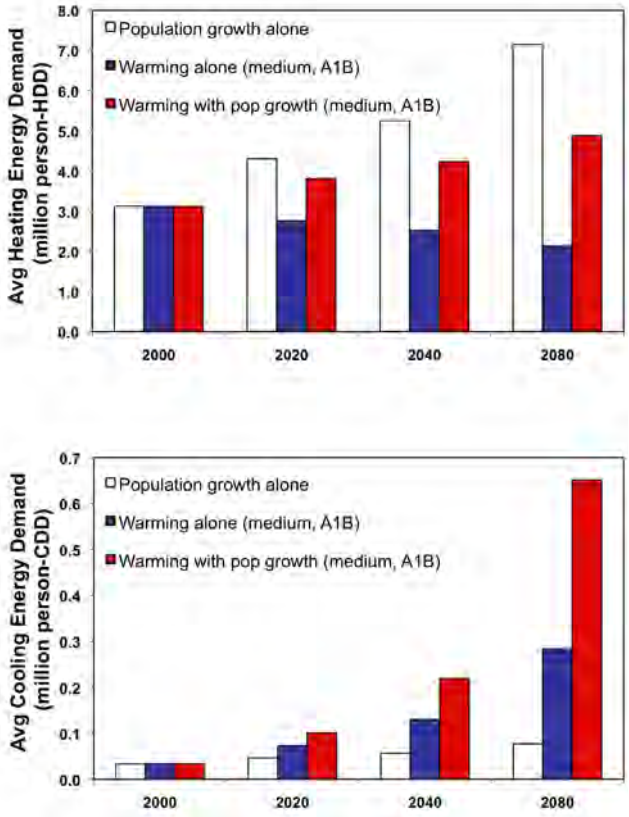

Figure 8. Heating energy demand (top) and cooling energy demand (bottom) for projected population growth and regional warming averaged over Washington. Units: million person-heating degree days (HDD) or million person-cooling degree days (CDD).

5. Agriculture

The impact of climate change on agriculture in eastern Washington State is assessed in this study by focusing on the major commodities in terms of output value: apples, potatoes, and wheat. Agricultural impacts depend on the direct effects of climate, but they also depend on increasing atmospheric carbon dioxide (CO_2) independent of CO_2's influence on climate. Increased CO_2 in the atmosphere can increase crop yields for some plants and also increase water use efficiency, which in turn may provide additional benefits in dryland crop yields. Projections presented assume that plants have adequate supply of nutrients and are well protected from pests and weeds, and for irrigated crops they assume adequate availability of water for irrigation (see section 3.2, Water Management and Irrigated Agriculture). Crop response to climate change[14] is assessed based on changes for 2020, 2040, and 2080 scenarios with respect to a baseline climate (1975-2005).

- **The impact of climate change on these crops in eastern Washington is projected to be mild in the short term (i.e., next two decades), but increasingly detrimental with time, with potential yield losses reaching 25% for some crops by the end of the century**. However, increased atmospheric CO_2 will likely offset some of the direct effects of climate and result in important yield gains for some crops. There is some debate about whether the CO_2 effect on plants will be temporary (perennial plants may adapt to new conditions or growth of plants in natural environments may be limited by other factors), but mounting experimental evidence involving agricultural crops show a definite beneficial effect of "CO_2 fertilization" on growth and yield of many crops, even for perennial crops such as fruit trees that are expected to be in production for many years.
- **Yields of dryland winter wheat are projected to increase (2% to 8%) for the 2020s and remain unchanged or increase slightly for the 2040s because earlier maturity in response to warming will allow plants to avoid some water stress.** However, yield reductions (4% to 7%) are projected for the 2080s in the higher precipitation region. When CO_2 increase is added, yields are projected to increase by 13% to 15% (2020s), 13% to 24% (2040s), and 23% to 35% (2080s), with the larger gains in drier sites. No change in spring wheat yields is projected for the 2020s, but declines of 10% to 15% for the 2040s, and 20% to 26% for the 2080s are projected due to climate change. Increased CO_2 will compensate for decreased yields, leading to increases of 7% and 2% for the 2020s and 2040s at Pullman, but a 7% increase (2020s) followed by a 7% reduction (2040s) at Saint John. Earlier planting combined with CO_2 elevation is projected to increase yields by 16% for the 2020s.
- **Yields of fully irrigated potatoes are projected to decline by 9%, 15%, and 22% for the 2020s, 2040s, and 2080s, respectively, with smaller losses of only 2% to 3% for all scenarios when the effect of CO_2 is included.** The development of varieties with a longer duration of green leaf area, combined with elevated CO_2, could potentially result in yield gains of ~15%. However, tuber quality is a concern due to tuber growth limitations under warmer conditions.
- **Without the effect of elevated CO_2, future climate change is projected to decrease fully irrigated apple production by 1%, 3%, and 4% for the 2020s, 2040s, and 2080s, respectively.** When the effect of CO_2 is added, yields are projected to increase by 6% (2020s), 9% (2040s), and 16% (2080s). Realizing potential yield gains and maintaining fruit quality standards at higher yields will require management adaptations.

Caveats of the projection of impacts on agriculture presented in this study are: a) possible changes in the frequency and persistence of extreme temperature events (both frosts and heat waves) are not well represented in current climate projections, which could adversely affect crop yields, b) the extent to which the potential benefits of elevated CO_2 will be realized is moderately uncertain, c) changes in impacts by pests, weeds, and invasive species could affect agriculture in ways not described here, and d) although water supply was assumed to be sufficient for irrigated crops, other studies (see Water Resources - Irrigated Agriculture) indicate that it may decrease in many locations as a result of climate change, adding additional stress.

[14] Climate change scenarios in the Agriculture sector used future scenarios from four global climate models with contrasting future conditions, rather than the average of many scenarios. These models were PCM1 (a model that projects less warming and more precipitation for the Pacific Northwest), CCSM3 (a model that projects more warming and less precipitation for the Pacific Northwest), and ECHAM5 and CGCM3 (models that project intermediate changes compared to the first two). All modeling used medium (A1B) CO_2 emission scenarios.

6. Salmon Production and Distribution

Climate plays a crucial role in salmon ecology at every stage of their life cycle. Key limiting factors for freshwater salmon reproductive success depend on species, their life history, watershed characteristics, and stock-specific adaptations to local environmental factors. The overarching questions addressed here are: (1) How will climate change alter the reproductive success of salmon and steelhead in freshwaters of Washington State? and (2) Where and under what conditions will salmon habitat be most vulnerable to climate change (increasing water temperatures and changes in the timing and amount of streamflow)?

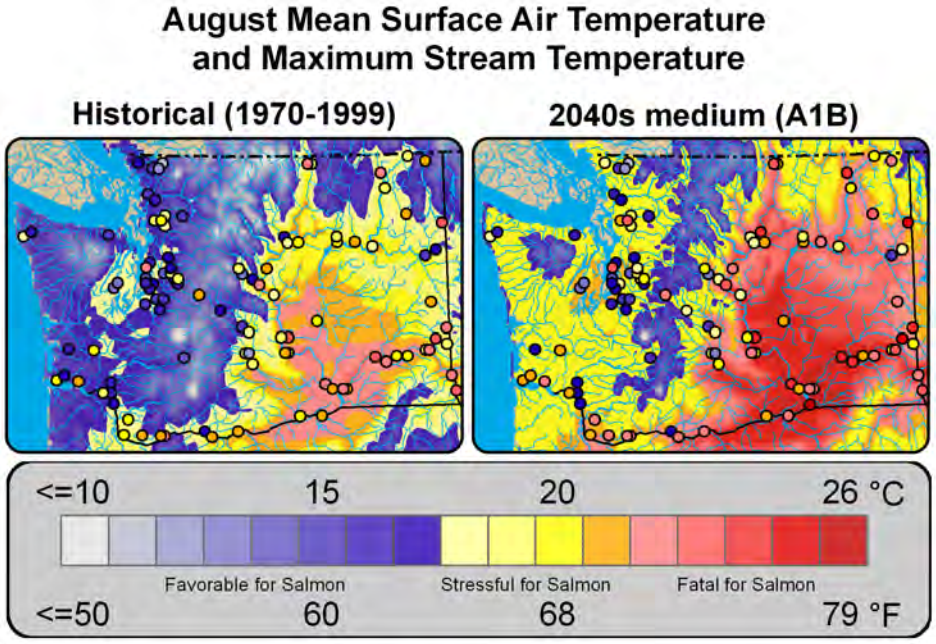

Figure 9. August mean surface air temperature (colored patches) and maximum stream temperature (dots) for 1970-1999 (left) and the 2040s (right, medium emissions scenario, (A1B)). The area of favorable thermal habitat for salmon declines by the 2040s in western Washington, and in eastern Washington many areas transition from stressful to fatal for salmon. Circles represent selected stream temperature monitoring stations used for modeling stream temperatures.

- **Rising stream temperature will reduce the quality and quantity of freshwater salmon habitat substantially.** Since the 1980s the majority of waters with stream temperature monitoring stations in the interior Columbia Basin have been classified as stressful for salmon (where annual maximum weekly water temperatures exceed 60°F). Water temperatures at these stations are projected to become increasingly hostile for salmon under both medium (A1B) and low (B1) emissions scenarios. The duration of temperatures[15] causing migration barriers and thermal stress in the interior Columbia Basin are projected to quadruple by the 2080s. Water temperatures for western Washington stations are generally cooler, and projected increases in thermal stress are significant but less severe - the duration of temperatures greater than 70°F will increase but such temperatures are still projected to be relatively rare for all but the warmest water bodies in Washington (Figure 9).

- **In the major river systems of Puget Sound and lower elevation basins in the interior Columbia Basin, flood risk will likely increase, which in turn increases the risk of streambed scouring of spawning habitat.** In snowmelt-dominated watersheds that prevail in the higher altitude catchments and in much of the interior Columbia Basin, flood risk will likely decrease. Summer low flows will decrease in most rivers under most scenarios (Figure 10), leading to reduced habitat capacities for rearing juveniles that must spend at least one summer in freshwater.

- **Consequences of these changes will vary with different populations and with where they spend the different parts of their life cycles.** Salmon populations that typically inhabit freshwater during summer and early fall for either spawning migrations, spawning, or rearing will experience significant thermal stress. For spawning migrations, effects of warming are projected to be most severe for adult summer steelhead, sockeye, and summer Chinook populations in the Columbia Basin, sockeye and Chinook in the Lake Washington system, and summer chum in Hood Canal. For rearing habitat, impacts of warming will likely be greatest for coho and steelhead (summer and winter run) throughout western Washington. Reductions in summer and

[15] Thermal stress for salmon in streams can be of several types. Salmon suffer physical stress when stream temperatures are too warm, but warm waters also present thermal barriers to migration because the water is too warm for salmon to pass through. Where weekly water temperatures exceed 70°F, both physical stress and thermal barriers to migration are very likely.

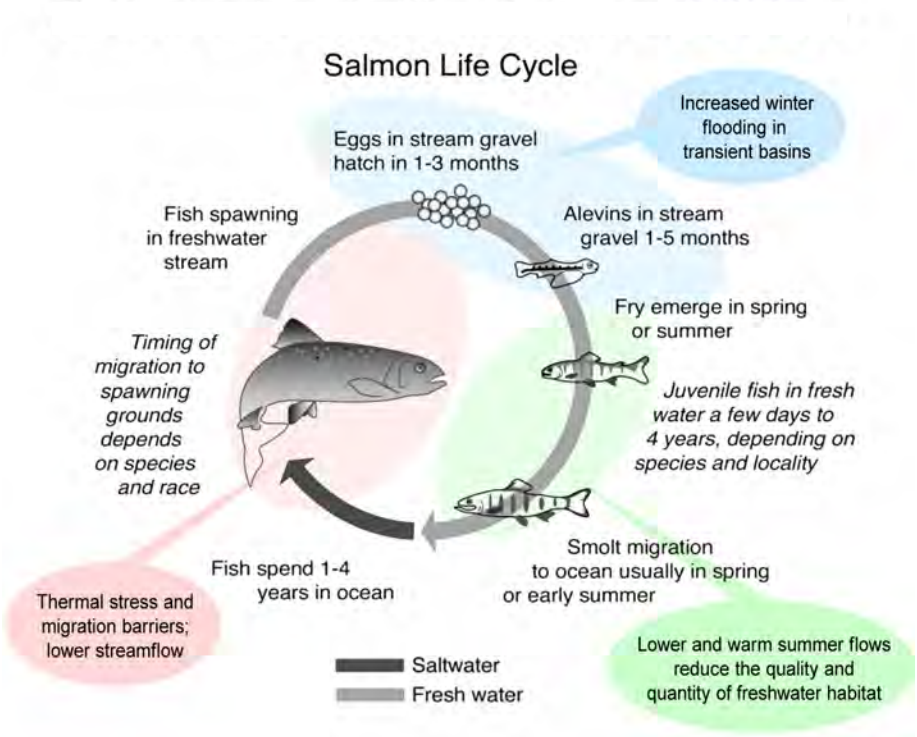

Figure 10. Life cycle assessment and impacts mechanisms for salmon and steelhead in Washington.

fall flows will likely negatively impact the rearing capacities and for coho, steelhead, and stream type Chinook because they all have a life history pattern that requires at least one year of juvenile rearing in freshwater.

7. Forests

Climate influences nearly all aspects of forest ecosystems. Forest fires, insect outbreaks, tree species' ranges and forest productivity are closely tied to climate. Profound changes in forest ecosystems are possible given the magnitude of projected climate changes. The combined climate change impacts on tree growth, regeneration, fire, and insects will fundamentally change the nature of forests, particularly in ecosystems where water deficits are greatest. Many impacts will likely occur first in forests east of the Cascade crest, but forests west of the Cascades will likely experience significant changes in disturbance regime and species distribution before the end of the 21st century.

- **Due to changes in summer precipitation and temperature, the area burned by fire regionally (in the U.S. Columbia Basin) is projected to double or triple (medium scenario, (A1B)), from about 425,000 acres annually (1916-2006) to 0.8 million acres in the 2020s, 1.1 million acres in the 2040s, and 2.0 million acres in the 2080s.** The probability that more than two million acres will burn in a given year is projected to increase from 5% (1916-2006) to 33% by the 2080s. Fire regimes in different ecosystems in the Pacific Northwest have different sensitivities to climate, but most ecosystems will likely experience an increase in area burned by the 2040s. Year-to-year variation will increase in some ecosystems.
- **Due to climatic stress on host trees, mountain pine beetle outbreaks are projected to increase in frequency and cause increased tree mortality.** Mountain pine beetles will reach higher elevations due to a shift to favorable temperature conditions in these locations as the region warms. Conversely, the mountain pine beetle will possibly become less of a threat at middle and lower elevations because temperatures will be unfavorable for epidemics. Other species of insects (such as spruce beetle,

Douglas-fir bark beetle, fir engraver beetle, and western spruce budworm) will possibly also emerge in areas that are no longer suitable for the mountain pine beetle.

- **The amount of habitat with climate ranges required for pine species[16] susceptible to mountain pine beetle will likely decline substantially by mid 21st century (Figure 11).** Much of the currently climatically suitable habitat is in places unlikely to have future climatic conditions suitable for pine species establishment and regeneration, and established trees will be under substantial climatic stress. The regeneration of pine species after disturbance will likely be slowed, if the species can establish at all.
- **The area of severely water-limited forests[17] will increase a minimum of 32% in the 2020s, and an additional 12% in both the 2040s and 2080s (Figure 11, medium scenario, (A1B)).** Douglas-fir productivity varies with climate across the region and will potentially increase in wetter parts of the state during the first half of the 21st century but decrease in the driest parts of its range. Geographic patterns of productivity will likely change; statewide productivity will possibly initially increase due to warmer temperatures but will then decrease due to increased drought stress. It is important to note that changes in species mortality or regeneration failures will possibly occur before the point of severe water limitation (as it is defined here) is reached.

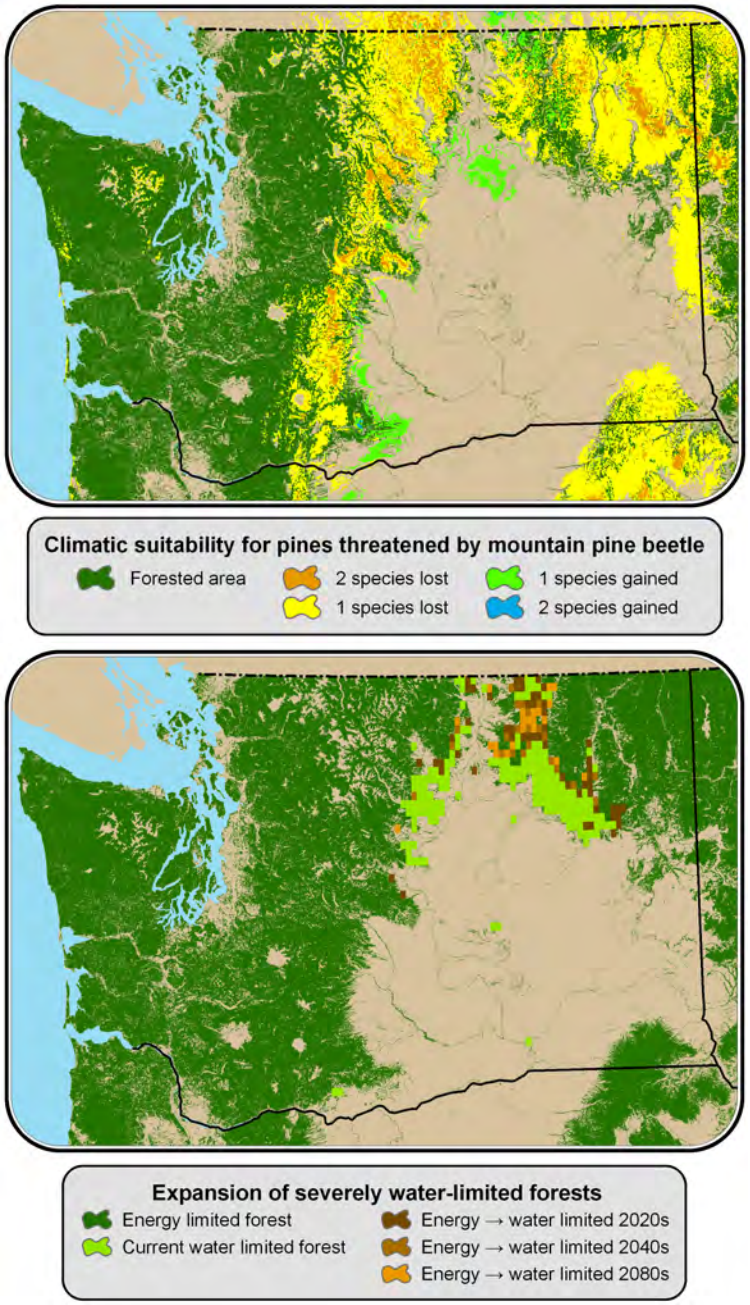

Figure 11. Changes in areas of potential pine species' ranges for 2060 (top panel) and severely water limited forest (bottom panel) in Washington. Areas of orange and yellow in the top panel indicate areas where one or more species of pines will possibly have difficulty re-establishing after disturbance (fire, insect attack, etc.) because the climate is beyond the ranges to which they are adapted (Data: Rehfeldt et al. 2006, multiple IPCC emissions scenarios[18]). Hydrologic modeling suggests that many forested areas on the northern edge of the Columbia basin will become severely water limited (bottom, scenario A1B), defined conservatively as those forests where summer environmental water demand exceeds annual precipitation. The area of water limited forests would increase substantially if the definition is expanded to a more general definition where forests are water limited if annual water demand exceeds annual precipitation (not shown).

[16] Ponderosa pine, lodgepole pine, and whitebark pine were considered in this study.

[17] Severely water limited forests occur where the annual supply of water does not meet the summer environmental demand for water. Specifically, when summer potential evapotranspiration exceeds annual precipitation, there is severe water limitation.

[18] The data (from Rehfeldt et al. 2006) used for this analysis were developed by researchers using similar emissions scenarios in an older generation of global climate models to model tree species' ranges in western North America. The ranges of projected future climate changes used in Rehfeldt are comparable to those developed for this assessment.

8. Coasts

Washington State's approximately 3000 miles of coastline (Figure 12) are diverse, ranging from the sandy beaches and shallow waters of Willapa Bay to the steep rocky shores in the San Juan Islands, to the heavily populated but relatively unstable bluffs of the Puget Sound region. While global climate change will drive the same basic physical changes throughout the region, each shore area, and the human activities in those areas, will respond in specific ways depending upon substrate (sand versus bedrock), slope (shallow versus steep cliffs), and the surrounding conditions (exposed versus sheltered from storms). Because Washington's coasts are heavily utilized for ports, home sites, public recreation, wildlife habitat, and shellfish aquaculture, these physical effects of climate change will pose significant challenges. The summary of coastal impacts, and related threats posed to homes, infrastructure, and commerce, are derived from examination of several specific sites and physical threats. Some of the specific sites examined include Willapa Bay, Bainbridge Island, Whidbey Island, the San Juan Islands, and the Ports of Seattle and Tacoma. This assessment does not examine impacts on wildlife habitat, which climate change could possibly affect through sea level rise, bluff erosion, water temperature, and other impacts.

Figure 12. Washington State coastal areas.

Overall, this brief survey of climate impacts on the coasts of Washington State has identified possible routes by which climate can interfere with typical human uses of the coast and has raised many questions requiring additional research.

- **Sea level rise will shift coastal beaches inland and increase erosion of unstable bluffs, endangering houses and other structures built near the shore or near the bluff edges (see Scenarios section for sea level rise information).** On Whidbey Island, future possible impacts include increased bluff erosion and landslides and inundation. On Bainbrige Island, inundation and, to a lesser extent, bluff erosion are possible. Willapa Bay would see possible increases in shoreline erosion.
- **Shellfish will possibly be negatively impacted by increasing ocean temperatures and acidity, shifts in disease and growth patterns, and more frequent harmful algal blooms.** Further, inter-tidal habitat for shellfish aquaculture will likely be slowly shifting shoreward as sea level rises. Health risks due to harmful algal blooms will possibly be a increasing concern, leading to more frequent closures of both recreational and commercial shellfishing.
- **The major ports of Seattle and Tacoma are only slightly above existing sea level, and both have some plans to raise the height of piers, docks and terminals in response to sea level rise.** Both ports also rely on access to highway and railroad transportation to move freight, but key railroad tracks and much of the container yards will possibly be subject to flooding without more extensive construction of dikes or land filling. Protecting the port lands and transportation networks will be a challenge for these and other ports throughout the state**.**
- **These conclusions extend to other coastal structures and facilities in the Puget Sound region which must accommodate to sea level rise or retreat to higher ground.**

Adapting to these effects will possibly involve both innovative property boundary laws to accommodate the shifting high tide lines and genetic research to select more resilient sub-species of shellfish. Further research will be a necessary element of any longer-term, adaptive strategy for climate change in the region.

9. Urban Stormwater Infrastructure

Washington's urban infrastructure elements are not equally vulnerable to weather and climate. This assessment focuses on stormwater management facilities in urban areas because the relationship to potential climate change (particularly precipitation extremes on which much of their design is based) is obvious, the consequences of inadequate facilities are severe, and the economic impact of increasing the capacity of stormwater facilities (or more severe flooding) would be substantial. Three specific areas – the central Puget Sound, Spokane, and Portland-Vancouver – were chosen for detailed analyses because they are the most populous in the state.

- **Few statistically significant changes in extreme precipitation have been observed to date in the state's three major metropolitan areas.** Nonetheless, drainage infrastructure designed using mid-20th century rainfall records may be subject to a future rainfall regime that differs from current design standards.
- **Projections from two regional climate model (RCM) simulations generally indicate increases in extreme rainfall magnitudes throughout the state over the next half-century, but their projections vary substantially by both model and region (see Figure 13).**
- **Hydrologic modeling of two urban creeks in central Puget Sound suggest overall increases in peak annual discharge over the next half-century, but only those projections resulting from one of the two RCM simulations are statistically significant.** Magnitudes of projected changes vary widely, depending on the particular basin under consideration and the choice of the underlying global climate model.

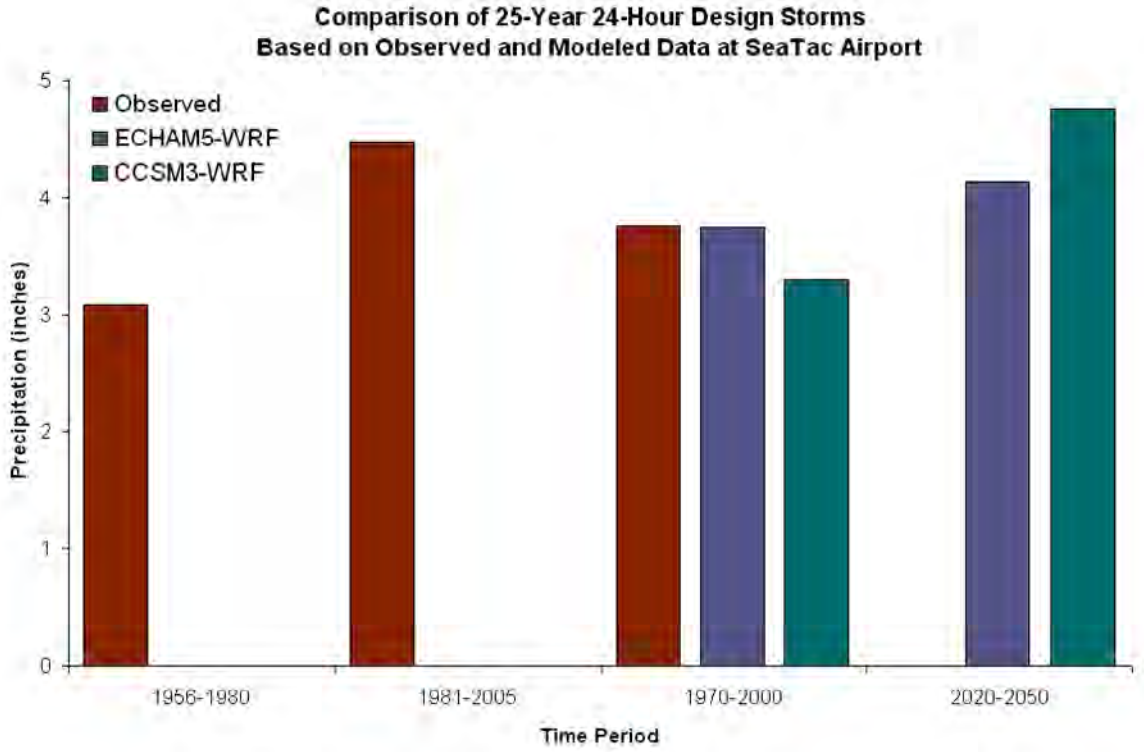

Figure 13. Comparison of 25-year, 24-hour design storms[18] based on observed and modeled (regional climate model) data at SeaTac airport. Projected changes under one climate model[19] are greater than those under another climate model, although both project increases. The historical range is similar to the range of projected changes. Note that the two time periods at left (1956 to 1980 and 1981 to 2005) overlap the third time period (1970 to 2000).

[18] 25-year, 24-hour design storm is a typical design standard for storm sewer capacity. The 25-year 24-hour design storm is the amount of precipitation falling over a 24 hour period that has a 1 out of 25 (4%) chance of being exceeded in any given year.

[19] ECHAM5 and CCSM3 are global climate models, and in this assessment, these global models were the two used to provide input conditions to a much more detailed regional climate model (WRF) – see Scenarios chapter for details.

10. Human Health

Illness and mortality related to heat and worsening air quality are core public health concerns associated with climate change projections. First, the historical relationship between mortality rates and heat events in the greater Seattle area (King, Pierce and Snohomish counties), Spokane County, the Tri-Cities (Benton and Franklin counties) and Yakima County from 1980 through 2006 are examined for different ages of people and causes of mortality. Second, increased mortality from projected heat events is estimated for 2025, 2045, and 2085. Third, increased mortality due to ozone pollution caused by climate change is estimated for mid century (2045-2054) in King and Spokane Counties. We focused on these impacts because they are among the more direct effects of climate on human health. It is possible that impacts related to communicable diseases, changes in disease vector habits, extreme weather events, and other factors would also become problematic in the future, but these were not addressed in this study.

- **Washington State residents were more likely to die during heat waves than during more temperate periods (baseline 1980-2006).** Risks increased during heat waves lasting two or more days, and were greatest for older adults. Among residents of the greater Seattle area (King, Pierce and Snohomish Counties) aged 65 and above, heat waves of two to four days' duration were associated with a 14% to 33% increase in the risk of death from non-traumatic causes. Greater Seattle residents aged 85 and above were 31% to 48% more likely to die during heat waves of two to four days (Figure 14).
- **Climate change in Washington State will likely lead to larger numbers of heat-related deaths. The greater Seattle area in particular can expect substantial mortality during future heat events due to the combination of hotter summers and population growth.** Considering just the effects of climate, a medium (A1B) climate change scenario projects 101 additional deaths among persons aged 45 and above during heat events in 2025. By 2045, approximately a 50% increase in additional deaths could be attributed directly to climate change; even more excess deaths could be expected if population continued to grow beyond 2025 projections. Nearly half of these are expected to occur among persons 85 years of age and older.
- **Although better control of air pollution has led to improvements in air quality, warmer temperatures threaten some of the sizeable gains that have been made in recent years.** The estimated number of summer deaths due to ozone pollution in 1997-2006 is 69 in King County and 37 in Spokane County. Ground-level ozone concentrations are projected to increase in both counties. Using projections of the future population size[20] and ozone concentrations, this would increase to 132 deaths in King County and 74 deaths in Spokane County by the 2040s.

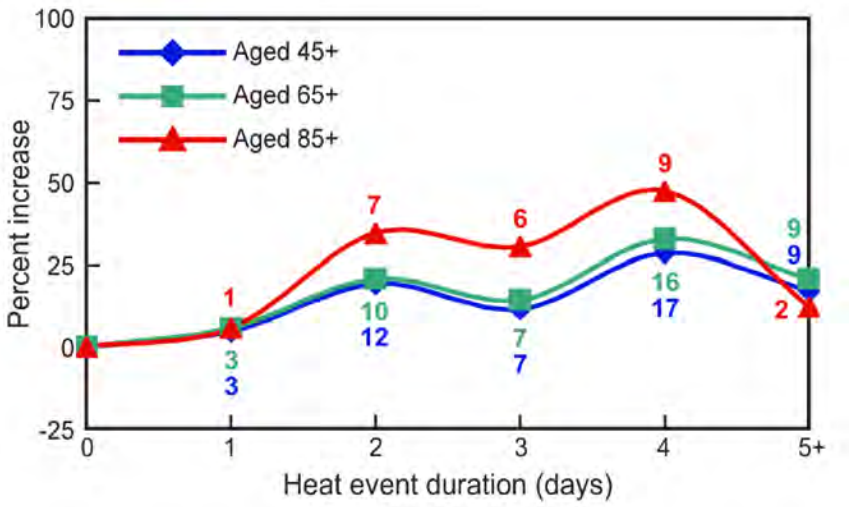

Figure 14. Percent increase in risk of death, and number of deaths each day for all non-traumatic causes by heat event duration, greater Seattle area, 1980-2006. Given 2006 population levels, residents of the greater Seattle area aged 65 and above could be expected to experience, on average, 3 additional deaths on day 1 of a heat event, 10 additional deaths on day 2, and so forth; over a 5 day heat event this age group would incur a total of 45 additional deaths, and during an average heat event of 2.2 days' duration, they would experience an additional 14 deaths. Persons aged 85 and above could be expected to experience 25 additional deaths during a 5 day heat event and 9 additional deaths during a typical heat event.

[20] Population estimates from Washington State's Office of Financial Management.

11. Adaptation

Climate change will affect many aspects of Washington's natural, institutional, economic, cultural, and legal landscape. Furthermore, because of lags in the global climate system and the long lifetime for key greenhouse gasses in the atmosphere, climate change impacts over the next few decades are virtually certain. Impacts in the second half of the 21st century are also certain, but the magnitude of those changes will be greatly influenced by the success or failure of efforts to reduce greenhouse gas concentrations both in the near-term and over time.

Preparing for (or adapting to) the impacts of climate change is necessary to minimize the negative consequences of climate change in Washington State, including an increased risk for drought, forest fires, habitat loss, and heat stress. Adapting to climate change also creates opportunities to maximize the benefits of climate change, such as a longer growing season and increased winter hydropower production. Additional reasons for preparing for climate change at the state and local level are provided in Box 4.

Navigating Washington's changing future will require regulatory, legal, institutional, and cultural changes to reduce the barriers that limit building a more climate resilient Washington. Washington's commitment to adapting to climate change was formalized on February 7, 2007, when Governor Christine Gregoire signed the Washington Climate Change Challenge (Executive Order 07-02). In addition to establishing greenhouse gas reduction goals for the state, Executive Order 07-02 committed the state to determining what steps the State could take to prepare for the impacts of climate change in five key sectors: public health, agriculture, coasts and infrastructure, forestry, and water supply. Adaptation recommendations from the Preparation/ Adaptation Working Groups (PAWGs) were presented to the Governor in February 2008.

The Washington Climate Change Impacts Assessment complements the State's effort with the PAWGs by providing updated and expanded details on the potential impacts of climate change in Washington. It is important to note that the adaptation discussion in the Washington Assessment should be viewed as starting point for initiating a more systematic look at the adaptation needs identified by the PAWGs in addition to other potential options. This could be done with continued involvement from the PAWGs and/or through a combination of intra- and inter-agency working groups (and public input) convened to evaluate what adaptation options are needed and how they can be implemented.

Box 4. Why Preparing for Climate Change Is Required at the State and Local Level

1. Significant regional-scale climate change impacts are projected.
2. State and local governments, businesses, and residents are on the "front line" for dealing with climate change impacts.
3. Decisions with long-term impacts are being made every day, and today's choices will shape tomorrow's vulnerabilities.
4. Significant time is required to develop adaptive capacity and implement changes.
5. Preparing for climate change may reduce the future costs of climate impacts and responses.
6. Planning for climate change can benefit the present as well as the future.

As Washington's state and local governments begin considering how to address climate change impacts, three fundamental principles must be recognized. **First, there is no "one size fits all" solution for adapting to climate change.** Options for adapting to climate change vary among sectors (e.g., between water resources and forest ecosystems) and even within sectors (e.g., between watersheds) depending on the unique characteristics of the systems being considered. Adapting to climate change will require multiple actions implemented over varying time frames based on projected impacts, resources, and risks.

Second, adapting to climate change is not a one-time activity. Climate will continue to change as will Washington's communities, economies, social preferences, and policies and regulations. The assumptions that shape adaptive planning must be revisited periodically and adjusted to reflect these changes. Thus, adapting to climate change must be seen as a continuous series of decisions and activities undertaken by individuals, groups, and governments rather than a one-time activity.

Third, effective adaptation will require more regulatory flexibility and systematic integration of governance levels, science, regulation, policy, and economics. Increased flexibility and integration is needed to accommodate uncertainties of climate change as well as the uncertainties in non-climatic stresses, such as population growth, changing

resource demands, and economic trends. More general options for increasing flexibility in Washington State policy-making include, but are not limited to, building social capital (increasing knowledge and engagement); broader use of market mechanisms, conditional permitting, adaptive management, and the precautionary principle; and increasing legislative flexibility in the courts. Implementing no-regrets, low-regrets, and win-win (co-benefit) strategies are also effective ways of moving forward with adaptation in the face of uncertainty. Without more integration and flexibility, the institutions, laws, and policies used to govern human and natural systems could become increasingly constrained in their ability to effectively manage climate change impacts.

Implementing the PAWG recommendations and adaptation options identified in this report will require a concerted effort on the part of state and local decision makers, working in partnership with federal agencies, tribal governments, and the private sector, to make needed changes in how human and natural systems are governed in Washington. Washington State faces unprecedented economic challenges, however. A significant budget deficit looms and deep cuts will be required to balance the state budget.

Despite these challenges, preparing for climate change can continue from its important beginnings in the 2007 PAWG process. Many of the actions recommended by the PAWG process as well as others provided within this report require nominal fiscal resources. Furthermore, many adaptive actions may create cost savings through damage avoidance or delayed infrastructure upgrades, for example. Finally, many of the changes required to develop a more climate-resilient Washington will take time to implement. Waiting for climate change to "arrive" will be too late in some cases and could be significantly more costly in other cases.

12. Conclusion

Climate plays a strong role in many of the resources and the quality of human life in Washington State. Projected increases in temperature and accompanying variability in precipitation point to a very different future for Washington's people and resources than that of the recent past. All sectors examined in this study project quantifiable impacts of climate change on important resources, and the projections of future climate indicate that these impacts are very likely to grow increasingly strong with time.

- **Adaptation to the changes in climate and their impacts on human, hydrological and ecological systems is necessary because the projected impacts of climate change are large.** There is enough current scientific information to plan and develop strategies for future projected climate changes and impacts even though information is not always complete. For example, "no regrets" strategies that provide benefits now and potential flexibility later are a good place to start. However, adaptation could be costly in some cases where the rate of change is very fast or where severe impacts are spread over large areas. Finally, significant impacts are projected in some sectors as early as the 2020s and certainly by the 2040s – these are not "far in the future" impacts.
- **To the extent that it can be identified, quantified, and mitigated, uncertainty is a component of planning, not a reason to avoid planning.** Many sectors report different impacts in different systems (e.g., snowpack response in low vs. high elevations, fire response in the western Cascades vs. Blue Mountains, different salmon populations and different crops etc.), but the **natural complexity (variability in geographic space and in time, such as decadal climate variability) of these systems is a key part of planning for the future.** Better climate information, better monitoring, and better awareness of complexity are all required to anticipate future impacts and to develop adaptation strategies that are likely to be successful.
- While there is compelling evidence that climate in the next century will differ markedly from that of the past, the exact nature of those differences are impossible to predict with precision. Our sensitivity to the inherent uncertainty of future climate change can be evaluated through an examination of multiple future climate scenarios and their associated impacts. **By understanding the likely direction and magnitude of future climate changes and impacts, we can manage risks and exploit opportunities in an informed and systematic way.**

Climate Science
in the Public Interest

APPENDIX C

Thurston County Public Health and Social Services
Planning for Health Consequences of Climate Change, A NACCHO Demonstration Project 2009-2010
White Paper: Projected Health Impacts of Climate Change in Thurston County

Thurston County Public Health & Social Services

Planning for Health Consequences of Climate Change

A NACCHO Demonstration Project 2009-2010

White Paper:
Projected Health Impacts of Climate Change in Thurston County

1. Scope of this paper
2. Future Thurston County climate
    a. Temperature
    b. Precipitation
    c. Sea-level rise
    d. Extreme events
3. Major climate impacts and related health impacts
    a. Heat waves
    b. Air quality
        i. Particulates
        ii. Ground-level Ozone
        iii. Pollen/fungal spores
    c. Infectious disease
        i. Arboviral
        ii. Food- and water-borne
        iii. Hantavirus
    d. Weather events
        i. River flooding
        ii. Storm water and urban flooding
        iii. Sea-level rise
        iv. Drought
    e. Social/psychological impacts
        i. Migration
        ii. Social services and public health
        iii. Energy demand
        iv. Stress, alienation, and health
4. Summary - chart of weather event, health effect, population affected
5. References

Scope of this Paper

This paper is a summary of the public health effects that can be expected due to climate change impacts in the Thurston County area. The information is based on a review of literature, websites, and conversations with local researchers. This review was conducted in September of 2009, as one of the early steps in carrying out a grant award from the National Association of City and County Health Officials (NACCHO) towards Goal 1: "Build Health Department understanding of and capacity to plan for the public health consequences of climate change."

The Centers for Disease Control and Prevention states (CDC 2009):

> There is widespread scientific consensus that the world's climate is changing. Some of the effects of climate change are likely to include more variable weather, heat waves, heavy precipitation events, flooding, droughts, more intense storms such as hurricanes, sea level rise, and air pollution. Each of these changes has the potential to negatively affect health.

Future Thurston County Climate

The University of Washington's Climate Impacts Group examined numerous models of future climate and produced scenarios of future climate for the Pacific Northwest (PNW) (CIG 2009). They are developing a regional climate model to look at regional-scale climate change impacts but this is not available at the time of this writing. Most of the following changes in temperature, precipitation, sea-level rise, and extreme weather events are taken from their scenarios project, with several other local research sources added in.

Temperature:

In comparison with the 20th century, the PNW climate will be warmer in the 21st century.

- Temperature corresponds to CO2 and other greenhouse gasses. Estimates of future carbon dioxide (CO2) concentrations range from 549 to 970 ppm by 2100. This increase is 2 to 3.5 times the pre-industrial (circa 1750) value of 280 ppm (CIG 2009).
- Climate models project an average rate of warming of approximately 0.5°F per decade through the 2050s; the observed rate of 20th century PNW warming was approximately 0.2°F per decade. The rate of change after the 2050s depends increasingly on the choice of greenhouse gas emissions scenarios.
- Recent reports (United Nations Environment Program 2009) project an even greater temperature rise, of 6.3°F by the end of the century.

- All seasons will be warmer. Temperatures are projected to increase across all seasons with most models projecting the largest temperature increases in summer (June-August).
- Average annual temperature will likely exceed the range of 20th century variability. Average annual temperature in the 21st century could increase beyond the range of year-to-year variability observed in the PNW during the 20th century as early as the 2020s.

Precipitation:

- Average annual precipitation in the PNW will likely stay within the range of 20th century variability. Taking an average of all models, CIG estimates that annual precipitation will increase only 1 to 2%.
- Existing seasonal patterns of precipitation could be exaggerated. Just over half (59%) of the models and scenarios analyzed show an increase in winter (Dec-Feb) precipitation in the 2020s and 2040s. By the 2080s increases in winter precipitation are more likely. More than 70% of models and scenarios analyzed agree that summer precipitation will decrease. Regardless of how much total winter precipitation changes, a larger percentage of overall winter precipitation is expected to fall as rain rather than snow due to warmer winter temperatures.
- Romero and Biever (2009) identified six precipitation patterns that regulate peak flow in our region's streams and lead to ground water or stream flooding. Four of these are from heavy rainfalls within a few days. The other two are from cumulative high rainfalls, greater than 15 inches in a month. Looking at the frequency of these six patterns over the last decade, Romero and Biever found they occurred 10 times from 1999 to 2009. However, during the previous five decades only one to four of these heavy precipitation patterns was found, per decade. (Note: The rain-on-snow event, such as we saw in the major flood of 2007, is not one of these six patterns and has a more anecdotal connection with flooding but clearly remains another pattern for peak floods [TRPC 2009].) Their research implies that heavy monthly rainfalls may become the norm and identification of the precipitation patterns early on could help emergency responders prepare.

Sea-level rise: Mote et al. (2008) project a "medium" estimate of 21st century sea-level rise for Puget Sound to closely match that of global sea-level rise. The Intergovernmental Panel on Climate Change (IPCC) projects global sea-level rise over the course of this century to be between 18 and 38 cm (7-15") for their lowest emissions scenario, and between 26 and 59 cm (10-23") for their highest emissions scenario.

Sea level is already rising in Olympia by about one foot per century due to post-ice age warming of the oceans and possibly subsidence of the land (City of Olympia 1993). Downtown Olympia lies only one to three feet above the current highest high tides. The one-foot sea level rise predicted by 2050 would result in ponding on some streets and flooding of low-lying structures once or twice a year during extreme high tides. Tidal waters flow "up" the storm water pipe systems and discharge into streets (A. Haub, personal communication 2009). If sea level rises more rapidly than assumed in that projection, the two-foot rise could result in stormwater not being able to discharge in several areas during extreme precipitation events. Flows could reverse during high tides and storms and the sea would flow from street drains into the streets.

Downtown Olympia has a network of wastewater lines, some of which are combined with stormwater pipes. Recent work has identified the areas that could overflow with mixed sewage and stormwater under different scenarios. The storm water and wastewater pipes are not definitively segregated into different areas of downtown (A. Haub, personal communication 2009).

Extreme Weather Events:

The Climate Impact Group (2009) does not speculate on how climate change may affect extreme weather events in the northwest in the future, stating that "Many key aspects of climate (e.g., windstorms, heat waves) either are not well simulated by models or cannot be studied using monthly mean values which are the standard model output." They go on to state:

> However, droughts may become more common due to the effects of warmer temperatures and reduced winter snowpack on late summer streamflows. Changes in the intensity of precipitation are uncertain, although a preliminary analysis suggests that average monthly (Nov-Jan) winter precipitation could become more intense by the end of the 21st century. Additionally, ongoing work at the CIG suggests that extreme daily precipitation could increase by the end of the century.

Major Climate Impacts and Related Health Impacts

The Climate Action Team identifies five mechanisms through which climate change is likely to affect health (CAT 2008):

1. Thermal stress from heat waves
2. Degradation of air quality
3. Infectious diseases, especially vector-borne and zoonotic diseases (VBZ)
4. Extreme weather events affecting public safety

5. Psychological stress, social disruption and economic disparities

Heat Waves

Short, intense heat waves have been responsible for hundreds of deaths in the United States and thousands in Europe in recent years. As heat waves become more frequent, more intense and longer lasting, the greatest impacts will be felt in cities with historically milder summers, less air conditioning and higher population densities. This describes the major cities of Washington State (CAT 2008), and the combined metropolitan areas of Olympia-Tumwater-Lacey may experience heat wave conditions of a greater intensity than years past (P. Brewster, TRPC personal communication 2009). One of the reasons heat waves are problematic is there is a lack of cooling overnight (Easterling 2009).

Elderly and very young populations, pregnant women, and the chronically ill are particularly vulnerable to thermal stress, also called hyperthermia. Effects include heat cramps, brief loss of consciousness, heat exhaustion, and heat-stroke (PAWG 2009). Others at greater risk include (Appendix P):

- Exercising children in particular are slower than adults to adapt to heat stresses
- Poor and isolated populations
- Urban dwellers and those living in heat islands (areas with more asphalt and fewer trees) within cities
- Adults engaged in heavy outdoor labor
- People with chronic disease (diabetes, heart disease, asthma, obesity) due to illnesses themselves and medications used
- Mentally ill, because of behavioral factors and the effect of psychoactive medications

Jackson et al. (2009) projected heat-related mortality due to increased temperatures and ran scenarios for three areas of Washington – King/Snohomish/Pierce, Spokane, and Tri-Cities. Looking at the King County area scenario, projected warming would likely result in 101 additional deaths among persons aged 45 and above during heat events in 2025 and 156 additional deaths in 2045 in the greater Seattle area alone (relative to 1980-2006). This specific review could also be done for Thurston County although the basic conclusion is that as summer heat increases and as the population grows, we can expect an increase in heat-related deaths, especially for people over age 45.

Air Quality

Air quality is adversely affected by higher temperatures, causing increases in both ground-level ozone levels and particulates. Poor air quality has direct impacts on respiratory and cardiac function; both acute and chronic pulmonary and cardiovascular disease are sensitive

to air quality. An additional health factor is a longer pollen season with increased allergenicity of some aeroallergens. Potential health effects are serious and include increased in numbers who develop chronic lung disease, asthma, lung cancer, and cardiovascular disease, and an increase in low birth weight or prematurity in newborns (CAT 2008).

- Ground-Level Ozone: Levels of ozone are highest in the summer, when temperatures rise and accelerate ozone-forming reactions. There will be an increase in the number of days in summer when ozone concentrations exceed regulatory standards and compromise health, particularly for individuals with asthma, chronic obstructive pulmonary disease, and those who work or play outside for extended periods of time (PAWG 2009).
- Particulates: Large wildfires (greater than 200 acres) contribute to air pollution, particularly in rural areas. Most wildfires in Thurston County are quite small (one acre or less) (Paul Brewster, TRPC, personal communication 2009). Between 1972-2007, a total of 2,473 fires occurred in Thurston County, about 70 per year on average. The largest recorded wildland fire was a grass fire off Old Highway 99 near Offut Lake in August 1998. It burned 140 acres. To Brewster's knowledge, wildfires have not caused significant loss of human life, injury, or damage to public infrastructure or private property in Thurston County. Larger fires could pose greater risks to people and property in the future as the fire season lengthens due to higher temperatures and drier conditions. Wildfires are a source of PM2.5, the fine fraction of particulate matter that is a health concern. (Vehicle exhaust is another source of PM2.5.) Higher temperatures would increase the frequency of wildfires; particulate matter is also trapped by temperature inversions. Increased particulate matter is associated with increases in both acute respiratory and cardiovascular effects which in turn will increase physician and emergency department visits and hospitalizations for asthma, heart attacks, and other cardiopulmonary conditions (PAWG 2009).
- Pollen/Fungal Spores: There will be an increase in some aeroallergens (pollens, fungal spores), an increase in the duration of the pollen season, and increased allergenicity of these aeroallergens (due to biological factors and combined exposure with increased particulate matter). Thus there may be an increased number of individuals who develop allergic symptoms and worsened symptoms in those already affected (PAWG 2009).

Heart disease is the leading cause of death in Washington State citizens over 65 years of age. By mid-century, King County will likely experience 132 additional deaths between May and September annually due to worsened air quality caused by climate change (Jackson et al 2009). In general, worsening air quality will have a disparate impact on elderly, young, urban

and rural poor, and those who spend more time outside, including the homeless, children active in sports, and outdoor laborers.

Infectious Disease

Increased temperatures and flooding may contribute to communicable diseases by influencing the habitat and range of disease reservoirs and vectors, by shaping human behaviors that might lead to increased exposure to a disease or vector, and through effects on the characteristics of the disease pathogen, or on the immune response of the host. More than 30 infectious diseases may be affected by climate change, and the whole spectrum of vector-borne and zoonotic disease (e.g., rabies, which can be transmitted from animals to humans) could change as temperatures rise. Changes in disease epidemiology should be expected. Important vector-borne and zoonotic diseases in Washington include Hantavirus pulmonary syndrome (spread by rodents), Vibriosis (raw shellfish), and mosquito-borne diseases such as malaria and West Nile virus (CAT 2008).

Human behavior may change due to recreational water use, outdoor food preparation and consumption, and increased or decreased clothing coverage. Extreme precipitation and flooding may increase exposure to waterborne pathogens that may contaminate surface and ground water supplies.

Expansion of the range of important insect and animal vectors and the diseases they transmit is one of the first impacts of rising temperatures. Many of these conditions – such as West Nile Virus and Hantavirus – are already targets of public health monitoring and surveillance. Other potential disease problems such as malaria, dengue fever, and certain vector-borne encephalitides would be new to Thurston County. However, there are limited studies on the effects of climate change on vectors like ticks and mosquitoes, thus it is not known whether increased disease will coincide with increased range.

- Arboviral diseases: Arboviral diseases are arthropod-borne viral diseases and include malaria, dengue, and West Nile. While no malaria has been contracted within the United States recently, the disease vectors for malaria do exist in Washington. West Nile Virus has been detected in 19 birds, 64 horses, and 326 mosquitoes, and there have been 25 human cases in Washington State as of fall 2009. (http://www.doh.wa.gov/ehp/ts/Zoo/WNV/WNV.html). Dengue is moving up into lower USA. Arboviral diseases are required to be reported to local health officials in Washington State (PAWG 2009).
- Food- and Water-Borne Illnesses: Climate change may influence pathogens' growth, virulence, and persistence or people may come in increased contact with the pathogens through climate events such as floods. The most commonly reported

enteric disease in Washington is *Campylobacteriosis*, with nearly 1000 cases reported in 2006. This disease appears to peak in warmer seasons. *Salmonella* also peaks in summer months, although this may be due to people's eating habits rather than a property of the bacterium. *Gastroenteritis* is caused by viruses and may be transmitted via food, drinking water, or recreational water. No studies have clearly linked temperature to disease occurrence. Gastroenteritis is not a reportable condition in Washington. *Vibriosis* is mainly contracted through consumption of raw or undercooked shellfish; there were 113 cases in 2007. Vibriosis is very likely to be an increasing threat to human populations with warmer summer temperatures. Outbreaks of water-borne diseases frequently follow heavy rain, flooding, and hurricanes; surface water contamination is a greater risk than ground water. Crops may become contaminated with *E. coli*, salmonella, or other pathogens during floods (PAWG 2009). *Cryptosporidiosis* and *giardiasis* are caused by parasites and associated with warm-weather recreational water use. Nearly 100 cases of cryptosporidiosis and over 400 cases of giardiasis were reported in 2006.

- Hantavirus Pulmonary Syndrome: Hantavirus is carried by deer mice (*Peromyscus maniculatus*) and other rodent species, and humans are infected by inhaling dust containing contaminated excreta. Populations of rodents increase following floods due to increased habitat.

Groups at risk for infectious disease include: infants, children under five years of age, the elderly, pregnant women, those with compromised immune systems, the rural poor, outdoor laborers, and socio-economically disadvantaged groups.

Impact of Extreme Weather Events

Many climate models suggest an intensification of storms that reach the Pacific Northwest coast. Coupled with rising sea levels from thermal expansion of the oceans and melting of land-based ice sheets world-wide, coastal erosion is expected to become severe. Various factors increase the likelihood of destructive river flooding. Coastal inundation, flooding, and landslides create direct hazards to humans who are living or traveling in harm's way. Landslides can hurt and kill people through destruction of structures and roads. Flooding can spread toxins and negatively impact water sources, local septic systems, and combined sewer outflows, each of which can threaten human health in the short and long term (PAWG 2009). Romero and Biever (2009) predict an increase in heavy precipitation patterns and note that in the last decade, flood damage from storms that led to ground and surface water flooding cost $100 million.

- River flooding: Flooding can disrupt water supplies and sewage treatment facilities, and potentially lead to the spread of toxins, vectors of disease (such as mosquitoes

and rodents), and human pathogens. Flooding can also cause injuries, drowning, and displacement, as well as serious disruption in transportation and services.

- Storm Water and Urban Flooding: Increased precipitation events will overwhelm urban stormwater conveyance systems that were designed for capacities based on historic projections. Commercial and residential neighborhoods and city streets will be susceptible to property damage and transportation delays.
- Sea-level rise: Sea-level rise will have acute impacts during extreme high tides, as well as longer-term incremental impacts. Impacts include saltwater intrusion, displacement of population, and increased water and vector-borne illness. McAllister Springs – the major water supply for Olympia and Lacey – is vulnerable to saltwater intrusion; however, a new wellfield is being developed that will be less vulnerable to this as well as other sources of potential contamination (A. Haub, personal communication, 2009).
- Drought: Due to extreme heat together with lack of snow melt, water supplies will be strained. Drought (as well as flooding) could have impacts on food producers (dairy farmers, CSA's, farmer's market vendors). The increasing number of households that rely on local agriculture for a significant portion of their seasonal diet could also be impacted.

Social and Psychological Impacts

Socially and economically vulnerable groups will be most affected by climate change, although all segments of society are at risk. The poor and the isolated often have difficulty gaining access to medical services, and also live in areas that are most susceptible to poor air quality and some kinds of flooding. Climate change also has the potential to undermine the social institutions that allow us to prepare for, adapt and respond to public health threats. The possibility of uncontrolled migration of climate refugees from even more heavily impacted parts of the world may further strain society's capacity to respond.

- Migration: Two streams of migration must be considered: immigrants into this region from harder hit areas that are seeking employment and escape from more extreme weather, and internal displacement within Thurston County for the same reasons.
- Social services and public health: Displaced persons will require shelter, food, clothing, health care, and job placement. Those in poverty will lean more heavily on social services; impacts on economics and industry will mean more people with lower wages or unemployed. At the same time as demands are higher, public health, fire, and other emergency response services will be overloaded.
- Energy demand: During summer the demand for cooling, coupled with less hydropower capacity, could lead to supply shortfalls during heat waves(PAWG 2009).. The Chicago heat wave of 1995 led to brownouts; in this city unaccustomed to very

high temperatures, 600-700 people died and 3300 were hospitalized with heat-related illnesses related to the 5-day event (National Assessment Synthesis Team, 2005).

Stress, alienation, and health: The effects of stress on illness are well established: stress affects immune and inflammatory responses and is implicated in cardiovascular disease, depression, infectious disease, and other ailments. Socio-economically disadvantaged populations suffer disproportionately (PAWG 2009).

Summary

The following table is copied from the CDC's Public Health Grand Rounds webpage.

Climate change has the potential to impact health in many ways. While some of these are unpredictable, others (shown in the table) are supported by considerable evidence.

Weather Event	Health Effects	Populations Most Affected
Heat waves	Heat stress	Extremes of age, athletes, people with respiratory disease
Extreme weather events,(rain, hurricane, tornado, flooding)	Injuries, drowning	Coastal, low-lying land dwellers, low socio-economic sector
Droughts, floods, increased mean temperature	Vector-, food- and water-borne diseases	Multiple populations at risk
Sea-level rise	Injuries, drowning, water and soil salinization, ecosystem and economic disruption	Coastal, low socio-economic sector
Drought, ecosystem migration	Food and water shortages, malnutrition	Low socio-economic sector, elderly, children
Extreme weather events, drought	Mass population movement, international conflict	General population
Increases in ground-level ozone, airborne allergens, and other pollutants	Respiratory disease exacerbations (COPD, asthma, allergic rhinitis, bronchitis)	Elderly, children, those with respiratory disease
Climate change generally; extreme events	Mental health	Young, displaced, agricultural sector, low socio-economic sector

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Appendix D

Staff Report: Lacey's Carbon Reduction Strategy, Land Use Committee, March 9, 2011
Attachment: Current and Potential Carbon Reduction Measures For Municipal Operations and the Lacey Community

Shaping our community together

CITY OF LACEY

LACEY CITY COUNCIL
LAND USE COMMITTEE MEETING
Meeting of March 9, 2011

SUBJECT:	Lacey's Carbon Reduction Strategy
RECOMMENDATION:	Consider adoption of carbon reduction targets for municipal operations and the Lacey community.
STAFF CONTACT:	Greg Cuoio, City Manager Scott Spence, Assistant City Manager Heidi Behrends Cerniwey, Public Affairs Management Analyst
ATTACHMENTS:	Current and Potential Carbon Reduction Measures
BUDGET IMPACT/ SOURCE OF FUNDS:	TBD
PRIOR COMMITTEE REVIEW:	On April 14, 2010, the Land Use Committee reviewed Lacey's 2005 carbon footprint baseline, emissions forecasts, and potential carbon reduction targets. The committee requested that staff identify meaningful measures that could be used as a framework to guide the city's policy on carbon reduction.

BACKGROUND:

In 2008, the City of Lacey joined ICLEI -Local Governments for Sustainability (formerly International Council on the Local Environmental Initiatives). ICLEI's mission is to help local governments reduce greenhouse gas (carbon) emissions and work toward sustainable practices and policies.

To do so, ICLEI developed a comprehensive framework, which includes five milestones:

Milestone 1: Conduct a baseline emissions inventory and forecast
Milestone 2: Adopt an emissions reduction target
Milestone 3: Develop a Local Climate Action Plan
Milestone 4: Implement policies and measures
Milestone 5: Monitor and verify results

Lacey's Baseline Emissions and Forecast:

Lacey conducted a baseline emissions inventory and forecast analysis for both municipal operations and the Lacey community. The analysis found that the municipal operations generated approximately 6,879 tons of CO_2e, and the community generated approximately 380,520 tons of CO_2e in 2005.

Note: Equivalent CO_2 (CO_2e) is the concentration of carbon dioxide (CO_2) that would cause the same level of environmental damage as a given type and concentration of greenhouse gas. Examples of such greenhouse gases are methane, perfluorocarbons, and nitrous oxide.

Emission forecasts were based on growth statistics provided by TRPC, Lacey's Comprehensive Plan, utility data, and a variety of city departments. With this information, a general outlook for Lacey's future carbon footprint could be determined. If the city or community does not adopt any reduction measures, the city's municipal operations carbon footprint would grow to approximately 17,899 tons of CO_2e, and the Lacey community is forecasted to generate approximately 712,789 tons of CO_2e per year by 2030.

Global and National Action:

Internationally, nationally, and locally, jurisdictions have acted to mitigate the impacts of increased levels of greenhouse gases released into the atmosphere brought about by human activities. Many jurisdictions have adopted greenhouse gas (GHG) reduction targets to curb emissions and are developing strategies to reduce their overall carbon footprint. The Kyoto Protocol and the U.S. Mayors Climate Protection Agreement recommends reducing greenhouse gas emissions by 7% below 1990 levels by 2012.

Along the West Coast, several states and Canadian provinces have joined a regional partnership to reduce greenhouse gas emissions. This partnership, called the Western Climate Initiative (WCI), recommends a regional emissions reduction target of 15% below 2005 by the year 2020. Washington State is a charter member of the WCI.

Washington State:

The Washington State legislature has passed laws mandating GHG emissions to 15% below 2005 levels by 2020, 36% below 2005 emissions by 2035, and 57.5% below 2005 levels by 2050. According to RCW 70.235.020, the state will reduce greenhouse gas emissions to 1990 levels by 2020, 25% below 1990 levels by 2035, and 50% below 1990 levels by 2050. Additionally, RCW 70.235.070 requires state agencies to consider whether the entities applying for funds for infrastructure or capital development projects have adopted policies to reduce greenhouse gas emissions.

Reduction Target Considerations:

ICLEI suggests that "a target provides an objective toward which to strive and against which to measure progress." Using the Local Government Operations Protocol (LGOP), Lacey's baseline carbon footprint was measured in 2005—the year with the most accurate data available. Lacey Land Use Committee members concurred that 2005 should be used as the basis for measuring future carbon reduction progress.

Using the reduction target set by the WCI as a guide, 15% below 2005 emissions by 2020, municipal operations would need to reduce emissions by 6,344 tons CO_2e and the Lacey community by 242,639 tons CO_2e (see summary calculations).

Municipal Operations

Base year 2005:	6,879 tons CO_2e
Target year projected emissions 2020:	12,191 tons CO_2e
Target year goal 15% below 2005:	5,847 tons CO_2e
Reduce emissions per year to achieve 2020 goal: *(difference)*	6,344 tons CO_2e

Lacey Community

Base year 2005:	380,520 tons CO_2e
Target year projected emissions 2020:	566,081 tons CO_2e
Target year goal 15% below 2005:	323,442 tons CO_2e
Reduce emissions per year to achieve 2020 goal: *(difference)*	242,639 tons CO_2e

A list of measures (initiatives) are included in the document Current and Potential Carbon Reduction Measures (see attached). The list of potential reduction measures serves only as an example of the impact that each stand-alone initiative may have on this proposed reduction target for purposes of determining feasibility. Measures are selected and prioritized during the carbon reduction strategy development or climate action planning phase.

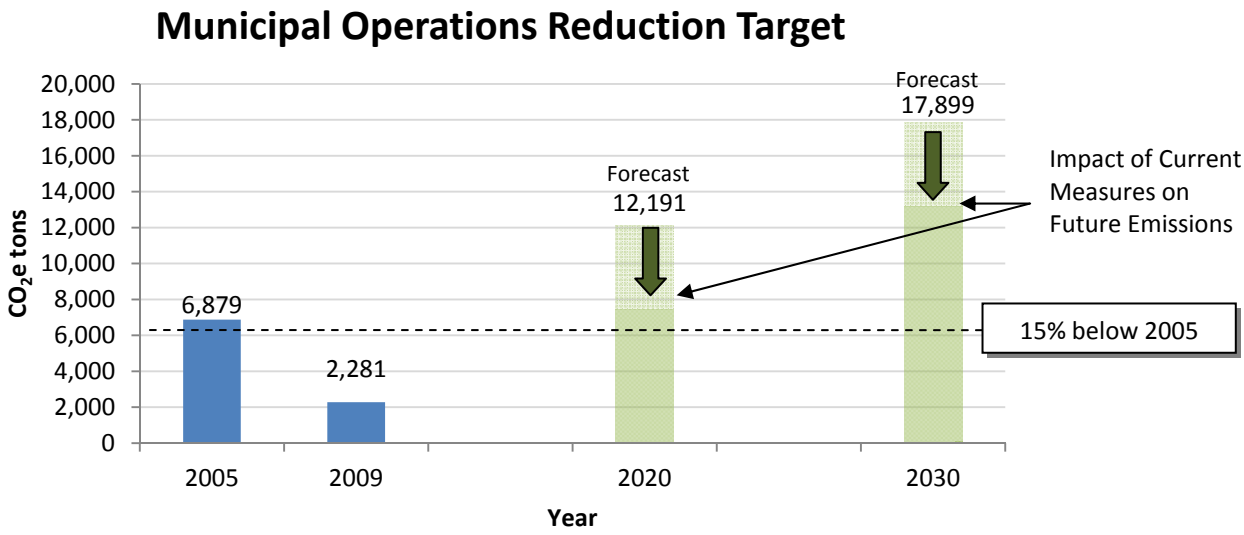
Current Municipal Operations Measures:

When considering future emissions reductions targets, it was important to account for Lacey's current carbon reduction activities. Therefore, an interim inventory was completed for the year 2009. Lacey's 2009 municipal operations emissions were 2,281 tons of CO_2e.

Significant measures that impact current emissions in Lacey government operations include:

- 100% Green Power in all municipal operations since 2007, resulting in 73% reduction in municipal emissions in 2009, a reduction of 6,152 tons CO_2e.
- A grant-funded Resource Conservation Manager program was implemented in late 2009 to conduct facility audits and engage staff to conserve energy and resources in city facilities.
- Lacey was one of the first jurisdictions to install LED traffic signals (2002).
- First LED streetlights in the county installed on Mullen Road Extension (West) in 2010.
- All new municipal fleet vehicles capable of alternative fuel use. Lacey has three hybrid vehicles and five fully electric TORO Workman vehicles for use in Lacey parks.

The City of Lacey's decision to purchase 100% green power for all municipal operations was the most significant measure to impact municipal operations emissions. Although this clean energy purchase offset emissions to a level well below the proposed goal (15% below 2005 baseline levels) in 2009, this measure alone will not be sufficient to sustain the level of reduction in the near future. In the target year of 2020, current measures will offset approximately 75% of the proposed target. Additional measures will need to be undertaken to reduce Lacey's carbon footprint as illustrated by the graph, titled Municipal Operation Reduction Target.



Future Potential Municipal Operations Reduction Measures:

Future municipal operations reduction measures may include energy efficiency upgrades to electronic systems, alternative energy applications, fleet conversions to fuel efficient vehicles or alternative fuels, etc. Cost, timing, and ease of implementation are only a few of the important considerations in defining a strategy to reduce emissions. Selecting and prioritizing future measures will take place during the climate action planning process.

According to these findings, given success of current and potential measures, the goal of reducing carbon emissions in Lacey's municipal operations 15% below 2005, by 2020, is achievable.

Current Lacey Community Measures:

Over the years, Lacey has undertaken numerous measures to protect the environment, improve air quality, and reduce emissions in the region. Some notable actions which impact Lacey's carbon footprint include:

- EPA Green Power Community—Lacey was the twelfth city in the nation to achieve this honored designation. A partnership with Puget Sound Energy to promote green power in the Lacey residential and commercial sector brought emissions reduction in the community. Nearly 5% of the community's electrical consumption is clean energy (accounting for a reduction of 7,342 tons of CO_2e from 2005).
- Lacey's urban forestry practices, park acquisition, and open space practices have provided increased opportunities to absorb carbon.
- Lacey Woodland Trail enhancements support multi-modal transportation options and assist in addressing the major contributor to carbon emissions. Transportation contributes to 52% of the Lacey community carbon footprint.
- Smart planning principles are incorporated into Lacey's long range plans to bring people closer to where they live, work, shop and play. These adopted principles help reduce the major contributor to carbon emissions—transportation.
- Award-winning Alternative Energy Fair to promote alternative transportation and sustainable energy use.
- Installation of electric vehicle recharging stations at City Hall and the Library encourage the use of alternative fuels.

- The City of Lacey supported the Thurston Climate Action Team (TCAT) with an EECBG subgrant to develop and implement a strategy to address energy efficiency (and carbon reduction) in the residential and commercial sector of Lacey and Thurston County. In partnership with the Economic Development Council of Thurston County, TCAT received $1.5 million in grant funding for the Thurston Energy program.

An inventory for the Lacey community was completed for the year 2009, to account for the impact of current measures to reduce Lacey's carbon footprint. In 2009, Lacey community emissions were 483,305 tons of CO_2e, an increase of 102,785 tons of CO_2e from 2005.

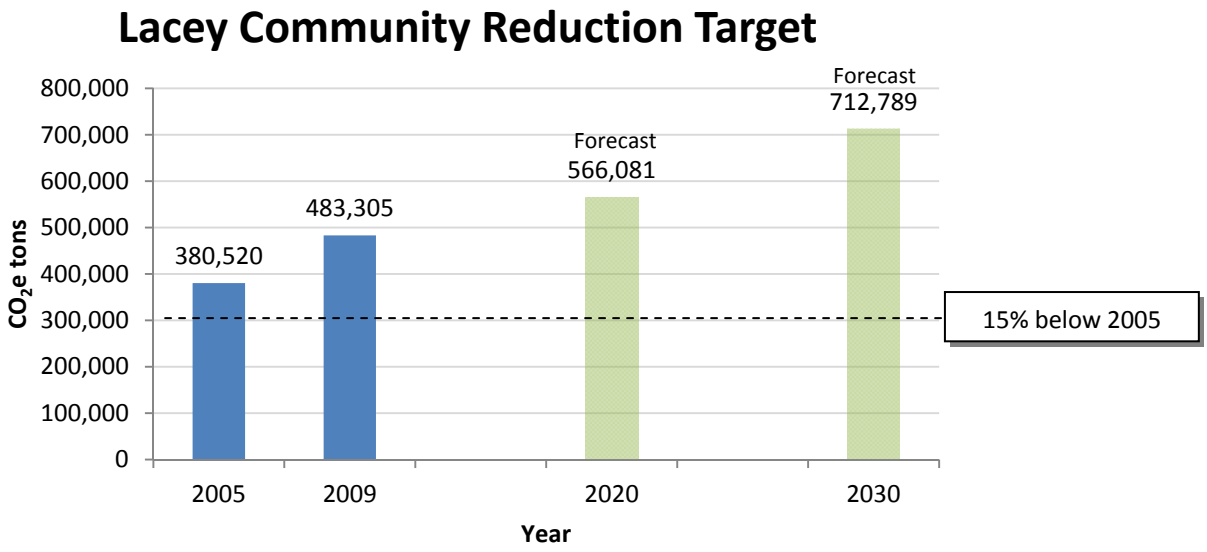
In response, the city has partnered with Puget Sound Energy to reengage the community about green power—this partnership has resulted in a new **Lacey Green Power Challenge**. If a total of 1,011 new customers enroll in PSE's green power program during 2011, with either a Lacey or Olympia address, the utility will install a $20,000 solar demonstration project in Lacey. This program has the benefit of lowering the Lacey community's carbon footprint, and promoting sustainable energy.

Lacey has also provided a sub-grant ($5,000 from EECBG funds) to Thurston Climate Action Team (TCAT) to support the mission of carbon reduction in the community. Additional grant funds are available due to under spending in other EECBG activities. The **Thurston Energy** program has agreed to provide additional incentives and services to the Lacey community to bring energy efficiency and carbon reduction opportunities to businesses and citizens in Lacey.

Future Potential Community Reduction Measures:

A number of potential measures were identified in the Current and Potential Carbon Reduction Measures for a range of implementation options. The list is not all-inclusive. Potential measures include residential and commercial green power purchases, energy efficiency upgrades, energy conservation measures, alternative fuel use for transportation and building heating/cooling, increasing sustainable energy use, transit options, smart planning, transit-oriented planning, fuel efficiency, and use of alternative fuels, to name a few. Potential reduction measures involve education, incentives, mitigation and policy mandates.

Using an aggressive array of measures that would require significant action by the Lacey community, the proposed goal of reducing carbon emissions in the Lacey community 15% below 2005, by 2020, is feasible according to these findings. Cost, timing, support, community participation, and ease of implementation are only a few of the important considerations in defining a strategy to reduce emissions. Selecting and prioritizing future measures will take place during the Climate Action Planning process.



Reduction Target Recommendation:

Consider adoption of carbon reduction targets for both municipal operations and the Lacey community at 15% below 2005 emissions, by the year 2020.

Carbon Reduction Strategy:

Once a reduction target is established, the process of drafting a climate action plan can be undertaken. A climate action plan involves selecting and prioritizing measures to meet municipal operations and community carbon reduction goals. Measures that impact municipal operations emissions are considerably more accessible than those which require changes on a community level. Lacey has a timely opportunity to bring community members into the strategy planning process. Lacey's Comprehensive Plan will be under revision during 2011. The review process provides a natural opportunity for public input for selecting and prioritizing measures to be included in the carbon reduction strategy.

Proposed Timeline:

Milestone 1: Conduct a baseline emissions inventory and forecast
- ☑ April 2010 Land Use Committee Review

Milestone 2: Adopt an emissions reduction target
- ☑ March 2011 Land Use Committee Review
- ☐ April 2011 Full Council Review and Adoption

Milestone 3: Develop a Local Climate Action Plan
- ☐ Fall 2011 Climate Action Plan-Citizen Review (Comprehensive Plan)

Milestone 4: Implement policies and measures
- ☑ Ongoing Current Measures
- ☐ April 2011 Lacey Green Power Challenge
- ☐ April 2011 Thurston Energy-Lacey programs
- ☐ January 2012 New Measures

Milestone 5: Monitor and verify results.
- ☑ April 2010 Interim Inventory for 2009
- ☐ 2015 Conduct Interim Inventory

Current and Potential Carbon Reduction Measures

For Municipal Operations and the Lacey Community

Heidi Behrends Cerniwey, Public Affairs Management Analyst
Alexandria Teague, Management Intern

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Background

In 2008 the City of Lacey joined ICLEI -Local Governments for Sustainability (formerly International Council on the Local Environmental Initiatives). ICLEI's mission is to help local governments reduce greenhouse gas (carbon) emissions and work toward sustainable practices and policies.

Proposed Reduction Target

Using the reduction target set by the WCI and Washington State (first tier goal for state agencies) as a proposed policy goal, **15% below 2005 baseline emissions by 2020**, reduction measures were quantified to determine if this goal was achievable. This target was selected because of its consistency, base year, and feasibility. Lacey's current actions (those considered to impact emissions since the baseline inventory) to protect air quality and the environment were quantified using standard inventory protocol for the year 2009. Since some measures began in 2009, data was not available to quantify impacts of all current actions. In the case of both current and potential measures, impacts were reported as a percentage of the proposed reduction goal.

Municipal Operations Carbon Reduction Measures

Current and potential measures to reduce greenhouse gas are listed in Table 1 below. For each measure, the amount of CO_2e (carbon dioxide equivalent) was calculated on a per year basis. The list of potential reduction measures serves only as an example of the impact that each stand-alone activity may have on this proposed reduction target. Selecting and prioritizing future measures will take place during the Climate Action Planning process.

Note: Each measure is calculated as a standalone strategy, and as such, the benefits of compounding measures is not presented. A short description of context, benefits, and implementation of each measure is listed in Appendix A. Current emissions reduction calculations were based on 2009 data. Modeling software was used to calculate future emissions with details in Appendix B.

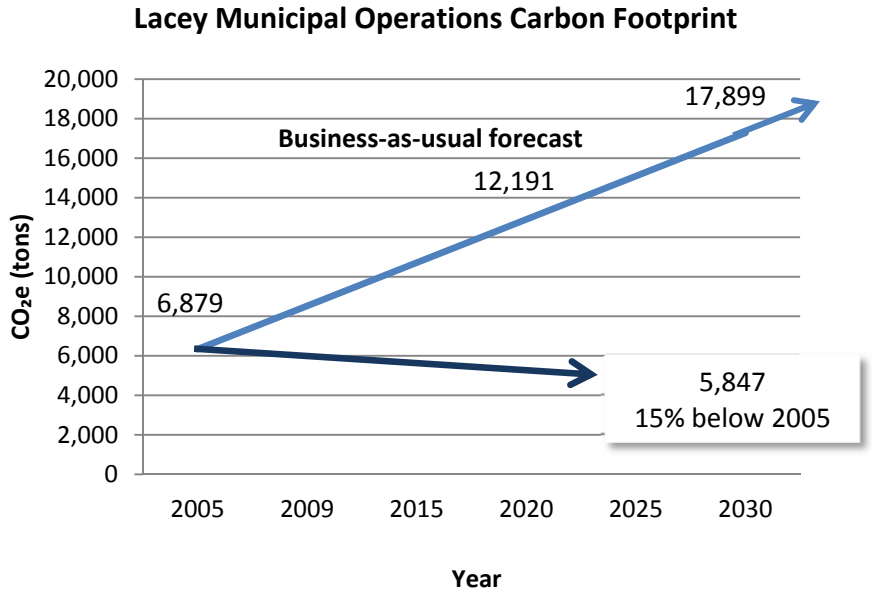


Table 1—Municipal Operations Measures

Base year (2005) emissions: 6,879 tons of CO_2e
Target year (2020) projected emissions: 12,191 tons of CO_2e
To reach Reduction Target of 15% below 2005 by 2020 (5,847): a reduction of 6,343 tons of CO_2e

CURRENT CO_2e REDUCTION MEASURE	Tons of CO_2e reduced per year	% of 2020 goal	Sector affected
Green power program	4,735*	75%	All
Lighting occupancy sensors	16.5	less than 1%	Buildings & Facilities
LED traffic signals	7.7	less than 1%	Traffic signals
Hybrid vehicles	8.8	less than 1%	Vehicle fleet
Employee trip reduction	19	less than 1%	Employee commute
Solid waste and recycling program	1.1	less than 1%	Solid waste
Resource conservation management	*TBA*	*TBA*	All
Capital investments (efficiency upgrades)	*TBA*	*TBA*	Buildings & Facilities
Current Measures TOTAL	***4,788.1***	**75.49%**	

POTENTIAL CO_2e REDUCTION MEASURE	Tons of CO_2e reduced per year	% of 2020 goal	Sector affected
ENERGY-STAR computers	1.8 - 4.7	less than 1%	Buildings & Facilities
ENERGY-STAR monitors	0.55 - 1.4	less than 1%	Buildings & Facilities
LED exit signs	3.3 - 6.6	less than 1%	Buildings & Facilities
ENERGY-STAR vending machines	1.1 - 3.3	less than 1%	Buildings & Facilities
ENERGY-STAR refrigerators	1.1 - 2.2	less than 1%	Buildings & Facilities
High performance local energy code (Green building ordinance)‡	77.1	1.2%	Buildings & Facilities, Water & Wastewater
Lights out at night policy	162	2.5%	Buildings & Facilities
Install low flow faucets	1.1	less than 1%	Buildings & Facilities
Low-maintenance landscaping	16.5 - 33.1	less than 1%	Water & Wastewater
Install green roof	3.3 - 6.6	less than 1%	Buildings & Facilities
Install reflective roofing	4.4 - 8.8	less than 1%	Buildings & Facilities
Solar PV energy panels	35.3 - 69.4	less than 1 - 1.09%	Buildings & Facilities
Ethanol vehicles	123.4 - 245.8	1.9 - 3.8%	Vehicle fleet
Smaller fleet vehicles	58.4 - 116.8	less than 1% - 1.8%	Vehicle fleet
Hybrid vehicles	90.4 - 180.7	1.4 - 2.8%	Vehicle fleet
Electric vehicles	99.2 - 197.3	1.5 - 3.1%	Vehicle fleet
Fleet conversion to B20	88.2 - 175.3	1.4 - 2.7%	Vehicle fleet
Fleet conversion to B100	55.1 - 110.2	less than 1% - 1.7%	Vehicle fleet
Police on bicycles program	69.4 - 138.8	1 - 2.1%	Vehicle fleet
Water system efficiency	534.6	8.4%	Water/ Wastewater
Bicycle incentives (bicycles for daily trips)	5.7 - 11.6	less than 1%	Employee commute

Promote rideshare	7.7 - 16.5	less than 1%	Employee commute
Employee trip reduction	65	1.02%	Employee commute
Employee car fuel economy (tire pressure efficiency)	16	less than 1%	Employee commute
Employee car fuel economy (engine maintenance)	21	less than 1%	Employee commute
Parking cash-out	13.2 - 33.1	less than 1%	Employee commute
Increase bus ridership	26.4 - 54	less than 1%	Employee commute
Promote telecommuting	2.2 - 4.4	less than 1%	Employee commute
Potential Measures TOTAL	***1,583.5***	**24.96%**	
Current and Potential Measures Municipal Measures by 2020 TOTAL	**6,353†**	**100.15%**	

*2009 off-set for all electricity (kwh) based municipal operations
‡Includes proposed municipal construction only
†19 tons of GHG not combined with potential CTR employee trip reduction

Lacey Community Carbon Reduction Measures

Current and potential measures to reduce greenhouse gas emissions in the Lacey Community are listed in Table 2 below. For each measure, the amount of CO_2e (carbon dioxide equivalent) was calculated on a per year basis. The list of potential reduction measures serves only as an example of the impact that each stand-alone activity may have on this proposed reduction target.

Note: Each measure is calculated as a standalone strategy, and as such the benefits of compounding measures is not presented. A short description of context, benefits, and implementation of each measure is listed in Appendix A. Current emissions reduction calculations were based on 2009 data. Modeling software was used to calculate future emissions with additional information in Appendix B.

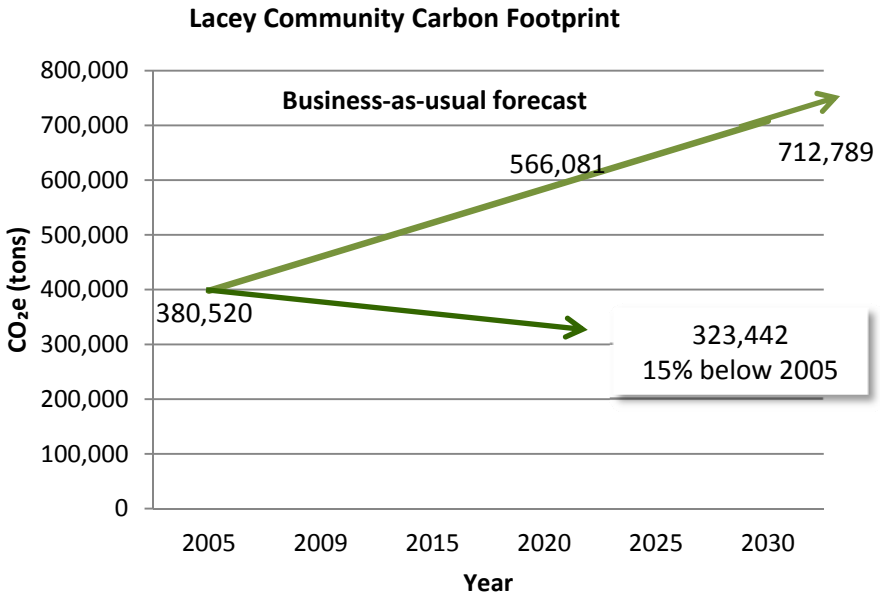


Table 2—Lacey Community Measures

Base year (2005) emissions: 380,520 tons of CO_2e
Target year (2020) emissions: 566,081 tons of CO_2e
To reach Reduction Target of 15% below 2005 by 2020 (323,442): a reduction of 242,639 tons of CO_2e

CURRENT CO_2e REDUCTION MEASURE	Tons of CO_2e reduced per year	% of 2020 goal	Sector affected
Green power program	7,342	3%	Residential, Comm., Ind.
Residential recycling program	11	less than 1%	Solid waste
Urban forestry (municipal tree donation)	26	less than 1%	Residential, Commercial & Trans.
Electric vehicle charging stations	10	less than 1%	Transportation
Fleet conversion to biodiesel (B20) – Intercity Transit	1,102	less than 1%	Transportation
Energy efficient building codes‡	3	less than 1%	Residential & Commercial
Thurston Climate Action Team	*TBA*	*TBA*	Residential & Commercial
Hybrid vehicle use	2,313	less than 1%	Transportation
Electric vehicle use	137.7	less than 1%	Transportation
Current municipal measures	4,788	1.9%	All
Current TOTAL	**15,733**	**6.5%**	

POTENTIAL CO_2e REDUCTION MEASURE	*Tons of CO_2e reduced per year*	*% of 2020 goal*	*Sector affected*
15% community green power*	24,820	10%	Resi., Comm. & Ind.
20% community green power*	33,093	14%	Resi., Comm. & Ind.
25% community green power*	41,366	17%	Resi., Comm. & Ind.
30% community green power*	49,639	20%	Resi., Comm. & Ind.
Transit oriented development	2,957	1.2%	Residential & Trans.
Promote energy efficient affordable housing	1,133	less than 1%	Residential
Offer loans for energy efficiency improvements	2,342	less than 1%	Residential
Low-income home weatherization	1,119	less than 1%	Residential
Require energy efficiency retrofits at time of sale	15,625	6.43%	Residential
Switch homes from electric heat to natural gas	4,793	1.97%	Residential
Use geothermal heat pump for heating and cooling	1,306	less than 1%	Residential & Commercial
Promote infill development	N/A	N/A	Residential & Commercial

High performance local energy code (Green bldg ordinance)†	299	less than 1%	Residential & Commercial
Energy efficiency education targeted at residents	9,063	4%	Residential
Water conservation ordinance	508.2	less than 1%	Resi., Comm. & Ind.
Promote ENERGY STAR dish washers	382.9	less than 1%	Residential
Promote ENERGY STAR clothes washers	238.8	less than 1%	Residential
Promote ENERY STAR refrigerators	884	less than 1%	Residential
Promote ENERGY STAR exit signs	38.5	less than 1%	Resi., Comm. & Ind.
Promote ENERGY STAR air conditioners	90.3	less than 1%	Residential & Commercial
Promote ENERGY STAR vending machines	236.9	less than 1%	Resi., Comm. & Ind.
Promote ENERGY STAR water heaters	3,385	1.39%	Resi., Comm. & Ind.
LED holiday light distribution	71.4	less than 1%	Residential & Commercial
Compact fluorescent light bulb (CFL) distribution	83.7	less than 1%	Residential & Commercial
HVAC retrofits/fan upgrades	134.4	less than 1%	Residential & Commercial
Energy efficiency education targeted at business	4,646	1.91%	Commercial & Industrial
Green business program	4,646	1.91%	Commercial
Promote lights-out-at-night policy	285.4	less than 1%	Commercial & Industrial
Bicycling paths and facilities	499.3	less than 1%	Transportation
Education on low-carbon transportation options	5,009.2	2.06%	Transportation
Promote fuel economy	15,610	6.42%	Transportation
Increase bus ridership	203.9	less than 1%	Transportation
Integrate bicycle and transit operations	2,506	1.03%	Transportation
Initiate a car share	5,826	2.40%	Transportation
Promote rideshare (carpool)	656.9	less than 1%	Transportation
Limit idling of local transit buses and school buses	59.5	less than 1%	Transportation
Electric vehicle charging stations (additional)	97	less than 1%	Transportation
Hybrid vehicle use	22,593	9.3%	Transportation
Electric vehicle use	12,347	5.1%	Transportation
Ethanol (E85) vehicle use	10,781.5	4.4%	Transportation
Biodiesel (B20) vehicle use	8,781	3.6%	Transportation
Biodiesel (B100) vehicle use	11,705	4.8%	Transportation
Smaller vehicle use	7,315	4%	Transportation

Provide bicycles for daily trips	328	less than 1%	Transportation
Provide free high school bus passes	3,860.2	1.6%	Transportation
Establish/expand business recycling programs	11	less than 1%	Waste
Establish/expand curbside recycling programs	11	less than 1%	Waste
Tree planting to shade buildings	194	less than 1%	Resi., Comm. & Ind.
Urban forestry expanded	52.9	less than 1%	Resi., Comm. & Ind.
Promote low maintenance landscaping	1,659	less than 1%	Residential
Promote solar panels	3,477	1.54%	Resi., Comm. & Ind.
Promote green roofs	82	less than 1%	Resi., Comm. & Ind.
Promote reflective roofs	111	less than 1%	Resi., Comm. & Ind.
Promote wind energy (wind turbine)	1,447.3	less than 1%	Resi., Comm. & Ind.
Potential municipal measures	1,583.5 – 2,297	less than 1%	N/A
Potential Measures TOTAL	**221,428**		
Current and Potential Community Measures GRAND TOTAL by 2020	**237,161**	**98%**	

*This number based off of 2009 electricity usage, GRAND TOTAL incorporates 30% green power

† Includes commercial construction only – based on 2009 estimated new construction square footage

Note: Resi. = Residential, Comm. = Commercial, Trans. = Transportation; Ind. = Industrial

Appendix A – Summary of Each Potential Measure

I. Potential Municipal Measures

Measure: ENERGY STAR computers
Context/Description: Switch non-ENERGY STAR computers with ENERGY STAR computers
Scale of project: 20 – 50 computers switched out
Emissions reduction (tons of CO_2e): 1.8 – 4.7

Measure: ENERGY STAR monitors
Context/Description: Switch non-ENERGY STAR monitors with ENERGY STAR monitors
Scale of project: 20 – 50 monitors switched out
Emissions reduction (tons of CO_2e): 0.55 - 1.4

Measure: ENERGY STAR exit signs
Context/Description: Switch non ENERGY STAR exit signs with ENERGY STAR exit signs
Scale of project: 25 – 50 exit signs switched out
Emissions reduction (tons of CO_2e): 3.3 – 6.6

Measure: ENERGY STAR vending machines
Context/Description: Switch non-ENERGY STAR vending machines with ENERGY STAR vending machines
Scale of project: 2 – 4 vending machines switched out
Emissions reduction (tons of CO_2e): 1.1 – 3.3

Measure: ENERGY STAR refrigerators
Context/Description: Switch non-ENERGY STAR refrigerators with ENERGY STAR refrigerators
Scale of project: 5 – 10 refrigerators switched out
Emissions reduction (tons of CO_2e): 1.1 – 2.2

Measure: High performance local energy code (Green building ordinance)
Context/Description: Adopt green building requirements for all new municipal buildings
Scale of project: 32,250 square feet of new municipal construction and renovation
Emissions reduction (tons of CO_2e): 77.1

Measure: Lights out at night policy
Context/Description: Require municipal buildings to turn switch lights off at night
Scale of project: 141,872 square feet with lights out at night policy
Emissions reduction (tons of CO_2e): 162

Measure: Install low flow faucets
Context/Description: Switch non-low flow faucets with low flow faucets
Scale of project: 25 – 100 faucets replaced
Emissions reduction (tons of CO_2e): 1.1

Measure: Low-maintenance landscaping
Context/Description: Landscape using local native plants that require less maintenance and watering
Scale of project: 20 - 40 acres of low maintenance landscaping
Emissions reduction (tons of CO_2e): 16.5 – 33.1
Notes: Landscaping with local native plants can greatly reduce or eliminate the need for watering, pesticides, and gasoline powered maintenance equipment.[1]

Measure: Install green roof
Context/Description: Green roofs use soil medium and plants on top of an impermeable membrane roof
Scale of project: 10,000 - 20,000 square feet of green roof installed
Emissions reduction (tons of CO_2e): 3.3 – 6.6
Notes: Green roofs help the building remain cool during heat and reduce the urban heat island effect.[2]

Measure: Install reflective roofing
Context/Description: Install a reflective membrane in the roof
Scale of project: 10,000 - 20,000 square feet of reflective roof installed
Emissions reduction (tons of CO_2e): 4.4 – 8.8
Notes: ENERGY-STAR certified reflective roof products reflect at least 65% of sunlight striking the roof and reduce the amount of heat entering a building through the roof.[3]

Measure: Solar PV energy panels
Context/Description: Install solar PV energy panels on the roof
Scale of project: 50 - 100 kW of PV installed
Emissions reduction (tons of CO_2e): 35.27 – 69.4

Measure: Ethanol vehicles
Context/Description: Use E85 (85% ethanol with 15% gasoline) in flexible fuel vehicles
Scale of project: 20 – 40 E85 vehicles (12,042 average annual miles per vehicle)
Emissions reduction (tons of CO_2e): 123.4 - 245.8
Notes: Helps build a green city fleet.

Measure: Smaller fleet vehicles
Context/Description: Use a smaller fleet vehicle when possible
Scale of project: 20 – 40 smaller vehicles (12,042 average annual miles per vehicle)
Emissions reduction (tons of CO_2e): 58.42 - 116.8
Notes: Helps build a green city fleet.

Measure: Hybrid vehicles
Context/Description: Use hybrid vehicles when possible
Scale of project: 20 - 40 additional hybrid vehicles for city fleet (12,042 average annual miles per vehicle)
Emissions reduction (tons of CO_2e): 90.4 – 180.7
Notes: Helps build a green city fleet.

Measure: Electric vehicles
Context/Description: Use electric vehicles when possible
Scale of project: 20 - 40 electric vehicles (12,042 average annual miles per vehicle)
Emissions reduction (tons of CO_2e): 99.2 – 197.3
Notes: Helps build a green city fleet.

[1] ICLEI-Local Government for Sustainability USA. 2010. *Climate and Air Pollution Planning Assistant Software.* ICLEI-Local Government for Sustainability USA.
[2] Ibid.
[3] Ibid.

Measure: Biodiesel fleet vehicles (B20)
Context/Description: Use B20 vehicles when possible
Scale of project: 20 – 40 B20 vehicles (12,042 average annual miles per vehicle)
Emissions reduction (tons of CO_2e): 88.1 - 175.3
Notes: Helps build a green city fleet.

Measure: Biodiesel fleet vehicles (B100)
Context/Description: Use B100 vehicles when possible
Scale of project: 10 – 20 B100 vehicles (12,042 average annual miles per vehicle)
Emissions reduction (tons of CO_2e): 55.1 – 110.2
Notes: Helps build a green city fleet.

Measure: Implement a police on bicycles program
Context/Description: police patrol in dense urban areas on bicycles
Scale of project: 10 - 20 bicycle officers
Emissions reduction (tons of CO_2e): 69.4 – 138.8

Measure: Water system efficiency
Context/Description: Upgrade the city's water delivery system
Scale of project: 16,000 households served by water authority
Emissions reduction (tons of CO_2e): 534.6

Measure: Bicycle incentives (bicycles for daily trips)
Context/Description: Offer free bicycles for employees to use for daily trips
Scale of project: 20 – 40 employees using bicycles for daily trips
Emissions reduction (tons of CO_2e): 5.7 – 11.6

Measure: Promote rideshare
Context/Description: Implement a ride-sharing program for employees
Scale of project: 20 – 50 employees offered carpool and vanpool incentives
Emissions reduction (tons of CO_2e): 7.7 – 16.5

Measure: Employee trip reduction
Context/Description: Reduce the average miles a trip per single occupancy vehicle (SOV)
Scale of project: reach an average daily SOV miles goal of 10 miles/trip
Emissions reduction (tons of CO_2e): 65

Measure: Employee car fuel economy (tire pressure efficiency)
Context/Description: Increase the average miles per gallon with tires properly inflated
Scale of project: Increase average miles per gallon from 17.27 to 17.78[4]
Emissions reduction (tons of CO_2e): 16

Measure: Employee car fuel economy (engine maintenance)
Context/Description: Increase the average miles per gallon with proper engine maintenance
Scale of project: Increase the average miles per gallon from 17.27 to 17.96[5]
Emissions reduction (tons of CO_2e): 21

[4] Based on 2009 total miles per gallon. Washington Department of Transportation, Financial Planning & Economic Analysis Office. 2008. "Forecast of fuel, vehicles, and related data through 2025." Accessed March 3, 2010. http://www.wsdot.wa.gov/planning/wtp/datalibrary/Modes/VehicleMilesTraveled.htm.

[5] Based on 2009 total miles per gallon. Washington Department of Transportation, Financial Planning & Economic Analysis Office. 2008. "Forecast of fuel, vehicles, and related data through 2025." Accessed March 3, 2010. http://www.wsdot.wa.gov/planning/wtp/datalibrary/Modes/VehicleMilesTraveled.htm.

Measure: Parking cash-out
Context/Description: Offer workers the option of giving up their employer provided parking space in exchange for its equivalent monetary value
Scale of project: 20 - 50 employees offered parking cash-out
Emissions reduction (tons of CO_2e): 13.2 – 33.1

Measure: Increase bus ridership
Context/Description: Promote employee bus ridership
Scale of project: 20 – 40 employees each day switching commute from car to bus
Emissions reduction (tons of CO_2e): 26.4 - 54

Measure: Promote telecommuting
Context/Description: Offer employees the option to telecommute some days
Scale of project: 15 – 30 employees offered telecommuting incentives
Emissions reduction (tons of CO_2e): 2.2 – 4.4

II. Potential Lacey Community Measures

Measure: Community green power
Context/Description: City residents purchase green power energy
Scale of project: 15 – 30% green power purchased
Emissions reduction (tons of CO_2e): 24,820 – 49,639
Notes: Community green power includes the residential, commercial, and industrial sectors.

Measure: Transit oriented development
Context/Description: Construct residential units with access to multiple modes of transportation
Scale of project: 100 - 400 residential units in transit oriented development
Emissions reduction (tons of CO_2e): 739.6 – 2,957

Measure: Energy efficient affordable housing
Context/Description: promote or require the construction of energy efficient affordable housing
Scale of project: 400 built efficient affordable housing units
Emissions reduction (tons of CO_2e): 1,133.2

Measure: Offer loans for energy efficiency improvements
Context/Description: Offer loans to households for energy efficiency improvements
Scale of project: 4,000 household targeted
Emissions reduction (tons of CO_2e): 2,342

Measure: Low-income home weatherization
Context/Description: Provide home weatherization services to improve energy efficiency to low income residents
Scale of project: 1,600 homes weatherized
Emissions reduction (tons of CO_2e): 1,119
Notes: Cost of each home weatherization may vary on the home.

Measure: Require energy efficient retrofits at the time of sale
Context/Description: Require upgrade of home efficiency when home is sold
Scale of project: 15,000 homes sold over 10 years
Emissions reduction (tons of CO_2e): 15,625
Notes: Emissions reduction depends on the number of homes sold each year.

Measure: Switch homes from electric heat to natural gas
Context/Description: Switching from electric based heat to natural gas
Scale of project: 3,200 homes switch from electric to natural gas heating system
Emissions reduction (tons of CO_2e): 4,793
Notes: Natural gas is far more efficient that electric heat, as electric heat is about one third as efficient as natural gas heating systems.[6]

Measure: Use geothermal heat pump for heating and cooling
Context/Description: Promote the installation of geothermal heat pumps in public and/or private facilities
Scale of project: 800 homes using electric heat
Emissions reduction (tons of CO_2e): 1,306
Notes: Geothermal heat pumps are ideal for public facilities such as schools.

Measure: Promote infill development
Context/Description: Promote infill as urban development
Scale of project: Promote infill development whenever possible instead of utilizing undeveloped land.
Emissions reduction (tons of CO_2e): N/A
Notes: Infill can be combined with a green building ordinance, water conservation ordinance, etc. The process of infill can include the rehabilitation and adaptive use of older urban buildings. Though GHG emissions are not depicted here, promoting infill can reduce GHG emissions in many community sectors.[7] For example, The Federal Transit Administration states that areas of compact development are significantly less auto-dependent and therefore reduce the amount of greenhouse gas emissions associated with development.[8]

Measure: High performance local energy code (Green building ordinance)
Context/Description: Adopt green building requirements for all new commercial construction
Scale of project: 125,000 square feet of new commercial construction and renovation
Emissions reduction (tons of CO_2e): 299.8
Notes: Example based on square foot of new commercial construction and renovation in 2009.

Measure: Energy efficiency education targeted at residents
Context/Description: Provide/promote energy efficiency education to residents
Scale of project: 8,000 households targeted (50% of households within the City of Lacey)
Emissions reduction (tons of CO_2e): 9,063

Measure: Water conservation ordinance
Context/Description: Implement a water conservation ordinance on a municipal level
Scale of project: 20% household savings under the water conservation ordinance
Emissions reduction (tons of CO_2e): 508.2
Notes: A water conservation ordinance may reduce the energy usage and cost of water delivery systems.

Measure: Incentives for replacing dish washers with ENERGY STAR dish washers
Context/Description: Switch non-ENERGY STAR dish washers with ENERGY STAR dish washers
Scale of project: 4,000 dish washers replaced with ENERGY STAR dish washers
Emissions reduction (tons of CO_2e): 382.9

[6] ICLEI-Local Government for Sustainability USA. 2010. *Climate and Air Pollution Planning Assistant Software.* ICLEI-Local Government for Sustainability USA.
[7] Hager Bailly Services, Inc. and Criterion Planners/Engineers. 1999. *The transportation and environmental impacts of infill versus greenfield development: A comparative case study analysis.* U.S. Environmental Protection Agency.
[8] Hodges, Tina. 2010. *Public transportation's role in responding to climate change.* Federal Transit Administration: U.S. Department of Transportation.

Measure: Incentives for replacing clothes washers with ENERGY STAR clothes washers
Context/Description: Switch non-ENERGY STAR clothes washers with ENERGY STAR clothes washers
Scale of project: 4,000 clothes washers replaced with ENERGY STAR clothes washers
Emissions reduction (tons of CO_2e): 238.8

Measure: Incentives for replacing refrigerators with ENERY STAR refrigerators
Context/Description: Switch non-ENERGY STAR refrigerators with ENERGY STAR refrigerators
Scale of project: 4,000 refrigerators replaced with ENERGY STAR refrigerators
Emissions reduction (tons of CO_2e): 884

Measure: Promote ENERGY STAR exit signs
Context/Description: Switch non-ENERGY STAR exit signs with ENERGY STAR exit signs
Scale of project: 300 exit signs replaced with ENERGY STAR exit signs
Emissions reduction (tons of CO_2e): 38.5

Measure: Promote ENERGY STAR window air conditioners
Context/Description: Switch non-ENERGY STAR window air conditioners with ENERGY STAR window air conditioners
Scale of project: 2,000 window air conditioners replaced with ENERGY STAR window air conditioners
Emissions reduction (tons of CO_2e): 90.3

Measure: Promote ENERGY STAR vending machines
Context/Description: Switch non-ENERGY STAR vending machines with ENERGY STAR vending machines
Scale of project: 300 vending machines replaced with ENERGY STAR vending machines
Emissions reduction (tons of CO_2e): 236.9

Measure: Promote ENERGY STAR water heaters
Context/Description: Switch non-ENERGY STAR water heaters with ENERGY STAR water heaters
Scale of project: 4,000 water heaters replaced with ENERGY STAR water heaters
Emissions reduction (tons of CO_2e): 3,385

Measure: Promote LED holiday light distribution
Context/Description: Switch strings of non-LED holiday lights with strings of LED holiday lights
Scale of project: 300 strings of holiday lights replaced with strings of LED holiday lights
Emissions reduction (tons of CO_2e): 71.4

Measure: HVAC retrofits/fan upgrades
Context/Description: Promote private/public HVAC retrofits and fan upgrades
Scale of project: 718,275 square feet of facilities with upgraded fans
Emissions reduction (tons of CO_2e): 134.4

Measure: Compact fluorescent light bulb (CFL) distribution
Context/Description: Distribute fluorescent light bulbs to residents by exchanging them for non-CFLs
Scale of project: 4,000 light bulbs exchanged for CFLs
Emissions reduction (tons of CO_2e): 83.7

Measure: Energy efficiency education targeted at businesses
Context/Description: Provide/promote energy efficiency education to businesses
Scale of project: 600 businesses targeted
Emissions reduction (tons of CO_2e): 4,646

Measure: Green business program
Context/Description: Encourage businesses to conduct business in an environmental friendly manner
Scale of project: 600 participating businesses
Emissions reduction (tons of CO_2e): 4,646

Measure: Promote lights-out-at-night policy
Context/Description: Encourage businesses to turn off lights at close
Scale of project: 250,000 square feet with lights out at night policy
Emissions reduction (tons of CO_2e): 285.4

Measure: Bicycling paths and facilities
Context/Description: Expand bicycle paths and facilities throughout the city
Scale of project: 4,000 weekly trips switching from car to bicycle
Emissions reduction (tons of CO_2e): 499.3
Notes: Measure could include paths, bicycle lanes, bicycle lockers, traffic signs, dangerous drain gates, etc.

Measure: Education on low-carbon transportation options
Context/Description: Educate residents on multi-modal transportation (other than driving)
Scale of project: 4,000 households targeted
Emissions reduction (tons of CO_2e): 5,009

Measure: Promote fuel economy
Context/Description: Increase fuel economy by keeping tires properly inflated and proper engine maintenance
Scale of project: Average fuel economy increase of 3% by keeping tires property inflated and fuel economy increase of 4% by proper engine maintenance
Emissions reduction (tons of CO_2e): 15,610
Notes: Emissions reduction is based on total community miles traveled per year and proper vehicle maintenance.

Measure: Increase bus ridership
Context/Description: Work with local transit authority to increase the number of daily bus passengers
Scale of project: 200 additional daily bus passengers
Emissions reduction (tons of CO_2e): 203.9
Notes: Hands down per person SOV produce the most GHG emissions per passenger mile. Again, the average person driving alone produces just less than one pound of CO_2 per mile traveled. Therefore, the more people take public transportation, rideshare, and bicycle, etc. the lower GHG emissions per passenger mile.[9]

Measure: Integrate bicycles and transit options
Context/Description: Expand opportunities for bicycles as public transportation options
Scale of project: 2,000 bicycles available
Emissions reduction (tons of CO_2e): 2,506

Measure: Initiate a car share
Context/Description: Promote the use of car share throughout the city
Scale of project: 4,000 number of car share participants
Emissions reduction (tons of CO_2e): 5,826

Measure: Promote rideshare (carpool)
Context/Description: Promote community carpools
Scale of project: 2,000 number of community members carpooling
Emissions reduction (tons of CO_2e): 656.9

[9] Hodges, Tina. 2010. *Public transportation's role in responding to climate change.* Federal Transit Administration: U.S. Department of Transportation.

Measure: Limit idling of local transit buses and school buses
Context/Description: Limit idling of local transit and school buses
Scale of project: 63 transit buses
Emissions reduction (tons of CO_2e): 59.5
Notes: Based on 1 hour of idling

Measure: Electric vehicle charging stations (additional)
Context/Description: Promote the development of electric vehicle charging stations
Scale of project: 50 additional charging stations
Emissions reduction (tons of CO_2e): 97

Measure: Hybrid vehicles
Context/Description: Use hybrid vehicles
Scale of project: 5,000 additional hybrid vehicles within the community (12,042 average annual miles per vehicle)
Emissions reduction (tons of CO_2e): 22,592

Measure: Electric vehicles
Context/Description: Use electric vehicles
Scale of project: 2,500 electric vehicles within the community (12,042 average annual miles per vehicle)
Emissions reduction (tons of CO_2e): 12,347

Measure: Ethanol vehicles
Context/Description: Use E85 (85% ethanol with 15% gasoline) in flexible fuel vehicles
Scale of project: 2,000 E85 vehicles within the community (12,042 average annual miles per vehicle)
Emissions reduction (tons of CO_2e): 10,782

Measure: Biodiesel vehicles (B20)
Context/Description: Use B20 vehicles
Scale of project: 2,000 B20 vehicles within the community (12,042 average annual miles per vehicle)
Emissions reduction (tons of CO_2e): 8,781

Measure: Biodiesel vehicles (B100)
Context/Description: Use B100 vehicles
Scale of project: 2,000 B100 vehicles within the community (12,042 average annual miles per vehicle)
Emissions reduction (tons of CO_2e): 11,001

Measure: Smaller vehicles
Context/Description: Use smaller vehicles
Scale of project: 3,000 smaller vehicles within the community (12,042 average annual miles per vehicle)
Emissions reduction (tons of CO_2e): 11,705

Measure: Provide bicycles for daily trips
Context/Description: Provide bicycles for daily community use
Scale of project: 150 number of bicycles available
Emissions reduction (tons of CO_2e): 238

Measure: Provide free high school bus passes
Context/Description: Provide free high school bus passes
Scale of project: 3,000 students given bus passes
Emissions reduction (tons of CO_2e): 3,860.2
Notes: Emissions reduction depends on number of bus passes given and student use

Measure: Establish/expand business recycling programs
Context/Description: Promote business recycling program
Scale of project: 406 pounds per person a year of waste diverted from landfill
Emissions reduction (tons of CO_2e): 11
Notes: Will vary based on the number of employees per businesses, and the recycling and waste reduction habits of each employee. Thurston County transfers solid waste to Roosevelt Landfill, Selah, WA. This site uses a methane recovery system, thereby reducing emissions.

Measure: Establish/expand curbside recycling programs
Context/Description: Promote residential curbside recycling
Scale of project: 406 pounds per person a year of waste diverted from landfill
Emissions reduction (tons of CO_2e): 11
Notes: Will vary based on the actual amount a household recycles. Thurston County transfers solid waste to Roosevelt Landfill, Selah, WA. This site uses a methane recovery system, thereby reducing emissions.

Measure: Tree planting to shade buildings
Context/Description: Properly place tree planting such that they will provide ample shade for buildings
Scale of project: 500 trees planted to shade buildings
Emissions reduction (tons of CO_2e): 48.5
Notes: Shade from trees can reduce the amount of energy needed to heat and cool buildings; measure can include trees planted in street edges, medians, parking lots, etc.

Measure: Urban forestry (expanded)
Context/Description: Preserve and build urban tree canopy
Scale of project: 2,000 trees planted
Emissions reduction (tons of CO_2e): 52.9
Notes: Emissions reduction is dependent on carbon sequestration based on tree species and maturity

Measure: Promote low-maintenance landscaping
Context/Description: Landscape using local native plants that require less maintenance and watering
Scale of project: 4,000 homes residences using low maintenance landscaping
Emissions reduction (tons of CO_2e): 1,659
Notes: Landscaping with local native plants can greatly reduce or eliminate the need for watering, pesticides, and gasoline powered maintenance equipment.[10]

Measure: Promote solar panels on roofs
Context/Description: Installation of solar panels on public and private buildings
Scale of project: 5,000 kW of PV installed
Emissions reduction (tons of CO_2e): 3,477
Notes: Annual kWh production is based on kW of PV Installed, 4 sun hours a day, and 365 days a year.

Measure: Promote green roofs
Context/Description: Installation of green roofs on public and private buildings
Scale of project: 250,000 square feet of green roofs installed
Emissions reduction (tons of CO_2e): 82.6

Measure: Promote reflective roofs
Context/Description: Installation of reflective roofs on public and private buildings
Scale of project: 250,000 square feet of green roofs installed

[10] ICLEI-Local Government for Sustainability USA. 2010. *Climate and Air Pollution Planning Assistant Software.* ICLEI-Local Government for Sustainability USA.

Emissions reduction (tons of CO_2e): 111

Measure: Promote wind energy (wind turbines)

Context/Description: Installation of wind turbines on public and private buildings

Scale of project: 1,000 – 2,000 capacity size (kW)

Emissions reduction (tons of CO_2e): 724 – 1,477

Appendix B—Reduction Measure Sources

The Climate and Air Pollution Planning Assistant (CAPPA) is a "decision support tool" designed to help cities identify and select emissions reduction actions, projects, and measures for their climate action plan. [11] CAPPA functions like a calculator. The software applies the proposed reduction target to municipal and community emissions separately, and may be used to create various scenarios.

The calculation for each measure is based on its appropriate degree of implementation, cost impacts, and measure benefits ratings (six key decision criteria). The degree implementation is the number of units to be implemented (i.e. the number of homes affected). Cost impacts include relevant data such as energy savings per unit, cost of fuel, typical use of a fuel, etc. The six key decision criteria include initial implementation cost, operation and maintenance costs, return on investment, time, level of effort, and degree of implementation control held by the local government. The benefit ratings function of the software is applied to each measure, but is especially important when using CAPPA to create a comprehensive reduction plan.[12]

The majority of calculations in CAPPA rely on national performance averages and simplifying assumptions.[13] Therefore, the reduction amount for each measure should not be considered exact values, but estimations. The list of potential reduction measures has been gathered from participating local governments and various agencies such as the Energy Information Administration. The calculation is propagated with the most current national default averages.

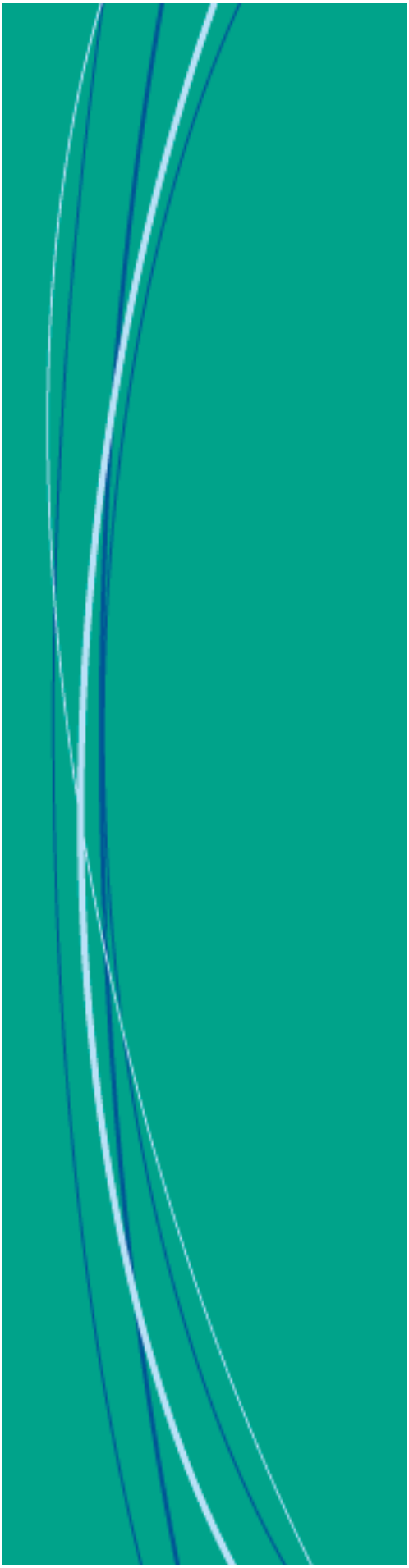
[11] ICLEI-Local Government for Sustainability USA. 2010. *Climate and Air Pollution Planning Assistant Software.* ICLEI-Local Government for Sustainability USA.
[12] Ibid.
[13] Ibid.

Appendix E

4 Ever Green in Lacey—A Community Engagement Program

- Video
- Display Board
- Handout with survey
- Online survey

Following public input on this plan. Recommendations for priority measures should be incorporated into this strategy, partnership opportunities explored, and undertaken as funding sources are identified.



DRAFT | June 19, 2012

Community Straw Poll--Prioritization of CR2 Measures

Energy Efficiency	# of Votes
"Smart" utility meters	8
Promote passive homes	6
Promote ENERGY STAR appliances	6
Energy efficiency education	5
Energy efficiency challenge	3
Tax credits for efficiency upgrades	3
Meter-based financing	2
Energy performance rating system	1
Building performance disclosure	1
District heating and cooling	0
Peak demand energy pricing	0
Renewable Energy	
Promote renewable energy	14
Solar or renewable challenge	13
Promote natural gas	4
Expand financing options	2
Local tax incentives	1
One block off the grid campaign	0
Co-generation power production	0
LID for district heating	0
Waste Reduction	
Ban recyclables from garbage	12
Promote residential recycling	8
Promote commercial recycling	6
Expand education programs	4
Promote green purchasing	1
Land Use	
Development incentives for transit-oriented development	8
Discourage sprawl through impact fees	5
Develop new neighborhoods around transit hubs	4
Development incentives for downtown	3
Green Building	
Reward system for green buildings	4
Adopt building codes that exceed current guidelines	3
Loan rates or financial incentives	3
Encourage use of sustainable building materials	3
Adopt or encourage LEED building standards for commercial and/or residential projects	1
Expand opportunities for green remodeling	1
Promote ENERGY STAR commercial buildings	1
Green roofs	

Transportation

Anti-idling ordinance	9
Provide commuting incentives	8
Enhance trail system	7
Car sharing program	4
Pay-as-you-drive car insurance	4
Restrict idling at public facilities	2
Expand fiber-optic network	2
Alternative fueling stations	1
Total votes	173

Topics with the most votes:	
Promote renewable energy	14
Solar or renewable challenge	13
Ban recyclables from garbage	12
Anti-idling ordinance	9
“Smart” utility meters	8
Promote residential recycling	8
Development incentives for transit-oriented development	8
Provide commuting incentives	8
Enhance trail system	7