6

Landfill Management and Solid Waste Disposal

Landfill Management and Solid Waste Disposal

Policies

DS-1 Operate and maintain the Cedar Hills Regional Landfill to meet or exceed the highest federal, state, and local standards for protection of public health and the environment.

DS-2 Maximize the capacity and lifespan of the Cedar Hills Regional Landfill, subject to environmental constraints, relative costs to operate, and stakeholder interests.

DS-3 Monitor and maintain closed landfills to meet or exceed the highest federal, state, and local standards for protection of public health and the environment.

Landfill Management and Solid Waste Disposal

Summary of Recommendations

Responsibility		Action	Detailed Discussion
1	**County**	Monitor options for disposal once the Cedar Hills Regional Landfill reaches capacity and closes. Consider waste export to an out-of-county landfill, a waste-to-energy facility(ies), and other disposal or conversion technologies, to handle all or a portion of the county's waste.	Page 6-2, 6-9
2	**County**	Evaluate partial early waste diversion considering effects on system costs versus benefits.	Page 6-2, 6-9
3	**County**	Explore beneficial reuse options for closed landfills, designing monitoring and environmental systems that will facilitate reuse of the properties and provide continued benefit to the surrounding communities.	Page 6-16
4	**County, cities, tribal governments**	To prepare for potential emergencies, work with state and regional authorities to coordinate a Debris Management Plan for King County.	Page 6-19

LANDFILL MANAGEMENT AND SOLID WASTE DISPOSAL

Solid waste generated in King County is disposed of at the Cedar Hills Regional Landfill – the only active landfill remaining in the county. Located on a 920-acre site in the Maple Valley area, Cedar Hills has provided for the safe and efficient disposal of the county's solid waste since 1965. In 2009, the landfill received more than 865,000 tons of municipal solid waste.

Estimates in the *Final 2001 Comprehensive Solid Waste Management Plan* (2001 Solid Waste Plan) indicated that Cedar Hills would reach its permitted capacity and close in 2012. This projected closure date has been extended, however, through the implementation of best management practices in daily landfill operations, natural settling of the waste through decomposition, ongoing waste prevention and recycling, and recent declines in tonnage attributable to the economic downturn. Further, a new Project Program Plan for the landfill, approved by County Council in December 2010, allows development of additional areas. With the approval of this plan, Cedar Hills Landfill is expected to remain in operation through about 2024.

The Cedar Hills Regional Landfill has been in operation since the early 1960s.

A comparative evaluation of alternative disposal options (R.W. Beck 2007) indicates that disposal at the Cedar Hills Regional Landfill is the most economical way to handle King County's solid waste. It is significantly less expensive than the projected costs of other disposal options, including transporting waste to an out-of-county landfill or to a waste-to-energy or other waste conversion facility. By extending the life of the landfill and delaying the transition to a new disposal method, the county will be able to delay the unavoidable rate increases that will be needed to accommodate this transition.

The *Solid Waste Transfer and Waste Management Plan* (Transfer Plan) approved by the King County Council in December 2007 contains the following recommendation for the future of the landfill:

> Explore opportunities for taking advantage of available landfill capacity to extend the life of this cost-effective disposal option; revise the *Cedar Hills Site Development Plan* and seek to maximize the capacity (lifespan) of the landfill, subject to environmental constraints, relative costs to operate, and stakeholder interests

Under this direction, the division has begun the process of updating the *1998 Cedar Hills Regional Landfill Site Development Plan* (Site Development Plan). Five action alternatives were developed for consideration that would extend landfill life for an additional 3 to 13 years beyond the currently projected closure date of 2019. A comprehensive environmental review was conducted on the five alternatives and a no action alternative, in accordance with the State Environmental Protection Act. The final Environmental Impact

The landfill area has been developed in sequential stages over time.

Statement, issued in July 2010, determined that none of the five action alternatives would pose any significant adverse environmental impacts compared with the no action alternative (KCSWD 2010a).

Based on the environmental review, operational feasibility, cost, stakeholder interest, and flexibility to further expand landfill capacity if circumstances warrant, a preferred alternative was identified. The King County Council approved the recommended alternative in December 2010. The selected alternative will develop 56.5 acres for construction of one to two new refuse areas in the southwestern portion of the landfill and extend landfill life for 5 to 6 years beyond 2019 (see page 6-8 for more details).

Consistent with the recommendation to extend the life of Cedar Hills, the division will also consider the benefits of diverting a portion of the waste stream from Cedar Hills to another disposal option(s) before the landfill closes. Partial early diversion would further extend the life of the Cedar Hills landfill and would provide an opportunity to assess other options before it is necessary to make a final decision. If the division were to implement early waste diversion, a wide range of disposal options would be evaluated, including export to an out-of-county landfill and waste-to-energy technologies. A decision about whether to proceed with partial early diversion will be made after the revised Site Development Plan is complete.

Even with a sound landfill development alternative and other strategies to extend the life of Cedar Hills, the landfill is likely to reach capacity and close within this 20-year planning period. In the 2001 Solid Waste Plan, county policy stated "the county should not seek to site a replacement landfill for the Cedar Hills regional landfill" and directed that the county "initiate solid waste export" and "contract for long-term disposal capacity at an out-of-county landfill" to handle the county's waste when Cedar Hills reaches its permitted capacity. While waste export to an out-of-county landfill is still a viable alternative, there are current and emerging conversion technologies that might also offer viable alternatives for handling all or some components of King County's waste in the future. As the timeframe for landfill closure approaches, the division will continue to monitor both landfill capacity and advancements in waste conversion technologies.

This chapter provides a brief background of the Cedar Hills landfill, a discussion of strategies and options for extending the life of the landfill, a snapshot of the range of potential disposal options after Cedar Hills closes, and an outline of criteria that would be used to screen options for future disposal and partial early waste diversion. The final sections of the chapter address the restoration of closed landfills, disposal of special wastes, and disposal in an emergency.

BACKGROUND OF THE CEDAR HILLS REGIONAL LANDFILL

The Cedar Hills Regional Landfill was originally permitted in 1960 by the King County Board of Commissioners, at a time when there were few regulations in place to govern the design and operation of landfills. Since then, environmental regulations have become increasingly rigorous, requiring the placement of an impermeable,

high-density polyethylene liner and clay barrier at the bottom of the landfill, daily cover (using soil or other approved materials) over the waste, and frequent environmental monitoring, among other requirements.

Over time, the Cedar Hills landfill has been developed in sequential stages (or refuse areas) in accordance with the most current Site Development Plan. The division has invested considerable effort and resources to upgrade older areas of the landfill, while designing and operating new areas to meet or exceed regulatory requirements. Figure 6-1 shows the layout of the landfill, including the boundaries of the past and active, refuse areas as currently permitted. As shown, Area 7 is the currently active refuse area, and is the last refuse area permitted for development at this time.

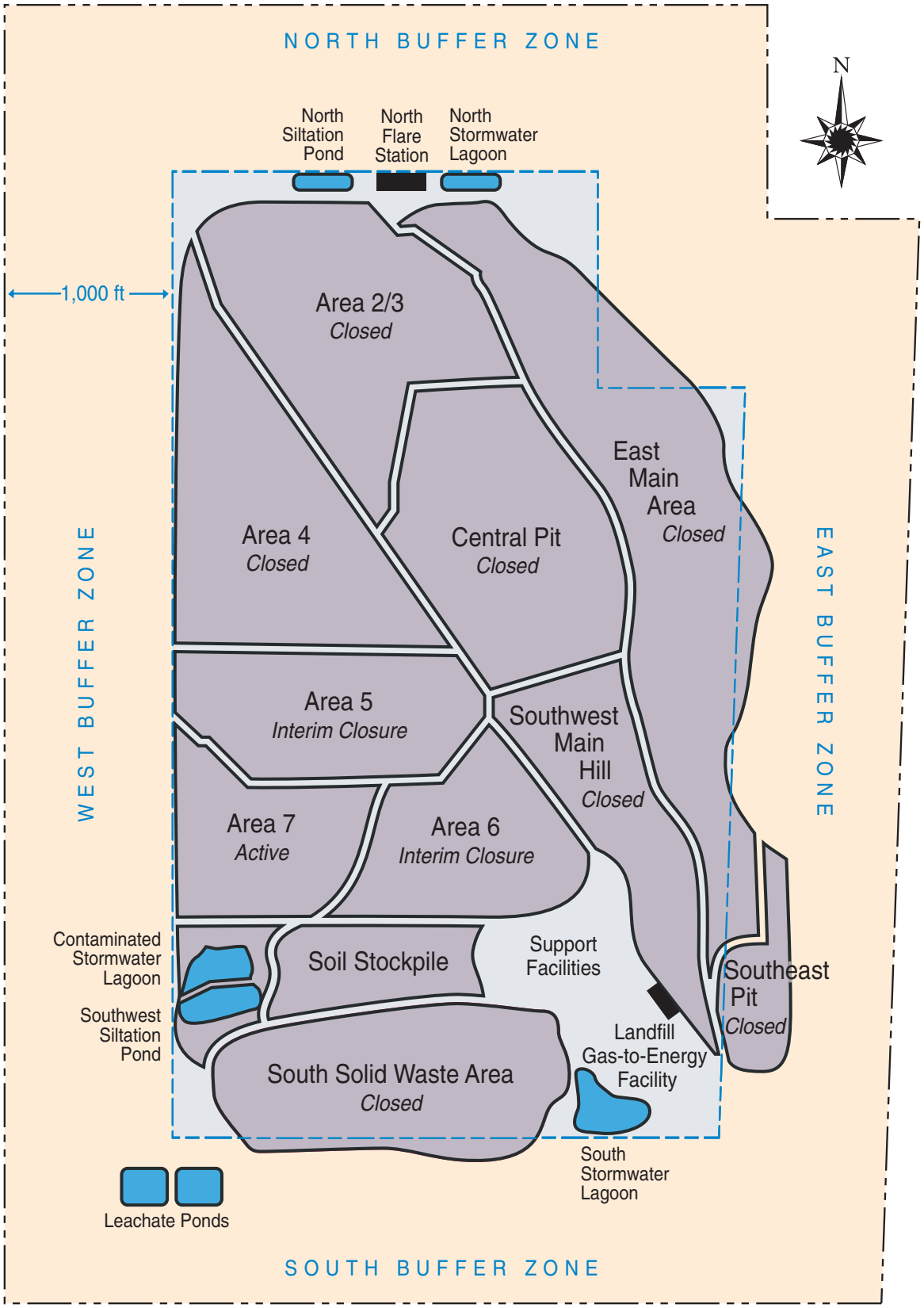
The landfill is bordered by residentially zoned property on the north, west, and east, and by property to the south that is zoned for mining, other resource extraction, and similar uses. State regulation WAC 173-351-140(3)(b) requires a 250-foot buffer between the active area and residentially zoned property, and a 100-foot buffer between the active area and non-residentially zoned property. However, a special use permit issued in 1960 specified that a 1,000-foot buffer be established around the landfill and left in its natural condition. Use of this buffer zone is currently limited to site access and approved uses not directly related to landfilling operations, such as environmental monitoring.

In the last 10 years, the landfill has received national recognition for its operations. The landfill's environmental control systems, for both older and newly developed areas, are operated and maintained to meet or exceed the highest federal, state, and local standards for protection of public health and the environment. This complex network of environmental controls consists of collection pipes, culverts, and holding ponds to manage water and landfill gas.

Leachate from the landfill is pretreated in an aeration pond before being sent to a wastewater treatment plant.

Rainwater and other water at the landfill is separated into two categories for treatment – contaminated stormwater, which includes leachate and other water that has potentially come into contact with garbage, and clean stormwater. Leachate is produced when water percolates through the garbage; it is collected in pipes within the landfill and diverted to on-site ponds. In the ponds, the leachate is aerated as a preliminary treatment before being sent to a wastewater treatment plant. The bottom liner and clay barrier beneath the landfill prevent leachate from seeping into the soil or groundwater. Stormwater that runs off the surface of active landfill areas is also potentially contaminated; therefore, it is collected in lined ponds before moving on to the treatment system. Clean stormwater is diverted to detention or siltation ponds to control flow and remove sediment, and is then discharged to surface water off-site.

Figure 6-1. Current layout of the Cedar Hills Regional Landfill



An extraction well collects gas from the landfill and routes it to the new landfill gas-to-energy facility for conversion to marketable natural gas

Landfill gas is generated through the decomposition of waste buried in the landfill. The gas consists of about 50 to 60 percent methane and about 40 to 50 percent carbon dioxide, with the remainder made up of oxygen, nitrogen, and other trace gases. Prior to 2009, the landfill gas from Cedar Hills was collected in a series of pipes and routed to high-temperature flares, where it was burned to safely destroy any harmful emissions. Now, the gas is routed to a new landfill gas-to-energy facility where it is run through a series of processors that remove and destroy the harmful components and convert the methane portion of the gas into pipeline-quality natural gas. The clean gas is routed to a nearby gas line and into the Puget Sound Energy grid. With the new energy facility in operation, the landfill gas flare system is no longer in regular operation, but is kept in standby mode for use during maintenance of the energy facility or in the event of an emergency. Air emissions from the flare system have been tested regularly and meet or exceed all applicable environmental regulations.

Conversion of Landfill Gas to Green Energy

In May 2009, a landfill gas-to-energy facility began operations at the Cedar Hills landfill to convert methane gas into pipeline-quality natural gas. The gas-to-energy facility, owned and operated by the private firm Bio Energy (Washington) LLC, is generating enough natural gas to supply about 24,000 homes with energy. The facility also contributes energy to support plant operations.

Because the converted methane gas from the landfill replaces an equal amount of natural gas from a non-renewable source, the landfill gas-to-energy project results in an overall reduction of emissions, including greenhouse gas emissions. The estimated annual reduction in greenhouse gas emissions from converting the landfill gas to natural gas is roughly equal to the emissions generated by 22,000 average passenger cars. This translates into an estimated 63 percent reduction in the carbon footprint of the landfill.

EXTENDING THE LIFE OF THE LANDFILL

The Cedar Hills landfill is a valuable asset to King County. Continuing to use the landfill for as long as reasonably possible will keep rates lower until the county transitions to another disposal option in the future. To maximize the benefit of the landfill, the division is pursuing three primary strategies:

- Operational efficiencies
- New area development
- Diversion of waste

These three strategies seek to extend the life by increasing landfill capacity and density, which are defined as follows:

Area 7, the currently active refuse area, is the last area permitted for development under the 1998 Cedar Hills Regional Landfill Site Development Plan.

- **Landfill capacity** – the amount of space available in which to place waste. Landfill capacity is the amount of space, often referred to as airspace, which is permitted and available for disposal of waste. It is calculated based on the height, footprint, and slopes of the landfill.

- **Density** – how tightly materials are packed together, in this case solid waste in the landfill. A higher density means more waste packed in a designated space. The density of solid waste within the landfill is a function of both natural processes and operational practices. Density is increased as waste is compacted by heavy machinery on the face of the landfill and by the natural settling that occurs over time as solid waste decomposes.

Operational Efficiencies

During the last seven years, the division has made a series of operational changes to increase landfill capacity and density. These changes include reducing the amount of soil and rock buried in the landfill, using more efficient unloading and compaction equipment, and taking advantage of natural settlement. Some of the key efficiencies are described below:

- In the past, six inches of compacted soil was used to cover the entire surface of the active solid waste disposal area at the end of each working day. Daily cover serves to control litter and discourage foraging by animals, such as rodents and birds; however, the use of soil can consume valuable landfill space. Therefore, in 2005, the division began using retractable tarps to cover most of the waste at the end of each day to reduce the amount of soil buried in the landfill; the tarps serve the same function as the daily soil cover. At the start of each day's operations, the tarps are rolled up, and more solid waste is placed directly on top of the previous day's waste. Soil is still used to cover side slope areas; however,

as much of this soil as possible is removed before more waste is placed, and the soil is then reused. Together, these practices have resulted in a reduction of the volume of soil buried in the landfill.

The Tarp-O-Matic covers the working face of the landfill at the end of each day.

- In December 2008 the division began using tippers to empty trailers rather than the walking floor trailers previously used. Walking floor trailers require a large, rock-covered surface for the trucks to drive on as the walking floor rolls the garbage out the back of the trailer. However, these large rock surfaces are not required with the tippers. Instead, the garbage trailers are backed onto the tipper, which tilts the trailer, allowing the garbage to slide out of the back and into the refuse area. The use of tippers not only reduces the use of rock, it decreases unloading time for each trailer by as much as half and reduces equipment and tire damage.

Side-by-side tippers greatly reduce the time required for unloading garbage trailers at the landfill.

- Over the last several years, the division has also begun using heavier equipment and improved methods to increase waste compaction. Packing the waste to a greater density allows more airspace for additional solid waste in each landfill area.

- Another strategy for increasing landfill capacity is taking advantage of the natural settlement that occurs as waste placed in each area decomposes. As this natural settling occurs, the level of the landfill drops below the permitted height, allowing more waste to be added to bring the height of a previously filled area back up to its planned level. To take advantage of this natural settlement, the division has delayed final closure of Areas 5 and 6, and will delay final closure of Area 7, to allow settling to occur so that additional waste can be added before final cover is applied.

With these operational changes, more solid waste can be placed within the already designed and permitted refuse areas, without further expansion of the landfill. The division will continue to pursue these and other best management practices that preserve airspace and add capacity to the landfill.

New Area Development – Updating the Site Development Plan

The 1998 Site Development Plan is in the process of being updated to further support the policy direction to extend the life of the landfill. During 2009 and 2010, the division explored alternatives for extending the life of the landfill. A wide range of alternatives was originally identified. Based on a preliminary assessment of operational and engineering feasibility, as well as likely environmental impacts, five action alternatives were selected for assessment through the environmental impact statement (EIS) process. Alternative 2 was selected as the preferred alternative, and in December 2010 the Council approved a Project Program Plan (PPP), allowing the division to move forward with a site development plan for the preferred alternative. Alternative 2 will develop 56.5 acres for construction of one new refuse area – Area 8 – which will extend the life of the landfill to about 2024 or 2025.

Divisison staff continually work to make landfill operations more efficient.

In accordance with the State Environmental Policy Act (SEPA), an EIS was prepared to provide a comprehensive environmental review of each of the five action alternatives and the no action alternative (i.e., no further development beyond Area 7). The final EIS, issued in July 2010, determined that none of the five action alternatives would pose any probable significant adverse environmental impacts compared with the no action alternative (KCSWD 2010a).

In the final EIS, the division recommended a preferred alternative for landfill development based on environmental review, operational feasibility, cost, stakeholder interest, and flexibility to further expand landfill capacity if future circumstances warrant. The preferred alternative (Alternative 2) will develop 56.5 acres in the southwestern portion of the landfill and extend landfill life until 2024 or 2025. This alternative maximizes the use of readily available space at the landfill with no significant potential adverse impacts on the environment and the least amount of disruption to existing landfill structures and the buffer. At the same time, it preserves the flexibility to implement further development if warranted in the future. Alternative 2 is a cost-effective option, balancing the cost of future development and operations with savings to the ratepayer.

Following publication of the final EIS, the division submitted a PPP to the King County Council for approval (KCSWD 2010b). The PPP, which provides the rationale for selecting Alternative 2, was approved by County Council in December 2010. In 2011 the division will prepare a detailed Site Development Plan.

Diversion of Waste

Reducing the amount of waste delivered to the landfill (waste diversion) is one of the more effective strategies for extending landfill life. The division will continue to practice current methods of waste diversion and may implement future strategies, as discussed below.

Current Strategies for Waste Diversion

Waste is currently diverted from Cedar Hills through two primary methods – waste prevention and recycling (WPR) and a ban on the acceptance of most construction and demolition debris (C&D).

WPR efforts have proven a successful strategy for extending the life of the landfill. Between 1988 and 2008, an estimated 10 million tons of materials that would otherwise have been disposed in the landfill were recycled, extending the landfill's life by approximately 10 years. Without the successful efforts of WPR, it is estimated that the Cedar Hills landfill would have reached capacity in December 2006. If the region achieves the goals established for WPR by 2015, as set forth in this plan (see discussion in Chapter 3, *Waste Prevention and Recycling*), these efforts would add approximately one more year to the life of the landfill by 2015.

Banning most C&D debris from the Cedar Hills landfill has also contributed to extending landfill life. Since the disposal ban in 1994, an estimated 3,227,000 tons of C&D debris has been diverted from the landfill. To manage the majority of the region's C&D, the division contracts with two private-sector companies – Allied Waste and Waste Management. The division's current C&D contracts are scheduled to expire in 2014. Before the expiration date, the division will evaluate options for ensuring adequate transfer capacity and recycling/reuse opportunities for C&D in the future. Options could include negotiating new contracts for C&D handling, allowing C&D to flow to private-sector facilities without division contracts, and accepting more C&D at new and reconstructed county transfer stations.

Future Strategies for Waste Diversion

As mentioned in the introduction to this chapter, the division will examine the feasibility of diverting a portion of the solid waste stream to another disposal option(s) while the landfill is still in operation. Possible options could include transporting waste to an out-of-county landfill or implementing waste-to-energy or another conversion technology. A cost/benefit analysis would precede any decision to pursue early diversion, followed by a thorough evaluation of environmental, social, and economic criteria for any proposed implementation strategies.

DISPOSAL OPTIONS ONCE CEDAR HILLS CLOSES

When the Cedar Hills landfill reaches capacity and closes, the county will no longer own or operate a disposal facility. The county is not considering the development of a replacement landfill either in King County or in another county. Conditions in King County – such as land availability, environmental considerations, public acceptance, cost, and other issues – would make siting a replacement landfill in King County difficult. With the large amount of already developed landfill space in the Pacific Northwest, siting a landfill elsewhere in Washington is not practical.

With approximately 825,000 to 1 million tons of solid waste to dispose annually, there has been considerable interest from the private sector in handling the county's waste after the Cedar Hills landfill closes. There are three national disposal companies with competitive landfill capacity within one day's rail

haul, and additional potential competitors farther away. In addition, a growing number of companies have shown interest in providing disposal service through a range of other options, including waste-to-energy and other conversion technologies.

In 2007, the division hired a private consulting firm, R.W. Beck, to study future waste disposal options for the county (Conversion Technology Report; R.W. Beck 2007). The report provides a preliminary look at a wide range of technologies, with an emphasis on three technologies that offer commercially proven systems – mass burn waste-to-energy, refuse derived fuel, and advanced thermal recycling, and compares them with waste export to an out-of-county landfill. Key conclusions of the report are as follows:

- The three conversion technologies and the waste export disposal option are each capable of handling the quantity and composition of the King County waste stream while meeting all applicable regulatory requirements.
- The conversion technologies are compatible with increased county recycling efforts up to a 70 percent recycling rate.
- The conversion technologies are more expensive than the waste export disposal option.
- An informed decision on disposal options will require a more detailed analysis to refine conclusions and evaluate specific characteristics.

The Conversion Technology Report was not intended to provide a recommended disposal option once the landfill closes, but rather to provide a starting point for evaluating the wide range of alternatives. The technologies reviewed will need further monitoring, evaluation, and consideration, as they are rapidly changing and developing, the costs can fluctuate significantly over time, and the Cedar Hills landfill will be in operation through at least 2024. Given these conditions, a decision about which disposal alternative or alternatives will be the most efficient, environmentally sound, cost-effective, and publicly acceptable when the Cedar Hills landfill closes will likely not be made during this six-year planning period. The division will continue to monitor existing and emerging technologies for consideration in the future.

What follows is a discussion of potential disposal options to consider once the Cedar Hills landfill closes and/or for diversion of a portion of the waste stream while the landfill is still operating. This list is likely to evolve over time as technologies emerge and are tested.

Export to an Out-of-County Landfill

Previous county policy established export to an out-of-county landfill as the choice for disposal after closure of the Cedar Hills landfill. While this plan recommends that other options be considered as well, export to an out-of-county landfill continues to be a viable alternative. A properly run landfill is an environmentally sound method of solid waste disposal. In the Pacific Northwest, existing landfill space is plentiful enough to handle the county's solid waste for many years to come, as shown in Table 6-1. There are at least four landfills currently available in the western U.S., with two additional landfills in development.

Export to an out-of-county landfill would require contracting with a private disposal company. Rail transport is the most likely mode of transport, so an intermodal facility, where solid waste containers are transferred from trucks onto rail cars, would be needed. This service could be part of the contract and obtained by the disposal company, or the division could obtain intermodal capacity on its own or develop its own intermodal site. The ability to access both railroad lines that serve King County – Burlington Northern Santa Fe Railway and Union Pacific – would increase the potential for competition among the private landfills, and thus likely have a positive effect on rates.

The Harbor Island property has access to the region's two rail lines.

To preserve the option to develop its own intermodal site, the county purchased property on Harbor Island in Seattle, which has access to both rail lines. The previously approved Transfer Plan recommended continuing to monitor local intermodal capacity and retaining the Harbor Island property as a potential option for an intermodal site.

Conversion Technologies

A conversion technology is defined in the Conversion Technology Report as "a process which converts solid waste from a waste product to a useful form of energy and/or useable byproduct, generally with some residual, unusable component that must be sent for disposal." For the purposes of the study conducted by R.W. Beck, it was assumed that the county would select a single facility with the ability to handle about 3,200 tons of waste per day. Since the report was produced, however, the county has concluded that a combination of disposal methods for specific components of the waste stream should also be further evaluated.

Table 6-1. Potential locations for out-of-county landfill disposal

Landfill Name	Location	Owner	Miles from Seattle	Total Permitted Capacity (tons)	Remaining Capacity (2009)	Opening Year	Estimated Closure
Active Landfills							
Columbia Ridge Landfill and Recycling Center	Gilliam County, OR	Waste Management	325	221,875,000	201,000,000	1990	2135+
Roosevelt Regional Landfill	Klickitat County, WA	Allied Waste Industries dba Regional Disposal Co.	330	244,600,000	205,000,000	1990	2075+
Finley Buttes Regional Landfill	Morrow County, OR	Waste Connections	352	124,000,000[a]	117,000,000	1990	2100+
Simco Road Regional Landfill	Elmore County, ID	Idaho Waste Systems	628	210,000,000[b]	200,000,000+	2000	2100+
Landfills Permitted, Not Operating							
Eagle Mountain Landfill	Riverside County, CA	L.A. County Sanitation Dist.	1,325	708,000,000	708,000,000	TBD [c]	2125
Mesquite Regional Landfill	Imperial County, CA	L.A. County Sanitation Dist.	1,420	600,000,000	600,000,000	~2011	2110

[a] *Finley Buttes has the potential to expand to a permitted capacity of 400 million tons.*

[b] *Simco Road Regional Landfill is currently expanding to a permitted capacity of 420 million tons.*

[c] *To be determined; Development of Eagle Mountain Landfill is on hold.*

Conversion technologies have various requirements in terms of the size of materials (or feedstock) they can process, the amount of materials they can process per day, and, in some cases, the types of materials they process. With most technologies, for example, metals must be extracted from the feedstock prior to processing. Some processes require that materials be shredded or otherwise reduced in size to between 2 and 12 inches before processing.

The Conversion Technology Report identified three proven thermal conversion technologies (also known as incineration) that would produce energy and could manage the county's entire waste stream – mass burn waste-to-energy, refuse derived fuel, and advanced thermal recycling. Thermal technologies use high-temperature combustion systems to convert refuse to energy in a controlled environment. These three technologies were identified as having sufficient operating experience in handling the volume of solid waste generated in the county. In addition, each has the demonstrated ability to meet permit requirements for air quality and to produce a manageable amount of ash and other residuals that can be properly disposed of or potentially reused. More detailed information is contained in the Conversion Technology Report (R.W. Beck 2007).

In addition to the established thermal conversion technologies, the report identified a number of other thermal, biological, and chemical technologies, some established and some emerging, that could handle all or specific components of the county's waste stream. Below is a sampling of these types of technologies.

Anaerobic Digestion – Anaerobic digestion is a biological process that breaks down organic molecules into methane and carbon dioxide. A useful product of anaerobic digestion is biogas (methane and carbon dioxide), which can be burned to generate steam and electricity. In addition to generating gas, anaerobic digestion produces a residue that contains inorganics, non-degradable organics, and other materials. Following the digestion process, these solids may be cured in standard composting type processes to produce a usable compost product.

Catalytic Cracking – Catalytic cracking is a thermo-chemical conversion process that breaks down polymers, such as plastics, into their basic unit, called a monomer. The monomers can then be processed to produce fuels such as low-sulfur diesel and gasoline.

Gasification – Gasification is an emerging thermal technology. While there are a number of facilities operating worldwide, there are no facilities using gasification to process solid waste in the U.S. During gasification, chemical reactions can be controlled to produce different products. For example, the gases produced can be cleaned and used as fuel, or can be used to produce chemicals such as methanol, ethanol, and other fuel liquids.

Pyrolysis – Pyrolysis is a thermal process that produces oils and fuel gases from organic materials, which can be used directly as boiler fuel or refined for higher quality uses such as engine fuels, chemicals, adhesives, and other products.

Steam Classification/Autoclave Technology – Autoclave technology is currently used for the management of medical waste and has had limited use in the disposal of solid waste. Through exposure to a combination of temperature, moisture, pressure, and agitation, the waste is sterilized and its volume reduced. Once processed, some of the remaining waste can be separated and recovered. Specifically, pulp

from paper and other fiber-based waste can potentially be reused by box-makers or combusted as refuse-derived fuel. Most non-recoverable waste is reduced in volume by 50 to 60 percent and is intended to be safe for landfilling.

Thermal Depolymerization – Thermal depolymerization is a process that reduces complex organic materials into crude oil. It is similar to the processes that occur in nature to create fossil fuels, but requires only hours to be completed. Also produced in the process are fatty acid oils used in various cleaners and pharmaceuticals, and minerals used in fertilizer products. This technology is currently being used to process agricultural and food-processing waste.

Waste-to-Ethanol – Waste-to-ethanol is a technology used to break down the organic portion of the waste (paper, food scraps, yard waste, etc.) into sugars, which are then distilled into ethanol.

The division is committed to the continued exploration of both emerging technologies and advancements in established disposal methods.

Screening and Evaluation Criteria for Disposal Options

The division has developed draft criteria by which disposal options may be screened and evaluated when making future decisions. The screening and evaluation criteria fall into six categories, each with a number of sub-categories. Specific requirements can be developed based on these criteria when it is time to make selections for partial waste diversion and disposal after Cedar Hills reaches capacity and closes.

- **Environmental**
  - Human health
  - Climate change
  - Air quality
  - Water quality
  - Energy production
  - Resource conservation
  - Compatibility with waste prevention and recycling

- **Social**
  - Environmental justice
  - Social justice/equity
  - Effects on livability and character of communities

- **Economic**
  - Capital cost
  - Financing
  - Operating cost
  - Revenue generated
  - Risk

Availability

- Capacity
- Start date
- Operating life of facility
- Siting, design, permitting, and construction requirements
- Operating and maintenance personnel
- Financial assurance and insurability

- **Operating history**
  - Proven performance
    - Ability to handle amount of waste
    - Operator record
    - Safety record
    - Regulatory compliance
  - Compliance with regulatory requirements
  - Ability to respond after an emergency
  - Ability to provide performance guarantees

- **Contract and operational requirements**
  - Minimum level of waste required
  - Composition of waste required
  - Contract flexibility
    - Length of commitment required
    - Opportunity for contract reopeners
  - Waste not accepted/ability to handle special waste
  - Residue disposal requirements
  - Compatibility with waste prevention and recycling
  - Compatibility with current collection and transfer systems

RESTORATION OF CLOSED LANDFILLS

The division maintains responsibility for nine closed landfills located throughout King County (Figure 6-2). The landfills were operated by King County and closed at various times between the mid-1960s and 1999. All of the closed landfills were thoroughly investigated; all findings were reported to the proper county, state, and federal agencies; where necessary, remedial actions were taken; and the division has continued to monitor the sites to ensure that they do not pose a risk to human health or the environment. None has been placed on the Hazardous Sites List under the state Model Toxics Control Act, or the federal Comprehensive Environmental Response, Compensation, and Liability Act, commonly known as Superfund.

Post-Closure Monitoring and Maintenance

At seven of the nine closed landfills, the division routinely monitors groundwater, surface water, wastewater, and landfill gas; the Bow Lake and Corliss landfills have reached a stable state and no longer require monitoring. Under the current monitoring program, sampling data are collected from more than 180 groundwater, surface water, and wastewater monitoring stations, and approximately 100 landfill gas monitoring stations. These data are summarized in quarterly and annual reports submitted to the Washington State Department of Ecology and Public Health – Seattle & King County (Public Health). Public Health also routinely inspects all of the closed landfills.

The closed landfills were constructed under different standards than those that guide landfill development today. With the exception of portions of the Vashon landfill constructed after 1989, they are unlined and do not, in most cases, incorporate all of the environmental control systems present in a modern landfill. Thus, the unique characteristics of each site – in particular the underlying geology, what lies downstream, and the waste that was originally placed in the landfill – play an important role in the post-closure needs of the site. These factors also influence the need for ongoing monitoring. As the closed landfills reach the end of their required post-closure periods, each will be evaluated to determine what level of ongoing monitoring is necessary. In some cases, there may be no need to continue monitoring; at other sites, monitoring may continue at a reduced frequency and for a reduced range of constituents.

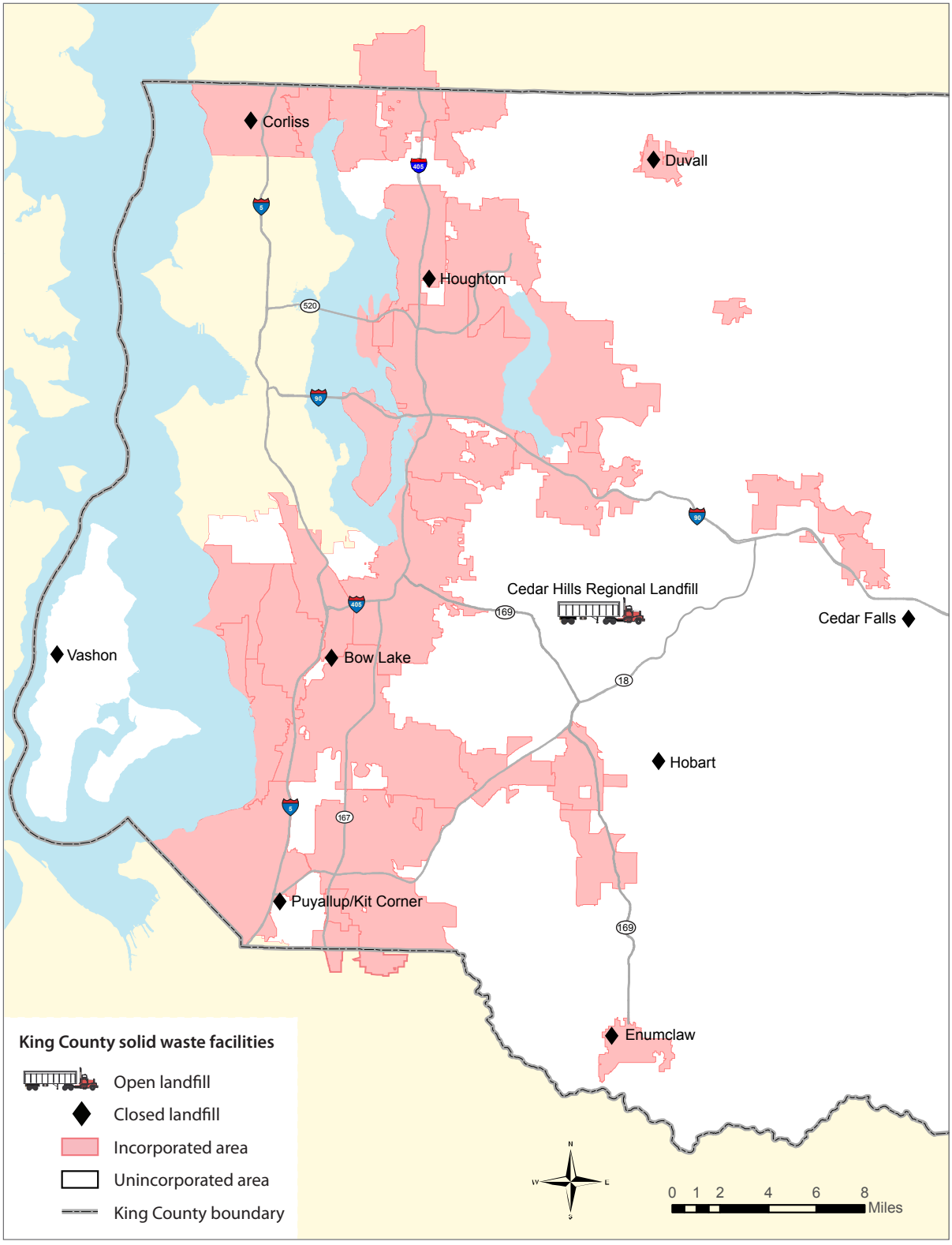
Over the years, environmental controls have been added at many of the closed landfills as determined by monitoring results. Additionally, most sites have been capped, with either composite cover systems or vegetative cover. At the Hobart landfill a subsurface slurry wall was constructed, which effectively maintains a separation between refuse and ground water. At the Corliss landfill, waste was removed when the Shoreline Recycling and Transfer Station was built. Some waste is being removed from the Bow Lake landfill as the new station is being built.

When the Cedar Hills Regional Landfill reaches capacity and closes, the bottom liner, capped top, and extensive gas and water control systems will inhibit releases to the environment for many years. Applicable regulations will define the post-closure period (currently 30 years). Landfill closure is guided by the Resource Conservation and Recovery Act, Title 40, Subtitle D, Part 258, Subpart F – Closure and Post-Closure Care and Washington Administrative Code 173-351. It specifies that the post-closure period must be 30 years, although that period may be shortened or lengthened based on the necessity to protect human health and the environment. After the post-closure period, there is expected to be some reduced level of monitoring and care to ensure the integrity of the cap and other environmental controls. A recent study by the Solid Waste Association of North America Applied Research Foundation (*The Long-Term Environmental Risks of Subtitle D Landfills*; SWANA 2008) concludes that, "For a closed landfill with a fully functional final cover system or one where only minor breaches have occurred, the environmental and public health threat is likely to be relatively minor."

Beneficial Reuse of Landfill Properties

The county continues to examine possibilities for the beneficial reuse of closed landfill properties. While the presence of monitoring equipment at these landfills can limit the types of beneficial reuse projects

Figure 6-2. Locations of closed landfills



that can be implemented, the county has been successful in converting several properties wholly or in part to new purposes:

Trees and vegetative cover at the Duvall landfill help reduce carbon dioxide (a greenhouse gas) in the atmosphere through the natural process of photosynthesis.

- **Houghton landfill** – Athletic fields were developed on the former Houghton landfill area. The division's environmental investigations, which were independently verified by Public Health, the University of Washington, and the U.S. Environmental Protection Agency, found that no health or safety threat would be posed by using the covered landfill for recreation.
- **Hobart landfill** – Model airplane enthusiasts and an astronomy club use the open spaces of the Hobart landfill.
- **Duvall landfill** – The county installed an 800-MHz radio tower outside of the refuse boundary of the Duvall landfill as part of its Emergency Communications Project.
- **Cedar Falls, Duvall, and Puyallup/Kit Corner landfills** – Walking and non-motorized biking trails in the property buffers are used by area communities.

In addition, the open spaces at closed landfills provide habitat for diverse species of plants and animals, often providing open grassy areas surrounded by woods. Closed landfills that currently provide homes to healthy populations of wildlife are Cedar Falls, Duvall, Hobart, Puyallup/Kit Corner, and Vashon. Grass covers have been placed over all the landfills, engineered to suit the naturally occurring features and areas of potential enhancement at the properties. Vegetative covers at the Duvall and Puyallup/Kit Corner properties include planted trees and other vegetation to improve ground cover and water quality, as well as perches and nesting boxes for hawks and owls. The Cedar Falls and Duvall landfills are near the headwaters of large streams and provide cover and a source of food for birds. Managing these properties as green space helps support the county's goals and policies for habitat preservation and increases carbon sequestration (i.e., reduces the total carbon emissions) at the properties.

The county will continue to explore beneficial reuse options for closed landfills, such as alternative energy farms, and designing monitoring and environmental systems to facilitate reuse of the properties and provide continued benefit to the surrounding communities.

DISPOSAL OF SPECIAL WASTES

Most of the waste delivered to the division's facilities is municipal solid waste (garbage) from residential and non-residential sources. A portion of the waste stream, however, requires special handling and waste clearance before disposal because of legal, environmental, public health, or operational concerns. Of

the approximately 825,000 to 1 million tons of solid waste disposed each year, between 6,000 and 9,000 tons is designated as special waste. These special items include industrial wastes, asbestos-containing materials, contaminated soil, treated biomedical wastes, treatment plant grit and vactor wastes, and other miscellaneous materials. It does not include household hazardous wastes.

Since 1993, the division has conducted a waste screening program to ensure that materials in the waste stream are handled in accordance with federal and state regulations (Resource Conservation and Recovery Act, Title 40, Subtitle D and WAC 173-351). Under this program, waste screening technicians, in cooperation with other staff, perform random manual and visual screening of incoming loads of waste at each transfer facility and the Cedar Hills landfill to identify and properly manage any potentially unacceptable wastes. More than 11,000 loads of waste are screened at division facilities each year. Waste screening, combined with ongoing surveillance and control of incoming solid waste by transfer station and landfill operations staff, is the first step in the county's solid waste enforcement program. The division also continues to educate customers on the county's waste acceptance policies through public outreach materials and hands-on customer service. In cases where special waste policies are repeatedly disregarded, division staff enforce compliance through an iterative process of warnings, citations, and eventually fines for improper disposal of special wastes.

Under the county's Waste Clearance Policy (PUT 7-2-1[PR]), the Special Waste Unit provides a free service to customers to evaluate wastes and determine if they can be accepted for disposal and under what conditions. Special waste staff process and provide more than 400 waste clearances for disposal each year. Conditions for disposal could include bagging or wetting to control dust, direct haul to the Cedar Hills landfill, specific packaging and labeling requirements, separation from other waste in a special waste disposal area, or certification of disposal by authorized landfill staff. Procedures for disposal of special waste are often defined by local, state, or federal regulation.

The method for handling special wastes once the Cedar Hills landfill closes will be considered during the screening of alternative disposal options.

DISPOSAL SERVICES AFTER AN EMERGENCY

The King County Operational Disaster Debris Management Plan (Debris Management Plan; KCSWD 2009) outlines the process for managing disaster debris recovery within the boundaries of unincorporated King County and for coordinating with the 37 cities with which King County has Interlocal Agreements. The Debris Management Plan is aligned with other national, state, and county plans, including the *2008 King County Comprehensive Emergency Management Plan*, as well as regulations and policies that will affect how King County manages disaster debris.

Debris management operations are grouped into three response levels – routine, medium, and high. The response level is determined by the division based on the geographic scope and impact of an actual or anticipated incident. Routine incidents are relatively common emergencies such as small landslides or minor flooding, which can be supported with existing resources and require minimal coordination. Medium impact incidents require more than routine coordination, and generally involve multiple jurisdictions. These include incidents such as moderate earthquakes, minor or moderate flooding in

multiple locations, and storms with snow, ice, and/or high winds. The situation may require mutual aid or contract resources, and it may be necessary for the King County Executive to proclaim an emergency. High impact incidents require a high degree of coordination and generally involve requests for state and federal assistance. These include incidents such as large earthquakes, severe flooding, or severe storms. In most cases, an emergency will have already been proclaimed by the King County Executive.

A regional approach to planning is essential for managing the multi-jurisdictional impacts of emergencies in the Puget Sound area and for coordinating the limited disposal capacity in western Washington. This disposal capacity is subject to two major constraints. First, most jurisdictions in the region export their solid waste to landfills east of the Cascade Mountains. Without local landfill space, disposal capacity relies on the region's transportation network, which could be compromised in a major emergency. Second, the only operational landfill in King County (Cedar Hills) does not accept materials other than municipal solid waste for disposal.

The coordinated regional Debris Management Plan emphasizes recycling to the extent possible. The plan calls for the use of temporary Debris Management Sites for storage of debris until it can be sorted for recycling or proper disposal. The division has worked with the King County Regional Communications and Emergency Coordination Center to coordinate public information and help cities and residents identify recycling options in preparation for and in response to emergency events of all types.

The division will consider the feasibility of a cost-sharing arrangement to secure long-term emergency capacity for the region as a whole after the closure of Cedar Hills. The update of the Site Development Plan will provide information with which to evaluate the feasibility of setting aside some portion of Cedar Hills for long-term emergency disposal. The ability to respond after a major regional emergency is one criterion that will be used to select a disposal option to be used once the Cedar Hills landfill closes.