CH2MHILL

Final

Comprehensive Site Development Plan

Glenmore Landfill

Executive Summary

June 2008

Submitted to

City of Kelowna

ES122007001VBC

Executive Summary

Purpose

The Glenmore Landfill was identified in the Regional District of Central Okanagan's (RDCO's) 1992 Solid Waste Management Plan as the best long-term residual disposal site in the entire District. In keeping with direction set in the Solid Waste Management Plan, this Comprehensive Site Development Plan (CSDP) has been prepared to provide guidance and details for future development at the site. The original CSDP was prepared in 2001. This document represents a revised version of the plan which has been updated to reflect recent changes, most notably the acquisition of additional lands south of the original property.

The intention of the City of Kelowna is to continue to develop and operate the site in a manner that it is recognized locally, regionally, and internationally. In accordance with this intention, the City has developed a *Vision Statement* and prepared *Guiding Principles* for the facility that define, in general terms, how development and operations are to proceed. In summary, the facility will provide an efficient solid waste management service for the region, together with effective protection and enhancement of the local and regional ecosystem. The facility will further encourage community-wide waste reduction and re-use strategies by providing convenient, affordable, and readily-accessible programs and facilities. Site end use will be beneficial and compatible with surrounding land use and local zoning.

Site Description and Current Operations

Site Description

The Glenmore Landfill is located on Glenmore Road approximately 1.5 km east of Lake Okanagan and 9 km northeast of the Kelowna city centre. It is situated in a narrow, flat-bottomed valley that is bordered on the west and east by tree-covered ridges and on the north and south by agricultural lands. The ridge northeast of the active filling area is known locally as Bredin Hill, while the southeast ridge is known as Tutt Mountain.

The Glenmore Landfill is located in a bowl-like drainage basin that has no surface water outlet. The landfill is located at the low point in the drainage basin and is the receiving point for surface runoff generated within the basin. There are no perennial streams in the basin, but there are roadside ditches and natural drainage courses.

Historical groundwater measurements show that the lateral component of groundwater flow is inward from the valley sides toward the centre of the landfill area. A strong upward groundwater gradient has been measured in the centre of the valley. Regionally, the predominant groundwater flow direction within the Glenmore Valley is from north to south.

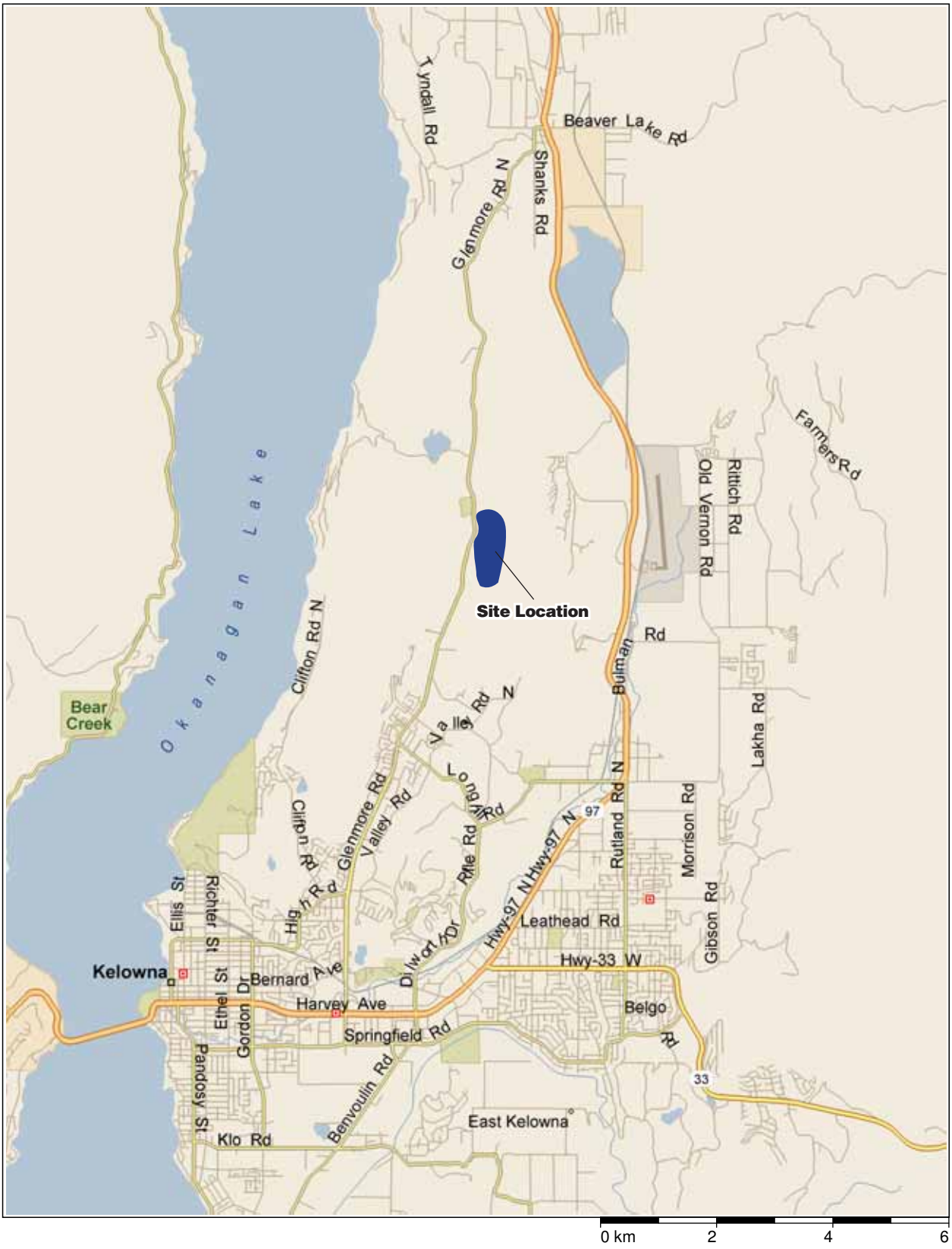

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Exhibit E-1
General Site Location

Available geological data suggest that the silt/clay layer beneath the landfill acts as a natural, low-permeability liner and inhibits the downward percolation of leachate from the landfill to the aquifer. Conversely, this layer also impedes the upward movement of groundwater from the aquifer into the landfill. Due to this upward gradient, this site makes an excellent location for a landfill because of its natural abilities to contain leachate.

Site Operations

The lands on which the landfill is located were originally leased from two local farmers but were later purchased by the City of Kelowna. The southern portion of the landfill, referred to as the Phase 3 area, comprises approximately 28 ha and is currently a slough. Phase 3 area has not received waste since the early 1980s. The northern portion of the landfill is approximately 53 ha in area and currently hosts Phases 1 and 2 of the active landfill area. Wastes have been buried in this area since 1966.

The City is presently landfilling in the northern portion of the site (Phase 1 and 2) using above-grade landfill cells constructed on the existing land or waste surface. Waste diversion activities, including recycling and composting, are also hosted at the site. Operations are done in accordance with Operating Certificate MR12218 issued by British Columbia's Ministry of Environment (BC MoE) under the *Environmental Management Act*.

The City also owns additional lands around the active landfill area which are often referred to as the Acquisition Lands. Originally, the Acquisition Lands consisted of parcels to the north and east of the Phase 1 area. More recently, land to the south of the Phase 3 area was purchased to support site activities.

Proposed Filling Plan

The City evaluated several filling options for the Glenmore Landfill and is currently proposing to landfill primarily within a footprint that encloses the wastes that have been previously buried on the site.

Based on the anticipated waste generation volumes and the proposed filling plan, the landfill is expected to be operational until approximately 2075. Landfilling on the site will take place in a general north-to-south direction.

Proposed Site Development Components

Water Management and Drainage

The proposed water management strategy involves continued use of Bredin Pond and Tutt Pond, and utilizing a newly constructed storage pond at the northeast corner of the landfill between Tutt Mountain and Bredin Hill. This arrangement provides a total storage capacity of 175,000 m^3. Excess water would be pumped to Little Roberts Lake in emergency situations.

The advantages of the proposed strategy is that it provides a greater reserve storage volume, it allows reduced peak pumping rates to Little Roberts Lake (if and when required), and it provides greater flexibility in managing on-site water.

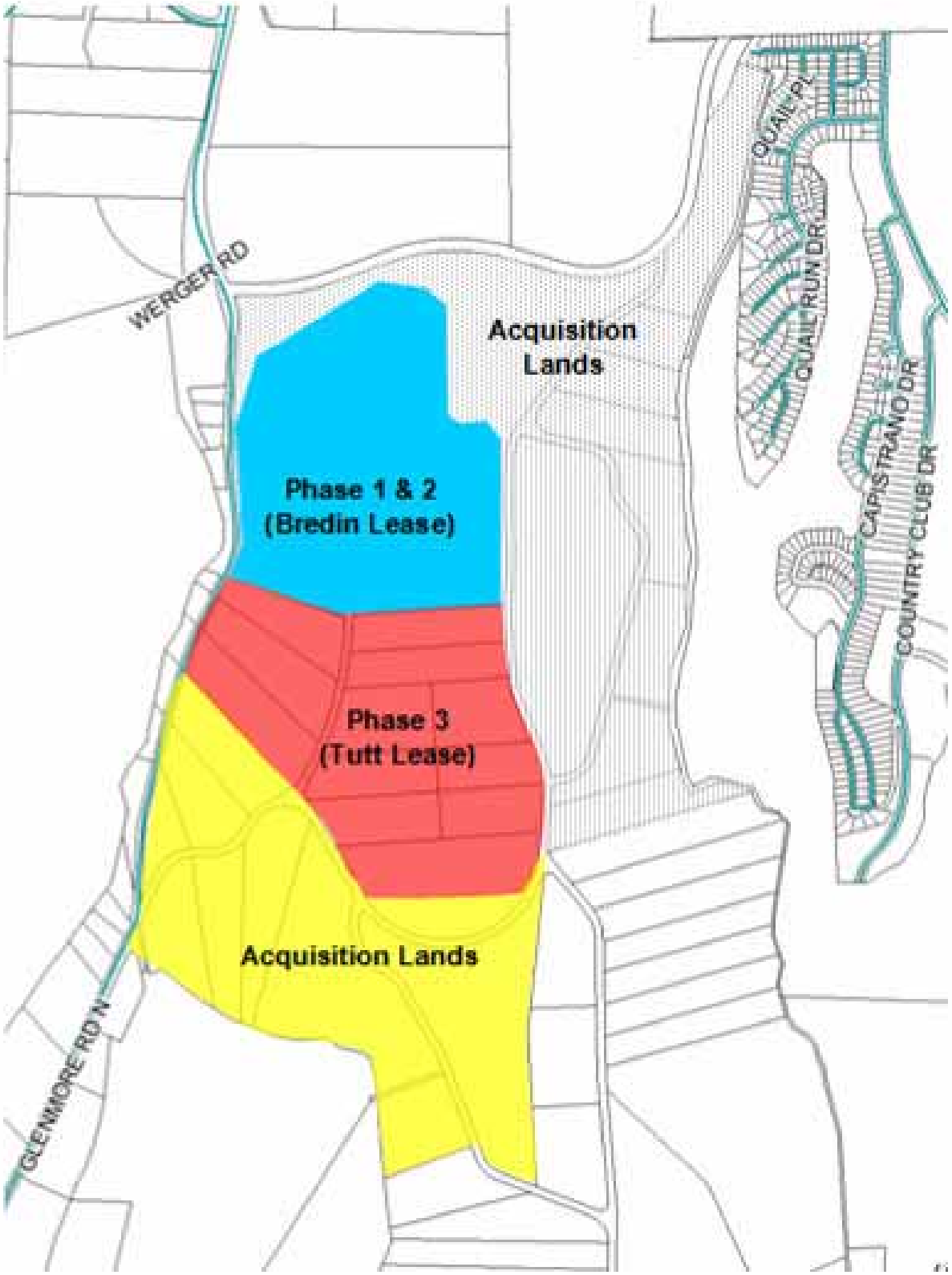

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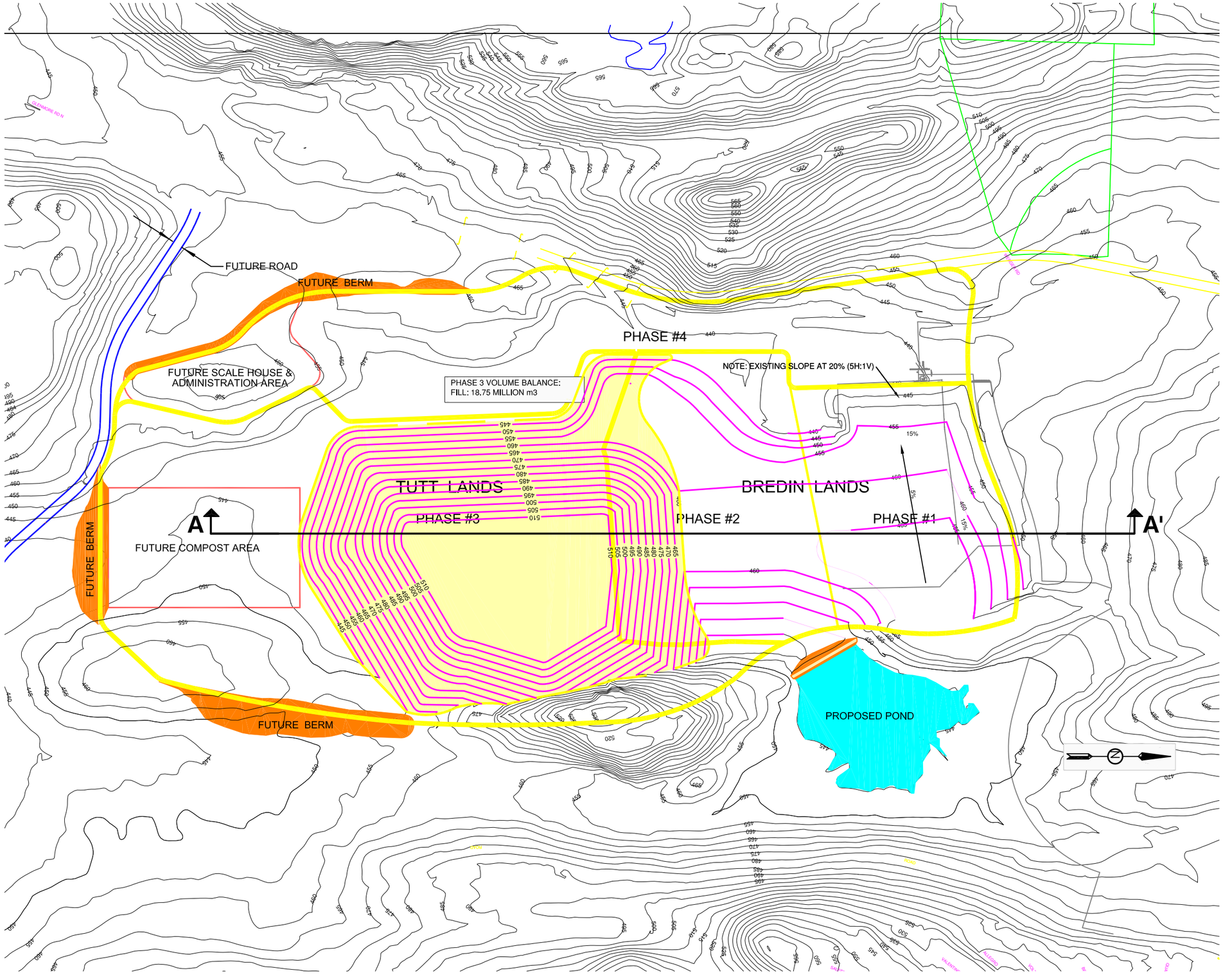
Figure E-2
Property Boundaries



SPERLING HANSEN ASSOCIATES

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LEGEND:

- PROPERTY LINE
- ROAD
- DITCH
- 5m EXISTING CONTOURS
- PHASE 2
- 5m DESIGN CONTOURS

CLIENT:

CITY OF KELOWNA

PROJECT:

GLENMORE LANDFILL COMPREHENSIVE PLAN UPDATE AND FILL CONTOURS REVIEW

TITLE:

PHASE 3 EXISTING FOOTPRINT PH 1 - 2 CONSTRAINTS

SCALE:	DATE:	PROJECT NO:
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Lining and Containment

The proposed footprint for the Glenmore Landfill site includes lands on which solid wastes have been deposited for many years as well as new areas (expansion areas) where no refuse has previously been deposited. The latter includes areas adjacent to Bredin Hill and Tutt Mountain, and parts of the Phase 3 area, primarily along its perimeter.

In light of the City's intent to continue to develop the Glenmore facility using state-of-the-art landfill construction methods, it has been recommended that composite liners be installed in the Bredin Hill and Tutt Mountain Expansion Areas. Not only will the composite liner system provide a higher degree of leachate control in this area, but its use will eliminate the need for extensive verification of existing soil conditions during construction. It is also anticipated that construction of a composite liner system in this confined area will be simpler than installation of a soil liner system, particularly in light of the need to ensure liner continuity around the base of these topographic features.

It is anticipated that a composite liner system will also be required for landfill expansion into Phase 3. Additional engineering studies will be required to determine the most appropriate liner system for that area. Since landfilling in the Phase 3 area will not take place for perhaps 15 to 20 years, there is adequate time available to conduct the necessary studies.

Leachate Control and Collection

Existing leachate collection facilities at the site include a network of leachate collection pipes within the Phase 1 North Expansion Area, a Phase 1 / Phase 2 leachate collection sump and a leachate collection trench located along the south edge of Phase 2. All of these systems convey leachate to a pump station at the north end of Bredin Pond. At the pump station, leachate is currently discharged through a forcemain to an off-site sanitary sewer.

The proposed leachate collection systems in the Bredin Hill and Tutt Mountain Expansion Areas would consist of a 0.3 m thick layer of drain sand overlying the bottom liner. Strip drains spaced at approximately 20 m would be embedded in the drainage layer. Perforated leachate collector pipes would be installed across the base of each expansion area adjacent to the toe of the existing waste pile. The purpose of the collector pipes would be to collect leachate from the strip drains and convey it to a single, solid leachate transmission pipe that would connect into the existing leachate collection system.

The leachate collection system recommended for the Phase 3 area would be similar to the system described above. A perimeter diversion berm, cut-off trench, and leachate collector pipe would be constructed around the Phase 3 area to facilitate pre-construction dewatering. The mounds of existing buried waste would be removed to a depth necessary to maintain the leachate head below an elevation of 437 m-asl, and the area would be subdivided into a series of cells approximately 100 m by 200 m. The base of each cell would consist of a 0.3 m thick layer of drainage aggregate sloping downward from the edge of the cell to the middle at a minimum grade of 2%. A leachate collector pipe would be installed down the middle of each cell and would drain toward the outer perimeter. Strip drains, or perforated 100 mm diameter lateral pipes, would be placed on the bottom of each cell in a herringbone arrangement and would drain to the central collectors. Leachate collected from

Phase 3 would pumped to the leachate pump station located at the north end of Bredin Pond.

In the future, it may be desirable or necessary to augment the current practice of conveying leachate to an off-site sanitary sewer by providing on-site treatment and/or partial disposal capacity. Such systems might include recirculation of leachate within the landfill, evaporation, or onsite treatment.

Landfill Gas Management

The City of Kelowna has taken a comprehensive approach to landfill gas (LFG) management at the Glenmore site. The CSDP prepared in 2001 included details for the proposed future development of the site and initial review of LFG management. LFG generation modelling conducted at the time using default input parameters indicated that the emissions of Non-Methane Organic Compounds (NMOCs) would exceed the trigger threshold of 150 tonnes/year and that a LFG control system would be required in order to meet Provincial requirements, as outlined by BC MoE.

As part of the City's proactive approach to LFG management, CH2M HILL was subsequently retained to design LFG control systems for the Phase 1 (in 2003) and Phase 2 (in 2005) areas of the site. Construction of initial horizontal gas collectors and the header system for Phase 1 commenced in 2004 and has since continued in conjunction with active landfilling operations. Construction of the Phase 2 LFG control system which ties into the existing Phase 1 system via an extended perimeter ring manifold commenced in 2006..

Currently, the site has three 30 kW Capstone microturbines, which utilize LFG to produce electricity. All excess LFG collected at the site is thermally destroyed through an open flare system.

A conceptual design for the Phase 3 LFG collection system has been completed which involves the placement of perforated pipes in collection trenches located within the refuse. The horizontal collectors would be placed in the same east - west alignment that was used for the Phase 1 and 2 collectors. The first series of horizontal collectors would be laid within the initial waste lift in trenches that extend across Phase 3. Subsequent waste lifts would also have a series of horizontal collection trenches installed parallel to, but horizontally offset from the collectors in the lower lift. A ring header system is proposed to be installed around Phase 3 and tied into the Phase 2 collection system.

The City and CH2M HILL have investigated other LFG utilization options for the site including increasing electrical power generation by installing additional microturbines; use of LFG as fuel for commercial/industrial boilers; direct sale of extracted LFG as medium BTU gas, delivered by pipeline, to potential customers located near the landfill; and treatment of LFG and production of high BTU fuel. The City is still in the process of evaluating these options.

Site Access

The site's entrance facilities are no longer suitable to support the existing level of activities and the expected increases resulting from closure of the Westside Landfill. Most significantly, there is insufficient space for cars and trucks to line up on the entrance road, which often results in the vehicle queue extending onto Glenmore Road and disrupting

traffic during peak periods. Waiting times at peak periods are also excessive, and the existing scales are too short to accommodate all vehicle types which frequent the site. Finally, the area around the scalehouse is undersized for the amount of ancillary activities taking place (offices and staff facilities, recycling depot, compost sales), and traffic flow is congested and confusing.

Upgrading the existing entrance and scale facilities is not feasible due to space constraints imposed by Bredin Pond and future waste-filling activities in this area. The City and CH2M HILL therefore investigated several options for expanding or relocating the site entrance. It was ultimately determined that accessing the site in its southeast corner from the future East-West Connector would be the most feasible location for a new entrance since any new facilities could be situated on non-landfillable land. Also, a southern access would be able to serve future landfill operations in Phase 3 and the new composting area without creating the need to develop and maintain an extensive internal roadway network.

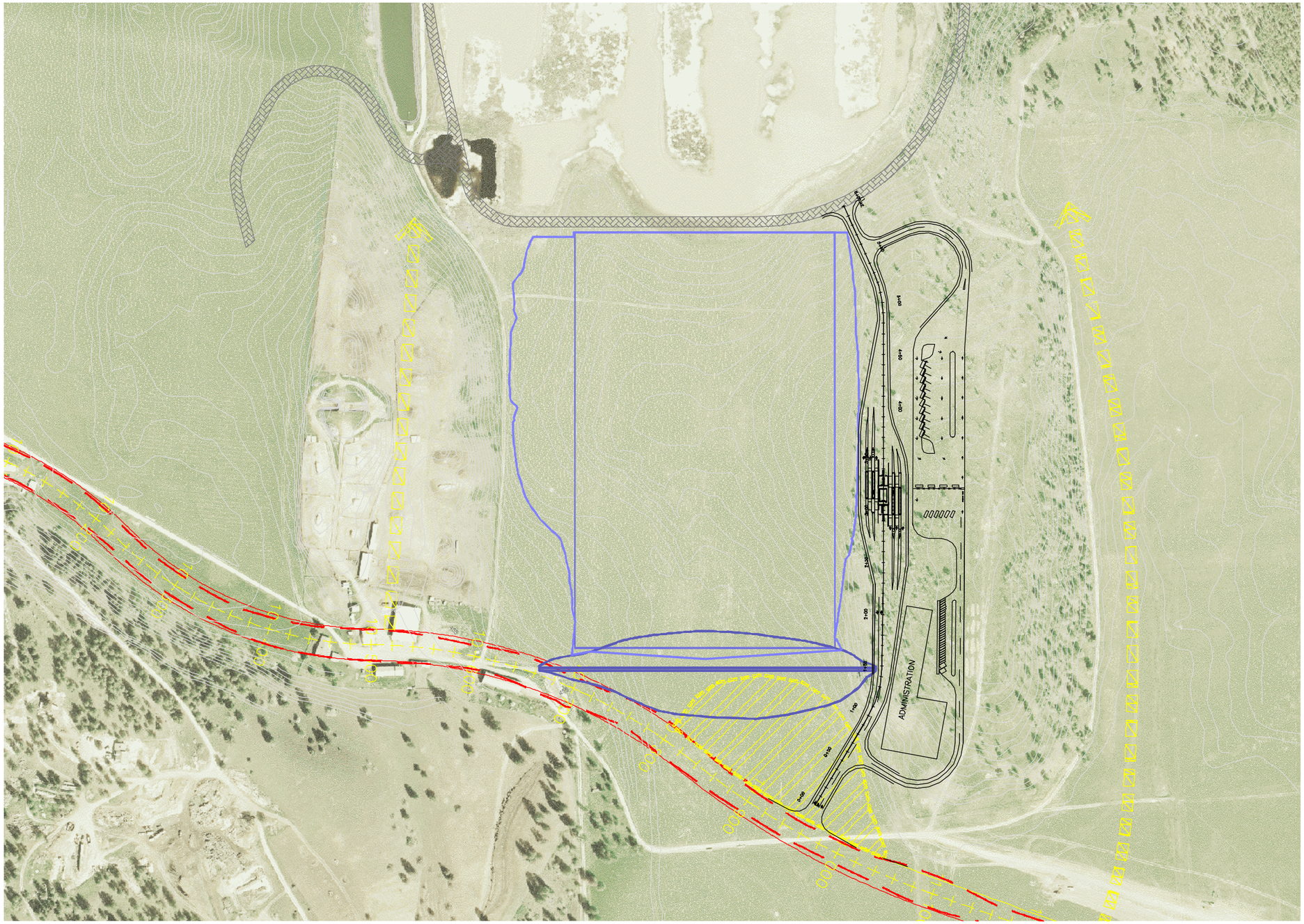
Recycling and Diversion Facilities

The Glenmore site is host to one of the region's drop-off recycling depots that serves rural and multi-family residents. The recycling depot also provides a convenient service to residential customers using the landfill site. In the longer term, it is recommended that the existing depot be replaced with an expanded "stop and drop" area in the new site entrance. This area would incorporate facilities for collection of recyclables and other materials into a single location that is designed specifically for small vehicle traffic and customer safety.

Additional facilities such as a "reuse centre", an area to conduct load audits, and/or educational displays could be incorporated in to the area. An important addition to the "stop and drop" area would be facility for collection of special wastes and household hazardous wastes. Conceptually, this facility would be compatible with the Product Care Association's Paint Plus Depot model and would be specifically designed for safety and environmental protection.

Separating wood and yard waste received at the site for subsequent reuse or composting allows a significant volume of airspace to be conserved each year. However, segregation of these materials requires a large area due to the quantities involved and customer safety requirements. The wood/yard waste receiving area will therefore be relocated to the new composting pad at the south end of the Glenmore facility in 2008. In addition to consolidating all of the organic waste handling operations in one location on site, this will make way for eventual landfilling operations in the Bredin and Tutt expansion areas.

In addition to providing space for receiving wood and yard waste, the newly constructed composting area will allow the City to handle the increased quantities of yard waste that will be diverted in the coming years. This increase is due to a anticipated closure of yard waste processing operations at the Westside Landfill, changes to curbside collection programs in the region, and an expected overall increase in program participation.



PLAN
NTS

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CH2MHILL
"Responsible Solutions for a Sustainable Future"

CITY OF KELOWNA

GLENMORE LANDFILL
SOUTHEAST ALIGNMENT
DETAILED CONCEPT LAYOUT

DATE	SCALE
APR 16/08	NTS
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Financial Management

Cost Recovery

At regional waste facilities which are operated by an individual municipality, it is important to ensure that the costs for handling any wastes imported from outside the region are not being subsidized by local taxpayers. For this reason, funding of municipal disposal facilities in many jurisdictions has been extracted from the tax base and set up on a user-pay basis. A user-pay system, in the form of weight-based tipping fees, was implemented at the Glenmore site several years ago and has been operating successfully since. Thus, with the increased use of the facility by regional residents and businesses, particularly following the closure of the Westside Landfill, the issue of cross-subsidization will be avoided.

Reserve Fund Structure and Contributions

The City of Kelowna currently maintains a "Landfill Reserve Fund" that is used to capitalize landfill infrastructure (i.e., disposal cells, leachate and landfill gas systems, water management systems) that is needed as development of the site progresses. This fund is also intended to be used to pay for landfill closure and post-closure costs. The value of the Landfill Reserve Fund is currently in the order of $9,000,000.

The City's fund structure and approach to setting contributions has historically been flexible enough to account for the impacts on development and closure timelines. However, due to new or expanded activities within the facility's scope of operations (e.g., composting, special wastes) and the increased importation of waste during the coming years, the City should consider an alternative reserve funding structure. Specifically, a contribution schedule that is tied to the actual rate of development as opposed to a projected rate, and a fund structure that provides segregation of funds for different activities would be beneficial.

Implementation Plan

It is intended that implementation of the various components outlined in the CSDP will proceed in a staged manner. This is a result of financial considerations (i.e., the need to distribute capital expenditures over a reasonable timeframe), as well as the fact that some components are prerequisites for others components. For example, a liner must be installed before a leachate collection system can be installed, and both of these components must precede waste-filling activities.

Two five year stages are proposed for implementing the main requirements of the development plan. Most of the capital works required to develop the site and meet the technical, environmental, and regulatory requirements will be done within this ten year timeframe. Only the items that are specific to the later filling phases would be postponed for implementation after the first ten years.

The following table shows the activities and the stages in which they are carried out. It is appropriate to review the development plan after each five year period.

TABLE ES-5
Implementation Plan

Activity	Stage 1 2008 – 2012	Stage 2 2012 – 2018	Stage 3 After 2018
Public Consultation & Regulatory Approvals			
Site Infrastructure and Facilities			
• Relocate scale and entrance facilities	✓		
• Relocate staff and administrative facilities	✓		
• Improve maintenance and fuelling facilities	✓		
Water Management and Drainage			
• Conveyance between Tutt Pond and Little Roberts Lake	✓		
Waste Diversion Facilities			
• Relocate/improve recycling and diversion facilities	✓		
• Establish household hazardous waste diversion facility	✓		
• Relocate wood and yard waste diversion areas	✓		
• Relocate composting operations	✓		
Landfill Containment and Leachate Management			
• Design and construction (Bredin Hill Exp)	✓		
• Design and construction (Tutt Mtn. Exp.)		✓	
• Design and construction (Phase 3)		✓	✓
Landfill Gas Management			
• Expand Phase 1 LFG system	✓		
• Expand Phase 2 LFG system	✓	✓	
• Design and construction of Phase 3 LFG system			✓

Cost estimates for capital projects proposed over the next 10 years were developed as part of the CSDP update. Budgetary estimates were prepared in anticipation of relocating site entrance infrastructure, enhancing facilities to increase waste diversion, as well as expanding the leachate management and landfill gas systems. The total capital cost associated with recommended projects over the next 10 years is expected to be in the order of $16.5 million (expressed in 2008 dollars).