PACIFIC groundwater GROUP

CITY OF KENT
WELLHEAD PROTECTION PROGRAM UPDATE

External Version

January 2022

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City of Kent

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LIST OF ACRONYMS

CSI	Contaminant Source Inventory
DBCP	Dibromochloropropane
DOH	Washington State Department of Health
EDB	Ethylene Dibromide
FSID	Facility Site Identification Database
GIS	Geographic Information System
LUST	Leaking Underground Storage Tank
MCL	Maximum Contaminant Level
MTCA	Model Toxics Control Act
NFA	No Further Action
UST	Underground Storage Tank
VOC	Volatile Organic Compound
WAC	Washington Administrative Codes
WHPA	Wellhead Protection Area
WHPP	Wellhead Protection Program
WSP	Water System Plan

SIGNATURE

This report, and Pacific Groundwater Group's work contributing to this report, were reviewed by the undersigned and approved for release.

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1.0 INTRODUCTION

The City of Kent (City) updated its Wellhead Protection Program (WHPP) to ensure continued compliance with Washington State Department of Health (DOH) regulations. The purpose of this WHPP update is to help prevent the City's water supply sources from becoming contaminated, and to develop contingency and emergency response procedures in case one or more sources is compromised due to contamination.

The Washington Administrative Code (WAC) 246-290 was revised in 1994 to include mandatory wellhead protection measures for Group A water systems. Under the WAC, public water systems have the primary responsibility for developing and implementing local wellhead protection programs. The DOH oversees the wellhead protection program.

The goal of a wellhead protection program is to prevent contamination of groundwater used for potable supplies by public water systems. This is accomplished (in part) by defining management zones around source wells or wellfields; cataloging and ranking known or suspected groundwater contamination sources; and limiting potential risks from such sources through management of land-use activities (to the degree possible) and by educating the local public on how to protect their drinking water resources. However, most water systems have limited jurisdictional and regulatory authority over the land uses within their service areas, so it is essential to work closely with local, state, and federal agencies with the appropriate authority. This program update meets the requirements of Washington Administrative Code (WAC) 246-290-135(3).

This WHPP update included the following:

- Combining the spring and well sources together into a single WHPP. The 2008 WHPP was separated into two plans, one for the Phase 1 spring water supply sources (Clark, Kent, and Armstrong Springs) and another for the Phase 2 groundwater supply sources (208th St., 212th St., Garrison, O'Brien, East Hill, and Seven Oak Wells);
- Updating inventories of known and potential sources of contamination that lie within both sets of wellhead capture zones, and evaluating the risks associated with these sources;
- Updating contingency planning for provision of water supplies in case one or more sources are impacted by contamination and emergency response planning for spills that might affect the well sources; and,
- Updating implementation strategies to educate the public and manage the contaminant sources in the Kent area.

Pacific Groundwater Group (PGG), a division of Mott MacDonald LLC, performed the project work, and prepared this report, in accordance with generally accepted hydrogeologic practices at this time and in this area for the exclusive use of the City of Kent with specific application to the study area. No other warranty, express or implied, is made.

2.0 DATA SOURCES

Prior WHPP reports completed by Aspect Consulting (Aspect 2008a and 2008b) served as the initial data sources for the study area background, hydrogeology, WHPA delineations, and spill and incident response plans. The 2008 WHPP included a variety of data sources ranging from hydrogeologic and geologic studies, a numerical groundwater flow model, and reports from King County, the City, and the United States Geologic Survey (USGS).

PGG's additional data sources include the 2019 City of Kent Water System Plan (WSP), Washington State Department of Health (DOH), Washington State Department of Ecology (Ecology), and King County.

3.0 STUDY AREA SETTING

The WHPP study area is shown on **Figure 1**. The study area consists of the Covington upland area east of the Kent Valley, south of the Cedar River, and north and east of the Green River. The upland extends to bedrock foothills to the east near Ravensdale and Black Diamond and is bisected by the Soos Creek drainage on a north-south line between Lake Youngs and the Green River. Smaller creeks that flow to the Cedar or Green Rivers also drain the uplands. A number of lakes (chiefly Lake Meridian, Lake Youngs, and Lake Sawyer plus several smaller lakes) also exist on the upland.

The spring sources consist of:

- Armstrong Springs
- Clark Springs
- Kent Springs

All three springs are located on the upland east of Soos Creek and SR 18. The upland area geology is a glacial drift plain surrounding isolated, low hills of bedrock (Aspect, 2008a).

The groundwater well sources consist of:

- 208th Street Well,
- 212th Street Wellfield,
- Garrison Well,
- O'Brien Well,
- East Hill Well, and
- Seven Oaks Well

The wells are located in the western portion of the upland and in the Kent Valley. The City's wells are completed in three aquifers consisting of the deep aquifer, sea-level aquifer, and the intermediate aquifer (Aspect 2008b).

4.0 HYDROGRAPHY AND HYDROGEOLOGY

This section describes the hydrography and hydrogeology for both the spring and groundwater sources as originally described by Aspect in the 2008 WHPP. The hydrography and hydrogeology text described in the sections below have been adapted from the previous WHPP with slight modifications. Aspect developed this section based on Chapter 2 from the 1996 WHPP (Hart Crowser, 1996) and upon review of more recent hydrogeologic information that had been collected up to 2008. The hydrogeologic setting provides the basis for the delineation of the wellhead protection area and assessment of the management strategies for aquifer protection. Figures from the original Aspect report are included in **Appendix A**.

4.1 SPRING WATER SOURCES

The hydrogeology in the area between Armstrong Springs in the west and Clark Springs in the east is complex because of the multiple geologic layers, varying recharge rates, and surface water groundwater interactions. This section describes the conceptual hydrogeologic model that formed the basis for development of a regional groundwater flow model that allowed for a better understanding of the area's complexities, delineation of the wellhead protection areas, and identification of areas for more focused hydrogeologic study.

4.1.1 Topography and Drainage

The spring sources lie within the central portion of the Covington Upland (South King County Ground Water Advisory Committee [SKCGWAC], 1989) physiographic area (**Figure 1**). The Covington Upland is a glacial drift plain bounded on the north by the Cedar River Valley, the south and west by the Green River Valley, and on the east by the foothills of the Cascades. The topography of the central upland area ranges from bedrock foothills at elevations of approximately 1,000 feet in the east (near the Clark Springs property) to gently sloping outwash plain at elevations of 500 to 400 feet in the west (between the Kent Springs and Armstrong Springs properties). Occasional till-capped knobs break up the outwash channels and several small kettle lakes and local marshy areas occur within the spring area.

The eastern portion of the spring area lies within the middle portion of the Cedar River Drainage Basin and the western portion of the study area lies within the Soos Creek Basin. **Figure 2-12** of **Appendix A** shows the surface water divide between these two major drainage basins. The surface water divides are important in defining potential rainfall runoff areas which contribute recharge to the aquifers supplying the springs and in analysis of the overall system water budget.

4.1.2 Surface Water Features

The dominant surface water features of the spring area include both creeks, which internally drain the outwash plain area and lakes, which are scattered throughout the area (see **Figure 2-12** of **Appendix A**). Rock Creek is the principal drainage feature in the east draining to the Cedar River. Rock Creek was identified by King County (1993) and originates in the southeastern corner of the spring area near Lake 12 and flows north and west through the City's Clark Springs property, and eventually flows northward to the Cedar River.

Ravensdale Creek, Covington Creek, Jenkins Creek, and the Little Soos Creek all originate in the drift plain west of Clark Springs. Each of these streams has a predominantly southwest flow pattern and eventually discharge to Soos Creek, which flows into the Green River near Auburn.

Complex relationships exist between the creeks and the shallow aquifer in the spring area. For example, during the wet winter months the streams may be recharging the groundwater system, while during the drier summer/early fall months the groundwater may be discharging to streams providing baseflows. These relationships may affect the amount of recharge to the aquifer system and groundwater flow patterns, particularly in the nearby vicinity of the streams. Runoff from the till and bedrock knobs in the spring area drains either into the streams or directly into the coarse-grained outwash deposits, which surround the base of these till-capped hills.

Lake Sawyer is the largest lake in the spring area. Ravensdale Creek flows into the lake from the east and Covington Creek flows out of the lake from the west. The lake, situated very close to the Covington and Kent Springs supply sources, appears to be situated in till over much of its subsurface area; however, a recessional outwash channel appears to occur in the northeast and southwest lake areas hydraulically connecting the lake to the recessional outwash aquifer.

A hydrogeologic study of the Lake Sawyer area (Hart Crowser, 1990) identifies at least 10 times as much outflow to the groundwater system as inflow indicating the lake as a source of recharge to the groundwater system. The study estimates an average outflow ranging from 1 and 4 cubic feet per second (cfs; range of 0.4 to 40 cfs) with the higher outflow occurring during the dry season. Flow from the lake to the groundwater occurs primarily at the north and west sides of the lake. Several smaller lakes including Retreat Lake, Ravensdale Lake, Wilderness Lake, and Pipe Lake also occur within the project area and may also provide recharge to the groundwater system.

4.1.3 Surficial Geology

The geology of the study area is characterized by Tertiary bedrock uplands in the eastern portion of the spring area and a thick sequence of Quaternary glacial and alluvial sediments in the western portion of the spring area. The bedrock is commonly mantled by till and interspersed with former drainage channels now infilled with glacial meltwater deposits. Moving westward, the bedrock dives deep beneath the subsurface, and a thick and variable sequence of glacial and interglacial sediments occur.

The west half of the spring area is dominated by recessional outwash deposits at the surface, which mark a major drainage pathway for meltwater streams during retreat of the last major glacial advance, the Vashon. Till-capped knobs underlain by pre-Vashon glacial and interglacial sequences are interspersed within the outwash of the western drift plain. **Figure 2-1a** of **Appendix A** presents a surficial geologic map of the spring area.

4.1.4 Recharge and Infiltration Potential

Precipitation is the principal source of recharge to the groundwater system and is largely controlled by the surficial geology. Likewise, the surficial geology and infiltration potential help define the susceptibility of the groundwater system to water quality impacts and the ease with which contaminants can move into the subsurface. In terms of infiltration potential and aquifer vulnerability, there are two distinct surficial geologic material groups in the study area:

- The outwash plain deposits, which are relatively permeable and have a relatively moderate-high infiltration potential. Recharge is likely highest in these areas, as is aquifer vulnerability to contamination. Recharge rates in these deposits are estimated to range between 30 and 40 inches per year.
- The bedrock and till-capped hills, which are relatively low in permeability and have a lower infiltration potential. In terms of aquifer susceptibility, these materials are important where they occur in the subsurface because they can provide some protection to deeper aquifers. However, these areas contribute to recharge because the relatively low infiltration capacity and steeper slopes cause runoff to the permeable outwash deposits surrounding these hills.

4.1.5 Water Quality

Chapter 6 of the 2019 WSP discusses the City's source monitoring results.

4.1.6 Principal Geologic Units

The surface and subsurface geology were evaluated and characterized by interpretation of geologic units using the South King County Ground Water Management Plan (SKCGWMP) Background Data report and well drilling records (SKCGWAC, 1989). The geologic units identified in this report are consistent with the nomenclature used in the SKCGWMP Background Data Report. Geologic conditions in the area east of the SKCGWMP area were based on USGS reports (Vine, 1969) and work completed by Dr. Derek Booth for the King County Cedar Basin Study (1993b). The major geologic units delineated and described for this study are shown on **Figure 2-1a** of **Appendix A**, and their characteristics are outlined below.

Vashon Recessional Outwash (Qvr)

- Consists predominantly of well-sorted sand and gravel;
- Occurs at the surface as an outwash plain throughout the study area with local areas of terrace and valley train deposits in the easternmost portion of the spring area;
- Has a relatively high infiltration capacity; and is an important aquifer supplying water to the City's Springs sources.

Vashon Ice-Contact Deposits (Qvi)

- Consist primarily of sand and gravel, but are less sorted than the Qvr deposits;
- Occur at the surface east of Clark Springs;
- Have a moderate to high infiltration capacity; and
- Are likely an important source of recharge for the Qvr aquifer in the eastern portion of the spring area.

Vashon Till (Qvt)

- Consists of a dense, unsorted mixture of clay, silt, sand, and gravel;
- Occurs at the surface throughout the area capping bedrock knobs and uplands, and in the subsurface beneath the Qvr in many areas;
- Has low infiltration capacity restricting local recharge; and
- Provides a protective layer to deeper aquifers from contaminant migration where it occurs in the subsurface.

Second Coarse-Grained Unit Qc(2)

- Consists of an older (than Vashon) glacial sequence possibly correlative with the Possession Drift sequence;
- Consists predominantly of granular soils and may include till layers;
- Occurs at depth in western portion of the spring area and in outcrops at a few locations in the southwest and northern portion of the spring area; and
- Is an important aquifer tapped by the Armstrong Springs, Kent Springs, and Covington wells.

Second Fine-Grained Unit Qf(2)

- Older interglacial sequence possibly correlative with the Whidbey Formation or the Kitsap Formation;
- Consists primarily of fine-grained alluvial and lacustrine sand, silt, clay, and peat; and
- Occurs primarily in the subsurface below the Qc(2) deposits and forms the lower boundary of the Qc(2) aquifer tapped by the City's wells.

Third Coarse-Grained Unit Qc(3)

- Next older glacial sequence may be correlative with the Salmon Springs Drift;
- Consists predominantly of coarse-grained materials and includes layers of till;
- Occurs at depth below the Qc(2) aquifer tapped by the City's wells and is typically recognized by its oxidized condition; and
- Next principal aquifer below the Qc(2).

Third Fine-Grained Unit Qf(3)

- Next older fine-grained sequence may be correlative with the Puyallup Formation; and
- Consists of a thick sequence of sand, silt, clay, and peat—difficult to distinguish from the Qf(2).

Tertiary Bedrock (Tbr)

- Primarily sedimentary bedrock of the Puget Group but also includes local outcrops of igneous rock;
- Occurs at shallow depths and at ground surface in the eastern portion of the study area but dives steeply to the west so that it is not a significant unit in the western portion of the study area; and
- Has low infiltration capacity restricting local recharge and generally considered to bound the area aquifers.

In addition to these primary units, there are several other geologic units defined on the maps and cross sections prepared for this report. These include the Recent Alluvium (Qal) which occurs in the major river valleys along the margins of the study area, thin peat layers (Qp) which occur locally throughout, and the Vashon Advance Outwash (Qva) which, except for some minor deposits beneath the Pipe Lake area, is largely absent from this area. Because these deposits have no significant effect on the supply and transport of groundwater to the Kent supply sources, they are not discussed much further herein.

4.1.7 Subsurface Geology and Groundwater Flow

As the surficial geology is important to the infiltration of precipitation, the characteristics and distribution of geologic deposits in the subsurface are important to the movement of groundwater to the wellhead. Subsurface cross sections were developed around each of the City's Springs properties to provide additional information on the subsurface stratigraphy, the layering and occurrence of geologic units which define the aquifers, and the transport pathways for potential contaminant movement to the wellheads.

The subsurface geology and its effect on groundwater flow around each of the source areas are discussed below. Refer to the Surficial Geologic Map (**Figure 2-1a** of **Appendix A**) and the Cross Sections (**Figures 2-2 through 2-5** of **Appendix A** and Aspect, 2008) which support the discussions.

Clark Springs Area

The Clark Springs are situated in a narrow, sediment-filled channel bounded by till-capped bedrock knobs to the north and south. The infilled materials are very coarse-grained recessional outwash sand and gravel deposited as the last glacier retreated from this area. These coarse-grained glacial deposits, mapped as Qvr and Qvi on **Figure 2-1a** of **Appendix A**, extend due east of the Clark Springs property, then fan out to the north and south just beyond the Georgetown area. The Qvr and Qvi comprise the aquifer which provides groundwater flow to Clark Springs. Cross sections C1-C1' through C4-C4' (**Figures 2-2 and 2-3** of **Appendix A**) depict the generalized hydrogeology through the Clark Springs aquifer area.

Bedrock confinement of the permeable outwash deposits to a narrow channel at the Clark Springs property is the cause of the springs which naturally emanate in this area. As shown on **Figure 2-1a** of **Appendix A**, bedrock surfaces again east, southeast, and southwest of Retreat Lake over 2 miles east of Clark Springs. In the area by Retreat Lake and southwestward, shallowing bedrock causes the Qvr and Qvi to rise in elevation (see Well group 32A, **Figure 2-3** of **Appendix A**). This rise distinguishes a northwest-southeast trending trough of recessional outwash that occurs along the east side of the bedrock knobs north and south of Georgetown and west of Retreat Lake. This trough may represent former meltwater discharge pathways to the Cedar and Green Rivers and a preferred pathway for groundwater flow through this area today.

Groundwater flow through the glacial deposits east of Clark Springs appears to be predominantly east to west as shown on the Groundwater Elevation Contour Map, **Figure 2-12** of **Appendix A**. However, within the trough of recessional deposits along the east side of the bedrock knobs north and south of Georgetown, a northward flow pattern is indicated. There appears to be a significant volume of groundwater flow moving through this foothills recharge area. In addition to the groundwater flow toward the Clark Springs area (over 3,000 gpm), the existing data indicate there is a component of groundwater flow northward that discharges to the Cedar River, and a component of flow southwestward moving through the Ravensdale area toward the Kent Springs and Covington wellfields. In addition to supporting these large water supply systems, the groundwater in this area also provides a significant contribution to Rock Creek flow, the only major surface water drainage in the eastern portion of the study area and an important fishery resource stream in the Cedar River Basin.

Kent Springs Area

The Kent Springs property lies just north of Lake Sawyer within the glacial drift plain in the western portion of the study area. In this area, the bedrock dives steeply beneath a thick sequence of glacial and interglacial sediments. The surficial deposits are predominantly Qvr, the permeable recessional outwash deposits seen further east. Till-capped knobs are interspersed within the flatter outwash channels. In this area the subsurface stratigraphy becomes more complex with a thicker sequence of variable material types. Cross sections K1-K1' through K3-K3' (**Figures 2-4 and 2-5** of **Appendix A**) show interpreted subsurface stratigraphy around the Kent Springs area. The Kent Springs aquifer appears to be made up of two coarse-grained glacial sequences, the Qvr and the Qc(2) units. At the Kent Springs property, these units appear to be in direct contact with each other, while to the north, east, and south, till typically separates these units. The till occurrence is illustrated on **Figures 2-4 and 2-5** of **Appendix A**. Till appears to occur beneath the Covington wells (**Figure 2-4** of **Appendix A**, Section K2-K2'), parts of Lake Sawyer (**Figure 2-5** of **Appendix A**, Section K3-K3'), and stretches beneath the ground surface between till-capped knobs to the northeast (**Figure 2-1a** of **Appendix A**). However, nearer the Kent Springs property, the till deposits thin or are absent. Limited data also suggest that the till may also be absent for some distance west-southwest of the Kent Springs (**Figure 2-4** of **Appendix A**, Section K1-K1').

Geologic materials and seasonal behavior suggest the Kent Springs are derived from the shallower recessional outwash (Qvr) and the wells are completed in the Qc(2) deposits. Use of the springs occurs primarily in the wetter months of year and this would correlate with renewed recharge of the shallower Qvr deposits. In the drier summer and early fall months, the deeper and more continuous Qc(2) unit provides a more reliable source. Well log data indicate the Qc(2) extends throughout the area beneath the till-capped knobs, while the extent of the Qvr aquifer is limited by the till.

Groundwater flow through the Kent Springs vicinity is a continuation of the east to west flow pattern discussed above for the Clark Springs property. Moving westward from the Georgetown area toward the Kent Springs property, groundwater passes through the bedrock-bounded recessional outwash channel around Ravensdale Lake into the drift plain in the western portion of the study area. Water level and well log data suggest that much of the groundwater supplying the Kent Springs property flows through the Ravensdale channel toward Lake Sawyer. Near Lake Sawyer, the groundwater flow bends slightly northwest as it flows toward the Kent Springs property. The aquifer supplying the Kent Springs also supplies the Covington Lake Sawyer wellfield just south of the Kent Springs property (see **Figure 2-1a** of **Appendix A**). The effect of Lake Sawyer on groundwater flow is not well-studied. In the area of the Kent Springs, the geologic data suggest hydraulic separation; however, as previously discussed, some recharge (range between 0.4 and 40 cfs) to the groundwater system occurs.

Armstrong Springs Area

The geology around the Armstrong Springs property is similar to the Kent Springs property. The property lies within the recessional outwash plain and the wells appear to tap into the deeper Qc(2), lying below the Qvr, in an area where the till seems to be thin or absent. Till occurs on hills to the southeast and northwest and till-like material appears to extend beneath the Qvr in these same directions away from the Armstrong Springs property. The till also appears eroded away in the area 1.5 miles to northeast of the property within the recessional outwash channel.

Cross sections A1-A1' through A6-A6' (Aspect, 2008a) present generalized geologic cross sections through the area around the Armstrong Springs. Aspect (2008a) described an apparent thinning of the till at the well site and along the outwash channel to the northeast of Armstrong Springs and indicated significant thicknesses of till to the east and west of the property. Groundwater flow patterns around the Armstrong Springs property are more complex than at the other properties because of the influence of several regional recharge and discharge factors. Regional recharge from the Lake Youngs area (SKCGWAC, 1989) creates a north to south flow pattern toward the Armstrong Springs property. This flow pattern converges with the regional east to west flow (dominating the Kent Springs property) in this same area. The Soos Creek valley, located less than a mile west of the Armstrong Springs property, is a central discharge area for both of these regional groundwater flow systems. Further complicating the groundwater flow interpretation is the likely location of a groundwater divide two miles to the northeast of Armstrong Springs, where groundwater flow may be directed toward the Cedar River.

4.2 GROUNDWATER SOURCES

This section describes the hydrography and hydrogeology for the groundwater sources as originally described by Aspect (2008b).

4.2.1 Topography and Drainage

The area of interest for the groundwater well sources includes a small portion of the Covington Upland area east of the Kent Valley, south of the Cedar River, and north and east of the Green River. The Covington Upland extends far east of the groundwater wells - to bedrock foothills near Ravensdale and Black Diamond. Topographic elevations within the area of interest range from approximately 25 feet above sea level in the Kent Valley immediately west of the groundwater wells to more than 400 feet above sea level on the upland surrounding the six groundwater wells. The annual average precipitation across the Covington Upland varies from approximately 40 inches per year in the western portion of the study area (near the groundwater wells) to 55 inches near the eastern boundary.

The Covington Upland is drained by a series of small creeks that are tributary to the Cedar and Green Rivers and by one large stream system, the Soos Creek drainage, which is flows to the Green River. Creeks near the groundwater well sources include Garrison Creek and Mill Creek. A number of lakes (Panther Lake, Lake Meridian, Lake Youngs, and others further east) also exist on the upland east of the groundwater wells.

4.2.2 Hydrostratigraphy

Hydrostratigraphic units are groupings of sediments with similar hydrogeologic characteristics. Since this definition may include material deposited at different times and by different processes, these units may or may not correspond with stratigraphic (geologic) units. Hydrostratigraphic units are typically identified as aquifers or confining layers. **Figure 2-1b** of **Appendix A** depicts surficial geology of the study area. **Figure 2-2** of **Appendix A** is a conceptual east-west cross section, reproduced from Robinson, Noble and Saltbush (2007a), representing the hydrogeologic conceptual model for the study area including the groundwater wells. The figure depicts the conceptual distribution of aquifer units and confining units in the study area. For the study, there are four major aquifers of primary interest identified. The City's groundwater supply wells are completed in three of these aquifer systems:

- A very deep aquifer providing water to the Garrison Creek, O'Brien, 208th and 212th Street Wells, labeled the Kent Deep Aquifer (DA);
- An aquifer close to sea level supplying the Seven Oaks Well, labeled as the Sea-Level Aquifer (SLA); and
- An upper aquifer, above sea level, tapped by the East Hill Well, labeled the Intermediate Aquifer (IA).

There is also a shallower aquifer on the upland, labeled as the Shallow Aquifer (SA), which may contain upper and lower sub-units. Above that, a seasonally present, spatially discontinuous Perched Aquifer (PA) is also present in some locations. Confining layers generally exist between, above, and below each of these aquifer units, as depicted conceptually on **Figure 2-2** of **Appendix A**. In addition, a thick sequence of river alluvium ("valley sediments") is present in the Kent Valley, just west of the groundwater wells.

4.2.3 Hydrostratigraphic Unit Descriptions

Robinson, Noble, and Saltbush (2007a) divided the geologic materials beneath the study area into 12 hydrostratigraphic units based upon their hydrologic characteristics. The thickness and distribution of these units was based upon a cross-sectional analysis of the study area. Each hydrostratigraphic unit is described below, from the surface (youngest) down to deeper (older) units

Alluvium

Several wells are completed in alluvial sediment (Qal) of the Kent Valley. Alluvial wells near Auburn are highly productive, being completed in ancestral Green River deltaic deposits in that area. Elsewhere, wells are variable in their characteristics, reflective of the large variability of alluvial sediments. Water levels in the alluvium are generally shallow, and upward hydraulic gradients exist in the alluvium at depth, consistent with its being a regional groundwater discharge area.

Vashon Till Confining Unit

The Vashon till confining unit (VCU) contains all confining materials above the shallow aquifer system. It typically contains other stratigraphic units in addition to the Vashon till including a clay unit and older till-like deposits. The deposit generally ranges in thickness from 10 to more than 150 feet. It is absent in the river valleys. At most locations the top of the unit is composed of Vashon till. Well logs indicate the till is typical of most

Vashon till found in southern King County: a mix of sand and gravel in a silt and clay matrix. The Vashon till is laterally continuous across much of the upland east of the groundwater wells, and is typically 30 to 80 feet thick, though it can locally be thinner or thicker. The till is occasionally under a thin veneer of younger peat or recessional outwash deposits. At many locations below the till is a sand and gravel unit. Where water bearing, this forms part of the Perched Aquifer (PA) as described below. Either directly below the Vashon till, or below the PA sediments, there often is a clay unit that may be correlative with the Lawton Clay (a glacial lake deposit). Where present, this clay unit is typically 10 to 50 feet thick.

Well logs describe it as clay that is sometimes sandy or gravelly. Below the clay is another till-like deposit of unsorted sand, gravel, silt, and clay that is likely pre-Vashon in age. Where present, this deposit is typically 20 to 60 feet thick. All of these materials are grouped into the Vashon till confining unit (VCU) hydrostratigraphic unit.

Perched Aquifer System

The PA is formed by discontinuous, hydraulically separated perched water-bearing units either within or on top of the Vashon till confining unit. These aquifers are most often found as sand and gravel lenses below the Vashon till, where the deposits probably correspond stratigraphically to the Vashon advance outwash. It is also found in places as saturated Vashon recessional outwash deposits on top of the till or permeable zones within the till. In portions of the eastern part of the study area, the perched aquifer system may be hydraulically connected with the shallow aquifer system where the till is missing. Locally, there may be more than one perched aquifer.

Wells completed in the PA typically have low yields. Specific capacities in these wells range from less than one to 15 gallons per minute per foot of drawdown (gpm/ft); potential yields range from less than one to 170 gpm.

Shallow Aquifer System

More wells are completed in the SA than all the other aquifer systems in the study area combined. The City's groundwater water supply sources are supplied by the SA. The aquifer system is widely distributed across the upland, being absent only in places where the surface elevation is below approximately 300 feet above sea level or areas where bedrock is at or close to the surface. Consequently, it is missing adjacent to the lower reaches of the Big Soos Creek and at the northern end of Lake Youngs and northeast of Lake Youngs. Boundaries to the aquifer system are controlled by erosion at the valleys or by shallow bedrock. In a few limited areas where all the deeper aquifer systems are missing (see below), the SA is the only major aquifer system on the upland. Flow in the SA is predominantly in a westerly direction from the eastern bedrock foothills area toward the Kent Valley. The flow pattern is also influenced by southerly flow directions near the Green River Valley and variously directed flows toward the creeks in the Soos Creek system (especially in the lower reaches).

Wells completed in the SA have specific capacities ranging from approximately less than one to more than 10,000 gpm/ft, with a median value of approximately 2 gpm/ft. Potential well yields are typically less than 50 gpm, ranging from less than 1 to more than 10,000 gpm (with a median of 36 gpm). This wide range of specific capacities and potential yields indicates the aquifer system is very prolific at some locations, but rather poor in others.

Confining Unit 1

This confining unit (CU1) separates the Shallow and Intermediate Aquifer Systems. Its occurrence is limited to the upland. Except where bedrock is shallow, the CU1 apparently covers the entire upland, except possibly for a small area west of Lake Sawyer. Its thickness is variable. It is typically between 50 and 120 feet thick but ranges from a minimum of approximately 15 feet to a maximum of approximately 150 feet. The unit typically consists of low permeability silty sands, silts, and/or clays, which provide effective confinement for the SA and IA, separating the head in the two systems typically by 20 to 50 feet.

Intermediate Aquifer System

At least 60 wells have been identified as completed in the Intermediate Aquifer System (IA) on the Covington Upland, including the City's East Hill wells. The distribution of wells across the Covington Upland has allowed for a fairly good definition of aquifer system extent. The IA is generally located in the central and south-central portions of the upland. The western boundary of the aquifer is terminated by the Kent Valley wall, since the elevation of the aquifer system is higher than the base of the valley. The aquifer system is also absent where buried bedrock rises in elevation, particularly under and near Lake Youngs. Due to the limited extents of the Sea-Level Aquifer (SLA) and Kent Deep Aquifer (DA; see below), the IA is the deepest unconsolidated aquifer over much of the upland.

In the area east of the Phase 2 wells, non-pumping (static) water level elevations in the aquifer range from approximately 200 to 450 feet above sea level. Water levels are highest south of Lake Youngs and lowest along the Kent Valley wall, where the aquifer terminates and discharges as springs. A groundwater divide occurs in the aquifer system running southeasterly from the highest water-level region (south of Lake Youngs).

The divide separates northerly and northeasterly flow toward the Cedar River from westerly flow towards the Kent Valley. Hydraulic gradient values range from approximately 0.007 (35 feet per mile) to 0.01 (50 feet per mile). The aquifer's water level is above that of the SLA (in areas where they coexist) and below that of the SA.

Transmissivity of the IA is variable, ranging from less than 500 to nearly 1 million gpd/ft, with the City's East Hill wells at upper end of the range. Aquifer storage coefficients have been calculated for three sites in the aquifer. At the City's East Hill well, the storage was calculated at 0.025, a relatively high value for a confined aquifer. At Covington Water District's Witte Wellfield, a value of 0.001 was found, a more typical value for confined aquifers. At Lake Meridian Water District Well 7, a lower value of 0.0001 was measured.

Wells completed in the IA have specific capacities ranging from less than one to more than 650 gpm/ft, with a median value of approximately 1 gpm/ft. Potential yields are typically less than 50 gpm, ranging from less than 1 to more than 10,000 gpm (with a median of 36 gpm). This wide range indicates the aquifer system is very prolific at some locations, but rather poor in others. The East Hill well 1 has a yield of approximately 1,900 gpm.

Confining Unit 2

Confining unit 2 (CU2) separates the Intermediate and Sea-Level Aquifer Systems. Except where absent in the northern and eastern portions of the study area due to rising bedrock, the CU2 covers the entire upland; no apparent windows in the unit were found. The CU2 thickness is variable, typically ranging between 50 and 200 feet thick. The composition of the unit is also highly variable. Although at most locations it appears to be formed by low permeability silts and/or clays, in some areas it is expressed by till-like deposits or sandy silt. Information on how well the unit provides confinement is limited due to the few wells completed in the underlying SLA. However, based on the limited data, the unit separates heads within the IA and SLA typically by 10 to 20 feet. Where the SLA is missing, the CU2 indiscernibly merges with the underlying CU3 confining unit.

Sea-Level Aquifer System

Few wells have been drilled into the Sea-Level Aquifer System (SLA). Only 11 wells on the Covington Upland are completed in the aquifer, including the City's Seven Oaks well. Several additional wells have been drilled through the system into the Deep Aquifer (DA). Even though well information for the SLA is relatively sparse, the extent of the aquifer system is fairly well known. The SLA is generally located in the west central portion of the study area, along the eastern Kent Valley wall, extending eastward onto the upland for one to three miles. It is present in the area of the City's Phase 2 wells, as illustrated on **Figure 2-4** of **Appendix A**. The western boundary of the aquifer is terminated by alluvial, valley-fill sediments. The northeastern boundary is believed to be controlled by bedrock at an elevation of approximately 50 feet above sea level. The eastern and southeastern boundaries are identified by deep exploration wells which did not find permeable sediments below the IA.

Non-pumping water level elevations in the aquifer range from approximately 50 to 330 feet above sea level. Water levels are highest in the furthest eastern extent of the aquifer, immediately southeast of Lake Meridian. In this area, as well as near lower reaches of Big Soos Creek, the SLA is the deepest identified aquifer (the DA appears to be missing in these areas). The gradient in the SLA is generally toward the west-southwest with a value of approximately 0.017 feet/foot (90 feet per mile). Generally, the upland aquifer's water level is above that of the DA (in areas where they coexist) and below that of the IA, indicating a downward gradient between aquifers. However, in the eastern edge of the Kent Valley, where the SLA exists in the "upland" sediments buried by the younger alluvium, water levels in the SLA are lower than those in the DA, indicative of an upward gradient in this regional discharge area.

Wells in the SLA have specific capacities ranging from approximately one to 16 gpm/ft, with a median value of 4 gpm/ft. Potential well yields are typically greater than 150 gpm, ranging from less than 10 to more than 1,600 gpm and with a median of 265 gpm. Aquifer transmissivity is generally low, ranging from 3,000 to 26,000 gpd/ft. A single storage coefficient has been estimated for the aquifer: approximately 0.0001, a typical value for a deep, confined aquifer, at Lake Meridian Water District Well 5.

Confining Unit 3

Confining unit 3 (CU3) separates the SLA and DA Systems. The CU3 apparently exists throughout the upland except in the northern and eastern portions of the study area due to elevated bedrock; no apparent windows in the unit were found. Data are limited on the thickness and hydraulic properties of the CU3. Based on what is available, the CU3 ranges from 80 to 150 feet thick.

The potentiometric surface maps prepared for the SLA and DA indicate that the intervening CU3 provides for head separations of less than 20 feet to more than 100 feet. The unit appears to consist mainly of silts and clays that are occasionally sandy or rarely gravelly. Where the DA is missing, the CU3 indiscernibly merges with the underlying CU4.

Deep Aquifer System

Although few wells have been drilled into the Deep Aquifer (DA) System, its extent can be reasonably estimated from the existing data. This is due to the aquifer system terminating on the west against alluvial valley-fill sediments and on the northeast against bedrock at an estimated elevation of approximately 200 feet below sea level. The east/southeastern boundaries are less certain, but still established by several deep exploration wells which found low-permeability sediments instead of the aquifer system. The City's Garrison, O'Brien, 208th Street, and 212th Street wells are completed within the Deep Aquifer.

The aquifer thickness is quite variable. At the City's Garrison, 208th Street, and 212th Street wells, the aquifer is greater than 250 feet thick. The aquifer apparently thins to the south. At the Mill Creek test well site, the aquifer was only 22 feet thick.

Figure 2-5 of **Appendix A** illustrates the inferred extent and groundwater elevation contours for the DA in the vicinity of the City's groundwater wells. Non-pumping water levels in the aquifer range from approximately 50 to 120 feet above sea level. The gradient is toward the southwest at approximately 0.004 feet/foot (21 feet per mile). As described above, vertical hydraulic gradients are downward from the SLA to the DA across the upland area, but upward along the eastern edge of the Kent Valley. DA water levels are typically also higher in these areas than water levels in water-bearing zones of the valley alluvium.

Confining Unit 4/Undifferentiated Sediments

Sediments below the DA were not differentiated for the Robinson and Noble (2007a) study. At the few locations where the DA was fully penetrated, the sediments making up the undifferentiated sediments of Confining Unit 4 (CU4) were low-permeability silts and clays. No water-bearing zones were recognized below the DA. In several places on the upland, test drilling has penetrated the full thickness of the CU4 and encountered bedrock. It is likely that bedrock is at the base of the unit throughout the entire study area where the CU4 is present.

Bedrock

The bedrock occurs at great depth in the area of immediate interest for the groundwater wells' wellhead protection areas. For the purposes of this project, the bedrock is considered to form an impervious boundary to the more productive aquifer systems found in the overlying unconsolidated sediments.

4.2.4 Regional Groundwater Flow

A description of the general flow system provides an explanation of how water enters, moves, and exits the groundwater system. Recharge generally enters with the infiltration of precipitation, either directly or as infiltration of surface runoff. Infiltrating surface runoff occurs in streams, lakes, and directly from overland flow off bedrock. There are two other important recharge sources that import water that would not otherwise be present in the region. One is Cedar River water imported by the City of Seattle to Lake Youngs, which then leaks out the bottom of the lake and forms recharge. The other recharge source is septic system discharge for homes which are served by imported water sources. Discharge occurs through many mechanisms, both natural and man-made. Discharge occurs as underflow out of the study area where the major valleys intersect study area boundaries. Discharge also occurs as leakage between units, well production, spring flow, evapotranspiration, and contributions to stream flow.

On the regional scale, groundwater flows radially off the upland to the north, northeast, south, and west. Most groundwater flow is westerly in the area of the groundwater wells (see **Figures 2-2 through 2-5** of **Appendix A**). Flow also moves downward as leakage to deeper aquifer systems. Travel through the aquifer systems is generally horizontal. Travel through the confining layers is largely downward (although below the Deep Aquifer, there may be minimal water movement in the CU4). At the edges of the upland, water naturally discharges as evapotranspiration, as springs above the valley floor, or as leakage into valley-fill alluvial sediments. Water in the alluvium discharges as flow to the river (or associated wetlands), as evapotranspiration, or as underflow outside the area.

4.2.5 Water Quality

Chapter 6 of the 2019 WSP discusses the City's most recent source monitoring results.

5.0 WELLHEAD PROTECTION AREA DELINEATIONS

A wellhead protection area (WHPA) defines the area surrounding a public water supply well where the well may be at risk from known or potential contaminants. It is based upon capture zones, which describe the area of the well's source aquifer that can contribute water to the well in a given period of time. Capture zones are typically defined for time-of-travel periods of 6-months, 1, 5, and 10 years. These four zones are defined by regulation as a management tool; the travel time of actual contaminants reaching the source aquifer may differ from the calculated time-of-travel[1].

Travel-time boundaries can be determined by either technical or non-technical methods. In general, there are four delineation methods available. They are, from generally least to most accurate: the calculated fixed radius method, analytical modeling, hydrogeologic mapping, and numerical modeling. The particular method employed (and the accuracy of that method) depends largely on the availability of hydrogeologic data. Numerical modeling, for example, can be highly accurate but also typically requires a relatively large amount of data. The 2008 Phase 1 and 2 WHPP reports relied on numerical modeling to delineate the WHPA zones (Aspect 2008a and 2008b).

Estimated capture zones for 6-month, 1-year, 5-year, 10-year, and buffer/surface water area times of travel for the City wells are shown on **Figure 1**. PGG reviewed the methods and assumptions used in the WHPA delineations and confirmed with the City that the existing WHPAs are adequate in their current form and do not require changes. PGG confirmed that the existing WHPA delineations employed pumping rates that remain representative for current and near-future operations and therefore updates were not needed.

5.1 SPRING SOURCES

This WHPP retains the wellhead protection areas delineated for Armstrong Springs, Kent Springs, and Clark Springs as part of the City's prior wellhead protection programs (Aspect 2008a; Hart Crowser, 1996). Hydrogeologic understanding of the study area and the hydrogeologic conceptual model remain generally unchanged, and thus the associated wellhead protection area delineations remain valid. The wellhead protection area delineation as described in Aspect 2008 is reproduced here directly from that report with only minor revisions.

The hydrogeology around each of the Springs sources forms the basis for delineation of the wellhead protection areas. A wellhead protection area is defined as the surface and subsurface area surrounding a well, wellfield, or spring that supplies a public water supply through which contaminants are likely to pass and eventually reach the water well(s) (DOH, 1995; revised in 2010). Determination of the wellhead protection area (WHPA) is the first step toward development of a wellhead protection program (WHPP) to manage the quality of groundwater-based drinking water supplies.

Delineation of the WHPA is an important component of the WHPP to ensure that the area managed will be protective of water quality and that no undue burden is placed on land

[1] WHPA time-of-travel calculations assume a contaminant has already reached the target aquifer. No accounting is made of the time for a contaminant to travel vertically from land surface to the aquifer.

use. Under the state's guidelines, the WHPA is determined based primarily on time-of-travel capture zones. Time-of-travel capture zones are estimates of the area constituting the most likely travel paths (based on travel times) of a hypothetical particle of water moving through the aquifer to the pumping well.

The DOH guidance defines three primary zones, Zones 1, 2, and 3, corresponding to the 1-, 5-, and 10-year time-of-travel capture zones, respectively. A capture zone is that portion of an aquifer contributing flow to a well or spring source. In addition, a buffer zone can be considered to provide additional protection and compensate for potential errors in calculating the WHPA. The intent of protection within each of these zones is outlined below.

- Zone 1 (6-month Capture Zone). This zone is managed to protect the drinking water supply from viral, microbial, and direct chemical contamination, and is the most intensely managed zone. The 1-year zone corresponds to the area with the most acute need for protection because there is not a great deal of time to identify a problem and take remedial action if a contaminant enters the aquifer.

- Zone 2 (5-Year Capture Zone). This zone should be actively managed to control potential chemical contaminants with an emphasis on pollution prevention. While there is more time for response within the 5-year zone, all potential sources should be identified and controlled.

- Zone 3 (10-Year Capture Zone). Within this zone, existing medium and high-risk potential contaminant sources should be targeted to receive increased regulatory attention and technical assistance to prevent pollution and reduce risk.

- Buffer Zone. This zone includes the area upgradient of the groundwater capture zones which may include the remaining area of contribution and the recharge area to the aquifer providing the water supply. It also provides conservatism relative to uncertainties in groundwater flow directions caused by variability in hydrogeologic conditions of the contributing area and seasonal influences.

For the purposes of this updated WHPP, a 6-month time-of-travel capture zone has also been delineated for each of the Springs source. The 6- month capture zone is part of Zone 1 and was not a management area identified in the 1995 version of the DOH guidance used by Aspect (2008a); however, it is a requirement for preliminary WHPA delineation to achieve DOH source approval when using the calculated fixed radius methodology (WAC 246-290-130). In this WHPP, the 6-month capture zone is factored into ranking of potential contaminant sources to provide a more refined assessment of potential risk, as described in Section 7.4.

5.1.1 Capture Zones Based on Numerical Modeling

The wellhead protection area for the City's Springs sources was delineated primarily using numerical modeling and hydrogeologic mapping. A numerical groundwater flow modeling approach was used because of the size of the water system, the complexity of the hydrogeology and boundary conditions in the vicinity of the City's Springs properties, and the susceptibility of the water sources to contamination. Results of the numerical modeling were used to define time-related capture zones.

The 1-, 5-, and 10-year capture zones were based primarily on development of a numerical groundwater flow model using MODFLOW. The hydrogeologic conditions discussed previously and presented in the surficial geologic map, in subsurface cross section diagrams, and water level contour data formed the basis for the numerical model construction. To accommodate the expected overlap of capture zones between the three Springs sources, an approximately 53-square-mile model was developed. The model was calibrated to the measured water level data and achievement of a reasonable water balance for the overall system. The numerical modeling approach and model configuration are discussed in detail in the Aspect report (2008a).

The MODFLOW groundwater flow model was linked to a particle tracking model, PATH3D, to define the time-related capture zones. This particle tracking model releases particles from the wellhead and tracks the movement of these particles backward in time to their point of origin, thus illustrating the portion of the aquifer contributing flow to the wellhead. The analysis was performed at each source area for a 1-, 5-, and 10-year period. The results of this analysis are presented on **Figure 3-1a** of **Appendix B**.

As part of this WHPP update, a 6-month time-of-travel zone was also estimated analytically for each of the Springs source to provide additional refinement for ranking potential contaminant sources within the WHPA. For each source, this was accomplished by measuring the modeled lengths of the 1-year and 5-year capture zones, which correspond to distances that groundwater flows in 1 year and 5-year periods of assumed constant (steady state) pumping. An exponential regression was fit to the distance versus time data points, and the flow distance for a 6-month time of travel was then calculated from the regression equation. Use of an exponential regression accounts for the fact that groundwater accelerates as it approaches the point of withdrawal (i.e., drawdown versus distance away from a pumping well is an exponential function). Consequently, the 6-month capture zone is more than half the length of the 1-year capture zone for each Springs source. The estimated 6-month WHPA for each source are depicted as dashed lines on **Figure 3-2** of **Appendix B**.

Because groundwater flow is generally from east to west in the study area, the predicted capture zones generally extend east from the groundwater production areas. Because of the relatively high hydraulic conductivities of the aquifers providing the supply, the capture zones for the three City Springs sources overlap each other. The specific capture zone modeling results for each of the City's Springs properties are described below.

5.1.2 Armstrong Springs

The 1-year capture zone for Armstrong Springs extends approximately 5,000 to 6,000 feet east of the production area. Within that zone, the 6- month capture zone extends approximately 3,000 feet east of the source. The 5-year zone extends another 6,000 feet east of the 1-year zone. The 10-year zone extends roughly 10,000 feet further east in its northern portion and almost to Ravensdale along its southern portion. Lower groundwater velocities predicted southeast of Lucerne Lake and the till knob south of Clark Springs limit the northern portion of the 10-year zone, while higher permeability sediments east of the Kent Springs area cause the capture zone to extend further east in this area. The Armstrong 10-year capture zone overlaps with the Kent Springs 1- and 5-year capture zones.

5.1.3 Kent Springs

The 6-month capture zone for the Kent Springs source extends approximately 6,000 feet east of the source area, while the 1-year zone extends approximately 9,000 to 10,000 feet east of the source area. Following the course of highly permeable recessional outwash deposits, the 5-year capture zone for Kent Springs extends east to the vicinity of Retreat Lake. The 10-year capture zone moves further down the valley south of Retreat Lake in the area of the glacial meltwater trough. The 10- year zone may extend as far as the surface water divide between the Green River and the Rock Creek drainage basin where a groundwater divide is also suspected to occur.

5.1.4 Clark Springs

The 1-year capture zone for Clark Springs is approximately 11,000 feet, approximately twice as long as the 1-year zone for the other source areas. The Clark Springs 1-year zone is substantially longer than the others because more groundwater is produced from Clark Springs and more permeable sediments were encountered east of Clark Springs compared to those encountered in the other two production areas. Within the 1-year zone, the 6-month capture zone extends approximately 7,000 to 8,000 feet east of the source area. The 5-year capture zone for Clark Springs extends further east, ending in an area where the aquifer thins rapidly as the bedrock shallows. Bedrock outcrops on the eastern edge of the study region form the eastern limit of the 10-year capture zones.

The 1-, 5-, and 10-year capture zones from Clark Springs probably overlap the 5- and 10-year capture zones from Kent Springs. The dividing line drawn on the map is based on the concept of a dividing streamline under assumed steady state conditions with both sources operating. In reality, natural mixing in the aquifer, seasonal changes in groundwater elevation, and variable groundwater withdrawals will cause this dividing line to move somewhat north and south from the fixed position shown on **Figure 3-1a** of **Appendix B.** The variable position of the delineated line between the Kent Springs and Clark Springs capture zones is noted on **Figures 3-1a** and **3-2** of **Appendix B**. This should be factored into the City's implementation of wellhead protection management strategies.

5.2 SURFACE WATER DIVIDE AS RECHARGE AREA

The surface water divide is used to distinguish the area providing recharge to the recessional outwash channel areas surrounding the Springs sources. This divide is delineated where surface water runoff would move toward the delineated capture zones. This area is particularly important in areas where till and bedrock hills occur because of the potential for runoff and infiltration into the more permeable recessional outwash deposits which surround these hills. The surface water divides were identified based on review of King County Surface Water Management group maps, local topography, and the predicted locations of the groundwater capture zones. The surface water divides are depicted on **Figure 3-1a** of **Appendix B** by a bounding dash-dot line.

5.3 ASSESSMENT OF DATA UNCERTAINTIES

There are a number of areas within the study area where hydrogeologic data are limited or lacking. In these areas, hydrogeologic judgement based on experience in other similar environments and interpretations presented in the SKCGWMP Background Data report were used as the basis for the conceptual and numerical modeling. There are only a few areas where limited data are likely to affect delineation of the capture zones. These are discussed below.

5.3.1 Groundwater Flow North-Northeast of Armstrong Springs

Little data exist on the aquifer properties north-northeast of Armstrong Springs. The relative magnitude of the groundwater flow contribution from the north versus from the east influences the size and orientation of the capture zones. If more flow is derived from the northern area, the Armstrong Springs capture zone could orient more northeasterly. Additional data could be developed in this area to better understand the flow contribution and its potential effect on groundwater capture at the Armstrong Springs property, particularly since till may be absent in a portion of this area. This uncertainty in development of a wellhead management area is discussed below.

5.3.2 Quantity of Recharge

The groundwater moving through the aquifers is wholly derived from precipitation recharge. The amount of recharge will have a significant effect on overall development of the groundwater flow model. Recharge rates are, at best, rough estimates. Precipitation amount and patterns, soil types, topography, and land use all affect the amount of recharge to the groundwater system. The recharge estimates relied primarily on Landsburg precipitation data and the USGS' precipitation-recharge relationships for glacial till and outwash across the East King County region (Aspect 2008a).

5.3.3 Aquifer Interaction with Surface Waters

A better understanding of surface water-groundwater interactions is needed to develop a more accurate hydrologic budget for the area. Aquifer-surface water interactions could also affect delineation of capture zones. For example, if there is an underestimate of the of the degree to which Lake Sawyer is a source of groundwater to the underlying aquifers, the actual capture zone for Kent Springs (and Covington's adjacent Lake Sawyer wellfield) may be substantially smaller than predicted. Likewise, a hazardous materials spill or release to a stream could adversely affect groundwater quality in losing reaches of the stream. Stream gaging with nearby groundwater level monitoring, such as has been completed on Rock Creek (a weir has been installed and is being monitored by the City), could be conducted on Ravensdale, Covington, Jenkins, and the Little Soos Creeks for better understanding of the surface water-groundwater interactions in the area.

5.3.4 Retreat Lake Area Groundwater Flow

Groundwater elevations, water table gradients, and groundwater flow rates through the drainage leading from Lake 12 past Retreat Lake toward the Georgetown area and northward to the Cedar River are not well known. Because the predicted capture zones for both the Kent Springs and Clark Springs properties extend into this area, additional data could be developed to more accurately assess flow rates through this area and boundaries of the 5- and 10-year capture zones for the Clark Springs, Kent Springs, and Covington sources.

5.4 COMPOSITE WELLHEAD MANAGEMENT AREA - KENT/COVINGTON WHPA

A composite map was made for wellhead protection management purposes to address uncertainties in the hydrogeologic data and to include the capture zones for Covington's Lake Sawyer wellfield, located just south of the Kent Springs area. Coordination of the wellhead protection activities was a goal of program development since the work began in the early 1990s and is particularly important for the Kent Springs and Lake Sawyer wellfields because of their close proximity. Additionally, capture zone delineation indicates overlap of the three City's Springs sources and Covington's Lake Sawyer wellfield.

To accommodate these factors, a proposed composite wellhead protection management area, the Kent/Covington (after the two major purveyors) Wellhead Protection Area (WHPA), is identified. This proposed Kent/Covington Wellhead Protection Area is presented on **Figure 3-2** of **Appendix B** and discussed below relative to each of the City's three Springs sources. The specific time-of-travel capture zones for this proposed composite Wellhead Protection Area are delineated as Zone 1 (1-year zone), Zone 2 (5-year zone), and Zone 3 (10-year zone). Within Zone 1 for each supply source, the 6-month time-of-travel zone is also identified.

5.4.1 Armstrong Springs

Zone 1 at Armstrong Springs includes the 1-year capture zone plus the area to the northeast where the till appears to be thin or absent. Zone 1 is expanded northward to the surface water divide (**Figure 3-2** of **Appendix B**). Without any confining layers between ground surface and the aquifer supplying water to the Armstrong Springs wells, the Qvr and Qc(2) aquifers are highly vulnerable to a potential contaminant release. Given the absence of till, the lack of pumping test data, and a poorly understood groundwater flow pattern, inclusion of this area is deemed appropriate to ensure adequate protection. Zones 2 and 3 use this same concept of expanding the 5-year and 10-year zones toward the surface water divide to incorporate uncertainties.

5.4.2 Kent Springs/Lake Sawyer Wellfield

Because of the proximity of the Kent Springs and Lake Sawyer wellfield water supply sources, composite Zones 1, 2, and 3 were developed, based on the 1-, 5-, and 10-year capture zones delineated as part of the 1998 WHPP effort (Aspect, 2008a). The Zone 1 boundary of both the Kent Springs and Lake Sawyer wellfield are slightly expanded beyond the 1-year capture zone to account for the more southerly location of the Lake Sawyer wellfield, the more northerly location of the Kent Springs wellfield, and to err on the conservative side with respect to uncertainty in the outer 1-year boundary. The composite protection area for Zone 2 also expands Kent's 5-year capture zone to the south to account for the more southerly location of the Lake Sawyer wellfield.

Precipitation on the small till-capped bedrock knob north of Ravensdale is likely to drain water into the highly permeable outwash deposits around Clark Springs and within the Ravensdale outwash channel. For this reason, the protection area boundaries are extended to the surface water divide in this area for both the Kent Springs/Lake Sawyer Zone 2 and the Clark Springs Zone 1.

Zone 2 for the Kent Springs/Lake Sawyer wellfield source extends the 5- year zone modeled for the Kent Springs source roughly 4,000 to 5,000 feet further south of Retreat Lake. Zone 2 is thus a composite of the modeled 5-year capture zone for the Kent Springs and the modeled 5- year capture zone for the Lake Sawyer wellfield. Differences in the 5-year boundary for the Kent Springs and Lake Sawyer wellfield stem from uncertainties in the amount of recharge occurring in this area and the limited water level and hydraulic conductivity data.

5.4.3 Clark Springs

Zone 1 for the Clark Springs source includes the City's property and north and south to the surface water divides. The surface water divide boundary is included based on the likelihood that runoff from the low permeability till-capped bedrock surrounding the property infiltrates into the high permeability outwash deposits comprising the aquifer. Because this could happen over a very short period of time, the Zone 1 boundaries were extended outward to include this area.

The boundary of the Clark Springs Zone 2 is extended northward to the Rock Creek surface water divide and bedrock outcrop. This larger area is proposed to account for uncertainties in the amount of flow to the Cedar River through this area.

5.4.4 Consider Surface Water Divide as a Buffer Zone

The surface water divide should be considered a buffer zone for groundwater quality protection. The hydrogeologic conditions indicate the potential for land use practices on adjacent upland areas to affect groundwater quality by degrading the quality of surface water runoff, which becomes groundwater recharge. Examples include; urban street runoff containing traces of gasoline or other petroleum products in areas providing surface water recharge to the Armstrong Springs, and surface water runoff from agricultural areas upland of the Clark Springs containing traces of fertilizers or pesticides.

The surface water boundary provides a margin of safety that addresses data uncertainties and natural variability in aquifer characteristics. Incorporating surface water recharge into the wellhead protection area is particularly important near Clark Springs. Because till-capped upland areas and bedrock outcrops dominate the recharge area for the Clark Springs and Kent Springs/Lake Sawyer wellfield source areas, runoff is a significant contributing factor to groundwater quality as well as quantity.

5.4.5 Future Data Collection

Subsequent to the 1996 and 2008 wellhead protection programs, the City has conducted additional work to evaluate groundwater-surface water interactions around Clark Springs as part of its proposed Habitat Conservation Plan, and to evaluate the position of the recessional outwash channel in the Kent Springs area. The results of these studies provide additional details regarding the hydrologic understanding of the Springs sources, but do not change the fundamental hydrogeologic conceptual model that was the basis for delineation of the Springs’ WHPAs.

Additional data can always be collected to further refine the understanding of groundwater flow to the water supply source areas. Hydrologic data collection includes continuing the ongoing water level measurements and water quality data collection that the City has been conducting (see Section 4) but can also include collecting data on aquifer characteristics and stream flows in specific areas where such data are lacking. These data can provide a means to more accurately describe the groundwater flow system and, if warranted, refine the groundwater flow model used for WHPA delineation, thus providing a better tool for making decisions regarding protection of the City's groundwater supply sources.

5.5 AQUIFER SUSCEPTIBILITY TO CONTAMINATION

An evaluation of the aquifer susceptibility was performed to characterize the WHPA in accordance with the Seattle/King County Health Department's Sensitive Aquifer Recharge Area designations. Although a portion of the study area was already mapped for susceptibility in the South King County groundwater management planning process, more detailed hydrogeologic analyses have been conducted for this wellhead protection program. Furthermore, a significant portion of the recharge area and WHPA extends beyond the eastern boundary of the South King County Groundwater Management Planning area and the area mapped by King County. The methodology used was consistent with the predominant method used by the Seattle/King County Health Department in the groundwater management planning process to differentiate areas of high, moderate, and low infiltration potential. The analysis included mapping of four hydrogeologic criteria over the wellhead protection area. The criteria included:

- Surficial Geology. Areas where the Qvr occurs at ground surface were considered areas of high infiltration potential, areas where Qvi occurs at ground surface were considered as moderate in infiltration potential, and areas where Qvt and Tbr occurred were considered to have a low infiltration potential.

- Soils. Soil units as defined by the Soil Conservation Service were mapped as high, moderate, and low infiltration capacity, based on the descriptions provided in the Soil Survey of the King County Area (1973). Generally, the soil types corresponded directly with the surficial geologic unit; with Qvr and Qvi forming Everett soils which are excessively drained, and Qvr and Tbr forming moderately well-drained Alderwood Association soils.

- Slope. Percent slope was obtained from topographic maps and the King County Soil Survey and the criteria used for the Redmond Bear Creek Groundwater Management Area. High infiltration was assumed to occur when slopes were less than 40%. Moderate infiltration was assumed to occur with slopes between 40% and 80%, and low infiltration was assumed for slopes greater than 80%.

- Depth to Groundwater. The depth to groundwater is an important factor in determining the amount of time it would take a contaminant to reach the aquifer. High potential susceptibility was assumed where the depth to water is less than 25 feet. A moderate susceptibility factor was assumed where the depth to water is between 25 and 75 feet, and a low factor was assumed where the depth to water was greater than 75 feet. An Aquifer Susceptibility Map (**Figure 3-3** of **Appendix B**) was created by overlaying the four maps developed for each of the criteria outlined above. The entire WHPA is either high or moderate in susceptibility with more than 66 percent of the area being designated highly susceptible to groundwater contamination. Aquifer susceptibility is an important factor in King County's and City of Covington's current categorization of critical aquifer recharge areas (CARAs). Recognition of the highly susceptible areas within the City's WHPA is extremely important to future land use decisions by the jurisdictions within the WHPA.

5.6 GROUNDWATER SOURCES

The hydrogeology described in Section 4 forms the basis for delineation of the wellhead protection areas for the City's groundwater source wells. The same wellhead protection zone designations and DOH delineation guidance used for the spring sources was applied to the groundwater sources. See Section 5.1 for a summary of the zone designations and guidance applied. The remainder of the text for this section was taken from Aspect 2008b, with only minor alteration.

5.6.1 Capture Zones Based on Numerical Modeling

The 6-month and 1-, 5-, and 10-year capture zones for the City's groundwater sources were delineated using a numerical groundwater flow model (MODFLOW) developed by Robinson, Noble, and Saltbush. Development of the numerical model is based on the conceptual model and well characteristics described in a series of Technical Memoranda by Robinson, Noble and Saltbush (2007a; 2007b), as summarized in Section 4.

The MODFLOW groundwater flow model was linked to a particle tracking model, PATH3D, to define the time-related capture zones. This particle tracking model releases particles from the wellhead and tracks the movement of these particles backward in time to their point of origin, thus illustrating the portion of the aquifer contributing flow to the wellhead during pumping. The analysis was performed to estimate the 6- month and 1-, 5-, and 10-year times of groundwater travel for each of the six groundwater well sources. Aspect (2008b) provides details of the groundwater flow model construction and calibration.

Because groundwater flow is generally from east to west in the study area, the predicted capture zones generally extend east from each of the Phase 2 wells. Because of the proximity of the four Deep Aquifer wells (208th Street, 212th Street, Garrison, and O'Brien wells), a composite capture zone was established to encompass the capture zones of the four individual wells.

To account for inherent uncertainties in the modeled capture zone dimensions, a buffer zone was added around the modeled 10-year capture zone for each of the Phase 2 wells (and composite capture zone for the four Deep Aquifer wells). The buffer was established with approximate dimensions of 1/8 mile downgradient, ¼ mile on each side laterally, and ½ mile upgradient, of the 10-year capture zone. The WHPAs are established to be the modeled capture zones with their associated buffer zones. **Figure 3-1b** of **Appendix B** illustrates the modeled 6-month and 1-, 5-, and 10-year capture zones and the defined WHPA for the groundwater sources. See Aspect 2008b for the full modeled capture zones (travel times greater than 10 years), which depicts the origin of the groundwater flow paths in the groundwater flow model. The dimensions of the modeled capture zones of each well are described below.

5.6.2 Deep Aquifer Wells

- 208th Street Well. The 6-month capture zone extends approximately 375 feet east (upgradient), while the 1-year capture zone extends approximately 650 feet east of the wellhead. The 5-year zone extends another 2,400 feet east of the 1-year zone. The 10-year zone extends roughly 1,200 feet further east of the 5-year zone. The maximum width of the 10-year capture zone is approximately 800 feet.

- 212th Street Well. The 1-year capture zone extends approximately 1,100 feet east of the wellhead. Within that zone, the 6-month capture zone extends approximately 650 feet east of the source. The 5-year zone extends another 3,000 feet east of the 1-year zone. The 10-year zone extends roughly 900 feet further east. The maximum width of the 10-year capture zone is approximately 1,800 feet (see **Figure 3-1b** of **Appendix B**).

- Garrison Well. The 6-month capture zone extends approximately 500 feet upgradient, while the 1-year capture zone extends approximately 800 feet east of the wellhead. The 5-year zone extends another 1,900 feet east of the 1-year zone. The 10-year zone extends roughly 1,700 feet further east. The maximum width of the 10-year capture zone is approximately 500 feet (see **Figure 3-1b of Appendix B**).

- O'Brien Well. The 6-month capture zone extends approximately 100 feet upgradient, while the 1-year capture zone extends approximately 200 feet east of the wellhead. The 5-year zone extends another 850 feet east of the 1-year zone. The 10-year zone extends roughly 1,600 feet further east. The maximum width of the 10-year capture zone is approximately 200 feet (see **Figure 3-1b of Appendix B**).

All of the Deep Aquifer wells' capture zones extend almost due east toward Lake Youngs, but the width of each well's capture zone varies with pumping rate and, to a lesser degree, localized distribution of aquifer parameters. The narrowest capture zone is for the O'Brien Well, approximately 200 feet wide, whereas the widest is nearly 1,900 feet across (212th Street Wells). As described above, the Deep Aquifer WHPA encompasses the capture zones from all four of the deep sources with a buffer added. The groundwater model indicates that all groundwater supplying the Deep Aquifer wells ultimately originates at the water table (Aspect 2008b).

5.6.3 Seven Oaks Well (Sea Level Aquifer)

The 6-month capture zone for the Seven Oaks well extends approximately 800 feet east of the wellhead, while the 1-year zone extends approximately 1,200 feet east of the well. The 5-year capture zone extends 800 to 1,300 feet beyond the 1-year capture zone, and the 10- year capture zone extends approximately 100 feet beyond the 5-year capture zone. The Seven Oaks well capture zone is approximately 1,900 feet in width. The maximum width of the 10-year capture zone is approximately 2,300 feet (see **Figure 3-1b of Appendix B**).

5.6.4 East Hill Well (Intermediate Aquifer)

The 6-month capture zone for the East Hill well source extends approximately 2,250 feet east, while the 1-year zone extends approximately 2,550 feet east of the well. The 5-year capture zone extends 2,200 feet beyond the 1-year capture zone, and the 10-year capture zone extends approximately 2,600 feet beyond the 5-year zone. The capture zone for the East Hill well is more radial than those of the Deep Aquifer wells, with a maximum width of approximately 7,600 feet (see **Figure 3-1b Appendix B**).

5.7 AQUIFER SUSCEPTIBILITY TO CONTAMINATION

An evaluation of the aquifer susceptibility was performed to characterize the WHPA in accordance with the Seattle/King County Health Department's Sensitive Aquifer Recharge Area designations. The methodology used was consistent with the predominant method used by the Seattle/King County Health Department in the mid-1990s groundwater management planning process to differentiate areas of high, moderate, and low infiltration potential. The analysis included mapping of four hydrogeologic criteria over the wellhead protection area. The criteria included:

- Surficial Geology. The vast majority of the WHPA areas are mantled by low permeability glacial till, as evidenced by many perched lakes and wetlands on the East Hill upland. Glacial till is considered to have a low infiltration potential.

- Soils. Soil units as defined by the Soil Conservation Service are mapped as high, moderate, and low infiltration capacity, based on the descriptions provided in the Soil Survey of the King County Area (1973). Generally, soil types corresponded directly with the surficial geologic unit; with glacial till (Qvt) forming moderately well-drained Alderwood Association soils.

- Slope. Percent slope was obtained from topographic maps and the King County Soil Survey and the criteria used for the Redmond Bear Creek Groundwater Management Area. High infiltration was assumed to occur when slopes were less than 40%. Moderate infiltration was assumed to occur with slopes between 40% and 80%, and low infiltration was assumed for slopes greater than 80%. The topography within the groundwater source WHPAs has slopes predominantly less than 40%.

- Depth to Groundwater. The depth to groundwater or, in the case of a confined aquifer, the depth to top of aquifer, is an important factor in determining the amount of time it could take a contaminant to reach the aquifer. The groundwater sources are completed in aquifers that, within the WHPAs, are roughly 250 to 600 feet below ground surface – significantly deeper than the 75-foot threshold for low susceptibility.

Based on the collective analysis presented above, particularly the surficial geology and aquifer depth, the groundwater source WHPAs are categorized as having low susceptibility. Aquifer susceptibility is an important factor in King County’s current categorization of critical aquifer recharge areas (CARAs), as described in Aspect 2008b.

6.0 WATER SYSTEM PLAN SUSCEPTIBILITY EVALUATION

In addition to the susceptibility determinations discussed in Sections 5.5 and 5.7, the City's 2019 Water System Plan (WSP) evaluated each of the City's sources as having a "high", "moderate", or "low" level of risk to contamination. The sources were ranked as follows:

- Clark Springs = High
- Kent Springs = Moderate
- Armstrong Wells #1 and #2 = Moderate
- North Kent Wellfield[2] = High
- East Hill Well #1 = Low
- Seven Oaks Well = Low
- O'Brien Well = Low
- Garrison Creek Well #2 = Low

The City should place a higher priority on monitoring water quality in Clark Springs, North Kent Wellfield, Kent Springs, and Armstrong Wells #1 and #2 because these sources have high or moderate susceptibility rankings.

Susceptibility rankings, along with the total number of system connections (15,768 service connections) are typically used to infer what WHPA delineation method is suitable for a given source. As described above in Section 5.0, the City used a numerical groundwater flow model to delineate the WHPAs for all sources, regardless of their individual susceptibility rankings. The use of a numerical groundwater flow model is the most sophisticated method to delineate the wellhead protection areas[3].

7.0 CONTAMINANT SOURCE INVENTORY

This section summarizes contaminant risks to groundwater supplies for the City. The joint categorization and evaluation of potential contaminant sources within the WHPAs represent an update to the City's Contaminant Source Inventory (CSI), as outlined in the DOH guidelines for Wellhead Protection Programs (DOH, 2010).

7.1 DATA SOURCES

Potential contaminant risks that lie within the vicinity of the City's WHPAs were investigated and mapped using data from a variety of sources listed below:

[2] Includes the 208th St Well and 212th St wellfield.
[3] As noted in Section 5, an analytical method was used to delineate the 6-month zone for the springs.

- The parcel database maintained by King County, which contains information regarding sewage handling[4] and the property heat source for parcels in the county.
- Zoning data from multiple jurisdictions including Black Diamond, Covington, Kent, and Maple Valley.
- Ecology's Underground Injection Control (UIC) database was used to map UIC facilities ("Dry wells") within the WHPAs.
- Coal mine hazard areas were obtained from King County.
- Data obtained from Ecology's Facility Site Identification Database (FSID)[5] includes state cleanup sites, federal superfund sites, hazardous waste generators, solid waste facilities and underground storage tanks (USTs).

Information from the above sources were plotted on GIS coverages to assess whether existing and potential contaminant sources were located within the City's WHPAs (including applicable buffer zones) and whether they posed a risk to the water supply sources.

PGG checked the locations of the sites listed within the FSID by verifying the site address and parcel information with Google Earth imagery and address look-up, and when necessary, moved the site's mapped location. PGG found that some sites were mislocated (with listed locations outside of the WHPAs) and therefore removed them from this inventory.

PGG also verified sites identified in the FSID and added new sites based on the results from the windshield survey, which was conducted in September 2021 by PGG Staff.

Ecology's FSID contains a list of sites and their interaction types within the WHPAs which could pose both known and potential risks to the City's supply sources. Each listed contaminant site includes an interaction type (or types). The interaction types relate to the specific known or potential contaminant associated with the site (i.e., stormwater runoff, hazardous waste). PGG identified a list of interaction types of concern which are present within the City's WHPAs as shown on **Table 1**. We removed interaction types that were considered not a concern based on the nature of the interaction, and our understanding of Ecology's categories. A complete list of all possible interaction types is listed on Ecology's FSID website[6].

The FSID also lists each interaction type as "inactive" or "active." Broadly, inactive interaction types are those that are no longer operational (such as construction stormwater discharge sites that become inactive once the construction activities have ceased) or sites where site activity has paused or been suspended pending decisions by the owner/responsibility party, Ecology, or both. Generally, interaction types that are inactive are considered less of a concern than active interaction types. However, given the uncertainty surrounding the site activity level, inactive interaction types were included in the CSI, with a few exceptions that are noted in **Table 1.** Inactive interaction types that were excluded

[4] Large on-site septic systems coverage was obtained from DOH (2021)
[5] Data was downloaded during May 2021 from the FSID
[6] https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Facility-Site-database/Facility-Site-Interaction-Types

had a low concern or no concern (i.e., construction-related stormwater discharge as noted above).

The FSID also lists sites that have received no-further action (NFA) decisions. NFA's indicate that site cleanup efforts have met standards in WAC 173-340 and that past releases have been remediated or were confirmed to have little or no further risks to human health or the environment. NFA sites were not considered a concern for the CSI (see Section 7.5).

7.1.1 Field Survey

A field survey of the ranked hazards within the study area is recommended in order to verify that listed sites are appropriately located and identifies and describes any additional sites of concern that were not included in the initial inventory (these sites are then added to the final inventory). This informal "windshield" survey is usually accomplished by the purveyor staff as they have the most familiarity with the businesses and land uses within their service area. However, due to time and staffing constraints, the City tasked PGG to conduct the survey.

PGG Staff visited select FSID sites within the 6-month and 1-year time of travel zones of the WHPAs during a windshield survey on September 9, 2021. Some FSID site locations could not be field verified and may not exist. Other sites were identified in the field, but the facility name may have changed, or the address may have been incorrect and were updated based on field observations. Sites that were visited during the windshield survey are indicated in the "notes" column of **Table 2**.

7.2 CONTAMINANT INVENTORY SOURCE RANKING

As described by DOH, 2010, the contaminant sources identified during the inventory need to be ranked based on their risk to the City's WHPAs. The ranking effort was also based on the level of confidence in the available data and information for the known and potential contamination sites.

After the removal of sites that were not a concern (based on Ecology FSID interaction types), NFAs, and sites that were incorrectly located (described above in Section 7.1) or not found during the windshield survey, a total of 165 sites of concern to water supply sources were identified within the City's WHPA's. These sites are listed on **Table 2** and were ranked based on the process described below. Sites excluded from the ranking are included in **Appendix C** for reference.

Each site was ranked according to three decision levels. The decision levels are listed below in **Table 3** (Level I represents the highest hazard risk criteria, Level III is the lowest). Each known or potential hazard was first scored and then ranked using decision Level I. Sites with equal Level I rankings were then further scored and ranked using decision Level II, etc., as shown on **Tables 4 and 5**. Once sites were differentiated in priority, no further ranking was necessary.

Table 3: Risk Prioritization Levels

Decision Level	Available Data and Information
I	Proximity of potential hazard within the WHPA
II	Type of contamination
III	Straight-line distance from the wells to the potential hazard

Decision Level I – Proximity to WHPA
For the first decision level, the sub-prioritization of contaminated sites was based on their location in the WHPA zones; the shorter the travel time, the higher the priority. Scores for each time-of-travel WHPAs are summarized in **Table 4**.

Table 4: Proximity to Source

Sub-Priority Score	Proximity to Source
1	6-month time-of-travel WHPA
2	1-year time-of-travel WHPA
3	5-year time-of-travel WHPA
4	10-year time-of-travel WHPA
5	WHPA Buffer Zone or Surface Water Drainage Boundary

Decision Level II – Type of Contamination

For the second decision level, the sites were ranked as either known contamination or potential contamination sites. Known contamination sites were defined as those with known releases of contaminants according to the environmental database survey results. Potential contamination sites are sites or land areas that are used in ways that could pose a risk to groundwater quality. Sites were then further ranked based on the interaction types. This category's sub-priority scoring is summarized in **Table 1**.

Land zoning categories were also ranked using the same sub-priority score system as the known and potential contaminant sites (scale of 1 through 8; 1 being the highest priority and 8 being the lowest priority). The zoning is further discussed in Section 7.3. For ranking purposes, each zone was divided based on whether properties in that zone were predominantly served by a public sewer or on-site septic systems, as shown on **Table 5** **(**FSID sites are scored in **Table 2)**.

Table 5: Zoning Ranking

Zoning classification	Waste System		Sub-Priority Score (Decision Level II)
	Septic	Sewer	
Industrial	X		5
		X	6
Commercial	X		6
		X	7
Residential	X		7
		X	8

Decision Level III – Straight-line Distance from Sources

For potentially hazardous sites with similar characteristics for prioritization decision levels I and II, the straight-line distance from the site to the source was used to further rank the sites. Those sites closest to the sources were given a higher priority.

7.3 LAND USE

Land zoning within the study area includes (in general order of prevalence) residential, commercial, industrial, and parks (various types of open-space or recreational uses). Zoning data can be used to assess which water-supply sources may be impacted by the approved uses on surrounding land. As a general rule, zoning associated with commercial and industrial operations pose the greatest risk to groundwater supplies, followed by residential (residential risk is largely due to the cumulative impact of many residences in a single area). However, any zoned land use potentially could cause a contaminant release; also zoning and land use today may not match historical land use or zoning.

Industrial and commercial zoning should be considered as both potential point and non-point source risks. Known point source risks are listed in **Table 2**, while non-point source risks associated with industrial and commercial zoning are considered here. The commercial storage of chemicals can pose a threat to groundwater quality since chemicals can be spilled accidentally or be disposed of improperly. The likelihood of such releases from spills can be reduced by proper methods of handling, spill prevention measures, and emergency response strategies. Risk reduction strategies should target onsite waste management practices. Improper disposal is likely the most common pathway for chemicals to be released into the environment.

Parcels associated with industrial, commercial, and residential zoning that fall within the 6-month and 1-year WHPA zones should be considered possible contaminant sources. Parcels with shorter time of travel should be considered more pressing to evaluate for risk management. However, given that zoning categories are quite broad, many of these parcels are likely not a significant hazard, and without additional information these parcels should be considered lower risk than the known and potential contaminant sources identified in **Table 2** and below in Section 7.5 where hazardous materials have been confirmed present on site or historically located on site.

Within these zoning categories, contaminants resulting from industrial, commercial, or residential activities can be unregulated and can result in improperly disposed contaminants into sewer or septic systems. Specifically, parcels with one of these three at-risk zoning categories that is also outside of the City's sewer system suggests that contaminants can be improperly disposed of in a septic system, which can discharge directly into shallow aquifers around the WHPAs. **Figure 2** shows the proximity of these zones to each WHPA's time of travel zones and shows the City's sewer service area. The City may wish to reach out to parcel owners within zoning types of concern to notify them that they are within the City's WHPAs.

7.4 POTENTIAL RISK SOURCES

Based on the general zoning and development types in the area, the following potential contamination sources have been included within or near the capture zones for the City's sources:

- Hazardous Materials;
- Underground Injection Control sites;
- On-site septic systems;
- Underground storage tanks;
- Stormwater;
- Unused and improperly constructed wells;
- Agriculture, parks, and lawns;
- Transportation corridors;
- Coal Mines

7.4.1 Hazardous Materials

The commercial use of chemicals poses a potential threat to groundwater quality, since chemicals can be spilled accidentally or be disposed of improperly. The likelihood of such releases from spills can be reduced by proper methods of handling, spill prevention measures, and emergency response strategies. Risk reduction strategies should target on-site handling and waste management practices. Improper disposal is generally the most common pathway for chemicals to be released into the environment.

The most significant threats to groundwater are related to the use and storage of solvents. Solvents can be persistent, soluble in water, and highly mobile. A large plume of contamination can be created with a small quantity of solvent.

Hazardous material interaction types of concern used in the FSID are shown on **Table 1** and are identified for sites of concern in **Table 2**.

7.4.2 Underground Injection Control

Underground Injection Control (UIC) wells inject fluid into the ground generally under the force of gravity[7]. UIC wells can include dry wells, drain fields, and infiltration trenches and are used for a variety of purposes such as stormwater management, groundwater remediation, aquifer recharge, and heat pumps. **Figures 3** and **4** show the UIC wells that are located within the WHPAs.

Discharge into the subsurface is a direct mechanism for transport because contaminants are discharged closer to the water table and by-pass the upper layers of soil, which can absorb and/or disperse many types of contaminants.

7.4.3 On-Site Septic Systems

On-site septic systems pose a risk to groundwater where they are relatively high in density and/or where hazardous wastes are discharged to them. Potential contaminants from septic systems include pathogenic organisms (bacteria and viruses), toxic substances, and nitrogen compounds.

The extent to which pathogens are transported in the subsurface away from a septic drain field depends on the type of pathogen and the chemical and physical conditions in the subsurface. In general, if a septic system is properly sited, constructed, and maintained, the transport of microorganisms will be limited. However, household hazardous chemicals such as cleaners, polishes, waxes, and paints can be transported to groundwater via a septic system. Some products contain toxic and persistent chemicals that can cause low-level contamination. Homeowners can improperly apply or dispose of chemicals because they do not understand the potential threat these chemicals pose to groundwater quality. In some areas, business and commercial facilities still use on-site septic systems for sewage disposal. Business, commercial, and industrial operations that utilize on-site systems need to take special precautions to avoid contamination of their wastewater.

Ammonia and nitrate are highly soluble in water and can generally be expected at detectable concentrations wherever an aquifer is locally affected by septic system discharges. Septic systems are a frequent source of nitrate in groundwater. Nitrate is regulated since ingestion can be potentially harmful to the elderly and infants. In the latter case, it can result in methemoglobinemia, or "blue baby" syndrome. Other sources of nitrate include fertilizers, feedlots, and natural mineral deposits. Background concentrations of nitrates in groundwater are typically less than 1 milligram of nitrogen per liter (mg-N/L). The maximum contaminant level (MCL) for nitrate is 10 mg-N/L.

The Covington upland area is partially served by sewer systems (**Figure 2**). Residents outside the sewer district rely on septic systems. Septic systems that were within the sewer system boundaries and within the WHPAs were mapped on **Figure 2**. Additionally, two large on-site septic systems are located within the Armstrong Springs 1-year time-of-travel zone and are also within the sewer system boundaries. The City's spring sources, unconfined (water-table) aquifers, and surface waters should be considered at risk from impacts from septic systems. Confined aquifers such as those serving the City's

[7] https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Underground-injection-control-program

wells, are less susceptible to direct contamination, but can still be at risk depending on the nature of the local hydrogeology.

7.4.4 Underground Storage Tanks

Contamination in soil and groundwater caused by leaking USTs (“LUSTs”) is a major environmental, legal, and regulatory issue. The most common causes of leaks are structural failure, corrosion, improper fittings, or improper installation. Although USTs usually contain flammable motor fuels or heating oils, they may contain other compounds used by industry, government, or business.

Leakage from USTs and associated piping can often occur without detection. Even relatively small amounts of certain compounds can adversely impact groundwater quality. Once released from an UST, some VOCs and petroleum products can rapidly migrate to groundwater. Of the many materials stored in USTs, solvents are considered the most toxic. However, petroleum products may pose a greater total risk because of their prevalence. Petroleum products contain many potential contaminants, including three EPA priority pollutants: benzene, toluene, and ethylbenzene. Benzene is a known human carcinogen.

Residential home heating oil tanks may also exist in the area. These are typically much smaller in storage volume, but they can be in close proximity to City sources and often receive a lower level of inspection and monitoring than a commercial UST. Properties using heating oil were mapped as locations that most likely have home heating oil tanks on site and are shown in **Figures 3 and 4**. In total, 460 parcels with home heating oil tanks are located with the City WHPAs.

7.4.5 Stormwater

Stormwater is produced when rainfall or other precipitation accumulates faster than it can evaporate, be used by plants, or infiltrate to the subsurface. Urban areas produce more runoff than rural areas because they have more impervious surfaces, such as rooftops, driveways, streets, and highways. These surfaces promote runoff and can limit aquifer recharge via infiltration. Grass lawns can also produce more runoff than forests and pasture.

Stormwater typically contains pollutants, such as sediment, nutrients, bacteria, oils and grease, metals, and other toxins. Many of these contaminants come from air pollution, motor vehicles, the application of pesticides and fertilizers, soil erosion, and animal feces. Roofing materials have also been identified as a diffuse source of metals in runoff, particularly zinc (Good, 1993). In general, contaminant concentrations in stormwater are similar for all land uses, though slightly higher nitrate concentrations occur in residential areas and higher heavy metals concentrations occur in commercial areas. Concentrated sources of stormwater contamination may also occur if undiluted pollutants (e.g., fertilizer, gasoline) are accidentally spilled or intentionally released and enter storm drains.

Stormwater contamination has primarily been a concern for surface-water pollution because most urban runoff is directed to streams, lakes, and other water bodies with fish and other aquatic life that are highly sensitive to common stormwater contaminants.

However, where stormwater is diverted to infiltration basins, there is increased potential for groundwater contamination to occur.

Given the suburban and rural character of the study area, the main concern for stormwater runoff is from roadways, especially the larger transportation corridors and commercial developments with large areas of pavement. There are few large stormwater facilities in the area; most runoff from developments and roadways is untreated, running to stormwater ditches or natural, vegetated rights-of-way before infiltrating into the ground.

7.4.6 Unused, and Improperly Constructed Wells

Well casings can provide a conduit between the ground surface and underlying aquifers. Improperly constructed or abandoned wells pose several potential problems. In wells with no surface seal, contaminants introduced near the wellhead can move downward outside the casing to underlying aquifers. Many older wells that were constructed before the implementation of the State's minimum well standards in WAC 173-160 (pre-1971) have no surface seal. Unused wells that have not been properly abandoned are left uncapped in some cases, posing a special risk because contaminants can be introduced directly into the aquifer. Unused wells also pose a risk if they are damaged during site redevelopment. Any of these situations can provide a conduit for contaminant movement.

Among the private wells in the study area, a portion were constructed prior to adoption of Ecology's drilling standards in 1971. Some wells constructed prior to 1971 were likely not registered with Department of Ecology, and we therefore cannot estimate the number of these older wells.

7.4.7 Agriculture, Parks, and Lawns

Fertilizers, pesticides, and herbicides are applied to residential lawns, commercial landscaping, agricultural lands, and landscaped areas adjacent to roads. If optimally applied, these chemicals pose little threat to groundwater; however, applications are often made incorrectly, and groundwater contamination can result if fertilizers are applied in exceedance of the agronomic uptake rate. Excess nitrate from fertilizer will be recharged to the underlying groundwater system. Frimpter and others (1990) estimated that an average of 9 pounds of nitrate-N leached annually to groundwater from each 5,000-square-foot lawn. Landscaping activities can also be the source of pesticides and herbicides such as EDB, DBCP, and dicamba.

Agricultural parcels, parks/school grounds, residential lawns, and other landscaped areas represent potential sources of nitrogen, pesticide, and herbicide contamination to surface water bodies and aquifers.

7.4.8 Transportation Spills

Vehicles transporting hazardous material can be a source of groundwater contamination through accidents and resultant chemical spills. The major transportation routes in the study area include:

- State Route 18
- State Route 169

- State Route 516/SE Kent-Kangley Road
- State Route 167
- State Route 515

As shown on **Figure 1**, SR-167 goes through the 6-month WHPA of the 208th Street and 212th Street Wells. SR-516 goes through the 6-month time-of-travel zone for the Seven Oaks Well and Armstrong Springs. SR-169 crosses through the 6-month time-of-travel for Kent Springs. SR-515 crosses through the 6-month time-of-travel zone for the East Hill Well. SR-18 crosses through the surface-water area (buffer) for Armstrong Springs. A major spill along any of these routes could adversely impact local surface water bodies and shallow groundwater. Deeper groundwater may also be impacted depending on the location and nature of the spill.

7.4.9 Coal Mines

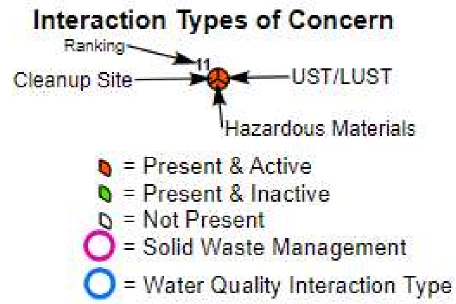
There are several areas labeled as coal mine hazard areas near the spring sources as shown on **Figure 3**. A coal mine hazard area is defined by King County as an area that is underlain or nearby and/or impacted by an abandoned coal mine[8]. There are many hazards associated with abandoned coal mines including roof and side wall failures. Abandoned subsurface mines result in large subsurface voids/caverns, which can suddenly collapse or result in land surface subsidence over time. The voids/caverns in abandoned subsurface coal mines can also store and transfer groundwater. This can affect groundwater quality as residual mine tailings or debris may include particulate matter such as coal dust, sulfur compounds, or other minerals that may affect water chemistry and/or turbidity.

7.5 RANKED HAZARD LIST

Table 2 shows the ranked sites and zoning categories based on their relative risk to the water supply sources using the ranking process described above in Section 7.2. Some sites in **Table 2** have a cleanup site ID, which indicate sites where known contaminants have polluted the environment and the site is responsible for cleaning up the contamination. Additionally, there is a "Notes" column that describes which sites were visited during the windshield survey and which sites were added based on observations during the windshield survey (Section 7.1.1).

Figures 3 and 4 map the sites identified in **Table 2** based on their rank for both the well and spring water sources. The sites are identified by their ranking number from **Table 2** and a symbol that visually shows which activities or risks occur at each site. The symbols for each site are broken down into three segments that each relate to a type of risk/activity. Any combination of the three segments is possible for a given site.

[8] https://www5.kingcounty.gov/sdc/FGDCDocs/COALMINE_fgdc.htm



The interaction types of concern are classified in **Table 1**. **Table 2** identifies specific interaction types associated with the site and if the interaction types are active or inactive (which corresponds to the red and green colored symbols in **Figures 3** and **4**)[9]. White shading indicates the interaction type was not present at a given site.

Sites that were excluded from the ranking process are described in Section 6.2 and include NFA sites, interaction types of concern that were not a concern for inactive sites, and sites that were not observed during the windshield survey. Excluded sites are included in **Appendix C** for reference.

7.5.1 Cleanup Sites

Cleanup sites have confirmed groundwater contamination or confirmed soil contamination with suspected groundwater contamination, and they pose a higher level of risk to groundwater quality than any other sites identified in this report. The top four highest ranked sites on **Table 2** are the cleanup sites discussed below.

Circle Store 1525 is located at 17624 SE 272nd St within the 6-month time-of-travel zone for Armstrong Springs. The site has confirmed soil and groundwater contamination of petroleum products above the cleanup level. The site is currently being cleaned up under independent action but has not received a NFA.

Arco 5568 is located at 17450 SE 272nd St within the 6-month time-of-travel zone for Armstrong Springs. The site has confirmed soil contamination of petroleum products above the cleanup level. The site is currently being cleaned up under independent action but has not received a NFA.

Safford Property is located at 26930 262nd Ave SE within the 6-month time-of-travel zone for Clark Springs. The site has confirmed soil contamination of metals and petroleum products above the cleanup level. The site has suspected soil, groundwater, and surface water contamination for base/neutral/acid organics, corrosive wastes, halogenated organics, non-halogenated solvents, and other reactive wastes. The site has also suspected groundwater and surface water contamination of metals and petroleum products. The site is awaiting cleanup.

[9] A conservative approach was taken during the ranking and mapping of active and inactive interaction types. An interaction type was mapped as "active" when a site with two of the same interaction types had both active and inactive versions of the same interaction type.

Landsburg Mine/Rogers Seam is located south of the S.E. Summit-Landsburg Road and north of S.E. Kent-Kangley Road within the 6-month time-of-travel zone for Clark Springs. The site has confirmed soil contamination of base/neutral/acid organics, conventional inorganic contaminants, halogenated organics, metals, non-halogenated solvents, petroleum products, phenolic compounds, and PCBs above the cleanup level. The same contaminants are suspected in groundwater. The site is currently being cleaned up under an Ecology supervised/conducted action but has not received a NFA. According to Ecology[10], industrial wastes were disposed at the mine during the late 1960s to late 1970s. There has been extensive monitoring and various investigations at this site, which indicate that there are no current impacts to the nearby Cedar River, private wells, or Clark Springs. As of May 2021, Ecology is amending the legal agreement and cleanup action plan for the site due to trace detections of 1,4-Dioxane in groundwater.

7.5.2 USTs and LUSTs

Thirty-four UST and/or LUST sites are identified as a risk in **Figures 3** and **4**, and **Table 2**. Of these ranked sites, five USTs are active LUST sites (two sites are within a 6-month zone, two are within a 10-year zone, and one is within a buffer/surface water area zone). As discussed above in Section 7.4.4, once released from an UST, some VOCs and petroleum products can rapidly migrate to groundwater and are a threat to nearby water sources.

7.5.3 Water Quality

The "water quality" interaction types of concern shown on **Figures 3** and **4**, and **Table 2**. Interactions types of concern within this group include the application of herbicides and other products in lakes to treat plants or algae, stormwater discharge from construction, industrial, and municipal sources, and sand and gravel mine runoff discharge. As discussed above in Section 7.4.5, unregulated stormwater discharge is a concern for surface-water pollution because most urban runoff is directed to streams, lakes, and other water bodies with fish and other aquatic life that are highly sensitive to common stormwater contaminants.

7.5.4 Hazardous Materials

The FSID indicates that there are 78 sites within the City's WHPAs that fall into one of the hazardous waste classifications shown on **Table 2**. Of those sites, only 11 have had cleanup actions, and of those, only eight are active cleanup sites. Of the eight active cleanup sites, two sites are within a 6-month zone, one site is within the 1-year zone and 5-year zone, and two sites are within the 10-year zone and buffer/surface water area zone. The FSID does not indicate whether sites listed are large or small hazardous waste generators. Sites are shown on **Figures 3** and **4**.

7.5.5 Solid Waste Management

Figures 3 and **4**, and **Table 2** indicate that there are two ranked solid waste management sites of concern. The identified solid waste management sites include landfills and energy recovery facilities which recover energy in a useable form from the incineration of solid waste. These sites are of concern due to leachate from solid waste that can migrate into the groundwater.

[10] https://apps.ecology.wa.gov/gsp/Sitepage.aspx?csid=60

8.0 WELLHEAD MANAGEMENT STRATEGIES AND IMPLEMENTATION

The completion of wellhead protection planning provides no safeguards unless effective management strategies are implemented to prevent potential contamination of groundwater sources. The City does not have land-use regulatory control within all of its WHPAs. Therefore, the City should endeavor to keep and maintain close, cooperative ties with King County and the entities in and neighboring the City's WHPAs. This includes the Cities of Black Diamond and Covington, along with Lake Meridian Water District and Covington Water District.

The City has been managing a WHPP since development of the initial plan for the spring supply sources in 1996. The City continues to interact with its neighbors and regulating agencies to exchange information on groundwater protection activities. The City also monitors land use activities and groundwater conditions within the WHPA for its supply sources.

The implementation strategies presented below are revised from the management programs described by Aspect in 2008 (Aspect 2008a, and 2008b) plus input from the City on which elements are most practical to include given their available time and resources. Implementation of some of the proposed management strategies will be dependent on the availability of City resources.

PGG and the City reviewed the strategies and management recommendations included in the 2008 Phase 1 and Phase 2 WHPP documents. Many of the strategies are repeated as they apply to both sets of water sources (springs and wells). For this review, we have only included those strategies that are on-going or have yet to be completed, as shown on **Table 6.** Completed strategies or those no longer applicable were not included.

Table 6: WHPP Management Strategies

Strategy	Name
Strategy MC-1	Maintain a Central Point of Contact
Strategy MC-2	Provide Current WHPA Maps to Controlling Jurisdictions
Strategy MC-3	Send Notification Letters
Strategy MC-5	Encourage BMPs in Land Management Activities
Strategy LU-1	Review Pending Land Use Permits
Strategy LU-2	Develop Notification Process for Pending Permits in WHPA
Strategy R-1	Track State Cleanup (MTCA) Sites
Strategy R-2	Participate in Future Updates to CARA Regulations
Strategy P-1	Promote Protective Stormwater Management
Strategy P-2	Obtain Notifications of Hazardous Materials Spills
Strategy P-3	Map Petroleum Pipelines and Develop Emergency Response
Strategy P-4	Encourage Use of Sewers and Develop Emergency Response Measures
Strategy P-5	Encourage Farm Planning

Strategy DM-1	Monitor Groundwater
Strategy DM-2	Inventory Underground Storage Tanks
Strategy DM-3	Track Dry Well Inventories
Strategy DM-4	Track Pesticide Use
Strategy DM-5	Inventory Abandoned Wells
Strategy E-1	Target Public Education Programs in the WHPA

These strategies are revised or updated below. Strategy numbering and listing order in the 2008 reports is retained to provide easy reference.

Strategy MC-1—Maintain a Central Point of Contact. The City should maintain a central point of contact for issues related to their Wellhead Protection Program. For purposes of this WHPP, this central point of contact is referred to as the "Wellhead Protection Coordinator." The Wellhead Protection Coordinator will foster and promote on-going interaction with jurisdictions inside the WHPA but outside the City limits, and will provide a central resource for departments within the City.

Strategy MC-2—Provide Current WHPA Maps to Controlling Jurisdictions. The City should provide the current electronic (GIS) and printed maps of their WHPAs to all land use authorities within the City's WHPAs on a periodic basis. These maps should also be provided to DOH, Seattle/King County Public Health Department and local fire departments or Districts.

Strategy MC-3—Distribute letters notifying owners/operators of all identified potential contaminant sources regarding their location within the City's WHPA, in accordance with DOH (1995) guidance, and serve as the point of contact for them and others in the local community regarding wellhead protection activities. The letters should include requests to notify the Wellhead Protection Coordinator regarding: (1) any monitoring wells located on the property (including a map of such); (2) getting copied on agency permit notifications pertinent to water quality or quantity; and (3) notice of any release of hazardous materials to the environment. See also Strategy P-2.

Strategy MC-5—Encourage BMPs in Land Management Activities. The City should engage with County and City planning departments to encourage that planners require developers use best management practices (BMPs) that reduce the potential for contaminants to enter the groundwater system.

Strategy LU-1—Review Pending Land Use Permits. Concurrent with Strategy MC-5 above, the City should track and review all pending land development projects within its WHPA. Review should include communication with the permit project manager and submission of comments to the permitting agency as necessary on mitigation and BMPs appropriate to protection of water quantity and quality.

Strategy LU-2—Develop Notification Process for pending permits in WHPA. The City should maintain a point of contact within the Cities of Covington, Maple Valley, and Black Diamond, and King County to ensure an opportunity to comment on pending land use activities within those jurisdictions and develop a process that ensures the City will be notified of all pending land use permitting actions.

Strategy R-1—Track State Cleanup (MTCA) Sites. The City should continue to track the status of all contaminated sites within their WHPA. This includes checking the Ecology databases at least every six months to determine if any new sites have been added to the contaminated sites lists (CSCSL or LUST). For sites that have cleanup work in progress (see Section 7.5.1), notify the Ecology Site Manager that the site is in a WHPA, and request that Ecology notify the City when the site status is updated or changed. Review all available information regarding activities being conducted on the site until the cleanup action and confirm that all monitoring is being completed as directed. Maintain periodic communications with the Ecology site manager to efficiently track status and maintain awareness of the site's location within the WHPA.

Strategy R-2—Participate in Future Updates to CARA Regulations. With adoption of Critical Area Ordinances (CAOs), King County and the Cities with land use jurisdiction over the City's WHPAs have adopted specific requirements for protection of critical aquifer recharge areas (CARAs). Each jurisdiction's current CARA regulations specifically designate CARAs as including WHPAs; however, King County's current CARA map, adopted in its CARA ordinance. Should CARA regulations change in the future, it is critical that the designation of CARAs based on WHPAs does not change. Other municipalities with jurisdiction over land use within the City of Kent WHPAs should be reminded to include WHPAs as CARAs in conducting CAO reviews.

Strategy P-1—Promote Protective Stormwater Management. The City should promote development of local stormwater requirements that provide water quality protection in the WHPA, generally consistent with the 2005 Ecology and King County Stormwater Manuals. Specifically, support development of the most protective criteria; such as 5 feet of separation between infiltration facilities and the water table, sufficient rigor in testing of potential infiltration pond locations, and mandatory treatment requirements within 1-year time-of-travel zones.

Strategy P-2—Obtain Notifications of Hazardous Materials Spills. Concurrent with Strategy R-1, the City should request notification from Ecology for any spills that occur within the WHPA. This should also include similar coordination with the first-response emergency units (e.g., Puget Sound Regional Fire Authority, National Response Center, State Emergency Management Division). The City should then follow up with Ecology on any cleanup action implemented following the spill.

Strategy P-3—The City should pursue adding the alignments of petroleum pipelines into the City's GIS database and ensure emergency response plans for pipeline failure.

Strategy P-4—Encourage Use of Sewers and Develop Emergency Response Measures. The City should encourage King County to require all industrial and commercial facilities within the WHPA to connect to sanitary sewers, if such services are reasonably available. The City, in coordination with the managers of local sewer systems, needs to develop emergency plans to be implemented in the advent of sewage leaks or spills.

Strategy P-5—Encourage Farm Planning. The City and the King Conservation District should discuss how farming practices can affect groundwater. The City should support the Conservation District in efforts to educate the community regarding the requirements for farm planning and availability of Conservation District assistance to do so, such that farm practices within the WHPA are specifically designed to protect groundwater quality.

Strategy DM-1—Monitor Groundwater. The City should actively participate in the collection and analysis of groundwater quality and water level information. The Monitoring Plan described by Aspect in 2008 provide the City guidance to collect long-term information on groundwater quality and quantity. The guidance included as part of Section 8 below.

Strategy DM-2—Inventory Underground Storage Tanks. The City should inventory and locate regulated underground storage tanks (USTs), and documented leaking USTs (LUSTs), within the 1-year time of travel zone.

Strategy DM-3—Track Dry Well Inventories. The City should maintain mapping of registered UIC wells completed by the state or King County, as the inventory is completed, and develop a GIS database of these potential contaminant sources.

Strategy DM-4—Track Pesticide Use. The City can monitor some of the state and county pesticide use within the WHPA by requesting annual reports from WSDOT and King County Roads. In addition, the City should encourage private land managers to use vegetation management practices which protect groundwater quality (Strategy E-1).

Strategy DM-5—Inventory Abandoned Wells. The City should locate and inventory abandoned (unused) wells. Owners of these wells should be notified of the potential liability such wells cause and be educated on the state's requirements for well decommissioning once a well is longer in use.

Strategy E-1—Target Public Education Programs in the WHPA. The City should continue to educate residents, particularly on groundwater quality issues. Customers within the WHPA should be targeted for distribution of literature regarding:

- Septic tank maintenance—compliance with the existing state regulations on septic tank use, which requires the owner to inspect and maintain the system, and notify Seattle/King County Public Health of any repairs, alterations, or expansions;
- Home heating oil storage tank maintenance and proper decommissioning;
- Residential use of herbicides and pesticides—encourage "waterwise" native vegetation planting and integrated pest management, rather than chemical applications; and
- Hazardous material use, disposal, and storage.

In addition to City-run programs, the City should strive to participate in and support small-quantity waste disposal programs and support King County and other local municipal governments in developing and creating public education programs concerning groundwater.

9.0 MONITORING PROGRAM

The City has developed a Monitoring Program for both the spring and well sources as originally described by Aspect in the 2008 WHPP. The Monitoring Program text described in the sections below have been adapted from the previous WHPP with slight modifications.

Aspect developed the Monitoring Plan based on their understanding of the hydrogeology around the City's spring and groundwater sources, the land use patterns at that time, potential contaminant concerns identified within the WHPAs, and the information gathered from the City's WHPA monitoring conducted since completion of its 1996 WHPP.

A Monitoring Program provides a means of identifying trends and detecting problems before they reach the wellhead. Monitoring data can support protective regulatory actions and allow proactive measures to be enacted before the City's water supply sources are impacted. In addition, the data collection and monitoring can assist with regional groundwater management since data provide the basis for making appropriate decisions for long-term protection of groundwater quality and quantity.

9.1 SPRING SOURCES

The following section describes the Monitoring Program developed by Aspect (2008) for the City's spring sources.

9.1.1 Existing Monitoring Program

The City has been actively monitoring surface water, groundwater levels and water quality at several locations within the WHPAs for Armstrong, Kent, and Clark Springs. Groundwater monitoring includes water level measurement and groundwater quality sampling and analysis in existing wells. Water level data are used to define flow directions and gradients and to detect seasonal and other temporal variations in groundwater flow. These data help define the migration pathway of potential contaminants that reach the aquifer. Groundwater quality data collected from selected wells and surface samples taken from streams can help identify water quality degradation and serve as an early warning of water quality changes. Together, these data are used to identify a problem and assess the potential impact to the water supply. Measuring seasonal and long-term changes in water levels also helps with assessing source reliability in terms of water quantity (e.g., during drought conditions). Surface water monitoring has also been conducted within the spring supply source WHPAs to characterize bedrock runoff quality that may affect groundwater quality, and to better characterize the degree of groundwater-surface water interaction. In the eastern study area, bedrock outcrops can generate runoff that infiltrates the aquifer within the Clark and Kent Springs WHPAs. Surface water monitoring includes measurement of water level (stage) and water quality sampling. The City's 24 current water quality monitoring locations within each WHPA are listed below.

- Armstrong Springs WHPA
  - Groundwater: Armstrong Springs well #1; and
  - Surface water: CranMar Creek, Jenkins Creek, and Winterwood Creek #1.
- Kent Springs WHPA

- Groundwater: Kent Springs well #2, Sawyerwood Estates well, and Retreat Lake well; and
- Surface water: CranMar Creek approximately 700 feet north of Kent Springs, Ravensdale Lake where it discharges to Ravensdale Creek, Retreat Lake, and three drainages: Ravensdale Draw (Reserve Silica Mine area), Lake Retreat Draw, and Sugar Loaf Draw southeast of Retreat Lake.

- Clark Springs WHPA
  - Groundwater: Clark Springs gravity line, Bridle Trails well #2, Hidden Lake well, Bremmeyer Logging Co. well, Bremmeyer community well, Lane well, and 4 additional wells that were added in 2018 as discussed below in Section 9.2 (French 2 well, Lorang well, Donnelly well, and MW-101); and
  - Surface water: Rock Creek just downstream of the Clark Springs collection facility.
  - Additionally, periodic groundwater quality monitoring is also being conducted at the Landsburg Mine Site, within the Clark Springs WHPA, by the potentially liable parties (PLP) for that site. The sampling includes monitoring wells at the south portal of the Rogers seam – located nearest the Clark Springs supply source. The City also independently monitors the Clark Springs gravity line, French 2 well, Lorang well, Donnelly well, and MW-101 for a full list of constituents for potential contaminant migration from the Mine site. Section 7.5.1 above summarizes conditions at the Landsburg Mine Site.
  - In addition, the City monitors groundwater levels (only) in eight additional wells located within and adjacent to the collective WHPA for the three spring supply sources. However, during 3rd quarter testing VOC's are collected at these eight additional wells. **Figure 2 and 3** of **Appendix D** shows locations of the City's current water quality and water level monitoring locations for the WHPAs.

Starting in 1997, the City's WHPA water quality Monitoring Program included quarterly monitoring for the following constituent groups:

- Field parameters including water level, specific electrical conductance ("conductivity"), pH, temperature, and turbidity;
- A suite of inorganic compounds (IOCs) including:
  - Total metals and metalloids (antimony, arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, sodium, thallium, zinc)
  - Anions (nitrate, nitrite, fluoride, chloride, sulfate)
- Diesel- and oil-range petroleum hydrocarbons; and
- Conventional parameters (color, turbidity, conductivity, hardness, total dissolved solids);

In addition, samples from Armstrong Springs well #1, Bremmeyer community well, Bremmeyer Logging Co., Bridle Trails well #2, Clark Springs gravity line, Hidden Lake well, Kent Springs well 2, Retreat Lake well, and Sawyerwood Estates well were analyzed biannually for a suite of synthetic organic compounds (SOCs) and volatile organic compounds (VOCs).

Chapter 6 of the 2019 WSP discusses the City's most recent source monitoring results.

9.1.2 Recommended Future WHPA Monitoring

This section presents recommendations written by Aspect (2008) for adjustments to the City's WHPA Monitoring Program for the spring supply sources based on evaluation of the monitoring data collected up until the 2008 WHPP, and the expected changes in land use occurring within the WHPAs. The section includes a baseline Monitoring Program to be applied to all monitoring locations, with the understanding that adjustments to the Monitoring Program should occur based on concerns with specific land use or other changes in the WHPA, and/or observed changes in groundwater quality, over time.

The recommended future WHPA Monitoring Program includes the following activities:

1. Monthly water level and water quality monitoring at all monitoring locations currently in the City's Monitoring Program.

2. During each monthly monitoring round, collect field parameters including:

    a. Water level (depth to water in wells; and water level (stage) at surface water locations);
    b. Specific electrical conductance (conductivity);
    c. pH; and
    d. Temperature.

3. Once per quarter, collect water samples for laboratory chemical analysis of nitrate + nitrite. If a trend of increasing nitrate concentrations over time is observed at a monitoring location, add analysis for chloride there during subsequent monitoring rounds until a probable cause of the increased nitrate is determined.

4. Once per year, during the dry season, add laboratory chemical analysis for volatile organic compounds (VOCs) for each groundwater sample[11]. The VOC analysis covers a wide range of the generally more mobile contaminants associated with common contaminant releases (e.g., fuels and solvents). The VOC analytical method should include chlorinated solvents, BTEX compounds, and MTBE as analytes.

5. Because of proximity to the Landsburg Mine site, analyze the quarterly groundwater samples from the Clark Springs gravity line and Bridle Trails #2 well for VOCs and diesel-/oil-range petroleum hydrocarbons (NWTPH-D analysis). Although a variety of industrial wastes were reportedly disposed of at the Landsburg Mine site, these two additional analyses should target the more mobile contaminants associated with the site based on the available data.

6. Where practical, groundwater and surface water monitoring points should be surveyed to allow for determining water level elevations. These data can help with

[11] VOC analyses are not recommended for surface water locations since VOCs will readily volatilize from open water (analysis cost outweighs benefit for the Monitoring Program).

better determining groundwater flow directions across the WHPAs, including potential seasonal changes.

This proposed monitoring represents a baseline program focused on detecting changes in water quality indicator compounds. At the same time, the City will continue to pay close attention to future land use changes and the status of environmental cleanup sites throughout the WHPA, as outlined in Section 7.5.1. These potential future changes may warrant adjusting the WHPA Monitoring Program, including adding monitoring locations and/or adding water quality analytes based on a specific upgradient land use or identified contaminant. Additional monitoring locations could be added to address data gaps regarding groundwater quality or groundwater quantity (e.g., flow direction), as warranted.

9.1.3 Data Supporting Potential Future Refinement of Groundwater Model

The data collection recommended above can also provide the basis for refinement of the numerical groundwater flow model used to delineate the WHPAs for the City's Springs sources, if warranted. Refinement of the flow model may be warranted based on future hydrologic changes resulting from land use changes, specific identified contaminant sources, and/or changes in operation of the water supply sources. Long-term aquifer management can continue to use this type of tool for decision-making purposes, and the WHPA monitoring data can be used to support better calibration of the model if warranted. These decisions might relate to a water quality concern that becomes apparent during monitoring or decisions about developing a new water supply well.

9.2 SPRING SOURCES MONITORING ADDENDUM

Aspect Consulting, LLC (Aspect) prepared an Addendum in 2018 to the City's 2008 WHPP Monitoring Program. The update included additional monitoring for the Clark Springs WHPA and is reprinted with minor adjustments below.

The three water supply sources (Clark, Kent, and Armstrong Springs) located east of City limits represent a substantial proportion of the City's current water supply and are referred to collectively as the City's "spring supply sources." The three spring sources are fed by groundwater from a shallow, highly transmissive glacial outwash aquifer[12] that is highly susceptible to contamination. The purpose of the WHPP is to provide long-term protection of the quantity and quality of the groundwater resource supplying these critical water supply sources.

The Monitoring Program described above in Section 9.1.1 includes groundwater and surface water monitoring to allow early detection of water quality changes that might affect the City's spring supply sources. The monitoring provides a means for identifying trends and detecting problems before they reach the supply source.

This Addendum to the WHPP Monitoring Program includes additional groundwater monitoring specifically for the Clark Springs source, which is the farthest east of the three spring sources and is the City's largest and most important water supply source.

[12] Vashon recessional outwash (Qvr).

A key reason for enhancing water quality monitoring within the Clark Springs source is its proximity to the Landsburg Mine Site (Site). The Site is an abandoned coal mine into which large quantities of industrial wastes were historically dumped, and consequently it is an environmental cleanup site under the state Model Toxics Control Act (MTCA).

There are two portals to the former mine, one at the north end and one at the south end. The south portal is located within the 6-month time of travel for the Clark Springs supply source. The WHPP ranked the Landsburg Mine Site as a high risk to the Clark Springs supply source. The City has been actively engaged with Ecology and the PLPs regarding cleanup efforts at the Site.

In March 2018, Ecology notified the City that the contaminant 1,4-dioxane, associated with chlorinated solvents disposed of at the Site, was confirmed to be present at concentrations exceeding the MTCA groundwater cleanup level at two compliance monitoring wells located at the Site's north portal. As a result of the confirmed contaminant breakthrough, and the vast uncertainties regarding how groundwater and contaminants move within this complex Site, the City is proactively enhancing the groundwater monitoring program around its Clark Springs source. The following sections detail the additional groundwater monitoring to be conducted for the Clark Springs Source as a component of the WHPP Monitoring Program.

9.2.1 Additional Groundwater Monitoring for Clark Springs

The following sections of this Addendum present the sampling locations, frequency, procedures, and chemical analyses comprising the additional groundwater monitoring. The groundwater monitoring defined in the existing WHPP Monitoring Program does not change as a result of this Addendum.

9.2.2 Additional Sampling Locations

The four additional wells to be monitored are all located on City-owned properties adjacent to Clark Springs. They include monitoring well MW-101 (installed June 2018) immediately southwest of the Landsburg Mine Site south portal, and three former domestic supply wells (the Lorang, French 2, and Donnelly wells), located generally south of MW-101, that have been repurposed for monitoring wells. The Lane Well is a monitoring location defined in the existing WHPP Monitoring Program, and it will continue to be monitored with the additional wells. See **Figure 1** of **Appendix D** for the well locations.

A sixth former domestic well, the French 1 well, is not included as an additional monitoring location because of its close proximity to the other wells. However, it is usable as a monitoring well and is retained as an optional sampling location if warranted based on data collected during the monitoring program. During time periods when the French 1 well is not being monitored, it should be pumped[13] approximately once per year to ensure it remains viable for monitoring.

[13] Pump a minimum of 20 gallons of water, preferably at a rate exceeding 2 gallons per minute.

For reference, **Figure 1** of **Appendix D** also depicts locations of the former Landsburg Mine, its south portal and the PLP's monitoring wells adjacent to it, and the boundary of the City's Clark Springs watershed property.

Figure 1 of **Appendix D** also overlays the surficial geology that shows the inferred distribution of the recessional outwash gravel aquifer (Qvr) supplying Clark Springs (in gray), and, in yellow, the Vashon glacial till (Qvt), which is of much lower permeability than the Qvr and is not a viable water supply source. The Qvr gravels were deposited in glacial outwash channels, on top of the Qvt, during retreat of the last glaciation. The Lorang, Lane, French 1, French 2, and Donnelly wells are completed in the Qvr aquifer. Well MW-101 is completed at a higher elevation than the other five wells, beyond the edge of the Qvr channel, and is completed in the Qvt.

In August 2018, Aspect conducted pumping of the Lorang, French 1, French 2, and Donnelly wells to verify that each produces groundwater representative of the formation and is suitable for water quality monitoring purposes. Each well was pumped at a flow rate of 2 to 3 gallons per minute (gpm), which is a rate higher than they will be sampled at. The pumping was conducted until the water visually cleared and the measured turbidity and specific electrical conductance of the pumped water stabilized, indicating it is drawing groundwater from the Qvr aquifer rather than stagnant water in the well casing. **Table A-1** in **Appendix D** presents the well depth, depth to groundwater, and stabilized water quality parameters, as well as the volume of groundwater extracted, as measured during the August 2018 pumping of each of the four wells.

Appendix D also includes the well log for newly installed monitoring well MW-101. After its installation in June 2018, well MW-101 was developed using a downhole development pump; however, the well pumped dry in successive attempts, due to the Qvt's low permeability, and only limited development could be accomplished. Nonetheless, the well is considered suitable for low-flow sampling, recognizing that it may produce only limited yield during seasonally dry conditions, as observed in June 2018.

9.2.3 Monitoring Frequency

The Monitoring Program for the four additional wells (Lorang, French 2, Donnelly, and MW-101) and the Lane well includes the following activities:

1. Monthly monitoring of water level and water quality field parameters including:
   a. Water level (depth to water measurements)
   b. Specific electrical conductance (conductivity)
   c. pH
   d. Temperature

2. Once per quarter and coincident with the monthly water levels, groundwater samples will be collected for the laboratory chemical analyses listed in Section 9.2.5. The City has the option to sample any or all the wells more frequently at their discretion.

9.2.4 Monitoring and Sampling Procedures

Groundwater levels will be measured, and samples collected at the additional wells using the methods described below.

9.2.4.1 Gauging Water Level

- Decontaminate the water level meter tape and probe by spraying with distilled/deionized water.
- Unlock and open the well monument and remove the well cap. Observe the well and document any damage to the monument, monument cover, or well cap in the field log.
- Open the well and remove any dedicated equipment (e.g., tubing). Note if the well casing was pressurized when first removing the cap (makes a low-pitched pop or thump sound).
- Wait a few minutes after opening/removing equipment to allow water levels to equilibrate to atmospheric pressure.
- Measure and record the depth to water from the marked (surveyed) reference point, or the north side of the well casing if no reference point is marked, to the nearest 0.01 foot.
- Record the time and water level measurement in a field logbook or on a field form. Note any smells, or residue on the water level meter, etc.

9.2.4.2 Low-Flow Purging and Sample Collection

Prior to sample collection, the additional monitoring wells will be purged using industry standard low-flow purge techniques (EPA, 1996). This can be accomplished using a peristaltic pump with tubing dedicated to each well, with an integrated water quality meter and flow-through cell for measuring field parameters. The standard operating procedures below are developed for the peristaltic pumping method.

- If not already present, install a length of new tubing into the well in such a way that it can be retrieved on subsequent visits (dedicated at each well). The dedicated tubing consists of 1 to 2 feet of 1/8-inch polyethylene tubing that discharges into sample containers, connected to approximately 1 foot of 1/4-inch Silicone tubing that is placed in the peristaltic pump head, connected to a sufficient length of 1/8-inch polyethylene tubing that goes down the well to reach the tubing intake depth described below. Replace the tubing if it becomes damaged or visibly dirty.
- Attach and secure the dedicated tubing to the sampling pump, with the silicone tubing within the pump head.
- For well MW-101, set the end of the tubing (intake) at the approximate middle of the saturated screened interval. For the French, Lorang, and Donnelly wells that are well casings open only at their bottom, set the tubing intake approximately 3 feet from the bottom of the well.

- Slowly lower the water level probe until it is just at the water surface and record initial depth to water level below the reference point (top of casing) on the field form.
- Connect the discharge end of the tubing to a flow-through cell containing the water quality meter. The water quality meter should be calibrated in accordance with manufacturer instructions prior to start of each monitoring event.
- To purge the well prior to sample collection, start pumping the well at a flow rate in the range of 0.1 to 0.5 liters (100 to 500 milliliters) per minute. Measure the pumping rate using a graduated cylinder (or other small container of known volume) and stopwatch. Record the pumping rate and depth to water.
    - Ideally, the pump rate should equal the recharge rate into the well such that little water level drawdown occurs in the well (total drawdown within the well should be 0.3 foot or less). This criterion may be relaxed for well MW-101, which is completed in low-permeability Qvt, if it cannot reasonably be achieved.
- Monitor field parameters (temperature, pH, oxidation-reduction potential [ORP], specific conductance, and dissolved oxygen) in 3- to 5-minute intervals during purging, maintaining a generally consistent time interval for a single well. Record each set of measurements on the field form.
- The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings, as follows:
    - ±0.1 for pH
    - ±3 percent for specific conductance
    - ±10 percent for dissolved oxygen (or ± 0.1 mg/L if dissolved oxygen is below 1 mg/L)
    - ±10mV for ORP
    - The recharge rate of the wells should be sufficient for low-flow sampling but, if not, do not purge the well dry. Lower the flow rate if the water level drops more than 0.3 feet or if air bubbles are observed in the purge stream. Do not lower the tubing intake. If a sample cannot be collected without significant drawdown, proceed in pumping the well to the bottom of the tubing, then allow the well to recover. Collect the sample as soon as there is sufficient water to do so, including, if necessary, collecting the sample over multiple cycles of drawdown and recovery.
- Once the field parameters have stabilized, disconnect the tubing from the flowthrough cell in preparation for sampling. Do not sample water that has passed through the flow-through cell.
- Samples should be collected by filling laboratory-supplied containers to the top but not overflowing. Samples for volatile organic compounds (VOCs) should be collected first—containers for VOC analysis should be filled with no headspace or bubbles. For total metals analysis, field filtering is not necessary prior to sample collection.
- After samples have been collected, measure and record the final water level.

- Stop the pump and disconnect the tubing from the pump. Dedicated tubing can be left inside the well for future sampling events; secure the tubing so that it doesn't fall down the well. The tubing may also be kept in a large Ziploc-type bag in between sampling events.
- Close and lock the well.
- Once samples are collected, label each sample, record them on the chain-of-custody form, and immediately put them into an iced cooler for shipment to the laboratory.

9.2.5 Chemical Analyses

In addition to the water quality parameters recorded during purging for sample collection, groundwater samples will be analyzed for the following constituent groups:

- Nitrate + nitrite
- Priority pollutant metals
- Volatile organic compounds (including chlorinated solvents, BTEX, MTBE, and 1,4-dioxane[14])
- Diesel- and oil-range petroleum hydrocarbons (NWTPH-D analysis)

9.3 GROUNDWATER WELLS

The following section describes the Monitoring Program developed by Aspect (2008) for the City's groundwater sources.

9.3.1 Monitoring Recommendations for Groundwater Wells WHPAs

This section presents recommendations for implementing a WHPA Monitoring Program for the groundwater wells based on the current and potential future land use occurring within the WHPAs, and the potential accessibility of existing wells for monitoring within the WHPAs. Information from water quality monitoring of the groundwater well sources, and from longer-term WHPA monitoring of the City's springs sources, is also factored into the recommendations.

The section outlines a baseline Monitoring Program, with the understanding that adjustments to the Monitoring Program should occur based on concerns with specific land use or other changes in the WHPAs, and/or observed changes in groundwater quality, over time.

The Monitoring Program will include monitoring existing water supply wells that the City receives well owner permission to access. Since most of the area encompassed by the groundwater well WHPAs falls within the water service areas of Kent or Lake Meridian Water District, there are relatively few operating private water supply wells remaining within the groundwater well WHPAs. Furthermore, redevelopment of residential

[14] Analyze for 1,4-dioxane using a separate analysis (e.g., EPA Method 8270 semi-volatile organic compounds) if it is not reported as part of the lab's VOC analysis.

parcels progressively results in decommissioning of older wells that had been used for domestic water supply.

A list of potential existing wells within the three WHPAs (Deep Aquifer wells, East Hill well, and Seven Oaks well) was initially assembled from a search of multiple data sources, including a well database prepared for the City as part of its groundwater source reliability study (Robinson Noble Saltbush, 2007), Ecology and King County well logs, DOH public water system information, and King County parcel information. Wells that were determined to be withdrawing from aquifer units deeper than the City supply well in each WHPA were not retained for further consideration as a WHPA monitoring location. For wellhead protection purposes, it is appropriate to monitor water quality in the same aquifer and, preferably, also in shallow aquifer units. The shallower aquifer units are more susceptible to contamination from the surface; therefore, wells in the shallower aquifer(s) represent sentinel wells providing early warning of potential contaminant migration to the deeper aquifers supplying the City's wells.

From the evaluation of data sources and the aquifer criteria, a list of wells representing potential monitoring locations was developed for each of the three WHPAs (more than 20 wells total). A field reconnaissance was conducted to look for the wells and, where possible, gather additional information on well locations. Attempts were also made to contact apparent owners of the identified wells, using available information from the data sources.

Based on all available information, **Figures 1 through 3** of **Appendix D** illustrates approximate locations of potential existing water wells that may serve as monitoring locations within the well WHPAs. On **Figure 2 and 3** of **Appendix D**, the well location is plotted based on best available information (often only to nearest quarter-quarter section). Each well is labeled by its local well number (with section number plus quarter-quarter section letter designation), and, in parentheses, the elevation of the well's open interval (top – bottom). The open interval is the length of the well screen or perforated interval or, for wells without perforations or screen, the depth of the open casing bottom (top and bottom elevation are same).

It is recommended that further evaluation of the existing wells be conducted to find suitable operable wells within each of the three WHPAs and obtain well owner permission to include them in the City's WHPA Monitoring Program. This will be an ongoing process.

It is recommended that two to three wells within the Deep Aquifer wells WHPA, two to three wells within the Seven Oaks well WHPA, and three to four wells within the East Hill well WHPA, be identified for long-term monitoring under this WHPA program. Where suitable existing wells cannot be identified or are not located in specific areas of key interest (e.g., areas with a high density of contaminated sites), the City can consider installing a new monitoring well in key locations, subject to availability of funding.

As appropriate wells are identified for monitoring, the recommended future WHPA Monitoring Program includes the following activities:

1. Monthly water level and water quality monitoring at each of the identified WHPA monitoring wells. The City can adjust this monitoring frequency to bimonthly or quarterly as deemed appropriate.

2. During each monitoring round, collect field parameters including:
    a. Water level (depth to water);
    b. Specific electrical conductance (conductivity);
    c. pH; and
    d. Temperature.
3. Once per quarter, collect water samples for laboratory chemical analysis of nitrate + nitrite[15]. If a trend of increasing nitrate concentrations over time is observed at a monitoring location, add analysis for chloride there during subsequent monitoring rounds until a probable cause of the increased nitrate is determined.
4. Once per year, during the dry season, add laboratory chemical analysis for volatile organic compounds (VOCs) for each groundwater sample. The VOC analysis covers a wide range of the generally more mobile contaminants associated with common contaminant releases (e.g., fuels and solvents). The VOC analytical method should include chlorinated solvents, BTEX compounds, and MTBE as analytes.
5. Where practical, groundwater monitoring points should be surveyed to allow for determining water level elevations. These data can help with better determining groundwater flow directions across the WHPAs, including potential seasonal changes.

This proposed monitoring represents a baseline program focused on detecting changes in water quality indicator compounds. At the same time, the City will continue to pay close attention to future land use changes and the status of environmental cleanup sites throughout the WHPAs, as outlined in Section 6. These potential future changes may warrant adjusting the WHPA Monitoring Program, including adding monitoring locations and/or adding analytes based on a specific upgradient land use or identified contaminant. Additional monitoring locations could be added to address data gaps regarding groundwater quality or groundwater quantity (e.g., flow direction), as warranted.

9.3.2 Data Supporting Potential Future Refinement of Groundwater Model

The data collection recommended above can also provide the basis for refinement of the numerical groundwater flow model used to delineate the WHPAs for the City's well sources, if warranted. Refinement of the flow model may be warranted based on future hydrologic changes resulting from land use changes, specific identified contaminant sources, and/or changes in operation of the water supply sources. Long-term aquifer management can continue to use this type of tool for decision making purposes, and the WHPA monitoring data can be used to support better calibration of the model if warranted. These decisions might relate to a water quality concern that becomes apparent during monitoring or decisions about developing a new water supply well.

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[15] Because nitrite is expected to be negligible based on monitoring data from the groundwater wells in the 2008 WHPP, the recommended analysis for nitrate + nitrite (e.g., EPA Method 353.2 or equivalent) quantifies nitrate and also provides 28-day sample holding time, which can simplify sampling.

10.0 CONTINGENCY PLANNING

Due to sensitive information regarding the City's water supply and facilities contained within the Water Supply Contingency Plan, this Section is restricted to staff use only. Restricted use is necessary to protect public safety and not increase the vulnerability of the City's water system.

11.0 SPILL AND INCIDENT RESPONSE AND PLANNING

As part of its management of its wellhead protection areas, the City must develop a spill and incident response plan. The City should summarize its spill response procedures, continue to coordinate its spill response planning with local emergency responders, Ecology's Spill Operations Section, Emergency Management Division of the Washington Military Department, local health departments, King County, and local emergency planning committees (at a minimum) and contact first responders and regulators to provide input into the completed plan. The following plan is reproduced with updates from the 2008 WHPP.

11.1 INTRODUCTION

This section outlines spill response procedures and capability for jurisdictions within the City's wellhead protection area (WHPA). Spill events can be large or small and can consist of materials that can range from inert to highly toxic. Spills can occur under conditions and locations which are easily contained, or not, so that surface water or groundwater are under immediate threat. This range of possibilities has prompted a spill response (and emergency response) system which is nationwide in scope (National Response System), yet one which is designed to handle the more common, small scale (yet potentially dangerous) spills. This plan takes into account this range of systems.

The ability of the City to affect the protocols and procedures of the national and state response systems is limited. Also, the majority of spills are small and require local response. Therefore, for the purposes of this WHPP, focus is given to local response capabilities and needs associated with these local response systems.

11.2 NATIONAL, STATE, AND LOCAL SPILL RESPONSE PLANS

Spill response planning has been ongoing throughout King County (County) and within Washington State for many years. As a result, there are many plans in existence, each focusing on a specific geographical area or type of substance. In addition, parties involved in the storage and transportation of hazardous materials have been required to develop contingency plans. Each of these contingency plans should be consistent with each other and fit within the context of the response plans listed and described below. The following spill response plans are in effect in Washington State and cover inland, or non-marine areas, such as wellhead protection areas and aquifer recharge areas:

- National Oil and Hazardous Substances Pollution and Contingency Plan (NCP), prepared by the Environmental Protection Agency (EPA);
- Oil and Hazardous Substance Pollution Contingency Plan for Federal Region 10 (RCP), prepared by Region 10 of EPA;
- Washington Statewide Master Oil and Hazardous Substance Spill Prevention and Contingency Plan, prepared by Ecology; and
- Local Emergency Response Plans prepared by city and county governments.

11.3 SPILL RESPONSE ORGANIZATIONS

Depending on the magnitude of the spill event, numerous organizations at all levels of government, some voluntary organizations, and the private sector may have a role in spill response and cleanup. Each of the plans mentioned above describes the relationship and roles of these organizations in terms of the particular concern. Some of the organizations listed below might be, depending on the size and nature of the release, involved in a spill response in the City's WHPA. Spill response plans stress that spill response procedures be effectively executed. For that to be accomplished, each party must be fully aware of their specific roles and responsibilities. Moreover, there must be an understanding of the roles of other parties potentially involved in response activities, as well as effective coordination, cooperation, and communication among responding agencies, organizations, and individuals. The discussion below briefly summarizes the organizations that may be involved in spill response within the WHPA and describes their roles and responsibilities. The discussion below is organized in order from federal to local jurisdictions.

11.4 FEDERAL SPILL RESPONSE

The EPA has primary responsibility for all spills that occur on land. As directed by the NCP, the EPA is pre-designated as on-scene commander (OSC) for spills occurring under its jurisdiction. The OSC determines the status of the local spill response and determines whether, or how much, federal involvement is needed. The EPA may call on the following response teams to assist them in responding to a spill.

National Response Team. The National Response Team (NRT) consists of representatives from the various federal agencies (such as EPA, the US Coast Guard, Fish and Wildlife Service, etc). It serves as the national body for planning and preparedness actions prior to a spill and as an emergency advisory center when a spill occurs.

Regional Response Team. The Regional Response Team (RRT), consisting of representatives from selected federal and state agencies, performs functions similar to those performed nationally by the NRT. Essentially, the RRT is the regional body responsible for planning and preparedness before an oil spill occurs and provides advice to the OSC following such incidents.

Technical Assistance Team. The Technical Assistance Team (TAT) is a contractor used by the EPA Region 10 Office to provide technical oversight for spill response. Requests for the TAT are made via the EPA. Once on site, the TAT will report the situation to the EPA duty officer who then decides whether an EPA OSC needs to be on scene. 8-3 EPA Environmental Response Team. The Environmental Response Team (ERT), based in Edison, New Jersey, is established to advise the OSC and RRT on environmental issues surrounding spill containment, cleanup, and damage assessment, with personnel expertise in areas such as treatment technology, biology, chemistry, hydrology, geology, and engineering.

11.5 STATE SPILL RESPONSE ORGANIZATIONS

Military Department Emergency Management Division (EMD). The state Emergency Management Division (EMD) is tasked with receiving and record verbal emergency toxic chemical release reports through its 24- hour duty officer system and making appropriate notifications. The EMD also assists and provides guidance to local emergency planning commissions for preparation of their emergency response plans.

Department of Ecology. Ecology is the lead state agency for environmental pollution response within the State of Washington. As such, it serves as an advisor to the OSC and the Incident Commander (IC) for many spills occurring in state jurisdiction. Ecology is the state designated OSC for all oil spills in water. In the event of a spill occurring on a state highway, Ecology coordinates with the Washington State Patrol (State Patrol), which assumes responsibility as IC. In addition, Ecology acts as the lead agency responsible for cleanup activities.

Ecology Spill Response Team. The Ecology Spill Response Team consists of Ecology regional office personnel. This team is responsible for determining the source, cause, and responsible party, as well as initiating enforcement action as appropriate. Additional responsibilities include ensuring containment, cleanup, and disposal are carried out adequately. The team coordinates its actions with other state, federal, and local agencies.

State Patrol. The State Patrol acts as the designated Incident Command (IC) Agency for incidents on interstate and state highways, and other roads and jurisdictions as delegated. When a spill occurs on a state highway, Ecology joins the Unified Command and acts as the lead agency for cleanup response.

Department of Fish and Wildlife (WDFW). The WDFW is a state agency with trustee responsibilities for fish and wildlife, and associated habitats. The WDFW Oil Spill Team (OST) provides round-the-clock oil spill response capability to address the needs of fish and wildlife resources. The OST also provides extensive technical support to the State's oil spill planning and preparedness efforts.

Department of Transportation (DOT). The Washington State Department of Transportation (DOT) may provide traffic control, equipment, and personnel for non-hazardous cleanup activities on and interstate highways. The DOT may provide and mobilize equipment necessary in a major spills incident.

11.6 LOCAL RESPONSE

Local governments have a duty to be prepared for all disaster emergencies. The county's Office of Emergency Management Division (OEM) is charged with establishing Local Emergency Planning Committees (LEPC) to facilitate the local planning efforts.

LEPCs have the responsibility to create local emergency response plans. General requirements for local response plans are contained in Title III of the Superfund Amendments and Re-authorization Act of 1986 (SARA). Generally, local agencies, particularly fire services and law enforcement agencies, can be activated to provide emergency response services when there is a threat to life and property. Emergency response services may include: fire and explosion controls investigation and documentation, perimeter control, evacuation, traffic controls, and initial containment or even removal, depending on the nature of the incident.

The "first responders" for the majority of spills are these local entities. They provide for immediate protection of health, property, and the environment. It is this group of responders who determine the need for additional assistance and mobilization of the additional resources provided by the state and federal government.

Local spill response within the WHPAs is within the jurisdiction of the Puget Sound Regional Fire Authority (PSRFA) HAZMAT team for hazardous materials response. The PSRFA has an automatic mutual aid agreement with adjacent Fire Districts 44 and 47 to provide spill response. A Fire Jurisdictions Map is included as **Appendix E**.

Within the City, the PSRFA has been appointed IC for hazardous material incidents, except upon State and Interstate roadways, where the State Patrol will assume the role of IC upon arrival at the scene. The PSRFA Hazardous Materials Emergency Response Plan (HMERP) is the guide for coordinating all resources, both public and private toward preparedness, response, recovery and mitigation efforts for hazardous material emergencies. The City's Director of Emergency Management plans for and coordinates emergency spill response services within the City.

11.7 THE RESPONSIBLE PARTY

The primary responsibility for assessing, responding to, and containing an oil spill or discharge falls upon the individual, agency, and/or company responsible for the spill incident. The responsible party (RP), whether there is an approved contingency plan or not, is responsible for containment and cleanup of the spill, disposal of contaminated debris, restoration of the environment, and payment of damages. State law (Chapter 70.105D RCW) and federal law (40 CFR 300, the NCP) specifically require that the removal of a discharge of oil or hazardous substance should be immediate.

11.8 SPILL RESPONSE CONTACT INFORMATION

A spill of any magnitude within the WHPA, must be reported to Ecology's Northwest Regional Office:

- Ecology (24 hour): **1-800-OILS-911 (645-7911)**
  or 206-594-0000 (during business hours)

https://ecology.wa.gov/About-us/Get-involved/Report-an-environmental-issue/Report-a-spill

If necessary, contact local first responders and other governmental agencies and request their assistance:

- Police: 911
- Fire/Ambulance: 911
- Seattle & King County Public Health 911 or (206) 296-4600

If a spill cannot be contained, Safety Kleen, a cleanup contractor in Seattle, Washington should be contacted:

- Safety Kleen 253-561-8270

If a spill can be contained, it should be pumped into a containment tank. If there are no containment tanks on site, contact BakerCorp in Everett, Washington:

- BakerCorp 425-347-8811

12.0 WHPA NOTIFICATION LETTERS

To help protect and coordinate spill response planning within the community surrounding the City's WHPAs, the City should send notification letters (example letters included in **Appendix F**) to contaminant site owners, emergency responders, and governmental and regulatory agencies. The notification letters should present a map of the WHPAs (similar to **Figure 1**), a table of the site of concern (similar to **Table 2**) and briefly describe appropriate procedures in the event of a spill. Notification letters for business/site owners should be sent all sites ranked in **Table 2** that are not already aware of their ranking status and/or have a valid mailing address **(**example letter is included in **Appendix F).**

Notification letters for emergency responders should be sent to the following entities (and an example letter is included in **Appendix F**):

- King County Sheriff's Office
- Puget Sound Fire (serving Cities of Covington, Kent, Maple Valley, and Seatac)
- Mountain View Fire & Rescue (stations in Kent, Black Diamond, Auburn, and Enumclaw)
- City of Kent, Black Diamond, Covington, Maple Valley Police Department
- Fire Protection Bureau - Washington State Patrol
- Emergency Response, Washington State Department of Transportation, Traffic Management Center

The following governmental and regulatory agencies should also be notified, and an example letter is included in **Appendix F**.

- Ecology Northwest Regional Office
- Washington State Department of Health Southwest Regional Office
- Seattle/King County Public Health

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TABLES

Table 1. Ecology Facility Site Database Interaction Types of Concern in Kent WHPAs

Ecology Program	Ecology Interaction Type Code	Ecology Interaction Type Name	Ecology Interaction Type Description	Interaction Types of Concern					Known Contaminant of Concern	Potential Contaminant of Concern	Sub-Priority Score[1]
				Hazardous Materials	Cleanup Site	UST/ LUST	Water Quality	Solid Waste			
All Programs											
	ENFORFNL	Enforcement Final	An Enforcement action (i.e. Penalty, Order, Notice) was finalized and issued to the respective party, indicating the enforcement action was taken. The start and end date listed in the database are both the date the action was issued to the responsible party.		Y				Y		2
Hazardous Waste and Toxics Reduction (HAZWASTE)											
	TIER2	Emergency/Haz Chem Rpt TIER2	Businesses that store 10,000 pounds or more of a hazardous chemical or 500 pounds or less, depending on the chemical, of an extremely hazardous chemical on site at any one time must report annually. Reports are sent to the State Emergency Response Commission [represented by Ecology] Local Emergency Planning Committees, and local fire departments for emergency planning.	Y						Y	3
	TRI	Toxics Release Inventory	Facilities in specific industries that manufacture, process or use more than the threshold amount of one or more of 600 listed toxic chemicals. Most threshold amounts are 10,000 or 25,000 pounds per year. Some chemicals have much lower thresholds.	Y						Y	3
	HWP	Hazardous Waste Planner	Under Chapter 173-307 WAC, facilities that report under Section 313 of the Emergency Planning/Community Right-To-Know Act (EPCRA), or that generate more than 2,640 pounds of hazardous waste per year, must prepare Pollution Prevention Plans.	Y						Y	3
	HWG	Hazardous Waste Generator	Facilities that generate any quantity of a dangerous waste. They may be classified as SQG, MQG, or LQG depending on hazardous waste generated for a given month.	Y						Y	3
	HWOTHER	Haz Waste Management Activity	Facilities that are required to have a RCRA Site ID# but who do not generate and/or manage hazardous waste (XQG generator status). This includes transporters, used oil recycler's, and dangerous waste fuel marketers and burners.	Y						Y	3
Toxics Cleanup (TOXICS)											
	INDPNDNT	Independent Cleanup	Any remedial action without department oversight or approval and not under an order or decree.		Y				Y		2
	LUST	LUST Facility	A leaking underground tank cleanup site being cleaned up with Ecology oversight or review.		Y	Y			Y		1
	SCS	State Cleanup Site	A site is being cleaned up under state regulations. Regulations include Model Toxics Control Act or its predecessors.		Y				Y		1
	VOLCLNST	Voluntary Cleanup Sites	For a fee, Ecology staff will review an independent cleanup report(s) and provide a written decision about the adequacy of the cleanup actions taken and described in the report.		Y				Y		2
	UST	Underground Storage Tank	Any one or combination of tanks (including connecting underground pipes) that is used to contain regulated substances and has a tank volume of ten percent or more beneath the surface of the ground. This term does not include any of the exempt UST systems specified in WAC 173-360-110(2) or any piping connected thereto. See WAC 173-360			Y				Y	4
Solid Waste Management (SOLIDWASTE)											
	LANDFILL	Landfill	A disposal facility or part of a facility at which solid waste is placed in or on land and which is not a land treatment facility.					Y		Y	4
	RECOVERY**	Energy Recovery	Energy recovery facilities that recover energy in a useable form from the burning (incineration) of solid waste. These include energy-recovery facilities that burn municipal solid waste and paper manufactures who burn wood waste at a rate of more than twelve tons of solid waste per day.					Y		Y	5
Water Quality (WATQUAL)											
	APALGAEGP**	AP Aquatic Plant and Algae Management GP	General permit to regulate application of herbicides and other products used in lakes to treat plants or algae in order to protect state waters.				Y			Y	6
	CONSTSWGP**	Construction SW GP	General permit issued to owner/operators of construction projects that disturb 1 or more acres of land through clearing, grading, excavating, or stockpiling of fill material that discharge stormwater to state waters.				Y			Y	6
	INDNPDESIP	Industrial NPDES IP	Individual NPDES and State permits issued to industries to regulate discharges of process wastewater to state waters.				Y			Y	5
	INDSWGP	Industrial SW GP	General permit issued to industries to regulate the discharge of contaminated stormwater to state waters.				Y			Y	5
	MS4P2WESTGP**	Municipal SW Phase II Western WA GP	General permit issued to operators of small municipal stormwater collection systems to regulate stormwater discharges to state waters in western WA.				Y			Y	6
	SANDGP**	Sand and Gravel GP	General permit issued to sand and gravel mining operators to regulate the discharge of pollutants to state waters.				Y			Y	6

Note: Professional judgement was applied in creating this list of potential groundwater hazards, and potential hazard activities were conservatively identified. It assumes that groundwater and surface water are in direct continuity, and therefore applications of pesticides or herbicides to surface waters could impact groundwater.

[1] Hazard ranking is based on professional judgement where each interaction type of concern was ranked on a scale of 1-8. 1 being the most hazardous interaction type and 8 being the least hazardous interaction type. See Section 6.2
Note that there were no interaction types of concern that were ranked with a sub-priority score above 6.

** Inactive sites of this interaction type are not considered a concern

Table 2. Known and Potential Contaminant Sites in Kent WHPAs

Rank	Facility Name	WHPA	Time of Travel	Interaction Type	1=known concern 2=potential concern[1]	Decision Level 1 (WHPA)	Decision Level 2 (risk type)	Decision Level 3 (distance)
1	Landsburg Mine Rogers Seam	Clark Springs	6-Month	SCS	1	1	1	5139
2	Circle Store 1525	Armstrong Springs	6-Month	inactive: HWG; HWOTHER; LUST; VOLCNST; TIER2. active: UST; LUST	1	1	1	1507
3	Arco 5568	Armstrong Springs	6-Month	inactive: HWGx2; TIER2. active: HWOTHER; LUST; UST	1	1	1	1606
4	SAFFORD PROPERTY	Clark Springs	6-Month	SCS	1	1	1	4035
5	CITY OF KENT GARRISON WELL	Garrison Well	6-month	TIER2	2	1	3	2
6	KENT CITY SEVEN OAKS WELL	Seven Oaks Well	6-month	TIER2	2	1	3	8
7	KENT CITY KENT SPRINGS	Kent Springs	6-month	TIER2	2	1	3	8
8	KENT CITY EAST HILL WELL	East Hill Well	6-Month	TIER2	2	1	3	9
9	KENT CITY CLARK SPRINGS	Clark Springs	6-Month	TIER2	2	1	3	35
10	Saggu Automotive Repair	East Hill Well	6-month		2	1	3	791
11	Sherwin Williams 8255	Armstrong Springs	6-Month	inactive: HWG. active: HWOTHER	2	1	3	969
12	O'reilly Autoparts	Armstrong Springs	6-month		2	1	3	1063
13	Valley Automotive Repair & electric	Armstrong Springs	6-month		2	1	3	1222
14	COVINGTON WATER DIST BLACK DIAMOND	Kent Springs	6-Month	inactive: HWGx3. active: Tier 2	2	1	3	1337
15	Covington MultiCare Clinic	Armstrong Springs	6-Month	inactive: CONSTSWGP; HWG; UST. active: HWG, TIER2	2	1	3	1512
16	Jiffy Lube Store 1118	East Hill Well	6-Month	HWG	2	1	3	1515
17	BP 07073	Armstrong Springs	6-Month	HWG	2	1	3	1621

Rank	Facility Name	WHPA	Time of Travel	Interaction Type	1=known concern 2=potential concern[1]	Decision Level 1 (WHPA)	Decision Level 2 (risk type)	Decision Level 3 (distance)
18	Home Depot HD4737	Armstrong Springs	6-Month	active: HWG; HWP; Tier2. inactive: HWP	2	1	3	2705
19	Ind/comm. Park: One 7, CLS Septics, Goodfellow Bros Shop, Skye Industrial, Broth	Clark Springs	6-month		2	1	3	6563
20	SHORT STOP MARKET	Seven Oaks Well	6-month	UST	2	1	4	359
21	RESIDENCE SE 272nd ST	Armstrong Springs	6-Month	UST	2	1	4	2617
22	LIFT STATION 11 KENT	Armstrong Springs	6-month	UST	2	1	4	5569
23	Glint Car Wash	Seven Oaks Well	6-month		2	1	5	355
24	Zoning Category	208th St. Well	6-month	Industrial Zoning (sewer)	2	1	6	200
25	Zoning Category	East Hill Well	6-month	Commerical Zoning (sewer)	2	1	6	250
26	KING CNTY DOT COVINGTON PIT	Armstrong Springs	6-Month	SANDGP	2	1	6	1230
27	Cedar Springs	Armstrong Springs	6-Month	CONSTSWGP	2	1	6	1456
28	Fox Subdivision	East Hill Well	6-Month	CONSTSWGP	2	1	6	1653
29	Lake Sawyer Restoration Team Lake Treatment	Kent Springs	6-Month	APALGAEGP	2	1	6	1696
30	Covington SR-516 (Jenkins Creek to SE 185th	Armstrong Springs	6-Month	CONSTSWGP	2	1	6	2349

Rank	Facility Name	WHPA	Time of Travel	Interaction Type	1=known concern 2=potential concern[1]	Decision Level 1 (WHPA)	Decision Level 2 (risk type)	Decision Level 3 (distance)
31	Ravensdale Regional Pk Sport Fields 2	Clark Springs	6-Month	CONSTSWGP	2	1	6	6358
32	Zoning Category	Armstrong Springs	6-Month	Residential Zoning (septic)	2	1	7	500
33	Zoning Category	Kent Springs	6-Month	Commerical Zoning (septic)	2	1	7	6500
34	Zoning Category	Seven Oaks Well	6-Month	Residential Zoning (sewer)	2	1	8	500
35	Northwest Pipeline Covington MS	Armstrong Springs	1-Year	inactive: SCS; HWGx2; HWOTHER. active: VOLCLNST	1	2	1	5385
36	SE 248th 102nd Ave	East Hill Well	1-Year	HWG	2	2	3	1288
37	Taylors Fine Drycleaning	East Hill Well	1-year	HWG	2	2	3	1950
38	FRED MEYER KENT SHOPPING CENTER	East Hill Well	1-year	UST	2	2	4	2118
39	Holiday of Kent	East Hill Well	1-Year	CONSTSWGP	2	2	6	1498
40	Park Place Subdivision	East Hill Well	1-Year	CONSTSWGP	2	2	6	1520
41	Morrill Meadows East Hill Park Improveme	East Hill Well	1-Year	CONSTSWGP	2	2	6	2069
42	Rainier Ridge Lennar	Kent Springs	1-Year	CONSTSWGP	2	2	6	6080
43	SR 169 / Ravensdale Creek	Kent Springs	1-Year	CONSTSWGP	2	2	6	7800
44	JUNIOR HIGH 6	Armstrong Springs	5-Year	inactive: LUST. active: UST	1	3	1	6433
45	Reserve Silica Corp	Kent Springs	5-Year	inactive: LANDFILL. active: SCS;UST	1	3	1	13741
46	James Street Cleaners	East Hill Well	5-Year	HWG; HWOTHER; VOLCLNST	1	3	2	2089
47	KENT FIRE POLICE TRAINING CENTER	East Hill Well	5-Year	ENFORFNLx11; UST	1	3	2	3869

Rank	Facility Name	WHPA	Time of Travel	Interaction Type	1=known concern 2=potential concern[1]	Decision Level 1 (WHPA)	Decision Level 2 (risk type)	Decision Level 3 (distance)
48	RESERVE SILICA CORPORATION	Kent Springs	5-Year	active: ENFORFNLx12;SANDGP. inactive: HWG; SANDGP; SCS	1	3	2	14672
49	Chevron 207528	East Hill Well	5-Year	active: UST. inactive: HWGx3; HWOTHERx3; TIER2	2	3	3	2277
50	USPS Kent 240th St	East Hill Well	5-Year	HWG; TIER2; UST	2	3	3	2449
51	WE Care Cleaners	East Hill Well	5-Year	HWG	2	3	3	2602
52	BP 07040	East Hill Well	5-Year	HWG; UST	2	3	3	4595
53	Knudsen Oil Environmental SV	Armstrong Springs	5-Year	HWG	2	3	3	7370
54	AC Cushion Molders	Armstrong	5-year	HWG	2	3	3	10028
55	Holcim US Inc Ravensdale	Kent Springs	5-Year	HWG	2	3	3	12892
56	Kanaskat Drums	Kent Springs	5-Year	HWG	2	3	3	27925
57	PD & J MEATS INC M LOTTO PRES	East Hill Well	5-Year	UST	2	3	4	3268
58	LAKE RETREAT CAMP & CONF CENTER	Kent Springs	5-Year	UST	2	3	4	25462
59	Zoning Category	Kent Springs	5-Year	Industrial Zoning (septic)	2	3	5	9200
60	COPPER RIDGE PLAT & PUD	208th St. Well	5-year	CONSTSWGP	2	3	6	785
61	Cedar Heights Middle School Fields	Armstrong Springs	5-Year	CONSTSWGP	2	3	6	6916
62	Plat of Garrison Glen	Garrison Well	5-year	CONSTSWGP	2	3	6	1986
63	Hillcrest Kent	208th St. Well	5-year	CONSTSWGP	2	3	6	2031
64	Montclaire Plat	East Hill Well	5-Year	CONSTSWGP	2	3	6	3184
65	BOHANNON SHORT PLAT	East Hill Well	5-Year	CONSTSWGP	2	3	6	3561
66	Leber Plat	East Hill Well	5-Year	CONSTSWGP	2	3	6	4451

Rank	Facility Name	WHPA	Time of Travel	Interaction Type	1=known concern 2=potential concern[1]	Decision Level 1 (WHPA)	Decision Level 2 (risk type)	Decision Level 3 (distance)
67	ARCO AM/PM Facility	East Hill Well	5-Year	CONSTSWGP	2	3	6	4588
68	Alpine Glen CalAtlantic	Armstrong Springs	5-Year	CONSTSWGP	2	3	6	7482
69	Covington Connector 204th Ave Roadway	Armstrong Springs	5-Year	CONSTSWGP	2	3	6	8834
70	Logbrook	Armstrong Springs	5-Year	CONSTSWGP	2	3	6	10676
71	Hope Fellowship	Armstrong Springs	5-Year	CONSTSWGP	2	3	6	11355
72	Ravensdale Trench Filling	Kent Springs	5-Year	CONSTSWGP	2	3	6	14668
73	Ravensdale Fill & Grade	Kent Springs	5-Year	CONSTSWGP	2	3	6	19303
74	TRANSPORTATION SERVICES BUILDING	East Hill Well	10-Year	active: UST; LUST; HWOTHER. inactive: LUST; HWGx4; HWOTHERx3	1	4	1	2471
75	EAST HILL AM PM	East Hill Well	10-Year	active: LUST; UST. inactive: HWG; HWOTHER; TIER2; VOLCLNST	1	4	1	3117
76	Circle K Store 01546	East Hill Well	10-Year	HWG;TIER2	2	4	3	2096
77	KING CNTY PARKS KENT POOL	East Hill Well	10-Year	TIER2	2	4	3	2558
78	AT&T WIRELESS KENT EAST HILL	East Hill Well	10-Year	TIER2	2	4	3	2820
79	Kelly Moore Paint Co Inc Kent	East Hill Well	10-Year	HWGx2; HWOTHER	2	4	3	3173
80	Meridian Middle School	East Hill Well	10-Year	active: HWOTHER. inactive: HWGx3; HWOTHERx2	2	4	3	6610
81	RAVER SUBSTATION	Kent Springs	10-Year	active: TIER2. inactive: UST	2	4	3	28623
82	MAPLE VALLEY CHEVRON	Armstrong Springs	10-Year	UST	2	4	4	12716
83	FLOYDS DETAILING	Armstrong Springs	10-Year	UST	2	4	4	13711

Rank	Facility Name	WHPA	Time of Travel	Interaction Type	1=known concern 2=potential concern[1]	Decision Level 1 (WHPA)	Decision Level 2 (risk type)	Decision Level 3 (distance)
84	LAKE SAWYER GROCERY	Armstrong Springs	10-Year	UST	2	4	4	13781
85	2015 Asphalt Overlays	East Hill Well	10-Year	CONSTSWGP	2	4	6	3572
86	Yashco Azalea Short Plat	East Hill Well	10-Year	CONSTSWGP	2	4	6	3781
87	Ward Short Plat	212th St. Wells	10-year	CONSTSWGP	2	4	6	4383
88	Paulson Property	East Hill Well	10-Year	CONSTSWGP	2	4	6	4581
89	Rainier Pond	East Hill Well	10-Year	CONSTSWGP	2	4	6	6431
90	MV216	Armstrong Springs	10-Year	CONSTSWGP	2	4	6	12836
91	Elk Run Division 8 Phase 2 & 3	Armstrong Springs	10-Year	CONSTSWGP	2	4	6	12958
92	216th Ave SE SE 272nd to SE 283rd St	Armstrong Springs	10-Year	CONSTSWGP	2	4	6	12994
93	Sun Ridge at Elk Run Division 2	Armstrong Springs	10-year	CONSTSWGP	2	4	6	16623
94	Terrace at Maple Woods	Armstrong Springs	10-Year	CONSTSWGP	2	4	6	21708
95	88th PL S	OBrien Well	Buffer	active: SCS; HWG. inactive: HWG	1	5	1	814
96	Texaco Station 632320283	208th St. Well	Buffer	active: UST. inactive: HWG; LUST; TIER2	1	5	1	5774
97	7 ELEVEN STORE 230320188	East Hill Well	Buffer	active: LUST; VOLCNST. inactive: TIER2x2; UST	1	5	1	9432
98	Kipperberg AST Spill	Armstrong Springs	Surface Water Area	SCS	1	5	1	13026
99	Metals West Inc	OBrien Well	Buffer	active: ENFORFNLx11; RECOVERY. inactive: INDSWGP	1	5	2	1161
100	Mill Brook Estates	Seven Oaks Well	Buffer	ENFORFNL	1	5	2	2098
101	Meridian Cleaners	Seven Oaks Well	Buffer	active: HWOTHER. inactive: HWGx2; VOLCLNST	1	5	2	4094
102	Panther Lake Shopping Center	208th St. Well	Buffer	VOLCLNST	1	5	2	6070
103	MAPLE VALLEY FOOD MART	Armstrong Springs	Surface Water Area	ENFORFNL; UST	1	5	2	13542
104	PACIFIC COAST COAL CO	Kent Springs	Surface Water Area	ENFORFNL; INDNPDESIP	1	5	2	15434

Table 2. Known and Potential Contaminant Sites in Kent WHPAs

Revised Feb. 9, 2022

Rank	Facility Name	WHPA	Time of Travel	Interaction Type	1=known concern 2=potential concern[1]	Decision Level 1 (WHPA)	Decision Level 2 (risk type)	Decision Level 3 (distance)
105	Pilchuck Contractors Diesel SP	212th St. Wells	Buffer	HWG	2	5	3	319
106	KENT CITY OBRIEN WELL	OBrien Well	Buffer	TIER2	2	5	3	607
107	Romaine Electric Corp Kent	208th St. Well	Buffer	HWG;HWOTHER	2	5	3	708
108	PLUSH PIPPIN FOOD CORP	OBrien Well	Buffer	inactive: INDSWGP. active: TIER2	2	5	3	997
109	K & D Equipment	212th St. Wells	Buffer	HWG	2	5	3	1017
110	PLUSH PIPPIN FOODS CORPORATION	212th St. Wells	Buffer	TRI	2	5	3	1078
111	Safeway Distribution Center Kent	212th St. Wells	Buffer	TIER2	2	5	3	1262
112	LAND N SEA DISTRIBUTING	212th St. Wells	Buffer	TIER2	2	5	3	1314
113	Seattle Freight Service Inc SR 599	OBrien Well	Buffer	HWG	2	5	3	1551
114	JIFFY LUBE STORE 2930	Armstrong Springs	Surface Water Area	TIER2	2	5	3	1791
115	A & W Bearing Service Inc Bellevue	Armstrong Springs	Surface Water Area	HWG	2	5	3	1876
116	Rite Aid 5198	Armstrong Springs	Surface Water Area	HWG	2	5	3	2299
117	Blair Industries	Armstrong Springs	Surface Water Area	HWG	2	5	3	2409
118	Wal Mart Store 5073	Armstrong Springs	Surface Water Area	HWG; HWP	2	5	3	2480
119	Safeway Store 792	Armstrong Springs	Surface Water Area	HWG	2	5	3	2516
120	Kent Meridian High School	East Hill Well	Buffer	inactive: HWGx2; HWOTHERx2. active: HWOTHER	2	5	3	3191
121	JIFFY LUBE STORE 2063	East Hill Well	Buffer	TIER2	2	5	3	3212
122	Northern Automotive D	East Hill Well	Buffer	HWG	2	5	3	3274
123	Verizon Wireless HIGHFIVE A 616083537	East Hill Well	Buffer	TIER2	2	5	3	3276
124	KENT CITY PUMP STATION 5	East Hill Well	Buffer	TIER2; UST	2	5	3	3289
125	Johnnys Food Center 2	East Hill Well	Buffer	HWG	2	5	3	3644

Rank	Facility Name	WHPA	Time of Travel	Interaction Type	1=known concern 2=potential concern[1]	Decision Level 1 (WHPA)	Decision Level 2 (risk type)	Decision Level 3 (distance)
126	Kent Kangley Road Spil	East Hill Well	Buffer	HWG	2	5	3	3683
127	Messners Waste	208th St. Well	Buffer	HWG	2	5	3	4095
128	East Hill Cleaners	East Hill Well	Buffer	HWG	2	5	3	4132
129	Kent Hill Plaza One Hour Marti	East Hill Well	Buffer	HWG	2	5	3	4213
130	COMCAST COMMUNICATIONS KENT DISTRIBUTION WHSE	East Hill Well	Buffer	TIER2	2	5	3	4319
131	Easthill Auto Center Buchan Bros Inv Pro	East Hill Well	Buffer	HWG	2	5	3	4384
132	Rite Aid 6934 DBA Bartell Drugs 034	Seven Oaks Well	Buffer	HWG	2	5	3	4914
133	Orchard Dry Cleaners	212th St. Wells	Buffer	HWG; HWOTHER	2	5	3	5728
134	Rite Aid 5189	208th St. Well	Buffer	HWG	2	5	3	5856
135	Safeway Store 459	208th St. Well	Buffer	HWG	2	5	3	5980
136	VERIZON WIRELESS CHESTNUT RIDGE A	212th St. Wells	Buffer	TIER2	2	5	3	6000
137	Albertsons 474	208th St. Well	Buffer	HWG	2	5	3	6076
138	Panther Lake Shopping Center Kent	208th St. Well	Buffer	HWG	2	5	3	6102
139	Verizon Business	East Hill Well	Buffer	HWG	2	5	3	7980
140	King Cnty Solid Waste Div Hobart Landfil	Armstrong Springs	Surface Water Area	inactive: HWG. active HWOTHER	2	5	3	19987
141	KANGLY CHEVRON	Seven Oaks Well	Buffer	UST	2	5	4	690
142	ELLISON GARY	Garrison Well	Buffer	UST	2	5	4	1728
143	MEADOW HILLS PUMP STATION	Seven Oaks Well	Buffer	UST	2	5	4	2153
144	KENT WA LINE SEG 51 PRINT 468	Seven Oaks Well	Buffer	UST	2	5	4	3091
145	FRIENDLY FOOD MART UST 419392	East Hill Well	Buffer	UST	2	5	4	3349

Rank	Facility Name	WHPA	Time of Travel	Interaction Type	1=known concern 2=potential concern[1]	Decision Level 1 (WHPA)	Decision Level 2 (risk type)	Decision Level 3 (distance)
146	RMLR QKI	East Hill Well	Buffer	UST	2	5	4	7605
147	WILLIAM & DOROTHY KENNELLY	Armstrong Springs	Surface Water Area	UST	2	5	4	11031
148	ELK RUN GOLF COURSE	Armstrong Springs	Surface Water Area	active: NONENFNx11. inactive: UST	2	5	4	15803
149	EZ Dozing	Armstrong Springs	Surface Water Area	UST	2	5	4	17365
150	Devonshire Pointe	208th St. Well	Buffer	CONSTSWGP	2	5	6	381
151	Sonic Drive In Kent	Seven Oaks Well	Buffer	CONSTSWGP	2	5	6	571
152	The Ridge Townhomes	OBrien Well	Buffer	CONSTSWGP	2	5	6	616
153	Valley View	208th St. Well	Buffer	CONSTSWGP	2	5	6	875
154	Affinity & Polaris at Covington	Armstrong Springs	Surface Water Area	CONSTSWGP	2	5	6	2129
155	Kent Meridian HS Field Renovation	East Hill Well	Buffer	CONSTSWGP	2	5	6	3030
156	VICTORIAN MEADOWS	Armstrong Springs	Surface Water Area	inactive: CONSTSWGPx2 active:UIC	2	5	6	3450
157	Roma Park	Garrison Well	Buffer	CONSTSWGP	2	5	6	3658
158	Morford Short Plat	Seven Oaks Well	Buffer	CONSTSWGP	2	5	6	5025
159	Islamic center of Kent	212th St. Wells	Buffer	CONSTSWGP	2	5	6	5431
160	Kent School District Academy	208th St. Well	Buffer	CONSTSWGP	2	5	6	5598
161	Maple Hills Division 4	Armstrong Springs	Surface Water Area	CONSTSWGP	2	5	6	11318
162	Spartan Self Storage	Kent Springs	Surface Water Area	CONSTSWGP	2	5	6	11502

Rank	Facility Name	WHPA	Time of Travel	Interaction Type	1=known concern 2=potential concern[1]	Decision Level 1 (WHPA)	Decision Level 2 (risk type)	Decision Level 3 (distance)
163	Tamarack	Armstrong Springs	Surface Water Area	CONSTSWGP	2	5	6	13880
164	New Tahoma High School	Armstrong Springs	Surface Water Area	CONSTSWGP	2	5	6	17662
165	Summit Park	Armstrong Springs	Surface Water Area	CONSTSWGP	2	5	6	20381

NOTES

FSID = Facility Site ID
WHPA= Wellhead Protection Area
Decision Level 1 is based on the site's WHPA. 1= 6-month; 2= 1-year; 3= 5-year; 4= 10-year; 5= buffer of surface water area
Decision Level 2 is based on the interaction type at the site and if it is a known of potential contaminant. See Table 1.
Decision Level 3 is based on the straight-line distance of the site to the nearest well of the WHPA
[1] Known and potential interaction types of concern are based of off Table 1
Interaction types with a "x#" next to the name indicate that there were more than one of that interaction type listed for a site (i.e., HWGx2 indicates that there were two HWG interaction types)

FIGURES

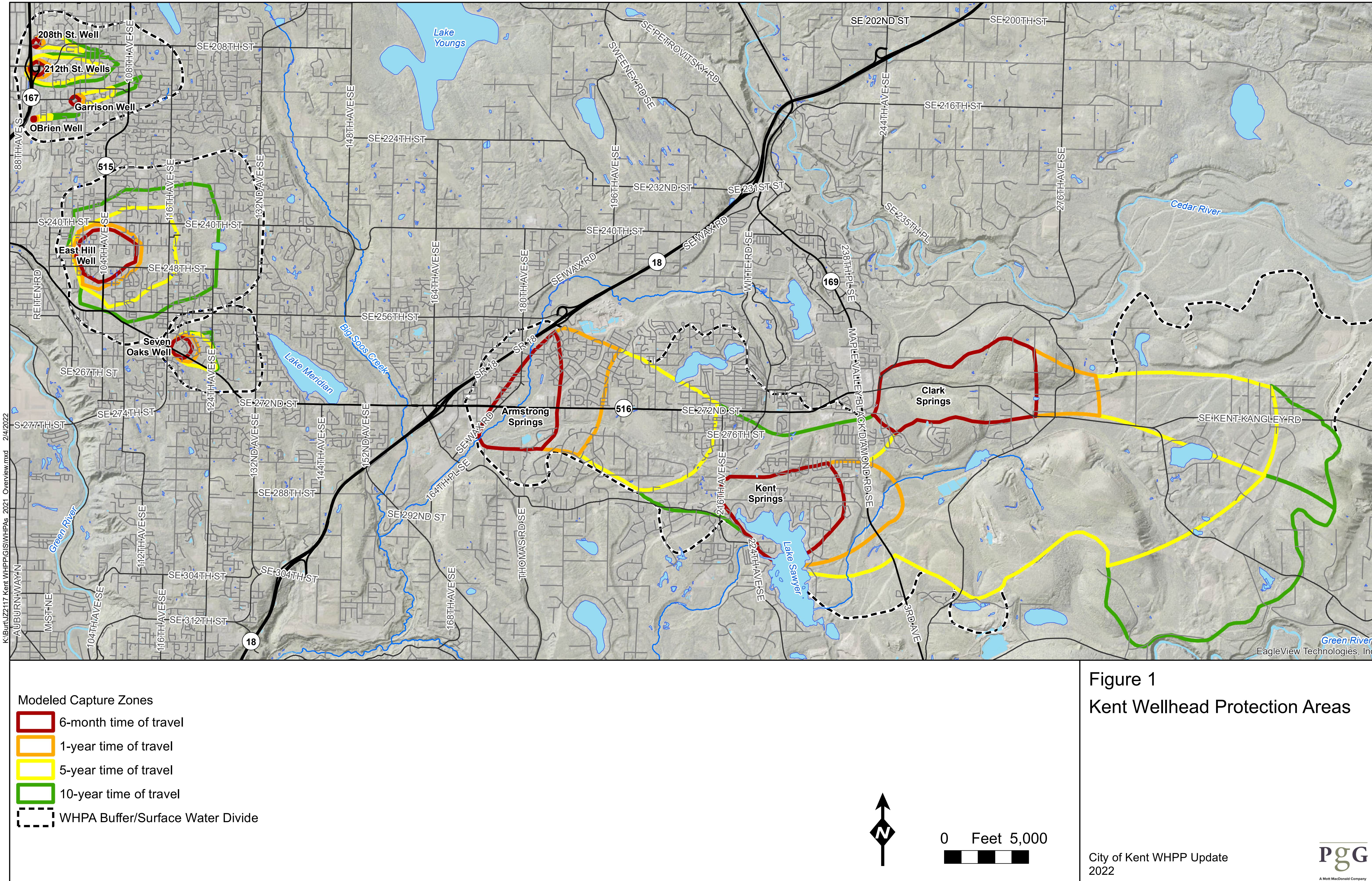
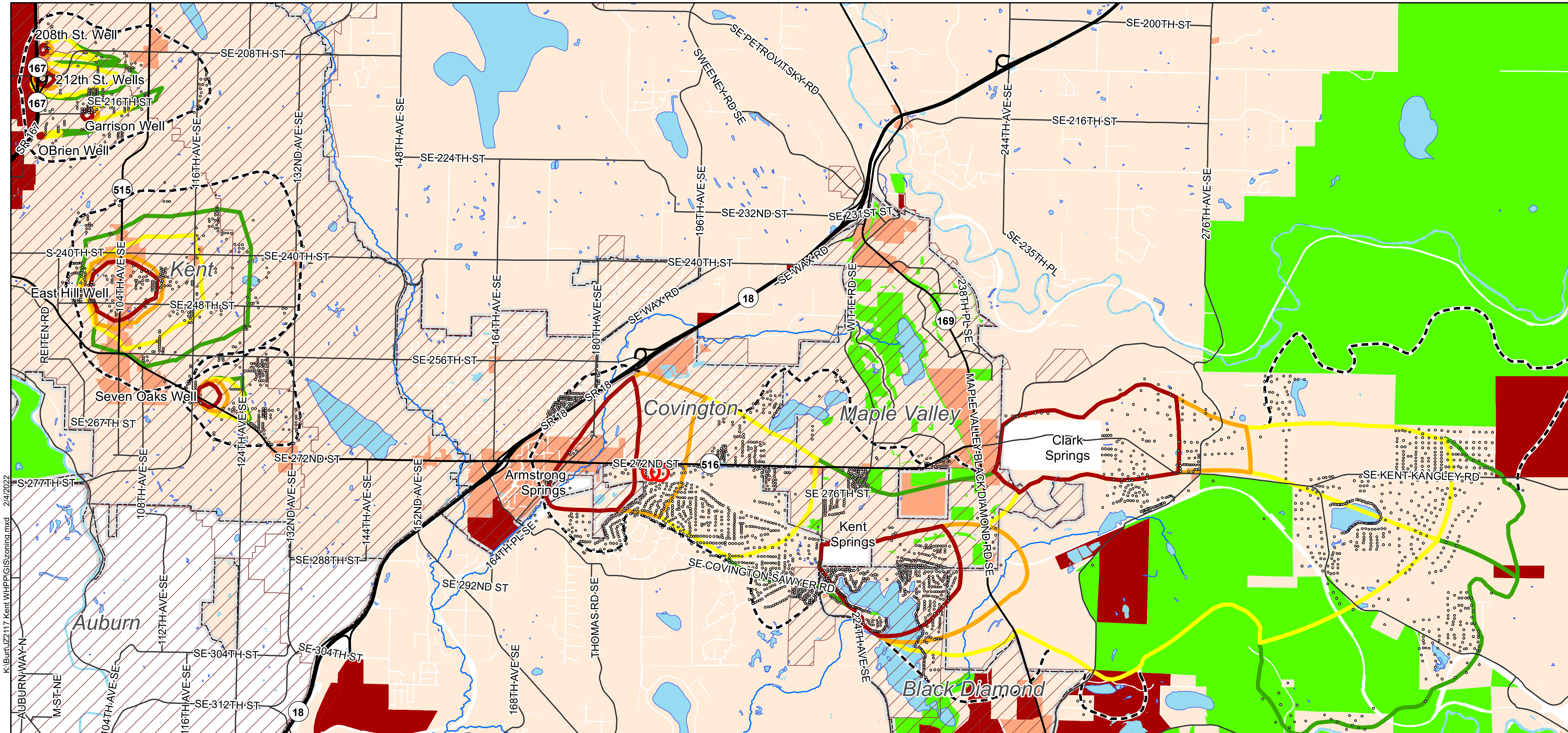


Figure 1

Kent Wellhead Protection Areas

City of Kent WHPP Update
2022

PGG



Modeled Capture Zones

- 6-month time of travel
- 1-year time of travel
- 5-year time of travel
- 10-year time of travel
- WHPA Buffer/Surface Water Divide
- Incorporated Areas

- Sewer System Service Area
- Large On-Site Septic Systems (WDOH 2021)
- Septic Systems (King County Assessor 2021)

Zoning

- Industrial
- Commercial
- Residential
- Public/Agriculture/Open Space

N

0 Feet 5,000

Figure 2

Zoning and Public Sewer System Boundaries Map

City of Kent WHPP Update
2022

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A Mott MacDonald Company

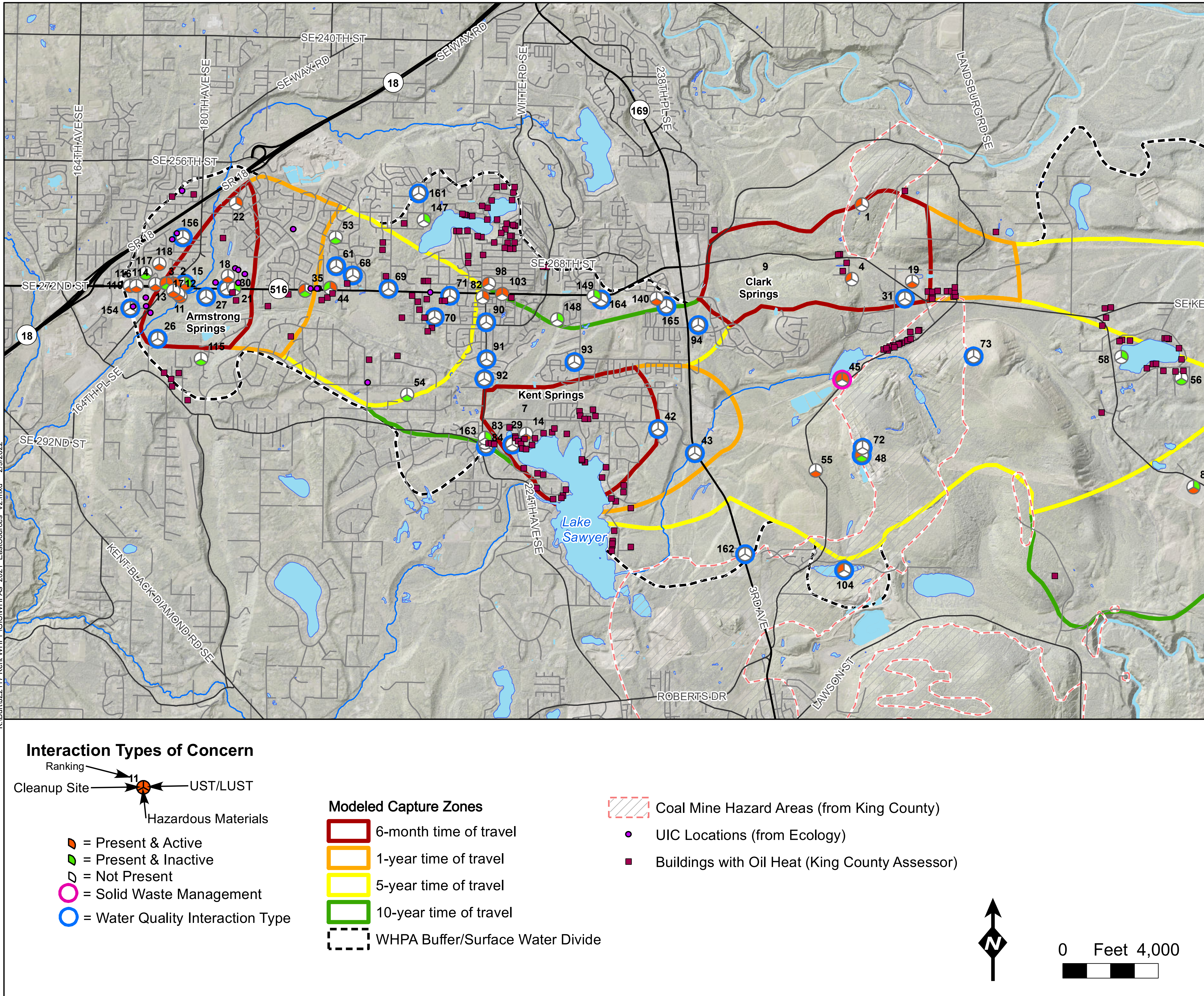

Figure 3
Spring Source (Phase 1)
WHPAs Hazard Ranking

City of Kent WHPP Update
2022

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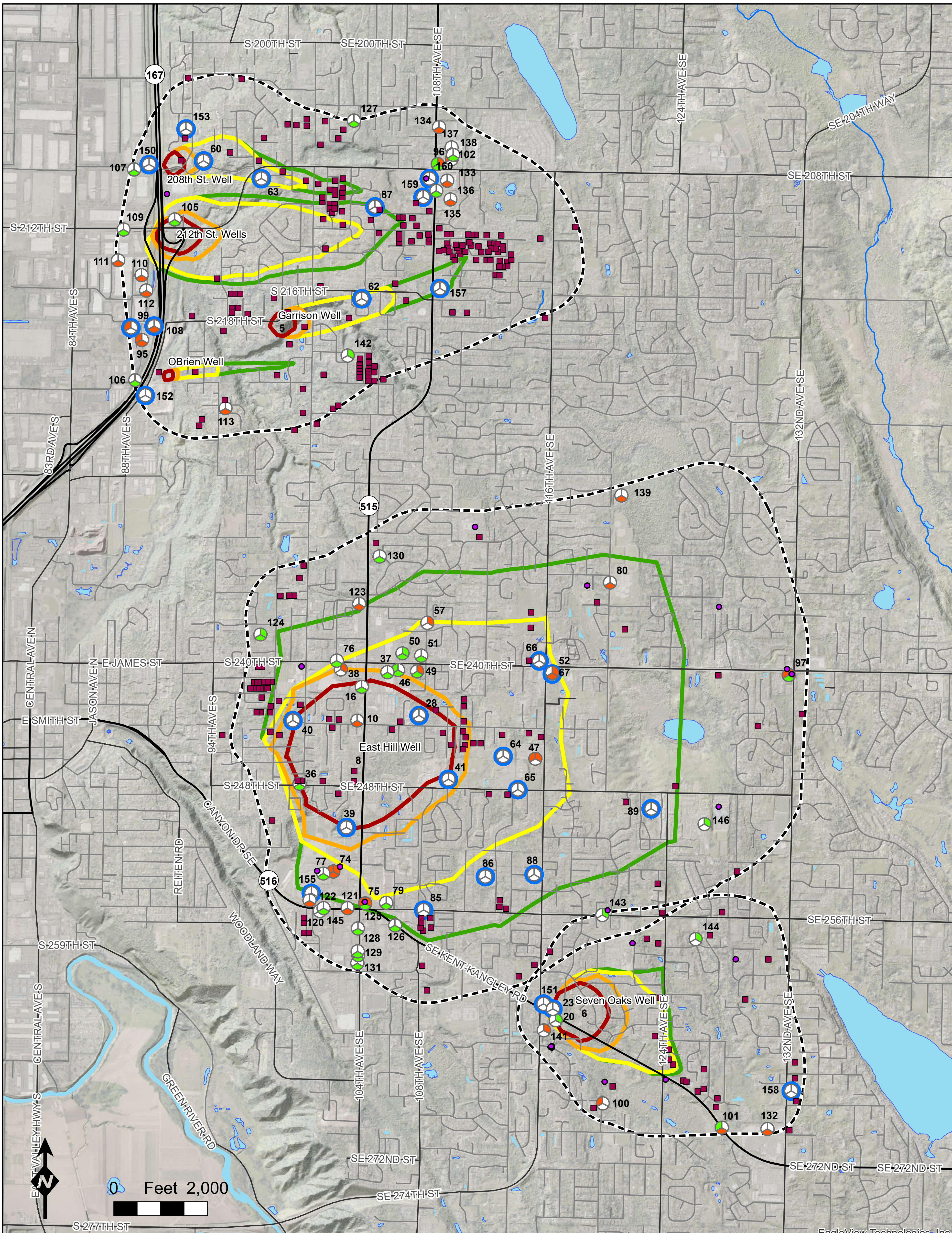

Interaction Types of Concern

Ranking
Cleanup Site
UST/LUST
Hazardous Materials

= Present & Active
= Present & Inactive
= Not Present
= Solid Waste Management
= Water Quality Interaction Type

UIC Locations (from Ecology)
Buildings with Oil Heat (King County Assessor)

Modeled Capture Zones
6-month time of travel
1-year time of travel
5-year time of travel
10-year time of travel
WHPA Buffer/Surface Water Divide

Figure 4
Groundwater Source (Phase 2)
WHPAs Hazard Ranking

City of Kent WHPP Update
2022

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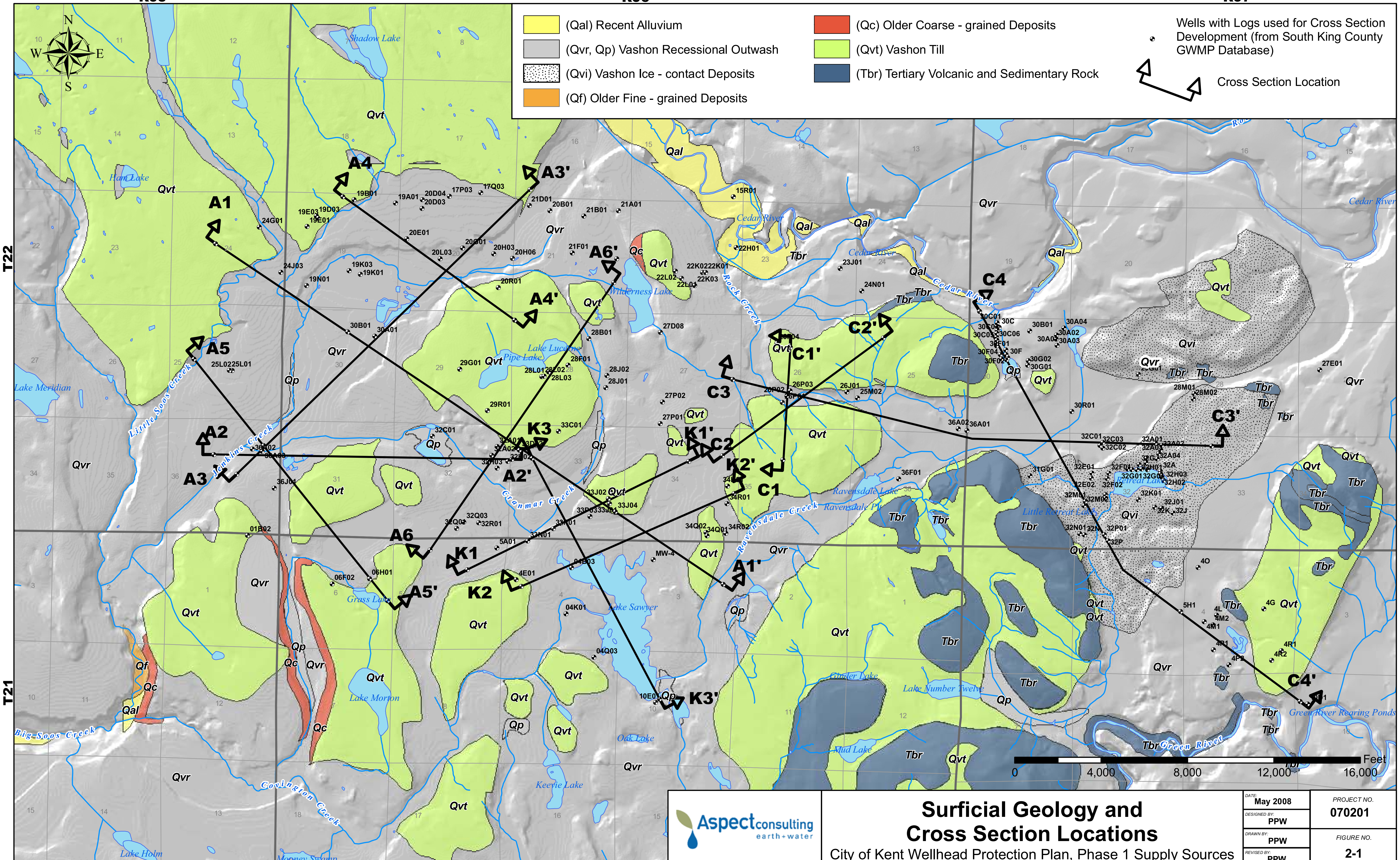
APPENDIX A

Hydrogeology Attachments

Figure 2-1a



Aspect consulting earth+water

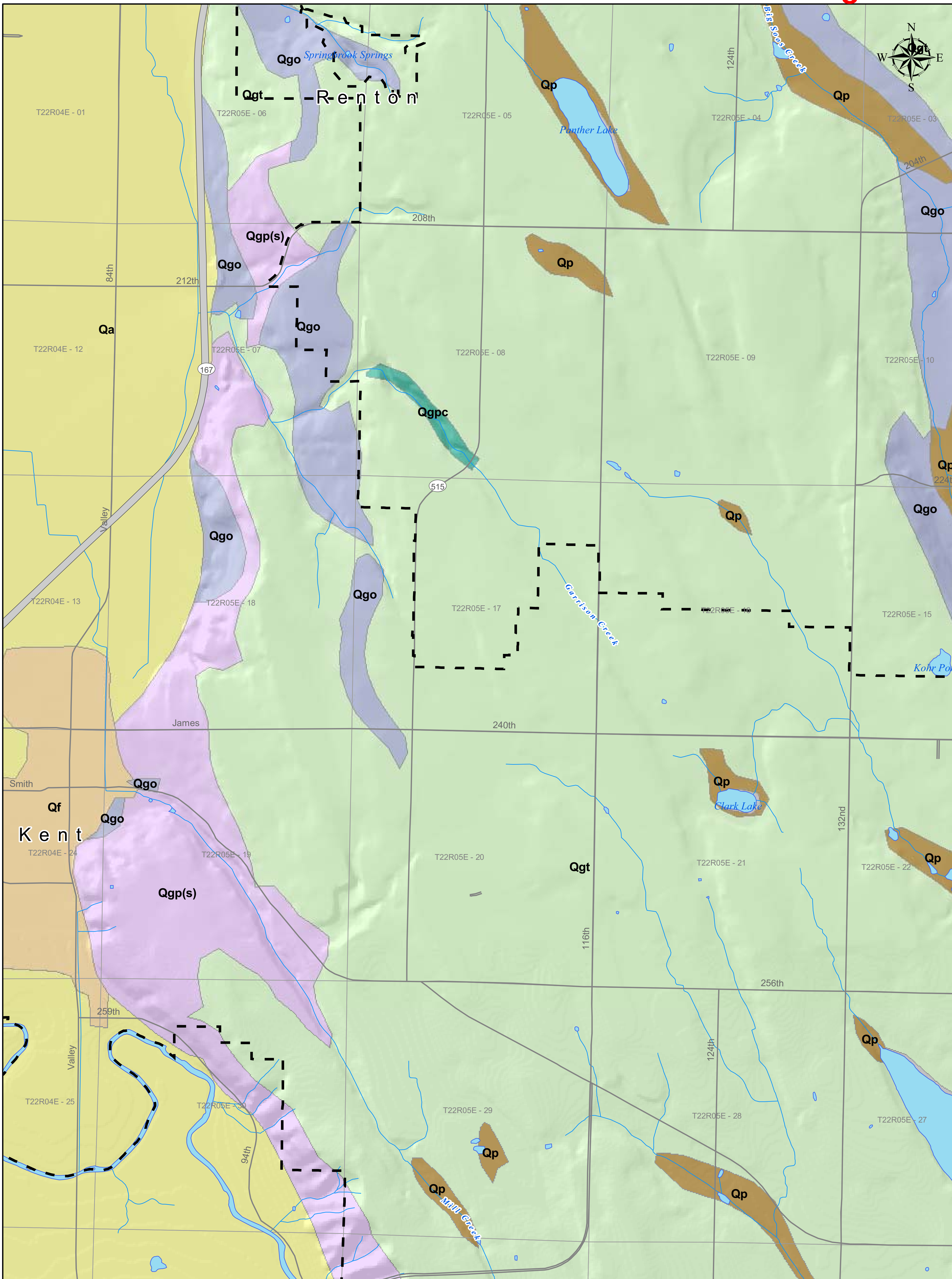
Surficial Geology and Cross Section Locations

City of Kent Wellhead Protection Plan, Phase 1 Supply Sources

DATE: May 2008	PROJECT NO. 070201
DESIGNED BY: PPW	
DRAWN BY: PPW	FIGURE NO. 2-1
REVISED BY: PPW	

Note: Figure adapted from Hart Crowser, 1996

Figure 2-1b



DNR 1:24K Geologic Units

- Qf - artificial fill, including modified land
- Qp - peat deposits
- Qa - alluvium
- Qgt - Fraser-age continental glacial till
- Qgo - Fraser Age continental glacial outwash
- Qgd - Fraser Age continental glacial drift
- Qgp/Qgp(s) - pre-Fraser continental glacial drift
- Qgpc - pre-Fraser continental glacial drift and nonglacial deposits
- City Limits

Aspect consulting earth + water

Surficial Geology

City of Kent Wellhead Protection Plan, Phase 2 Supply Sources

DATE: May 2008	PROJECT NO. 070201
DESIGNED BY: PPW	
DRAWN BY: PPW	FIGURE NO. 2-1
REVISED BY: PPW	

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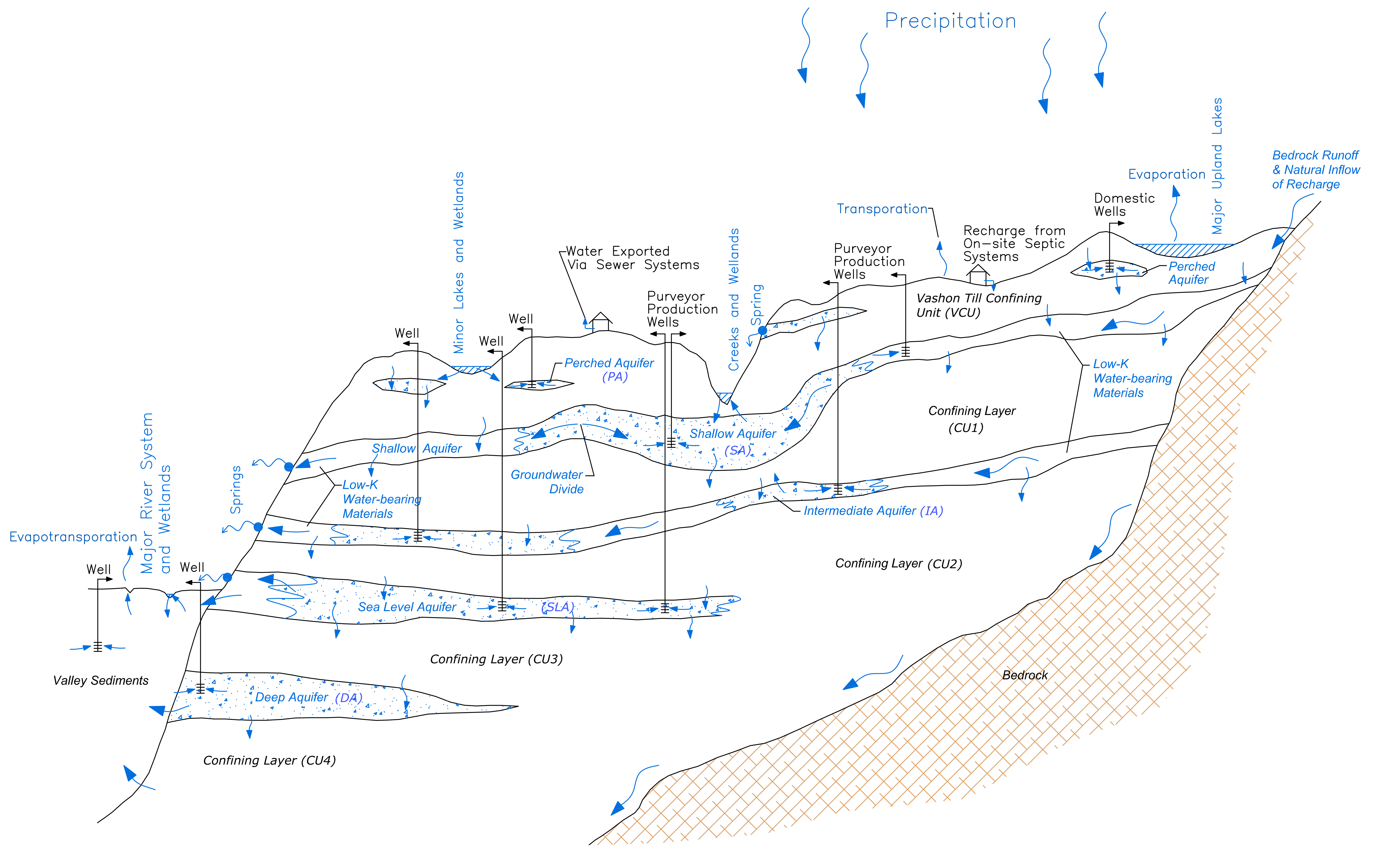
Figure 2-2



Note: Adapted from Robinson and Noble (2007a)

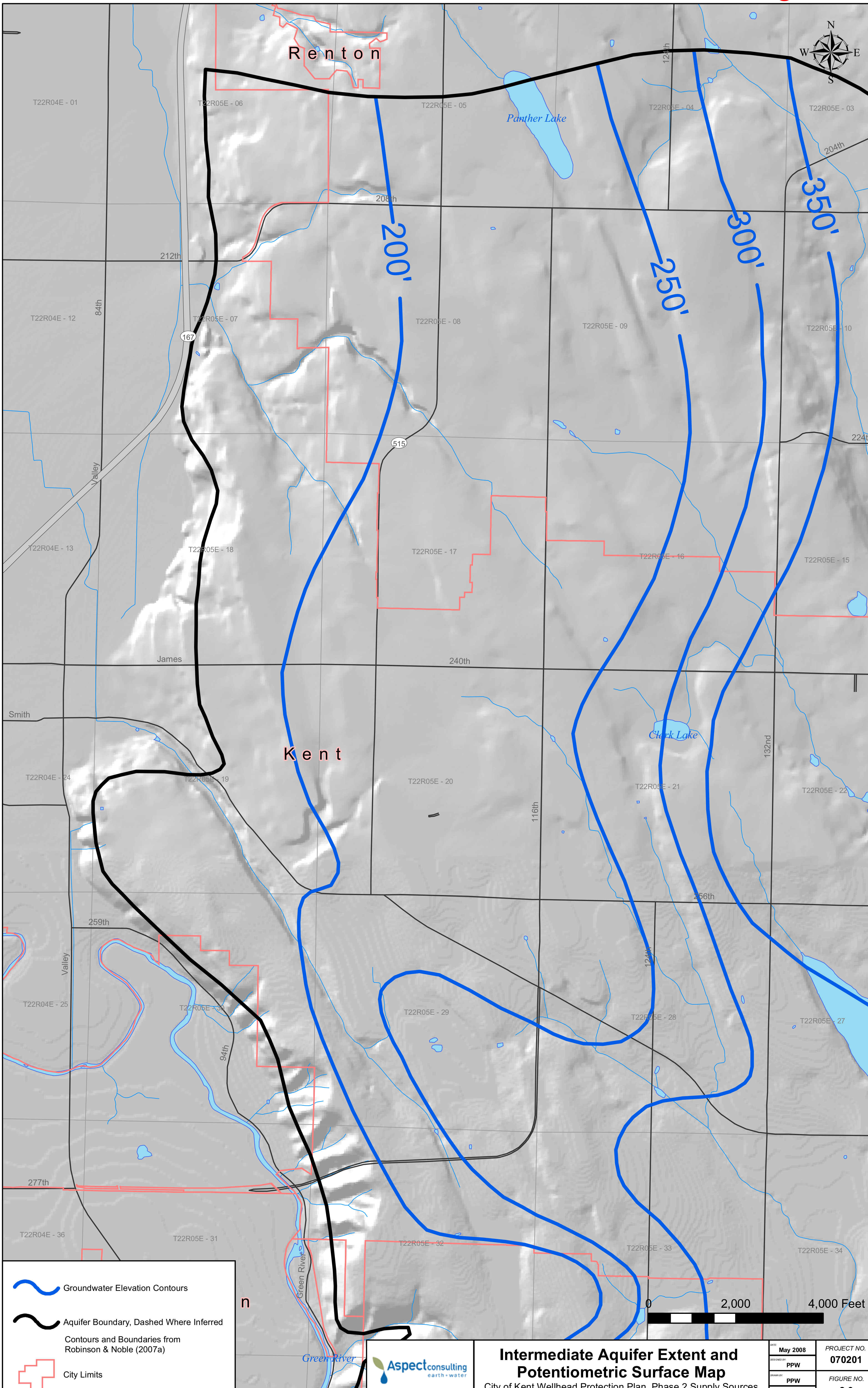
Aspect consulting earth+water

Hydrogeologic Conceptual Model

City of Kent Wellhead Protection Plan, Phase 2 Supply Sources

DATE: April 2008	PROJECT NO. 070201
DESIGNED BY: R&N	
DRAWN BY: R&N	FIGURE NO. 2-2
REVISED BY: PPW	

Figure 2-3



Intermediate Aquifer Extent and Potentiometric Surface Map
City of Kent Wellhead Protection Plan, Phase 2 Supply Sources

Aspect consulting — earth + water

DATE: May 2008	PROJECT NO. 070201
DESIGNED BY: PPW	
DRAWN BY: PPW	FIGURE NO. 2-3
REVISED BY: PPW	

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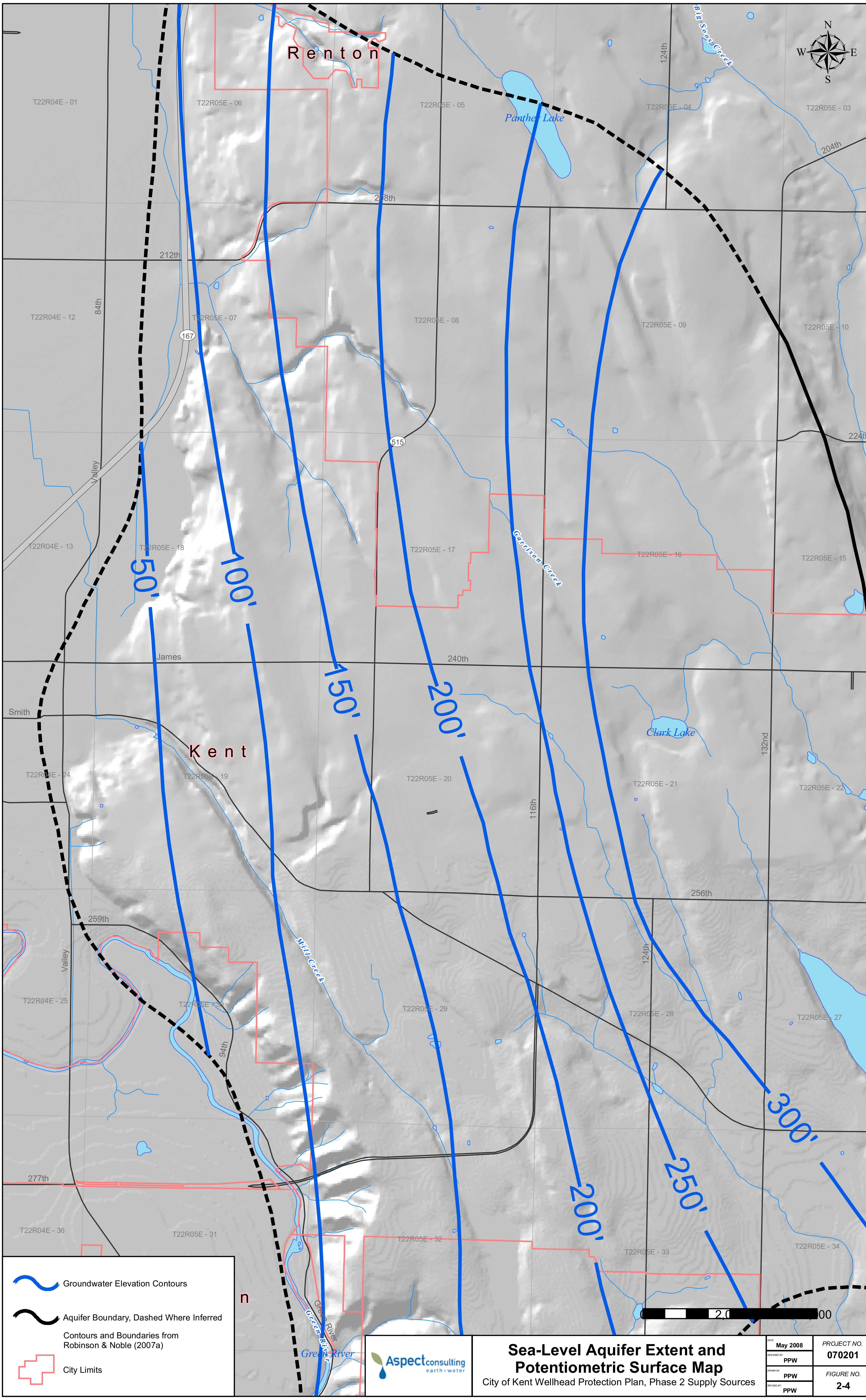
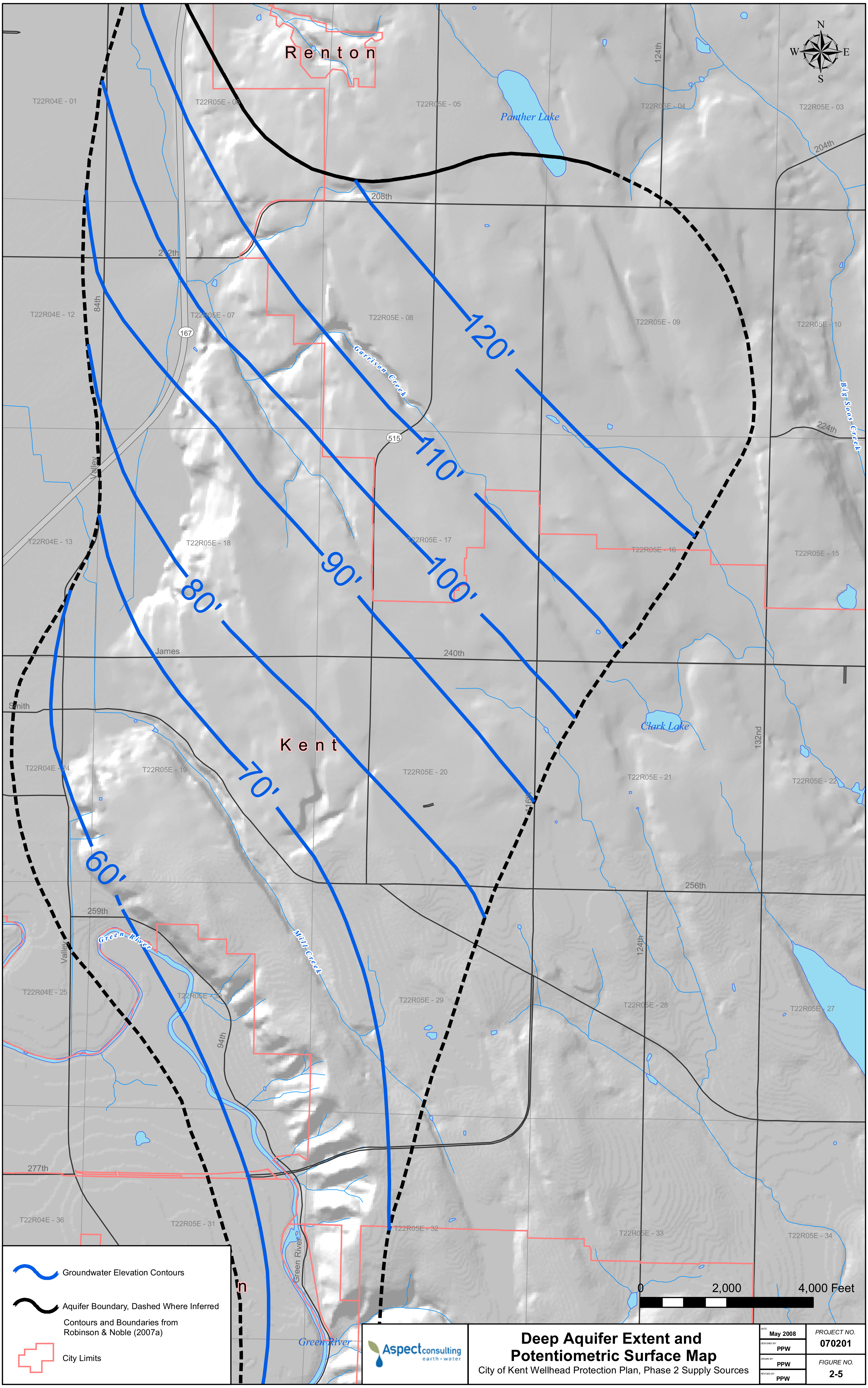
Figure 2-4



Sea-Level Aquifer Extent and Potentiometric Surface Map

City of Kent Wellhead Protection Plan, Phase 2 Supply Sources

Figure 2-5



Aspect consulting earth + water

Deep Aquifer Extent and Potentiometric Surface Map

City of Kent Wellhead Protection Plan, Phase 2 Supply Sources

May 2008 | PPW | PPW | PPW

PROJECT NO. 070201

FIGURE NO. 2-5

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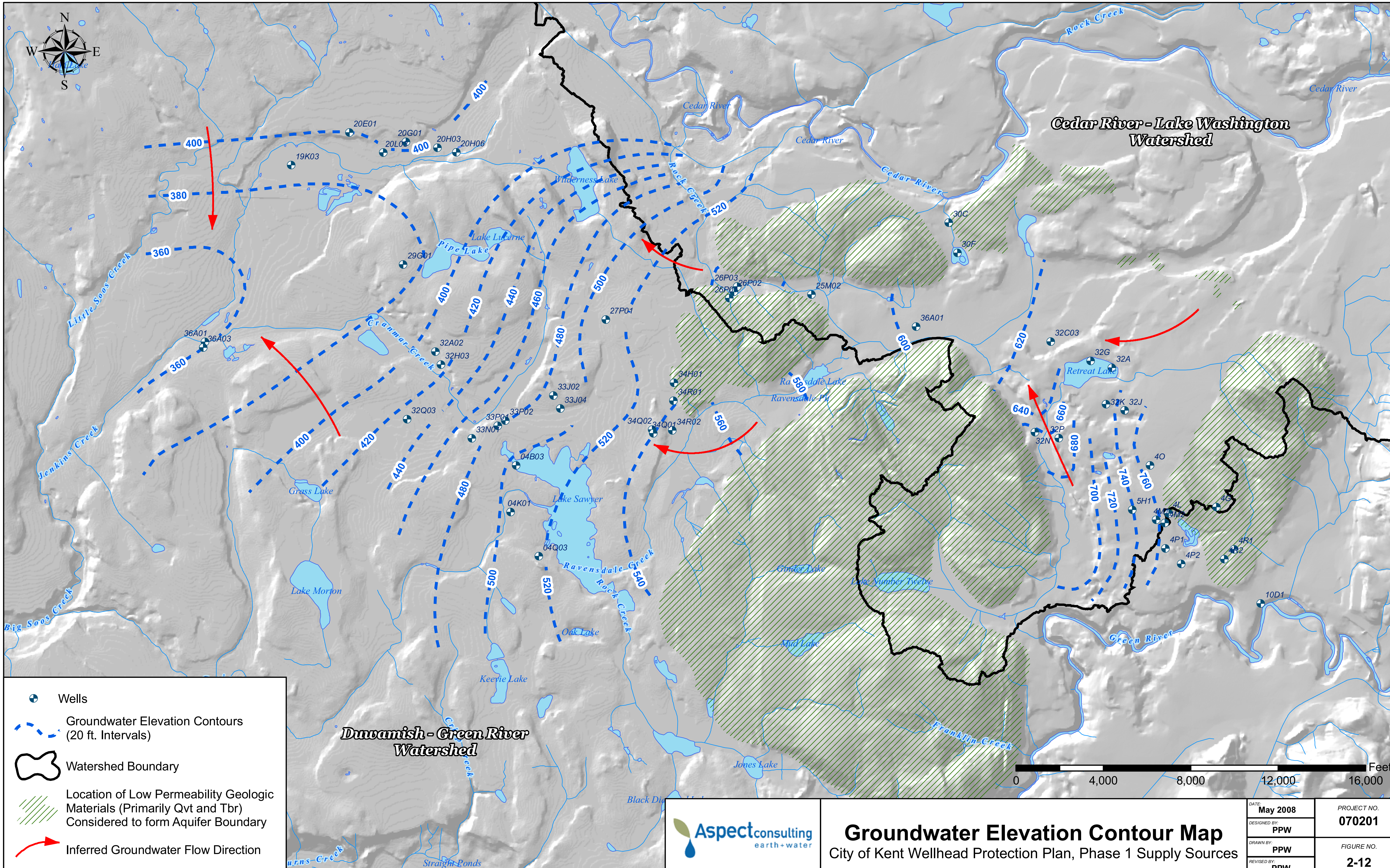
Figure 2-12



Aspect consulting earth + water

Groundwater Elevation Contour Map

City of Kent Wellhead Protection Plan, Phase 1 Supply Sources

DATE: May 2008	PROJECT NO. 070201	
DESIGNED BY: PPW		
DRAWN BY: PPW	FIGURE NO. 2-12	
REVISED BY: PPW		

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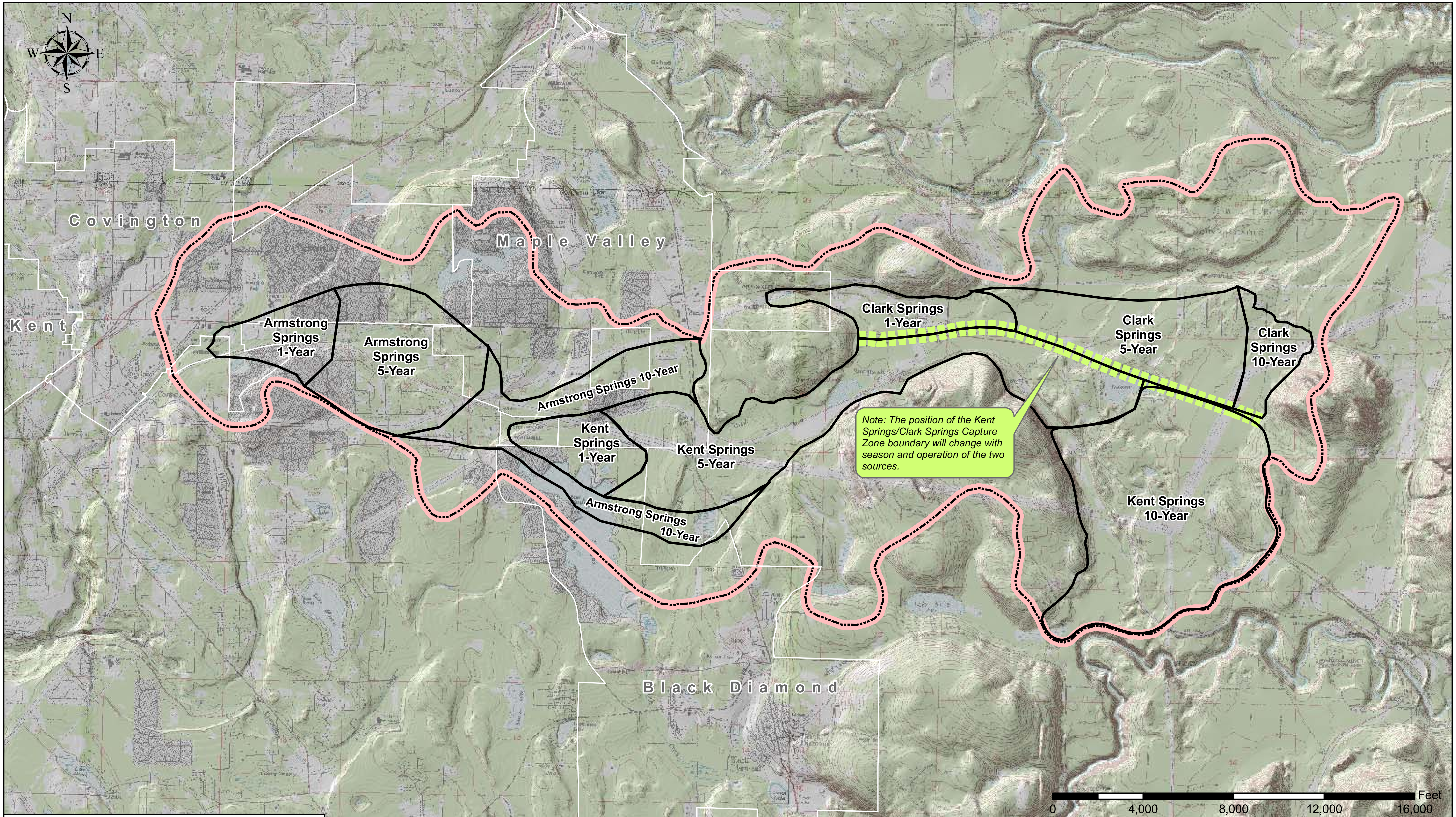
Note: Figure adapted from Hart Crowser, 1996

APPENDIX B
WELLHEAD DELINEATION ATTACHMENTS

Figure 3-1a



Aspect consulting earth+water

Modeled Capture Zones and Surface Water Divide Map

City of Kent Wellhead Protection Plan, Phase 1 Supply Sources

DATE: May 2008	PROJECT NO. 070201
DESIGNED BY: PPW	
DRAWN BY: PPW	FIGURE NO. 3-1
REVISED BY: PPW	

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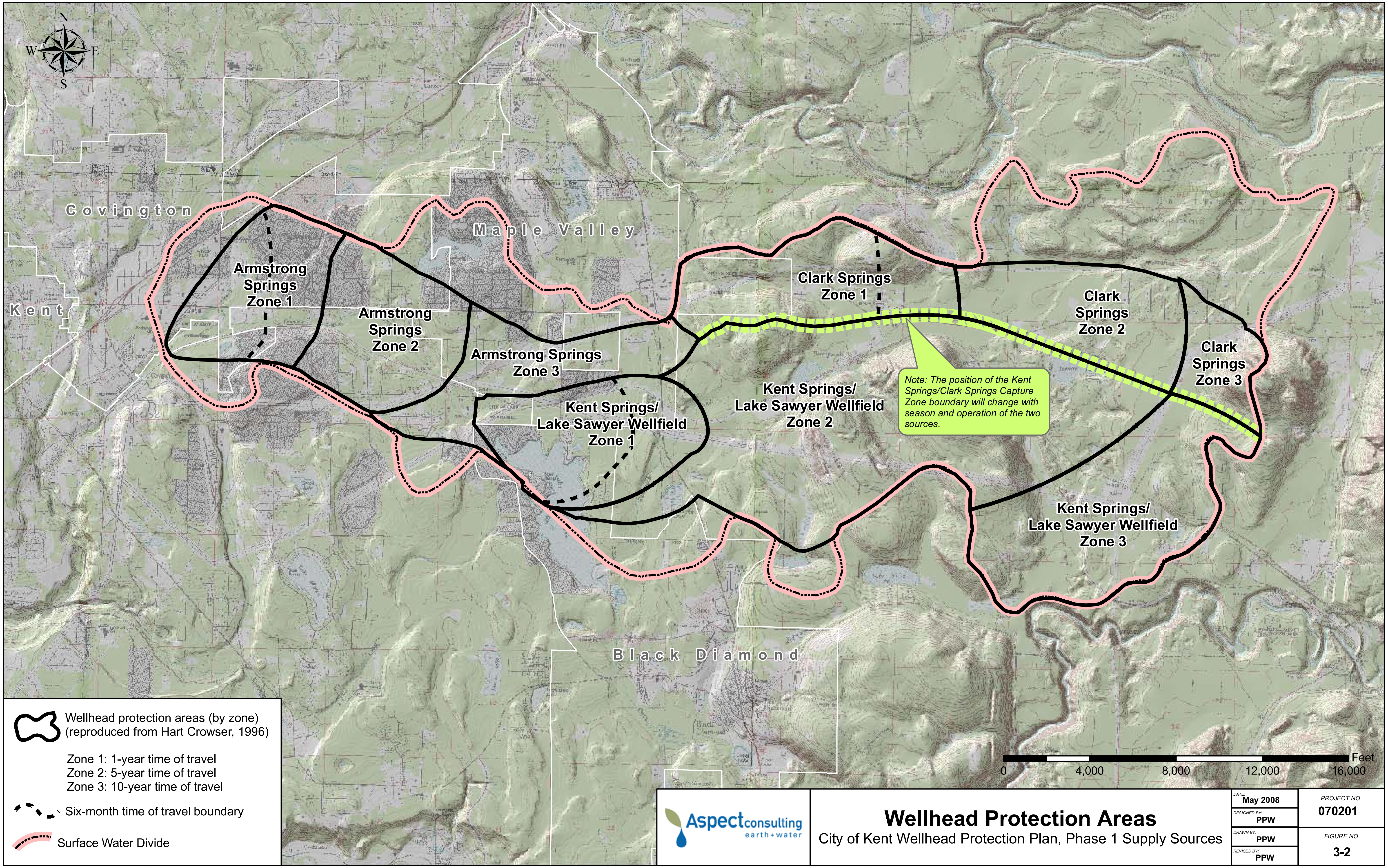
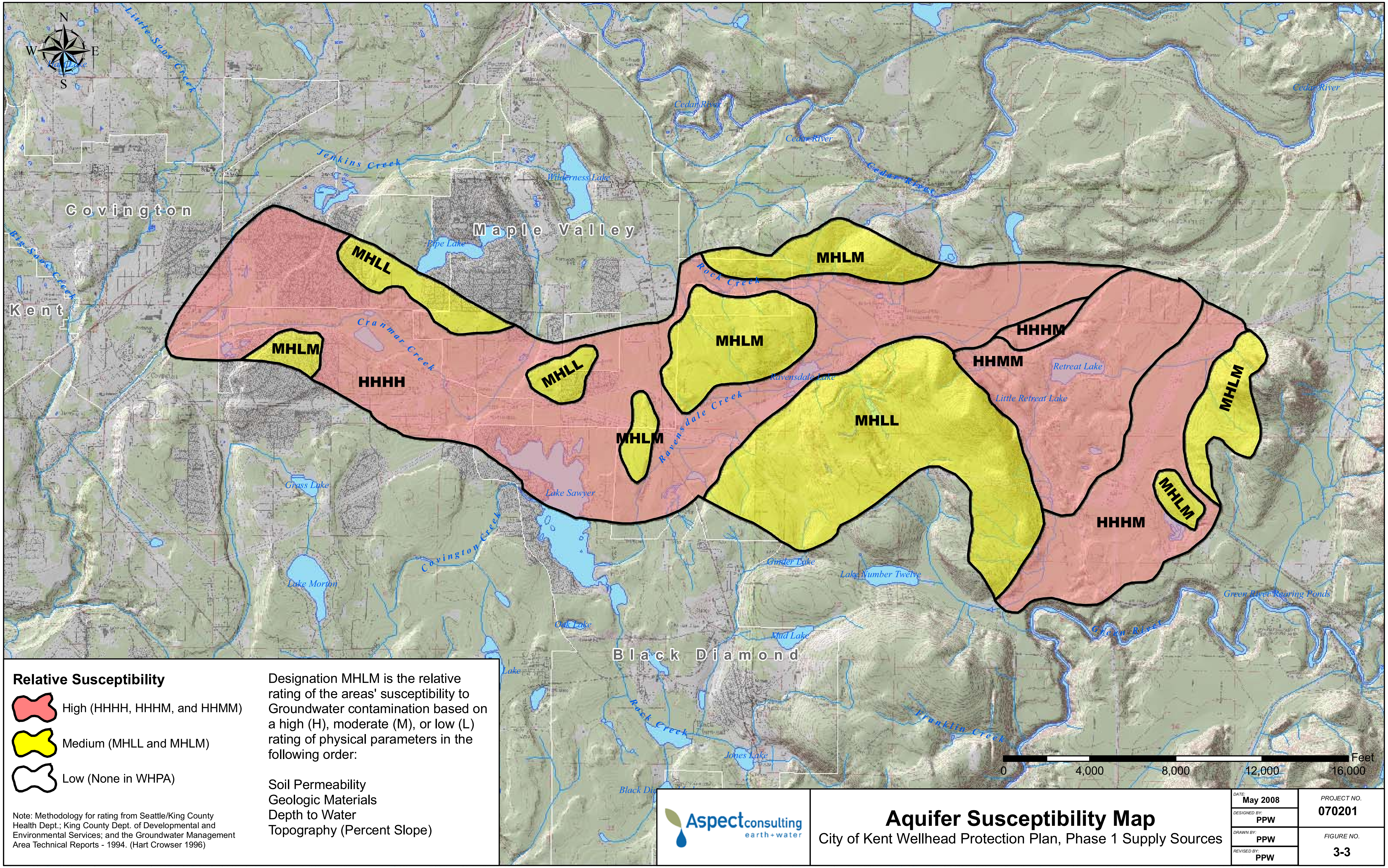
Figure 3-2



T:\projects_8\Kent\WHPP-070201\Delivered\Phase1\pub_rev_draft\WHPAs_overview.mxd

Figure 3-3



Relative Susceptibility

High (HHHH, HHHM, and HHMM)

Medium (MHLL and MHLM)

Low (None in WHPA)

Note: Methodology for rating from Seattle/King County Health Dept.; King County Dept. of Developmental and Environmental Services; and the Groundwater Management Area Technical Reports - 1994. (Hart Crowser 1996)

Designation MHLM is the relative rating of the areas' susceptibility to Groundwater contamination based on a high (H), moderate (M), or low (L) rating of physical parameters in the following order:

Soil Permeability
Geologic Materials
Depth to Water
Topography (Percent Slope)

Aspect consulting earth+water

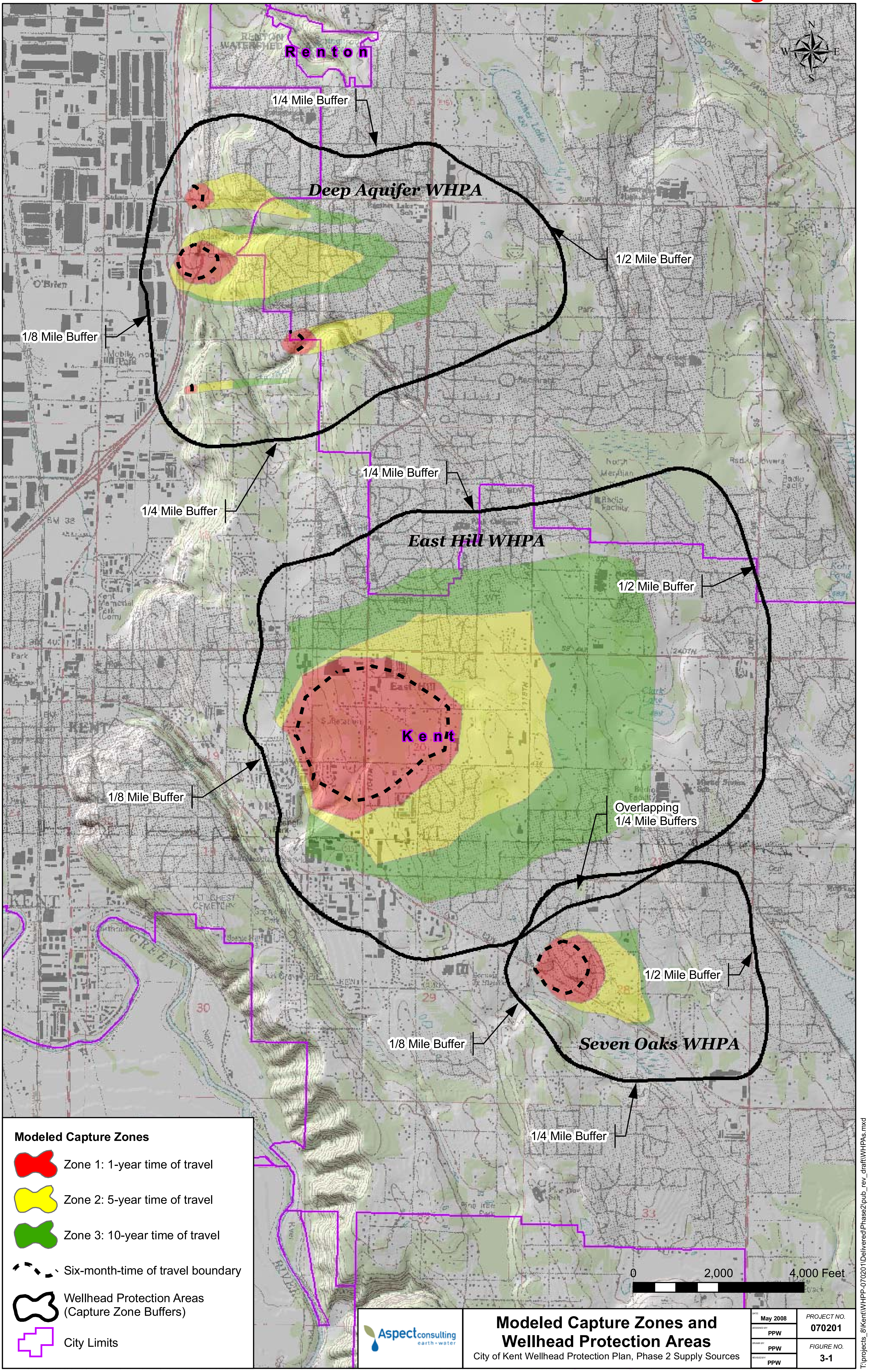
Aquifer Susceptibility Map

City of Kent Wellhead Protection Plan, Phase 1 Supply Sources

DATE: May 2008	PROJECT NO. 070201
DESIGNED BY: PPW	
DRAWN BY: PPW	FIGURE NO. 3-3
REVISED BY: PPW	

T:\projects_8\Kent\WHPP-070201\Delivered\Phase1\pub_rev_draft\aquifer_suscept.mxd

Figure 3-1b


Renton
Deep Aquifer WHPA
East Hill WHPA
Seven Oaks WHPA
Kent
1/4 Mile Buffer
1/2 Mile Buffer
1/8 Mile Buffer
1/4 Mile Buffer
1/4 Mile Buffer
1/2 Mile Buffer
1/8 Mile Buffer
Overlapping
1/4 Mile Buffers
1/2 Mile Buffer
1/8 Mile Buffer
1/4 Mile Buffer
Modeled Capture Zones
Zone 1: 1-year time of travel
Zone 2: 5-year time of travel
Zone 3: 10-year time of travel
Six-month-time of travel boundary
Wellhead Protection Areas
(Capture Zone Buffers)
City Limits
0
2,000
4,000 Feet
Modeled Capture Zones and
Wellhead Protection Areas
City of Kent Wellhead Protection Plan, Phase 2 Supply Sources
May 2008
PPW
PPW
PPW
PROJECT NO.
070201
FIGURE NO.
3-1

APPENDIX C
Facility Site Database Additional Data

Table C1: Facility Site Database Additional Data

The sites below were indentified in the FS database, but were not included in the rankings due to the following reasons:
1) the site had an interaction type(s) that was not a concern for inactive sites; 2) the site had an NFA; 3) the site was not identified during the windshield survey

Rank	FS_ID	Facility Name	WHPA	Time of Travel	Active Site (Y/N)	Interaction Type	1=known concern 2=potential concern	Cleanup Site ID	Straight-Line Distance (ft)	Rank 1	Rank 2	Rank 3	Notes
	2270	SLAG DISPOSAL BECKWITH PROPERTY	OBrien Well	Buffer	N	SCS	1	1875	907	5	1	907	The Site has an NFA.
	2328	SUN CHEMICAL CORPORATION	212th St. Wells	Buffer	Y	HWG (ictive); TIER2 (active); INDPNDNT (inactive)	1	1827	663	5	1	663	The Site has an NFA.
	2546	SOUSHEK PROPERTY	Armstrong Springs	Surface Water Area	N	SCS (inactive); VOLCLNST (inactive)	1	2467	17189	5	1	17189	The Site has an NFA.
	2557	CHEVRON Sta 60093594	East Hill Well	Buffer	Y	TIER2 (inactive); UST (active); HWG (inactive); LUST (inactive); IRAP (inactive)	1	5148	3432	5	1	3432	The Site has an NFA.
	24446	PSE Covington Gate Station	Armstrong Springs	1-Year	N	INDPNDNT	1	12565	5360	2	1	5360	The Site has an NFA.
	99475	McVea Trucking Diesel Spill	Kent Springs	5-Year	Y	INDPNDNT	1	15166	13668	3	1	13668	The Site has an NFA.
	1392870	Meadows at Rock Creek	Armstrong Springs	Surface Water Area	N	VOLCLNST	1	3816	15942	5	1	15942	The Site has an NFA.
	3531259	Plum Creek Land Company	Kent Springs	1-Year	Y	inactive: VOLCLNST; active: HWG	1	243	7321	2	1	7321	The Site has an NFA.
	4696074	WALGREENS KENT WA	Seven Oaks Well	Buffer	N	VOLCLNST	1	4009	2938	5	1	2938	The Site has an NFA.
	12328353	Lakeridge Paving Co LLC	Armstrong Springs	Surface Water Area	Y	inactive: UST; LUST active: HWG	1	7932	4912	5	1	4912	The Site has an NFA.
	18637277	COLUMBIA GREENHOUSE	East Hill Well	Buffer	N	LUST; VOLCLNST; UST	1	5642	7365	5	1	7365	The Site has an NFA.
	27783389	KING CNTY DOT DPW SUMMIT MAINT FACILITY	Armstrong Springs	Surface Water Area	Y	inactive: LUST; VOLCLNST; UST active: TIER2; SANDGP	1	5810	16958	5	1	16958	The Site has an NFA.
	34881715	Circle K Store 1457	East Hill Well	10-Year	N	UST; TIER2; HWG	2	5922	3201	4	2	3201	The Site has an NFA.
	36134827	Texaco Station 632320498	East Hill Well	5-Year	Y	active: UST inactive: TIER2; LUST; HWG;	1	8872	2287	3	1	2287	The Site has an NFA.
	45478124	CIRCLE K NO 1546	East Hill Well	5-Year	Y	active: UST; HWG; VOLCLNST inactive: LUST; HWG; VOLCLNST; HWOTHER	1	6111	1948	3	1	1948	The Site has an NFA.
	47783192	Circle K Store 2701602	212th St. Wells	Buffer	Y	active: UST; HWG inactive: TIER2; LUST; HWG; VOLCLNST; HWOTHER	1	9385	5620	5	1	5620	The Site has an NFA.

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Rank	FS_ID	Facility Name	WHPA	Time of Travel	Active Site (Y/N)	Interaction Type	1=known concern 2=potential concern	Cleanup Site ID	Straight-Line Distance (ft)	Rank 1	Rank 2	Rank 3	Notes
	55253198	KANGLX 76	East Hill Well	Buffer	Y	active: HWG inactive: UST, TIER2, HWG, LUST, HWOTHER, VOLCLNST; ENFORFNLx11	1	7096	3393	5	1	3393	The Site has an NFA.
	55592315	CHAMBERS PROPERTY	Armstrong Springs	Surface Water Area	N	SCS	1	4318	13244	5	1	13244	The Site has an NFA.
	58557527	Shell Station 120459	East Hill Well	5-Year	Y	active: UST inactive: TIER2; LUST; HWGx3; HWOTHERx3 VOLCLNST	1	6344	2147	3	1	2147	The Site has an NFA.
	61356799	Kent School Dist Maint Dept	Seven Oaks Well	Buffer	Y	active: MS4P2WESTGP; HWOTHER inactive: UST, HWOTHER; HWG	2	9878	2179	5	2	2179	The Site has an NFA.
	67877985	SZYMIK RESIDENCE	East Hill Well	5-Year	N	VOLCLNST	1	1008	4063	3	1	4063	The Site has an NFA.
	81135179	ORCHARD PLAZA SHOPPING CTR DRY CLEANERS	212th St. Wells	Buffer	N	VOLCLNST	1	4322	5756	5	1	5756	The Site has an NFA.
	81636212	HARRIS ENTERPRISES 1	Armstrong Springs	Surface Water Area	Y	inactive: LUST active: UST	1	10615	1607	5	1	1607	The Site has an NFA.
	81949545	Firestone Tire Rubber Co Kent	East Hill Well	5-Year	Y	inactive: LUST; HWG active: UST	1	10630	2420	3	1	2420	The Site has an NFA.
	82119966	SOUTHLAND CORP 2323 14468	East Hill Well	10-Year	N	UST; TIER2; LUST	1	10637	2634	4	1	2634	The Site has an NFA.
	83883567	7 ELEVEN STORE 230326722	East Hill Well	5-Year	N	UST; TIER2; LUST; VOLCLNST	1	12054	2537	3	1	2537	The Site has an NFA.
	85831936	Plat of Shady Estates	208th St. Well	Buffer	N	VOLCLNST	1	4325	4498	5	1	4498	The Site has an NFA.
	87214792	Bremmeyer Logging Co	Clark Springs	6-Month	Y	active: UST; TIER2 inactive: HWG; LUST; LSC	1	10885	7270	1	1	7270	The Site has an NFA.
	87845491	Oleary Electric Util Const Inc	208th St. Well	Buffer	N	inactive: HWG; LUST; UST	1	10908	564	5	1	564	The Site has an NFA.
	95742456	Kayo Oil 2705490	East Hill Well	Buffer	Y	active: UST inactive: TIER2, HWG, HWOTHER; INDPNDNT; VOLCLNST; LUST	1	11600	9470	5	1	9470	The Site has an NFA.
	96615498	Unocal SS No 5575	East Hill Well	5-Year	Y	active: UST inactive: TIER2; HWG; VOLCLNST; LUST	1	6947	1940	3	1	1940	The Site has an NFA.
	9694	FOREST HILLS NORRIS HOMES	OBrien Well	Buffer	N	CONSTSWGP			348	5		348	not an interaction type of concern for inactive sites.
	4403	Hollinger Property	OBrien Well	Buffer	N	CONSTSWGP			484	5		484	not an interaction type of concern for inactive sites.

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Rank	FS_ID	Facility Name	WHPA	Time of Travel	Active Site (Y/N)	Interaction Type	1=known concern 2=potential concern	Cleanup Site ID	Straight-Line Distance (ft)	Rank 1	Rank 2	Rank 3	Notes
	22212	VALLEY VIEW PLAT KENT	208th St. Well	Buffer	N	CONSTSWGP			898	5		898	not an interaction type of concern for inactive sites.
	15536	Apex Center	Armstrong Springs	6-Month	N	CONSTSWGP			1069	1		1069	not an interaction type of concern for inactive sites.
	7686	Covinhgton WA Firestone	Armstrong Springs	6-Month	N	CONSTSWGP			1293	1		1293	not an interaction type of concern for inactive sites.
	40497	Oakhaven	East Hill Well	6-Month	N	CONSTSWGP			1296	1		1296	not an interaction type of concern for inactive sites.
	9452	ESTES PLAT & GARRISON REACH PLAT	OBrien Well	Buffer	N	CONSTSWGP			1310	5		1310	not an interaction type of concern for inactive sites.
	22115	Kent Slag Pile	OBrien Well	Buffer	N	CONSTSWGP			1323	5		1323	not an interaction type of concern for inactive sites.
	20608	SR516 WAX RD IMPROVEMENTS	Armstrong Springs	6-Month	N	CONSTSWGP			1403	1		1403	not an interaction type of concern for inactive sites.
	11850	PANTHER LAKE ELEMENTARY SCHOOL	Garrison Well	Buffer	N	CONSTSWGP			1408	5		1408	not an interaction type of concern for inactive sites.
	5269	Multicare Covington Medical Center	Armstrong Springs	6-Month	N	CONSTSWGP			1614	1		1614	not an interaction type of concern for inactive sites.
	12332	SE WAX RD 180TH AVE	Armstrong Springs	6-Month	Y	CONSTSWGP(inactive); NONENFNL(active);SEAPROJ(active)			1619	1		1619	Note that NONENFNL is not an interaction type of concern for active or inactive sites. CONSTSWGP and SEAPROJ are not interaction types of concern for inactive sites.
	8355	BJORGO SHORT PLAT	OBrien Well	Buffer	N	CONSTSWGP			1720	5		1720	not an interaction type of concern for inactive sites.
	4482	Bandon East	East Hill Well	5-Year	N	CONSTSWGP			1828	3		1828	not an interaction type of concern for inactive sites.
	20154	SINGH ONE A 27	East Hill Well	6-Month	N	CONSTSWGP			1876	1		1876	not an interaction type of concern for inactive sites.
	7015	Westview-Malik Subdivision	East Hill Well	10-Year	N	CONSTSWGP			1929	4		1929	not an interaction type of concern for inactive sites.
	68139	Kent Meridian Transportation Center	East Hill Well	10-Year	N	CONSTSWGP			2283	4		2283	not an interaction type of concern for inactive sites.
	977	RIVER OF LIFE CHURCH EXPANSION	Garrison Well	5-year	N	CONSTSWGP			2458	3		2458	not an interaction type of concern for inactive sites.

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Rank	FS_ID	Facility Name	WHPA	Time of Travel	Active Site (Y/N)	Interaction Type	1=known concern 2=potential concern	Cleanup Site ID	Straight-Line Distance (ft)	Rank 1	Rank 2	Rank 3	Notes
	10284	COCHRAN SUBDIVISION	Seven Oaks Well	Buffer	N	CONSTSWGP			2469	5		2469	not an interaction type of concern for inactive sites.
	1887	Cheema Short Plat	East Hill Well	5-Year	N	CONSTSWGP			2550	3		2550	not an interaction type of concern for inactive sites.
	5553	S 203RD ST SHORT PLAT	208th St. Well	Buffer	N	CONSTSWGP			2793	5		2793	not an interaction type of concern for inactive sites.
	1564	Stack Storage	Armstrong Springs	6-Month	N	CONSTSWGP			3353	1		3353	not an interaction type of concern for inactive sites.
	10534	SFS Plat	East Hill Well	10-Year	N	CONSTSWGP			3478	4		3478	not an interaction type of concern for inactive sites.
	9100	Braun Plat	East Hill Well	5-Year	N	CONSTSWGP			3573	3		3573	not an interaction type of concern for inactive sites.
	7131	SE 256th Street Improvements	East Hill Well	10-Year	N	CONSTSWGP			3684	4		3684	not an interaction type of concern for inactive sites.
	18085	ELLIS	Seven Oaks Well	Buffer	N	CONSTSWGP			4062	5		4062	not an interaction type of concern for inactive sites.
	16396	TURNKEY PARK EXPANSION	East Hill Well	Buffer	N	CONSTSWGP			4291	5		4291	not an interaction type of concern for inactive sites.
	11056	PETER SHORT PLAT	East Hill Well	5-Year	N	CONSTSWGP			4446	3		4446	not an interaction type of concern for inactive sites.
	10824	SUNNFJORD CSWGP	East Hill Well	5-Year	N	CONSTSWGP			4540	3		4540	not an interaction type of concern for inactive sites.
	5331	Sunrise Meadows Kent	East Hill Well	10-Year	N	CONSTSWGP			5269	4		5269	not an interaction type of concern for inactive sites.
	18949	Cornerstone Plat	Armstrong Springs	1-Year	N	CONSTSWGP			5382	2		5382	not an interaction type of concern for inactive sites.
	22591	Schuver Estates	East Hill Well	10-Year	N	CONSTSWGP			5494	4		5494	not an interaction type of concern for inactive sites.
	1503	SUNRISE MEADOWS PUD KENT	East Hill Well	10-Year	N	CONSTSWGP			5523	4		5523	not an interaction type of concern for inactive sites.
	7269	NICK ADDITION	East Hill Well	10-Year	N	CONSTSWGP			6048	4		6048	not an interaction type of concern for inactive sites.
	4263	PUGET SOUND PERSONAL WAREHOUSE	208th St. Well	Buffer	N	CONSTSWGP			6473.013	5		6473	not an interaction type of concern for inactive sites.

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Rank	FS_ID	Facility Name	WHPA	Time of Travel	Active Site (Y/N)	Interaction Type	1=known concern 2=potential concern	Cleanup Site ID	Straight-Line Distance (ft)	Rank 1	Rank 2	Rank 3	Notes
	23584	Meadow Park View	East Hill Well	Buffer	N	CONSTSWGP			7095	5		7095	not an interaction type of concern for inactive sites.
	10969	EAST HILL OPERATIONS CENTER	East Hill Well	Buffer	N	CONSTSWGP			7743	5		7743	not an interaction type of concern for inactive sites.
	23315	MAPLE HILLS 204TH AVE SE IMPROVEMEN	Armstrong Springs	5-Year	N	CONSTSWGP			8849	3		8849	not an interaction type of concern for inactive sites.
	19296	KENTLAKE HIGHLANDS DIV 1A 1B 2	Armstrong Springs	10-Year	N	CONSTSWGP			12558	4		12558	not an interaction type of concern for inactive sites.
	21202	216th Avenue SE SE 272nd to SE 283rd St	Armstrong Springs	10-Year	N	CONSTSWGP			12923	4		12923	not an interaction type of concern for inactive sites.
	5205	ELK RUN REGIONAL STORMWATER FAC	Armstrong Springs	10-Year	N	CONSTSWGP			14895	4		14895	not an interaction type of concern for inactive sites.
	11661	ROGNEBY SUBDIVISION	Armstrong Springs	Surface Water Area	N	CONSTSWGP			15538	5		15538	not an interaction type of concern for inactive sites.
	15994	Elk Run 4 Div 1	Armstrong Springs	10-Year	N	CONSTSWGP			15852	4		15852	not an interaction type of concern for inactive sites.
	3234	MEADOWS AT ROCK CREEK DIV III	Armstrong Springs	Surface Water Area	N	CONSTSWGP			17252	5		17252	not an interaction type of concern for inactive sites.
	20937	JORDANS CROSSING	Armstrong Springs	10-Year	N	CONSTSWGP			20306	4		20306	not an interaction type of concern for inactive sites.
	57952343	On Site Lube Inc	Kent Springs	6-Month	N	HWG	2		3344	1	2	3344	Could not find during windshield survey. Lat/long in powerline right-of-way.
	4418632	Lifetime Muffler Renton Easthill Radiato	Seven Oaks Well	1-Year	N	HWG	2		785	2	2	785	Lat/long was a residential house. Could not find during windshield survey.
	5767537	American Power Systems	East Hill Well	1-Year	N	HWG	2		1657	2	2	1657	Unmarked shed next to apartment buildings and condos. May house hazardous waste, but could not be determined. Could not find during windshield survey.

NOTES
FSID = Facility Site ID
WHPA= Wellhead Protection Area
Decision Level 1 is based on the site's WHPA. 1= 6-month; 2= 1-year; 3= 5-year; 4= 10-year; 5= buffer of surface water area
Decision Level 2 is based on the interaction type at the site and if it is a known of potential contaminant. See Table 1.
Decision Level 3 is based on the straight-line distance of the site to the nearest well of the WHPA
[1] Known and potential interaction types of concern are based of off Table 1
Interaction types with a "x#" next to the name indicate that there were more than one of that interaction type listed for a site (i.e., HWGx2 indicates that there were two HWG interaction types)

APPENDIX D
MONITORING PROGRAM ATTACHMENTS

Figure 1, Figure 2, & Figure 3 - WHPA Monitoring Locations

Due to sensitive information regarding the City's water supply and facilities contained within Figure 1, Figure 2, and Figure 3 of Appendix D, these figures are restricted to staff use only. Restricted use is necessary to protect public safety and not increase the vulnerability of the City's water system.

Coarse-Grained Soils - More than 50% [1] Retained on No. 200 Sieve	Gravels - More than 50% [1] of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines [5]	GW	Well-graded gravel and gravel with sand, little to no fines
			GP	Poorly-graded gravel and gravel with sand, little to no fines
		≥15% Fines [5]	GM	Silty gravel and silty gravel with sand
			GC	Clayey gravel and clayey gravel with sand
	Sands - 50% [1] or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines [5]	SW	Well-graded sand and sand with gravel, little to no fines
			SP	Poorly-graded sand and sand with gravel, little to no fines
		≥15% Fines [5]	SM	Silty sand and silty sand with gravel
			SC	Clayey sand and clayey sand with gravel
Fine-Grained Soils - 50% [1] or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50		ML	Silt, sandy silt, gravelly silt, silt with sand or gravel
			CL	Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		MH	Elastic silt, clayey silt, silt with micaceous or diatomaceous fine sand or silt
			CH	Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			PT	Peat, muck and other highly organic soils

Terms Describing Relative Density and Consistency

	Density	SPT [2] blows/foot
Coarse-Grained Soils	Very Loose	0 to 4
	Loose	4 to 10
	Medium Dense	10 to 30
	Dense	30 to 50
	Very Dense	>50

	Consistency	SPT [2] blows/foot
Fine-Grained Soils	Very Soft	0 to 2
	Soft	2 to 4
	Medium Stiff	4 to 8
	Stiff	8 to 15
	Very Stiff	15 to 30
	Hard	>30

Test Symbols

FC = Fines Content
G = Grain Size
M = Moisture Content
A = Atterberg Limits
C = Consolidation
DD = Dry Density
K = Permeability
Str = Shear Strength
Env = Environmental
PiD = Photoionization Detector

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

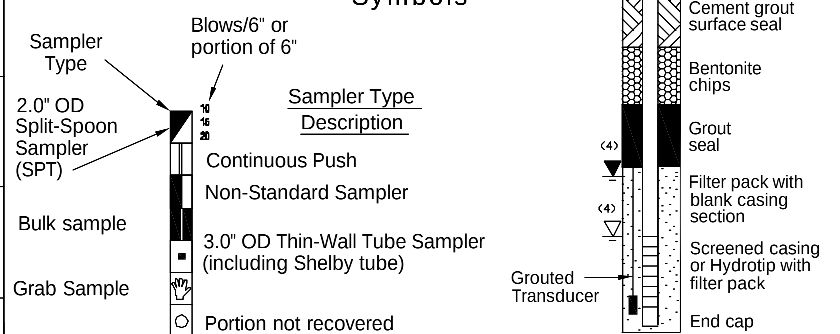
[3] Estimated Percentage

Percentage by Weight	Modifier
<5	Trace
5 to 15	Slightly (sandy, silty, clayey, gravelly)
15 to 30	Sandy, silty, clayey, gravelly)
30 to 49	Very (sandy, silty, clayey, gravelly)

Moisture Content

Dry - Absence of moisture, dusty, dry to the touch
Slightly Moist - Perceptible moisture
Moist - Damp but no visible water
Very Moist - Water visible but not free draining
Wet - Visible free water, usually from below water table

Symbols



(1) Percentage by dry weight
(2) (SPT) Standard Penetration Test (ASTM D-1586)
(3) In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)
(4) Depth of groundwater
▽ ATD = At time of drilling
▼ Static water level (date)

(5) Combined USCS symbols used for fines between 5% and 15% as estimated in General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)

BGS = below ground surface

Classifications of soils in this report are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System.

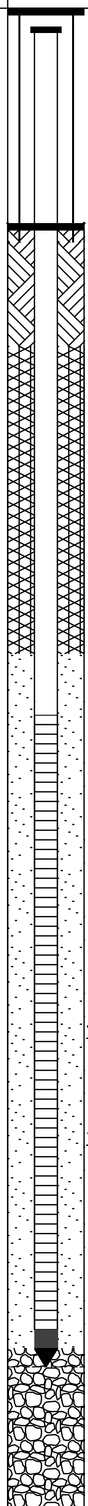
Aspect CONSULTING

Exploration Log Key

DATE:	PROJECT NO.
DESIGNED BY:	
DRAWN BY:	FIGURE NO.
REVISED BY:	A-1

Q:_ACAD Standards\Standard Details\Exploration Log Key A1.dwg

Aspect CONSULTING	City of Kent - Clark Springs - 090015			Monitoring Well Log	
	Project Address & Site Specific Location			*Coordinates (Lat,Lon WGS84)*	*Exploration Number*
	26204 SE Kent Kangley Rd, Ravensdale, WA, near pond			47.36417, -121.99262 (est)	**MW-101**
Contractor	*Equipment*	*Sampling Method*		*Ground Surface (GS) Elev.*	Ecology Well Tag No. BKL384
Holt Services, Inc.	Truck-mounted Geoprobe	Percussion Hammer		Not Available	
Operator	*Exploration Method(s)*	*Work Start/Completion Dates*		*Top of Casing Elev.*	*Depth to Water (Below GS)*
Louie	Direct Push	6/14/2018		Not Available	15' (ATD)



Depth (feet)	Elev. (feet)	Exploration Completion and Notes	Sample Type/ID	Analytical Sample Number & Lab Test(s)	Field Tests	Material Type	Description	Depth (ft)
-3		3.5-ft-tall stickup monument						-3
-2		2-in Sch 40 PVC casing with Thermos cap						-2
-1								-1
0							**FILL** SILTY SAND WITH GRAVEL (SM); moist to very moist, brown; fine to coarse sand; fine to coarse gravel; trace rootlets and pieces of wood.	0
1		Casing in concrete						1
2		Casing in bentonite chips						2
3								3
4							Becomes moist and dark brown with numerous rootlets and a 2-inch-wide piece of coal.	4
5								5
6							**WEATHERED VASHON TILL** SILTY SAND WITH GRAVEL (SM); moist, brown; fine to coarse sand; fine to coarse gravel; trace rootlets.	6
7								7
8		10-slot PVC screen in 10/20 sand filter pack					Becomes very moist and orange brown.	8
9							**VASHON TILL** SILTY SAND WITH GRAVEL (SM); moist, brown; fine to coarse sand; fine to coarse, subrounded to subangular gravel.	9
10								10
11								11
12							SILTY GRAVEL WITH SAND (GM); moist, brown; fine to coarse sand; fine to coarse, subrounded gravel.	12
13		▼ 6/14/2018						13
14								14
15		▽ 6/14/2018					SILTY SAND WITH GRAVEL (SM); wet, brown; fine to coarse sand; fine to coarse, subrounded to subangular gravel.	15
16								16
17								17
18		Aluminum point in slough						18
19								19
20							Becomes moist.	20
21							Bottom of exploration at 21 ft. bgs.	21

Legend

Sample Method:
- ◯ No Soil Sample Recovery
- ◫ Continuous core 1.85" ID

Water Level:
- ▼ Static Water Level
- ▽ Water Level ATD

See Exploration Log Key for explanation of symbols

Logged by: NHC
Approved by: AET

Exploration Log MW-101

Sheet 1 of 1

Table A-1. Groundwater Parameters for Former Domestic Wells to be Monitored

090015 City of Kent - Clark Springs, Ravenale, WA

Well ID	Well Depth (ft BTOC)	Depth to Water (ft BTOC)	Temp (C°)	Specific Conductance (µmhos/cm)	pH -	Turbidity (NTU)	Total Volume Pumped (gallons)
Lorang	31.2	14.18	10.1	141.9	6.04	9.9	60
French 1	20.0	14.05	9.6	98.2	6.49	27.5	70
French 2	42.0	14.53	9	99.1	6.19	5.2	80
Donnelly	20.1	11.10	9.5	96.3	7.77	2.9	100

Notes:

Measurements made on August 8, 2018

Figure A-1 provides well MW-101 construction details and depth to water measured at time of its June 2018 installation.

BTOC = below top of casing

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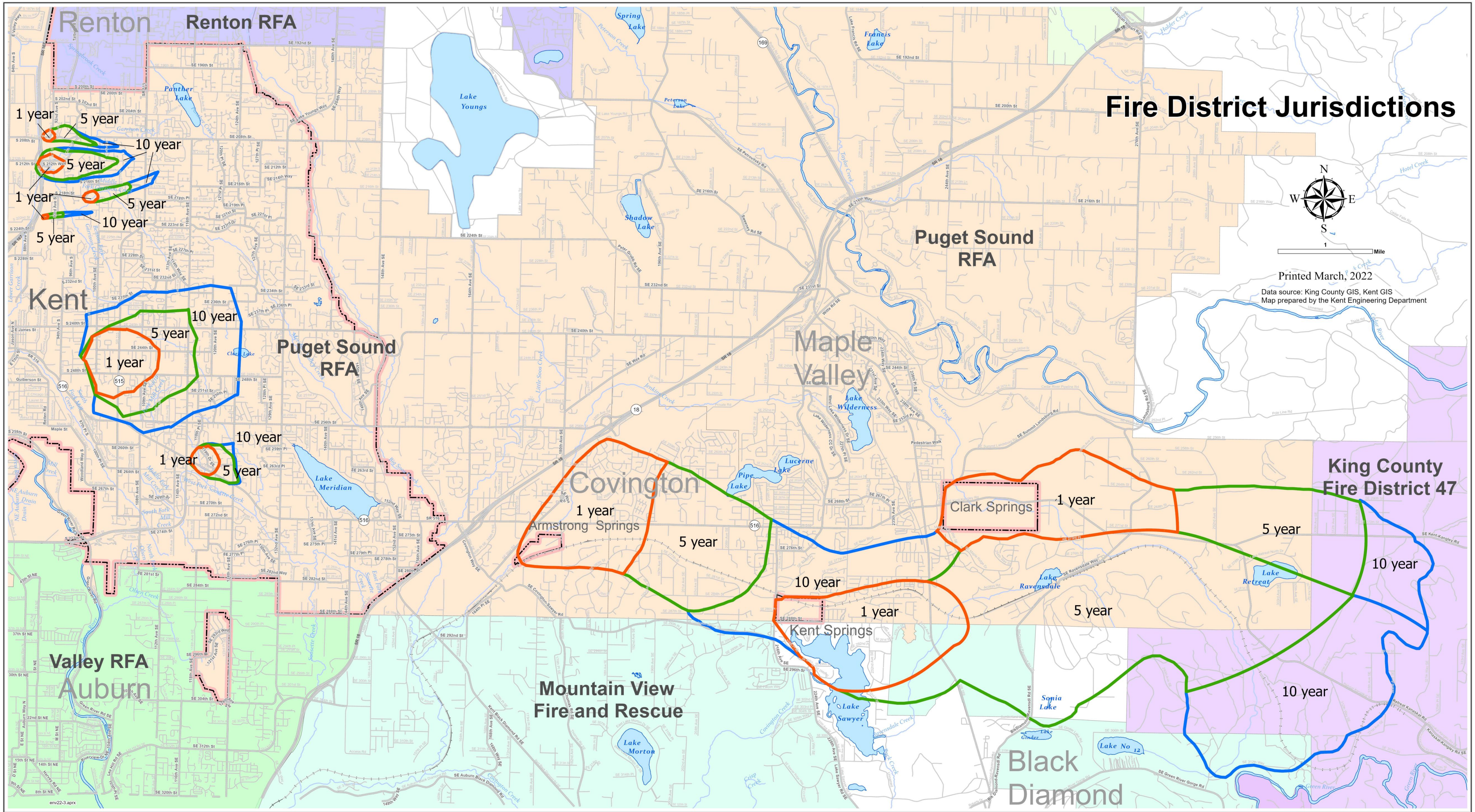
APPENDIX E
Fire Jurisdictions Map



Fire District Jurisdictions
Printed March, 2022
Data source: King County GIS, Kent GIS
Map prepared by the Kent Engineering Department
N
S
E
W
1
Mile
Renton
Renton RFA
Kent
Puget Sound RFA
Puget Sound RFA
Maple Valley
Covington
King County Fire District 47
Valley RFA
Auburn
Mountain View Fire and Rescue
Black Diamond
Clark Springs
Armstrong Springs
Kent Springs
1 year
5 year
10 year
Lake Youngs
Lake Meridian
Lake Wilderness
Lake Sawyer
Lake Morton
Shadow Lake
Panther Lake
Pipe Lake
Lucerne Lake
Spring Lake
Francis Lake
Lake Retreat
Lake Ravensdale
Sonia Lake
Lake No 12

APPENDIX F
Notification Letters

PUBLIC WORKS DEPARTMENT
Chad Bieren, P.E.
Public Works Director
400 West Gowe St
Kent, WA 98032
Fax: 253-856-6500
PHONE: 253-856-5500

[DATE]

[Address of local business or cleanup site]

RE: Protecting Drinking Water Resources &
Location Within a Wellhead Protection Area

To Whom It May Concern:

In our community, we rely upon groundwater as our primary source of drinking water. Throughout Washington, occurrences of groundwater contamination have shown us the fragile nature of our water resources. The City of Kent is taking a proactive approach to ensure drinking water in our community maintains its excellent quality. This proactive approach includes preparing maps identifying critical areas around each city water source where pollution spilled on the ground may cause contamination to drinking water sources. These areas are Wellhead Protection Areas (WHPAs) and are identified on the enclosed map.

The purpose of this letter is to notify you that your facility is located within a City of Kent WHPA. Since the activities conducted at your facility may involve the use of oil, gasoline, pesticides, or other pollutants, the potential exists that a spill at your facility may adversely impact the city's drinking water supply. If a spill occurs at your facility, please notify the City of Kent immediately at (253) 856-5600. In the event of an emergency, please call 911.

With an increase in urban growth, it is important that all businesses and residents within the WHPA work together to preserve groundwater resources in our region. If you have any questions on how you can help preserve water quality, please feel free to contact me at (253) 856-5527. Thank you for your assistance in protecting our valuable natural resources.

Sincerely,

Evan Swanson

Evan Swanson
Conservation Coordinator
City of Kent

PUBLIC WORKS DEPARTMENT
Chad Bieren, P.E.
Public Works Director
400 West Gowe St
Kent, WA 98032
Fax: 253-856-6500
PHONE: 253-856-5500

DATE

Address of Emergency Responder

RE: City of Kent Wellhead Protection Areas

Dear Emergency Responder:

The City of Kent updated it's Wellhead Protection Program to help maintain drinking water quality for our residents. The Program is based on the Washington State Department of Health WAC 246-290-135(3) regulations. As part of the Program, maps were prepared that show the areas around each City drinking water source where pollution spilled on the ground may cause contamination of the well/aquifer. These areas are Wellhead Protection Areas (WHPAs).

As part of this Program, the City must provide wellhead protection information to agencies responsible for incident/spill response procedures. It is important that you are aware of where potential contaminant releases could adversely impact drinking water quality.

Maps of the WHPAs are enclosed for your review. Also enclosed is a table providing the facility ID, name, and ranking number which corresponds to the mapped locations on the figures. An acknowledgment of receipt of this information or a response from your office would be appreciated, for documentation purposes for the Wellhead Protection Program. Please note that the City of Kent has sent notices to these properties informing them of their location within a WHPA boundary.

In the event of a spill or contaminant release within these WHPA's, we ask that you immediately notify the City of Kent and the Department of Ecology so we can take appropriate measures to coordinate cleanup.

Thank you for your attention in this matter. If you have any questions or would like a copy of the wellhead protection program update, please contact me at (253) 856-5527.

Sincerely,

Evan Swanson

Conservation Coordinator

City of Kent

PUBLIC WORKS DEPARTMENT
Chad Bieren, P.E.
Public Works Director
400 West Gowe St
Kent, WA 98032
Fax: 253-856-6500
PHONE: 253-856-5500

DATE

Address of Government or Regulatory Agency

Re: City of Kent Wellhead Protection Areas

Dear Regulatory/Governmental Agency:

The city of Kent has updated it's Wellhead Protection Program to help maintain drinking water quality for our residents. The Program is based on Washington State Department of Health WAC 246-290-135(3) regulations. As part of the Program, maps were prepared that show the areas around each city drinking water well and spring where pollution spilled on the ground may cause contamination of the well/aquifer. These areas are Wellhead Protection Areas (WHPAs).

The enclosed maps depict WHPA boundaries, source wells, and identified potential contaminant sources. Also enclosed is a table providing the facility ID, name, and ranking number which corresponds to the mapped locations on the figures. Please review the map and use it as a reference when inspecting and permitting the storage, use, and disposal of hazardous material within our WHPAs.

Please note that the city of Kent has sent notices to these properties informing them of their location within a WHPA boundary.

Thank you for your attention in this matter. If you have any questions or would like a copy of the wellhead protection program update, please contact me at (253) 856-5527.

Sincerely,

Evan Swanson

Conservation Coordinator

City of Kent