3.3 WATER RESOURCES

3.3.1 Affected Environment

3.3.1.1 Surface Water

The Desert Claim project area and the sites for Alternatives 1 and 2 are located within the central portion of the Upper Yakima River drainage basin. The Yakima River begins from the eastern slope of the Cascade Mountains at Keechelus Lake in the Upper Kittitas Valley and flows southeasterly through the lower plateau and river-bottom lands to the Columbia River (EES 2001).

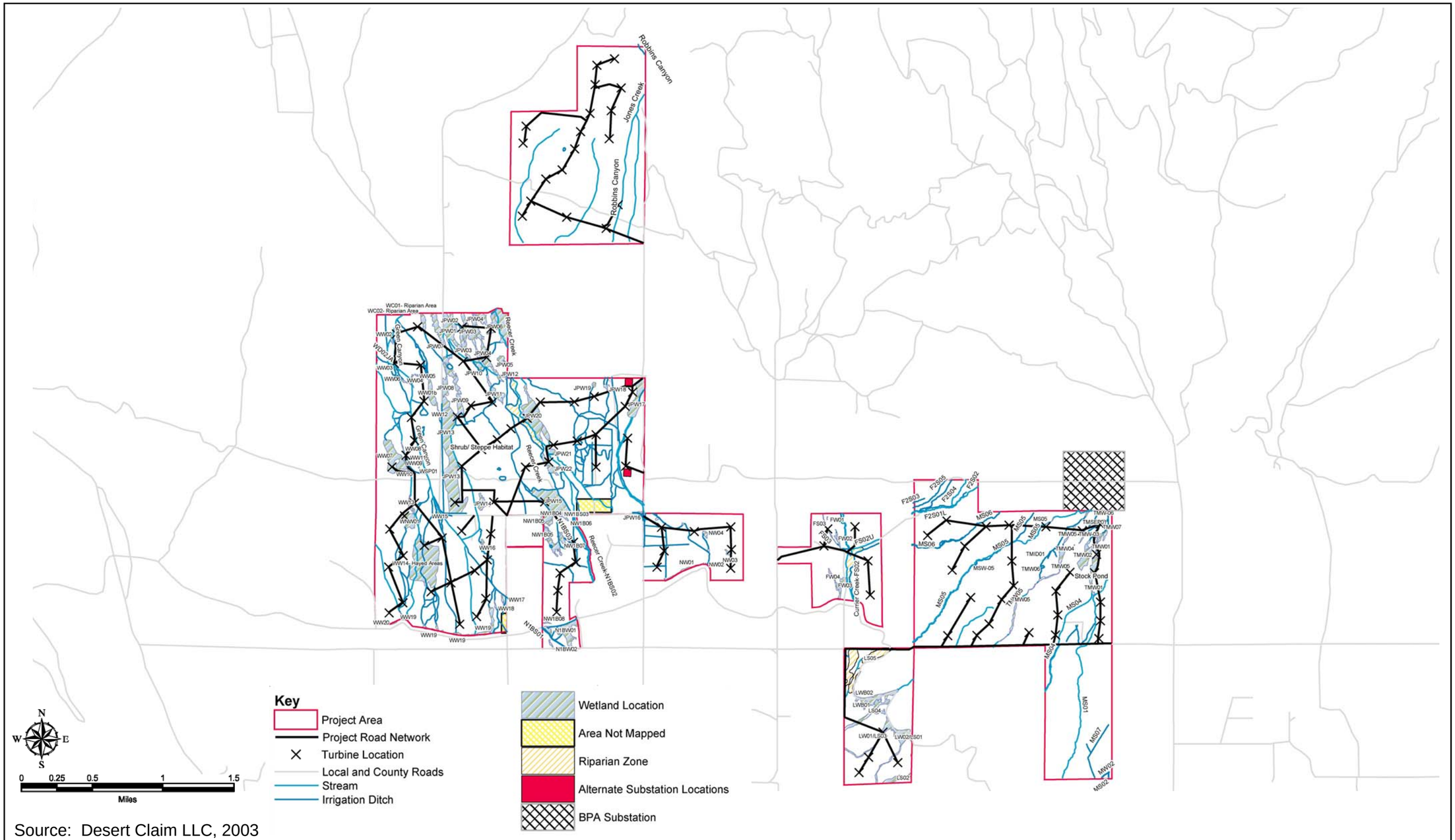
The Yakima River drains an area of 6,155 square miles. The USGS has a gaging station on the Yakima River close to the project area. The gaging station is 10 miles south of Ellensburg. An area of approximately 1,594 square miles is drained by the Yakima River at this point. The USGS has calculated an average discharge (for the period 1934 to 2002) for the river at this gage of 2,450 cubic feet per second (cfs). Average discharge for the 2002 water year was 2,308 cfs (Kimbrough et al. 2002).

Project area streams delineated during field surveys drain into the Yakima River upstream of Ellensburg, and approximately 40 miles downstream of the river's headwaters. Because the Yakima River Basin receives little direct precipitation (8.9 inches per year), these streams are primarily fed by snowmelt off the ridges to the north of the project area (WRCC 2003).

Project Area Surface Water Features

Perennial, intermittent, and ephemeral streams in the Desert Claim project study area were identified through map review and field survey during June and July 2003. **Figure 3.3-1** is a map of surface water hydrology, including streams and wetlands, in the project area. The Kittitas County Critical Areas Ordinance (KCC) classifies perennial and intermittent streams according to the definitions provided in WAC 222-16-030. The ordinance does not classify irrigation ditches, waste ways, drains, outfalls, operational spillways, channels, storm water runoff facilities or other wholly artificial watercourses as streams (KCC 17A.02.273).

Based on the map and field investigations, 19 streams were identified within the Desert Claim project area and the immediate vicinity. The streams were characterized as having perennial or intermittent flow, as indicated in **Table 3.3-1**. This table also provides information on the water body to which the stream drains and the stream classification according to the Washington water typing system. **Appendix B, Exhibit 1** provides more detailed information from the stream inventory of the project area.



Source: Desert Claim LLC, 2003

Huckell/Weinman Associates, Inc.
HWA

Kittitas County
Desert Claim Wind Power Project EIS

Figure 3.3-1
Streams and Wetlands Identified in the Project Area

Table 3.3-1
Summary of Streams in the Project Area

Name	Flow Type	Waterbody Tributary To	Stream Classification*
unnamed stream	Intermittent	unnamed stream[1]	5
unnamed stream	Intermittent	Dry Creek	5
Green Canyon Creek	Perennial	Dry Creek	3
unnamed stream	Perennial	Green Canyon Creek	3
unnamed stream	Intermittent	Reecer Creek	5
unnamed stream	Intermittent	Reecer Creek	5
Robbins Canyon Creek	Intermittent	unnamed stream	5
Jones Creek	Intermittent	Currier Creek	4
unnamed stream	Perennial	Reecer Creek	3
Reecer Creek	Perennial	Yakima River	3
unnamed stream	Perennial	Jones Creek	3
Currier Creek	Intermittent	Reecer Creek	4
unnamed stream	Intermittent	unnamed stream	5
unnamed stream	Intermittent	Currier Creek	4
unnamed stream	Intermittent	Currier Creek	5
unnamed stream	Intermittent	Currier Creek	5
unnamed stream	Intermittent	Currier Creek	5
unnamed stream	Intermittent	Currier Creek	5
unnamed stream	Intermittent	Currier Creek	5

* Stream classification is according to the Washington water typing system.

From west to east, the following named streams bisect the project area:

- Green Canyon (perennial);
- Reecer Creek (perennial);
- Robbins Canyon (intermittent);
- Jones Creek (intermittent tributary to Currier Creek); and
- Currier Creek (intermittent).

Reecer Creek was identified as the highest-quality stream in the project area, with sustained flow throughout the year and riparian habitats along most of the channel. Reecer Creek drains to the Yakima River at a location just west of Ellensburg and about 6 miles south of the project area. Reecer Creek was studied by the Washington State Department of Ecology in a flow summary of streams and creeks to the Upper Yakima River. Daily average discharge of Reecer Creek determined in this study ranged from 68 ft^3/sec to 4 ft^3/sec (Ecology 2000). Jones Creek and Currier Creek are tributaries to Reecer Creek. Green Canyon is a tributary to Dry Creek, which also flows into the Yakima River.

The North Branch Irrigation Canal also crosses a portion of the project area. The canal runs generally from west to east, and conveys water supplied by the Kittitas Reclamation District.

Kittitas County uses Washington State's five-tier water typing system (WAC 222-16-030) to classify streams, lakes and ponds. Types 1, 2, 3, 4 and 5 waters are classified according to their flow and habitat quality. Using the stream inventory map published by the Washington Department of Natural Resources (WDNR 1974, modified November 1996), 5 streams in the project area were classified asType 3 waters, which are characterized as segments of natural non-shoreline waters that have a moderate to slight fish, wildlife, or human use. The remaining 14 streams in the project area exhibited characteristics of Type 4 or 5 waters, which do not have a moderate to slight fish, wildlife, or human use and are of varying widths.

As further described in **Section 3.4.4**, none of the streams within the project area are known to support indigenous fisheries. In addition, none of the streams are listed as impaired on the Washington State Clean Water Act 303(d) list of impaired water bodies (Ecology 1998).

Perennial Streams

Five perennial streams in the project study area were mapped and characterized as Type 3 waters. These streams normally have flow throughout the year. In addition to Green Canyon Creek and Reecer Creek, there are three unnamed perennial streams in the project area. Details on the location, widths, and receiving waters are provided in **Table 3.3-1** above and in **Appendix B**.

Intermittent Streams

Fourteen (14) of the streams mapped in the project study area are intermittent streams. Intermittent streams (seasonal streams) are dry for a large part of the year, generally in the winter and fall. Flow generally occurs for weeks and/or months in response to seasonal precipitation and groundwater recharge in the spring and early summer. Three of these project-area streams were classified as Type 4 waters, and 11 as Type 5 waters.

Ephemeral Streams

Ephemeral streams are not included in the WDNR stream maps and are not identified separately in **Appendix B**. Ephemeral streams convey runoff for only brief periods during or after rainfall events. These drainages typically have unconsolidated beds of silt, sand, gravel, cobble, or a combination of these substrate types. In general, mapped washes in the project area were characterized by a defined bed and bank. Some of these features had vegetated banks, while others were un-vegetated.

Irrigation Ditches

Many of the streams discussed above convey water to irrigation ditches located within the project area. These ditches are particularly prevalent on the western portion of the project area. Several stock ponds are also present within the project area. Detailed information regarding these features was not collected during the field surveys, as these artificial features are not regulated by Kittitas County.

Wetlands are discussed in **Section 3.4.2** of the EIS.

Surface Water Supply

Surface waters of the Yakima Basin that are used for water supply purposes include the main stem of the Yakima and Naches Rivers (Tri-County Water Resources Agency 2003). The water users in the Yakima Basin depend upon a variety of systems to meet their demands for water supply. These include municipal water supply systems, both large or small, irrigation systems and private wells.

The U.S. Bureau of Reclamation (Reclamation) provides the water supply for a majority of the water uses that divert surface water from the Yakima and Naches River. In addition, several tributary streams provide surface water in the Yakima Basin. Seasonal precipitation occurring from October to March supplies water to the rivers and tributary streams (Tri-County Water Resources Agency 2003), with high flows from April to June. The seasonal precipitation falls either as snow or rainfall, mostly in the Cascade Range. Winter snowfall is stored in the Cascade Range snow pack, which provides most of the high runoff in the Yakima Basin from April to June.

Reclamation delivers diverted surface water to a number of local irrigation districts and water companies in the basin, who in turn supply water to individual water users. The Kittitas Reclamation District (KRD) supplies water to irrigators and other users in a large portion of the Kittitas Valley. The North Branch Canal, one of the major water conveyance facilities in the KRD system, traverses the north side of the Kittitas Valley and passes through a portion of the Desert Claim project area.

Surface Water Quality

The Upper Yakima River and several of its tributaries are currently listed as impaired surface waters under Section 303(d) of the Clean Water Act. The 303(d) listing identifies the following parameters as the sources of impairment: fecal coliform bacteria, 4,4'-DDE, DDT, mercury, dieldrin, silver, copper, cadmium, temperature, dissolved oxygen (DO) and ammonia (Ecology 2003b). The water quality concerns reflected in the 303(d) listing are based on conditions in the mainstem river and some of the larger tributaries, and are not necessarily representative of conditions in smaller tributaries such as those near the project area.

Reecer Creek, a minor tributary to the Yakima River, is the largest stream that runs near or through the Desert Claim project area. Reecer Creek is not on the most recent (1998) 303(d) list (Ecology 2003b). The watershed assessment for the Yakima River Basin completed in January of 2003, however, found Reecer Creek to have reduced water quality for temperature, DO, total suspended sediment and fecal coliform (EES 2003). Water quality information for other surface waters in the Desert Claim project area is limited or nonexistent.

As is discussed in **Section 3.3.4**, existing water resource conditions in the project area reflect past activities and current land use. Potential pollutant sources for surface water and ground water that may be present in the project area include natural salts or minerals (such as arsenic) present in the soil, septic systems, underground storage tanks, applications of fertilizers and pesticides, application of animal manure, chemical or fuel spills, leaching from landslides, and burial or dumping of wastes (EES 2003).

Alternative 1: Wild Horse Surface Water Resources

The Wild Horse site, the project area for Alternative 1, is located on exposed ridge tops away from surface waters. Surface waters that are within one-half mile of the site include Whiskey Dick, Skookumchuck, and Whiskey Jim Creeks and their tributaries; the Wild Horse, Skookumchuck Heights, Dorse, Reynolds, Thorn, Government, Pine, and Seabrock springs; stock watering ponds; and unnamed ephemeral creeks. Whiskey Dick, Skookumchuck, and Whiskey Jim Creeks all originate within the project boundary for Alternative 1, at an elevation of approximately 3,400 feet. Whiskey Dick and Skookumchuck Creeks flow east and southeast to an elevation of about 700 feet at their mouth at the Columbia River. Both creeks have a relatively steep gradient, with an average creekbed slope of 200 to 250 feet per mile over the 10- or 12-mile lengths of these creeks. Whiskey Jim Creek has an average gradient of 250 to 300 feet per mile until it joins Parke Creek at the eastern edge of the Kittitas Valley. Each of these creeks collects water from surface runoff, springs, and seeps within each drainage.

Wild Horse, Skookumchuck Heights, Dorse, Reynolds, Thorn, Government, Pine and Seabrock springs and one unnamed spring are all identified on maps covering the Wild Horse area. Several of the springs have been developed by local ranchers to supply water for livestock. Observed flow rates at these springs were found to be in the range of 1 to 5 gallons per minute. The majority of the springs exist between the elevations of 3,300 and 3,400 feet. Because of the relatively short distance from the top of the ridges down to the position of the springs, the recharge areas are relatively small; consequently, it is anticipated that flows from the springs decrease later in the summer and fall.

Alternative 2: Springwood Ranch Surface Water Resources

The Yakima River bounds the Springwood Ranch site along most of its east and north sides. Taneum Creek, a tributary to the Yakima River, bisects the northern and southern portions of the site. No other perennial streams are located within or adjacent to the site defined for Alternative 2. An intermittent stream with two branches crosses the northern portion of the site and empties into the Yakima River. Another intermittent stream drains from the plateau area near the middle of the site and flows into the Yakima River north of Taneum Creek.

Two irrigation canals, the KRD Main Canal and North Branch Canal, cross the northwestern portion of the site. Two ponds near the Sunlight Waters community are located just to the west of the northwest corner of the Alternative 2 site.

Most of the shoreline of the Yakima River along the northeastern boundary of the Springwood Ranch site has been mapped as high erosion hazard and landslide hazard area. Most of the traverse of Taneum Creek through the site is bounded by soils with moderate erosion and landslide potential. Some soils with high erosion and landslide potential are also located at the mouth of Taneum Creek.

Ecology monitors water quality in the state's surface waters and maintains a list of water bodies that are characterized by impaired water quality or limited for various wildlife and habitat functions and values. The Yakima River downstream of the Springwood Ranch is listed by Ecology as impaired for fish rearing, harvesting, spawning and migration attributed to agricultural activities, habitat modification and removal of vegetation. Taneum Creek is listed as limited for instream flows and temperature.

3.3.1.2 Ground Water

Regional Hydrology

The project area is underlain by the Columbia Plateau regional aquifer system, which extends across portions of Idaho, Oregon, and Washington. The Ellensburg Basin of the Kittitas Valley occurs in three different geologic units:

- Grande Ronde Basalt
- Ellensburg Formation
- Undifferentiated alluvial and glacial deposits

Bedrock Aquifers

The Miocene-age rocks of the Columbia River Basalt Group (CRBG) are generally the major aquifers of the Columbia Plateau. The Grande Ronde Basalt is the largest series of basalt flows of the CRBG and is composed of approximately 120 flows that underlie the entire Columbia Plateau and Kittitas Valley. No other basalt flows of the CRBG extend as far west into the Yakima River Valley as the Grande Ronde, which therefore forms the only CRBG aquifers beneath the project area.

Basalt flows are typically permeable at the individual flow tops and bottoms because of rubble zones, vesicles, and fractures. Expected yields from wells that penetrate permeable zones are about 1.5 gpm for each foot of saturated material penetrated (USGS 1994).

The Miocene-age Ellensburg Formation is composed of unconsolidated and semi-consolidated sedimentary rocks that are interbedded with and overlie the basalt flows. The Ellensburg Formation and coeval deposits are areally extensive in the Columbia Plateau, however the Ellensburg is confined to the western Columbia Plateau in Washington. Sedimentary units that interfinger and lie on top of the CRBG units in the central and eastern Columbia Plateau are identified as separate units; however, there is ongoing research and revision over the naming and extent of Neogene (Late Tertiary) sedimentary units. The Grande Ronde Basalts are some of the oldest basalt flows of the CRBG, and were emplaced relatively rapidly. This limits the thickness of interbedded Ellensburg Formation units within the Grande Ronde Basalt. Suprabasalt sedimentary units (units overlying the basalt flows) may be more extensive along the western edge of the Columbia Plateau (in the project vicinity) than interbedded units. Highly productive aquifers may be encountered in the Ellensburg Formation units; however, a USGS study (1994) does not differentiate the Ellensburg Formation aquifers from Grande Ronde aquifers because interbedded Ellensburg Formation sediments occur near permeable flow tops and bottoms and can be relatively thin.

Alluvial Aquifers

In structural lows (basins and valleys) of the plateau, unconsolidated alluvial deposits (including glacial deposits) have accumulated over the Miocene bedrock. Deposits consist primarily of sand and gravel. The unconsolidated deposits form aquifers that can be productive aquifers for public-supply, domestic, commercial, and industrial purposes. They also are important sources of water for agricultural (primarily irrigation). Alluvial aquifer thickness exceeds 800 feet locally, within basins, as is the case in the deepest portions of Kittitas Valley. The hydraulic conductivity of these aquifers varies from less than 10 to greater

than 2,000 feet per day. Well yields are generally up to 0.5 gpm for each foot of saturated material penetrated (USGS 1994).

Desert Claim Project Area Hydrology

Grande Ronde Basalt, Ellensburg Formation sandstone, and undifferentiated alluvial and glacial deposits also comprise the three main aquifer systems beneath the Desert Claim site and immediate surrounding areas. The Grande Ronde Basalt and Ellensburg Formation aquifers are generally characterized as relatively deep, confined to semi-confined aquifers. The undifferentiated alluvial/glacial aquifer is shallower and is interpreted to exhibit semi-confined to unconfined aquifer conditions.

The Desert Claim project area is located on the northern edge of the Ellensburg Basin. A north to south cross-section of the project area is presented as **Figure A-2** and located on **Figure A-1** (Cross-Section A-A'). Kittitas Drift and Quaternary-age alluvial material dominate the near-surface geology but pinch out to the north where Grande Ronde Basalt crops out. A review of area well logs reveals that most wells are producing water from fracture and flow top and bottom aquifers in Grande Ronde Basalt or Ellensburg Formation sandstones. The following sections summarize the hydrogeology of the Grande Ronde Basalt, Ellensburg Formation, undifferentiated alluvial and glacial aquifers, and interactions between ground water and surface water at the site.

Undifferentiated Alluvial and Glacial Aquifers

Alluvial aquifers are present throughout the project area; however, the majority of wells are withdrawing from bedrock aquifers. Alluvial aquifers are primarily gravel or sandy gravel, and some are reported as cemented gravel. Well yields are moderate and most range from 10 to 30 gpm, and peak at 40 gpm. A review of area well logs shows that the alluvial aquifers range from 40 to 400 feet thick in the project area. Static water levels are relatively shallow generally ranging from near surface to 250 feet below ground surface (bgs). The aquifers are generally unconfined and water levels follow the topography.

Grande Ronde Basalt Aquifers

The majority of wells in the vicinity of the project are completed in Grande Ronde Basalt aquifers. The depth of producing intervals varies from 70 to 1,000 feet bgs; the majority of wells are between 100 and 600 feet bgs. Static water levels vary greatly, ranging from artesian flow (wells 35 and 38) to 670 feet bgs (well 33). The majority of static water levels in Grande Ronde Basalt aquifers are between 300 and 500 feet bgs. Three wells (15, 16, and 37) were reported as dry upon completion of drilling. The significant variability in static water levels is caused by permeability barriers in the subsurface units. Low permeability barriers may be related to fracture filling by clay in basalt or fine-grained sedimentary interbeds. The low permeability zones or layers behave as barriers to ground water flow between aquifers and can result in a pressure gradient between aquifer intervals (**Figure A-2**). Grande Ronde Basalt aquifers exhibit confined to semi-confined behavior.

Well yields across the project area also vary greatly. A range of 1 to 85 gpm is reported on well logs, however, most yields are less than 40 gpm. One well located near the center of the project area (well 57) was reported as yielding 400 gpm.

Ellensburg Formation Aquifers

Ellensburg Formation aquifers are penetrated by wells throughout the project area. The majority of wells are extracting from Grande Ronde Basalt aquifers but often the Ellensburg Formation is associated with these aquifers. In general, static water levels of Ellensburg Formation aquifers are lower than basalt aquifers and most range from about 60 to 300 feet bgs. Well yields are moderate to high, the bulk ranging from 15 to 40 gpm and up to 85 gpm. Static water level and well yield variation of Ellensburg Formation aquifers is similar to Grande Ronde Basalt aquifers because the Ellensburg is generally located near the permeable flow tops and bottoms of the basalt, since sediments that make up the Ellensburg Formation accumulated between basalt flow emplacement. Water levels in wells that penetrate Ellensburg Formation aquifers in the project vicinity generally follow the topography, indicating the aquifers penetrated in the area are unconfined. Deep, semi-confined to confined Ellensburg Formation aquifers likely exist in the area, but are indistinguishable from Grande Ronde Basalt aquifers with available well log information.

The wells located on the southeastern portion of the project area, in the Green Canyon valley, are dominated by Ellensburg Formation aquifers. Wells numbered 100 and 104 are included in this grouping and appear on Cross-Section A-A' (**Figure A-2**). Both of these wells are producing water from a sandstone formation interpreted to be Ellensburg Formation.

Ground Water Flow, Recharge and Discharge

The Cascade Range in Oregon and Washington is an important recharge area for the Columbia Plateau regional aquifer system. Ground water is little used in the Cascade Range; the Tertiary volcanic and sedimentary rocks are extremely permeable and readily accept large volumes of precipitation that recharge underlying aquifers (USGS 1994).

Geologic structures are important controls on ground water occurrence and movement in the Columbia Plateau. Folded and subsequently eroded layers of rock crop out in upland areas where water enters the aquifer system; the water then moves downgradient along permeable zones. Folding and faulting of rock layers can influence the movement of ground water by creating barriers to ground water flow, or alternatively by creating new or enhanced flow pathways through fracturing. The general movement of water in the aquifer system is from recharge areas near the edges of the plateau toward regional surface water drainages, such as the Columbia River (USGS 1994). Topography plays a dominant role in ground water flow direction in the project area. Ground water flow is generally north to south, following the topography toward the Yakima River in both the alluvial and bedrock aquifers.

Recharge to the alluvial aquifers is provided by infiltration of runoff from surrounding bedrock ridges, streamflow, direct precipitation, and leakage from irrigation sources (including ponds and the North Branch Canal). Regional ground water flow in the alluvial aquifers of Kittitas Valley generally corresponds to the topography, eventually flowing down the Yakima River Valley. Ground water flowing in the alluvial aquifer is interpreted to discharge primarily into the Yakima River, streams, irrigation lakes and the North Branch Canal, and underlying bedrock.

Recharge to bedrock aquifers is provided by overlying alluvial aquifers, flow from other bedrock aquifers, and direct precipitation. The up-folded limbs of Grande Ronde Basalt and Ellensburg Formation that crop out north of the project area also receive water from direct precipitation and stream flow. Ground water flow in the bedrock aquifers is typically controlled by the orientation of structures such as folds and fractures, and the physical characteristics and orientation of the individual stratigraphic layers. Water flowing in the various bedrock aquifers likely discharges to other bedrock aquifers (both shallower and deeper), overlying alluvial aquifers and surface water.

Ground Water - Surface Water Interaction

The Yakima River northern tributary streams that flow through the Desert Claim project area (Green Canyon, Reecer Creek, Robbins Canyon, Jones Creek, and Currier Creek), wetlands, irrigation ponds, and the North Branch Canal are surface water features that directly interact with ground water in the project area.

The tributary streams interact with ground water through three general processes: (1) streams gain water from inflowing ground water; (2) streams lose water to ground water by outflow through the streambed; or (3) streams vary between gaining water in some reaches and losing water in others. All of the project area streams vary between gaining and losing reaches. During a field drainage reconnaissance preformed in late summer of 2003, much of the tributary stream water eventually infiltrated through the underlying alluvium before reaching the Yakima River.

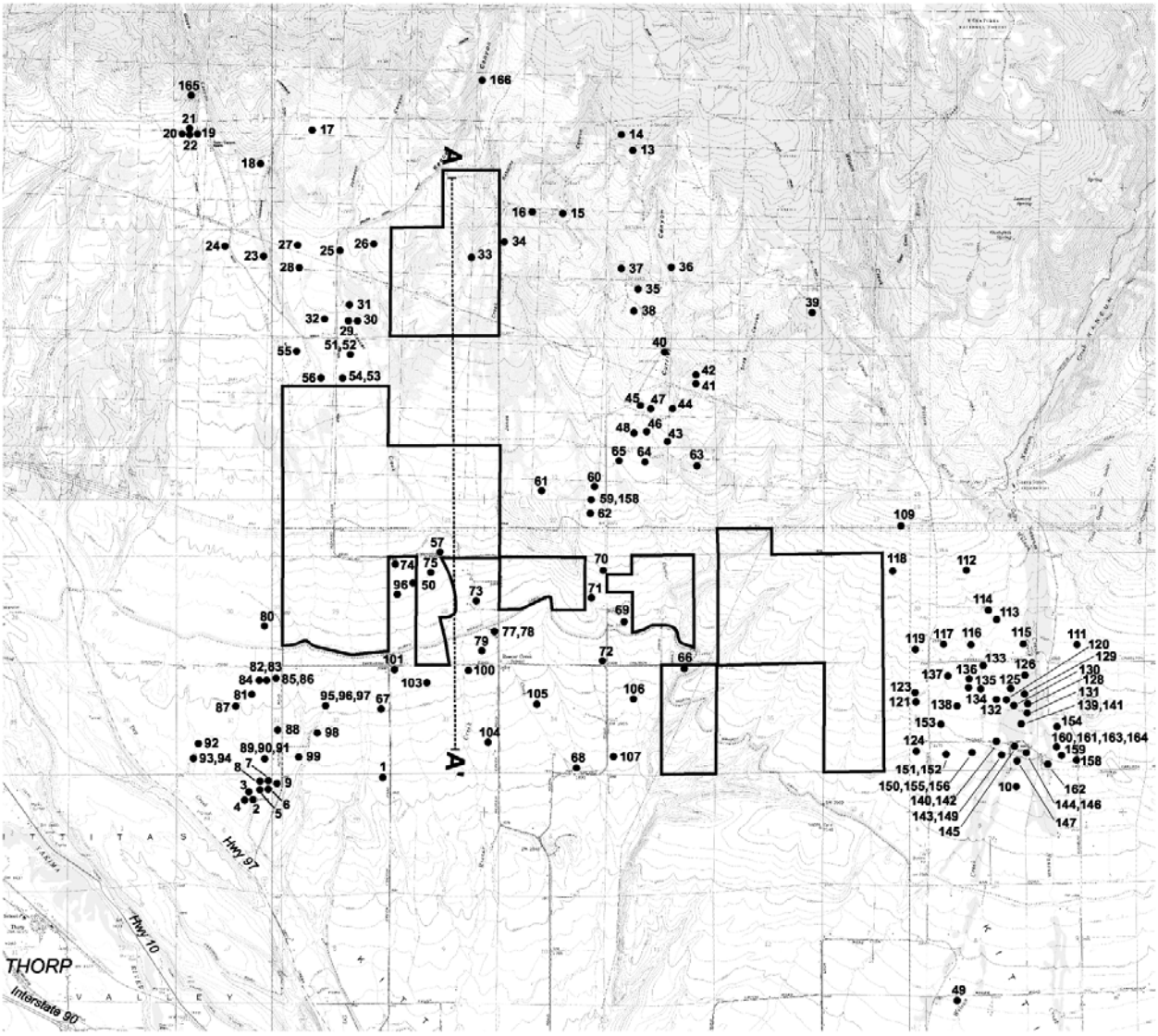
A review of area well logs shows that the majority of wells are withdrawing from Grande Ronde Basalt aquifers that are semi-confined to confined. As such, little interaction between surface water and these deeper aquifers is expected in the area. Conversely, the alluvial aquifers are in direct connection with surface water because they are shallow and permeable.

The existing condition of surface water flow on the Columbia Plateau has been dramatically affected by irrigation practices. Water diverted for irrigation from surface water sources (streams, ponds, and reservoirs) increases local recharge and, in effect, creates localized ground water table highs. Highs up to 300 feet have been recorded in Washington (USGS 1994). Ground water table rises have caused localized ponding, creating a need for drain installation. Conversely, irrigation using ground water has resulted in declines of local ground water tables of as much as 150 feet in Washington (USGS 1994). A review of well logs and water rights claims encompassing 92 square miles surrounding the project area identified only 5 wells that are used for irrigation, however water usage estimates from Ecology data show that irrigation uses about 7 times more water than domestic water uses.

Ground Water Supply

According to the U.S. Geological Survey (USGS 1994), large well yields are common in the Ellensburg area. Unconsolidated deposits in the Ellensburg Basin of Kittitas Valley are up to 1,000 feet thick and yield up to 3,200 gallons per minute (gpm) to wells for public supply, domestic, commercial, and agricultural (primarily irrigation) purposes. The Grande Ronde Basalt underlying the unconsolidated deposits yield up to 4,800 gpm (USGS 1994).

Water well logs obtained from the Washington Department of Ecology (Ecology) were reviewed and compiled for the area immediately surrounding the Desert Claim project site. The wells were located to the nearest quarter-quarter section, or by address when available, and a database was created to compile and retrieve pertinent drilling and well construction information. The wells are located surrounding and within (4 wells) the project area for a total of 166 wells, over 92 square miles. Five wells are used for irrigation purposes and the remaining wells are for single-family domestic use (according to well logs and water rights claims). The well locations are shown in **Figure 3.3-2**. Based on the tools and methods used by the sources reporting the well logs and the standard practice of reporting well locations only to the nearest quarter-quarter section, the locations shown in **Figure 3.3-2** should not be considered highly precise; location inaccuracies in the well logs are relatively common.



REFERENCE: TOPO MAP FROM DELORME.

LEGEND

1 ● Approximate location of water well, well locations based on 1/4-1/4 section description or address

Project Area

A----------A' Cross section location

N

0 4000

SCALE IN FEET

Source: Associated Earth Sciences, Inc.

Huckell/Weinman Associates, Inc. HWA

Kittitas County Desert Claim Wind Power Project EIS

Figure 3.3-2

Well Locations

A study of the hydrology of Kittitas Valley and a review of well logs for the EIS indicate that well yields average 20 to 23 gpm in the Desert Claim project vicinity (Owens 1995). The study concludes that ground water yield and flow in the Kittitas Valley is largely dependent on stratigraphic and structural controls and high well yields do not necessarily correlate to depth although on average yield increases with depth. Grande Ronde Basalt aquifers tend to produce higher yields than the Ellensburg Formation aquifers, probably because Grande Ronde Basalt aquifers are generally confined and have a larger recharge area in the mountains north and south of Kittitas Valley (Owens 1995).

Under Washington water law, small domestic, stock-watering, or industrial water wells may withdraw up to 5,000 gallons per day (gpd) of waterwithout requiring a ground water right permit (these are known as exempt wells). Ecology estimates that typical use for a single-family home is about 300 gpd. Assuming typical water use, the 166 existing domestic wells in the vicinity of the project withdraw approximately 50,000 gpd of water. All of the homes in the area use on-site septic systems to discharge waste water; therefore, a large portion of the water used is returned to the shallow subsurface. Water rights data obtained from Ecology indicate that irrigation in the project vicinity uses substantially more ground water than single-family residences. Approximately 350,000 gpd of water is used for irrigation (estimated from Ecology data). There are 32 claims for ground water rights in the area that are not quantifiable, according to Ecology. These claims could be for either domestic water use or irrigation, and therefore an estimation of the amount of water used by these claimants cannot be made.

Ground Water Quality

Washington State has ground water quality standards that are protected for beneficial uses by Chapter 173-200 of the Washington Administrative Code (WAC), and drinking water standards that are protected by WAC 246-290-300. Ground water quality standards are designed to protect ground water quality, and existing and future beneficial uses through an anti-degradation policy and by defining maximum contaminant level (MCL) criteria. The purpose of drinking water regulations is to ensure that health quality standards are maintained for public drinking water supplies. Drinking water standards established by the Washington Department of Health (WDOH) comply with the Federal Safe Drinking Water Act of 1974 and subsequent 1986 amendments. The standards outline monitoring protocols and MCLs for bacteriological, inorganic chemical, and physical characteristics.

The WDOH monitors several public drinking water supply wells in Ellensburg for constituents that include volatile organic compounds, inorganic compounds, and pesticides/herbicides. Recent ground water quality measurements were obtained from the WDOH. Most chemical constituents analyzed were below the state required detection limit of the laboratory analyses. The state required detection limits are well below the MCLs allowable for each contaminant. All detected concentrations of contaminants were below applicable MCLs. The following contaminants were detected in analyses: fluoride at 0.83 milligrams per liter (mg/L), magnesium at 3.6 mg/L, and calcium at 8.2 mg/L. The following physical parameters were measured and are all within acceptable ranges for drinking water: hardness at 36 mg/L and pH at 6.8.

Regional water quality studies have been performed in the Columbia Plateau aquifer system by the USGS. One study investigated a shallow alluvial aquifer in Kittitas Valley (Larson 1997). The following parameters were measured: pesticides, nitrogen, temperature, pH, and specific conductance. Detectable amounts of pesticides were found in some shallow wells (less than 50 feet below ground surface), however all contaminant levels were below the MCLs for public drinking water. Nitrate was also detected

in some well samples, but only one (11.9 mg/L) exceeded the drinking water standard of 10.0 mg/L. A verification sample collected 7 months later had a concentration of 3.2 mg/L.

Alternative 1: Wild Horse Ground Water Resources

As noted in the Earth Resources section, the Wild Horse site is also located within the Yakima Fold Belt sub-province of the Columbia Plateau physiographic province. Numerous hydrologic units exist within the complex geology of the Yakima Fold Belt and the greater Columbia Plateau aquifer system. To simplify the description of the area's hydrogeology, the aquifers in the vicinity of the Wild Horse site have been grouped into two main hydrologic units: the overburden and the basalt aquifers.

The overburden in the structural basins of the Columbia Plateau physiographic province readily transmits water and comprises water table aquifers. These aquifers are generally coarse-grained and highly permeable in their upper sections and fine-grained and less permeable at depth. Where the overburden is thick, such as in the structural basins in the Yakima Fold Belt, extensive coarse-grained layers exist deeper in the section and function as water-producing zones. Groundwater movement in the overburden is downward from the anticlinal ridges toward the streams and rivers (i.e., Columbia and Yakima Rivers) in the intervening synclinal basins (USGS, 2000). The water-level contours for the overburden aquifer roughly parallel the land surface (Whiteman, 1986; Lane and Whiteman, 1989; Hanson et al, 1994). Recharge is mainly from infiltration of applied irrigation water and from precipitation (USGS, 2000), with precipitation the predominant source of recharge (Bauer and Vaccaro, 1990). Discharge is to rivers, lakes, drains and waterways and the underlying basalt unit. Downward movement of water to the basalts is controlled by intervening fine-grained sedimentary layers and by head difference between the units (USGS, 2000).

Groundwater in the basalts occurs in joints, vesicles, fractures, and in intergranulated pores of the intercalated sedimentary interbeds. The basalt forms an extremely complex heterogeneous aquifer system with interflow zones that potentially function as small semi-confined to confined aquifers. Deeper basalt units are generally confined. However, because the hydraulic connection between units is sufficient to allow continuous vertical movement of water between them, the confined units are referred to as being semi-confined (USGS, 2000). Water-level data indicate that over most of the plateau, the vertical component of regional flow in basalts is downward except near discharge areas, located generally along streams and rivers (Lane and Whiteman, 1989). Localized anomalies to this pattern are caused primarily by geologic structures of both known and uncertain nature and secondarily by groundwater pumping and irrigation (USGS, 2000). Similar to the overburden aquifer, groundwater movement in the basalt aquifers of the Yakima Fold Belt is from the anticlinal ridges toward the streams and rivers (i.e., Yakima River) in the intervening synclinal basins (USGS, 2000).

Groundwater in the basalt aquifer system is generally suitable for most uses. However, groundwater has not yet been exploited for beneficial use via drilled wells within the Wild Horse area (Ecology, 2003). The groundwater wells mapped in the area are at least 2 miles from the site boundary, and at least 1,000 feet lower in elevation. Groundwater is vigorously used in the surrounding areas for domestic, irrigation, and other agricultural purposes, especially in the Kittitas Valley to the west.

Alternative 2: Springwood Ranch Ground Water Resources

Information on ground water resources for the Springwood Ranch site is largely incorporated from the MountainStar Master Planned Resort Draft EIS, Appendix C (Kittitas County, 1999).

The Springwood Ranch site shares the same regional hydrogeology as the Desert Claim and Wild Horse sites. Three main aquifers are present beneath the Springwood Ranch site and surrounding areas: (1) a shallow alluvial aquifer consisting of glacial outwash and alluvium; (2) the Ellensburg Formation; and (3) the Grande Ronde Basalt. Several wells are located near the southern and eastern property lines of the Springwood Ranch.

The shallow alluvial aquifer system provides significant quantities of water to several wells located downgradient of the site. Groundwater flowing in the shallow aquifer system beneath the upland terraces and moraines at the site likely flows generally toward the Yakima River. Local groundwater flow directions in the alluvial aquifer system are likely controlled by: (1) the presence and distribution of fine-grained sediments within the glacial outwash sequences; and (2) the shape of the underlying bedrock surface.

The Ellensburg Formation consists of poorly-consolidated to well-consolidated sandstone, siltstone and conglomerate, resulting in a range of permeabilities and potential groundwater yields. Groundwater flow in the Ellensburg Formation appears to be toward the Yakima River. Because of the limited thickness of the Ellensburg Formation in the immediate vicinity of the Springwood Ranch site, wells completed in this formation produce relatively low (5 to 15 gpm) groundwater yields.

Groundwater in the Grande Ronde Basalt is typically encountered in interflow zones, fracture zones and sedimentary interbeds. Groundwater flow in the Grande Ronde Basalt aquifer is controlled by the orientation of these water-bearing zones, and structural folds and faults. Converse (1989) estimated that groundwater in the Grande Ronde Basalt likely flows towards and along the axis of sub-basins such as Taneum Creek, and then towards the axis of Kittitas Valley, which corresponds to the axis of the Kittitas Valley syncline. Groundwater in the Grande Ronde Basalt generally occurs under confined hydraulic conditions, and reported yields from wells completed in the vicinity of the Springwood Ranch site ranged from less than 20 gpm to 700 gpm (Converse, 1989).

Most of the wells in the vicinity of the Springwood Ranch site were constructed for domestic use at single-family residences. The few wells near the site that are used for municipal or irrigation water supply withdraw the largest volume of groundwater in the area (Converse, 1989).

3.3.2 Environmental Impacts of the Proposed Action

3.3.2.1 Surface Water

The proposed project would result in an impact to surface water resources if it:

- Substantially altered the existing drainage pattern of the site or area;
- Substantially depleted surface water supplies;
- Substantially depleted groundwater supplies or interfered substantially with groundwater recharge;
- Violated any water quality standards or waste discharge requirements; or
- Conflicted with any local policies or ordinances protecting water resources, such as the Kittitas County Critical Areas Ordinance.

Appendix B, Exhibit 1 identifies the streams delineated in the study area and their location relative to the proposed layout of the project facilities (i.e., whether a turbine, access road location or other project facility intersects the drainage feature). The following discussion summarizes the potential water resource impacts associated with each type of project feature.

The activities associated with project construction that might have a potential adverse impact on streams include: disturbance of bed and banks of ephemeral, intermittent and perennial streams; removal of riparian vegetation adjacent to the stream banks; and the potential filling in and relocation of portions of ephemeral or intermittent streams. The impacts would result from road crossings and potential tower placement in or near streams or riparian areas. Additionally, if no mitigation measures were required, the proposed project could potentially affect the water quality of streams draining into the impaired reach of the Yakima River as a result of temporary exposures of soils during construction and placement of turbines, access roads, and other project facilities within streams and riparian areas. Disturbance of streambed and banks, removal of riparian areas adjacent to the stream banks, and the potential filling in and relocation of portions of ephemeral or intermittent streams also could contribute sediments to streams in the project area. Temporary exposure of soils during construction could also increase erosion in the project area. Erosion and sedimentation can alter the physical characteristics of stream channels, and can contribute to degraded water quality in the stream.

Table 6.1-2 in **Appendix B** identifies stream reaches that would be affected (a) temporarily by turbine and access road construction activities and (b) permanently by the presence of towers and access roads, based on the modified project layout as reflected in **Section 2.2** of the Final EIS. The expected temporary and permanent impacts on surface water resources are described below for each major facility component of the project. This is followed by a summary discussion that addresses the aggregate impacts.

Turbines

For purposes of calculating temporary disturbance impacts, it was assumed that construction crews would require an area around each of the turbines measuring 130 feet in radius for extra workspace, or about 1.25 acre per turbine. This temporary disturbance area would provide adequate space for the turbine tower and associated concrete pad, transformers, and the crane pad**.** Construction crews would use this area for constructing the tower foundation, erecting the tower, and installing the transformer. Topsoil, cleared vegetation and onsite supplies would also be stored in this workspace.

At each tower location, a smaller area measuring 120 feet long by 40 feet wide, or about 0.11 acres, would be constructed as a crane pad. For the purposes of calculating impacts to streams, it is assumed that the rectangular area would be oriented with the long side overlapping with the nearby road. This area would envelop the tower and transformer and would be backfilled with gravel or compacted soil, or otherwise altered to prevent full restoration. The turbine towers and transformer pads themselves would be permanent, impermeable, above-ground facilities. Based on the backfill or type of operations use, the crane pad area is not expected to revert to stream habitat and would therefore be considered permanently displaced.

The temporary disturbance zone around the modified turbine locations overlaps with 7 stream segments, including three different reaches of Reecer Creek. An estimated total of approximately 1,200 linear feet of stream channel would be within the temporary disturbance zone associated with turbine construction. In addition, three riparian areas would be impacted by temporary disturbance at the turbine locations, with the combined area of riparian disturbance estimated at 0.25 acres. Riparian areas are designated as

priority habitat by the WDFW and are incorporated into **Table 6.1-2** in **Appendix B**. Streams and riparian areas within the temporary disturbance zone would be impacted by the clearing of vegetation and soil, compaction from construction equipment, and by vehicular traffic. Under the modified project configuration, one wind turbine pad would at least partially overlap a stream channel, permanently occupying an estimated 40 linear feet of stream channel and an estimated total of approximately 0.03 acres of riparian habitat. A foundation placed within the stream or riparian area would result in permanent filling-in of the feature in this area. Based on the extremely small area that would be affected by the turbine, however, it is quite possible that turbine impacts on streams and riparian areas could be avoided through micro-siting.

GIS analysis of project facility locations relative to surface water resources indicates that one proposed turbine location (in T19N R18E Section 20) is within an existing stock pond. This stock pond is the largest within the project area, so it is anticipated that this turbine would be relocated to avoid impacting the stock pond. Alternatively, it might be feasible and more efficient for the applicant to construct a new stock pond for the affected landowner.

Access Roads

A network of access roads would be developed for the project. Where possible, existing roads would be improved to accommodate project access needs rather than constructing new roads. Each access road is anticipated to be approximately 15 to 20 feet in width, with an additional 15 percent increase (2 to 3 feet) to accommodate intersections with non-project roads. Culverts would be installed at all stream crossings to ensure normal flow through the drainage, and would be sized to handle the significant sheet flow that occurs each spring in this area. Within the permanent road footprint, the surface of the road would be cleared of vegetation and graded to a safe slope. Construction crews would also use a narrow area on either side of the road for grading, widening, or otherwise improving existing roads or creating new roads. Cleared vegetation, soil, rocks and onsite supplies would be stored in the temporary disturbance zone. The temporary disturbance zone is anticipated to span 15 feet on either side of the road location, resulting in a temporary disturbance width of 50 feet (plus the 15 percent overall increase to account for intersections to non-project roads). Potential temporary and permanent impacts to streams and riparian areas from project roads were estimated based on these dimensions.

GIS analysis of the proposed access road layout (see **Figure 2-12**) indicates that access roads would cross 16 streams, 8 of which would be crossed at least twice. The temporary disturbance zone associated with access road construction overlaps with an estimated 2,400 linear feet of stream channel. In addition, three riparian areas would be impacted by temporary disturbance for the access roads, with a total disturbance area estimated at 2.7 acres. Streams and riparian areas within the temporary disturbance zone could be impacted by the clearing of vegetation and soil and potential subsequent erosion, and by compaction from construction equipment and vehicular traffic. The access road network would permanently occupy an estimated total of 1,100 linear feet of stream channel and 0.9 acres of riparian habitat. Permanent roads placed within streams or riparian areas would result in relocation and conversion of the stream bank and permanent displacement of the riparian vegetation.

GIS analysis indicates that one section of proposed access road (in T19N R18E Section 20) is within an existing stock pond. As noted above, this road segment could be relocated to avoid impacting the stock pond or a new stock pond might be constructed.

Substation

In the modified project layout, the proposed substation is located in the northeast corner of Section 21, T. 19N, R. 18E. Alternatively, the substation could be located further south in Section 21, near the BPA transmission lines. The substation would be approximately 300 feet by 300 feet in size, or approximately 2.1 acres. During construction an extra 50–foot-wide area on all sides of the permanent location would be utilized for construction activities and storage. The surface water inventory conducted for the EIS indicates that no water bodies are located within the area of either substation location or the surrounding temporary disturbance zone.

Power Collection System

A power collection system would be installed underground between each of the wind turbines to connect them with the project substation. (Exceptions to the underground location would occur only in locations where physical conditions [such as bedrock or sensitive environmental features such as a stream] made it infeasible to install underground cable; overhead power lines on wood power poles would be used in such locations.) Wherever possible, the power collection cables would be installed adjacent to the project access roads and within the disturbance zone for the roads. The cables would be installed by trenching or plowing at a depth of 4 feet below the ground surface. While there might be permanent impacts to streams from gravel fill, compaction, or operation activities in the area directly above the collection system.

Construction crews would use a 10-foot wide area centered on the collection system for digging a trench (or plowing) and installing the underground cables. Cleared vegetation, soil, rocks and onsite supplies would be stored in this narrow temporary disturbance zone. Once cable installation was completed the trench or plow furrow would be backfilled, topsoil would be replaced on the surface and the disturbed area would be reseeded with native plants. Consequently, there would be no permanent above-ground facilities associated with the power collection system (except in locations where conditions dictated use of overhead lines), and no permanent impacts to streams or riparian areas. There could be temporary impacts resulting from trenching or plowing, cable installation and backfilling activities, however. Stream channels and riparian areas within the temporary disturbance zone would be disturbed by the clearing of vegetation and soil and potential subsequent erosion, and by compaction from construction equipment and vehicular traffic.

Based on the disturbance zone width of 10 feet used for calculating temporary impacts, power collection cable locations outside of the project access road disturbance footprint would affect a minimal area of stream channel estimated at approximately 60 linear feet. This temporary disturbance area would be associated with the crossing of one Type 3 stream and would result in a total temporary impact of 0.03 acres. No areas of existing riparian vegetation would be impacted by temporary disturbance at this location. The underground power collection system would have no permanent impacts.

Above-ground power collection cables might need to be installed at selected locations in the project area where underground lines would not be feasible, such as crossings of streams, steep slopes or ravines or where bedrock existed at or close to the surface. Wood pole structures would be installed at regular intervals to support the overhead cables, as described in **Section 2.2.3.9**. Because there is considerable flexibility in the placement of the support structures and the stream channels in the project area are rather narrow,it is assumed that no overhead power collection structures would be placed in stream channel or riparian areas. The transmission alignment from either alternative substation location to the BPA or PSE transmission lines would not cross or adversely affect any stream channels.

Other Project Elements

The project O&M facility would be co-located with the project substation; as indicated previously, there would be no impacts to surface water resources at either alternative substation location. Similarly, the project communication lines would be co-located with the power collection cables and would not create any incremental impacts. The specific locations of construction staging areas have not yet been identified, although it should be possible to locate these facilities so as to avoid temporary or permanent impacts to streams and riparian areas.

Figure 2-8 identifies the locations for five proposed permanent meteorological towers. Two met tower locations in the western part of the project area are near, but not adjacent to Green Canyon Creek and irrigation ditches; two locations in the eastern part of the project area are near, but not adjacent to small wetlands; and the proposed tower location in the northern part of the project area is not near any identified surface water resources. Construction and operation of the meteorological towers in these locations are not expected to result in impacts to surface water resources.

Following installation of the wind power facility, original pre-construction contours and drainage patterns would be restored around the turbines, roads, and substations. Restoration would minimize loss of stream functions or associated wildlife habitat.

In addition to the potential physical changes to surface waters, project construction would entail some risk that hazardous materials could be spilled and, if uncontained, migrate to surface water bodies. This concern primarily applies to petroleum fuels used in construction equipment and vehicles. Project operation would involve similar use of fuels, on a much more limited scale, and use of lubricating oils in vehicles and mineral oil in electrical transformers. Spill prevention, containment and control (SPCC) plans are standard requirements of state and local agencies with jurisdiction over surface water. Implementation of such plans is typically sufficient to avoid significant water quality impacts from spills.

It is not anticipated that the project would require surface water withdrawals or diversions during construction or operation, and the applicant has not indicated it would seek to use surface water supplies. Some temporary water supply would be required for project dust control and other purposes during construction; this water would be obtained from a host landowner or purchased locally and transported to the site. If an on-site concrete batch plant were utilized during construction, to minimize the impact of transporting concrete to the project area, some temporary water supply would be required. Any such use would be subject to the requirements of the State Water Code. In addition, storm water would be controlled to prevent runoff of sediment-laden water to streams in the project area. After construction, the project would be designed to deliver storm water to its pre-existing discharge points. Project area storm water runoff volumes are not expected to increase as a result of the project.

Summary of Impacts to Surface Water Resources

The aggregated temporary disturbance impact from construction of the turbines, project access roads and power collection system would amount to nearly 3,700 linear feet of stream channel. Approximately two-thirds of the impact area would result from access road construction across stream channels. Five streams identified as Type 3 waters would be affected by this temporary disturbance; these include reaches of Green Canyon Creek, an unnamed stream that is a tributary to Green Canyon Creek, Reecer Creek, an unnamed stream tributary to Reecer Creek, and an unnamed stream tributary to Jones Creek. The remaining 11 streams subject to temporary construction disturbance were classified as Type 4 or Type 5

waters, which are not truly streams but are waterways that are intermittent and may be dry at any time of the year. As discussed in more detail in **Section 3.3.5**, it might be possible to avoid at least some of these disturbance impacts through micro-siting, and stream disturbance that could not be avoided would be subject to required Best Management Practices (BMPs) intended to control erosion and storm water runoff and thereby protect stream resources. Based on the classification of the project-area waters, the relatively small stream area disturbed, the temporary nature of the disturbance, use of BMPs during construction and restoration following construction, potential construction disturbance impacts to surface water resources are not expected to be significant.

The actual placement of tower foundations and access roads within or adjacent to stream channels would permanently affect a total of up to nearly 1,200 linear feet. Based on restoration of stream areas, use of appropriately-sized culverts and compensatory enhancement for unavoidable residual impacts, long-term impacts to surface water resources are also expected to be insignificant.

3.3.2.2 Ground Water

The proposed project would result in an impact to ground water resources if it:

- Substantially altered or impeded ground water flow, recharge or discharge;
- Substantially depleted ground water supply; or
- Substantially lowered ground water quality or violated water quality standards.

Construction and Operation Impacts by Project Element

Of the 5,237 acres within the Desert Claim project area, approximately 82 acres of permanently disturbed area would result from construction of the proposed wind energy facility, including impervious surfaces associated with turbine footings, transformers, the substation footprint, and the O&M building footprint. Approximately 63 acres of this would be gravel roads and lots associated with buildings. About 340 acres of land would be temporarily disturbed from the project, including construction of gravel roads and installation of underground cable.

Turbines

Construction of turbines and associated transformers would be spread across the project area, each creating approximately 480 square feet of impervious surface. Due to the very small impervious surface cover at individual turbine sites, amounting to a total project area of 13.2 acres, no impact is expected to ground water recharge.

Buildings

The co-located substation and O&M building would disturb a total area of about 4 acres of ground surface. The area around the buildings would be cleared, graded, and covered with gravel, rendering the entire footprint nearly impervious. This would result in a slightly greater volume of surface water runoff than the existing condition in the locations of the buildings. This would have minimal impacts to ground water recharge, and only in the immediate vicinity of the buildings. Given the nature of the alluvial and glacial outwash soils covering most of the site surface, most of the localized runoff would likely be conveyed to nearby permeable soils and infiltrate over a relatively short distance, resulting in a slight increase to ground water recharge.

Access Roads

Construction of roads would permanently occupy about 61 acres and temporarily disturb about 165 acres, including underground cable installation along the roads. The ground surface would be graded and compacted, and gravel would be installed for road construction. This would render the land area occupied by the roads nearly impervious. The disturbed acreage would be restored and revegetated at the end of construction. Nearly impervious surface created by the road installation would cover about 1 percent of the total project area and be spread across the project area. It is unlikely that road installation would result in a quantifiable impact to ground water recharge for the project. There could be localized areas of increased runoff due to the additional impervious surfaces. However, given the nature of the alluvial and glacial outwash soils covering most of the project surface, most of the localized runoff would likely be conveyed to nearby permeable soils and infiltrate over a relatively short distance, resulting in a slight increase to ground water recharge.

Other Project Elements

Blasting might be necessary to install turbine footings in bedrock areas. Vibration due to blasting and due to the operation of the wind turbines is not expected to significantly affect local ground water and/or wells in the project area. The impact of vibration on ground water flow to wells or withdrawal from water wells depends primarily on the well construction, geologic conditions and proximity to the vibration source. Strong vibration can impact ground water flow and water wells in the following ways: material on the inside of the well bore can slough or collapse, short-term turbidity can occur due to minor water level fluctuation during the blast and rock can fracture, causing increase or decrease of groundwater flow to the well.

The level of ground and structure/well vibrations caused by blasting depends on many factors including explosive type and weight, blasting technology, site geology, and distance between the blasting site and the structure/well. Washington State regulates the use of explosives (Chapter 296-52 of the Washington Administrative Code (WAC), Safety Standards For Possession, Handling, and Use of Explosives). Vibration and damage control is addressed directly in WAC 296-52-67065. The Washington standards are based on federal regulations developed by the U.S. Department of Interior, Office of Surface Mining (formerly the U.S. Bureau of Mines (USBM)). The codes provide methods for determining the maximum ground vibration at any dwelling, public building, school, church, commercial site, cofferdams, piers, underwater structures, or institutional building; however neither the Washington State nor federal regulations provide guidelines for safe blasting distance specifically from domestic water wells. Due to the proximity of existing water wells in the project area to structures that are protected by the regulations, blasting design for turbine installation is expected to be subject to the Washington state regulations.

According to WAC 296-52-67065, the maximum allowable peak particle velocity (PPV, a measure of vibration intensity) for ground vibration at a protected structure is 1.0 in/s (inch per second) for distances of 301 to 5000 feet from the blasting site (blasting for Desert Claim turbine installation would be at least 1000 feet from residences). The regulations also provide recommendations for determining the maximum explosive weight for each blast. Performance of blasting using these guidelines should produce vibration intensities at the water wells and existing protected structures below the standard of 1.0 in/s. Vibration research suggests vibration tolerance for buried utilities, including wells and pipelines, is as high as 5 in/s (Siskind 2000), or five times greater than the PPV recommendations for surface structures at this distance this condition indicates that wells have a higher threshold for vibration than do the surface structures.

A former USBM researcher performed a review of several studies of blasting and mining impacts on domestic water wells and well yields (Hawkins 2000). This research indicates that well sloughing or collapse only occurs when large explosive weights are used (in excess of the standard for protected structures) and the well is inherently weak (Hawkins 2000). This and other studies of blasting vibration indicate that blasting had no effect on wells or ground water flow to wells when it was performed at distances and with explosive weights that are in general compliance with regulations for protected structures (Hawkins 2000; Daniel B, Stephens & Associates, Inc 2002). Minor water level fluctuations have been noted in small to moderate blasts (that are expected to be in general compliance with the standard) that may cause short-term turbidity of the well water (Hawkins 2000). Hawkins' (2000) review of blasting studies suggests that documented long-term changes to well yield at mining sites are likely due to the opening of fractures caused by stress release that is due to the mining operations and removal of rock, and not due to vibration from blasting.

Existing water wells in the project area that are in the immediate vicinity of potential blasting sites are over 1,000 feet away from those blasting sites. Ground water aquifers that supply these wells range in depth from 127 to 895 feet below ground surface and are bedrock aquifers. The distance between the wells and the potential blasting sites and the depth of ground water aquifers should mitigate the possibility of adverse impacts on wells or ground water supplies. The likely potential impacts to water wells and ground water flow from blasting vibration at the project include minor water level fluctuations and minor short-term turbidity in some wells during blasts. Turbidity is not expected to be substantial or long-term. Well sloughing, well collapse or well yield fluctuations are not expected because of the distance between the wells and the blasting sites and the depth to aquifers in the potential blasting areas.

Locations of wells may differ from those provided by the Department of Ecology Water Well Reports. Well locations in proximity to blasting sites should be verified prior to blasting. Potential impacts from vibration due to blasting can be mitigated by following the appropriate regulations for blasting vibrations for protected structures and applying those regulations to water wells.

The wind turbines would generate a certain amount of vibration during operation. Vibration is expected to be far less than the vibration due to blasting and to dissipate quickly with depth beneath the ground surface. A seismic study was performed by the University of Oregon to determine the ground vibration caused by operation of wind turbines at a location in Washington State with geologic conditions similar to those at the Desert Claim site. The study provides information on the magnitude of ground motion caused by the operation of wind turbines. According to this study, for distances of approximately 1000 feet, vibrations caused by a wind turbine would be on the order of a million times less than the maximum allowable vibration intensity provided by the blasting regulations discussed above (Schofield 2002). In terms of human perception of vibration in the long term, the threshold for which people begin to perceive vibration is in the range of 0.01 in/s to 0.02 in/s PPV, which is on the order of 10,000 times greater than the vibration expected from a wind turbine 1000 feet away (Hendron 1976). No impacts to ground water or water wells are expected from vibrations caused by turbine operation.

Ground Water Supply

A limited amount of ground water would be needed for long-term operation of the project. This would be provided either by a participating landowner or through development of an exempt well, per the Washington State Water Code, Chapter 90.03 RCW. Less than 5,000 gpd would be extracted for domestic use for the O&M building, as allowed by Ecology for an exempt well. Restroom and kitchen facilities

would drain into an on-site septic system, recharging the ground water in the vicinity of extraction. No quantifiable impacts to ground water supply would result from this usage.

Ground Water Quality

One on-site septic system would be developed to serve the proposed project O&M facility. The septic system would be treating and discharging up to 5,000 gpd of water, likely much less, from limited domestic kitchen and bathroom use. Assuming the on-site septic system is adequately maintained, no impacts to ground water quality are expected from wastewater generated by the proposed project.

Heavy equipment and vehicles would be used in the project area during the construction phase. On-site fueling and limited storage of products such as lubricating oil and hydraulic fluid would be expected. Unintended release of fuels, oil, or hydraulic fluid would be possible and could contaminate soils. If unattended or uncontrolled, spills could migrate to ground water or into surface water resources. The State Stormwater Construction Discharge Permit (SWPPP, discussed in **Section 3.3.5**) should also be used to plan control measures and spill response to prevent or control construction equipment leakage of fuel or other petroleum- based products, such as oil and hydraulic fluid. Water quality impacts from construction spills can typically be prevented or limited to very local areas by best management practices (BMPs) and accidental spill provisions as required by the National Pollutant Discharge Elimination System NPDES permit (discussed in **Section 3.3.5)**.

Minor short-term turbidity due to water level fluctuations in wells from blasting vibration is a potential water quality impact. Studies suggest that the amount of turbidity expected from the project is comparable to significant rainfall events or water level fluctuation due to heavy well pumping (Hawkins 2000). Adherence to state and federal regulations in regard to blasting distance and explosive weight limits should mitigate this potential impact, as discussed above.

Ground Water Conclusions

Potential impacts to ground water from the proposed project include disruption to ground water flow, recharge, or discharge, depletion of ground water supply, or lowering of ground water quality. Impervious surfaces would be created by the project, but they are limited in size and extent across the project area and are expected to have minimal impacts to recharge, discharge or ground water flow if recommended mitigations are followed. Impacts to ground water supply are not expected from the proposed project. Localized impacts to ground water quality are possible from wastewater and petroleum product spills, but can be avoided if recommended mitigations are followed. Minor short-term turbidity due to water level fluctuations in wells from blasting vibration is a potential water quality impact, but would be minimized by following the applicable regulations. Overall, the project is not expected to result in the potential for significant adverse impacts to ground water flow, recharge or discharge, ground water supply or ground water quality.

3.3.3 Impacts of the Alternatives

3.3.3.1 Alternative 1: Wild Horse Site

Surface Water

Impacts on surface water from Alternative 1 would be similar to those described in **Section 3.3.2** for the proposed action. Surface water runoff potential from precipitation would be greatest during the construction period, when large quantities of soil would be disturbed for development of roads, tower foundations and other infrastructure. However, impacts to surface waters in the project area are expected to be minimal, due to the relative distances between project facility locations and existing surface water sources. In addition, erosion and stormwater control measures for Alternative 1 would be essentially the same as those described for the proposed action. Construction of Alternative 1 would likewise require water use for road construction, wetting of concrete, dust control and other activities. The possibility of construction water discharge entering surface waters would also be remote. Water withdrawal for construction uses would not cause an impact to nearby surface waters because the contractor would arrange for delivery of water to the site via water trucks from an offsite source with an existing water right.

Operation of Alternative 1 would not require the use of any water for cooling or any other use besides the domestic well serving the limited needs of the operations and maintenance facility. Therefore, project operation is not expected to result in any discharges to surface water.

Ground Water

The tower foundations and other facilities would be sufficiently above the water table depth to avoid any significant impacts to subsurface hydrology. Construction of the foundations would likely begin during the dry season (July) and continue through the end of autumn (mid December); potential impacts to groundwater would likely be low because dry weather conditions and a low water table are typical in the region during this period.

Operation of the project would have minimal impacts to groundwater. A licensed installer would develop a domestic well to serve the operations and maintenance facility. This well would provide water for bathroom and kitchen use, which is expected to consume less than 1,000 gallons per day. It is anticipated this well would be installed to a depth well below the shallow groundwater that supports the springs in the area, and is likely to be disconnected from the same shallow aquifer that supplies the springs. There would be no discharges to groundwater from project operations. Wastewater from the O&M facility would be discharged to a domestic septic tank installed pursuant to the requirements of Kittitas County Environmental Health Department

3.3.3.2 Alternative 2: Springwood Ranch Site

Surface Water

Impacts on surface water from Alternative 2 would be of the same type as those described in **Section 3.3.2** for the proposed action. Alternative 2 would involve potential impacts over a smaller area and in fewer specific locations, however, because of the smaller site and fewer turbines associated with

Alternative 2. The possibility of construction stormwater discharge entering surface waters would also be small, because the site has few surface water features and because the erosion and stormwater control measures for Alternative 2 would be essentially the same as those described for the proposed action. In addition, most of the project facilities for Alternative 2 would be relatively distant from existing surface water features. Six to eight of the presumed turbine locations (and their associated access roads) would be within approximately one-quarter mile of the Yakima River, however, and are near slopes mapped as high erosion and landslide hazard areas. These physical conditions represent localized concerns for potential impacts to surface water during construction, and might warrant site-specific mitigation measures.

Operation of a wind energy project developed under Alternative 2 would create minimal demands for water supply and would have minimal influence on existing surface water runoff patterns for the site. Therefore, long-term operation would not result in significant impacts to surface water resources.

Ground Water

As discussed for the proposed action and Alternative 1, construction of a wind energy project under Alternative 2 would have minimal impacts on ground water. Wind turbines would be located at higher elevations within the project site, and construction of their foundations would not be likely to affect subsurface hydrology in the shallow aquifer underneath the site. Runoff from disturbed areas would be infiltrated on site, resulting in a minor temporary increase in groundwater recharge. Any blasting that might be necessary for construction of tower foundations would not be expected to affect local wells.

Operation of the project would likely have minimal long-term impacts to ground water. Impervious surfaces associated with turbines, roads and buildings would result in a minor increase in surface runoff volume, some of which could translate into a minor increase in groundwater recharge in the shallow aquifer(s) underlying the upland portions of the site. Water demands for project operation would be negligible and would have no impact on ground water supply.

3.3.3.3 No Action Alternative

Surface Water

Under the No Action Alternative, the proposed wind power facility would not be constructed and the potential surface water impacts identified in **Section 3.3.2** would not occur. Past and current effects to streams from existing land uses would continue for the foreseeable future. Additional land use conversion and low-intensity residential development would be possible over the long term, and could result in additional direct and indirect impacts to streams.

Ground Water

Impacts on ground water recharge under the no action alternative would be dependent on: (1) the amount of impervious surfaces resulting from future development of the individual parcels; and (2) the best management practices (BMPs) used to convey and discharge collected stormwater runoff. A maximum of about 400 developed parcels could result from future development of the project area, based on existing zoning provisions. Development of the parcels would likely occur on a lot-by-lot basis. The total amount of impervious surfaces resulting from this scenario would probably represent less than 1 to 2 percent of the total acreage. It is unlikely that this development density would result in a quantifiable impact to ground water recharge for the site. There might be localized areas of increased runoff due to the

additional impervious surfaces. However, given the nature of the alluvial and glacial outwash soils covering most of the site surface, most of the localized runoff would likely be conveyed to nearby permeable soils and infiltrate over a relatively short distance, resulting in minimal impacts to ground water recharge.

Water supply for future development of individual parcels under the no action alternative would likely be provided using exempt domestic wells, with daily use limited to less than 5,000 gpd for each well. A maximum cumulative ground water extraction rate of 2.0 million gallons per day (MGD) might occur if each of 400 exempt wells were to pump water at the maximum rate of 5,000 gpd. However, the actual ground water extraction rate would likely be less than this amount because some lots might be developed as recreational residences and would likely not be occupied year-round, and total ground water needs for individual residences typically average much less than 5,000 gpd. Some of the withdrawn ground water would be returned to the subsurface through use of individual on-site septic systems.

Potential impacts to aquifers would be minimal as a result of ground water pumping from 400 exempt wells dispersed across the 5,237-acre project area. Based on the relatively small fraction of water withdrawn for domestic use, the no action alternative is expected to have an insignificant impact on the quantity of water available from aquifers underlying the project area.

3.3.4 Cumulative Impacts

Cumulative impacts for all elements of the environment are addressed in **Chapter 4**.

3.3.5 Mitigation Measures

3.3.5.1 Surface Water

Micro-Siting

Specific locations of wind farm project components are often shifted somewhat during project planning and prior to final design, in a process known as micro-siting. To a degree, the modified project configuration evaluated in the Final EIS already reflects a level of micro-siting to avoid or reduce resource conflicts identified in the Draft EIS. The applicant proposes to conduct further micro-site analyses of turbine and project access road locations during the Critical Areas review process to avoid and/or minimize impacts to water bodies and/or wetlands identified in **Section 3.3.2.1**. In addition, in some locations it might be possible to shift the temporary disturbance zone, which has been calculated as a 100-foot radius buffer around each turbine, to avoid placing these directly in surface water or riparian areas or to reduce the extent of overlap. Project construction and access roads would be designed to avoid stream crossings wherever possible.

Erosion and Storm Water Runoff Control

If temporary and/or permanent access roads must be constructed across streams and drainage ways for the project, these roads would be designed so runoff from the upper portions of the watershed can flow unrestricted to the lower portion of the watershed. Erosion control measures would be installed prior to construction and maintained throughout construction until disturbed areas have been successfully revegetated.

Any creek crossings or work adjacent to creeks and wetlands would adhere to applicable federal and state regulations that would be addressed in the State Stormwater Construction Discharge Permit, Surface Water Pollution Prevention Plan (SWPPP), and Temporary Erosion and Sedimentation Control Plan (TESCP). Other measures to reduce or control impacts include compliance with applicable requirements of Kittitas County Critical Areas regulations (KCC Title 17A), the State Water Code (RCW chapter 90.03), and the State Water Pollution Control Act (RCW Chapter 90.48).

A NPDES Construction Stormwater Permit would be obtained prior to the construction of the wind turbines and project access roads. On-site erosion control measures as outlined in the State NPDES Construction Stormwater Permit, SWPPP, and TESCP would be implemented to control project-related surface water runoff.

Best Management Practices (BMPs) would be incorporated into the NPDES Construction Stormwater permit, SWPPP and TESCP, including:

- Appropriate sized culverts would be installed at stream crossings;
- Sedimentation fences, certified weed-free straw bales or other control devices would be placed in areas of bare excavated soil, and in roadside drainage ditches and streams downstream of the work sites, to reduce surface runoff velocities and to protect stream channels;
- Erosion control measures would be implemented and would employ the use of water bars, slope breakers (silt fence, staked hay or straw bales, or sand bags), and mulch (straw, hay, erosion control fabric, or some functional equivalent) as necessary; and
- Project staging areas would be not be located within 100 feet of drainages or any other body of water, or wetland or riparian areas, to reduce the potential contamination from spills.

Section 3.1.5.1 also discusses erosion and sedimentation control measures that would be required under terms of the applicable permits.

Waste Materials

It is not anticipated that waste materials would enter ground or surface waters. Best Management Practices would be used to control the use and disposal of waste materials during and following project construction, including implementation of a spill prevention, containment and control plan. Waste materials from construction equipment would be minimal and are not expected to impact ground or surface waters. Hazardous materials, such as lubricants, would be stored in approved containers and storage facilities. Use of hazardous materials would follow prescribed procedures intended to prevent accidents and spills, and to control and limit the consequences of any spills that might occur.

3.3.5.2 Ground Water

Mitigation measures to minimize potential adverse impacts to ground water flow, recharge or discharge include the following.

- Infiltrate water within or as close as possible to facilities that would generate surface water runoff from the impervious surfaces.
- Use biofiltration swales, surface dispersion and infiltration through roadside ditches.

Roof runoff would be infiltrated into subsurface soils surrounding the substation and O&M buildings.

Mitigation measures to minimize potential adverse impacts of vibration on ground water flow to wells or to water wells operation due to the use of explosives for turbine installation includes the following.

- Verification of water well locations in the vicinity of blasting sites
- Compliance with all existing regulations in regard to blasting design, including allowable distances to existing protected structures, including wells, and allowable explosive weights.

Mitigation measures to minimize potential adverse impacts to ground water quality include the following.

- Control all pollutants on-site, including removal and legal disposal of construction waste or soils contaminated by construction activity or accidental spills.
- Prepare and maintain accidental spill response plans, on-site clean-up materials storage, and worker training.
- Inspect and maintain on-site septic systems annually.

3.3.6 Significant Unavoidable Adverse Impacts

The analysis of surface water resources identified several types of potential impacts to surface water bodies and associated riparian areas from the modified project layout. The existence of these potential surface water impacts relates primarily to access road crossings of streams, and secondarily to several mapped turbine locations that are near streams. Ground disturbance at streams would be small in extent, and most of the disturbance would be temporary; disturbed stream bank areas would be restored with native vegetation. Permanent culverts of sufficient size would be installed at all stream crossings, resulting in no long-term changes to stream character, discharge capacity or flow patterns. Potential surface water impacts associated with erosion and sedimentation would be avoided or minimized through use of best management practices that are standard requirements for construction activities. With appropriate mitigation that would be required under the terms of the applicable permits, all of the potential temporary and permanent surface water impacts identified in **Section 3.3.2** would be avoided, counteracted through restoration, or offset through provision of compensatory stream enhancement or development. Similarly, there would be no significant, unavoidable adverse impacts to ground water recharge, discharge or supply from the project. Impervious surfaces resulting from construction of permanent facilities would be small in extent and would have a negligible effect on local runoff and ground water recharge patterns. Project construction and operation would not result in discharges that degraded ground water quality. If blasting were necessary in some locations for construction of project facilities, it would be conducted according to regulations that protect wells and structures from significant impacts. Therefore, no significant unavoidable adverse impacts to water resources are expected as a result of the proposed project.