



Network Engineering

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## SEA Hyak – Radio Frequency (RF) Documentation

### Overview:

Verizon Wireless strives to provide excellent wireless service with a network of cell sites that allows our customers to reliably place and receive mobile phone calls. In this particular case, we are trying to remedy coverage challenges in this area in Snoqualmie Pass. Specifically, the SEA Hyak site will cover I-90 approximately between Exit 54 east bound and the far East end of Keechelus Lake. In addition to providing coverage to the interstate, Hyak will provide coverage to the ski lodges in the area. This site will add needed coverage improvements to these areas so that customers will receive better service and faster data speeds.

Construction of the proposed site entails installing twelve (12) antennas, auxiliary equipment, and the supporting base station equipment at the top of the East Peak Chair Lift in Snoqualmie Pass, WA. In-building penetration for new Ski Resprts, coverage challenges along I-90, and continued growth in our customer base, and call traffic in this area has dictated the need for the proposed site.

### Capacity:

An additional function of some wireless sites, such as the subject SEA Hyak site, is to provide additional capacity in an area. The capacity of wireless networks is limited by the spectrum availability, the number of available antennas, and the radios and amplifiers associated with those antennas and spectrum. When a mobile user attempts to make a call on a wireless network where capacity is limited by these factors, the resulting delay and busy signal can be very frustrating. To remedy capacity issues, additional sites and or spectrum, which are directly correlated to the number of antennas at the site as outlined below, are added to an area to provide additional calling capacity for Verizon Wireless customers.

There are some Verizon Wireless sites in the immediate vicinity that are at or near capacity due to trying to provide service to customers in the poor coverage area. To remedy the reduced capacity, the subject site is being proposed so that calls at surrounding sites can be "offloaded" to the proposed site and thus creating more wireless capacity for the vicinity. In order for this capacity off-loading to be successful, precise placement of the new antennas is necessary. If the site is too far away, the signal will not have adequate strength to capture calls from the impacted existing sites or cells. Similarly, sites that are too close together will not provide the needed capacity relief to the existing sites. Thus for new site/cell capacity solutions to work, site placement and height are critical factors and must be chosen carefully.

### Coverage:

In order to provide excellent Cellular service, which Verizon Wireless defines as  $-85$  dBm or better, the antenna height and site location need to provide a line of sight to the roads, ski lodges, and homes, and hotels where our customers need the coverage the most. Four sets of four antennas (a total of twelve (12) antennas are being proposed, in order to provide the necessary radio frequencies supporting all of Verizon Wireless voice and data services. Equipment cabinets are being placed within a new enclosure. The proposed antenna height of 55' is the minimum height needed for the effective functioning of the proposed rooftop antennas. The tower size of 150' is the minimum height needed to achieve the needed



cellular coverage. Terrain diversity and the tree line in the vicinity make this the minimum height necessary to provide adequate levels of coverage and usage offloading in the context of surrounding Verizon Wireless sites.

#### **Alternative Sites Reviewed:**

Verizon Wireless reviewed other potential locations in the area. The East Peak Chair Lift summit is the only location in the area that has the line of site to I-90 needed to achieve all of the desired coverage as well as a potential to provide the power necessary to run the site.

#### **Propagation Maps:**

There are several methods for determining where coverage gaps exist within a given network of wireless sites. One of these is through the use of propagation maps. The propagation map is a computer simulation of the strength of Verizon Wireless signals at a given height and location in the context of the network. Propagation maps are one tool for determining whether a proposed site will meet the coverage objective and what antenna height is needed to provide robust service for Verizon Wireless customers. The radio propagation tool is designed to take factors such as terrain, tree coverage, and existing buildings into account, so that it depicts a reliable estimate of coverage that would be provided by a proposed site.

The propagation maps that follow show three levels of service, designated as the following colors:

Green  $\geq$  -80 dBm, a level of service adequate for providing reliable coverage inside a building

Yellow  $\geq$  -90 dBm, a level of service adequate for providing reliable coverage outdoors or inside a car

White  $\leq$  -90 dBm, unreliable signal strength, may not be not capable of reliably making and holding a call depending on environment

The planned service area of SEA Hyak currently has spotty outdoor coverage. Verizon would like to use SEA Hyak to improve the outdoor and indoor coverage for the area which can be seen in the attached propagation maps.

#### **Site Location:**

The location of the subject site has been selected based on its relationship with surrounding Verizon Wireless sites within Kittitas County. The Kittitas County code requires within the Forest and Range zone that applicants provide justification for construction of new facilities and demonstrate that the proposed facility is the minimum height for needed for effective antenna functioning and that the antennas have been consolidated as much as feasible.

As noted above, the proposed antenna height of 55 is the minimum height needed for the effective functioning of the proposed antennas. The new tower height, antenna sizes and the terrain diversity in the vicinity make this the minimum height necessary to provide adequate levels of coverage and usage offloading in the context of surrounding Verizon Wireless sites.

The antennas have been consolidated as much as possible and still meet coverage objectives. Verizon uses separate antennas for each frequency that will be transmitted from the cell site and also must separate frequencies that cause intermodulation interference with each other. Each of these antennas





needs line of site to the desired service area. They must be faced to the coverage area with nothing directly between the coverage area and the antenna and minimal roof space directly below the antenna so that the bottom portion of the beam is not blocked

#### **Antenna Diversity:**

Antenna diversity, also known as space diversity, is one method of enhancing wireless signal to improve the quality and reliability of a wireless link. Often, in urban environments such as the environment surrounding the subject site, there is not a clear line of sight between the antennas and customers' handsets. In these cases, the signal may be reflected along multiple paths before it finally reaches the receiver. These reflections can result in phase shifts, time delays, attenuations, and signal distortion that the customer may experience as an echo or warbling in the signal, or the signal dropping altogether.

Antenna diversity is especially effective at remedying these types of issues because multiple antennas provide several "observations" of the same signal. Each antenna will experience a different interference environment resulting in an added 5-8 dB in processing gain in the RF link budget. So, for example, if one antenna is experiencing a deep fade it is likely that another antenna physically separated, but in the same sector, will have sufficient signal. Providing receive signal diversity then, is absolutely necessary for providing robust signal at the proposed location.

#### **Spectrum:**

The SEA Hyak site will utilize our PCS A5, C2 & D 1900 MHz frequencies, 700 MHz LTE Upper C Block, and AWS B, C, & D 2100 MHz. It will basically be three wireless facilities located in the same physical equipment area, with separate antenna requirements for each frequency set. For the SEA Hyak the proposed technologies are PCS LTE 4G MIMO, 700 LTE 4G MIMO, and AWS LTE 4G MIMO. Interference mitigation requirements between our frequencies have specific antenna configuration requirements.

#### **Design:**

Each licensed frequency has specific propagation characteristics further influenced by hardware power limitations. The 750 MHz has better propagation characteristics than the PCS and AWS band. The lower frequency bands received signal will be stronger at the mobile phone than the higher frequency signal if all are transmitted from the same base station with the same output power and same coding scheme.

With the addition each PCS, AWS, and 700 LTE frequencies, and recognizing jurisdictional need to minimize the number of antennas per sector/site Verizon Wireless has made the design decision to utilize Cross pole single band antennas for all frequencies. The Cross pole antennas can be thought of as two vertically stacked antennas in the same physical package. The aforementioned processing gain for spatial diversity in the RF link budget is reduced or eliminated depending upon the environment for all frequency sets. Ideally an optimal design would utilize two physically separated antennas per frequency per sector. With three frequency sets this would lead to four antennas per sector and twelve antennas for a three sector site such as this one. Verizon Wireless RF Design has made a conscious decision to minimize the antenna requirements at the expense of the RF link budget.

SEA Hyak has been designed with twelve (12) antennas. This is the minimum antenna requirement for this four sector site to get the best possible service from each of our transmit frequencies and add the needed service capacity to the area.



## Wireless E- 911

Approximately 400,000 Wireless 911 calls are made every day nationwide, and this number continues to increase. (source: CTIA, the Wireless Association) Wireless E-911 service depends on reliable signal strength and a fairly dense network of antenna sites in order to function effectively. Because of our federally-mandated obligation to provide wireless E-911 service, signal reliability is paramount. Using multiple antennas with spatial diversity is an effective way to decrease the number of drop-outs and lost connections to ensure that coverage in this area is robust and reliable.

### Summary:

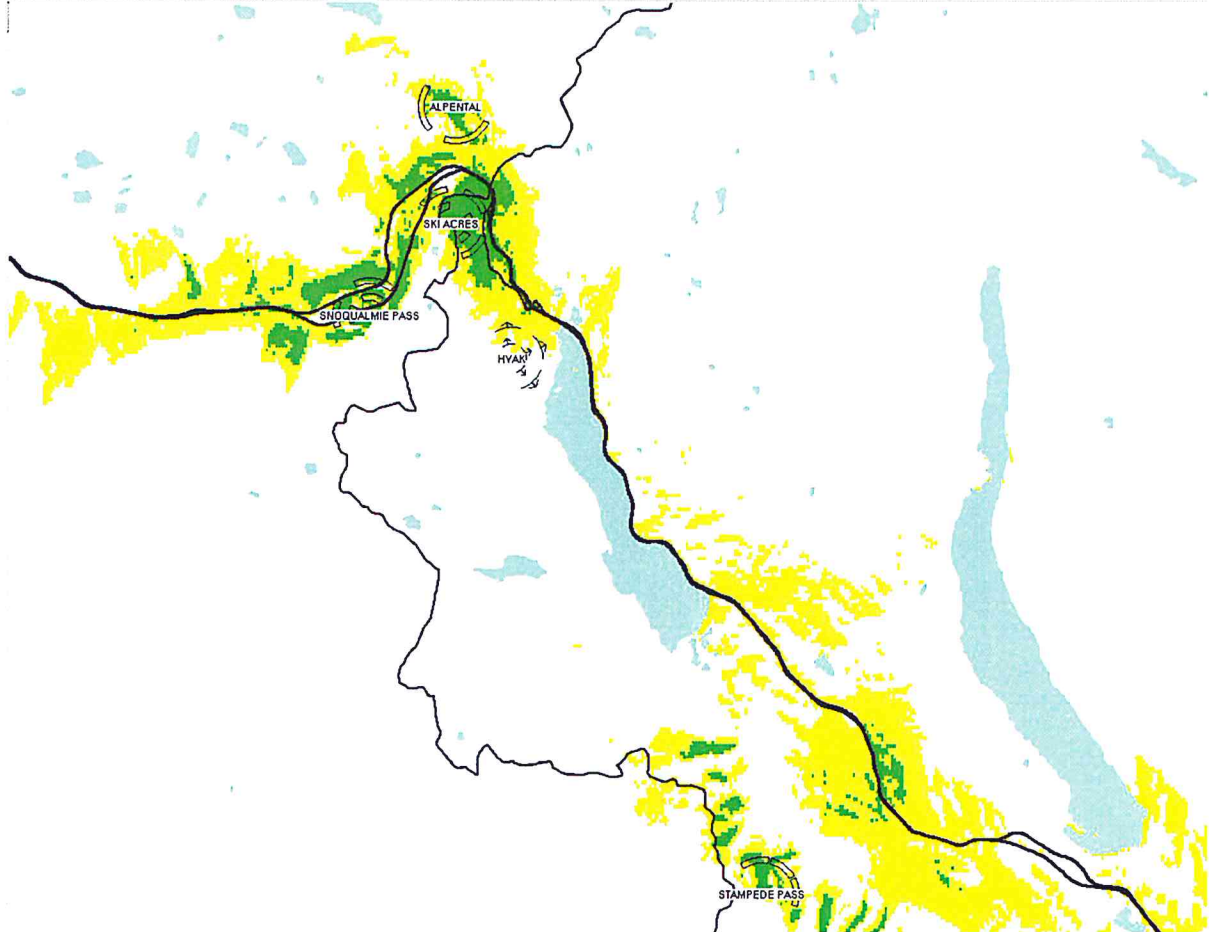
In summary, the proposed site would meet the RF coverage objective of the subject site. The height of the twelve (12) antenna array is the minimum required for the effective functioning of the proposed minor communication utility.

Sincerely,

A handwritten signature in black ink, appearing to read "Krystal Taylor", written over a horizontal line.

Krystal Taylor  
Verizon Wireless

Before Hyak



After Hyak

