SENSOR ENVIRONMENTAL LLC
2483 Old Middlefield Way, Suite 209, Mountain View, CA 94043-2330
www.sensorenvirollc.com

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SUPPLEMENTAL ENVIRONMENTAL ASSESSSMENT (EA) OF THE ELECTROMAGNETIC EFFECTS OF OPERATING WEATHER SERVICE RADAR – 1988, DOPPLER (WSR-88D) TO SERVE COASTAL WASHINGTON AT SCAN ANGLES BELOW +0.5 DEGREE

Prepared by

James Manitakos Jr., Principal
Roshni Easley, Technical Editor
Anne Elston, Environmental Analyst
Linda Hawke-Gerrans, Senior GIS Specialist

Sensor Environmental LLC

Prepared for

National Weather Service / Centuria Corporation
WSR-88D Radar Operations Center
Norman, OK

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EXECUTIVE SUMMARY

The National Weather Service (NWS) is in the process of installing a Weather Service Radar – 1988, Doppler (WSR-88D) to serve the Coastal Washington area. The new radar will be incorporated into the NWS nationwide network of weather radars. The WSR-88D is being installed at the Langley Hill site in Grays Harbor County. The WSR-88D is an S-band Doppler, dual polarized weather radar. The NWS objectives are to improve analysis and prediction of strong winter storm systems that frequent the region and to optimize radar coverage over areas not adequately served by the existing NWS radars in Seattle, Washington, and Portland, Oregon. In July 2010, NWS issued a Final Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) for construction and operation of the WSR-88D to serve Coastal Washington. WSR-88Ds in the nationwide network currently operate at a minimum scan angle of +0.5 degree (deg) and the 2010 EA analysis addressed that minimum scan angle.

The NWS is considering operating the WSR-88D to serve Coastal Washington at a minimum scan angle between +0.5 and 0.0 deg (i.e., up to one-half deg lower than the current minimum system scan angle). Because the 2010 EA did not analyze scan angles below +0.5 deg, NWS prepared this Supplemental EA to analyze the environmental consequences of the proposed lower scan angles.

This Supplemental EA extends that prior study to examine the possible effects of operating the WSR-88D to serve Coastal Washington at scan angles between +0.5 and 0.0 deg (i.e., lower than the scan angles examined in the April 1993 Supplemental EA). The NWS objectives for this radar would be advanced by altering the scan pattern used by the radar to include scanning at angles below the +0.5 deg above horizontal. Operating this radar at lower scan angles would increase the area of radar coverage and increase the amount of radar information provided to NWS forecasters and other data users. Table S-1 (see page ii) shows the change in area covered at various elevations above site level (ASL) for the existing +0.5 deg scan angle and the lower scan angles under consideration by the NWS. Radar coverage distances would increase, primarily over the Pacific Ocean, with lowering of the minimum center of beam scan angle down to +0.2 deg. Lowering the scan angle below +0.2 deg would not result in any additional increase in coverage.

The time-averaged power density of radiofrequency radiation (RFR) was compared to the C95.1-2005 standard (i.e., the current national standard) for safe exposure of humans to RFR. The C95.1-2005 standard was developed by the Institute of Electrical and Electronic Engineers, and formally approved by the American National Standards Institute. This standard is intended to protect all members of society (including elderly persons, pregnant women, and infants) from long-term RFR exposure and includes a 50-fold safety factor to ensure that no harm will result to persons from exposure to RFR fields. The WSR-88D radio signal, operating at minimum center of beam scan angles of +0.5 to 0.0 deg, will comply with the safety standards for both the general public and occupational exposure at all locations outside the WSR-88D radome. At the surface of the radome, the RFR power density will be 60 percent below the safe exposure level for the general public contained in the standard. At ground level at the base of the tower, RFR power density will be 2,170 times less than safe exposure level for the general public. The closest location where the ground surface would be illuminated by the WSR-88D main beam is 3.5 miles (mi) from the radar. At that distance, the RFR power density will be 10,000 times less than safe exposure level for the general public. Two licensed radio towers are located at distances of 2,900 and 5,600 ft from the WSR-88D site. Those towers would make negligible contributions to the RFR levels in the vicinity of the radar site. Cumulative RF exposure would comply with safety standards for human exposure to RFR.

The standard also covers occupational exposure; the RFR safety level for occupational settings is higher than the safe exposure level for the general public. Operating the WSR-88D to serve Coastal Washington at a minimum scan angle between +0.5 and 0.0 deg would not result in RFR exposure hazards to the general public or workers in the vicinity of the radar.

Table S-1. Change in Coverage Area for Each Minimum Scan Angle

Minimum Center of Beam Scan Angle (deg)	Coverage Floor Scan Angle (deg)	Total Area Covered at 2,000 feet (ft) ASL in square miles (sq mi) (change from +0.5 deg scan)	Total Area Covered at 4,000 ft ASL in sq mi (change from +0.5 deg scan)	Total Area Covered at 10,000 ft ASL in sq mi (change from +0.5 deg scan)
+0.5	0.0	9,419	19,669	52,240
+0.4	-0.1	11,402 (+21.1%)	22,382 (+13.8%)	56,540 (+7.9%)
+0.3	-0.2	13,715 (+45.6%)	25,311 (+28.5%)	60,699 (+16.2%)
+0.2	-0.3	16,131 (+71.3%)	28,196 (+43.4%)	64,573 (+23.6%)
+0.1	-0.4	16,131 (+71.3%)	28,196 (+43.4%)	64,573 (+23.6%)
0.0	-0.5	16,131 (+71.3%)	28,196 (+43.4%)	64,573 (+23.6%)

The WSR-88D to serve Coastal Washington will operate at a frequency of 2,836 megahertz (MHz). This frequency was selected to minimize the potential for electromagnetic interference (EMI) with other radiofrequency (RF) users. The National Telecommunications and Information Administration (NTIA) of the Department of Commerce licenses government radio stations and has approved the 2,836 MHz operating frequency for this WSR-88D. The NTIA regulations reserve the 2,700 to 3,000 MHz band for government radiolocation users (e.g., meteorological and aircraft surveillance radars). The WSR-88D operates outside the frequencies used by television and radio broadcasts, cellular telephones, and personal communication devices. Based on the government experience over the last 23 years operating 155 WSR-88Ds, the potential for WSR-88D to cause EMI with television, radio, cellular telephones, or personal communication devices is very low.

Under certain conditions, high power RFR can cause electro-explosive devices (EEDs) to pre-maturely detonate or ignite fuel being moved between containers (i.e., fueling of boats or aircraft). The U.S. Navy Sea Systems Command developed technical guidance that establishes the safe separation distance for EEDs and fuel handling activities, considering characteristics of the RFR emitter and the susceptibility state of the EED. For the most susceptible EED, the safe separation distance from a WSR-88D is 6,030 ft. For fuel handling, the safe separation distance is 537 ft from the WSR-88D. These risks are only present if the EED or fueling is directly illuminated by the main beam of the radar. The WSR-88D operating at 0.0 deg minimum scan angle would not illuminate the ground within 3.5 mi (18,480 ft) of the radar. No hazards to EEDs or fuel handling activities would result.

Under certain conditions, high power RFR can cause EMI with active implantable medical devices (e.g., implantable cardiac pacemakers, implantable cardiac defibrillators). The Association for Advancement of Medical Instrumentation (AAMI) developed requirements for the RFR field levels that such devices must be able to withstand without malfunction or harm to the device. The WSR-88D main beam would exceed the AAMI threshold level only within 2,060 ft of the radar. The main beam would not illuminate the ground within that distance and there is very low potential for harm to wearers of active implantable medical devices.

Implementing the proposed action would not require construction of new facilities or physical modification to the WSR-88D tower, antenna, or support equipment and structures. No changes in the cultural or natural environment would result.

The NWS distributed the Draft Supplemental EA to interested members of the public and government agencies for review and comment. Comments on the Draft Supplemental EA were accepted by NWS during a 30-day comment period running from July 8, 2011 through August 7, 2011. Official responses to all pertinent comments are contained in Section 6.3 of this document.

The additional analysis contained in the Supplemental EA confirms that the Finding of No Significant Impacts issued by the NWS in 2010 remains valid. Neither individual not cumulative environmental impacts would be significant. Preparation of an environmental impact statement is not required.

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CONTENTS

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FIGURES

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TABLES

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ABBREVIATIONS

AGL	above ground level
AAMI	Association for Advancement of Medical Instrumentation
ANSI	American National Standards Institute
ASL	above site level
CZM	Coastal Zone Management
D	distance
deg	degree(s)
DoA	Department of Agriculture
EA	Environmental Assessment
E field	electric field
E.O.	Executive Order
EED	electro-explosive device
EMI	electromagnetic interference
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESS	Expanded Site Survey
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FONSI	Finding of No Significant Impact
ft	foot, feet
G-5	General Development District-5
H field	magnetic field
HERO	Hazards of Electromagnetic Radiation to Ordnance
IEEE	Institute of Electrical and Electronics Engineers
JSPO	Joint System Program Office
m	meter(s)
MBTA	Migratory Bird Treaty Act (of 1918)
MHz	megahertz
mi	mile(s)
MPE	maximum permissible exposure
MSL	mean sea level

mW/cm^2	milliwatts per square centimeter
mya	million years ago
NAAQS	National Ambient Air Quality Standards
NAO	NOAA Administrative Order
NEPA	National Environmental Policy Act
NEXRAD	Next Generation Weather Radar (also known as WSR-88D)
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NTIA	National Telecommunications and Information Administration
NWS	National Weather Service
PEIS	Programmatic Environmental Impact Statement
RF	radiofrequency
RFR	radiofrequency radiation
S.R.	State Route
SEPA	State Environmental Policy Act
SHPO	State Historic Preservation Officer
sq mi	square mile(s)
SWPPP	Storm Water Pollution Prevention Plan
U.S.	United States
USAF	U.S. Air Force
USFWS	U.S. Fish and Wildlife Service
WSR-88D	Weather Service Radar – 1988, Doppler

1 BACKGROUND AND SCOPE OF REPORT

1.1 BACKGROUND

The National Weather Service (NWS) operates a nationwide network of weather radars that provide critical real-time information on atmospheric conditions to weather forecasters. Additional similar weather radars located in Alaska and Hawaii are operated by the Department of Transportation Federal Aviation Administration (FAA). The Department of Defense Air Weather Service also operates weather radars located at United States (U.S.) military installations in the U.S. and abroad. The weather radars operated by these three agencies are part of a network.

The network radars operated by NWS are named Weather Service Radar – 1988, Doppler (WSR-88D) after the year they were first put into service and their capabilities to use Doppler shift measurements to determine wind velocities. They are also known as Next Generation Weather Radars (NEXRADs). Like all active radars, the WSR-88D transmits a radio signal, which reflects off targets and returns to the radar. The radar measures the strength of the return signal, its direction of return, and the time between transmission and return, which allows determination of the targets characteristics. Because the WSR-88D has the potential to cause electromagnetic effects on the environment, NWS carefully considered these effects and strives to prevent effects, or when effects cannot be avoided, mitigate the significance of those effects. To that end, the NEXRAD Joint System Program Office (JSPO) prepared environmental reports evaluating potential electromagnetic effects of the WSR-88D during planning and implementation of the WSR-88D network. In 1984, the JSPO issued the first environmental document which considered electromagnetic effects (among other effects). That report is titled *Next Generation Weather Radar Programmatic Environmental Impact Statement (PEIS), Report R400-PE201* [NWS, 1984]. In 1993, JSPO issued a supplemental report updating the analysis contained in the 1984 PEIS to account for changes since 1984 in electromagnetic standards and guidelines and developments in radar design and operational modes. The supplemental report is titled *Final Supplemental Environmental Assessment (SEA) of the Effects of Electromagnetic Radiation from the WSR-88D Radar* [NEXRAD JSPO, 1993].

In 2009, the NWS proposed adding a new WSR-88D to be located in the Coastal Washington area to the nationwide network. NWS issued an Environmental Assessment (EA) analyzing potential effects of the proposed WSR-88D to serve Coastal Washington in June 2010. That report is titled *Final Expanded Site Survey / Environmental Assessment Report, National Weather Service (NWS) Network Radar to Serve Coastal Washington* [SRI International, 2010]. The 2010 EA found that environmental consequences of installing this radar would not be significant and NWS issued a Finding of No Significant Impact (FONSI) in July 2010. The NWS is currently in the process of installing the WSR-88D to Serve Coastal Washington. The International Civilian Aviation Organization identifier for this radar is KLGX.

NWS evaluated the radar coverage to be provided by the WSR-88D to serve Coastal Washington and found that lowering the minimum scan angle used in radar operations below +0.5 degrees (deg) (the minimum scan angle currently used by other WSR-88Ds in the nationwide network) would increase its range over the Pacific Ocean and lower the height of the coverage floor over the ocean, which will benefit weather forecasters and other users of the radar data.

Because the 2010 EA did not address operation of the Costal Washington WSR-88D at scan angles below +0.5 deg, NWS prepared this Supplemental EA evaluating the potential electromagnetic effects of operating this radar at minimum scan angles between +0.5 and 0.0 deg. As used in this report, minimum scan angle refers to the center of the WSR-88D main beam.

1.2 SCOPE OF REPORT

To improve the capability of the WSR-88D to serve Coastal Washington, NWS proposes to operate the radar at a scan angle lower than 0.5 deg above horizontal, which is the lowest scan angle currently used in WSR-88D operations. The lowest angle which the NWS is considering is 0.0 deg (i.e., horizontal). This Draft EA report analyzes the potential effects of the lower scan angles on persons and activities in the vicinity of the radar. The National Oceanic and Atmospheric Administration (NOAA) is the parent agency of the NWS. NOAA requirements for complying with the National Environmental Policy Act (NEPA) are contained in NOAA Administrative Order (NAO) 216-6, *Environmental Review Procedures for Implementing the National Environmental Policy Act* [NOAA, 1999], and NWS is subject to those requirements. Section 6.03c of NAO 216-6 specifies the proper level of NEPA review for actions proposed by NOAA components and lists types of actions that are categorically excluded from the need to prepare a NEPA analysis document (e.g., an EA or environmental impact statement). Section 6.03c3(h), which addresses NEXRAD Radar Coverage, states that “Change in NEXAD radar coverage patterns which do not lower the lowest scan angle and do not result in direct scanning of previously non-scanned terrain by the NEXRAD main beam” are categorically excluded from NEPA. The proposed action would not meet these specifications and does not qualify for categorical exclusion treatment. Therefore, NEPA analysis is required and this EA report satisfies this requirement.

This Supplemental EA report assesses the degree to which lowering the minimum scan angle of this WSR-88D would affect the area of radar coverage and the height above site level of the coverage floor. Because the tilt angle of the WSE-88D antenna is adjustable in 0.1 deg increments, the radar coverage analysis evaluates minimum scan angles of +0.5 deg (current WSR-88D system minimum), +0.4 deg, +0.3 deg, + 0.2 deg, +0.1 deg, and 0.0 deg (i.e., horizontal). Because operating the WSR-88D at minimum scan angles below horizontal would not improve coverage, NWS is not considering scan angles below 0.0 and the range of scan angles evaluated by this Supplemental EA is limited to +0.5 to 0.0 deg.

At this time, the NWS proposes to implement the lower scan angle only at the WSR-88D to serve Coastal Washington. Therefore, the scope of this EA is limited to analyzing potential effects from lowering the scan angle of only that one radar, and does not address potential effects of lowering the scan angle of other WSR-88Ds or of lowering the scan angle for the WSR-88D network as a whole.

2 PURPOSE AND NEED

The NWS is the nation's premiere meteorological forecasting organization. The agency's official mission is as follows:

> "The National Weather Service (NWS) provides weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy. NWS data and products form a national information database and infrastructure which can be used by other governmental agencies, the private sector, the public, and the global community [NWS, 2009]".

The nationwide network of WSR-88Ds plays a crucial role in meeting the NWS mission. Data from the WSR-88Ds is used by the NWS to improve the accuracy of forecasts, watches, and warnings. As an example, the WSR-88D generates precipitation estimates allowing prediction of river flooding in hydrological basins of the area. The NWS then disseminates advance flood warnings to local and state public safety, emergency managers, and the public, allowing them to take appropriate actions to minimize hazards to life and property. Because the meteorological phenomena of greatest interest occurs with a few thousand feet (ft) of the ground surface, radar coverage of the atmosphere at altitudes below 10,000 ft above ground level (AGL) is of great value to forecasters.

However, the elevation above the ground or ocean surface at which the WSR-88D can collect data increases with increasing distance from the radar due to earth curvature and the upward tilt of the radar beam, which is currently +0.5 deg or greater. The proposed action of lowering the WSR-88D minimum scan angle below +0.5 deg would expand the geographic area with radar coverage below 10,000 ft AGL, a substantial benefit to forecasters and other users of WSR-88D data. That benefit would be particularly relevant to the Coastal Washington area because the prevailing storm track for approaching storms is from the west (i.e. from the Pacific Ocean). There are no network radars located in the Pacific Ocean, thus the additional radar coverage achieved by lowering the minimum scan angle would be in areas lacking current radar coverage. Thus, the proposed action would provide radar coverage over an important storm approach area that would otherwise not be covered.

During normal operation, the highest scan angle of the WSR-88D is +19.5 deg, and that maximum scan angle would not be changed. This EA report describes the area of radar coverage that would result if the NWS operates the WSR-88D to serve Coastal Washington at scan angles down to 0.0 deg and the environmental effects that may result.

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3 DESCRIPTION OF PROPOSED ACTION AND NO-ACTION ALTERNATIVE

3.1 PROPOSED ACTION

3.1.1 Description of WSR-88D

The NWS of the Department of Commerce, Air Force of the Department of Defense, and FAA of the Department of Transportation operate a nationwide network of Doppler meteorological radars, known as NEXRAD or WSR-88D. The WSR-88D collects data on weather conditions and provides critical inputs to forecasters. The network is composed of 155 radars, most of which were installed in the late 1980s and 1990s. Each radar includes a roughly 28-ft diameter dish antenna mounted on a steel lattice tower of varying height (depending on local conditions), and shelters housing electronic equipment, a standby power generator and fuel tank, and a transitional power maintenance system. The dish antenna rotates 360 deg and is covered by a fiberglass radome to protect it from the elements. These structures are contained in a 68 ft by 102 ft compound surrounded by a chain-link fence for security purposes. Figure 1(a) is a photograph of a typical WSR-88D. Figure 1(b) is a drawing showing the standard WSR-88D site layout.

The NWS is in the process of installing a WSR-88D to serve the Coastal Washington area. The radar will be located at the crest of Langley Hill, about 3.5 miles (mi) east of Copalis Beach in Grays Harbor County, Washington (see Figures 2[a], 2 [b], and 3). This radar will be mounted on a 30-meter (m) tower (the tallest tower available for the WSR-88D) so that the antenna rises above nearby terrain and trees.

3.1.2 Proposed Change in Scan Angles

The WSR-88D is designed to detect and track weather phenomena within a roughly 230 mi distance of the radar. It accomplishes this task by emitting a narrow main beam. The WSR-88D rotates continuously to cover the entire surrounding area. The main beam scan angle is the number of degrees above or below horizontal at the center of the main beam and varies as the antenna rotates. The upward tilt of the antenna (and therefore the scan angle of the main beam) can be changed, allowing the radar to scan the sky at angles up to +60.0 deg and down to -1.0 deg; however, in normal operation, the maximum scan angle is +19.5 deg and the normal minimum scan angle is +0.5 deg.

The WSR-88D main beam has a total width of 1 deg in the horizontal and vertical directions (i.e., beam width is ½ deg from the center of the beam to the edge), as shown in Figure 4. The power density of the WSR-88D is greatest at the center of the beam and decreases towards the edge of the beam. At the edge of the main beam, the power density is one half of the center of beam power density. In current operation, the minimum scan angle of the main beam is +0.5 deg (i.e., 0.5 deg above horizontal at the center of the main beam) and the lower edge of the main beam is at 0.0 deg (i.e., horizontal). NWS proposes to reduce the minimum scan angle below +0.5 deg, which would decrease the height above the ground (or the ocean) of the coverage floor, as shown in Figure 5. No changes in the maximum scan angle are necessary or proposed. The benefits of reducing the lowest scan angle are two-fold:

1. Additional radar coverage would be achieved at relatively low altitude above the ground or ocean surface, where atmospheric conditions have the greatest effects on people and economic activity, and
2. The WSR-88D would provide coverage below 10,000 ft AGL (or above ocean level) at greater distance from the radar site.

The second benefit would be achieved in all directions where the radar beam is not blocked by elevated terrain, trees or structures. In the case of the WSR-88D to serve Coastal Washington, this benefit would be achieved to the northwest, west, and southwest of the Langley Hill site, which are important weather approach directions. The area of increased coverage would be predominantly over the Pacific Ocean. The scan angle of the WSR-88D is adjustable in 0.1 deg increments and the NWS is considering lowering the minimum scan angle by up to 0.5 deg.

The NWS plans to complete construction of the WSR-88D to serve Coastal Washington during summer 2011. The radar will then undergo checkout and optimization and must pass performance tests before being commissioned into the WSR-88D nationwide network. The software that controls the radar operations and processes data from the radar must be modified to implement scan angles below +0.5 deg into day-to-day operation of the radar. No changes to the radar antenna, tower, or physical infrastructure would be necessary. If the NWS decides to implement the proposed action, the necessary software modifications would occur prior to commissioning of the radar, currently expected to occur in late summer or fall 2011.

3.2 NO-ACTION ALTERNATIVE

Section 5.03b of NAO 216-6 requires analysis of the no-action alternative in EAs. For purposes of this Supplemental EA report, the no-action alternative is defined as operating the WSR-88D serving Coastal Washington with a minimum center of main beam scan angle of +0.5 deg. This is the same minimum scan angle used by the other WSR-88Ds in the nationwide network. The no-action alternative is analyzed in this Supplemental EA for comparative purposes.

FIGURE 1(a) PHOTOGRAPH OF TYPICAL WSR-88D

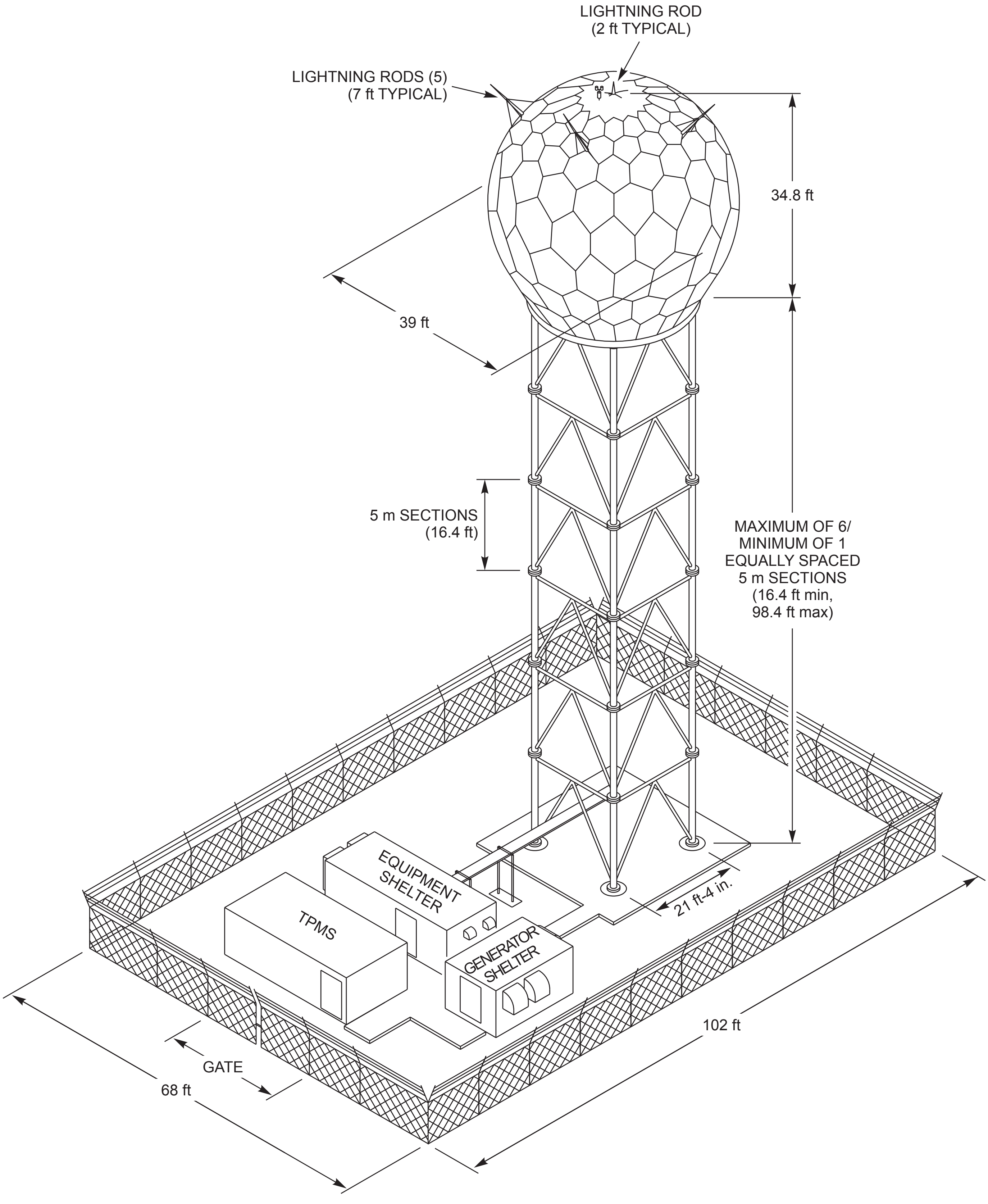

FIGURE 1(b) STANDARD WSR-88D SITE LAYOUT

FIGURE 2(a) LOCATION OF WSR-88D TO SERVE COASTAL WASHINGTON (LANGLEY HILL SITE)

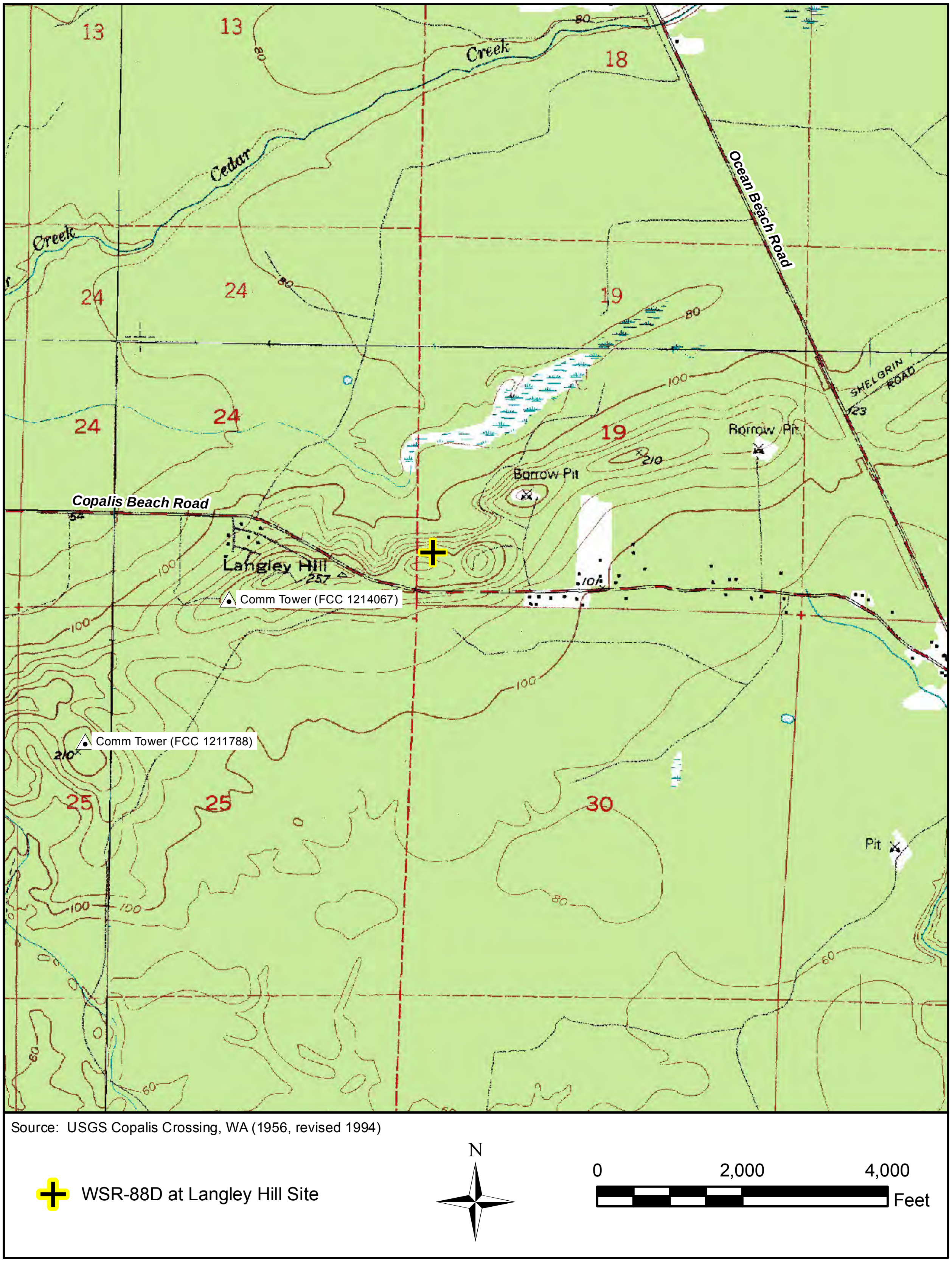

FIGURE 2(b) LOCATION OF WSR-88D TO SERVE COASTAL WASHINGTON (LANGLEY HILL SITE)

FIGURE 3 AERIAL PHOTOGRAPH — LANGLEY HILL SITE FOR WSR-88D TO SERVE COASTAL WASHINGTON

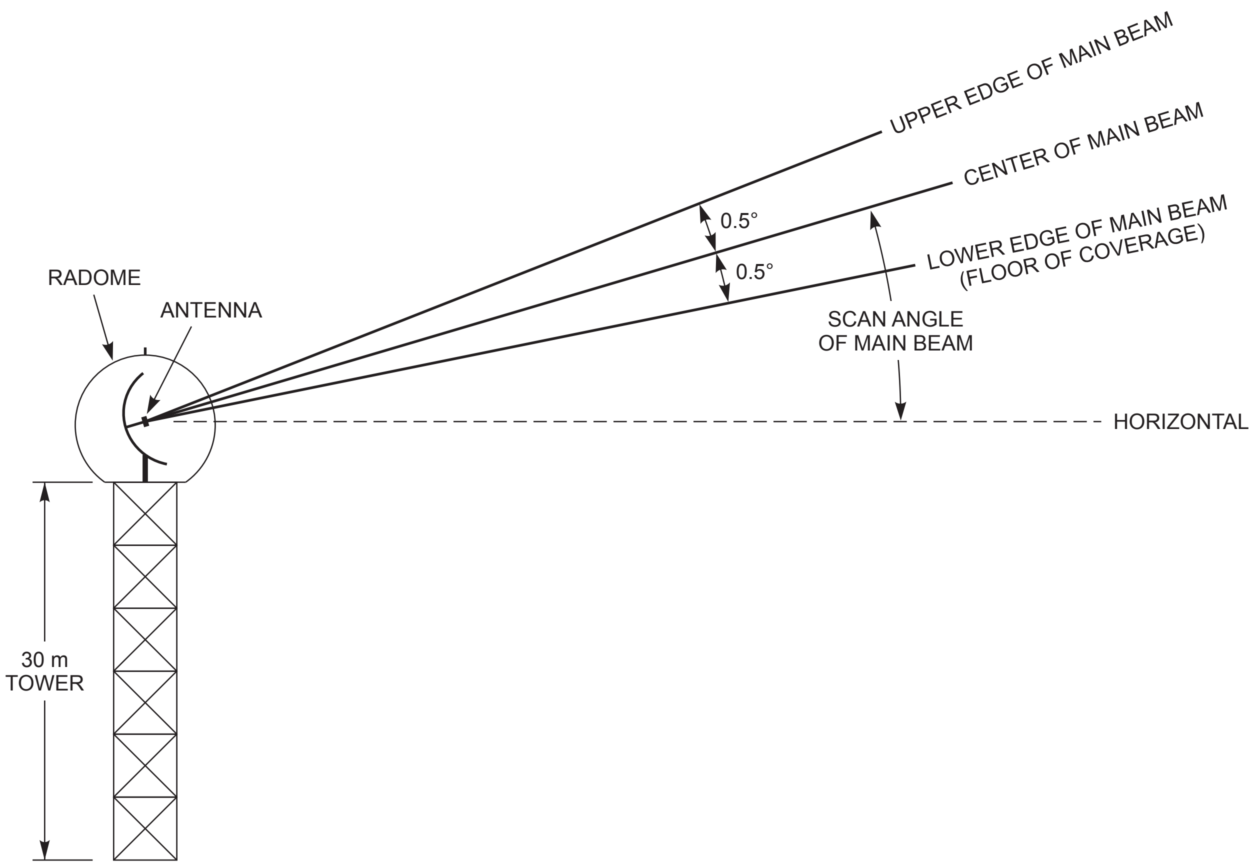

FIGURE 4 SCHEMATIC DRAWING OF WSR-88D MAIN BEAM (NOT TO SCALE)

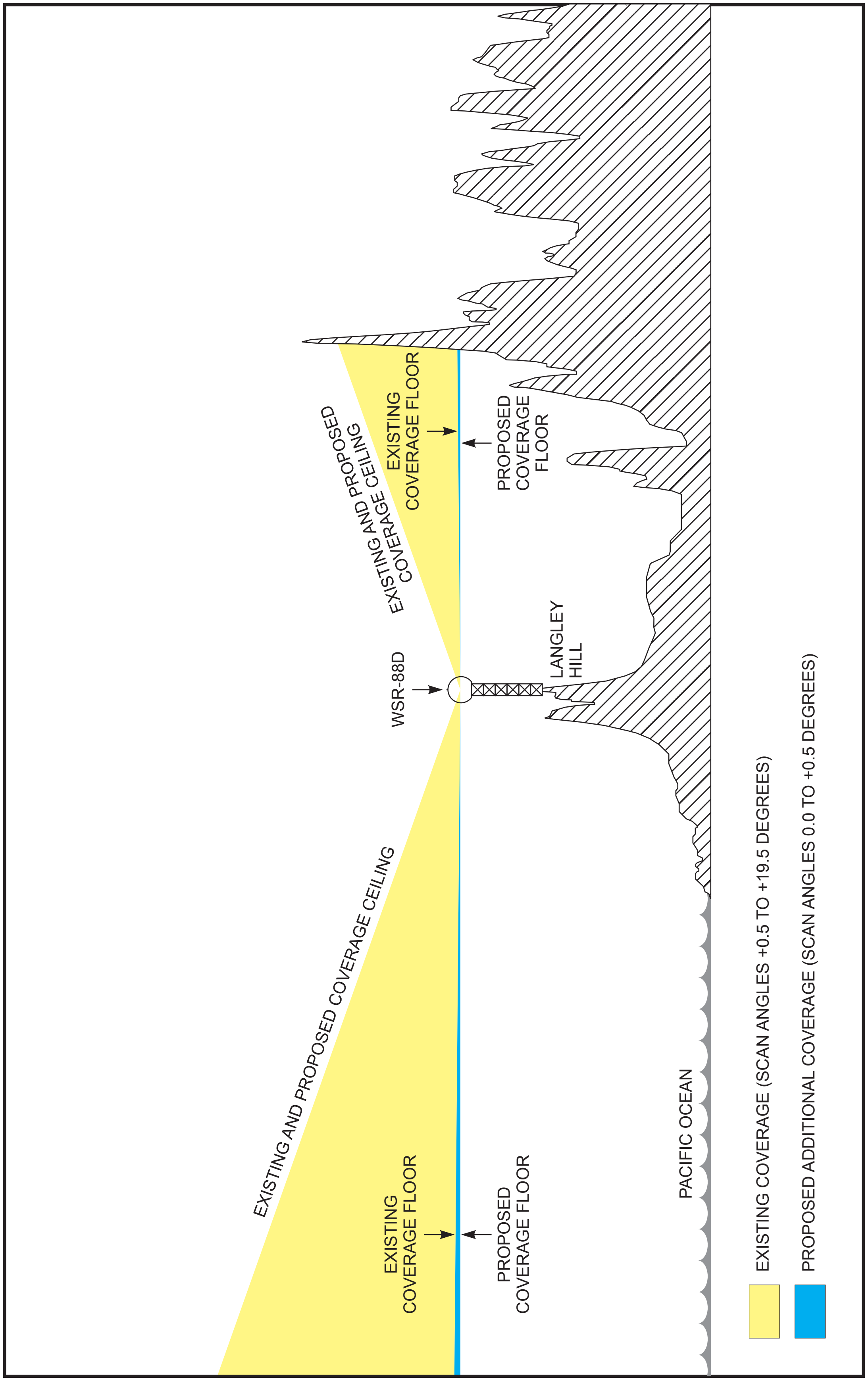

FIGURE 5 SCHEMATIC DRAWING OF WSR-88D COVERAGE USING EXISTING AND PROPOSED SCAN LIMITS

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4 RADAR COVERAGE

The proposed lowering of the minimum scan angle of the WSR-88D serving coastal Washington would increase the geographic area covered by the radar at various elevations above the mean sea level. The WSR-88D scan angle can be adjusted in increments of 0.1 deg and NWS is considering all scan angles between the current minimum center of beam scan angle of 0.5 deg and 0.0 deg. The minimum scan angles for the center of the main beam under consideration are +0.4 deg, +0.3 deg, +0.2 deg, +0.1 deg, and +0.0 deg. To quantify the increase in radar coverage that could be achieved at each of the five possible lower scan angles, we used Level 1 Digital Terrain Elevation Data and assumed 4/3 earth radius, which accounts for refraction of the radar beam under standard atmospheric conditions. The edge of the WSR-88D main beam occurs where radiated power decreases to one half of the maximum power level within the beam. The main beam diameter is 1.0 deg between the half-power points and the radius to the lower half-power point is 0.5 deg. Thus, the floor of radar coverage occurs at 0.5 deg below the center of the main beam, which corresponds to angles of -0.1 deg, (i.e., horizontal) through -0.5 deg for the lower scan angles under consideration.

The WSR-88D to serve Coastal Washington is under construction at the Langley Hill site in Grays Harbor County and will be mounted in a 30-m tower. The site elevation is 242 ft above mean sea level (MSL) and the center of antenna elevation will be about 356 ft MSL. When operating at the currently used minimum WSR-88D scan angle of +0.5 deg, the WSR-88D main beam would be blocked by terrain between azimuths of 334 deg and 164 deg (i.e., from north-northwest eastward through south-southeast) decreasing the range of coverage from the theoretical maximum. Figure 6 shows radar coverage at a minimum center of beam scan angle of +0.5 deg (the lowest scan angle in current use by WSR-88D radars) and the areas of obstructed and unobstructed coverage. The unobstructed coverage occurs predominantly over the Pacific Ocean. A small wedge of unobstructed coverage also occurs over land to the south of the radar between azimuths 164 deg and 185 deg. The lower half power point of the main beam defines the coverage floor. At center of beam scan angles below +0.5 deg, the coverage floor is at a negative angle and coverage of the atmosphere below site elevation is possible. However, this occurs only in proximity to the radar as the earth curves away from the radar and the amount of curvature increases with the square power of distance. Because earth curvature increases at greater distances from the radar, the elevation of the coverage floor rises at those distances. Figure 7 shows the extent of coverage which would achieved using a +0.4 deg minimum center of beam scan angle, which corresponds to a coverage floor of -0.1 deg. The main beam of the WSR-88D would not impinge on the surface of the ocean when operating at this minimum scan angle and coverage at 2,000 ft , 4,000 ft, and 10,000 ft above site level (ASL) would extend farther over the Pacific Ocean. The 0.4 deg scan would also not be obstructed between azimuths 164 deg and 185 deg (i.e., westernmost Pacific County in Washington and portions of Clatsop, Tillamook, and Yamhill counties, Oregon); coverage range would increase over these azimuths. In all other directions (azimuths 334 deg through 164 deg), the extent of coverage at

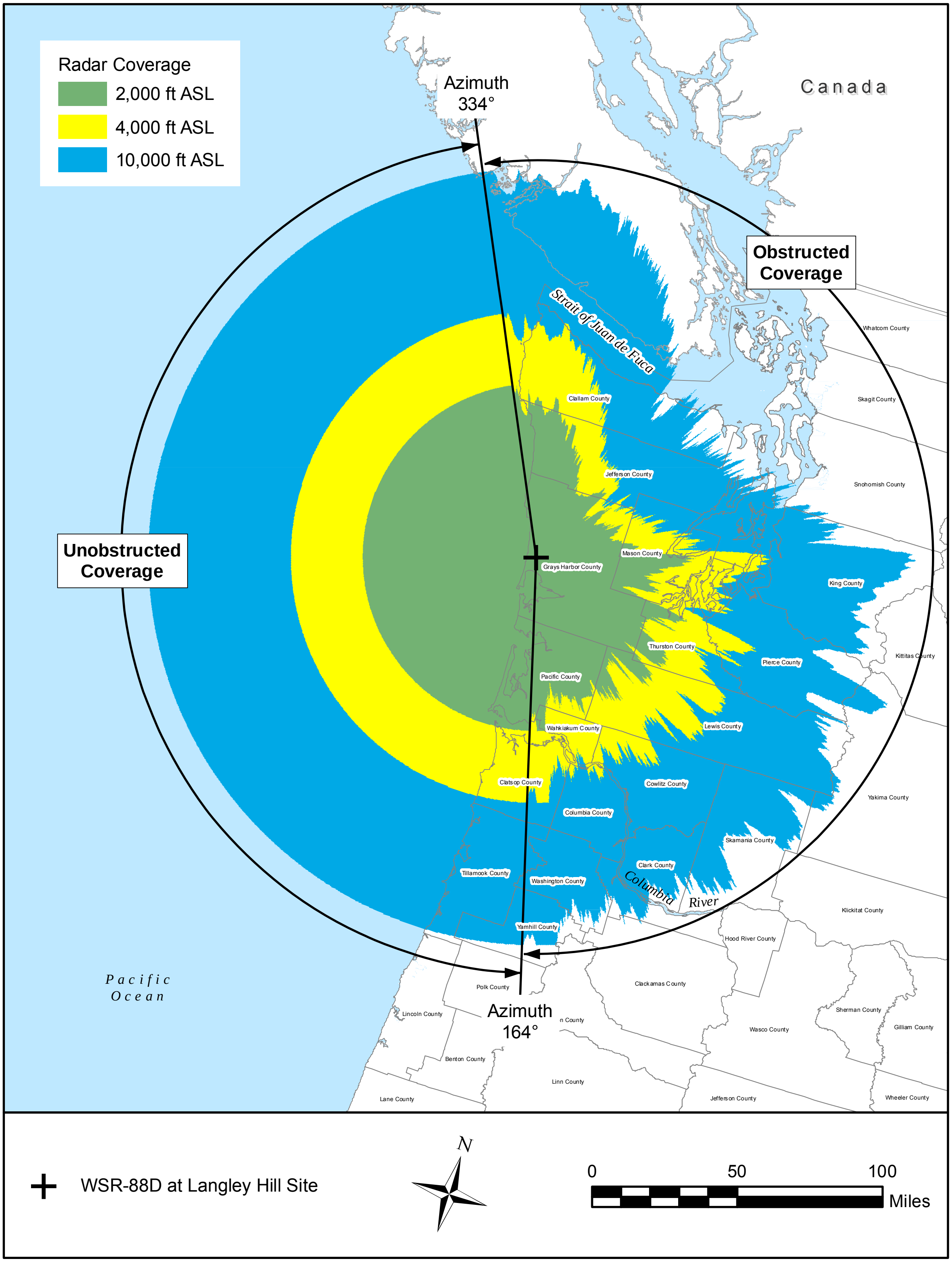

FIGURE 6 ESTIMATED RADAR COVERAGE USING +0.5 DEGREE CENTER OF BEAM MINIMUM SCAN ANGLE

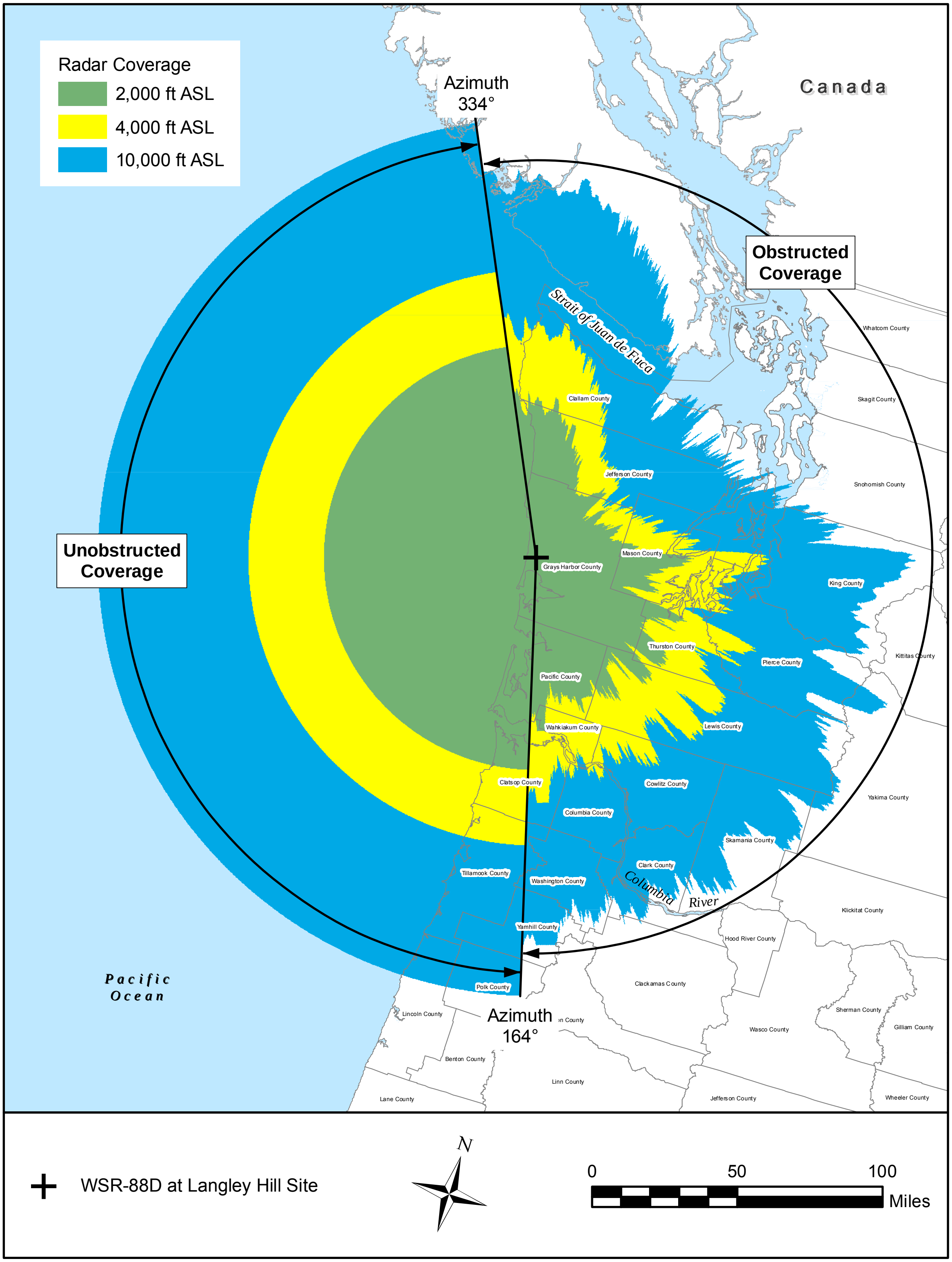

FIGURE 7 ESTIMATED RADAR COVERAGE USING +0.4 DEGREE CENTER OF BEAM MINIMUM SCAN ANGLE

2,000 ft, 4,000 ft, and 10,000 ft ASL would be unchanged compared to the +0.5 minimum scan angle. Figure 8 shows the extent of radar coverage which would achieved using a +0.3 deg minimum center of beam scan angle, which corresponds to a coverage floor of -0.2 deg. The main beam of the WSR-88D would not impinge on the surface of the ocean. Compared to the +0.5 deg and +0.4 deg minimum scan angles, coverage at 2,000 ft, 4,000 ft, and 10,000 ft ASL would increase in range from azimuths 185 deg through 334 deg. The hills east of Grayland, Washington, would obstruct the main beam scanning at +0.3 deg between azimuths 164 deg and 185 deg; therefore, the range of coverage would not increase over these azimuths compared to the +0.4 deg minimum scan angle. In all other directions (azimuths 334 deg through 164 deg), the extent of coverage at 2,000 ft, 4,000 ft, and 10,000 ft ASL would be unchanged compared to the +0.5 deg or +0.4 deg minimum scan angles.

Figure 9 shows the extent of radar coverage for minimum scan angles of +0.2 deg, +0.1 deg, and 0.0 deg (i.e., coverage floor at -0.3 deg, -0.4 deg, and -0.5 deg, respectively). At a center of beam scan angle of +0.214 deg (i.e., coverage floor angle of -0.284 deg), the lower edge of the main beam would graze the surface of the ocean surface at a distance of 28 mi from the radar. Operating at center of beam scan angles below +0.214 deg would cause the WSR-88D main beam to impinge on the ocean surface. No increase in the area of radar coverage would be achieved as the main beam would be partially obstructed by the ocean surface. Thus, minimum scan angles of +0.2, +0.1, and 0.0 deg would all result in the same areas of coverage.

Table 1 summarizes by azimuths the changes in range of coverage at 2,000 ft, 4,000 ft, and 10,000 ft ASL that would be achieved by lowering the minimum scan angle of the WSR-88D. Each minimum scan angle is compared to the preceding scan angle (i.e., +0.4 is compared to +0.5 deg; +0.3 deg to +0.4 deg, and so on).

For each center of beam scan angle under consideration by NWS, Table 2 gives the distances from the WSR-88D at which the coverage floor would be 2,000 ft, 4,000 ft, and 10,000 ft ASL in the azimuths with no obstruction of the main beam. For comparison purposes, the corresponding distance for the currently used +0.5 deg scan are included. Table 2 also provides the coverage area in square miles (sq mi) and the percentage increase compared to the +0.5 deg minimum scan angle.

Figure 10 shows the extent of radar coverage at 2,000 ft ASL that could be achieved if the WSR-88D operates at the current minimum center of beam scan angle of +0.5 deg and each of the alternate minimum scan angles under consideration by NWS. As shown in Figure 10, the 2,000 ft ASL coverage area increases incrementally with the lowering of the minimum scan angle down to +0.2 deg minimum scan angle. A minimum scan angle of +0.2 deg would increase the area of 2,000 ft ASL coverage by 71.3 percent compared to the +0.5 deg minimum scan angle. Lowering the minimum scan angle below +0.2 deg does not result in any additional increase in 2,000 ft ASL coverage.

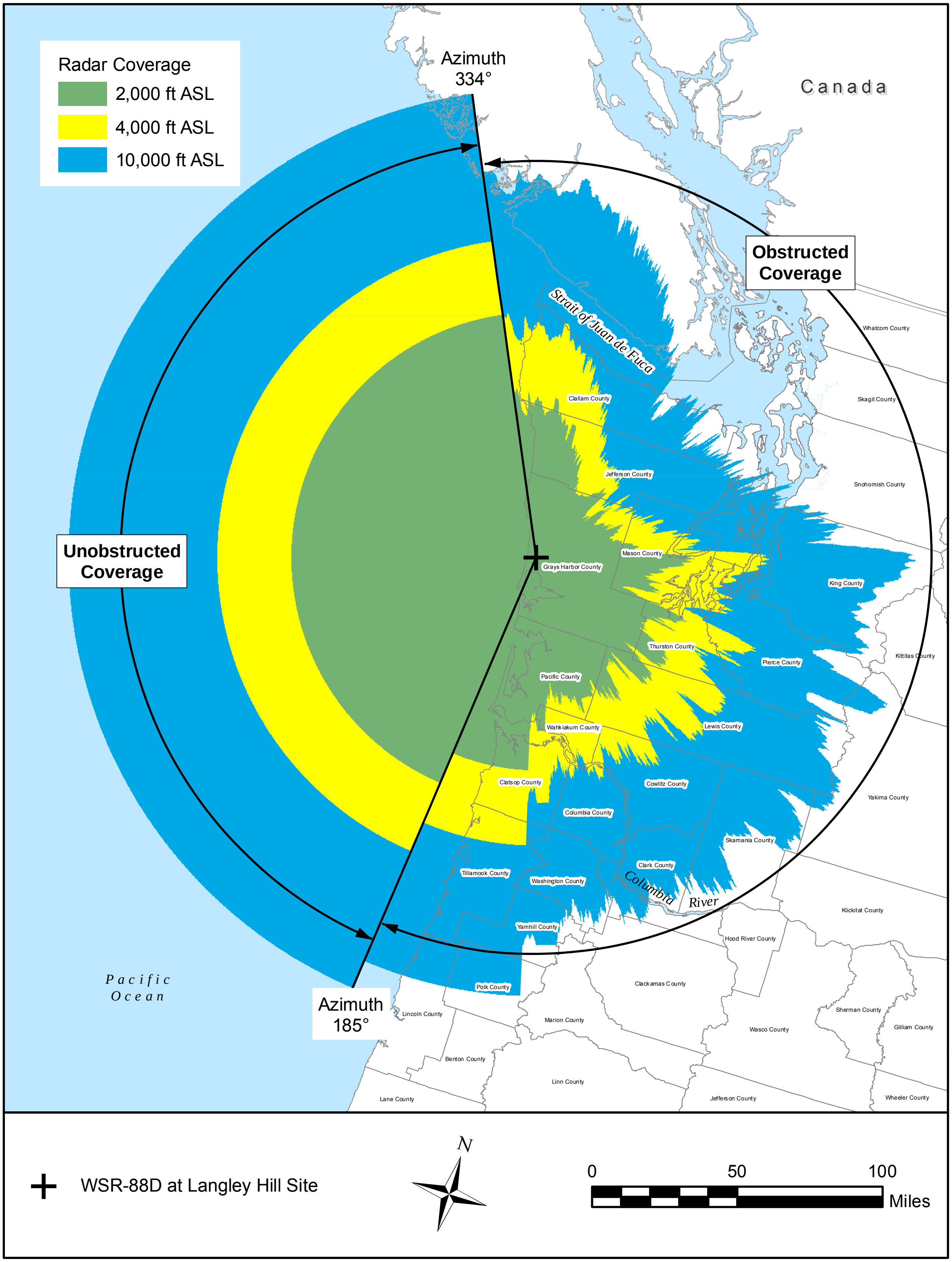

FIGURE 8 ESTIMATED RADAR COVERAGE USING +0.3 DEGREE CENTER OF BEAM MINIMUM SCAN ANGLE

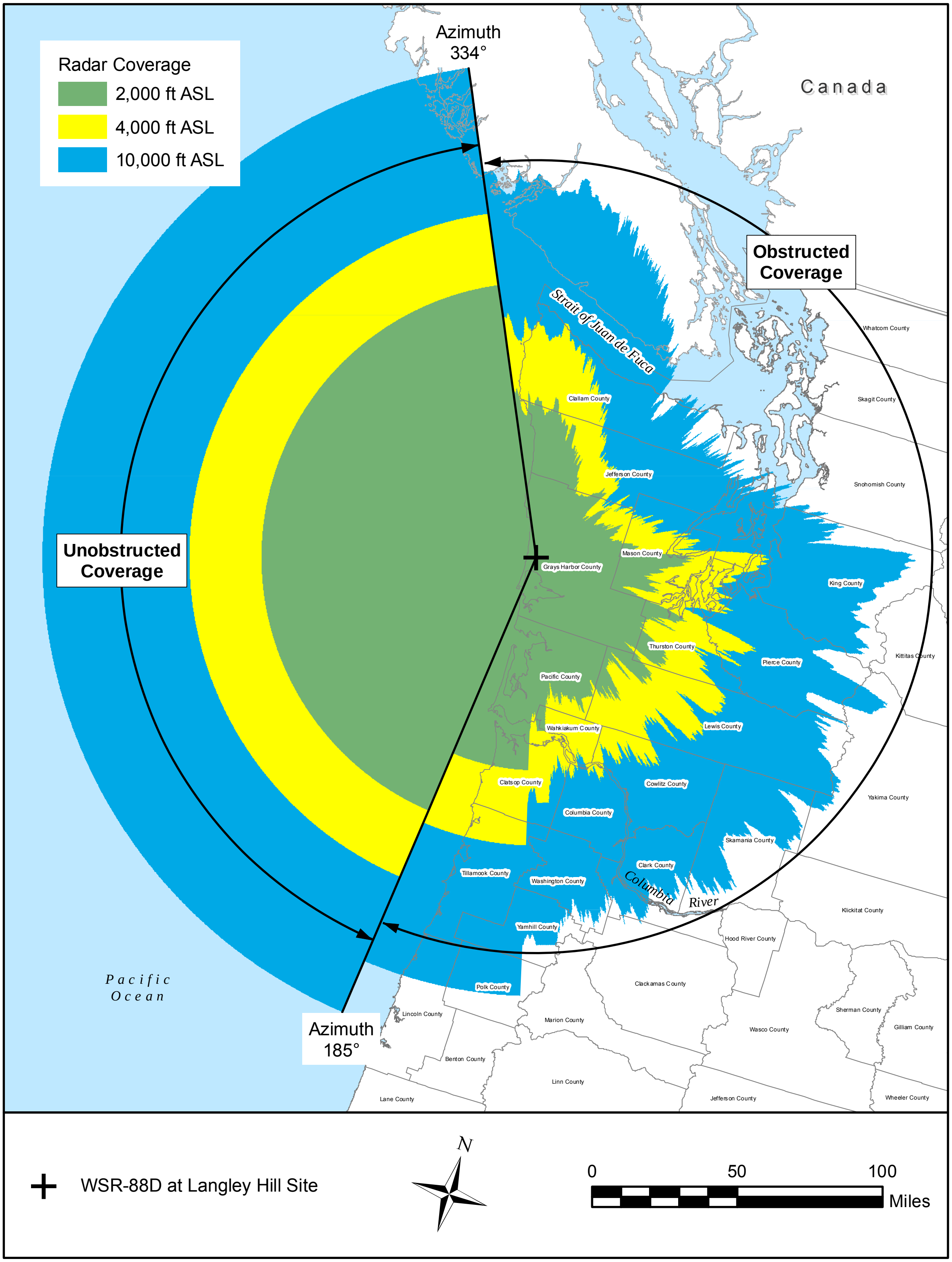

FIGURE 9 ESTIMATED RADAR COVERAGE USING +0.2, +0.1, OR 0.0 DEGREE CENTER OF BEAM MINIMUM SCAN ANGLE

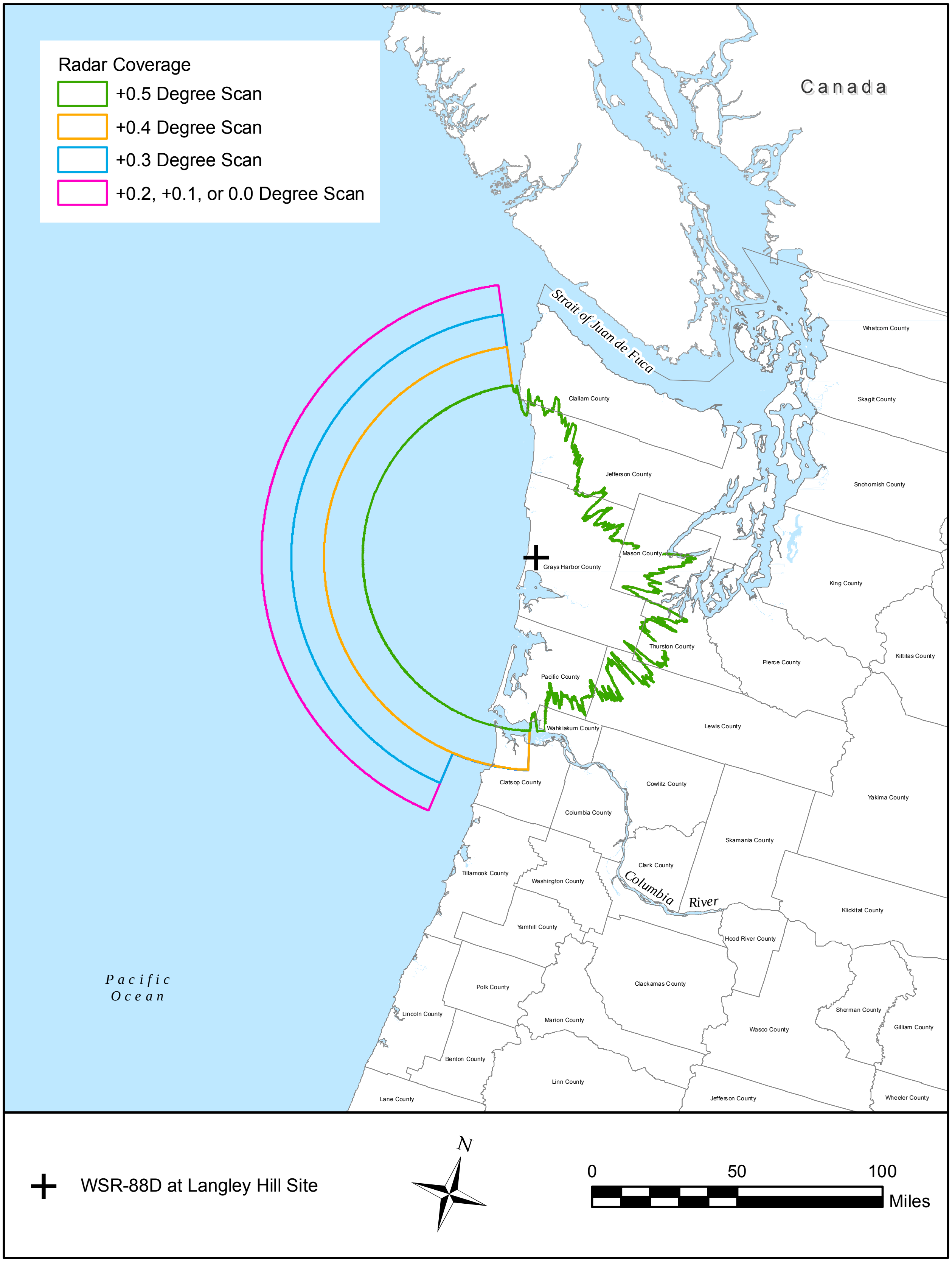

FIGURE 10 ESTIMATED EXTENT OF RADAR COVERAGE AT 2,000 ft ASL USING ALTERNATIVE MINIMUM SCAN ANGLES

Table 1. Change in Range of Coverage by Minimum Scan Angle and Azimuth Compared to Next Lowest Center of Beam Scan Angle

Center of Beam Scan Angle (deg)	Coverage Floor Scan Angle (deg)	Azimuths 185 deg to 334 deg	Azimuths 334 deg to 164 deg	Azimuths 164 deg to 185 deg
+0.5	n/a	n/a	n/a	n/a
+0.4	-0.1	increase	no change	increase
+0.3	-0.2	increase	no change	no change
+0.2	-0.3	increase	no change	no change
+0.1	-0.4	no change	no change	no change
0.0	-0.5	no change	no change	no change

Table 2. Coverage Distances Over Pacific Ocean and Total Area Covered for each Minimum WSR-88D Scan Angle

Minimum Center of Beam Scan Angle (deg)	Coverage Floor Scan Angle (deg)	Distance to Far Edge of 2,000 ft ASL Coverage (mi)	Total Area Covered at 2,000 ft ASL (sq mi) (change from +0.5 deg scan)	Distance to Far Edge of 4,000 ft ASL Coverage (mi)	Total Area Covered at 4,000 ft ASL (sq mi) / (change from +0.5 deg scan)	Distance To Far Edge of 10,000 ft ASL Coverage (mi)	Total Area Covered at 2,000 ft ASL (sq mi) / (change from +0.5 deg scan)
+0.5	0.0	63.3	9,419	89.4	19,669	141.4	52,240
+0.4	-0.1	73.1	11,402 (+21.1%)	99.1	22,382 (+13.8%)	150.9	56,540 (+7.9%)
+0.3	-0.2	84.3	13,715 (+45.6%)	109.8	25,311 (+28.5%)	161.0	60,699 (+16.2%)
+0.2	-0.3	94.6	16,131 (+71.3%)	119.4	28,196 (+43.4%)	170.0	64,573 (+23.6%)
+0.1	-0.4	94.6	16,131 (+71.3%)	119.4	28,196 (+43.4%)	170.0	64,573 (+23.6%)
0.0	-0.5	94.6	16,131 (+71.3%)	119.4	28,196 (+43.4%)	170.0	64,573 (+23.6%)

Figures 11 and 12 show the coverage provided by the WSR-88D at 4,000 ft ASL and 10,000 ft ASL, respectively, for the current minimum center of beam scan angle of +0.5 deg and each of the minimum scan angles under consideration by NWS. The greatest increase in 4,000 ft coverage is provided by a minimum scan angle of +0.2 deg, which would increase 4,000 ft ASL coverage area by 43.4 percent compared to the +0.5 deg minimum scan angle. Lowering the minimum scan angle below +0.2 deg would not increase the 4,000 ft ASL coverage area. This is true for the 10,000 ft coverage also. The maximum increase in coverage area would be achieved at the +0.2 deg minimum scan angle. Compared to the +0.4 deg scan, the increase at +0.2 minimum scan angle would be 23.6 percent.

Comparison of the achievable increase in coverage area shows that 2,000 ft ASL coverage benefits the most (i.e., greatest percentage increase in coverage area) from lowering the scan angle and the 10,000 ft coverage the least. This is because the increased range of coverage achieved by a negative scan is offset by earth curvature. Because the change in earth curvature is a square power function the lower scan angle is a linear function, earth curvature predominates at greater distances from the radar and increasingly offsets the benefits of the lower scan angle.

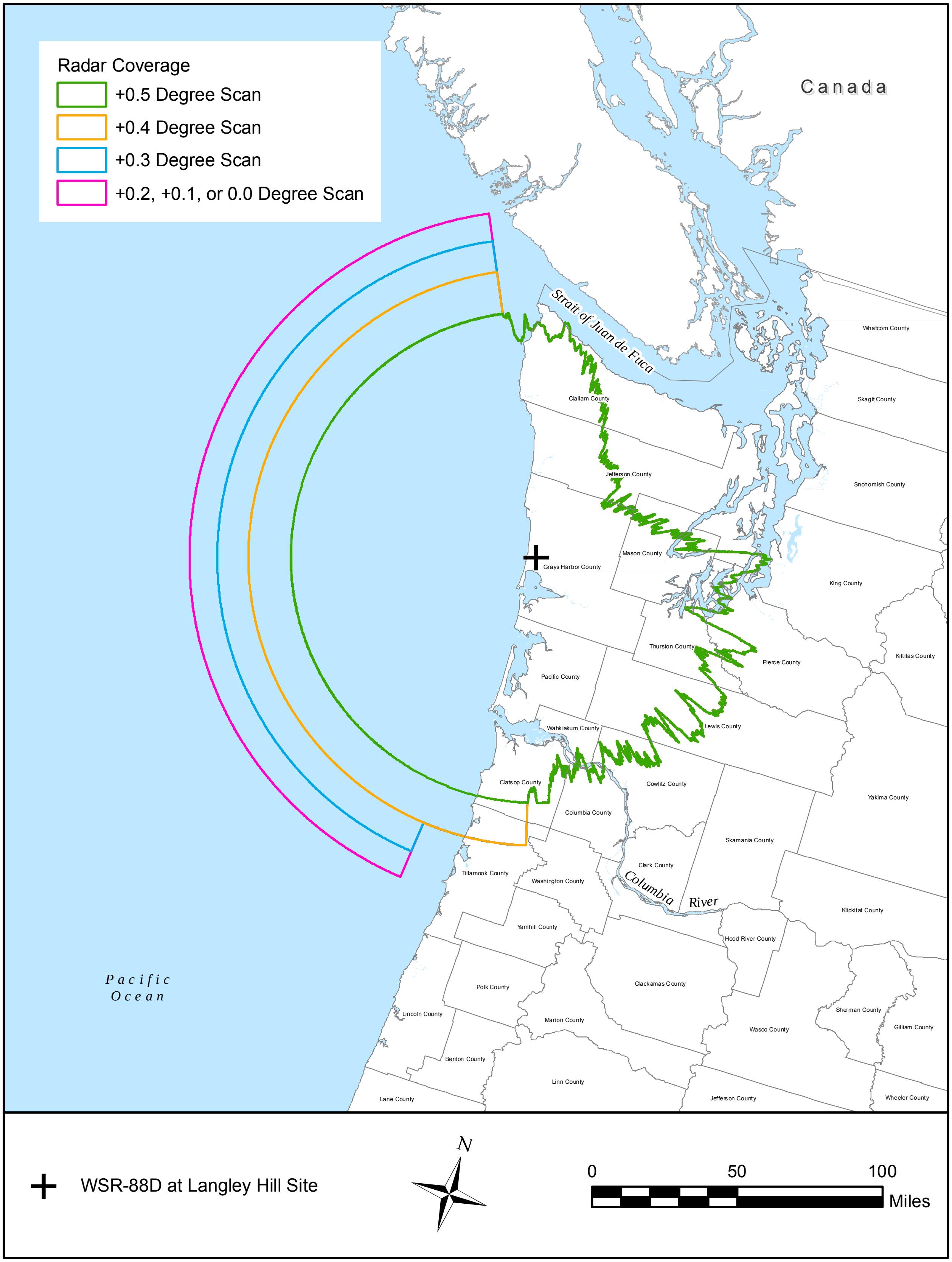

FIGURE 11 ESTIMATED EXTENT OF RADAR COVERAGE AT 4,000 ft ASL USING ALTERNATIVE MINIMUM SCAN ANGLES

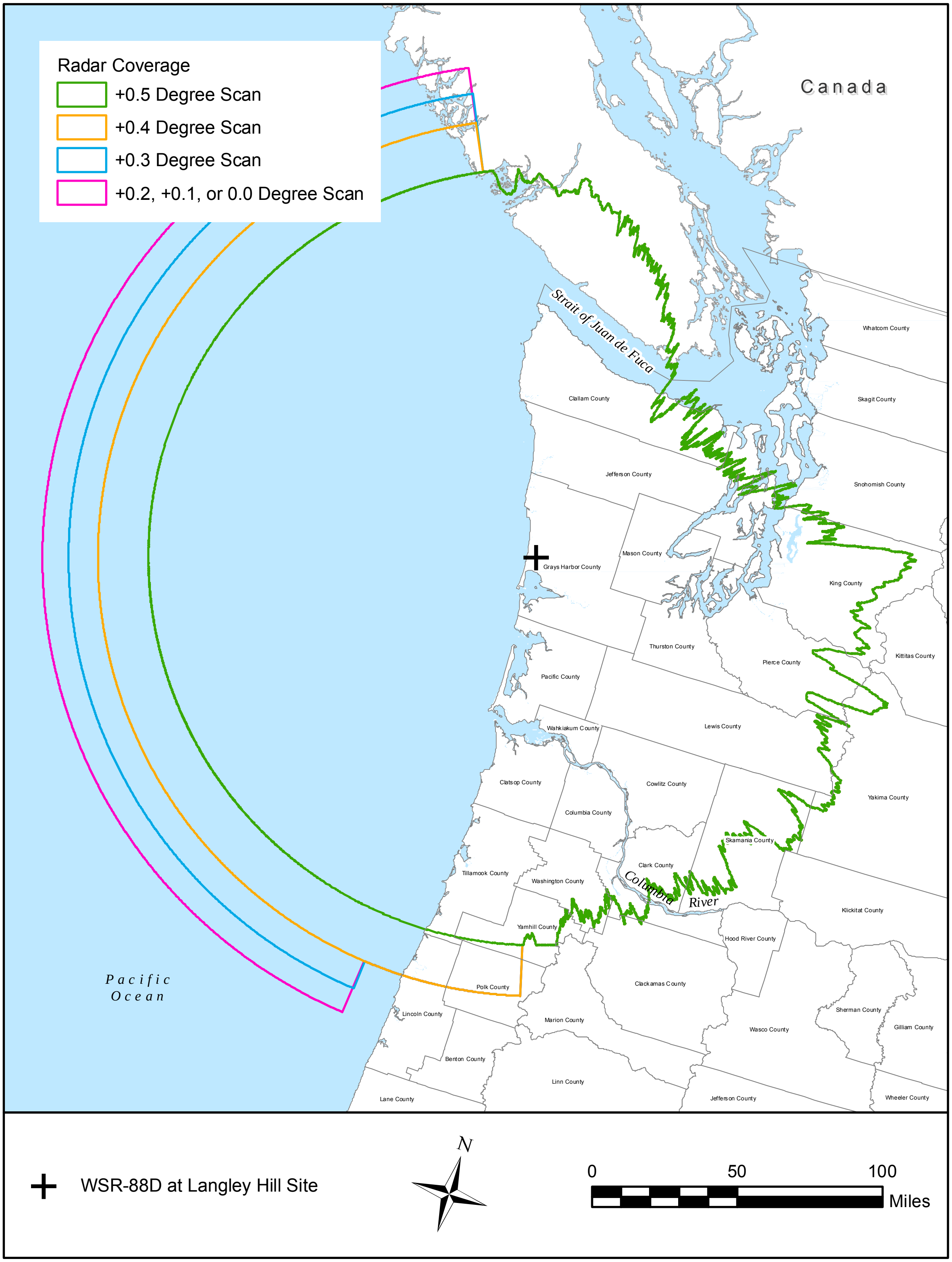

FIGURE 12 ESTIMATED EXTENT OF RADAR COVERAGE AT 10,000 ft ASL USING ALTERNATIVE MINIMUM SCAN ANGLES

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5 ENVIRONMENTAL SETTING, CONSEQUENCES, AND MITIGATION

5.1 EXPOSURE OF PERSONS TO RADIOFREQUENCY RADIATION

The electromagnetic environment consists of electric fields (E fields) created by electric charges and magnetic fields (H fields) created by the movement of electric charges. The electromagnetic environment at a specific location and time is composed of the all the electromagnetic fields from various sources (natural and manmade) that arrive there. The electromagnetic spectrum in an area is a continuously usable resource whose dimensions are amplitude, time, frequency, and space. In areas large enough to permit adequate spatial separation of users, the electromagnetic spectrum can simultaneously accommodate many users if they are sufficiently separated in frequency. A high power signal can mask a lower power signal operating on the same frequency. The electromagnetic environment at any point can change nearly instantaneously and will vary spatially, even at locations in close proximity; therefore, it is convenient to measure and characterize electromagnetic phenomena using averages over time and space.

Manmade contributions to the electromagnetic environment are both intentional and unintentional. Radio and television broadcasts, cellular telephone transmissions, and radar signals are examples of intentional contributions. Electromagnetic noise generated by power lines, fluorescent lights, and motors of all sorts are examples of unintentional human contributions. The WSR-88D emits radiofrequency radiation (RFR) in the 2,700 to 3,000 MHz frequency band. These frequencies are within the microwave portion of the electromagnetic spectrum. Although microwaves can add heat to objects, they do not contain sufficient energy to ionize water or organic molecules; and are therefore a form of non-ionizing radiation. In this regard, microwaves are fundamentally different from ionizing radiation (e.g., x-rays, ultraviolet rays) which occur at higher frequency portions of the electromagnetic spectrum.

The Institute of Electrical and Electronics Engineers (IEEE) has developed safety guidelines for human exposure to RFR, which has been approved by the American National Standards Institute (ANSI) [ANSI/IEEE, 2006]. The ANSI/IEEE safety standard is designed to protect all persons (including infants, elderly persons, pregnant women, and so forth) from adverse health effects from exposure to radiofrequency (RF), even if exposure should last over an entire lifetime. These guidelines set safety levels for maximum permissible exposure (MPE) to RF signals, which include a 10- to 50-fold safety margin and are intended to protect all members of the population. MPEs are specified in power density of the radio signal in milliwatts per square centimeter (mW/cm^2) and vary with operating frequency. Separate MPEs have been established for exposure of the general public and workers and for time-averaged exposure and peak exposure. At the frequency of 2,836 MHz, which the WSR-88D to serve Coastal Washington will use, the time-averaged MPE level (i.e., safety standard) for exposure of the general public is 1.0 mW/cm^2, based on averaging time of 30 minutes. The safety standard for occupational exposure is 9.45 mW/cm^2, based on an averaging time of 6 minutes.

Appendix A includes calculations of the time-averaged power density of the WSR-88D RFR signal in the vicinity of the proposed radar, assuming that the NWS lowers the minimum scan angle to 0.0 deg. Table 3 summarizes the results from Appendix A. Compared to a minimum scan angle of +0.5 deg, lowering the minimum scan angle to 0.0 deg would increase average

RFR power densities at ground level near the WSR-88D by up to 15 percent. The values shown in Table 3 are worst-case estimates and would not increase if NWS operates the radar at a minimum scan angle between +0.5 and 0.0 deg. The table gives the elevation of the lower edge of the WSR-88D main beam at various distances based on the highest terrain in the vicinity of the radar site.

Table 3. Time-average RFR Power Density Compared to Safety Standards

Location	Time-Averaged Power Density (mW/cm^2)	Factor Under General Public Safety Level (times)	Factor Under Occupational Safety Level (times)
Surface of Radome	0.60040	1.7	15
Base of Tower*	0.00046	2,170	20,540
200 ft from radar at 98 ft AGL	0.05170	19	183
1,000 ft from radar at 60 ft AGL	0.00850	118	1,112
1 mile from radar at 20 ft AGL	0.00030	333	3,150
3.5 miles from radar at ground level	0.00003	10,000	31,500

* Not within main beam

The WSR-88D to serve Coastal Washington is mounted on a 30 m tall steel-lattice tower. The center of the antenna is 114 ft AGL and the lower edge of the antenna is 98 ft AGL. Because the radar would be located at the highest ground in the local area, the radar's main beam would not illuminate the ground in proximity to the radar. Operating at the lowest possible scan angle of 0.0 deg and considering local topography, the main beam would illuminate the ground at a minimum distance of about 3.5 mi from the radar. This would occur to the north, where the hills east of Carlisle, Washington, would be illuminated by the main beam, and to the south, where Saddle Hill would be illuminated. The maximum average power density at ground level (at the base of the tower) to which the general public could be exposed would be less than 0.00046 mW/cm^2, 2,170 times lower than the current U.S. safety standard.

The ANSI/IEEE safety guidelines also cover possible induction of currents within the bodies of persons and the potential for electro-stimulation of persons who make contact with conductive objects in the RFR field. The result is potentially harmful sensation of shock and/or burn. These effects only occur in the of RFR fields at frequencies below 110 MHz (ANSI/IEEE, 2006). The WSR-88D to serve Coastal Washington would operate at 2,836 MHz, well outside the frequency range where induced currents or electro-simulation occur, and would not cause these effects.

As shown in Table 3, the power density of RFR transmissions decreases exponentially with distance from the antenna. At all ground locations in the vicinity, RFR emitted by the WSR-88D would be hundreds to thousands of times less than the safe level for RFR exposure of the general public. It is improbable that radio emissions from an external source would add significantly to the RFR exposure of persons in the vicinity of the WSR-88D. Cumulative RFR exposure from all sources in the vicinity of the radar would not exceed the national safety level. No safety hazards would result from exposure of the general public to RFR emissions from the proposed WSR-88D. The WSR-88D radio signal would also comply with the safety standard for occupational exposure by a wide margin and no occupational risks would result to workers outside the WSR-88D radome.

Appendix A contains calculations of the contribution to cumulative RF exposure that would result from the two licensed transmission towers in the vicinity of the WSR-88D site. The combined RF emissions from those towers have a power density less than 1/10 of 1% of the safety level for human exposure to RFR. Cumulative exposure to RFR emissions from the WSR-88D and other nearby transmitters would comply with safety standards and would not result in hazards to persons in the vicinity. No mitigation measures are required.

5.2 EXPOSURE OF EQUIPMENT AND ACTIVITIES TO RFR

5.2.1 Television, Radio, and Cellular Telephone, and Personal Communications Devices

High-power radar, such as the WSR-88D, can interfere with operation of radio, television, cellular telephone, and personal communications devices in close vicinity to the radar antenna. However, these devices operate at different frequencies from the WSR-88D, reducing the potential for radio interference. NTIA regulations reserve the 2,700 to 3,000 MHz band for government radiolocation users (e.g., meteorological and aircraft surveillance radars) [NTIA, 2009]. The WSR-88D operates outside the frequencies used by television and radio broadcasts, cellular telephones, and personal communication devices. Based on the experience of the NWS in operating a nationwide network of over 100 radars for the last 23 years, the potential is very low for electromagnetic interference with transmissions from radio, television, cellular telephones, or personal communication devices, or reception of those transmissions.

Two communications towers licensed by the Federal Communications Commission are located in proximity to the WSR-88D (see Figure 2[b]). American Tower operates a tower located about 2,900 ft west of the WSR-88D. The base of that tower is at 213 ft MSL, and the top of the structure is 408 ft MSL. Communications systems using that tower are licensed to operate at a number of frequencies between 150 MHz and 2360 MHz [FAA, Air Traffic Air Space Branch, ASW-520, 2006]. Spectrasite Communications operates a tower located about 5,600 ft southwest of the WSR-88D. Communications systems using that tower are licensed to operate at frequencies between 580 and 5,741 MHz (FAA, Air Traffic Air Space Branch, ASW-520, 2009). The base of that tower is at 206 ft MSL, and the top of the structure is 518 ft MSL.

Both communications towers are taller than the WSR-88D and the antennas are mounted near the top of the communications towers. The WSR-88D main beam would illuminate those antennas whether at a minimum scan angle of +0.5 deg (current minimum scan angle used by WSR-88D radars) or at 0.0 deg (minimum scan angle NWS proposes). The potential for electromagnetic interference (EMI) would not be affected by implementing the proposed action. Given the separation in operating frequencies and the separation distance between the WSR-88D and each of those towers, EMI is unlikely.

5.2.3 Electro-explosive Devices (EEDs)

Electro-explosive devices are used to detonate explosives, separate missiles from aircraft, and propel ejection seats from aircraft. Under extreme circumstances, electromagnetic radiation can cause unintended firing of EEDs. Calculations based on a U.S. Air Force (USAF) standard indicate that using electric blasting caps at distances beyond approximately 900 ft from the WSR-88D is a safe practice, even in the main beam of the radar, where the power density of the WSR-88D radio signal is greatest [USAF, 1982]. The U.S. Navy Hazards of Electromagnetic Radiation to Ordnance (HERO) regulations classify ordnance as safe, susceptible, or unsafe and unreliable, based on compliance with MIL-STD 664 (series). HERO safe ordnance is considered safe in all RFR environments. HERO susceptible ordnance may be detonated by RF energy under certain circumstances. HERO unsafe or unreliable ordnance has either not been evaluated for compliance with MILSTD 664 or is being assembled, dissembled, or subject to unauthorized conditions, which can increase its sensitivity to RFR. Safe separation distances are not applicable to HERO safe ordnance and vary for susceptible and unsafe or unreliable ordnance [Naval Sea Systems Command, 2008]. For HERO susceptible ordnance, the safe separation distance (D) in ft is calculated as follows:

$$D = (781)(f)^{-1}(\text{average power x antenna gain})^{½}$$

Where f is operating frequency in MHz and average power = maximum transmitted power × duty cycle. Inserting these values gives:

$$D = (781)(2{,}836)^{-1}\ (475{,}{,}000\ \text{W} \times 0.0021 \times 35{,}500)^{½}\ \text{ft}$$

$$D = 1{,}640\ \text{ft}$$

For HERO unsafe or unreliable ordnance, the safe separation distance (D) in ft is calculated as follows:

$$D = (2{,}873)(f)^{-1}(\text{average power x antenna gain})^{½}$$

$$D = (2{,}873\ )(2{,}836)^{-1}\ (475{,}000\ \text{W} \times 0.0021 \times 35{,}500)^{½}\ \text{ft}$$

$$D = 6{,}030\ \text{ft}$$

HERO concerns are only applicable in locations illuminated by the main beam of the radar. The main beam of the WSR-88D to serve Coastal Washington would not illuminate the ground within 3.5 mi (18,480 ft) of the radar site, which exceeds the safe separation distance for all categories of ordnance. The WSR-88D would not be a threat to EEDs use in the vicinity and no mitigation is necessary.

5.2.4 Fuel Handling

Electromagnetic fields can induce currents in conductive materials and those currents can generate sparks when contacts between conductive materials are made or broken. Sparks can ignite liquid fuels, such as gasoline. This phenomenon is rare, but can result in hazards to human health and property. This potential hazard arises during the transfer of fuel from container to another (e.g., fueling an automobile, boat, or airplane). The U.S. Navy developed a Technical Manual identifying the circumstances where this hazard may occur and providing direction on how to prevent it. The Technical Manual identifies a safe standoff distance based on radar operating characteristics [Naval Sea Systems Command, 2003]. Using formula contained in the Technical Manual, the distance from the WSR-88D at which RFR hazards to fuel may occur is 537 ft. This hazard only exists in areas directly illuminated by the main beam. The WSR-88D main beam, even at a minimum center of antenna scan angle of 0.0 deg, would not illuminate the ground within 537 ft of the radar and no hazards to fuel handling activities would result. No mitigation is required.

5.2.5 Active Implantable Medical Devices

ANSI and the Association for Advancement of Medical Instrumentation (AAMI) developed the PC69:2007 standard to prevent external electromagnetic sources from causing electromagnetic interference with active implantable medical devices, including cardiac pacemakers and implantable cardiac defibrillators [ANSI/AAMI, 2007]. This standard specifies that cardiac pacemakers and ICDs must be tested by exposing them to a specified magnetic field and that the device must operate without malfunction or harm to the device. The specified field strength varies with frequency. For the WSR-88D operating frequency of 2,836 MHz, the field strength is 3 A/m. This is converted to power density (S) in units of W/m^2 by assuming free air attenuation of 377 ohms:

$$S = 377\ |3|^2 \quad W/m^2$$

$$S = 3{,}393\ W/m^2$$

To convert to mW/cm^2, we multiply the numerator by 1,000 mW/W and the divisor by 10,000 cm^2/m^2 which gives a value of 339.3 mW/cm^2. The peak pulse power of the WSR-88D is given by the following formula (see Appendix A):

$$U_1 = 1.44 \text{ X } 10^9/R^2 \ mW/cm^2$$

Inserting R = 2,060 ft gives a value of 339.3 mW/cm^2, which equals the threshold established by PC69:2007 standard. At distances of 2,060 ft or greater, the main beam of the WSR-88D would not adversely affect implantable medical devices. There would also be no hazards to implantable medical devices at locations outside the main beam. Operating at the minimum potential center of beam scan angle of 0.0 deg, the main beam of the WSR-88D to serve Coastal Washington would not illuminate the ground within 2,060 ft of the radar and no hazards would results to persons on the ground with implanted devices. Theoretically, persons in aircraft flying within 2,060 ft of the radar could be exposed to magnetic field levels above the device susceptibility threshold set by ANSI/AAMI, but the likelihood of significant harm is extremely low for three reasons. First, the aircraft body would attenuate the RFR level. Second, the device susceptibility threshold in the PC69:2007 standard is based on coupling of the RFR directly into the device leads (which is the test protocol); the WSR-88D signal would be incident upon the surface of the body and would decrease considerably in strength at the location of the device leads within the body. Third, even in the unlikely event that the WSR-88D RFR couples into the device at levels above the susceptibility threshold, the device would revert to safe mode of operation that would prevent significant harm to the wearer or damage to the device [ANSI/AAMI, 2007]. No significant effects on wearers of active implantable medical devices are expected. No mitigation measures are required.

5.3 LAND USE, ZONING, COASTAL ZONE MANAGEMENT, AND AIR SPACE COMPLIANCE

The Langley Hill site is located in a rural area of Grays Harbor County, Washington, on privately owned timber land leased by the NWS. The site has been cleared of trees and installation of the radar at the site is currently in progress. The surrounding areas are forested and undeveloped. The nearest residences are approximately 1,500 ft southeast of the WSR-88D.

Grays Harbor Title 17, Zoning, is the local zoning ordinance. The ordinance describes permissible uses, allowable building and structure heights, parking, and required set-backs around structures for each of the twelve districts within Grays Harbor County [Grays Harbor County, 2011]. The site is within the General Development District-5 (G-5). The proposed action of operating the WSR-88D radar at scan angles below +0.5 would only require modification of the WSR-88D software and would not require development, change the footprint of the facility, or add to the height of the radar. The proposed action would be compatible with local zoning requirements and would not require approval or permits from the county.

The Washington State Coastal Zone Management (CZM) program is federally approved under the Federal Coastal Zone Management Act of 1972. The Coastal Zone is comprised of 15 coastal counties, including Grays Harbor County and all lands and waters from the coastline seaward to three geographical miles. The Washington State Department of Ecology administers the program and is required to review certain federal agency actions in Washington State for consistency with the CZM program. These include actions which would occur inside the coastal zone or actions outside the coastal zone which affect coastal resources. Appendix E in the CZM program document lists federal actions subject to consistency review [Washington State Department of Ecology, 2001]. The proposed action is not subject to consistency review under the CZM program.

The Washington State Environmental Policy Act (SEPA) requires environmental review of specified proposed state and local actions [Washington State Legislature, 2011]. SEPA is not directly binding on federal agencies. Because the proposed action would be implemented solely by the NWS no state or local government approvals or permits are required for the proposed action; SEPA is not applicable to the proposed action and SEPA review is not required [SEPA, 2010].

The proposed action would not interfere with timber production in the vicinity of the site. Due to the distance to the closest residences, impacts on residences are not expected. The proposed action would be compatible with local land uses (e.g., timber production and rural residential uses), zoning requirements, and coastal zone management policies. The NWS sent a copy of the Draft Supplemental EA to the Washington State Department of Ecology for review.

The FAA previously determined the WSR-88D to serve Coastal Washington would comply with air space regulations at 14 CFR Part 77, *Objects Affecting Navigable Airspace*, and would not be a hazard to air navigation [SRI International, 2010]. No physical alterations to the WSR-88D structure would be needed to implement the proposed action; and the height and bulk of the WSR-88D tower would not change. NWS has filed FAA Form 7460-2 (Notice of Actual Construction or Alteration) with the FAA. The previous FAA determination of no hazard to air navigation remains valid. No mitigation is required.

The no-action alternative would also be compatible with local land uses, zoning requirements, and Washington State's coastal zone management plan.

5.4 GEOLOGY, SOILS, AND SEISMIC/TSUNAMI HAZARDS

The Langley Hill site is located within the Coastal Mountains and Valleys physiographic province of Washington. Substrate consists of terrace deposits and loess of Quarternary age (1.8 million years ago [mya] to present), overlaying Montesano formation siltstone of the Miocene epoch (11 to 25 mya). The Montesano formation is folded and faulted in this area [American Association of Petroleum Geologists, 1995].

Soil at the site, access drive, and utility easement is Newskah loam on 8 to 30 percent slopes. Newskah loam is deep and well drained with a moderate shrink-swell potential. It forms on terraces and the parent material is sandy marine deposits [Natural Resources Conservation Service, 2009]. The site and vicinity appear to be geologically stable. The Natural Resources Conservation Service (NRCS) classifies Newskah loam on 8 to 30 percent slopes as moderate to severely erodible [NRCS, 2009]. However, no evidence of slope instability or accelerated erosion was noted during site reconnaissance [SRI International, 2010].

Coastal Washington is a seismically active area, and over 1,000 earthquakes are measured in the state each year. Most of these earthquakes are too small to cause injury or damage, but strong ground shaking could result during a major earthquake. The Juan de Fuca tectonic plate lies off the coasts of Northern California, Oregon, and Washington and is slowly sliding under the North American plate. The area of convergence of these two plates is called the Cascadia subduction zone, which has the potential to generate large earthquakes of magnitude 8.0 or more at intervals of roughly 300 to 600 years. In addition, volcanic activity in the Cascade Mountains can also generate earthquakes. The radar facility is being built in conformance with appropriate seismic safety standards.

Secondary hazards from earthquakes include landslides, rock falls, soil liquefaction, and tsunamis. Coastal Washington is considered to be at risk from a tsunami [Nosan et al., 1988]. Tsunamis generated by earthquakes on the Cascadia subduction zone or elsewhere in the Pacific Rim could affect the coast of Washington. A magnitude 8.0 earthquake on the Cascadia subduction zone could generate 30 ft high tsunami waves. The WSR-88D is located at 242 ft MSL, and would not be directly affected by a tsunami [State of Washington, 2007]. The proposed action of lowering the scan angle below +0.5 deg would not cause soil erosion or make the radar more susceptible to primary or secondary seismic hazards. No mitigation measures are required.

The no-action alternative of operating the WSR-88D serving Coastal Washington with a minimum center of main beam scan angle of +0.5 deg, would not be affected by tsunamis, earthquakes, or landslides, or cause soil erosion.

5.5 DRAINAGE AND WATER QUALITY

Langley Hill is part of the drainage divide between the Copalis River basin and the Humptulips River basin. Because the site is on the drainage divide, storm runoff from the radar site flows northward into a headwater of Cedar Creek, a tributary of the Copalis River, and also southward and eastward into an unnamed tributary of the Humptulips River. The access drive and utility easement are within the Humptulips River watershed. The closest drainage within the Copalis River basin is an unnamed tributary of Cedar Creek, approximately 1,200 ft north of the site. The closest drainage within the Humptulips River basin is an unnamed tributary, approximately 5,000 ft east of the site. Runoff flowing southward and eastward from the site would collect in drainage ditches along Copalis Beach Road and flow eastward into the tributary of the Humptulips River, [SRI International, 2010].

The site has been cleared and construction of the radar has begun. NWS is currently implementing a Storm Water Pollution Prevention Plan (SWPPP) in conformance with Environmental Protection Agency (EPA) regulations at 40 CFR 122.26, *Storm Water Discharges*, and requirements of the Construction General Permit and Permit WAR10000F.

Neither the proposed action nor no-action alternative would affect the amount of impervious surface area at the radar site or the rate of storm runoff flowing from the site during or after precipitation events. No changes in the SWPPP would be necessary. There would no impacts to the Copalis River or Humptulips River watersheds and no adverse impacts to water quality would result from either the proposed action or no-action alternative. No mitigation measures are required.

5.6 TRANSPORTATION

The Langley Hill site is reached by traveling on Copalis Beach Road, a two-lane paved road maintained by Grays Harbor County, and logging roads within the property containing the site. The length of the logging roads between Copalis Beach Road and the site is approximately 1,400 ft. The access road will be surfaced with crushed rock. While the site is under construction, construction equipment, workers' vehicles, and supply trucks will be traveling to and from the site on a daily basis, generating up to 50 trips per day [SRI International, 2010].

The proposed action requires modification of Coastal Washington WSR-88D software to be able to scan at angles below +0.5 deg. After the radar is constructed, NWS technicians and engineers will travel to the Langley Hill site to perform initial testing to determine that the modified software is operating properly. Travel to the site would be minimal and would not result in significant congestion on Copalis Beach Road. No disruption of traffic on Copalis Beach Road or closure of the road or lanes would be required. Transportation effects would not be significant. No mitigation measures are required.

The no-action alternative of operating the Coastal Washington WSR-88D radar at +0.5 deg scan angles would not result in any additional traffic. Under the no-action alternative, there would be no impact to transportation.

5.7 AIR QUALITY

As required by the Clean Air Act (amended in 1990), the EPA issued National Ambient Air Quality Standards (NAAQS) for six criteria pollutants to protect public health, including the health of sensitive populations (that is, asthmatics, children, and the elderly). Those regulations are found at 40 CFR Part 50, *National Primary and Secondary Ambient Air Quality Standards* [EPA, 2011]. The six criteria pollutants are carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide. Areas of Washington State are classified by the EPA as attainment, non-attainment, maintenance, or unclassified for the NAAQS. An attainment designation indicates that the area has met the NAAQS for the given pollutant. Grays Harbor County is in attainment for all six criteria pollutants [EPA, 2011].

Implementation of either the proposed action or no-action alternative would not generate air emissions. A Clean Air Act Federal Conformity Determination is not required. No mitigation measures are required.

5.8 FLOODPLAINS

Executive Order (E.O.) 11988, *Floodplain Management*, requires the Federal Government to avoid adverse impacts to the 100-year or base floodplain (that is, the area subject to a 1 percent annual chance of flooding), unless there is no practicable alternative [President, 1977a]. Federal Emergency Management Agency (FEMA) maps show the Langley Hill site and the access and utility easements within Zone C—Areas of Minimal Flooding, which is outside the 100-year or base floodplain [FEMA, 1986].

The proposed action of lowering the Coastal Washington WSR-88D minimum scan angle below +0.5 deg at Langley Hill would not affect floodplains. No mitigation measures are required.

The no-action alternative of operating the WSR-88D serving Coastal Washington with a minimum center of main beam scan angle of +0.5 deg, would also not affect floodplains.

5.9 WETLANDS

E.O. 11990, *Protection of Wetlands*, requires the Federal Government avoid funding or implementing projects which would adversely impact wetlands unless there is no practicable alternative [President, 1977b]. Federal definition of wetlands are those areas that contain hydric soils, water at or near the ground surface during the growing season, and support (or could support) hydrophilic vegetation. Based on National Wetland Inventory maps prepared by the U.S. Fish and Wildlife Service (USFWS), the site and the access/utility easements to serve the site do not contain federal jurisdictional wetlands [USFWS, 2011]. The nearest federal-jurisdictional wetland is located 1,400 ft north of the site.

The proposed action of lowering the Coastal Washington WSR-88D minimum scan angle below +0.5 deg would not affect federal jurisdictional wetlands and no mitigation measures are required.

The no-action alternative of operating the WSR-88D with a minimum center of main beam scan angle of +0.5 deg would not affect federal jurisdictional wetlands.

5.10 BIOLOGICAL RESOURCES / PROTECTED SPECIES

The Migratory Bird Treaty Act (MBTA) of 1918 prohibits the taking of migratory birds listed for protection. The MBTA protects species that are native and belong to families, groups, or species covered by conventions implemented by the MBTA. The MBTA does not contain habitat protection policies.

The Federal Endangered Species Act (ESA) of 1973 protects plants and animals in danger of extinction, and Section 9 of the Act prohibits taking of these species. Take is the act of harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, or collecting threatened or endangered species. Harming a listed species includes injuring or destroying individuals of the species or modifying the habitat of the listed species. Threatened and endangered species are protected under the ESA. Candidate species receive no formal protection under the ESA; however, the USFWS encourages agency cooperation in conservation of candidate species since these species may warrant future protection under the ESA.

Under the ESA, federal agencies must ensure their activities will not adversely modify critical habitat, thereby negatively affecting species recovery. Critical habitat designation is given to habitat deemed essential to federally listed species. Designated critical habitat for these species is not present at or near the site [USFWS, 2011]. Table 4 lists federally protected species that occur in Grays Harbor County [Washington Department of Fish and Wildlife, 2008].

Table 4. Threatened and Endangered Species that Occur in Grays Harbor County

Common Name	Scientific Name	Description	Federal Status	Habitat
Marbled Murrelet	*Brachyramphus marmoratus*	Bird	Threatened	Nearshore and pelagic—nesting up to 84 kilometers (km) inland in Washington
Northern Spotted Owl	*Strix occidentalis caurina*	Bird	Threatened	Low and mid-elevation mature forests
Oregon Silverspot Butterfly	*Speyeria zerene hippolyta*	Non-migrating butterfly	Threatened	Coastal salt spray meadows, stabilized dunes, and mountain meadows
Streaked Horned Lark	*Eremophila alpestris strigata*	Bird	Endangered	Large expanses of bare or thinly vegetated land, e.g. fields, dunes, upper beaches, airports

The site does not contain suitable habitat for the Oregon silverspot butterfly or nesting habitat for the three listed bird species. According to USFWS, the nearest suitable marbled murrelet nesting habitat is 7 mi away from the Langley Hill site; however, marbled murrelets may occur in the vicinity of the radar [SRI International, 2010].

The report, *Preliminary Site Survey/Environmental Assessment Report*, determined the construction of the WSR-88D radar facility at the Langley Hill site “may affect, but is not likely to adversely affect” marbled murrelets. The USFWS concurred with this determination. Based on formal and informal consultation with USFWS, NWS determined that no adverse effects to endangered or threatened species would result from construction of the radar facility at Langley Hill [SRI International, 2010].

The proposed action of operating the WSR-88D radar at minimum scan angles below +0.5 would not require clearing of vegetation, alteration of the existing radar tower and antenna, or construction of new facilities or infrastructure. The proposed action would result in slight increase in ground-level RFR levels. RFR levels would be well below the U.S. national safety standard and would not be expected to adversely affect birds or other wildlife. The proposed action would not adversely affect migratory birds, threatened and endangered species, species eligible for listing (e.g., candidate species), or designated critical habitat. No mitigation measures are required.

The no-action alternative of operating the Coastal Washington WSR-88D minimum scan angle at +0.5 deg would not impact species protected under the MBTA or ESA, species eligible for ESA listing, or designated critical habitat.

5.11 CULTURAL AND HISTORIC RESOURCES

Section 106 of the National Historic Preservation Act of 1966 (as amended) requires that federal agencies consider the effects of their actions on historic places and, if effects may result, provide the State Historic Preservation Officer (SHPO) with an opportunity to comment on their actions. Section 106 regulations are set forth in 36 CFR Part 800, *Protection of Historic Properties* [Advisory Council on Historic Preservation, 2010]. Additional NOAA compliance procedures for considering impacts to places of cultural, historical, and scientific importance are laid out in NAO 216-6, Environmental Review Procedures for Implementing the National Environmental Policy Act.

The report, *Final Expanded Site Survey/Environmental Assessment Report, National Weather Service (NWS) Network Radar to Serve Coastal Washington*, evaluated the impacts from the construction and operation of a new WSR-88D radar at the Langley Hill site, and determined that no places listed or eligible for listing on either the National Register of Historic Places or Washington Heritage Register occur within the vicinity (a quarter mile) of the Langley Hill site. The NWS determined that no historic places would be affected. The Department of Archaeology and Historic Preservation concurred with NWS’s determination [SRI International, 2010]. Additionally, the EA report determined that the likelihood of archaeological resources occurring at the site was low because the land had been previously disturbed from timber harvests. The

Langley Hill site and access/utility easements have been cleared and the facility foundation has been laid. No archaeological resources were discovered during construction.

The proposed action of lowering the Coastal Washington WSR-88D minimum scan angle below +0.5 deg does not have the potential to impact cultural or historical resources. Under Section 106 Regulations 36 CFR Section 800.2 (a)(1), *Protection of Historic Properties*, if the proposed action doesn't have the potential to affect historic properties, NWS "has no further obligations under Section 106" and consultation with Washington SHPO regarding possible impacts on historic properties is not required [Advisory Council on Historic Preservation, 2010]. The proposed action has no potential to affect historic resources. NWS submitted a copy of the Draft Supplemental EA to the Washington SHPO for courtesy review. No mitigation measures are required.

The no-action alternative of operating the Coastal Washington WSR-88D minimum scan angle at +0.5 deg would not impact cultural or historical resources.

5.12 ENVIRONMENTAL JUSTICE SOCIOECONOMIC IMPACTS

E.O. 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations*, requires federal agencies to identify and address, as appropriate, disproportionately high and adverse environmental or human health effects on minority populations and low income populations. Federal agencies, programs, and policies should not exclude people and populations of people based on race, color, or nationality from federal activities or benefits of such activities. Minority communities and low income communities must also have access to public information on matters related to human health and the environment (President, 1994).

The Langley Hill site is located in Census Tract 2 in Grays Harbor County. Year 2010 U.S. Census has been partially processed and released; therefore, most of our analysis relies on year 2000 Census data. According to the year 2000 U.S. Census, Census Tract 2 had 5,997 persons. Compared with the county as a whole, Census Tract 2 in year 2000 Census had somewhat higher per capita income and lower rates of unemployment, persons living in poverty, and percentage of minorities in the population [SRI International, 2010]. The percentage of minorities within the county increased in 2010 compared to 2000; however, the percentage of the tract's residents that are minorities remained relatively unchanged in 2000 and 2010, with about 11 percent minorities residing in Census Tract 2 [U.S. Census Bureau, 2011]. The county unemployment rate has increased since the year 2000 Census reaching 14.3 percent in February of 2011 [Grays Harbor Economic Development Council, 2011].

The proposed action of lowering the scan angle of the Coastal Washington WSR-88D below +0.5 deg would provide improved weather forecasts that would benefit many of the industries (e.g., tourism and logging) of Grays Harbor. These benefits would accrue to the general population, including minorities and low-income persons. Disproportionately high and adverse environmental or human health effects would not result to minority or low-income populations due to implementation of either the proposed action or no-action alternative. Implementing the proposed action may involve modest amounts of travel by NWS staff to Grays Harbor County, but would not result in significant expenditures in the county. The proposed action would have minimal direct economic effects. No mitigation is required.

5.13 FARMLANDS

The Farmland Protection Policy Act sets forth federal policies to prevent the unnecessary conversion of agricultural land to non-agricultural use. NRCS regulations at 7 CFR Part 658, *Farmland Protection Policy Act*, are designed to implement those policies. Completion of Form AD-1006 and submission to the U.S. Department of Agriculture (DoA) is required if a federal agency proposes to convert land designated as prime farmland, farmland of statewide importance, or unique farmland to non-agricultural use [NRCS, 2010].

No conversion of farmlands or impacts to farmlands would result from the proposed action of lowering the Coastal Washington WSR-88D minimum scan angle below +0.5 deg. No mitigation measures are required.

Under the no-action alternative, there would be no conversion of prime farmland, farmland of statewide importance, or unique farmland.

5.14 ENERGY CONSUMPTION

Grays Harbor Public Utilities District will provide primary electric service to the radar via extension of existing electric power lines from Copalis Beach Road (in the vicinity of the Langley Hill site) to the facility. The radar will be provided with 200-amp 208Y/120 primary electric service.

The report, *Final Expanded Site Survey/Environmental Assessment Report, National Weather Service (NWS) Network Radar to Serve Coastal Washington*, evaluating the impacts of construction and operation of a new WSR-88D at the Langley Hill site and two other alternative sites determined energy consumption would not be significant. The report assumed the Coastal Washington WSR-88D would be operated with a minimum center of main beam scan angle of +0.5 deg. The proposed action of lowering the Coastal Washington WSR-88D minimum scan angle below +0.5 deg would not change the energy consumption reported in the report. No mitigation measures are required.

Under the no-action alternative, the energy consumption reported in the report, *Final Expanded Site Survey/Environmental Assessment Report*, *National Weather Service (NWS) Network Radar to Serve Coastal Washington*, would remain unchanged.

5.15 VISUAL / LIGHT EMISSIONS

The 41-mile section of State Route (S.R.) 109 between Hoquiam and Toholah, which is about 3 mi from the WSR-88D, is a designated Washington State Scenic Byway known as the Hidden Coast Scenic Byway. This byway provides views of pristine beaches and rugged cliffs. In addition, large numbers of shorebirds migrate through this area in the spring [Washington State Department of Transportation, 2011]. S.R. 109 supports a large number of recreational travelers, and highway access is the primary mode of transportation in the area.

The report, *Final Expanded Site Survey/Environmental Assessment Report, National Weather Service (NWS) Network Radar to Serve Coastal Washington,* evaluating the impacts of construction and operation of a new WSR-88D at the Langley Hill site and two other alternative sites determined visual effects and light emissions to S.R. 109 and nearby residences would not be significant. No additional visual effects or light emissions would result from the proposed action of lowering the Coastal Washington WSR-88D minimum scan angle below +0.5 deg. No mitigation measures are required.

Under no-action alternative of operating the WSR-88D with a minimum center of main beam scan angle of +0.5 deg, visual effects and light emissions analyzed in the report, *Final Expanded Site Survey/Environmental Assessment Report, National Weather Service (NWS) Network Radar to Serve Coastal Washington,* would remain unchanged.

5.16 SOLID AND HAZARDOUS WASTE

The amount and types of waste generated at the WSR-88D facility is not dependent on the scan angle of the radar. The proposed action of lowering the Coastal Washington WSR-88D minimum scan angle below +0.5 deg would not affect the amount of solid waste generated at the radar site There would be no difference in waste generation between the proposed action and the no-action alternative. Impacts would be insignificant and no mitigation is necessary.

5.17 WILD AND SCENIC RIVERS

The Wild and Scenic Rivers Act of 1968 protects free-flowing rivers of the U.S. These rivers are protected under the Act by prohibiting water resource projects from adversely impacting values of the river: protecting outstanding scenic, geologic, fish and wildlife, historic, cultural, or recreational values; maintaining water quality; and implementing river management plans for these specific rivers. There are three designated wild and scenic rivers in Washington State: Klickitat, Skagit, and White Salmon rivers. All designated wild and scenic rivers are located outside of Grays Harbor County [DoA et al, 2009]. All wild and scenic rivers are too distant from the Langley Hill site to be affected by the WSR-88D radar [SRI International, 2010]. There have been no newly designated wild and scenic rivers within Grays Harbor County; therefore, no impacts will result from the proposed action or no-action alternative. No mitigation measures are required.

5.18 CUMULATIVE IMPACTS

Persons, equipment, and activities located in the proximity to the WSR-88D to serve Coastal Washington would be exposed to cumulative electromagnetic emissions from the radar and other transmitters in the area. Because power levels decrease greatly with distance from the transmitting antenna, only transmitters in close proximity could potentially measurably add to the RF emissions generated by the WSR-88D. Licensed radio towers containing a number of radiating antennas are located about 2,900 ft and 5,600 ft from the WSR-88D. At the WSR-88D site, the RFR emissions from all of the antennas on these towers would add to less than 1/10 of one percent of the safety level for human exposure to RFR. Cumulative exposure to RFR emitted by the WSR-88D and other nearby antennas would not represent a safety hazard to persons in the vicinity.

Non-electromagnetic impacts were fully analyzed in the 2010 EA. Lowering the minimum scan angle used during WSR-88D operation would not change impacts to the natural or cultural world that would result from construction and operation of this radar. Lowering the minimum scan angle would not cumulatively add to those impacts or increase the significance of those impacts. The analysis of environmental consequences contained in the 2010 EA remains accurate; no significant effects to the human environment would result.

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6 PUBLIC INVOLVEMENT

6.1 AVAILABILITY OF DRAFT SUPPLEMENTAL EA

NWS distributed the Draft Supplemental EA to interested members of the public, organizations, and government agencies for review and comment. Appendix B contains a list of the persons receiving the document. In addition, an electronic copy of the Draft Supplemental EA was posted on the NWS Seattle Weather Forecast Office web site. A notice of availability (NOA) of the Draft Supplemental EA was published in *The Daily World*, a general circulation newspaper serving the Grays Harbor, Washington, area (see proof of publication in Appendix C).

6.2 OFFICIAL REVIEW AND COMMENT PERIOD

NWS established a 30-day period for public and agency review of the Draft Supplemental EA, beginning on July 8 , 2011 and ending on August 7, 2011. The distribution letter accompanying the Draft Supplemental EA, NOA published in the newspaper, and NWS web site all provide information on how to submit comments, which were accepted via either U.S. mail or email.

6.3 COMMENTS RECEIVED AND RESPONSES

NOAA Office of Planning and Program Integration (PPI) and Environmental Compliance Division submitted comments on the Draft Supplemental EA via email. Those comments are reprinted in Appendix C of this Final Supplemental EA. The NWS response is given below.

Responses to Comments from Steve Kokkinakis, NOAA PPI

Unnumbered comment: Sections 5.1, 5.2, and 5.18, and Appendix A of this Final Supplemental EA analyze the potential for cumulative impacts to result from implementation of the proposed action and other past, present, and reasonably foreseeable future actions. Cumulative electromagnetic exposure would result from exposure to emissions from the proposed WSR-88D (operating at the lowered scan angles described in this document) and other emitters in area. Cumulative exposure levels would comply with applicable standards for safe exposure of humans, equipment and activities to electromagnetic fields.

Comment No. 1: As noted in the comment, this EA supplements the EA prepared by the NWS in 2010 analyzing construction and operation of the WSR-88D to serve Coastal Washington. The term “Supplemental” has been added to the cover of the EA and where appropriate throughout the document.

Comment No. 2: The 2010 EA is cited where appropriate in this document. A complete citation for the 2010 EA is included in Section 10 – References of this document.

Comment No. 3: The cover sheet of the Supplemental EA has been revised to include National Weather Service, which is the sponsoring the proposed action.

Comment No. 4: On behalf of the NWS, Sensor Environmental LLC sent copies of the Draft Supplemental EA to the Nancy Briscoe, NOAA Office of General Counsel and Thanh (Minh) Trinh, NOAA Safety and Environmental Conservation Office (SECO) at the time of public and agency distribution in early July 2011.

Response to Comment from Thanh M. Trinh, NOAA Environmental Compliance Division

See response to unnumbered comment from Steve Kokkinakis, NOAA PPI, above.

7 FINDINGS

The proposed action (i.e., lowering the minimum scan angle of the WSR-88D to serve Coastal Washington below +0.5 deg) would not result in significant changes in the quality of the human environment compared to operating the radar at a minimum scan angle of +0.5 deg, substantially add to the level of RF exposure, or cause violation of safety standards. Individual and cumulative effects expected to result from implementation of the proposed action would not be significant, This finding applies to operation of the radar at any minimum center of beam scan angle between +0.5 and 0.0 deg.

The proposed action would improve the quality of meteorological radar data available to NWS forecasters and others users of the data. This may indirectly benefit the residents of the Coastal Washington area by improving the accuracy of forecast and severe weather alerts, which could result in environmental benefits if weather dependent economic activities (e.g., timber production, seafood harvesting, transportation, water management, agriculture) become more efficient or safer as a result of improved weather services. The resulting environmental benefits are difficult to quantify, but are unlikely to be significant.

The no-action alternative would result in the WSR-88D to serve Coastal Washington operating at a minimum scan angle of +0.5 deg, which is the same minimum scan angle utilized by other WSR-88D radars. The environmental effects of operating at the current minimum scan angle of +0.5 deg were thoroughly analyzed in the EA prepared by the NWS in 2010 (*Final Expanded Site Survey/Environmental Assessment Report*, *National Weather Service (NWS) Network Radar to Serve Coastal Washington* [SRI International, 2010]) and found to be individually and cumulatively non-significant. That finding remains valid. Preparation of an environmental impact statement is not required.

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8 LIST OF PREPARERS

This Supplemental EA was prepared by Sensor Environmental LLC, Mountain View, California, under contract to Centuria Corporation, Arlington, Virginia. Sensor Environmental LLC is a small business registered with the Small Business Administration. The following staff from Sensor Environmental LLC and consultants working for Sensor Environmental LLC contributed to this Supplemental EA:

- Roshni Easley, A.A., general studies-social science, Foothill College, Los Altos Hills, California. Ms. Easley has 8 years experience editing technical reports with a specialization in environmental and alternatives analysis reports for surveillance systems. Ms. Easley served as technical editor for this Supplemental EA.
- Anne Elston, B.S., biology with an emphasis in marine science, University of California, Santa Cruz; 5 years experience analyzing resource impact data, including marine fishery and desert ecosystem data. Ms. Elston conducted resource analysis research for this Supplemental EA.
- Linda Hawke-Gerrans, A.A., technical illustration, College of San Mateo, California; 35 years experience in technical illustration and 13 years experience in geographic information systems (GIS). Ms. Hawke-Gerrans served as illustrator and geographic analyst for this Supplemental EA.
- James Manitakos, Jr., J.D., law, Peninsula University College of Law; M.A., geology, University of California at Berkeley; B.A., geology and economics, Williams College, Williamstown, Massachusetts; certificate in hazardous materials management, University of California at Santa Cruz Extension; California Registered Environmental Assessor I-07047; 27 years experience in environmental impact assessment and project management. Mr. Manitakos served as Project Manager for this Supplemental EA.

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9 AGENCIES AND PERSONS CONTACTED

During preparation of this Supplemental EA, the following NWS Managers and Engineers were consulted.

- Edward Berkowitz, Program Branch Chief; William Deringer, NEXRAD Program Manager; Jeffery B. Turner, General Engineer; and Marty Williams, Lead General Engineer, NOAA NWS Radar Operations Center

Additionally, the Draft Supplemental EA was distributed to the persons and organizations listed in Appendix B for review during the official 30 day comment period, which ran from July 8 until August 7, 2011. NWS accepted comments on the Draft Supplemental EA submitted either through U.S. mail or email. All comments that were received are reproduced in this report.

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10 REFERENCES

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APPENDIX A

RADIOFREQUENCY RADIATION POWER DENSITY CALCULATIONS

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TECHNICAL MEMORANDUM

TO: William Deringer, NEXRAD Program Manager, National Weather Service; Jeffrey B. Turner, General Engineer, National Weather Service (NWS)
Cc: Linda Hawke-Gerrans, Anne Elston, Sensor Environmental LLC
FROM: James Manitakos, Principal, Sensor Environmental LLC
RE: Environmental Assessment (EA) of Lower Scan Angles for WSR-88D to serve Coastal Washington
DATE: May 1, 2011 (revised August 16, 2011)

OBJECTIVE

To quantify the power densities of the radiofrequency radiation (RFR) emitted by the Weather Service Radar – 1988, Doppler (WSR-88D) during operations that include minimum scan angles of +0.5 to 0.0 degrees (deg). The calculated power densities will be used to analyze the potential for effects to result from exposure of humans, equipment, and activities to the WSR-88D radio signal, and the significance of any identified potential effects.

METHODOLOGY

This memorandum builds upon the analysis included in the 1993 *Supplemental Environmental Assessment (SEA) of the Effects of Electromagnetic Radiation from the WSR-88D Radar* [NEXRAD Joint System Program Office, 1993]. The 1993 analysis analyzed the potential electromagnetic effects of the WSR-88D signal when the radar operates at a minimum center of beam scan angle of +0.5 deg. This memorandum builds on that analysis by considering operations at minimum scan angles of between +0.5 and 0.0 deg. The following parameters of the WSR-88D would not be changed from the 1993 analysis:

Parameter	**Value**
Operating Frequency	2,700 to 3,000 megahertz (MHz)
Wavelength at center frequency (2,850 MHz)	0.345 ft, 10.5 cm
Maximum radiated pulse power	475 kiloWatts (kW)
Maximum duty cycle	0.21%
Antenna diameter	28 ft, 853 cm
Antenna gain	35,500:1, 45.5 dB
Beam width to half-power points	1.0 deg
First sidelobe relative power density, maximum	0.00325, -25 dB
Other sidelobe maximum power density, relative to main beam	0.0004, -34 dB

The NWS proposes to modify the minimum center of beam scan angle used during operation of the newly constructed WSR-88D to serve Coastal Washington below the +0.5 angle currently used by other WSR-88D radars. This would not require changes to the antenna, other hardware which composes the WSR-88D, or the radiated pulse power of the WSR-88D. However, incorporating scans at angles below +0.5 deg could affect the amount of RFR exposure experienced by persons, equipment, and activities at or near ground level in the vicinity of the radar. This memorandum quantifies that change.

MODIFIED VOLUME SCAN PATTERN 31

The WSR-88D uses a number of complex volume scan patterns to maximize the quality and usefulness of the meteorological data it collects. The 1993 SEA analyzed Volume Coverage Pattern (VCP) 31, which results in the highest levels of ground-level RFR exposure. VCP 31 consists of eight 360 deg rotations of the antenna at various scan angles. NWS proposed to add two additional antenna rotations at a scan angle between +0.5 and 0.0 deg to this scan pattern to increase the range at which the radar can detect and track meteorological phenomena, especially at low elevations within the atmosphere. This memorandum assumes that the two added scans would be at 0.0 deg (i.e., lower half power point of -0.5 deg), the lowest scan angles under consideration by NWS. Adding two 0.0 degree scans would result in the greatest possible increase in ground level RFR exposure. The modified VCP 31 would be as follows:

- Two complete rotations at +0.0 deg
- Two complete rotations at +0.5 deg
- Two complete rotations at +1.5 deg
- Two complete rotations at +2.5 deg
- One complete rotation at +3.5 deg
- One complete rotation at +4.5 deg.

The complete pattern would include 10 rotations of the antenna at a speed of 0.8 revolutions per minute (rpm), the pattern would take about 12 minutes and 22 seconds to complete [Turner, 2011].

CALCULATION OF RFR POWER DENSITIES

Appendix A of the 1993 SEA includes detailed calculations of the RFR power density and exposure levels resulting from VCP 31. The proposed scan change would not affect the distance of the transition from the near field to the far field, calculated at 800 ft in Section A.3 of the 1993 SEA Appendix A.

Far Field

The values of U_1, U_2, and U_3 would be unchanged from the values derived in 1993 SEA Appendix A. The maximum pulse power density within the main beam (U_1) is given by the formula:

$$U_1 = 1.44 \times 10^9/R^2 \text{ milliWatts per square centimeter (mW/cm}^2\text{)}$$

where R is the distance from the antenna in ft. The maximum pulse power density at locations greater than 6 deg off the main beam axis (i.e., outside the area illuminated by the main beam and first five sidelobes is U_2 (unchanged from 1993 SEA Appendix A), given below:

$U_2 = 5.76 \times 10^5/R^2$ mW/cm^2

The RF (radiofrequency) human exposure standards are based on time-averaged RF exposure for six minutes (occupational exposure) or 30 minutes (general public exposure) [American National Standards Institute/Institute of Electrical and Electronic Engineers, 2005]. We use six minutes as the averaging time as a worst-case analysis. The time-averaged power density for the main beam rotating continuously at +0.5 deg, considering the contributions from both the main beam and the first five sidelobes is given by U_3 (unchanged from 1993 SEA Appendix A), below:

$U_3 = 1.35 \times 10^4/R^2$ mW/cm^2

At this point the analysis must consider the proposed modifications to VCP 31. The modified VCP 31 would have two additional 0.0 deg scans. Within our six minute averaging time, these two added scans would replace the RFR contribution from one +1.5 deg and one +2.5 deg scan. As described in the 1993 appendix, U_4 sums the RFR contributions at center of antenna level from each of the scans performed during the six minute period of interest. The coefficients for the 0.0 deg scans are 2.4/6 reflecting the proportion of the 6 minutes and 1.0 because the center of beam will be at antenna level (i.e., 0.0 deg). The corresponding coefficients for the two + 0.5 deg scans within the six minutes are 2.4/6 and 0.5, and for the one +1.5 deg scan within the six minutes are 1.2/6 and 0.012. The modified U_4 calculation is given below

$U_4 = [(2.4/6)(1.0) + (2.4/6)(0.5) + (1.2/6)(0.012)]\ U_3$

$U_4 = (0.627)U_3$

Inserting the U_3 value of $1.35 \times 10^4/R^2$ milliwatts/cm^2 (mw/ cm^2), yields:

$U_4 = 8.46 \times 10^3/R^2$ mW/cm^2

U_4 is the 6-minute time-averaged power density at locations in the far field directly illuminated by the main beam and at the same elevation as the WSR-88D antenna, considering the RFR contributed from the main beam and the first five sidelobes. According to the WSR-88D specification, sidelobes of higher order than the first five will contain less than 5% of the eradiated energy. The 1993 SEA calculated the average power density of these higher order sidelobes at $4/R^2$ mW/cm^2. We add this to U_4 to obtain U_5, the total time-averaged power density at an elevation even with the center of antenna elevation and distances greater than 800 ft from the antenna:

$U_5 = 8.46 \times 10^3/R^2 + 4/R^2 = 8.464 \times 10^3/R^2$ mW/cm^2

Near Field

Appendix A of the 1993 SEA calculates the height Y of the mathematical cylinder illuminated by all scans during the 6-minute period using the formula Y = 28 ÷ R Tan 2 deg + 0.035R. Since the modified scan pattern of interest includes scans of +0.0. +0.5, and +1.5 degs, the angular range is 1.5 deg, and we recalculate Y as follows:

$$Y = 28 + RTan\ (1.5\ deg) = 28 + 0.026R$$

The circumference of the illumination cylinder is 2πRY and the total area A is

$$A = 2\pi RY = 176R + 0.16R^2$$

The average power radiated is less than or equal to 1 kW, and the average power over the cylindrical surface cannot exceed this value divided by the area. At the mid-height of the cylinder, the local power density will exceed the average value by a factor of 2 (unchanged from the 1993 analysis). We introduce this factor, multiply by 10^6 to convert from kW to mW, and divide by 929 to convert from sq ft to square centimeters (sq cm):

$$U_6 = 2 * 10^6 / (929)\ (176R + 0.16R^2) = 13{,}450 / (R^2 + 1{,}100\ R)\ mW/cm^2$$

U_6 is the time-averaged RFR exposure within the area illuminated by the WSR-88D main beam up to distances of 640 ft where the beam begins to spread.

Combined Result

Table A-1 shows the time-averaged RFR power densities that would result at locations directly illuminated by the main beam of the WSR-88D to serve Coastal Washington when operating in modified VCP 31. The near field is within 640 ft of the radar and the U_6 formula is used to calculate these near field values. At greater distances, the far field formula for U_5 is used. For comparison purposes, corresponding values for the original VCP 31 are also shown. The lower edge of the illuminated area starts at 326 ft MSL (i.e., bottom of antenna) and is horizontal for the original VCP 31 which has a coverage floor of 0.0 deg. The illuminated area decreases at 0.5 deg with distance for modified VCP 31. It As can be seen from Table A-1, use of modified VCP 31 would lower the elevation at which the main beam occurs and would also slightly increase the time-averaged power densities in the near field by no more than 15%. We add this 15% increase to the values presented in the 1993 SEA Appendix A to estimate the time-averaged power densities at ground level (i.e., 100 ft below the center of the antenna) in the near field, shown in Table A-2. Table A-2 values assume that the ground surface is level within the 640 ft distance. In fact, the WSR-88D is located at a hillcrest and the ground surface in all directions is less than the 242 ft MSL base of tower elevation. Thus, Table A-2 presents a very conservative estimate of the ground level power densities.

Table A-1: Comparison of Time-Average RFR Power Densities Within the Illuminated Area Using VCP 31 and Modified VCP 31

Distance (ft)	Distance (mi)	Original VCP 31 Lowest Elevation (ft MSL)	Original VCP 31 Time-Average Power Density (mW/cm2)	Modified VCP 31 Lowest Elevation (ft MSL)	Modified VCP 31 Time-Average Power Density (mW/cm^2)
20	0.004	340	0.5976	340	0.6004
40	0.008	340	0.2917	340	0.2950
60	0.011	340	0.1899	340	0.1932
200	0.04	340	0.0490	340	0.0517
500	0.09	340	0.0151	340	0.0168
640	0.12	340	0.0106	340	0.0121
1,000	0.19	340	0.0058	331	0.0085
2,640	0.5	340	0.0008	317	0.0001
5,280	1.0	341	0.0002	295	0.0003
10,560	2.0	344	0.00005	250	0.00008
18,480	3.5	345	0.00002	185	0.00003
26,400	5.0	353	0.000008	12296	0.000012
42,240	8.0	372	0.000003	≤ 0 MSL	0.000005
52,800	10.0	390	0.000002	-71	0.000003

Table A-2: Time-Average RFR Power Densities at Ground Level Within 640 ft of the WSR-88D Using Modified VCP 31

Distance (ft)	Modified VCP 31 Time-Average Power Density (mW/cm^2)
Base of Tower	0.00046
50	0.00031
100	0.00023
200	0.00016
640	0.00003

RF CONTRIBUTION FROM EXTERNAL TRANSMITTERS IN AREA

Two radio towers, each hosting multiple antennas are located in the vicinity of the WSR-88D to serve Coastal Washington. Table A-3, lists information on those towers [FAA, Air Traffic Air Space Branch, 2006 and 2009].

Table A-3: Licensed Transmitters Radio in Vicinity

Tower Operator	American Tower Corp.	Spectrasite Communications, Inc.
Distance and Direction from WSR-88D	2,900 ft (884 m) west	5,600(1,707 m) ft southwest
FAA Aeronautical Study Number	2006-ANM-4128-OE	2009-ANM-1169-OE
Range of Transmission Frequencies	150 to 2,360 MHz	580 to 5,741 MHz
Federal Communications Commission Antenna Structure Registration No.	1214067	1211788
Total Combined Effective Radiated Power (ERP) of all Antennas	21, 537 W	21,477 W

As a worst-case assumption, we assume that all of the antennas on these towers are broadcasting at full power simultaneously. That assumption is very unrealistic, but allows calculation of the theoretical upper limit of the contribution to RF exposure that these towers may provide. The power density of these transmissions at the WSR-88D site can be calculated by dividing the total radiated power by the surface area of a sphere with a radius equal to the distance from the tower to the WSR-88D. The area of the sphere = $4\pi R^2$, where R is distance.

First, we calculate the American Tower Corp. transmissions power density at WSR-88D site:

$$(21{,}537\ \text{W}) \div 4\pi(884)^2 = (21{,}537\ \text{W}) \div (9.82 \times 10^6\ \text{m}^2)$$

We multiply the numerator by 1,000 to convert from watts to milliwatts and multiply the denominator by 10,000 to convert from m^2 to cm^2, giving

$$(2.15 \times 10^7\ \text{mW}) \div (9.82 \times 10^{10}\ \text{cm}^2)$$

Which is equal to

$$0.00022\ \text{mW/cm}^2$$

A similar calculation gives the Spectrasite Communications, Inc. Transmissions Power Density at WSR-88D

$$(21{,}477\ \text{W}) \div 4\pi(1{,}707\ \text{m})^2 = (21{,}477\ \text{W}) \div (3.66 \times 10^7\ \text{m}^2)$$

We multiply the numerator by 1,000 to convert from watts to milliwatts and multiply the denominator by 10,000 to convert from m^2 to cm^2, giving

$$(2.15 \times 10^7 \text{ mW}) \div (3.66 \times 10^{11} \text{ cm}^2)$$

Which is equal to:

$$0.000059 \text{ mW/cm}^2.$$

The combined RF emissions from all transmitters on the two licensed towers is

$$(0.00022 \text{ mW/cm}^2) + (0.000059 \text{ mW/cm}^2) = 0.00028 \text{ mW/cm}^2$$

This value is 2,144 times less than the strength of the WSR-88D signal at the WSR-88D radome. It is also less than 1/10 of one percent of the time-averaged safety level for human exposure to RFR. RF emissions generated by licensed transmitters in the vicinity of the WSR-88D make a negligible contribution to overall RF exposure at or near the WSR-88D site.

REFERENCES

American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE). *IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*. IEEE Std C95.1-2005 (April 19, 2006).

FAA, Air Traffic Air Space Branch, ASW-520. *Aeronautical Study 2006-ANM-4128-OE* (November 8, 2006).

FAA, Air Traffic Air Space Branch, ASW-520. *Aeronautical Study 2009-ANM-1169-OE* (July 1, 2009).

Next Generation Weather Radar Joint System Program Office (JSPO), *Final Supplemental Environmental Assessment (SEA) of the Effects of Electromagnetic Radiation from the WSR-88D Radar* (April 1993).

Turner, Jeffrey B. General Engineer, National Weather Service, email to James Manitakos, Sensor Environmental LLC, (April 26, 2011).

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APPENDIX B

REPORT DISTRIBUTION

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John Andrews
andrews.lisam@gmail.com

Heidi A. Beltico
Qwest
711 Capitol Way S, Suite 307
Olympia, WA 98501

Ms. Nancy Briscoe
NOAA Office of General Counsel
1325 East West Highway
Silver Spring, MD 20910-3283

Allyson Brooks
Washington State Department of Archaeology and Historic Preservation
PO Box 48343
Olympia, WA 98504-8343

Mr. George E. Brulotte
Rayonier, Northwest Forest Resources
3033 Ingram Street
Hoquiam, WA 98550-4410

Mr. David Burnett
Confederated Tribes of the Chehalis Reservation
420 Howanut Road
Oakville, WA 98568

Dr. Brad Colman
Seattle WFO
7600 Sandpoint Way NE
Seattle, WA 98115-6349

Ms. Linda Crerar
State of Washington, Department of Agriculture
PO Box 42560
Olympia, WA 98504-2560

Mr. William Deringer
NOAA NWS Radar Operations Center
1200 Westheimer Drive
Norman, OK 73069

Jenni Dykstra
U.S. Fish and Wildlife Service, Division of Consultation and Technical Assistance
510 Desmond Drive, SE, Suite 102
Lacey, WA 98503

Ms. Teresa Eturaspe
State of Washington, Department of Fish and Wildlife
P.O. Box 43200
Olympia, WA 98504-3155

Mr. Michael A. Ferry
Grays Harbor County, Department of Public Services, Building Division
100 W. Broadway, Suite 31
Montesano, WA 98563-3614

Mr. Geoffrey Glass
Olympic Region Clean Air Agency
2940-B Limited Lane, NW
Olympia, WA 98502-6503

Mr. Wesley W. Gray, P.E.
Grays Harbor PUD
2720 Sumner Avenue
Aberdeen, WA 98520-4321

Arthur (R.D.) Grunbaum
Friends of Grays Harbor
P.O. Box 1512
Westport, WA 98595-1512

Mr. Jaen P. Henry
PO Box 457
Ocean Shores, WA 98569

Mr. Steve Kokkinakis
NOAA PPI
1325 East West Highway
Silver Spring, MD 20910-3282

Dr. Socorro Medina
University of Washington, Department of Atmospheric Sciences
618 ATG Building, Box 351640
Seattle, WA 98195-1640

Charlene Nelson
Shoalwater Bay Tribal Council (Shoalwater Bay Tribe)
2373 Old Tokeland Road
Tokeland, WA 98590

Helen Peters
P.O. Box 527
Copalis Beach, WA 98535

Mr. Stanley G. Pinnick
North Beach School District No. 64
729 Point Brown Avenue, NW
Ocean Shores, WA 98569-9563

Ms. Carol Lee Roalkvam
State of Washington, Department of Transportation
PO Box 47330
Olympia, WA 98504-7330

Tony Sermonti
Olympia, WA
sermonti20@yahoo.com

Fawn Sharp
Quinault Indian Nation
1214 Aalis Drive
Taholah, WA 98587

Mr. Brian Shea
Grays Harbor County, Department of Public Services, Planning & Building Division
100 W. Broadway, Suite 31
Montesano, WA 98563-3614

Mr. Mark A. Tew
NOAA NWS Western Region Headquarters
125 S. State St, Room 1311
Salt Lake City, UT 84138

Mr. Steve Todd
Portland WFO
5241 NE 122nd Avenue
Portland, OR 97230-1089

Brian Tole
Montesano, WA
tole_brian@yahoo.com

Ronald P. Thomasson
Coast Communications
ron@coastaccess.com

Mr. Mihn Trihn
NOAA Safety and Environmental Compliance Officer
7600 Sand Point Way NE
Seattle, WA 98115

Mr. Jeffrey Turner
NOAA NWS Radar Operations Center
1200 Westheimer Drive
Norman, OK 73069

Mr. Mike Walsh
Green Crow Management Services LLC
PO Box 990
Aberdeen, WA 98520-0916

Mr. Robert G. Whitlam, Ph.D.
Washington State Department of Archaeology and Historic Preservation
PO Box 48343
Olympia, WA 98504-8343

Mr. James M. (Marty) Williams
NOAA NWS Radar Operations Center
1313 Halley Circle
Norman , OK 73069

Board of Commissioners
(Herb Welch, Terry L. Willis, and Mike Wilson)
Grays Harbor County
100 West Broadway, Suite #1
Montesano, WA 98563

Department of Natural Resources, SEPA Center
PO Box 47015
Olympia, WA 98504-7015

Review Team
State of Washington, Department of Community Development
906 Columbia Street, SW
Olympia, WA 98501-1216

State of Washington, Department of Ecology
Mike Drumwright and Roberta Wood
PO Box 47775
Olympia, WA 98504-7775

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APPENDIX C

NOTICE OF AVAILBILITY AND COMMENTS RECEIVED

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Notice of A[illegible]
Draft Environmental A[illegible]
Operation of the National [illegible] (NWS)
Radar, Model 1988 Doppl[illegible]
Coastal Washington at Scan A[illegible]

NWS announces the availab[illegible] Assessment (EA) for publ[illegible] ment. The National Weat[illegible] of installing a WSR-88D [illegible] area. The Draft EA include[illegible] magnetic effects on per[illegible] on the environment [illegible] scan angles betwee[illegible] horizontal. In complia[illegible] Atmospheric Administra[illegible] The Draft EA also provi[illegible] impacts from the no-ac[illegible] objectives for this rad[illegible] the scan pattern used [illegible] at angles below +0.5 deg above horizon[illegible] is the lowest scan angle curren[illegible] As part of the proposed action NWS would [illegible] this radar at a minimum scan angle [illegible] (i.e. horizontal) and +0.5 deg [illegible] increase the area of radar [illegible] accuracy of forecast and seve[illegible] NWS will accept public and [illegible] comments on the EA during the official comment period [illegible] July 8 to August 7, 2011.

[illegible] port is available electronically at: www.wrh.noaa.gov/wrh/washington_coast_[illegible] radar/

[illegible] submit requests for copies of the Draft EA or [illegible] on the Draft EA to:

Sensor Environmental LLC
[illegible] Old Middlefield Way, Suite [illegible]
Mountain View, California 9404[illegible]
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NANCY M. BARNETT
NOTARY PUBLIC
STATE OF WASHINGTON
My Commission Expires Oct. 09, 2014

COMMENTS ON DRAFT SUPPLEMENTAL EA

Comments from Steve Kokkinakis, NOAA PPI

Tim,

Sorry I missed one additional comment on this draft EA.

There wasn't any discussion of cumulative impacts regarding the proposed action analyzed in the document (environmental consequences) or at least mentioning whether the "effects" were not any different from what was analyzed originally in the previous EA for this NWS Network Radar site serving Coastal Washington.

Thanks,

Steve

From: Steve Kokkinakis [mailto:Steve.Kokkinakis@noaa.gov]
Sent: Tuesday, August 02, 2011 1:13 PM
To: 'Tim D Crum'
Cc: 'Steve Kokkinakis'; 'Nancy Briscoe'; 'Minh Trinh'
Subject: PPI comments on draft EA of Electromagnetic Effects of Operating Weather Service Radar-1988, Doppler (WSR-88D)

Hi Tim,

Here are my comments on the draft EA for the subject action serving Washington at scan angles below +0.5 degrees.

1)I believe this document should be titled as a Supplemental Environmental Assessment, which supplements the analysis within the "Final Expanded Site Survey/EA Report, NWS Network Radar to Serve Coastal Washington" for the revised proposed action.

2)This previously prepared EA also needs to be sited in the References section of the document.

3)Cover Sheet: seems like there should be information identifying NWS and NOAA on the cover sheet. It says this is "Prepared for: William Deringer, NEXRAD Program Manager, Centuria Corporation" This should ID the NWS office/decision maker not a supporting contractor.

4)Just wanted to request that this draft EA document also get reviewed by a NOAA General Counsel. I believe Nancy Briscoe would be the appropriate person. Wasn't sure if she was on the previous mailing distribution. So I'm copying her here to on this email. Also, does the SECO office also review this as part of the "safety" aspect of this proposal? I've copied Minh Trinh as well on my email reply.

Please let me know if you have any questions.

Regards,

Steve

NEPA Logo-1
NOAA Office of Program Planning and Integration
Steve Kokkinakis
Senior Advisor on NEPA
SSMC3, Rm. 15723 (PPI)
1315 East-West Highway
Silver Spring, MD 20910
Tel: (301) 713-1622 x189
Fax: (301) 713-0585
email: Steve.Kokkinakis@noaa.gov
Website: www.nepa.noaa.gov <http://www.nepa.noaa.gov/>

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Comment from Thanh M. Trinh, Environmental Compliance Specialist, NOAA Environmental Compliance Division, Western Region

Tim,

Sorry for not getting back to you sooner. I just completed the review. I have only one comment in that Section 5 should include a section that discusses cumulative summary of impacts.